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1944

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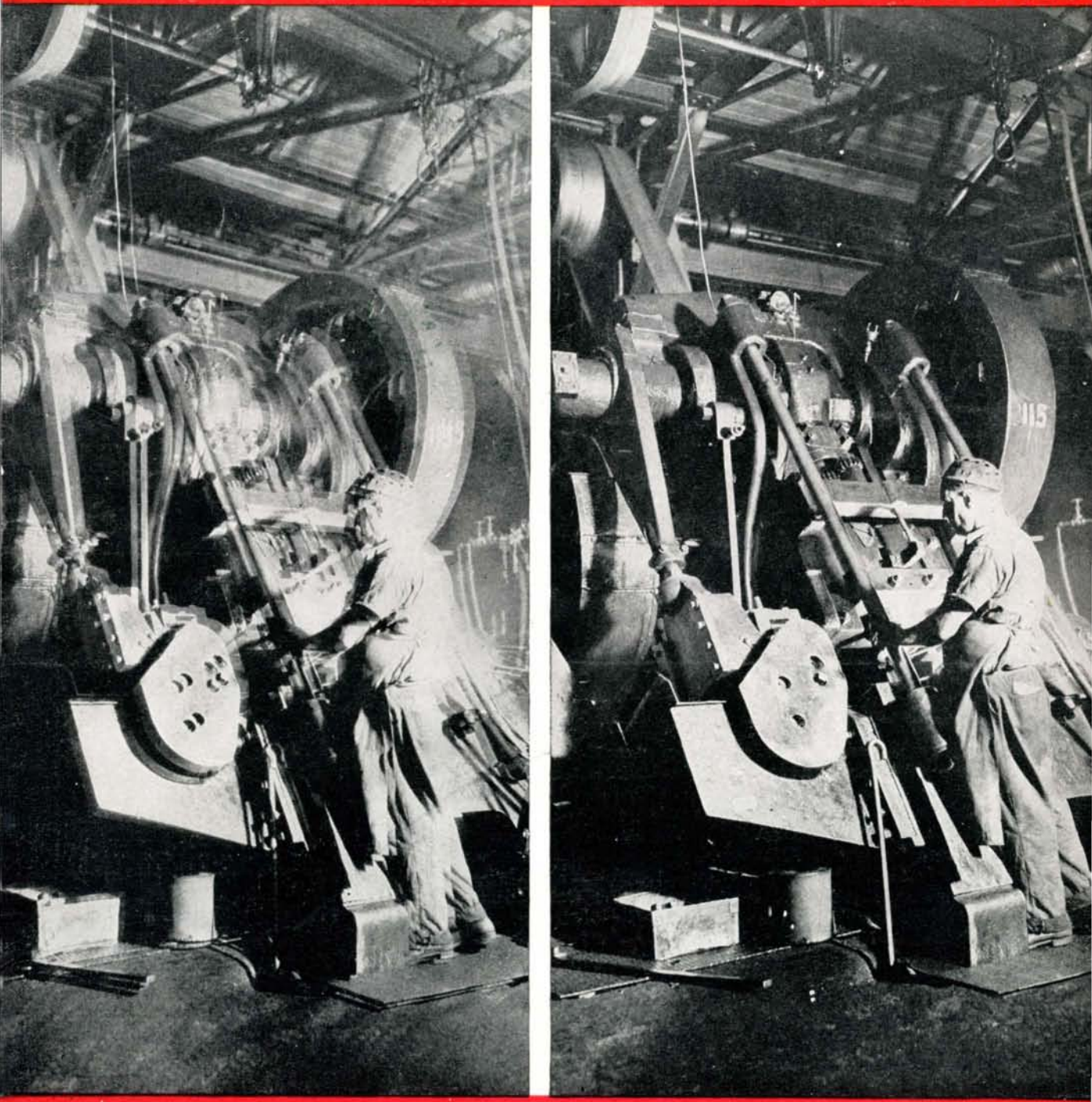
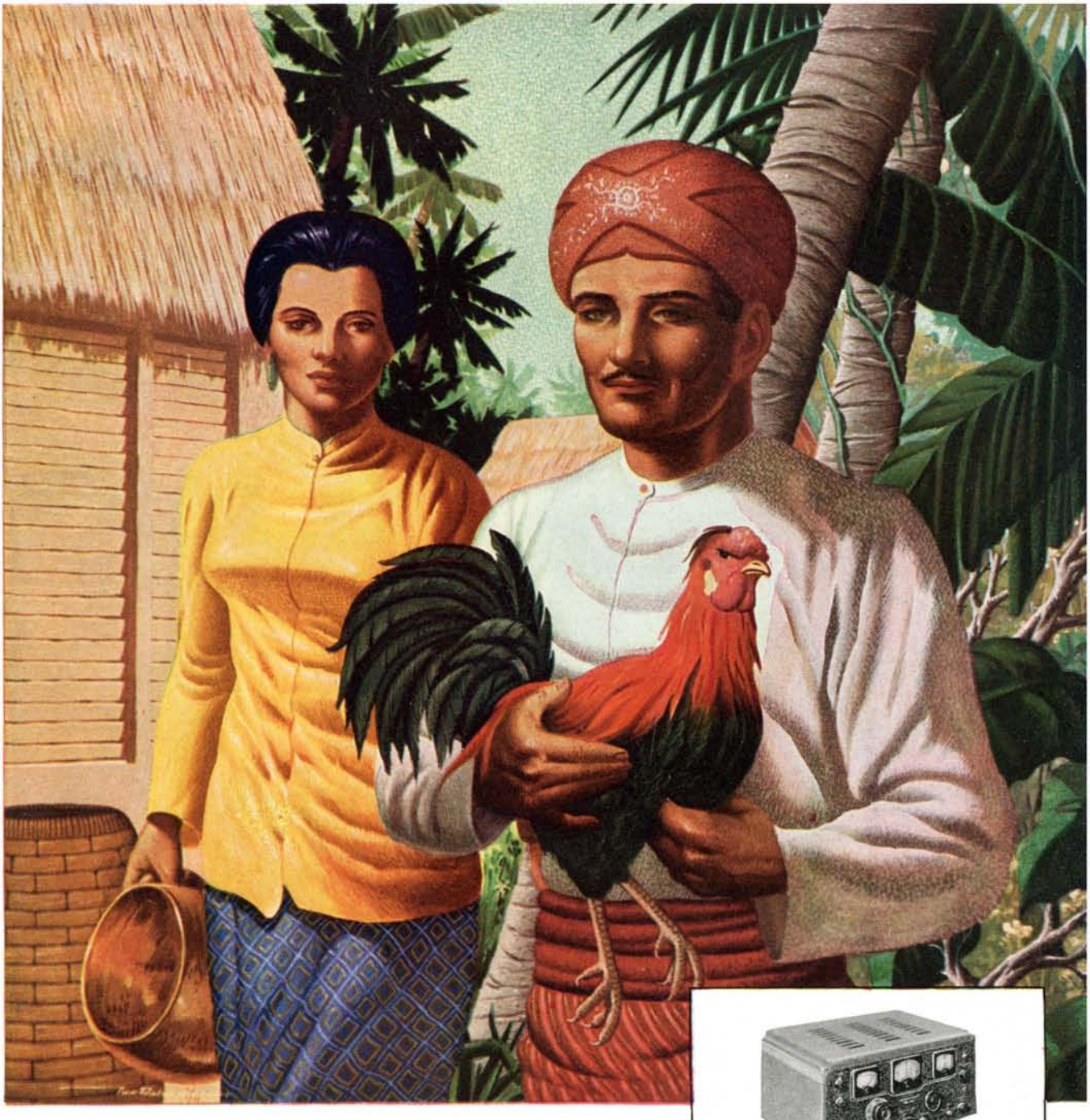


Machinery-Wrecking Vibration Can be Isolated . . . See pages 97 and 118



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Java stands right at the crossroads of one of the most exciting corners of the world. It is one of the string of important stepping stones to Asia and the East —steps that include the magic sounding islands of Madura, Sumatra, Borneo and the Celebes. These help make the bridge from Australia to our own Pacific outpost, the Philippines. Today Java is Jap held. Tomorrow the Japs will be blasted out of there. Hallicrafters short wave radio equipment in the first assault wave will help do the job. The day after tomorrow Hallicrafters will help introduce Java into the widening circle of new, world neighbors. On that day, and through this medium, new knowledge, new understanding will help secure the peace we're fighting for. Hallicrafters radios, constantly refined under fire of war will be ready for the peace with the finest short wave radio equipment available.

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COVER: Symbolizing the tremendously destructive force of vibration in machinery, the picture to the left on the cover is a double exposure, made purposely to dramatize the effects of uncontrolled and unleashed vibration. Since vibration cannot usually be completely stopped, the next best thing to do is to isolate its effects. The article on page 118 tells how.

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Previews of the Industrial Horizon

By A. P. Peck

WHAT ABOUT PREFABRICATED HOUSES?

THE ESTIMATE of a potential demand for one million private dwellings per year for at least five years after the war (this page, February 1944), still holds. If the building industry meets this demand, it will climb to a peak considerably higher than ever in the past. But there are many problems that must be solved first and not the least of them is the economic one of funds available by the average prospect for a new home versus increased labor costs that will undoubtedly remain at high levels after the war.

Some people look to the prefabricated-house industry to furnish a large part of the answers. Let's glance first at the cost of the labor that goes into the construction of a moderate cost home. Reliable figures show this to be only about 8 percent of the total purchase price. So, from a labor standpoint, prefabrication has only a small part of the whole to work on. Then it is found that the building itself, the "rough and finished structure," accounts for only 47 percent of the purchase price, and this includes the cost of labor on this part of the job. Since prefabrication cannot affect land costs, street improvements, excavation and grading costs, and the like, it can be expected to prove its worth on only a part of the total problem.

The probabilities are that the advantages which prefabrication can offer to the industry and the home buyer will be summed up in better houses for a given cost rather than greatly lowered cost for a given quality. Production of unit wall and roof sections, of standardized bathrooms and kitchens, of insulating procedures and heating equipment will first make available soundly engineered homes at minimum cost for architectural consultation. Then, when such production can be placed on a mass basis and a demand can be created, there can come "production-line" economies that will have some effect on final costs.

Considering every side of the question, however, some of the claims of the advocates of prefabrication must be taken with a whole shakerful of salt. When they talk of savings up to 50 percent of the total, they are talking through their hats. But when they point out that, through prefabrication, homes can be quickly erected, wall surfaces can be prefinished, sturdier homes can be provided where required, they have points that are worth studying.

But, lest the deep-end beckon too strongly, it must be remembered that the horizon of prefabrication will not glow with a bright, rosy hue until mass buying makes mass production a possibility.

CLEANER PLANTS

IF WAR-NECESSITATED industrial plant construction has done nothing else, it has brought home forcefully the fact that clean plants, attractively designed, tastefully landscaped without and decorated within, are worth the slight extra cost and trouble that these features entail. Community pride is developed thereby, workers are happier, and the overall picture is brighter.

Industrial engineers are heeding this trend, foresee its spread to post-war remodeling of existing buildings. Included will be more attention to personal facilities for employees, dust and dirt elimination and collection, air conditioning, and other details that will react to the benefit of all.

AIR TRAVEL TOMORROW

IN ALL the talk of post-war weekends in China, mid-week excursions for big-game hunters in Africa, and all the other possibilities of commercial aviation tomorrow, let's not get too far ahead of ourselves. The aviation industry is going to make great strides in passenger carrying. That much is beyond question. Speed of air travel is going to climb far beyond that of pre-war aviation, airports are going to be available all over the world, aviation will be less affected by weather. But air travel is still going to be expensive except where time is of great importance. The average vacationer and pleasure traveler will still be largely earthbound, depending for transportation on motor car, train, and ship. This is not to say that the airlines will not be patronized. They will. But they will not, at least for a long time to come, carry more than a small fraction of the traveling public.

COLD IN THE HOME

ONE COMPANY that is planning to get in on the ground floor of a relatively new industry after the war is Westinghouse. Already they are conducting field tests on types of freezing units for home use, designed not only to freeze home-grown foods but also to keep commercially frozen foods for extended periods of time.

Such freezing units will tap a new market, a market already conditioned by the spreading use of frozen-food lockers. And the extensive use of freezing units in the home will make many changes in the whole food industry. Foods will be more generally bought in large quantities for storage until used, necessitating revision, to some degree, of distribution methods. All in all, home freezing units have a bright future and one that should be closely watched for its effects on other industries.

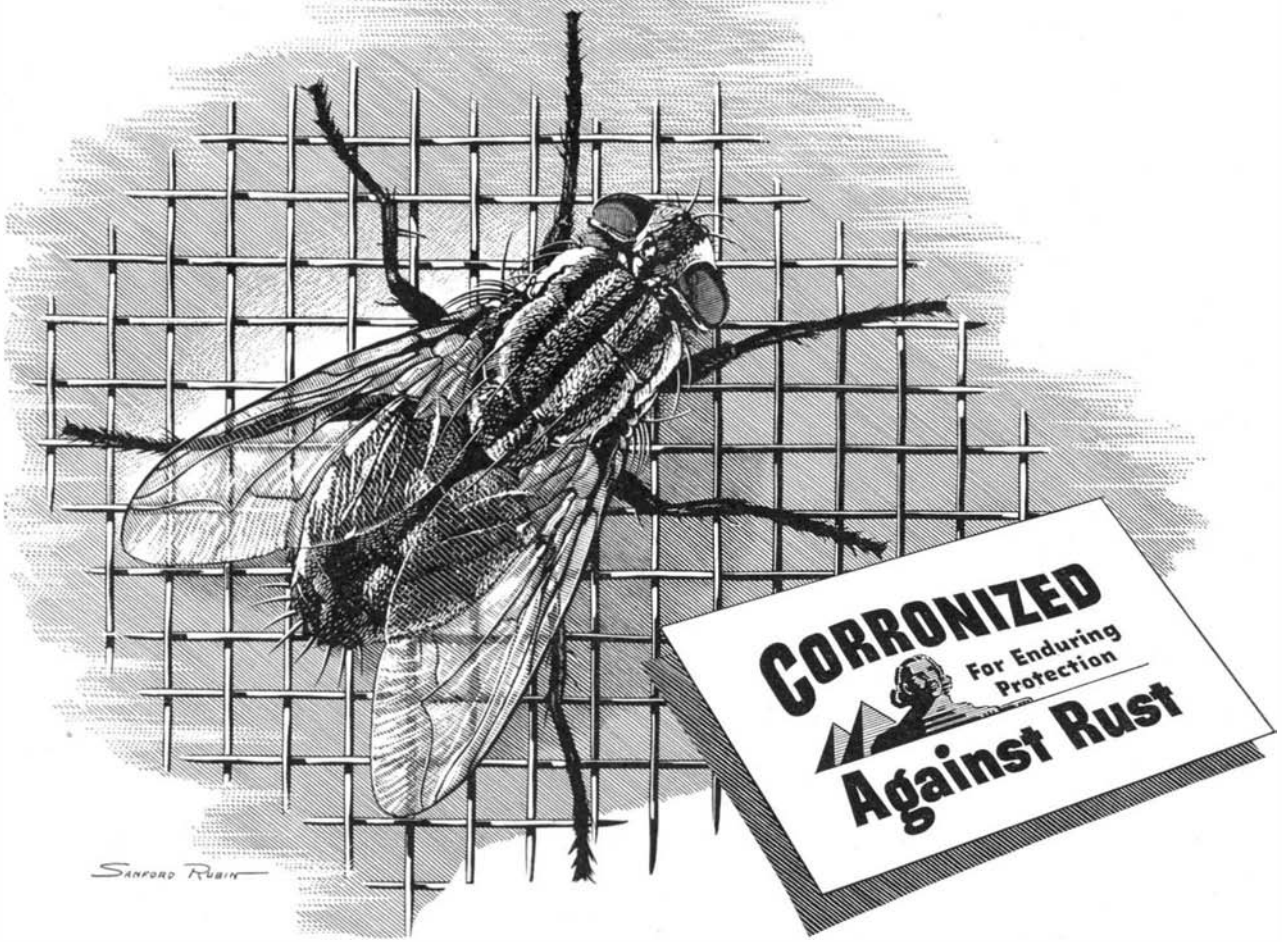
WOOD AND FURNITURE

IF THE Wood Office Furniture Institute has anything to say about it, metals, plastics, and other materials are not going to take much of the market away from that part of the industry which they represent. Already post-war models of desks and chairs have been produced, featuring improved design, adaptability to persons of different sizes, adjustable footrests, suspension-hung drawers moving on rollers, and so on. Truly the horizon brightens for the desk-bound executive and his staff.

FOR FUTURE REFERENCE

SYNTHETIC rubber will have at least three post-war years in which to prove itself for civilian use before imports of natural rubber can be rebuilt. . . And don't forget that political considerations will have definite effects on the whole rubber picture. . . Aluminum has a calculating gleam in its eye as it watches development of uses for itself in the electrical industry, where its lightness and relatively high conductivity can be used to good advantage. . . Highway engineering in the future will demand trained personnel instead of the part-time working engineers of the past; new highway construction will be on a higher plane. . . Executives in metal-working industries who have not investigated the possibilities of metallizing may be missing a bet. . . Man-made gems—sapphires and rubies especially—that have been developed for industrial uses may adversely affect the gem market in the not far distant future. . . The paint industry is one that will quickly get back into peace-time stride, since reconversion offers practically no problems except in the line of containers. . . . Forward-looking business men are giving serious thought to re-employment of handicapped veterans; more should do the same without waiting for war-end.

Why Tomorrow's Screens Will Say "KEEP OUT!" 4 TIMES AS LONG!



WITH the coming of Victory, rust will no longer limit the life of window screens to a few short years. Corronizing, a new armor against rust, will make possible screens that say "Keep Out" four times as long before rust destroys them!

Already tested and proved, Corronizing awaits only Victory to add to the life and value of hundreds of products. Not only screens, but autos and planes . . . lawn mowers and tractors . . . ash cans, heating equipment, refrigerators and ranges . . . will give up to *four times* as much service for the buyer's money!

The simple, inexpensive Corronizing process is available to all makers of metal products. It was developed through years of research by Standard Steel Spring Company, long makers of special steel products and today a leading producer of armor plate, bombs and other war materials.

Standard Steel Spring Company

ARMY NAVY

Peacetime producers of automobile bumpers and springs, precision mechanical coil springs, universal joints, floor gratings and stair treads.

CORRONIZING DIVISION
CORAOPOLIS, PENNSYLVANIA

Victory Is Still Many Dollars Away. Buy More War Bonds.

To Executives
in Manufacturing, Engineering and Sales

The Corronizing process is being used on war products and is available right now for essential manufacturing. When Victory is won, Corronizing of your peacetime products will enable you to offer far longer product life—far more for the customer's money. On the retail counter, the "Corronized" label will be a key to easier sales. In manufacturing, Corronizing offers unique production advantages. Write for details.

50 Years Ago . . .

SCIENTIFIC AMERICAN

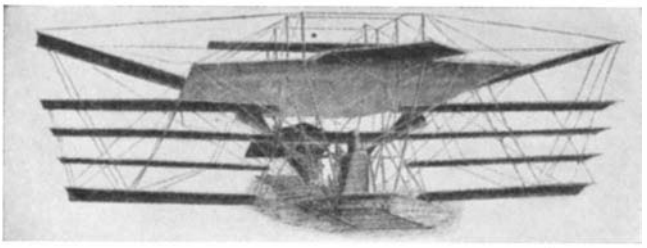
(Condensed from Issues of September, 1894)

ELECTRIC BLANKET — "A new invention, called by its inventor the thermogen, consists of a quilt containing a coil of wire bent in the fashion of a gridiron, inclosed in insulating and non-conducting material, and embedded in cotton wool or other soft substance with a silk or woolen covering. The resistance offered by the coil to the flow of an electric current through the wire produces heat. . . A uniform temperature of about 150° Fah. is thus maintained."

BLAST — "A large and successful blast was made July 29 in the quarries of the American Cement Company at Egypt, near Allentown, Pennsylvania. The blast consisted of 22 charges of dynamite in holes drilled 20 feet deep. There was a total of a ton of dynamite. It was all set off simultaneously by electricity. . . It is calculated that the enormous amount of 12,000 tons of cement rock was dislodged by the blast."

GLASS MARKING — "M. Charles Margot, of the physical laboratory of the University of Geneva . . . has found that by rubbing on glass with an aluminum point we obtain clear metallic lines, which cannot be removed by washing, no matter how often repeated. . . An indispensable condition is that the glass and the aluminum point shall be clean."

FIRST TO FLY — "On Tuesday, July 31, for the first time in the history of the world, a flying machine actually left the ground, fully equipped with engines, boiler, fuel, water, and a crew of three persons. Its inventor, Mr. Hiram Maxim, had the proud consciousness of feeling that he had accomplished a feat which scores of able mechanics had stated to be impossible. Unfortunately, he had scarcely time to realize his triumph before fate, which so persistently dogs



The Maxim flying machine

the footsteps of inventors, interposed to dash his hopes. The very precautions which had been adopted to prevent accidents proved fatal to the machine, and in a moment it lay stretched on the ground, like a wounded bird with torn plumage and broken wings. Its very success was the cause of its failure, for not only did it rise, but it tore itself out of the guides placed to limit its flight, and for one short moment it was free. But the wreck of the timber rails became entangled with the sails, and brought it down at once."

PRESERVATIVE PAINTING — "Graphite, mixed with pure boiled linseed oil to which a small percentage of litharge, red lead, manganese, or other metallic salt has been added at the time of boiling to aid in its oxidation, forms a most effective paint for metallic surfaces, as well as for wood and fiber."

METAL VIOLINS — "Aluminum violins were explained by Mr. Alfred Springer. . . He said that sounding boards of aluminum were analogous to those of wood, in that they did not produce secondary tones discordant to the prime tones. Among the difficulties encountered was the fact that the plates had to be riveted instead of soldered. He overcame uneven thickness of parts of the violin by sheet metal ribbed and arched."

INDIAN IRONWORK — "In the last twenty years, the number of iron foundries and machine shops has greatly increased in India, and the country is less dependent on Europe for general iron work; importations of wrought iron and steel are yearly increasing."

FLY WHEELS — "The enormous amount of energy stored in a revolving fly wheel is strikingly shown when it flies in pieces, as one did in the Manville Mills, at Manville, R. I., on the morning of the 18th ultimo. In bursting, the wheel destroyed two other fly wheels of the same size, 20 feet in diameter and 25 inch face. The break will cause a shut-down of the mills for nearly a month for repairs and the damage amounts to $16,000. . . Large pulleys and other machinery above the engine room were smashed and twisted into a mass of wreckage. Fortunately no one was injured."

ELECTRICITY AFLOAT — "There are some very interesting matters in connection with the new steel passenger steamship Northwest, of the Northern line, especially in reference to the vessel's use of electricity. . . The vessel is lighted by 1,800 incandescent globes. . . The Northwest's lighting equipment is driven by three direct coupled engines, each dynamo having 600 light capacity. The vessel has electric elevators between the freezing rooms in the forehold and the kitchens and cafe."

SHRINK FIT — "A method for instantaneously removing iron parts shrunk on hot, like a crank on a shaft, has been communicated by M. Raffard to the Bulletin Technologique of the French Societe des Anciens Eleves des Ecoles Nationales d'Arts et Metiers. . . M. Raffard recommends that molten lead be run round the part to be detached—a method he applied with success in removing a crank that had been shrunk on a shaft 8 inches in diameter."

CAST IRON — "Mr. W. J. Keep . . . has for six years been trying to verify the belief that sulphur is in every way injurious to cast iron; and he has made numerous experiments with artificially sulphurized cast iron up to 2 percent of sulphur, both gray and white. . . The conclusion finally reached is that the proportion of sulphur retained by gray cast iron cannot materially injure the iron, except by increase in shrinkage, which in the extreme ends seems to be from 0.168 inch to 0.194 inch per foot."

PRUSSIAN SHOES — "On the late visit of Prince Bismarck to the Emperor, the latter called the attention of the ex-Chancellor to the improvement made in the boots of the Prussian infantry. This consisted in the displacement of the old fashioned steel nails by nails from aluminum, which is much lighter and more durable."

SOFT COAL — "Mr. C. M. Higginson, an expert Chicago engineer, in a paper on the abatement of the smoke nuisance, gave the following rules as essential to good combustion: 1. A good draught. 2. Open grate bars. 3. Means for supply of air above the fire. 4. Means for mixing the air with the volatile gases. 5. Distance in which to complete the combustion of the mixture."

CHROMIUM — "From some new researches of Mr. Henri Moissan upon chromium, it results that, through the use of the intense heat produced by the electric arc, it is possible to prepare fused chromium in very large quantities. . . The metal obtained under such circumstances takes a beautiful polish, and is not attacked by atmospheric agents. It is attacked but slightly by acids and resists aqua regia and alkalies in fusion."

SPEAKING WATCH — "To get up anything new in the way of watches seems difficult. . . Mr. Sivan, a French watchmaker, established at Geneva, has, nevertheless, succeeded in stepping outside of the beaten track in devising a chronometer that speaks the hours, instead of striking them, through an ingenious application of the phonograph."

American fighters make sure our big guns are hitting enemy installations. Artillery fire control crew receive directional data from observers and pass it on to gun crews.

Telephones keep Long Toms on target

War needs the plants and manpower that would normally be making telephone instruments, wires, cables and switchboards for civilian use. That's why there are many people waiting for telephone service.

It will be some time before equipment is available to give service to all who want it. But we shall continue to do everything we can to make that time as short as possible.

BELL TELEPHONE SYSTEM

Please give the service men first call on Long Distance from 7 to 10 each night. That's the best time for most of them to call home.

"Quotes . . ."

"TELEVISION broadcasting facilities today are within reach of approximately 25,000,000 people, provided receivers were available." *James H. Carmine, Vice President, Philco Corporation.*

" " "

"IT IS EASY to see how calamitous it would have been a century ago to have been satisfied with conditions as they then existed. We may feel superior to our primitive ancestor who did not know that the mud at his feet would some day be converted to aluminum and permit his descendants to fly, but we cannot be sure that future advances will not make us seem equally backward." Dr. George O. Curme, Jr., Vice President, Carbide and Carbon Chemicals Corporation.

" " "

"PUBLIC EXPENDITURE for new construction after the war should be limited to projects for which there is need in terms of the direct products of construction and not employment." *Wilson Wright, Armstrong Cork Company.*

" " "

"FOR THE PERIOD for at least five years after the war the military market will contribute the major proportion of the (aviation) industry business." E. E. Lothrop, Director of Research, Aeronautical Chamber of Commerce.

" " "

"I SUGGEST a fifth freedom—freedom to manage your own affairs unhampered by needless controls, as a necessary adjunct to the Four Freedoms," *Walter S. Tower, President, American Iron and Steel Institute.*

" " "

"WE DON'T WANT to set up a WPA for small businesses. We want companies to give us their plans and policies for reconversion. I am 100 percent in favor of helping them, but not running them." Chairman Donald M. Nelson of the War Production Board.

" " "

"A VIRTUAL VACUUM of all kinds of electrical appliances has developed, and it will take months to stock distributors and dealers once production has been resumed, to say nothing of meeting the urgent demands of the public." *James H. Carmine, Vice President, Philco Corporation.*

" " "

"THERE ARE MANY startling developments of the war that will be adapted to consumer purposes in the post-war period. However, in the early stages before tools can be built, demand established, and cost gotten down on these new products, the primary—if not the almost entire—dependence for commercial activity and employment opportunities must be on the old pre-war products or on minor variations of them." L. R. Boulware, Operations Vice Chairman, WPB.

METALS IN INDUSTRY

Conducted by FRED P. PETERS

Courtesy Linde Air Products Company

Billets for seamless steel tubing, after being flame cut to correct length and lined up side by side, are quickly centered by an oxy-acetylene cutting blowpipe

Flame Filled Future

Oxy-Acetylene Flames, Once Thought to Have Extremely Limited Uses, are Branching Out as Versatile Tools in the Metal-Working Industry. They are Being Used to Cut Threads, to Work the Hardest Steels, to Correct Warpage, for Surface Hardening, and in a Number of Other Applications

By DANIEL MINTURN

WAY BACK in the gay nineties when more than 90 percent of modern metals fabricating methods had yet to be born, the oxy-acetylene blowpipe was a familiar sight in every railroad repair shop, manufacturing plant, and steel fabricating yard. Strange to relate, during the last 40 years thousands of methods engineers have written off the blowpipe as a tool which had long since reached the narrow horizons of its field of usefulness. Yet during this war the blowpipe has accomplished the impossible so many times that nobody any longer tries to guess where its horizons may be. The tool whose abilities everybody knew, has become the tool whose future nobody guesses.

The trouble is, nobody can tell which uses of oxy-acetylene flame are new developments of this war, and which are really mere extensions of old techniques.

Cutting cast iron is an example. Any well thumbed old textbook will tell you that the oxy-acetylene flame cannot cut gray iron castings successfully—the graphite in the cast iron is refractory enough toward heat so that it shields the iron areas against the temperatures at which they will burn, and some of the oxides melt at higher temperatures than the iron itself. Nevertheless, cast iron has been cut successfully for the past several years. The amount of preheating is greater than for low carbon steel (low carbon steel is the easiest ferrous metal to cut), the flame is given an excess of acetylene which helps to keep up the preheating, the cutting temperature is higher, but, most of all, the torch is moved so that it takes a series of moon-shaped bites, keeping hot slag and molten metal washing down through the cut and adding to the preheating. Used mostly to remove damaged parts of castings or to cut vees in broken castings preparatory to welding in the pre-war days, the blowpipe now is one of the commonest foundry tools for removing risers and other extraneous metal from castings.

Another of the "impossibles" was torch cutting of some of the stainless steels. Here the flow-of-slag method has been borrowed from cast iron cutting technique. Each piece of stainless is sandwiched between two plates of readily-cut low carbon-steel. The cut starts in the low carbon steel and washes its way down through the stainless. The sandwich can be a double decker, or triple —alternate layers of low carbon and stainless can be built up for the stack cutting method.

One of the oddest things in the oxy-acetylene picture is the number of "insiders" who don't realize how the blowpipe art has cut through its old bonds, and therefore don't see what is going on around them.

FLAME-CUT THREADS—The editor of a prominent technical journal, for example, overheard two engineers talking about cutting threads with flame. He approached to talk to them, only to have them escape in the crowd. The

publicity man for an equipment maker likewise had never heard of this. But thread cutting for lead screws has been done with flames since 1932. It originally developed from deseaming—the removal of flaws or seams from the surfaces of steel. Often a seam or fault would be caused to go spirally around the surface of a round bar, the accuracy of pitch of the spiral being produced by the evenness of the speed with which the bar passed through the rollers in the steel mill. In flame-gouging this seam, so that a flawless bar might be finished, the oxy-acetylene torch naturally was made to follow the accurate pitch of the seam itself, and therefore to cut a groove which looked like a coarse lead screw.

Accordingly when lead screws were wanted for special conditions, and did not need to be too accurate, on more than one occasion the flame was used to cut them. Accuracy could be gained by making several passes with different blowpipe heads to get different shapes of flame. Often the lead screw was cut and hardened in one operation.

How accurate the cutting of threads with flame has become, and how fine are the finest threads being cut, is one of those secrets which will come out after the war. But the accuracy of flame cutting in general is far higher than most engineers envision.

In cutting off low carbon steel, for example, precision flame cutting equipment can maintain the following tolerances in day-by-day production:

Stock to	1″	thick,	plus	or	minus	0.003″
” ”	2″	”	”	”	”	0.010″
” ”	4″	”	”	”	”	0.0175″
” ”	6″	”	”	”	”	0.0312″

Highly skilled operators, who know how to keep their machines in adjustment, can do much better than this. These figures are safe ones—safe for machine makers to cite when they are not too sure of the skill of the operators who will use their machines.

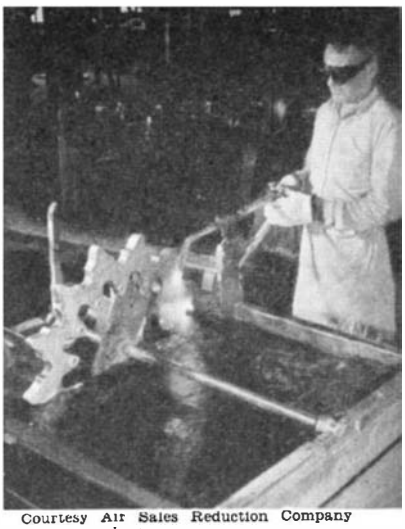
As in all metal-cutting operations, the higher the accuracy the slower the work. Nevertheless, in making cuts which ordinarily would be made on milling machines or planers, a single flame-cutting head can remove from 500 to 1800 pounds of soft carbon steel an hour. How this compares with the best that machine tools using cemented carbine tools can do today is not known; but in pre-war practice the flame cutting was 200 percent to 300 percent or more faster than the best of other cutting tools, provided the cuts to be made were suitable for flame methods.

On harder steels the differences were even greater. Comparative figures were being compiled when Pearl Harbor interrupted the research. But, for quite a few steel types, the harder the steel the greater the speed differential in favor of flame machining.

All flame-machining men like to make it clear that flames are not likely to drive other cutting and fabricating methods out of business. Flames are doing remarkable work in their own fields, but they cannot do everything. They can, for example, rough plane a steel plate, preparatory to finish grinding, if a further smoothness is needed, but they cannot finish plane it. (Or, at least, not yet.)

Flame heads are like other tools. They can be varied to change the sizes, shapes, directions, chemical effects, and to some degree the temperatures of the flames. They can be equipped with spraying or quenching devices which keep down the temperatures of the work areas. And they can be ganged.

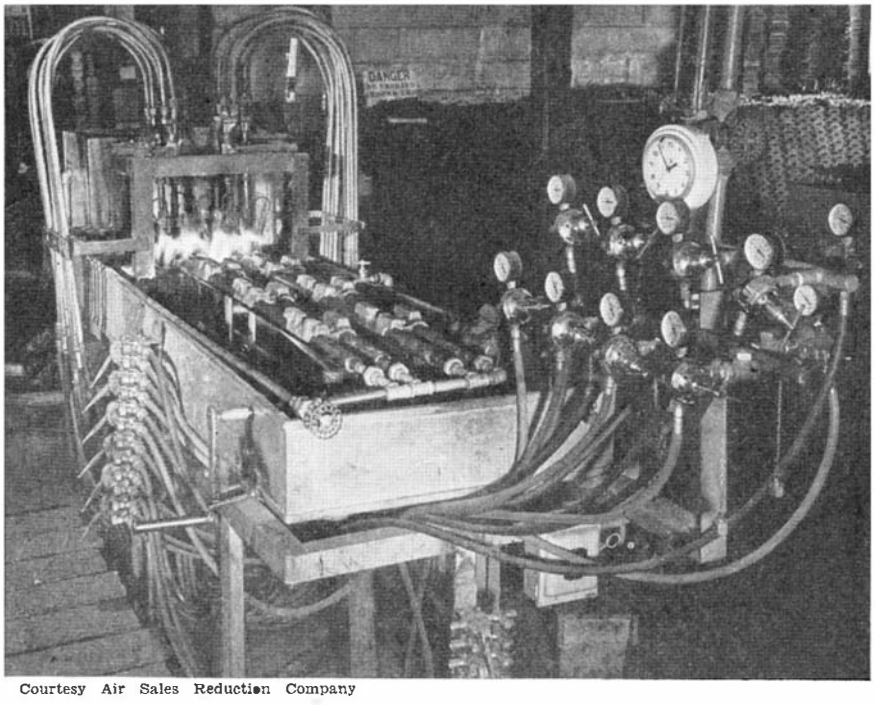
One example of ganging is the rip-trim cutting of plate edges preparatory to welding. For this, three flame heads are ganged on a planer. By being directed at suitable angles, two of these heads bevel off the top and bottom corners of the plate edge, while the third cuts off the sharp apex where these two cuts meet at the middle of the plate edge, this cut leaving a "nose." As a result, when two edges of these plates are abutted for welding, two small vees are provided instead of one large one to be filled up with the welding rod, and the weld is performed with half the consumption of rod that was needed for the old-fashioned single deep vee.



Courtesy Air Sales Reduction Company

Tank sprocket teeth are flame hardened, then water quenched, to impart hardness and wear resistance to withstand grinding against the treads

Another example is in contour cutting. As originally done, a single blowpipe followed the entire contour of the piece to be cut from flat or other stock. Now two or more blowpipes attack simultaneously at various parts of the contour, getting the work done much faster. In some cases several contours are cut simultaneously from the same piece, as when an outside or peripheral contour, an inside or "hole" contour, and several piercings from the remaining or "rim" stock, are to be produced. Machines which perform several operations at one time usually have full electrical controls operated from highly complex panels. The limits to the future of their development are nowhere in sight.



Courtesy Air Sales Reduction Company

A conveyorized eight-torch flame hardening machine at work on tank grousers

MANY CUT AT ONCE—Parts to be cut on contours are quite commonly stacked and thus many are cut at one time. The contour may be sketched right on the stack, and followed by hand. However, for high production a template or other permanent guide is provided, and the machine follows this, the flame head being guided by some form of pantograph mechanism.

Often the primary guide is a simple steel pointer which is manipulated by hand to follow a line on a drawing. Other models use power to run the guide around a template, or to cause it to follow a track or to cling to a magnetized path.

One of the latest devices employs a photoelectric cell which, by interpreting variations in light, will cause the guide to follow a drawn line.

The details of some of the best of these controls are not being released at the present moment. When military secrecy is abolished, the art of flame cutting of contours will be found far advanced from its prewar days.

Flame hardening of surfaces is another old practice which is becoming

brand new. It is safe to say that our military tank production program—the first in the war to cross its peaks and suffer cutbacks—never could have been carried out at all if flame cutting and hardening techniques had not been available.

Size is no deterrent to the flame hardening of parts. Small parts may be hardened, thin sections hardened without warpage or destructive strains, or small sections of large parts hardened locally while leaving the remainders soft.

The hardening process may be that of heating the steel through its critical range and then quenching in air, water, or oil, or may include a degree of carburizing.

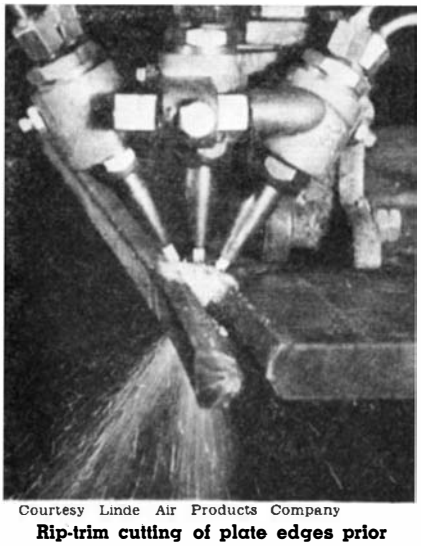
NEW ABILITIES DISCOVERED—All this was known before the war. But the war brought out the real abilities of flame hardening in short order.

Railroad switch frogs, for example, always had been made of manganese steel. Manganese gave the steel toughness with which to take the beatings and the shocks from fast rolling, heavily loaded wheels. But when shortage of manganese came to the steel mills, flame-hardened carbon steel frogs were tried. So well have these "emergency" frogs stood up, that some railroad men believe manganese types may never come back.

In the meantime flame hardening had to be brought to the nicest degrees of control, so that duplicate results would be obtained. Modern processes control the temperature, the volume of heat applied (B.t.u.), the pressure, depth of heating, and time of application. Going on from there, the temperature of the quench and the draw (heating, quenching, and drawing may be performed in one operation) were controlled.

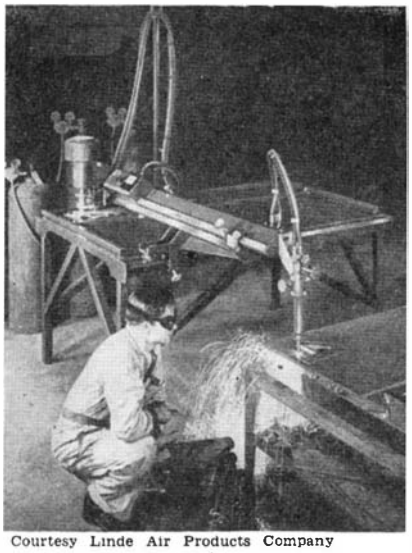
The hardening process was brought to the work instead of the work of the furnace. Ways and bearing surfaces were hardened on machine tools, followed by quenching either with water, with water and compressed air to form a mist, or with compressed air alone.

Control goes to such extents as to harden the odd teeth—numbers 1, 3, 5, and so on—on a gear in succession, then the even ones, to avoid over-hardening at the root of any tooth. Gears and other parts may be stacked for hardening, a row of teeeth on several gears in a stack being hardened, then the following row. In many cases water sprays are used to keep cool the parts that are not to be hardened.



Courtesy Linde Air Products Company

Rip-trim cutting of plate edges prior to welding them is done with this unit with three ganged flame heads



Courtesy Linde Air Products Company

Pantograph controlled machines of this type are widely used for automatic flame cutting of steel plate

Thin parts which had warped while being hardened in furnaces—worms, shafts, and shear blades, for example—formerly had to be discarded. Now a touch of flame is given to the high spot, the top of the bend. Often the flame is applied for only one second to a spot. Nevertheless the heated metal, trying to expand and being held by the metal around it, will upset and shrink when it cools, pulling the piece into straight line. This takes a skilled operator, but in the case of some welding operations the straightening becomes a repetitive task and a less skilled operator can perform it.

Long, flat plates or other pieces will warp as the result of welding, or from concussion or other violence. They can be straightened in this way. Borrowing a page from the book of the flame hardener, automatic quenching sprays are being applied around flame heads to keep the temperature of the heated metal down to 600 degrees, Fahrenheit, or so; this permits the flame straightening of galvanized sheets since the zinc does not melt or give off dangerous fumes until it is at 750 degrees, Fahrenheit.

The shrinking and upsetting action from spot heating will raise "welts" on steel surfaces. Produced in carefully controlled bands or areas, these can be used to reduce the bores—or the contact areas of bores—of sleeves which have been made oversize, or to increase the effective diameters of shafts which must fit such bores.

Flame brushes are used to remove scale, rust, and moisture from steel surfaces before painting. The result of this is to present a clean, dry, warm surface to which priming coats bond with unusual smoothness and tightness; the paint dries from the inside out instead of from the outside in.

As results of these techniques, oxy-acetylene blowpipes are found where steel is cut, welded, soldered, brazed, hardened, repaired, or painted. Plant after plant is piping oxygen to large departments from central distributing points, as ordinarily as a management runs water pipes or electric wires.

What the industrial future of oxy-acetylene will be—where it will meet surprise displacements by other war-developed processes and where it will surprise its own practitioners by the things engineers have learned to do with it—nobody knows right now. But one thing is sure: Although it is one of the oldest techniques, oxy-acetylene is to have one of the newest industrial beginnings.

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NEW LEAD COATINGS

Give Corrosion Resistance To Sheet Steel

THE CORROSION resistance of lead and its alloys has in the past been utilized chiefly in products made from lead sheet, pipe, and so on. In recent months, however, new lead alloys and fluxes have been developed that permit the rapid, uniform, and highly effective coating of steel with lead alloys; the resulting products possess the strength and light weight of steel plus the corrosion resistance of the lead.

The alloys, developed by The National Lead Company, contain small amounts of tin and have excellent working properties, including improvement in their hardness on aging. They can be handled in present hot-dipping equipment of the usual type and are being applied with economy of money and materials and excellent service results to such diverse items as gasoline tanks, radiators, oil containers, boat brackets, air-conditioning ducts, convection heater coils, radio housings, metal fencing, farm equipment, and so on.

POWDER METALLURGY DEVELOPMENTS

Involve Copper-Coated Steel and Aluminum Bearings

TWO RECENT developments in the application of metal powders in the fabrication of mechanical parts are significant from the standpoint of post-war metalworking.

One is the use by the Navy's Metal Process Section (under R. G. Olson), of a copper-coated steel powder and a braze-sintering process in making gears and other parts that must be shock resistant, highly precise, and made in large quantities. The copper-coated powder is pressed to shape in the usual powder metallurgy presses but, instead of "sintering" the parts in the usual way, the Navy heats the briquettes to a copper-brazing temperature (about 2000, Fahrenheit) in a hydrogen atmosphere; the copper melts and forms a cementing

(*Please turn to page* 134)

Electronic Counting

A Newly Developed All-Electronic Counter Decade Now Makes Possible Accurate Counting at Rates up to a Million Objects per Second, Surpassing Mechanical and Electromagnetic Counters in Accuracy and Versatility. It Can be Applied to a Wide Range of Industrial Counting Jobs

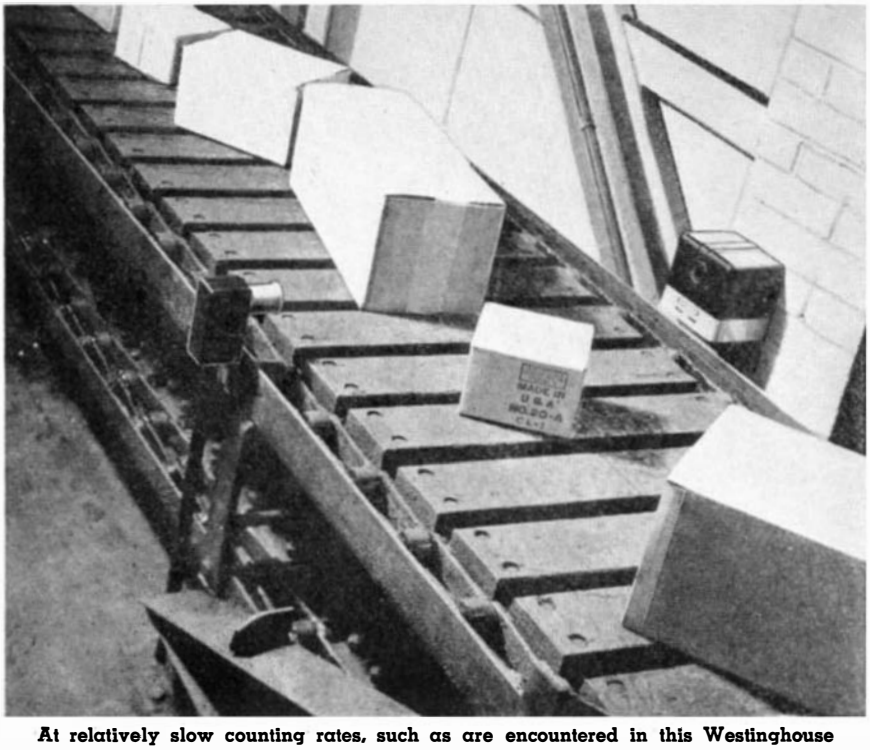
ANY moving objects capable of interrupting a light beam or of producing an electrical pulse can be counted electronically. If the objects are on a moving conveyor belt, the beam is simply directed across the top of the belt at the proper level for interception. It is aimed at a phototube which is connected through an amplifier to an electromagnetic counter. If the objects are cosmic particles bombarding the earth, electrical pulses are produced by catching these particles in a metal can called a Geiger counter, and the pulses are fed into an all-electronic counter that ticks off the count by means of blinking lamps.

Electronic counting is most appreciated in connection with objects that for some reason must not or cannot be touched during the counting process. Examples are counting of freshly painted objects, fragile glass objects like radio tubes, sterile articles, delicate sheets of paper moving at high speed through printing or folding machines, unwrapped foods and meats, people or animals passing a given point, flashes of light such as those due to flashover on generators, and irregular-shaped or light-weight objects that could not readily be positioned to actuate mechanical counters reliably.

One industrial application is counting the actual output of a punch press where feeding conditions are such that the press may now and then operate without material, making a count of press operations inaccurate as a production figure.

Whether electronic counters are preferable to simple mechanically actuated counters or to lever-operated switches serving electromagnetic counters depends upon production conditions when it comes to products outside the untouchable category. Consideration of electronic equipment for any counting job is certainly justified, however, in view of the wide variety of existing commercially successful applications. These include counting of automobile running boards, connecting rods, tire casings, refrigerator parts, steel ingots, billets, bars and sheets (both hot and cold), mica sheets, logs, bottles, beer cases, sacks of sugar and bags of candy, tea, and cocoanuts, to mention just a few.

Electronic counting removes the accurate-positioning requirement of other methods because the object can interrupt any part of the light beam. The cost of an installation in many instances is under a hundred dollars since packaged electronic units made by mass-production methods are suitable for most jobs. Maintenance is no problem because there are only a few radio parts in the equipment in addition to the automobile-type lamp in the light source, the phototube, and a few radio-type vacuum tubes.



At relatively slow counting rates, such as are encountered in this Westinghouse conveyor installation, a light source and phototube unit mounted on opposite sides of the conveyor provide an accurate count of cartons or other objects moving past, regardless of quite wide variations in their sizes, shapes, or relative positions

SIMPLICITY PLUS— Electronic counters of various types have been in use for many years, principally for such research purposes as counting cosmic rays, but this essentially experimental equipment has generally been both bulky and costly. A simple electronic counter, developed recently by John T. Potter of Potter Instrument Company, shows every promise of meeting industrial demands for a "streamlined" model that is economical to manufacture and dependable under a wide variety of conditions. It should find definite applications in fields where the characteristics of electromagnetic or mechanical counters place operating speed limits on associated machinery or apparatus.

A suitable number of the basic counter decade units (one for each digit in the maximum quantity to be counted) can be readily connected to appropriate input circuit accessories for any particular industrial application.

The counter decade uses a minimum number of parts and tubes to represent the numbers from 0 through 9. Various combinations of four numbers may be used to constitute a full decade, such as 1-2-2-5, 1-2-3-4, 1-2-4-8. The last combination, 1-2-4-8, is a binary progression that may represent the numbers 0 to 16 if properly used.

The binary system is well adapted to electronic counting. A series of trigger circuits may be connected in

such a manner that two pulses from one circuit may cause one operation of the succeeeding circuit. The binary system of notation is difficult to interpret, however, since all of us have been educated to interpret numbers by the decimal system. For this reason it is necessary to introduce a method of stopping the binary counting progression at the count of ten and resetting the electronic counter to zero. This is accomplished easily and automatically by two feedback capacitors in the new counter.

The counter decade comprises four stages, each employing an ordinary dual-triode vacuum tube (such as a 6SN7, 6N7, 6J6, and so on) arranged in a trigger circuit in conjunction with an indicating neon lamp. The basic functioning of all stages is alike, and is dependent upon shifting of operating potentials back and forth between two sets of values each time a signal pulse enters a stage.

Each stage, then, has a neon lamp and two tube sections which, for convenience, can be designated as the L section and R section. Only one tube can conduct current at a time, and the neon lamp can glow red only when the L section conducts. Each electrical pulse fed into the stage causes a switchover from one tube section to the other. Thus, if the R section is initially conducting and the neon lamp is out, the first arriving pulse will block the R section and make the L section conducting, so the neon lamp comes on. The next pulse will restore original conditions and put out the lamp, with this process repeating itself for succeeding pulses.

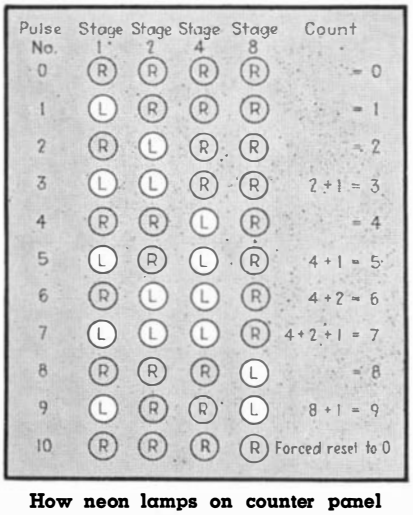
In a complete counter decade for providing a count of 10, four stages are used end to end. Each time the neon lamp goes out in a stage (due to switchover from L section R section), the stage sends a pulse on to the next stage. The resulting blinking of lamps during a long series of incoming pulses looks pretty confusing, since it takes two blinks of one lamp to make one blink of the succeeding lamp, but the beauty and efficiency of the system becomes readily apparent if the lamps in the four stages are numbered 1, 2, 4, and 8 respectively in the binary system. As will be seen later, the number assigned to each stage is equal to the number of pulses required at the input of the decade to make the neon lamp in the stage come on the first time.

HOW COUNT IS MADE—The manner in which four neon lamps can give a count up to 10 is shown in the drawing. For zero all lamps are out, as indicated by dark circles, and hence the R sections are conducting in all four stages. The first pulse turns on lamp 1 and we count one, as indicated in the second horizontal row. The second pulse puts out lamp 1 and turns on lamp 2 so we count 2. The third pulse turns on lamp 1 but does not affect lamp 2 (remember, only when lamp 1 goes out does stage 1 send a pulse to stage 2); two lamps are glowing, so we add their values to get a count of 3. The next pulse puts out lamp 1, sending a pulse to stage 2 to put out lamp 2, and this stage in turn sends a pulse to the next stage to turn on lamp 4 and give a count of 4. The process continues in the same fascinating manner through a count of 9.

For its tenth operation, the decade must transmit a negative pulse to the succeeding decade and must reset to its original zero condition as required by the decimal system. This means that the tenth pulse must put out all lamps. The count of 10 in the binary system calls for lamps 8 and 2 being on, hence lamp 1 (on for the 9 count) will go out automatically. Forced resetting therefore means putting out lamp 8 and preventing lamp 2 from coming on. This is ingeniously accomplished with two capacitors, as follows:

After the ninth pulse, the left-hand sections are conducting in both stage 1 and stage 8. When stage 1 is reversed by the 10th pulse, a negative pulse obtained in this stage is fed through a capacitor to stage 8, putting out lamp 8.

In an essentially similar manner, a positive pulse obtained from stage 8 during the forced switchover of this stage is fed through another capacitor to stage 2, where it completely overwhelms the negative pulse fed into this stage from stage 1. Since the lamp for

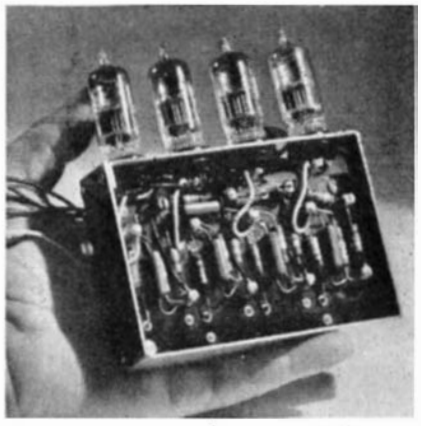


How neon lamps on counter panel indicate count. See text description.

stage 2 was out after the ninth impulse, it therefore stays out. All lamps are thus out for the count of ten (or zero), with one pulse being fed to the next decade (where the first lamp would represent 10, and the others 20, 40, and 80, respectively).

An unusual feature of this type of counter decade is the ability to operate at pulse rates ranging all the way from above 100,000 times per second down to as low a rate as desired, with no substantial changes in circuit constants. It is only necessary to provide a negative pulse at the input that is approximately the correct strength and shape. When sine-wave input exists, as from an oscillator that is started and stopped at the beginning and end respectively of the interval to be measured, a single multivibrator stage is generally inserted between the oscillator and the decade input for pulse-shaping purposes.

MANUAL RESET—The counter decade may be reset to zero manually by momentarily pressing a push-button switch, then selected counters may be turned on before a count. If, for example, lamps 2 and 1, or a count of three, are turned on manually, then the output will operate when seven pulses have passed through the counter. In this manner, the future performance of a counter may be rendered predetermined.



A complete electronic decade using four miniature tubes. The neon indicating lamps are remotely mounted

In the case of welding timing, the counter may be operated from the 60-cycle power frequency, and after a predetermined reset will count the exact number of cycles going into a weld. In the same field, the counter may be used as a cycle counter to check present timing equipment.

One of the widest present uses of electronic counters is in the field of interval timing. In this application, a crystal-controlled oscillator frequency is fed into the counter by an electronic switch or gate operated by initiating and terminating pulses from the time interval. With five decades and a 100,000-cycle crystal, intervals up to one second can be read with an accuracy of 0.01 percent for a full-scale reading.

Many variations of this type of counter may be useful. For example, an accumulated count may be used with fewer decades to indicate whether a watch is fast or slow, from the 5-cycle on and off beats of a watch. A predetermined number of beats can be used to switch the counter on and off, giving an accumulated reading that would average out any errors caused by irregularities of the watch rate.

Camera shutters or exposure timers can readily be tested by using a counter to indicate the accuracy of timing of the spring movement.

The counter used as a chronograph can be applied in practically all cases that at present use some graphic recorder for recording a time interval against a time base, with the advantage that the time interval will be directly and immediately indicated on the panel of the counters.

Most counters used as scaling circuits in radiation counters up to the present have not had a resolution time comparable to the resolution time of the counter tube. The electronic counter just described has a resolution of 0.00001 second and can readily be made to have considerably higher resolution.

The basic part of most calculators is a mechanical counter decade. Substitution of an electronic decade should give much greater speed and may result in a less expensive method of adding, subtracting, dividing, and multiplying, especially in business uses.

The electronic counter offers a method of increasing the rate of circuit selection, now generally done by stepping relays as in dial-telephone operation. A series of rapid pulses may be transmitted over a line for almost instantaneous selection of a desired circuit.

Electronic counters will provide an accurate count when objects are moving through the light beam of a phototube system at rates higher than can be handled by a mechanical counter. Electronic counters can handle any counting rates encountered in industry, even up to a million objects per second. They can increase the operating speed of such equipment as card-counting sorters, now limited by the speed of mechanical counters.

Many industries use the technique of ratio-weighing. A very fast counter used with a sorter and photoelectric pickup would give greater accuracy, especially in instances where a variation occurs in the density of the material in the article being sorted.

The electronic counter thus promises to become an important tool for use in many fields. Undoubtedly its development will stimulate thinking directed to a multitude of additional uses.

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ELECTRONIC THERMOMETER

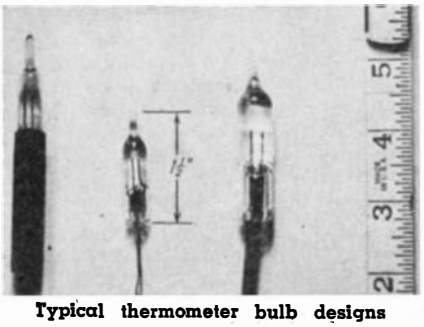
Utilizes Resistance

Coefficient of Liquid

A NEW temperature measurement and control system utilizes an electronic arrangement to provide a much lower heat lag than most conventional types of temperature controls used on heating systems. Another advantage is that the system permits indications of temperature to be made at distances of several hundred feet from the controlled point.

Operation of the instrument depends on the extremely high temperature coefficient of resistance of some organic liquids. A small glass bulb containing two thin wire electrodes is filled with the thermometric liquid and an alternating voltage applied to the electrodes. Changes in temperature cause the resistance between the two electrodes to change and thereby change the voltage of an A.C. bridge circuit in which the bulb is connected.

An electronic amplifier and discriminator receives the alternating voltage and produces a direct current flow to actuate a sensitive relay for control purposes or an indicating meter for observation. The sensitivity of the system can be adjusted for a ± 0.01 degree, Fahrenheit, range of control. The instrument was developed by Kollsman Instrument Division of Square D Company.



Typical thermometer bulb designs

RADAR FOR TRAINS

May Develop Many

Safety Applications

A PROGRAM of study and experimentation in the use of radar and other electronic devices for train communication and control has been inaugurated on the Chicago, Rock Island, and Pacific Railway. The plan is to develop a radio communications system in the microwave region for use between the front and rear end of trains, in yards between yard offices and switching crews, and ultimately between dispatchers and crews of trains enroute.

Experimentation on the Rock Island in the use of radar, particularly in safety applications, may also have far reaching practical applications in the safe and efficient operation of trains.

CAB ROUTING

Would be Accomplished by

Radio Under New Plan

IF ALL the companies that plan to utilize radio equipment after the war are allowed to do so by the Federal Communications Commission, the day of personal two-way radio telephones may soon arrive. Already, railroads and utility companies are keeping in touch with their rolling stock by means of two-way radios and plans are being worked out for taxicabs in Cleveland to use such apparatus.

Cab Research Bureau, Inc., representing the taxi industry, and the Electronic Department of General Electric Company, are working on plans that would make it possible to establish contact with any cab at any place in the city, reduce cruising mileage, and eliminate unattended call boxes connected to telephone lines. If approval can be obtained from the Federal Communications Commission, this will be the first two-way taxicab radio system in the United States.

ELECTRONICS GUIDES PLANES

Crossed Pointers are

Actuated by Radio Signals

BLIND landings by planes within 50 feet of a pre-selected spot on runways are made possible by an instrument now being built into combat planes and training planes. The instrument, shown in the photographs, is the indicator of an electronic system that is the result of seven years of continuous research and development by Westinghouse Electric and Manufacturing Company and the Washington Institute of Technology, which worked with the United States Navy to originate a simplified device for taking the guesswork out of blind landings.

Above: Checking blind-landing instruments. The third unit from left shows correct position of pointers when landing. Below: The blind-landing instrument is on the panel just above the pilot's control post

In use, the pilot watches two crossed pointers and two signal lamps on the instrument. Positioning of the pointers is accomplished by two radio receivers which pick up directional radio beams transmitted by the ground equipment. One receiver responds to the localizer, or on-course beam, and moves the vertical pointer on the instrument dial. The second receiver responds to altitude signals and actuates the horizontal pointer.

The ground radio equipment consists of four radio transmitters and two antenna systems located near the airport. These produce beams which first indicate the pilot's approach to the field and then mark the field's boundary; establish the invisible glide path which leads to the runway; and signal directions for keeping the glide to the field neither too shallow nor too steep.

The electronic landing system is in daily service at several commercial airports as well as on Army and Navy flying fields.

Airports for America

Civil Aviation Should Advance Rapidly After the War. Some Six Thousand Airports will be Needed and the Initiative, also Most of the Development, Should be Local Whether for Large Cities, Medium Cities, or Villages. How May the Interested Reader Go About that Initiative for his City?

THE WAR has led to the construction of many large flying fields well adapted to military needs, but has not produced a coördinated system of airports adequate for the real needs of the United States. If civil aviation is to advance rapidly in the post-war period, there must be a national airport policy, bold investment of funds, full co-operation between Federal Government, states, and municipalities, and, what is perhaps even more important, the help of interested citizens in thousands of communities.

Immense airports will be needed, with long runways for the huge passenger and cargo airplanes now being designed or already in operation—runways 7000 feet in length. Also needed will be a great number of smaller fields for short-haul or feeder line transportation. And, finally, air traffic will require many small fields or flight strips if the private owner is to make use of the efficient and safe, modern planes that will soon be at his disposal.

Charles I. Stanton, Civil Aeronautics Administrator, summarizes these needs. There are now 3000 civil airports, of which some 900 are suited for heavy operation. There will be need for 600 extra fields immediately after the war, and soon thereafter at least 3000 extra fields in all, which will bring the total number of fields to 6000. Mr. Stanton made this estimate partly on the basis of there being 6670 communities having a population of 1000 or more in the United States.

William A. M. Burden, Assistant Secretary of Commerce, has estimated the investment needed at $800,000,000, or about double the present investment. Yet this will be only one third of the annual expenditure of $2,250,000,000 for roads and highways incurred by our governmental authorities. Mr. Stanton has submitted a financing program to Congress whereby Federal funds will be apportioned on the basis of the area of the state, the size of population, the number of aircraft in service, and the number of airports within a given region. The Civil Aeronautics Authority has also established an Urban Planning Section to work with local authorities in surveying and planning. It is not sufficient, however, that the CAA put forth its best efforts. Local communities themselves, not only officials but business men, merchants, public spirited citizens generally, must help in building up our national airport system.

AIR TRAFFIC GROWTH—If any city in the United States is entitled to a series of airports, it is New York. About 67 percent of all Americans who go abroad live within the northeastern regions of the United States. When Fiorello H. La Guardia started to build the field later named for him, he was criticized as a visionary, yet La Guardia Field reached the saturation point even prior to the war, and during the war it has handled in one month 500 large planes. Some 4000 passengers and 2,500,000 pounds of cargo left in one month for the United Kingdom and North Africa. Prior to the war, La Guardia Field handled a million passengers a year.

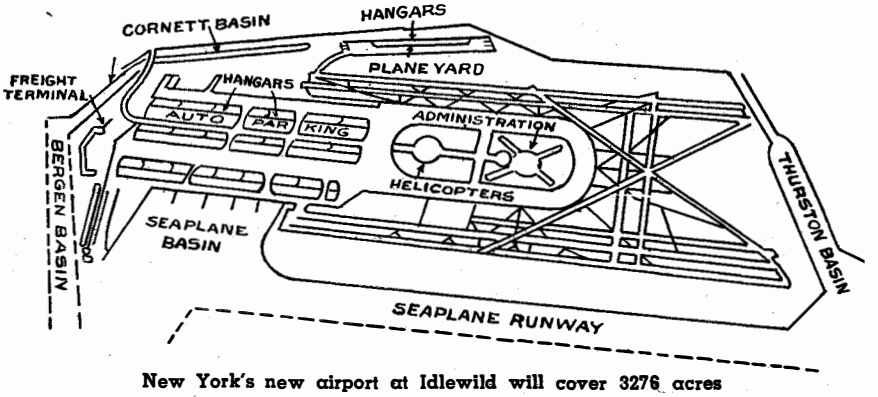
New York's new field, Idlewild, which also will be in that part of Long Island that lies within the limits of New York City, is therefore being planned for use ten years hence, but in all probability it will be congested three years after it is put into service.

The statistics of the new terminal, as given to us by Jay Downer, its engineer-designer, are imposing. Area will be 3276 acres (at first the figure was set at 500 acres, but it was soon agreed that this figure was ridiculous). Dredging and filling requires 39,000,000 cubic yards. Length of drains, 28½ miles. Length of runways, 14.4 miles. Concrete in runways and taxiways, 2,050,000 square yards, concrete in loading aprons, 1,200,000 square yards—both 12 inches thick. Estimated cost, $45,000,000 for the field and $15,000,000 for the buildings, including one hangar. This estimate of cost is, of course, too low. It is much more likely that the cost will run to $100,000,000.

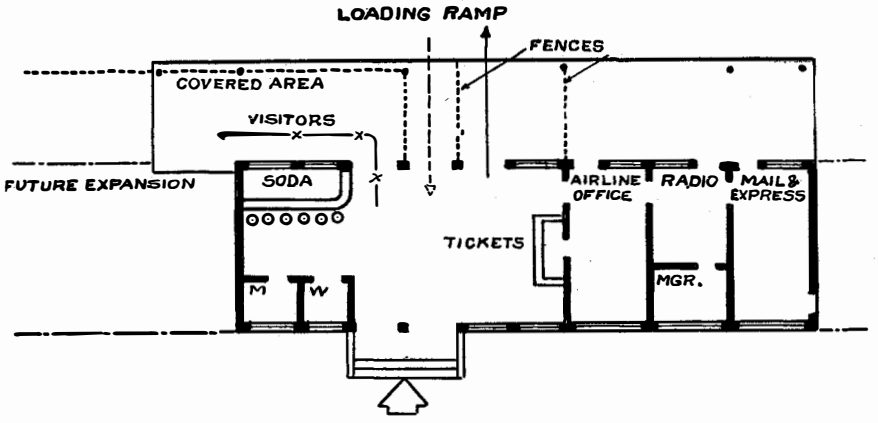
In spite of the huge task, Commissioner McKenzie hopes to have the airport in operation by the end of 1944. Hundreds of tons of fill are being dredged rapidly from Jamaica Bay. The airport will have both long land runways and a vast seaplane runway in the well protected waters of Jamaica Bay. It will be provided with a seaplane basin, parking space for helicopters, a huge auto parking space, runways ten thousand feet long, plane yards, repair hangars, 40 hangars to be leased to the airlines, the most complete administration and public facilities, and bus services for employees and workmen within the airport itself. With rent from the hangars and concessions, and the daily sale of 2,000,000 gallons of gasoline, the municipal authorities hope that the undertaking will be self-supporting.

FIELDS FOR PRIVATE FLYING—Idlewild gives a picture of the airport terminal in its most ambitious form. For contrast, and because private flying is just as important in its way as scheduled airline operation, a consideration of the small field for the private owner is in order. Here we are indebted to an excellent booklet written by W. T. Piper of Piper Aircraft, entitled "What Your Town Needs for the Coming Air Age."

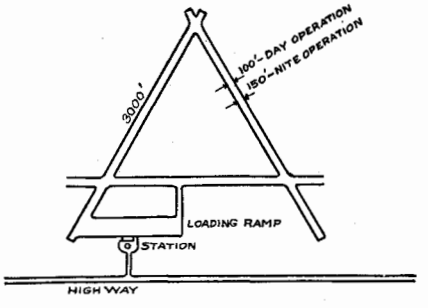
From his writings, addressed to the Mayor of any small city, comes this: "Man of little income, everywhere, is going to fly. He will use the large city airport if he hasn't a smaller one in his own locality. To thin out the congestion that would result in excessive use of the large airports by private planes, landing



New York's new airport at Idlewild will cover 3276 acres



Above: Station plan for a Class 2 airport. Simplicity plus utility are important factors in such airports on feeder lines. Right: Runway pattern for a Class 2 airport



strips and small airports are needed in great numbers in the towns and even in the vicinity of the larger fields."

Separate fields for private planes are all the more necessary because these land at lower speeds than do the large planes, and therefore intensify traffic problems. Mr. Piper continues: "Every town, village, hamlet, and cross road should establish its landing area. A national system of small airports and landing strips must be developed to take care of private flying and short-haul air transportation. Be sure your community is included."

Certainly many benefits are likely to accrue for a community which takes care to be included in the airport development program. It will be termed progressive, there will be more patronage for community activities, local merchants will benefit, connections with airlines will help existing business and industries and may cause new industries to locate in the small town or city. Moreover, Mr. Piper believes that for the small town, limited facilities and outlays will be sufficient. He continues:

"Landing strips are ideal for the small town where immediate requirements do not warrant an airport or where sites for one are not available. Landing strips are recommended for the residential sections of larger cities as auxiliaries to their municipal airports. A landing strip can be laid out as a single straight strip or in the form of an L, or a T, depending on its location. The L-shape and the T-shape strips are the most desirable, as they will allow planes to land against the wind from four different directions. By all means have a landing strip, running into the prevailing winds, even if it can't be more than 1800 feet by 100 feet. A larger strip, of course, adds safety. One 2500 by 200 or 300 feet is desirable. A level sod field is satisfactory. Each strip should have air-marking numerals, windsock, direction pointer, and corner markers and should be close to town and the highway."

Whether in a giant city or in a small country town, the right kind of airport, located in the right spot, will come into being only if local effort supplements or complements the overall planning of the Federal Government. In our national airport program, it is the duty of civil leaders everywhere to co-operate with the Civil Aeronautics Administration, perhaps to get in touch with William P. MacCracken, Jr., of the National Aeronautic Association, chairman of a committee which is making a special study of the local airport problem.

It will also be worth while to consult the airlines, which are always ready to help. For example, Eastern Air Lines has published a fine pamphlet, "Your Airport Problems," which, with a foreword by Eddie Rickenbacker, contains much sense. Airlines will also be glad to help in surveys and information. Eddie Rickenbacker recommends the formation of aircraft planning committees, charged with the duty of studying the probable volume of air traffic, of relating airline facilities with density of population, of studying the relationships between city centers, of determining whether a single jointly owned airport might not serve two or three towns better than several individual airports of lesser facilities.

Quite naturally the first duty of the local Airport Planning Committee is the selection of a site. But such groups should be warned that the selection of a site is a difficult matter, involving a number of factors. The topography of the country must be fully taken into account. The landing field should have a surrounding area which is at least partially free of obstructions. A stack 130 feet high would have to be at least one mile from the airport if the field is to comply with Civil Air Regulations. The time required for and the method of transporting passengers from the airport to the center of the city must be taken fully into account. Data must be obtained on the intensity and direction of prevailing winds as the best guide to the design of the runways. The Planning Committee should learn all it can on the prevalence of fog, snow, and the like. There must be sufficient land for expansion. It is odd that no one seems fully to appreciate how quickly aviation can grow; if insufficient land is bought at the time the airport is constructed, it may be necessary to spend huge sums for expansion afterward.

RUNWAY DESIGN IMPORTANT — The Planning Committee should, in the case of an airport of any size, employ competent engineers or architects, but professional men do their best work only when the employing body knows the job in hand well enough to exercise critical supervision. Therefore the Planning Committee should learn something of runway location and design. The length of runways should correspond to the type of aircraft likely to use the field. A runway for small private aircraft need be only half or even a smaller fraction of the length demanded for a huge airliner. The number of runways depends on the prevailing wind conditions, but if a single runway is the best that can be had it should be in fair alinement with the wind direction for at least a greater part of the time. The longest runway should be in the direction of the prevailing wind of minimum velocity.

Secondary airports do very well with runways of some 3500 feet. Runways should facilitate traffic, and if possible there should be two sets of them, one set of long ones for airline operation, and another set of shorter ones for private aircraft.

The design of airport buildings should be functional, and their layout should be such as to permit handling either passengers or cargo with ease. Another sage word of advice from Captain Rickenbacker: There should be segregation of passengers from mail and cargo handling, and separation of incoming and outgoing passengers. In any field, no matter what its size, there must be facilities for repair, for administration, for aids to flying and navigation. Distance from the passenger loading location to the terminal proper should not involve excessive walking.

Civil airports may be divided into those catering to scheduled airline operation and those suitable for private flying. Some idea has already been given of the dimensions required for the simple private flying field. Airports for transport operation are classified by the CAA as follows:

Type of Community	Class	Landing strip
Small community not on carrier system, up to 5000 population	1	1800 to 2500 ft.
On feeder lines, 5000 to 25,000 population	2	2500 to 3500 ft.
Important cities on feeder lines and intermediate stops on main lines, 25,000 to several hundred thousand	3	3500 to 4500 ft.
Major industrial centers and important junctions or terminals on the airlines	4	4500 ft. and over

The accompanying sketches of a Class 2 Airport show the utmost in simplicity. The runway pattern is held to the minimum, and runways are simply arranged. Loading apron is so placed that a minimum of taxying is required. All administrative facilities and facilites for handling mail, cargo, passengers, and spectators have been lumped together into one simple building. Even in such a

simple airport passengers are segregated from spectators, after leaving the ticket window.

Larger airports may be far more elaborate, but the principles of design are likely to remain the same.

It is impossible to quote exact airport cost figures. From the $50,000 which can give a small community the nice little airport sufficient for the needs of a few privately owned airplanes, to the $100,000,000 of Idlewild there is an infinite range of requirements and prices. A Planning Committee would do well to see how much assistance it could get from the Federal or State authorities. Then it should estimate the quantities involved, such as cubic yards required for grading, square yards of paving, cubic content of hangars. Then such quantities should be multiplied by unit prices prevalent in a given locality. The cost of land, the equipment needed for lighting, equipment costs, insurance, architect fees, and many other items must be taken into consideration. The final cost estimate must be multiplied by a generous safety factor. Also some attempt should be made to estimate what can be earned through leasing of hangars, by landing charges, and from various concessions.

Aviation has a great future and it is not likely to be hampered by the lack of airports any more than the automobile was hampered by the lack of highways. But there is every reason why the people as a whole should give this matter of airports intensive thought without relying implicitly on the Federal Government. Moreover, they should never allow the Federal authorities to dominate in construction and operation. Advice, and allocation of funds on reasonable assurance of meeting requirements should be as far as even a well intentioned body such as the CAA should go.

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ROCKET PRINCIPLE

Being Used in a Number of Military Developments

BECAUSE the Germans have made striking use of the rocket or jet principle in their so-called "robot" planes it must not be inferred that the United Nations are lagging behind in the application of such principles. For example, the Germans do not appear to have anything to equal the Bell jet-propelled aircraft, though they have made similar experiments. The Navy has recently revealed that the Grumman Avenger torpedo planes have been equipped with rockets and have sunk submarines with such weapons. These rockets, particularly those of the larger size, deliver a tremendous blow for their weight. The Navy has also revealed recently that it has utilized the rocket principle in assisted take-offs of heavy, overloaded bombers.

The German robot plane has a range of well over 100 miles. It carries a ton of explosives in the nose of the 25-foot fuselage, which has a very small frontal area. This means that the robot is heavily loaded per square foot of wing area, and must fly fast if it is to stay up at all. Since the wings are not to account for take-off and climb, these being supplied probably by catapult and ramp, they can be small in area and low in aspect ratio, which means that the span is not so many times greater than the width or chord of the wing.

It is apparent that the craft is controlled by a gyroscopic compass and another device which actuates the elevator and possibly the rudder. The robot flies at a predetermined altitude of, say, 1000 feet. This is no doubt controlled by means of an aneroid unit which raises or lowers the elevator indirectly, or perhaps reduces or increases the amount of fuel.

The range of the robot is likewise controllable, probably by means of an air log, in the form on an air-driven propeller which, as it rotates, turns gears and brings a device into play which terminates the flight after a certain number of revolutions. All these control devices do not constitute direction and distance control, since the atmosphere still comes into play, and the pressure of the atmosphere can vitiate the control of the aneroid unit, while side or head winds can ruin both direction or range.

There remains for conjecture the engine of the strange craft. We can imagine that the nose of the motor carries radiator-like openings through which the air enters, because of the high speed, with a certain ram or supercharging effect. Fuel is admitted to the chamber through a simple valve, and this fuel can be kerosene or any other low grade type. It is probable that an electric spark fires the mixture. As pressure is built up, the opening at the nose of the engine is shut by the pressure, and hence the gases of combustion rush out to the rear, producing propulsion. When the explosive cycle is completed, the nose of the engine is again opened, air is again rammed into the cylinder, the spark ignites another charge, and the cycle is repeated so rapidly that the sound of the engine resembles the whir of the ordinary airplane engine.

More powerful robot planes, with radio guidance, may eventually develop into a dangerous and significant aerial torpedo of real military value, but then they will no longer be the simple, inexpensive device which it is possible to turn out in great quantities.

AIRPORT SAFETY

Offers Fertile Field for Ingenuity and Invention

THE FIFTEENTH Annual Safety Convention of the Greater New York Safety Council had interesting sessions covering safety both in aircraft manufacture and in airplane operation. At the airport, in the opinion of Walter T. Johnson, Safety Director of American Airlines, the major problems from an accident point of view are two-fold. One is air and automotive traffic control. The other involves the hazards of servicing aircraft, such as gasing operations, supplying auxiliary power, inspection on the ground, and so on. One lesson is that the less auxiliary equipment on the ramp and apron at the airport the fewer the accidents.

It is not uncommon at the airport to see a clutter of gasoline trucks, air-conditioning trucks, baggage carts, passenger ramps, and tractors in front of the hangars. In some of the newer airport designs, many of these obstacles have been removed from the surface. For example, pits are being provided for the storage of gasoline, for air-conditioning service and the like, but these pits have themselves created electrical and moisture hazards.

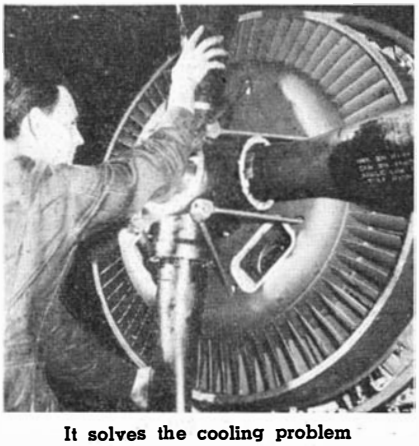
A peculiar accident is described by Mr. Johnson. The nose of a fuselage projected over a pit. The ground serviceman opened the cover and a spark from faulty electrical equipment on the aircraft caused an explosion of vapors in the pit.

There seems to be a field for ingenuity and invention in the safetying of the auxiliary equipment of an airport.

ENGINE COOLING

Facilitated by New Propeller Fan

NO MATTER how carefully cowled an aircraft engine may be, the problem of cooling its cylinders when working at full capacity is a serious one. When the aircraft in which the engine is installed is a relatively slow one, and is used for long-range cruising as are the Glenn Martin PBM-3D Mariners now on patrol duty in the Pacific, the difficulty is even greater. After experiments which go back as far as 1930, Wright Aeronautical engineers have made an advance in the art of engine cooling by the development of a special fan, bolted to the propeller and turning with it, and a fixed diffuser attached to the engine. Both rotor and diffuser are riveted assemblies fabricated from sheet aluminum alloy.



It solves the cooling problem

As can be seen from the photograph, the rotor has a sheet metal center and vanes similar to airfoils or twisted propeller blades around the outer perimeter to force added air past the cooling fins on the engine cylinders. The diffuser has corresponding vanes so designed as to convert the speed of the air supplied by the rotor into pressure sufficient to drive the air past the cooling fins.

Better Water for Industry

Location Determines the Physical and Chemical Properties of Water Available for Industrial Use. Only Through the Application of the Best Talents of the Chemist and the Engineer Can Existing Processes be Applied to the Solution of Many Industrial Water Troubles

EDITOR'S NOTE: In our June issue, page 265, appeared an article on the general aspects of water conditioning. This aroused considerable interest and attracted many inquiries regarding water treatments for specific industrial purposes. The present article deals with industrial water treatment practice and supplements the information previously published.

WATER is as indispensable to manufacturing and industrial operations as it is to the maintenance of life itself. But, unlike the human body which automatically adapts itself to the use of water varying over comparatively wide ranges of quality, many industrial processes require specific modification of natural waters in order to operate successfully.

A classic example of the importance of water quality to industrial processing may be cited in connection with the manufacture of Bourbon whiskey. Kentucky distillers claim that the distinctiveness and superiority of their product may be attributed in large measure to the use of processed water drawn from wells that penetrate limestone formations. It is said that only the wells near Louisville produce a water with the special attributes needed for the manufacture of Bourbon.

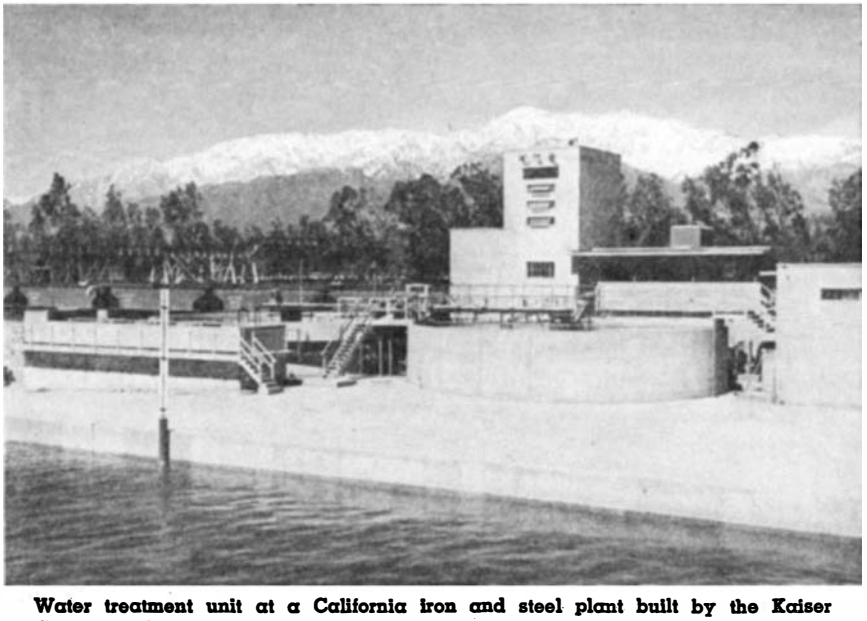
While the peculiar relationship of Louisville groundwater to whiskey processing may be debatable, it is a fact that water varies as much in its physical and chemical properties as there are locations from which it is obtainable.

There is no such thing as a natural, pure water; even the rain descending from the clouds is contaminated by contact with atmospheric dust before it strikes the earth's surface. And once it touches the ground the rain water acquires characteristics of quality that reflect everything with which it comes in contact. Thus, in a limestone region, the soft rain water quickly becomes mineralized and "hard"; in a swamp area the water displays acid characteristics and color from decaying vegetation; and rainwater that flows across a newly tarred or oiled road absorbs enough phenol to acquire a decided taste.

Considering the wide variations to be found in terrain, geology, and man-made culture, it is not surprising, therefore, that water quality characteristics should be almost infinite in number, varying not only with location but with seasonal factors as well. Heavy runoff with floods, for example, will cause surface streams to be more turbid in the spring than they are during the winter months.

One of the major problems of industry is the need to condition water for its specific requirements. Hardly ever can an industry so locate its operations to take advantage of a water supply that exactly fits its need. In fact, within a single industry it may be necessary to modify water differently for each of three broad classifications—(1) cooling and condensing, (2) processing, and (3) steam generation. Even the most perfect surface or groundwater sources or the supply emanating from a municipal water treatment plant cannot be expected to meet all these special needs.

Vast strides forward have been made in this special field of industrial water treatment, and there is available today equipment and processing techniques to fit virtually every need. Depending on the use to which water is put and the particular quality standards desired (see table classifying standards according to industry), there are various forms of treatment to which it must be subjected.



Water treatment unit at a California iron and steel plant built by the Kaiser Company, Inc. A complete system of reclamation and purification is used

FIVE OBJECTIVES—The objectives to be sought, as outlined by Robert T. Sheen and Lewis B. Miller, engineers of the W. H. and L. D. Betz Company, water consultants, are as follows: For processing purposes water must be treated for (1) suspended solids and turbidity removal; (2) color reduction; (3) hardness and alkalinity reduction; (4) removal of iron and manganese; (5) removal or reduction of carbon dioxide, hydrogen sulfide, organic or free mineral acids.

Quality requirements for boiler feedwaters, they point out, are far less stringent for steam produced at low pressure than for steam produced in the high pressure units of the power plant. There are very definite limitations in hardness, total solids, pH, dissolved silica, and so on, in the water used for steam generation which must be met if operating difficulties are to be avoided. The higher the steam pressure the more rigid and sharply circumscribed are

	Boiler Feed Water			Brewing		Canning	Carbonated Beverages	Cooling Water	Pulp & Paper					Raw Water Ice	Tanning	Textile
	0–150 lb.	150–250 lb.	250 & up lb.	Light	Dark				Ground wood	Kraft	Soda & Sulfite	Bleached	Rayon			
Turbidity	20	10	5	10	10	10	2	50	50	25	15	5	5	5	20	5
Color							10		20	15	10	5	5	5	10–100	5–20
Dissolved oxygen* in cc/liter	2	0.2	0													
Color plus O_2 consumed in ppm	100	50	10				10									
Odor (or free chlorine) " "				0	0	0	0							0		0
H_2S " "	10	5	0	0.2	0.2	1	0.2	5								
Total hardness ($Ca\ CO_3$) " "	75	40	8			25	250	50	180	100	100	50	8		50–135	10
Methyl orange alkalinity " "				75	150 & up		50–100						50	30–50	135	
Ca " "				100–200	200–500											
Fe " "				0.1	0.1		0.2	0.5	1.	0.2	0.1	0.1	0.05	0.2	0.2	0.2
Mn " "				0.1	0.1		0.2		0.5	0.1	0.05	0.05	0.03	0.2	0.2	0.2
Fe plus Mn " "				0.1	0.1	0.2	0.3	0.5	1	0.2	0.1	0.1	0.05	0.2	0.2	0.2
Al_2O_3 " "	5	0.5	0.05										8			
SiO_2 " "	40	20	5										25	10		
Cu " "													5			
F " "				1	1	1	0.2									
CO_3 " "	200	100	40													
HCO_3 " "	50	30	5										60			
OH " "	50	40	30										8		8	
Total solids " "	3000–1000	2500–500	1500–100	500	1000		850			300	200	200	100	300		
Na_2SO_4—Na_2CO_3 ratio	1 to 1	2 to 1	3 to 1													
$CaSO_4$				100–200	200–500											
pH	8.0 & up	8.5 & up	9.0 & up	6.5–7.0	7.0 & up											
Potability				U.S.T.	U.S.T.	U.S.T.	U.S.T.							U.S.T.		

Values represent standard A.P.H.A. determinations. * Determination by Winkler method. U.S.T. means U.S.Treasury standards for drinking water.

Standards of water quality classified as to industrial applications. From data by International Filter Company

these limitations. And failure to condition water properly may result in boiler tube losses at a time when tube replacements are difficult to secure promptly, if at all.

Regarding corrosion, Messrs. Sheen and Miller state that corrosion of ferrous materials is caused principally by dissolved oxygen, acid conditions, or by electrolytic corrosion. There are other specific conditions under which corrosion will result on certain materials. Thus a water of high pH value may be quite as corrosive as a water of low pH value on zinc or galvanizing. Ammonia will have a corrosive action on copper, copper bearing alloys, nickel, or nickel-bearing stainless steel. Mills using process water that occasionally contains salt or seawater encounter corrosive conditions due to the salt content. In many cases the cause of corrosion in a particular mill may be readily and correctly attributable to one or more of the factors described and, by proper correction, substantial reduction in the amount of corrosion may be effected.

Methods of industrial water treatment vary from simple sedimentation of a supply, secured by quiescent storage in a reservoir or tank, to the introduction of complex organic chemical conditioning agents at specific points in the plant. A typical example of the latter technique is to be found in the applications of cupric chrome glucosate, pioneered by the D. W. Haering Company, for the control of algae and bacteria growth as well as for the inhibition of corrosion.

Where sedimentation alone is not sufficient for the removal of finely suspended, colloidal, or coloring matter, coagulation is used. This process involves the addition of small amounts of an aluminum or iron salt to the water. The acid-salt reacts with the alkalinity of the water to form gelatinous precipitates. The latter enmesh the tiny particles suspended in the water, grow heavier in so doing and settle to the bottom of the tank. This treatment affords a fairly high degree of clarification when long and quiescent periods of detention can be provided.

SAND FILTER—To secure the utmost in clarification, a filter is employed following coagulation. The filter generally consists of a sand bed (18 to 22 inches in thickness) underlain by several layers of graded gravel (totalling about 20 inches in depth). The water containing finely suspended material and coagulent floc is applied on the top of the sand bed, and finds its way through the sand and gravel to reach an underdrain system. The filters may operate either by gravity flow or pressure. The latter type is housed in a steel shell tank, while the gravity flow filter is built in the form on an open, concrete box. Removal of the foreign matter in the water occurs at the surface of the sand bed, which is cleaned periodically by backwashing. This is accomplished by simply reversing the flow of water through the filters; the upward flow expands the sand beds and then washes away the material on the surface.

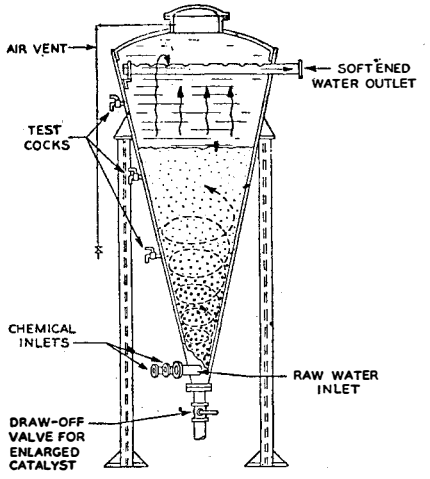
Sedimentation, coagulation, and filtration are processes that remove suspended matter, turbidity, and color and reduce the bacterial content of water. The removal of substances that cause so-called hardness—principally calcium and magnesium salts—calls for the use of water softening processes.

Several methods of water softening are in vogue, including lime-soda precipitation (hot or cold), and base-exchange processes (zeolite treatment). The cold lime-soda treatment operates on the principle that these chemicals added to water containing calcium and magnesium carbonate, bicarbonates, and sulfates will react to form precipitates and thus settle out in the form of a sludge. In the older treatment plants this reaction was carried out in an ordinary tank. A much more efficient device, known as a Spaulding precipitator, is now available for this purpose.

The precipitator is a cone-shaped tank inside of which is suspended an inverted cone-shaped baffle. With this arrangement and a motor-driven agitator it is possible to maintain a "blanket" of pre-

cipitated sludge through which incoming water must pass. Thus the water to be treated is brought into more intimate contact with the chemicals and the result is a more efficient and economical softening operation than that obtained in a plain tank.

A more recent development is the Spiractor, a device by means of which a catalytic agent is used to accelerate softening reaction. The Spiractor process employs a conical shaped tank slightly more than half filled with fine granules of calcium carbonate catalyst. Raw water enters the bottom of the



The Spiractor cold lime softening process developed by the Permutit Company. Water enters at the bottom of the tank, circulates upward through a bed of granular catalyst, and emerges as softened effluent

tank through a special fitting containing a tangentially disposed nozzle. Through another opening in the fitting, the proportion dosage of lime suspension is pumped. This mixes with the upward swirling water, the flow rate of which is high enough to maintain the granular bed in a suspended condition and low enough to avoid carrying any of the granules over the top of the tank.

The immediate contact of the chemically treated water and the suspended catalyst granules greatly accelerates the softening reaction between the added lime and the hardness content of the water. Relatively insoluble reaction products are formed while the water is still in contact with the granules and these deposit on the surface of the granules in the form of successive, firmly adherent layers.

Not only does the process give fast action (normally a 5 to 10 minute detention period) with resulting economies in size of plant, but the end product is a granular substance quite unlike the sludge normally produced by lime treatment.

The hot lime-soda technique for water softening is used only for the treatment of boiler feed water. It is similar to the cold process in that it uses the same chemicals; however, the reactions are carried out at or near the boiling point of water. Exhaust steam is used for heating the water prior to the addition of the chemicals and since the effluent from the settling tank and filters is hot it can be fed directly to the boiler. One of the principal advantages of the hot process is that the chemical reactions proceed more rapidly at higher temperatures and more complete reactions are obtained. Also, part of the hardness (bicarbonates of calcium and magnesium) is removed when the water is heated.

One of the most popular methods of softening water for industrial use involves the use of zeolites. These are complex, insoluble mineral compounds, similar in size to coarse sand, which are found in natural deposits or can be manufactured synthetically. [See page 265, June Scientific American.—*Ed.*]

One of the more recent developments in zeolite processing comes about by the availability of a non-siliceous zeolite that is equally effective in removing both carbonate and non-carbonate (sulfate) hardness. It is composed of a sulfonated organic material that operates either on the sodium or hydrogen cycle of base exchange. Operated on the sodium cycle, it takes out carbonate hardness and is regenerated with salt, the same as the older forms of zeolite.

When it is operated on the hydrogen cycle, this zeolite removes sulfates and chlorides as well as the bicarbonates of calcium, magnesium, and sodium (in the latter case leaving nothing but the carbon dioxide which can be removed by aerating the water). Regeneration on the hydrogen cycle is accomplished with dilute sulfuric acid.

Iron and manganese, as well as hydrogen sulfide, are found in water. The latter is extremely troublesome because it imparts corrosiveness, while iron and manganese contribute to many processing difficulties. Aeration followed by filtration is a frequent method of treatment for removal of iron and manganese; these substances are thus oxidized and removed by the straining action of the filter. Zeolite treatment for softening also aids in the removal of iron and manganese.

Hydrogen sulfide can be removed by aeration but where this proves inadequate it becomes necessary to use degassifying equipment of special design.

This brief discussion of industrial water treatment practice illustrates the many techniques that are available for conditioning water to meet virtually any need. It must be emphasized, however, that the application of these techniques calls for specialized knowledge far beyond the ken of the general plant superintendent or maintenance engineer. Even the experts admit that industrial water treatment is a complex science calling for the best talents of the chemist as well as the engineer.

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WATER FILTERS

Designed for Army, Uses Cake of Diatomaceous Earth

DIATOMACEOUS earth has been found to provide an ideal filtering medium for purifying water for army troops in the field, according to recently released information from the Engineer Board of the Corps of Engineers. The need for better filtration equipment arose from the failure of standard sand filters to remove cysts of *Endamoeda histolytica*, one of the causative agents of dysentery.

The filter equipment consists of a series of cylindrical, porous refractory elements suspended in a metal shell. Upon such an element a cake of diatomite, (one of several forms of diatomaceous earth) is deposited by circulating slurry through the unit. When deposited, the cake is built up to a thickness of 0.06 to 0.09 inch. This cake is the filter medium through which the water passes and upon which suspended matter and bacteria are deposited. Backwashing of the filter to remove suspended material trapped in the filter cake is accomplished by reversing the flow of water through the filter.

Two sizes of diatomite filtration equipment have been produced for field use. One has 3.6 square feet of filter area, with a nominal capacity of 15 gallons per minute, suitable for pack transport and weighing 50 pounds. The other has 10 square feet of filter area with 50 gallons per minute capacity.

WATERWORKS COST

Can be Based on Analysis of Contract Data

A YARDSTICK for approximating the cost of a waterworks system—and a recent survey indicates that our postwar agenda should provide for new waterworks in almost 5000 communities—may be fashioned from data collected by the Public Works Administration.

In the period 1933-39, the PWA participated in the construction of 781 complete water supply projects. An analysis of the contract data shows the following average cost per capita, arranged in three population groups.

Population Range	Avg. Cost per Capita
100 to 500	$84.00
500 to 1,000	65.00
1,000 to 10,000	45.00

Construction prices have risen since the above data were compiled, and the present per capita cost should be increased by about 32 percent to conform with present-day prices.

MAGNETIC SWEEPERS

Used by State Highway-Patrol Trucks

ELECTROMAGNETS attached to highway patrol trucks in North and South Dakota collect as much as 12½ tons annually of nails, bolts, and other small pieces of metal that fall on the road surface. In North Dakota the average yearly collection is about 6¼ pounds per mile, while in South Dakota it averages only 1¾ pounds per mile.

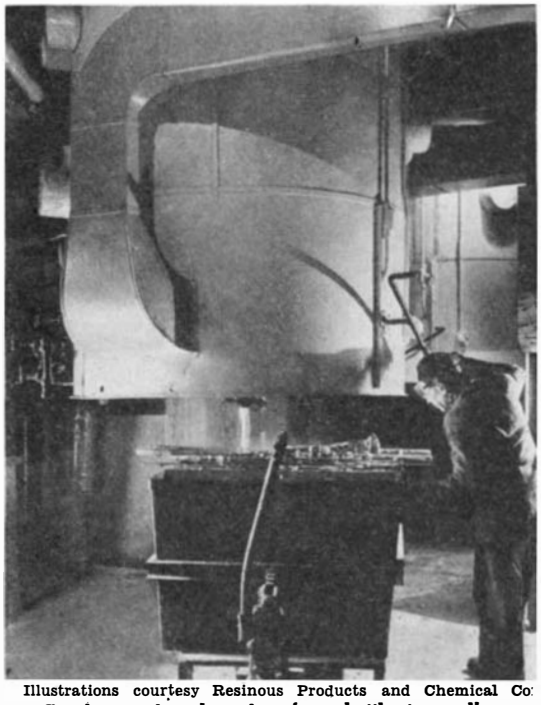
It is conservatively estimated that for each pound of scrap collected the motorist is saved $4.80 over and above the cost of collection. This figure is obtained by assuming that each pound of metal left on the road would cause ten punctures, each of which would cost about 50 cents to repair.

The Resin Dog with the Plastics Tail

Quick-Drying Enamels, Better Plywoods, and Improved Fabrics, are Only a Few of the Developments of the Synthetic Resins Industry. Plastics Aside, These Resins are Doing Jobs that Have Immediate and Long-Range Implications to a Number of Industries and to the General Public

IN THE overall field of synthetic resins, molded and sheet plastics have become the tail that wags the dog. The plastic bomber noses and gun turrets on our fighting planes; medical instruments that pipe curved light; furniture and tableware; jewelry and novelties, have caught the public eye, and the layman feels that these plastics are the whole resin story. Actually, many invisible resinous miracle-makers—alkyds, urea, melamine and phenol formaldehydes, vinyls, acrylics, and maleics—preceded the moldable plastics, take in a larger scope, and have an equally impressive record.

Synthetic resins make possible the "four-hour" enamels, and they are now responsible for the completely weather-, water-, and fungus-proof plywoods, replacing vitally needed war-time metals —a feat which remains one of the outstanding material developments in the war. In almost every conceivable field of production, these resins see active service: in flexible adhesives, caulking compounds, gas-resistant coatings, aircraft lacquers, life rafts, army raincoats and tent cloths, weatherproof fiberboard for shipping containers, and protective coatings for hard-working Navy vessels and weather-abused Army tanks and jeeps. Also in service on the home front, they make brake-linings wear far longer, prevent spoilage of medicinal enzyme preparations, help to purify drugs, make tougher grinding wheels, recover precious metals from industrial wastes, increase sugar yields, purify water, and reclaim valuable tartrates from grape wastes. But in each case the resins are more or less invisible, their work more or less unknown, and their share of the spotlight dependent upon their more gaudy colleagues—the plastics.



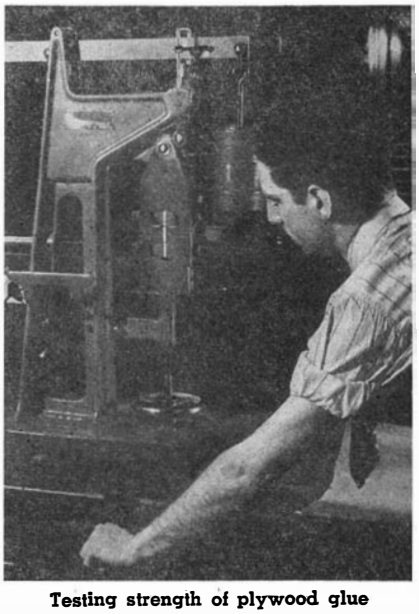
Illustrations courtesy Resinous Products and Chemical Co.

Coating resins dropping from kettle to cooling vats when correct reaction has been reached

Credit for bringing these invisible wonder-workers to their present industrial status cannot be pinned on any one firm. While many resin-makers were dazzled by the vision of a plastic molded world, some few research groups concentrated on other-than-molding uses for resins. In 1924, for example, one of these groups, the Resinous Products and Chemical Company, presented the paint industry with a synthetic resin that made possible fast drying paints and inaugurated a period of spectacular growth in the resin industry. This was many years after Dr. Leo Baekeland first sought a shellac substitute in phenol-formaldehyde reactions but sidetracked his original quest when his "shellac" turned out to be a miraculous molding material.

Prior to 1934, most plywood was produced in this country with the aid of animal and vegetable glues. Because of the susceptibility of such glues to moisture, vermin, and mold growth, plywood tended to separate at the plies and deteriorate altogether too rapidly to make it a satisfactory structural material.

With the development of special phenol-formaldehyde resins, plywood emerged as a new structural material of almost unlimited versatility. The introduction of these new glues made great changes in the technique of plywood production, making it simpler and faster. The adhesive was supplied in sheet form in continuous rolls which could be cut to fit the size of any plywood assembly. This eliminated the need for spreading liquid glue on veneers and made possible the very thin plywood used on airplanes today. Whereas the older glues depended upon drying out of water for adhesion, this resin film, after being inter-leaved between veneers, was placed in a hot press where the combination of heat and pressure fused the wood and resin into plywood which was proof against continued boiling in water. The manufacture of plywood was cut from hours to minutes by this method and the hot press installations in plywood and woodworking plants increased from 13 to over 225 in the past decade. For the first time, completely waterproof resin-bonded plywood became available for aircraft, boats, housing, transportation, radios, furniture, musical instruments, and scores of other new uses.



Testing strength of plywood glue

As the demand for resin-bonded plywood grew, thought was given to the production of plywood without the use of hot-pressing equipment. Among the first successful resins which have thus tremendously expanded the development of resin gluing were a group of urea-formaldehyde resins. As in the case

Checking resin condensate in supply kettle for spray drier

of the film, the resin glue line produced with these resins is stronger than wood itself, and is highly resistant to moisture, vermin, and mold. These resins are produced as dry, water-soluble powders and as aqueous solutions.

Suitable catalysts or hardening agents are used to control the working life of the glue and to accelerate its setting after application to the gluing surface. After these glues are set they cannot be softened by exposure to water or heat.

Prior to the war these adhesives were most widely used in the manufacture of the better grades of furniture and radio cabinets. They are produced in neutral color, thus eliminating staining difficulties, particularly with light-colored woods and thin veneers. During the war a large part of production of the phenol formaldehyde and urea formaldehyde resins have been utilized as assembly adhesives for plywood aircraft construction, wood life rafts, boats, cargo bodies for trucks, timber structures, and so on. The advances in the molding of plywood by flexible pressure rather than rigid pressure plates made complex curved forms possible. Used to curve irregular shapes or for pieces requiring curves in more than one plane —such as the egg-shell shape required for airplane "drop-tanks"—this method employs an inflated or deflated bag as one of the halves of a pair of molding dies. After layers of veneer are wrapped on a concave mold, an inflated bag may exert pressure on one side, or the veneer-covered mold may be placed inside an open-mouthed bag, the bag deflated so that it adheres to the contours of the mold, and the whole inserted into an autoclave, or "pressure cooker," where heat and pressure are applied by steam.

SYNTHETIC RAINCOATS—When parts for planes, tanks, guns, and similar military equipment are packed for overseas shipment, they are coated with a sprayed liquid synthetic resin that wards off destructive effects of salt water corrosion.

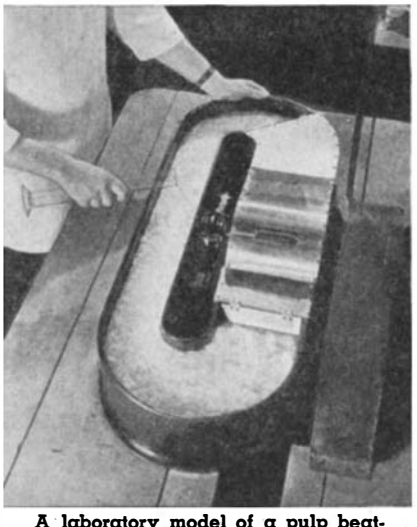
The acrylic resins are used to waterproof military maps, to eliminate polishing of brass and copper, to preserve art treasures, and to make possible luminescent paints which are used on gunsights for jungle fighting and to illuminate submarine instrument panels, aircraft dials, road markers, and air-raid shelter signs.

Other resins, water-dispersed acrylic ester polymers, go into leather coats for aircraft pilots, making the leather grease-proof and eliminating the fire hazard coming from grease-soaked clothing for pilots forced to parachute from a burning plane. Not only is this leather fire resistant, but it is also unaffected by the intense cold encountered in high altitude flying. It remains tough and flexible.

Still another recent accomplishment in the synthetic resin field has been increasing the wet strength of paper. The resin most widely used is of the urea formaldehyde family. The lack of color, odor, and taste, resistance to mold and fungus, ease of handling in paper processing, and chemical resistance of these resins in final insoluble form have given the paper maker a tool that enables him to make wide use of less expensive and more readily available pulps. One of these resins, specially tailored for the paper-making process, may be added at any accessible point on the paper machine prior to sheet-formation, preferably at the beater. The required ratio of resin to paper is so small that the appearance and feel of the sheets is practically indistinguishable from ordinary paper, but the paper's wet strength is increased as much as ten times. Soft absorbent paper toweling may now be used like a cloth without fear of its tearing into shreds. In the blueprint and photographic paper field, the dimensional stability of the resin treated paper under varying conditions of temperature and humidity has proved particularly useful. Not only is wet strength increased in paper treated in this manner, but dry strength as well—measured in terms of the standard tests of tensile strength. Disposable garbage buckets, frozen food packs, cloth substitutes, and camouflage papers may be mentioned among the many uses of resin treated papers.

Another problem of the paper industry was solved with urea-formaldehyde resins. Fiberboard is made by gluing together, under pressure, sheets of paper to form a heavy, strong laminate. Corrugated board is the familiar carton stock consisting of a fluted paper center with outer plies of heavy paper. While both of these types are very strong when dry, exposure to dampness causes them to become soft and upon continued wetting the plies may separate, as the ordinary glues used offer little resistance to moisture. The need for fiber packing cases which would be weather-proof and more suitable for exposed storage and overseas shipments necessitated the development of an adhesive which would not fail when wet. Urea formaldehyde resins, when used in combination with dextrin or starch, make possible low cost weather-proof fiber shipping containers which hold together in wet sand or the dank holds of ships and, at the same time, because of their light weight, permit additional tons of precious cargo to be carried in ships bound for combat zones. These containers have been so toughened by the addition of the urea resin that it is actually possible to float them to beaches in the surf—a stunt that would almost instantly ruin the best pre-war shipping carton.

RESINS TREAT FABRICS—Other synthetic resins have become standard for use in coating lacquers applied to fabrics to produce oil cloths, tarpaulins, raincoats, bridge-table covers, and artificial leather. In each case the fabric acts as a backing or supporting material for a continuous, heavy lacquer film. For the modification of textile fabrics, the



A laboratory model of a pulp beater in which urea formaldehyde is added to various pulps in studies to determine the effect of such additions on wet strength of paper

resins are impregnated into the fiber and may impart to the fabric improved properties of crush resistance, luster, strength, and resilience. However, the appearance of the fabric is not altered and the fabric retains all of the properties of a textile—characteristic porosity, absorbency, elasticity, flexibility, and serviceability.

In the development of urea-formaldehyde resins in the industrial finishing field, it was found that, by combining urea and formaldehyde chemically with a third ingredient, alcohol, the solubility characteristics of the resin could be so changed that, instead of mixing easily with water, it preferred instead the solvents commonly used in lacquers and enamels.

Urea formaldehyde resins are particularly well suited for use in combination with alkyd resins in the surface coating field. The two types of resin supplement each other, bringing out in the film the most desirable properties of each. Combinations of these resins have found wide use in the production of "synthetic porcelain" enamels—for refrigerators, washing machines, stoves, sanitary ware, and in many other industrial finishes where exceptional whiteness, marproofness, chemical (particularly alkali) resistance, and durability are desired.

Another kindred resin, closely related chemically to the urea type, is the "melamine-formaldehyde" resin. This resin resembles urea formaldehyde in many respects but is favored in certain applications because of its outstanding heat resistance—a characteristic readily apparent in the maintenance of gloss and whiteness in stove enamels.

VERSATILE VINYLS—Equally remarkable are the accomplishments of the vinyl resins. Recent booms in their development have come from increasing demands from industry for corrosion-resistant rubber-like materials. As a group they cover the thermoplastic field in clear, translucent, and opaque forms from hard molding resins through tough, flexible, rubber-like products to soft casting gels. They make excellent adhesives for cloth, paper, glass, and metal. They are also used as textile, paper, and leather finishes, electrical cable coatings, flexible solvent-proof tubing, and chemically-resistant metal finishes.

Still another type known as "ion exchange resins" has made possible the elimination of sugar juice impurities, removing from 60 to 80 percent of the non-sugars and 50 to 90 percent of the color from clarified sugar juices. These ion exchange resins have found wide use in the purification of the great volume of water used in the emulsion polymerization step in synthetic rubber production. One of their newest applications may be the recovery of amino acids from meat waste, soybean meal, and similar inexpensive sources. Amino acids, plentiful in meats and essential to a well-balanced diet, are expected to go far toward ridding war-torn countries of dietary deficiencies. Their recovery has long been an expensive, complicated process, but this new recovery method contributes much to a practical plan of fortifying carbohydrates with these vital acids.

The ancient alchemists hoped to accomplish feats such as the transmutation of the elements to turn base metal into gold, a hope which the fathers of modern chemistry considered absurd. Yet, many of the problems which they posed have been solved by the research of chemistry. The scientist of today is the alchemist of yesterday, transforming substances of nature into new and better products. Particularly is this true in the case of synthetic resins, a vast array of products contributing to almost every phase of present-day living.

RESINS AVAILABLE

Can be Put to Use by A Number of Industries

With the removal of Vinsol resin and Truline binder from allocation by the War Production Board, these materials are now available to industry for all uses, it is announced by Hercules Powder Company.

During the period of WPB allocation, Vinsol resin was used in asphalt emulsions for the construction of Army airports and roads in this country and overseas, and also in the manufacturing of plastics and paperboard, to replace the use of strategic metals.

Prior to being placed on allocation, Vinsol resin was used in the manufacture of paperboard, plastics, air-entraining Portland and masonry cements, emulsions, paint and varnish, linoleum, rubber, ink, adhesives, and leather.

Truline binder finds uses in cores and molds by foundries producing castings of all metals and will extend supplies of less available materials, such as cereal binders and linseed oil.

HARD-WATER SOAP

Produced by Addition of New Ingredient

To help the Army keep clean, even when it has to wash in cold sea water, a new soap ingredient has been developed from petroleum by the Du Pont Company. Mixed with the other constituents of soap in a proportion of about one to two, the new material will remove dirt, oil, and grease in any kind of water, salt or fresh, cold or hot, hard or soft.

After the war, variations of this soap formula will be available for household use—some as toilet soaps and others for the kitchen and laundry. They will lighten the task of washing greasy pans, will make glassware sparkle, and will quickly erase road film from your car. This type of soap lathers well and leaves very little "ring" around the tub.

The new ingredient is a synthetic detergent, or "soapless soap." It is a sulfonated product which is sold to soap manufacturers, who use it in the manufacture of toilet soap.

The reason ordinary soaps do not work well in hard water arises from the fact that they contain sodium or potassium and the hard water contains calcium and magnesium. When the soap is mixed with the water the sodium or potassium is pushed out of the soap molecule and is replaced by calcium and magnesium. The reaction creates an insoluble calcium or magnesium compound, which is precipitated as a sticky curd—the ring around the tub or washbasin. Not until all the calcium and magnesium is precipitated and the water thereby softened will ordinary soap produce lather and do a good cleansing job. When it unites with hard-water minerals, the new soap forms not a heavy curd but a very finely dispersed precipitate, which remains suspended in the water and does not interfere with the soap's quick and efficient cleansing job.

NEW THERMOPLASTIC

Can Be Boiled or Sterilized and Retain Strength and Shape

The first thermoplastic ever developed that can hold its shape and strength in boiling water and yet can be molded by the fastest, most economical methods, is known as Cerex. This new plastic opens up an entirely new field of industrial and household applications by virtue of its ability to withstand sterilization.

Produced for some time on an experimental basis by Monsanto, the new plastic has already found wide use in war work, particularly Radar, radio, and other military electronic equipment where substances of light-weight and suitable electrical and heat-resistant properties are in demand. It is also in demand for surgical instruments, aircraft instruments, and many other war applications. The entire production is now going to war work. After the war, an equally wide range of civilian applications is possible wherever high heat-resistant qualities are in demand such as in dishes and utensils which are subjected to boiling water.

FADE-PROOF RAYON

Results from Development of New Dyeing Method

A new method of dyeing acetate rayon fabrics which gives such fabrics dyed in a number of colors a high degree of resistance to atmospheric gas fading, has been developed by the North Carolina Fabrics Corporation, in co-operation with technicians of the American Viscose Corporation, rayon producers and dyestuff manufacturers.

Fading of colors caused by acid gases given off from fuel combustion and other sources has been a cause of frequent complaint in the past.

To date a line of six colors has been developed, all of which show no fading or color loss after 60 hours' exposure to atmospheric gases under test conditions. They are also resistant to sunlight and perspiration. Additional colors are being developed as rapidly as conditions permit.

If You Can't Kill It, Isolate It

Today There are Ways of Reducing Destructive Vibration in Machinery but These are Limited, and Thus Isolation by Means of Elastic Suspensions has a Wide Field of Application. The Design of Mountings Using Rubber for this Purpose has Now Reached the Stage of a Predictable Science

By H. H. FINK

Product Design Engineer, The B. F. Goodrich Company

VIBRATION, uncontrolled and unleashed, is the greatest single destructive power that confronts mankind. It is always present and constantly reveals itself in one form or another. Every single movement made by any person or any thing is motivated by a force which creates vibration or is created as a result of vibration.

The ultimate desire of every modern design engineer is to obtain maximum energy output per unit weight of producing equipment. This constant striving for weight reduction has of necessity made the engineer conscious of a class of vibratory forces heretofore given little consideration. Every piece of rotating or reciprocating machinery when in operation has some inherent or impressed unbalance which produces alternating accelerations of the moving masses. These alternating accelerations create alternating forces in the machine and in the supporting structure, resulting in an undesirable oscillatory movement commonly known as vibration.

Vibration is accompanied by numerous detrimental effects which are both wasteful and costly. A machine's serviceable life is materially shortened by an increase in internal stresses resulting from vibration. Since a machine must supply the energy necessary to maintain vibration, its efficiency is greatly reduced. Because of the transmissibility of vibration through supporting structures, it may be detrimental to other machine operations, thus interfering with the micrometer accuracy which is so essential in modern processing. It also induces noise, human discomfort, and fatigue.

Several plans of attack are available in the battle against these destructive forces. Vibration created by static and dynamic unbalance of moving parts can be reduced at its source by means of mass balancing. Although this method is employed to some extent in every piece of rotating equipment, the degree of perfection attainable is necessarily dictated by the element of cost. Also, mass balancing cannot eliminate torsional vibrations due to power impulses from internal combustion engines.

Dynamic absorbers may be used, consisting of tuned elastic systems added to the original vibrating system to absorb the energy of vibration. However, they are not applicable to variable speed disturbances and therefore their usefulness is somewhat limited.

The last and most desirable method of approach to the problem is to isolate the machine by means of an elastic suspension. This type of isolation is suitable for variable speed disturbances and therefore has an unlimited field in reducing vibration effects.

Fundamentally, the principle of vibration isolation by means of an elastic suspension is very simple. A machine which is a source of noise and vibration may be suspended on springs so chosen and arranged that the machine may move freely without appreciably disturbing its foundation. The ideal condition may be visualized as a machine suspended in space. If an alternating force acts on the body, the inertia of the mass is the only force available to resist it. Therefore, the entire mass is accelerated through a small vibratory motion. Practically this is not possible but, by using an elastic suspension, this ideal condition may be approached. If the suspension be made soft enough, the inertia resistance of the mass cannot follow the quick changes in direction of the accelerating force, with the result that the mass remains practically stationary. Thus the only force transmitted to the foundation is the spring force carried through the suspension as it oscillates with the movement of the suspended mass. Without an elastic system interposed between the mass and the support, the entire vibratory force would be directly transmitted to the foundation.

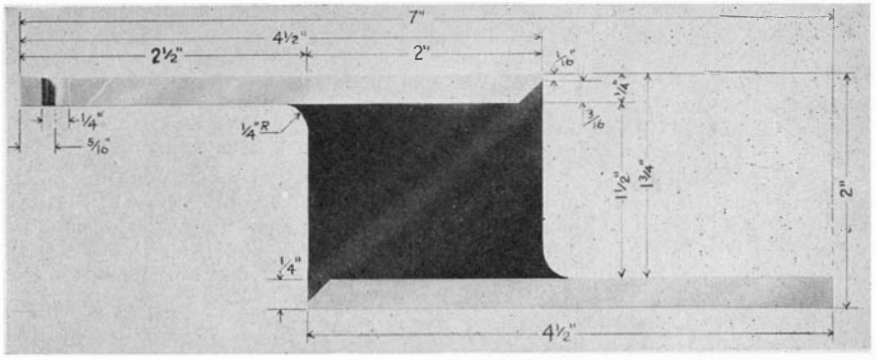
An exhaust fan mounted on rubber Vibro-insulators of the shear type. The rubber is strongly bonded to the metal parts

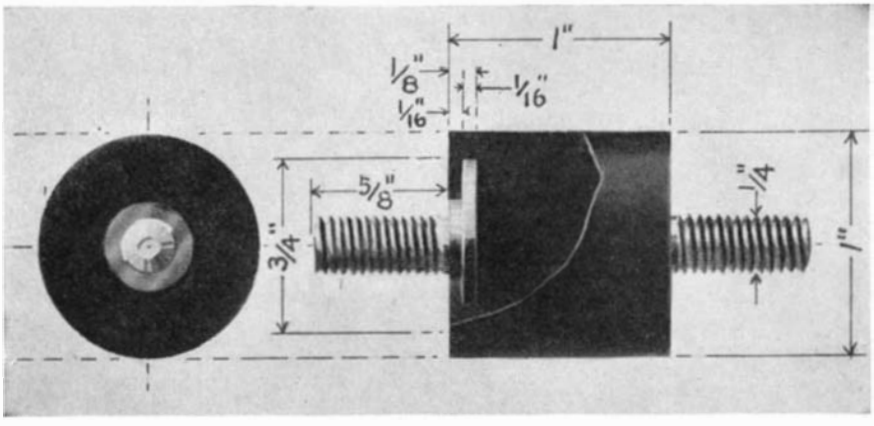
UNDERSTANDING IT—In order to understand the principle through which the installation of an elastic suspension cushions impacts, reduces vibration, and eliminates noise, it is necessary to consider first the "natural frequency" of the machine-mounted suspension, and second the "disturbing frequency" of the vibrations or impacts that originate in the machine. The natural frequency is the number of movements which occur in a unit time-element when the suspended machine is given a single impulse. Natural frequency varies with the amount of load suspended and the physical characteristics of the type of suspension.

The disturbing frequency is usually the number of revolutions or impacts per unit time-element of the machine that creates the disturbance. Many machines produce disturbing vibrations in more than one frequency. In such cases the lowest frequency is the one to be considered when selecting an elastic suspension. Any spring that satisfactorily isolates the lowest frequency will be still more effective with the higher frequency vibrations.

When there is considerable difference in these frequencies, the disturbance may be

either isolated or cushioned. Should any of the vibratory forces happen to occur in step with one of the natural frequencies of the suspended machine, it would vibrate excessively in one or more directions. Vibrations of that frequency would be amplified at the foundation unless means were provided to dampen them. The amplifying effect is analogous to the well-known case of the pendulum, wherein a very small force repeated at the correct interval of time may gradually increase the swing of the pendulum from very small to very large amplitudes.





Above: This insulator may be used in shear or in compression. Used endwise, in shear, its deflection may be an inch. Left: This type is for use only in compression

Careful consideration must be given to the proper design and location of the mountings if the elastic suspension is to be effective. It is highly desirable to obtain a layout in which the various vibration nodes act independently of each other. This requires that the mountings be placed as nearly as possible in a plane containing the center of gravity and the axis of oscillation. An independent suspension of this type allows alternating accelerating forces in a translational direction to produce true translational motion, and those in a torsional direction to produce true torsional motion. Also, it permits maximum flexibility with a minimum loss of stability, and is thus desirable in mobile installations where shock and abnormal accelerations are prevalent. If an independent suspension is not used, the translational and rotational motions combine, resulting in a complex movement of the machine. The resulting frequencies are quite complicated and the machine stability is greatly reduced. When it is not possible to mount equipment in an independent manner, and where horizontal external forces exist, it may be necessary to prevent objectionable rocking or swaying by the use of radius rod attachments or similar flexible means.

RUBBER AND STEEL—The design of mountings, to fit the selected type of suspension and to have the proper loading characteristics, requires careful consideration in selecting a springing material. Of the numerous materials available for use as isolating mediums, rubber and steel appear to be the most outstanding.

Cork and felt, although used extensively for sound isolation, have limited applications in the field of vibration isolation because of the extreme loads necessary to obtain large deflections. The high damping and sound isolating qualities of these materials make them a useful counterpart of steel spring suspensions.

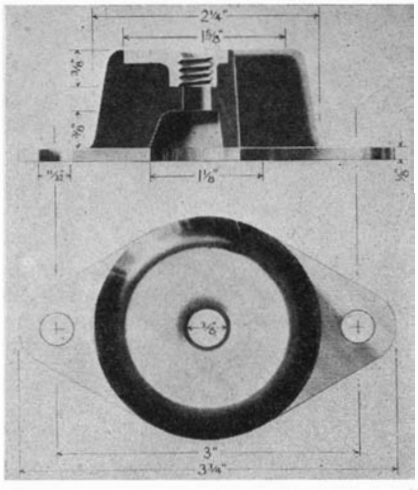
Steel springs have had the advantage in the past, because they were able to isolate a larger range of vibrations due to the greater deflections obtainable through versatility of design. They are not affected by oil or temperature changes and have a long serviceable life. However, because of their low damping factor, it becomes necessary to add an external means of damping for resonant conditions. Their lack of stability without external means of support, together with their high sound transmitting qualities, is a definite disadvantage.

Rubber used as a springing material has many advantages. It has high resilience, a small degree of inherent damping which is beneficial at resonant conditions or when sudden impulses occur, the capacity for storing large amounts of energy per unit volume, and excellent sound isolating qualities. Rubber springs have a lack of static friction and require no lubrication. Rubber can now be fabricated into economical and effective springs and can be designed to control the stiffness and stability in any direction by means of the shape characteristics. Recent developments in versatility of design now permit large deflections where previously small limitations were imposed. The life expectancy of rubber springs can be long if they are properly compounded, designed, and cared for.

It is true that rubber is affected by contact with oil and by temperature changes. Synthetic rubbers would be more suitable in this respect. The creep and damping properties of rubber vary with load, temperature, and frequency. Also, the dynamic properties differ somewhat from the static properties. However, on an overall basis of comparison, rubber appears to be the most suitable springing material for elastic supports.

Rubber can be used as a springing material when loaded in tension, compression, or shear, since the deformations are great under any of these methods. The type of installation, available space, direction of forces, freedom of movement, and physical characteristics required in the mounting will dictate the proper selection, since each method has its advantages as well as its disadvantages. Rubber loaded in tension has been given little consideration in the mounting of engines because it is easily damaged, resulting in progressive tear and ultimate premature failure.

Rubber loaded in compression was possibly the first method employed in the suspension of engines. The load-carrying capacity is very high, but the rate of stiffening is also very great. Thus the compression modulus and, consequently, the elastic restraint are variable functions. The deflection characteristics not only depend on the hardness of the compound but also on the size and shape of the mounting. For maximum service life, the deflection of rubber used in compression is usually maintained below 20 percent of the undeformed thickness. Present-day applications use this method primarily as a counterpart of the design of shear type mountings where snubber action is desired. The



A type of mounting suitable only for use in compression, as on fans

rubber can be so proportioned to give any degree of build-up resistance to overloads.

A BIG INCREASE—With the advance in the development of rubber-to-metal adhesion, the use of rubber in shear has increased tremendously. The deflection characteristic in shear is, for all practical purposes, a straight line function throughout the working range, and therefore the shear modulus is constant. For the same unit loading and thickness, rubber in shear has six or more times the deflection of rubber in compression. In other words, the same deflection in shear could be accomplished with less than one sixth the amount of rubber necessary in compression. Although the variable size and shape factor precludes any rigid rules of design, it may be generally stated that, for normally stressed applications, shear type rubber can easily carry loads ranging from 50 to 100 pounds per square inch on the bonded area, as the ultimate bond strength is approximately 300 pounds per square inch. Good practice limits the deflection of shear type mountings to two thirds of their thickness and the thickness is limited to that of the smallest dimension of the bonded side, or a maximum of two inches. This insures uniformity of cure as well as stability.

In the design of rubber mountings, the three types of loading cannot be considered independently of each other, for a mounting may function in shear in one direction but any forces perpendicular to the shear plane place the rubber in compression, and vice versa. By a combination of all three methods of loading—that is, tension, compression, and shear—it is now possible to design rubber springs for almost any desired loading conditions. Stability or lack of stability can be incorporated as required. There are two basic designs from which the more complicated mountings are fashioned. These are the elementary compression and shear types as shown in Figure 1. A few of the more common combined designs are illustrated in Figures 2 and 3.

Series mountings, whether they be compression or multiple shear plate types, as well as the double shear plate, are designed to obtain large deflections and, at the same time, retain stability. These styles are soft in all directions in the shear plane, but are stiff in the one direction of compression.

The tubular and multiple tubular shear type have the advantage of being soft in one direction only, that of shear. They are quite stiff in all directions in a plane perpendicular to the shear axis.

The annular and multiple annular torsional types are also a one-directional style. They deform little under any radial load but are relatively soft in torsional shear. By means of torsion arms, large deflections can be obtained. This design has the advantage that the rubber forms its own bearing and is capable, moreover, of sustaining great loads.

The angular torsional shear type is normally soft in two directions. The versatility of design possible with the multiple angular torsional shear arrangement as shown is very far-reaching. This design permits a wide range of physical characteristics by slight alterations in the dimension of the rubber thickness, rubber diameter, or of the length of the interconnecting arm. Extreme deflections can be secured, if desirable, under very light loads and freedom of movement is obtainable in all directions.

The design of rubber mountings can now be classified as a predictable science and placed in the same category as that of steel and other structural materials. The advances made in recent years by the rubber technologist and research engineer have removed the mysterious air that once surrounded rubber. The rubber industry is now prepared to collaborate on any problems involving the isolation of noise, shock, and vibration.

IN SUM—Our problem of isolating machinery thus resolves itself into a four-point program: First, the degree of isolation necessary to obtain ultimate performance must be established. Second, an analysis of the machine characteristics and a determination of the type and degree of vibration disturbances must be made. Third, from these, the proper spring stiffnesses must be calculated and the type of suspension selected. Fourth, the individual mountings must be designed not only to fit the points of support but also to give the desired and necessary loading characteristics.

Having accomplished this, the engineer can take pride in the fact that another forward step has been made toward defeating the destructive power of vibration.

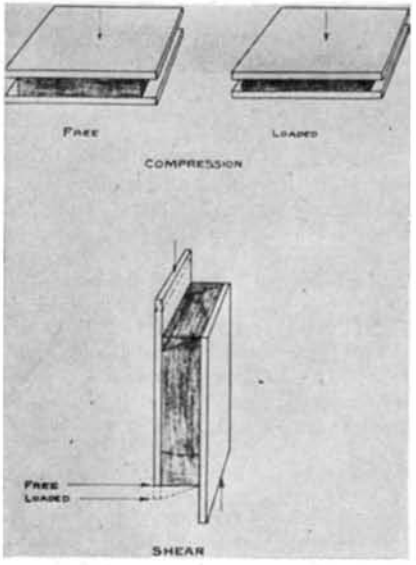


Figure 1: Above: The two basic, elementary designs

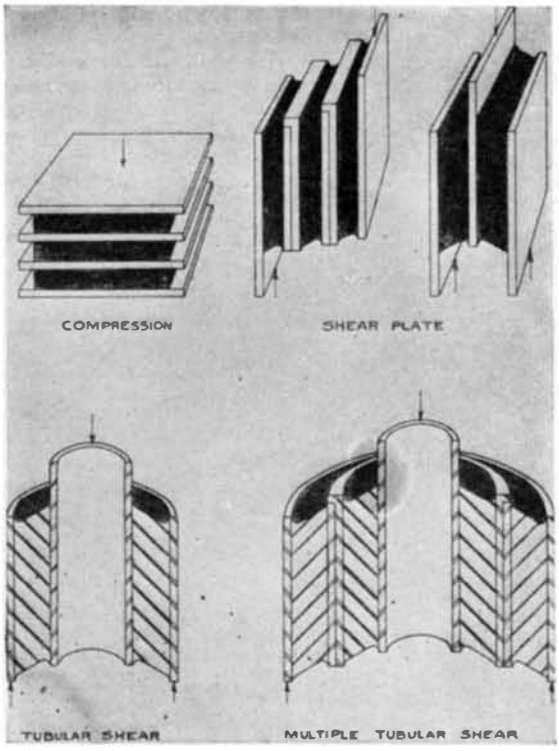


Figure 2: Left: A variety of compound mountings

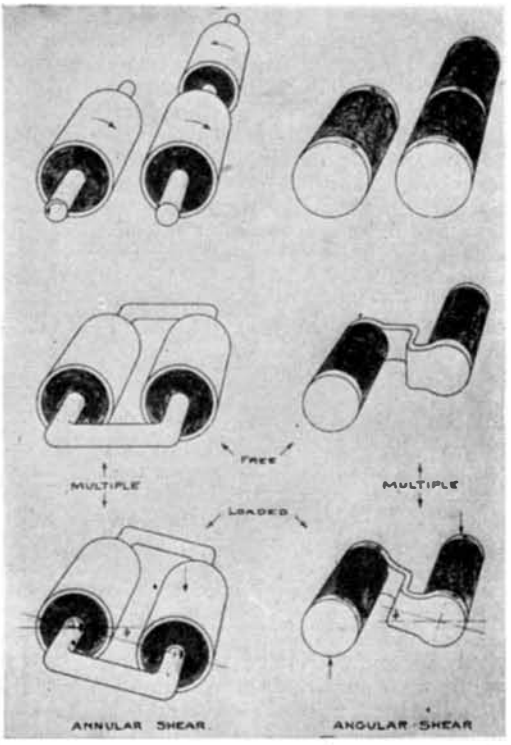


Figure 3: Right: Some compound torsional mountings

Illustrations courtesy Boeing Aircraft Company

America's mightiest warbird, the B-29 Superfortress

IN OTHER FIELDS

Conducted by The Staff

Battleship of the Air

The Superfortress (B-29) is Far More than the Outstanding Aerial Bomber so Far Produced; It is a Harbinger of Better Things to Come. Good Visibility, Pressurized Cabin, and Comfortization are Some of the Features that the Aviation Industry May Well Study

THE SUPERFORTRESS, the B-29 which the AAF has used to such good advantage in the Pacific theater, is so huge, so complex, that its detailed description would require a fair sized book, just as its design required a whole corps of engineers and draftsmen. But there are a few points of special significance that can be described here —points of not only military significance but of importance to the future of civil aviation.

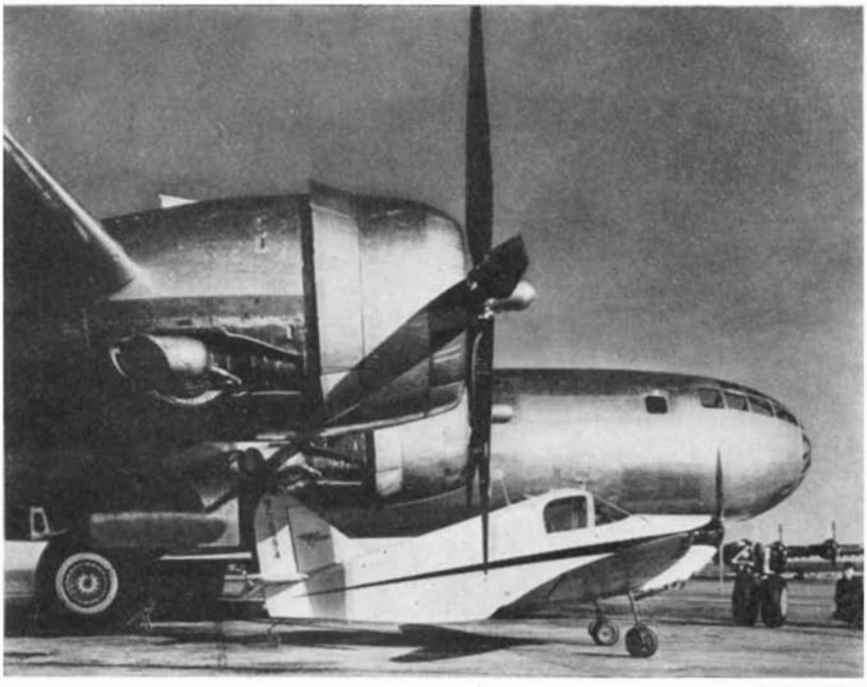
Although its performance is still secret, it is known that the B-29 has a greater range, flies faster, and carries a larger bomb load than any other bomber in the world. Thus the Superfortress becomes a new strategic weapon of such importance that these bombers will come under the centralized control of the Joint Chiefs of Staff, with a single commander, and will be ready to act in any theater of war.

It has been customary for many years to refer to bombers as battleships of the air, in the sense that a battleship is a vessel which can defend itself against anything afloat. It is perhaps only the Boeing Superfortress which really deserves to be called a battleship of the air: It is so robust, so armed and armored that it can defend itself against all comers—in particular against the best single-seater fighters. The B-29 is armed with .50-caliber machine guns, and 20mm cannon mounted in power turrets, with gun-sight blisters on the side of the fuselage. The vision for fighting is as good as the vision for piloting, and even the tail gunners have a roomy cabin and perfect vision in three directions.

Many lessons can be learned from the Superfortress. The B-29 derives from the B-17 and its designers had a wealth of knowledge and experience to help them, yet the preliminary design was begun in 1936, some eight years ago. This means that the development of large military aircraft is a lengthy process, and that if, in the post-war period, our production is limited drastically, there should be no decrease in research, experimentation, and effort to evolve new designs.

Although the B-29 is a new ship, its similarity to the B-17 is so great as to point the moral that military aircraft design should be evolutionary rather than revolutionary. Still another thought, prompted by the accompanying picture of Wellwood E. Beall, (Boeing vice president in charge of engineering, and responsible for the over-all direction of engineering), is that aircraft design rightly belongs to the hands of young men. Mr. Beall, a graduate of the Guggenheim School of Aeronautics

Wellwood E. Beall, the young engineer mainly responsible for the development of the new Superfortress



Above: The huge bulk of the Superfortress dwarfs the single-engined Culver by its side. The wing span of the B-29 is in excess of 141 feet and its extreme height is over 27 feet. Stability of the craft is remarkable

of New York University, is only 37 years of age. He combines solid engineering brains with imagination and executive ability.

The B-29 is enormous (the single-engined Culver is dwarfed in one of the photographs) and its dimensions are far greater than those of the Flying Fortress. The B-29's wing span is more than 141 feet, its length is 100 feet, and it has an overall height of 27 feet, 9 inches. The Flying Fortress had a span of 103 feet, a length of 74 feet, 9 inches, and a height of only 19 feet.

REMARKABLE STABILITY—Aerodynamic novelties cannot be too great a part of the picture and the B-29 therefore has a very close resemblance to the B-17. It is cleaner, however, and has a longer cylindrical fuselage with the nose projecting far ahead of the wing. The characteristic Boeing large vertical fin and extensible flap are present, and the landing gear is so completely retracted that no sign of it is visible when in flight. The stability of the new craft is remarkable. By virtue of previous flight experience with the Flying Fortress, the Superfortress, in spite of the huge size of its control surfaces, has direct control which means remarkable refinement in balancing of the aerodynamic loads involved. The tricycle landing gear has been adopted, with two wheels on each of the three components of the landing gear.

The B-29, even if it did not produce startling aerodynamical novelties, had claims to great progress in size, performance, and construction, the overcoming of production difficulties, and freedom from bugs and development accidents.

But there is another aspect of the design which is equally noteworthy; that is, the greater comfortization of the aircraft. The day when the comfort of the crew in military aircraft could be disregarded has long gone by. Since the ship operates over great ranges, its design had to be such as to reduce crew fatigue and irritations to a minimum.

Right: Size of this four-bladed propeller of the B-29 can be gaged by comparison with the man. Note the single air duct in the nose of the engine nacelle

First of all, heating and sound proofing are adequate, and the cabin is so supercharged that the B-29 can be operated at 40,000 feet without the use of oxygen masks or other annoyances. The bugaboo that prevented pressurization of military aircraft was the danger of "explosive decompression" if a shell should pierce the cabin. In early tests of the Superfortress, a side-gunner's blister blew out, but the crew members reached for their oxygen masks and no one suffered.

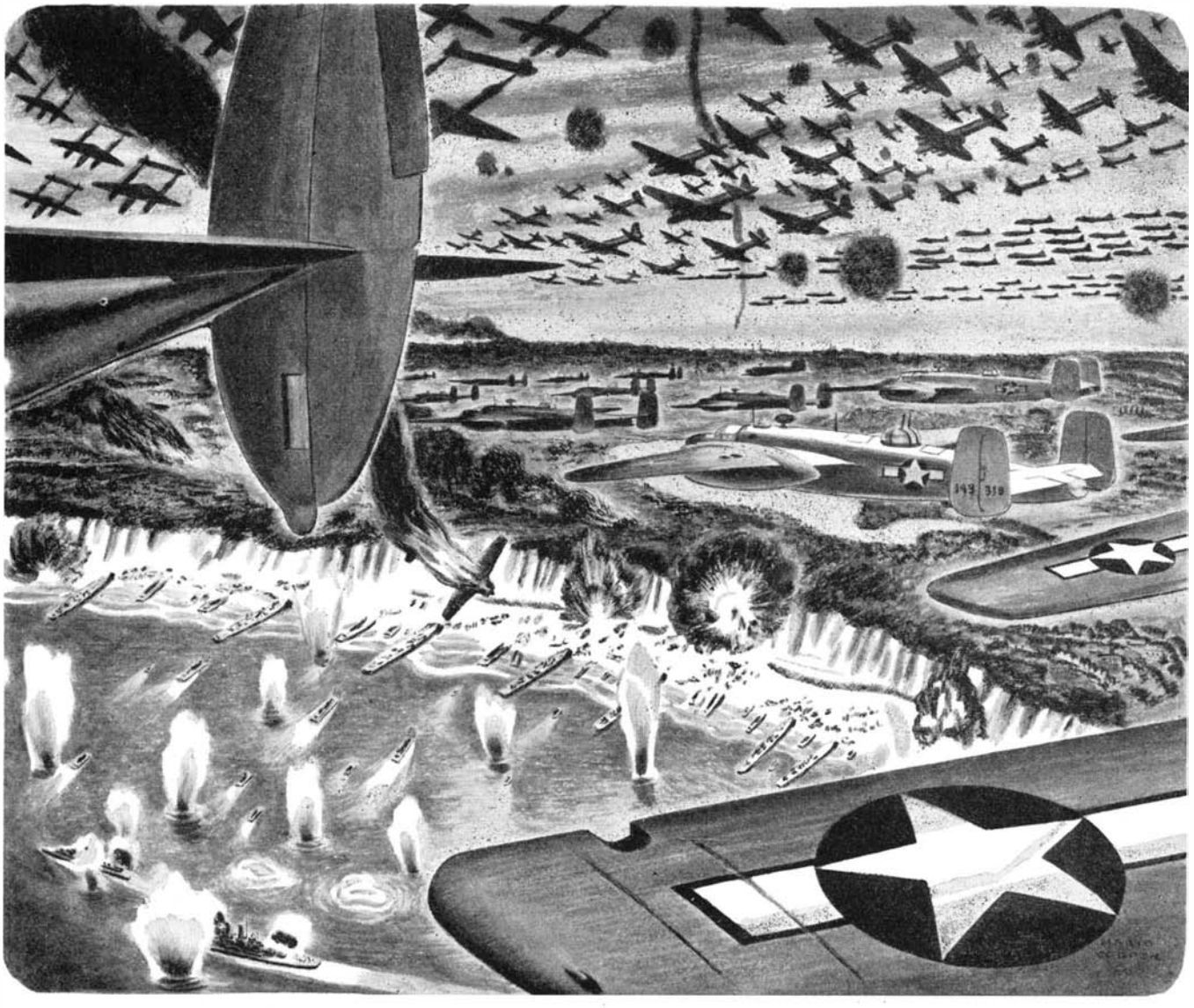
While the pilot and co-pilot of the B-29 occupy conventional positions, the complexity of the instrument board has disappeared. Pilots have just a few dials in front of them and the flight engineer back of them takes care of other instruments. Another physical and moral help lies in the fact that the bombardier is in the same cabin, on only a slightly lower level, and all four men can talk comfortably to one another in the soundproofed compartment. There are eleven men in the crew in all and all of them are comfortable, thanks to a small bunk room, chairs with sponge rubber pads, and so on. The navigator has a big desk and chart rack. All this makes a great difference on a long and dangerous assignment.

It used to be thought that there was a definite limit to the power of the aircraft power plant; and that, when the motor reached a certain size, the propeller could no longer absorb its power.

Both of these views are wrong, as is habitual with defeatist engineering predictions. The 18-cylinder Wright Cyclone produces 2200 horsepower and, while its development has meant overcoming many difficulties, it is remarkably successful. Certainly even this huge and complex engine does *not* represent the final word in engine design.

In rebuttal of the second of the two bad predictions named above, engineers have found it perfectly possible to design propellers capable of absorbing the power, and of maintaining high efficiency. First of all, Hamilton-Standard (responsible for the propeller design) built a four-bladed airscrew, with the enormous diameter of 16 feet 7 inches. Then, to avoid too high a top speed (and the compressibility shocks which might occur), they geared down the propeller to only 35/100 of the revolutions per minute of the engine. Then they used the NACA laminar-flow airfoil as a further safeguard against the effects of compressibility. Construction is of the conventional aluminum alloy type. Another interesting wrinkle in the power-plant design lies in the large duct in the nacelle nose which eliminates a multiplicity of air inlets in the wings and helps in giving the plane streamlining. Two superchargers are employed with each engine and are enclosed.

All in all the American people can be proud of the B-29, of the high ranking



It takes a lot of gasoline

TO MAKE AN UMBRELLA FOR G.I. JOE

WHEN YOU know that just one single-seater fighter carries about 500 gallons of gasoline on take-off, you can well imagine what any large-scale operation requires. The figures run into millions—and every gallon must be top quality. Fighting gasoline is the "cream" of U.S. production, practically all of which contains Ethyl fluid.

When peace is won, most of this high-octane gasoline will be able to stay home . . . and ultimately post-war automobile, truck, bus and tractor engines will be designed to get more power from high quality gasoline.

We of Ethyl look forward to working with the engineers of the automotive, petroleum and aviation industry in the development of post-war engines and fuels. Many of our research workers in Detroit and San Bernardino are now engrossed in necessary war work. When the fighting is over they will once more be ready to serve industry in the improvement of peacetime transportation.

+ + +

ETHYL CORPORATION

Manufacturer of Ethyl fluid, used by oil companies to improve the antiknock quality of aviation and motor gasoline.

GASOLINE POWERS THE ATTACK—DON'T WASTE A DROP!

officers of the AAF who sponsored it, of the test pilots and engineers who designed it, of the manufacturers, foremen, and skilled artisans who built it. They will be equally proud of the especially selected pilots, bombardiers, flight engineers, and gunners who will carry it on its missions against the enemy.

While the Superfortress is of tremendous military importance at the moment, the experimental and research work that has gone into its design and construction have written at least the first page of a new chapter in commercial air travel. Of course, not much can be said about details of the comfortization previously mentioned, but the groundwork has been laid for high-altitude flight by huge passenger planes in the near future. The same is true of many other details of the B-29, but out of such efforts by the best aeronautical brains will come faster, safer, more comfortable air transportation for the general public, plus a sounder basis for the post-war aviation industry.—*A.K.*

⊕ ⊕ ⊕

HELIUM OUTPUT

Far Greater, Cost Lower Than Ever Before

HELIUM for war use is being produced for less than two cents a cubic foot and at a rate ten times greater than the amount turned out by a single plant before the war, according to *Aviation News.*

The price of less than two cents compares with $2500 some 25 years ago. Five plants are now producing helium for anti-submarine blimps, barrage balloons, meteorological balloons, and other war uses. Production for the last six months of 1943 and the first two months of 1944 greatly exceeded production for the entire preceding 12 months.

FARM-WASTE PLASTICS

Can be Processed in Normal Manner

NOREPLAST is the name of a series of new molding compounds which have been developed from farm waste in the United States Department of Agriculture's Northern Regional Research Laboratory at Peoria, Illinois. These compounds have been tested at several industrial plants and have successfully met the molding conditions normally used.

A company in West Virginia is now actively undertaking the commercialization of Noreplast. Another company in Ohio is considering Noreplast formulation for the post-war manufacture of toys.

A number of Noreplast formulations have been developed and rather thoroughly studied. Dr. O. E. May, Chief of the Bureau of Agricultural and Industrial Chemistry which operates the Peoria Laboratory, states that one of the significant things about this new plastic is that it can be made with one half the phenol-formaldehyde resin—a critical war material—commonly required in the manufacture of this type of plastic. All formulas contain 50 percent or more ground agricultural residues, such as wheat straw, flax shives, cornstalks, peanut shells, and so on, and some are mixtures of these. The formulas differ specifically in the amount of phenol-formaldehyde resin, either liquid or dry form, and in the percent of a special plasticizer designed specifically to produce rapid flow during the molding operation. The percent phenol-formaldehyde resin varies from

Courtesy Northern Regional Research Laboratory
Cornstalks being placed in a digester as first step in plastic making

47 to 25 percent, the plasticizer from zero to 15 percent.

Any of these Noreplast formulas will mold in the regular commercial moldings cycle and will produce articles having strength and finish characteristics approximately equal to general-purpose phenolic resins containing approximately 50 percent phenol-formaldehyde and 50 percent wood flour.

Water resistance in military articles is of considerable importance. Military specifications which Noreplast might serve have been set up on the basis of general-purpose phenolics. It has been found that as the percent of phenol-formaldehyde is decreased in Noreplast formulation from 47 percent to 25 percent the water resistance decreases. Noreplast with 47 percent phenol-formaldehyde content will meet military requirements, and 35 percent is satisfactory for some things. Requirements for strength and finish are met with a content of 28 percent but the water resistance is too low.

To prepare Noreplast, finely-ground agricultural residue is mixed with the dry or liquid phenolic resin, the powdered plasticizer, catalyst, lubricant, and coloring agents in a dough mixer or other machine capable of producing a uniform mixture. The mixture is then rolled between heated differential rolls to obtain the desired characteristics of density, flow, and setting time. The rolled sheets are then ground and screened to produce the molding compound ready for use. In experimental molding tests to ascertain the molding speed of the new plastic, it took about 2½ minutes to mold a pencil tray, pin tray, or a cup; about 23 seconds for a bottle cap; 2 1/3 minutes for a safety razor; and 3 to 4 minutes for the distributor head for an automobile ignition system.

The natural color of the molded product ranges from light brown to black, but products ranging from ivory or very light tan through light blues, greens, reds, browns, blacks, or mixtures of these colors can be made by the use of appropriate dyes and pigments. Flax shives, wheat straw, cornstalks, tobacco stalks, tobacco stems, peanut shells, and soybean hulls are the agricultural residues which have been compounded and examined. The particular residue to be used depends upon which one is the most economically available to the producer.—*The Chemurgic Digest.*

CONTINUOUS HEAT TREATMENT

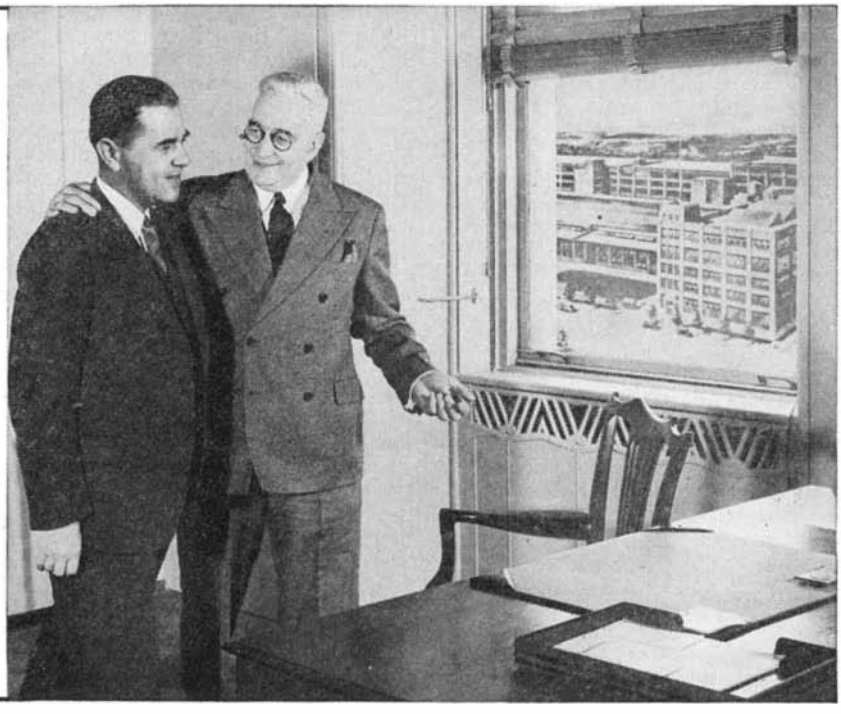
Made Possible by Use of High-Frequency Energy

THE FIRST production-line process of high-speed continuous heat treating, using Megatherm high-frequency energy, has been established by the Industrial Electronics Division, Federal Telephone and Radio Corporation. The application is to finished bearing pins, each 2½ inches long by ½ inch in diameter, case hardened to a depth of .025 inch as they are fed automatically through a glass tube and water quenched as they leave the heating coil at the rate of 75 bearing pins per minute.

High-frequency induction heating is the only known process capable of this performance. Employing five-megacycle energy, the surface of each part treated is heated above its critical temperature in less than one second. Due to the high speed with which the heat is applied to the surface, there is insufficient time for it to penetrate into the core and, in consequence, only a thin surface layer experiences a change in physical state. This means that the

Production-line heat-treating set-up and, inset photomicrograph of hardened surface of a bearing pin

Want to join the management?



OF COURSE, you do. No one choosing business as a career wants to remain among the rank-and-file employees when there is a chance to take on the responsibilities, prestige and financial rewards of top executive positions. And such opportunities are always open.

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- ☐ Super-Service and Salesmanship
- ☐ **Show-Card Lettering**
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central portion retains all its original toughness and strength.

The factory application of this process to continuous production-line surface hardening of bearing pins involves the following equipment: the hopper from which the unhardened parts are fed into the glass tube; the heating coil; the Megatherm induction units; a connection providing a continuous flow of water for quenching, and an ordinary work table carrying suitable containers for the finished and hardened product as ejected from the heating fixture.

The pins are finish ground prior to heat treating, and after the hardening process there is no scale or warpage. This is due to high speed of the process, which makes possible the surface hardening of parts after finish grinding. By the elimination of much costly finishing, which heretofore has been required on hardened steel parts, immense savings are effected.

The coil used in this bearing pin application is a single layer approximately one inch long by ¾ of an inch in diameter. It consists of five turns of small copper tubing, and is a permanent fixture which does not experience wear or deterioration. The water-cooled coil is grounded and does not carry high voltage.

The bearing pin application is only one of a family which includes a wide range of shafts, bearings, round and flat surfaces, zones, spots, cam surfaces, gear teeth, lever ends, and other common machine tool parts. The method has been applied to pieces as small as ⅛ inch in diameter and to bearing surfaces up to six inches in diameter. All applications are characterized by high speed, the fact that a uniform thin surface layer of hardened material is obtained, and by freedom from distortion.

STEEL STIFFNESS

Shown to be Greater Than That of Cast Iron

A SIMPLE device for demonstrating the stiffness superiority of steel over cast iron is shown in the accompanying illustrations.

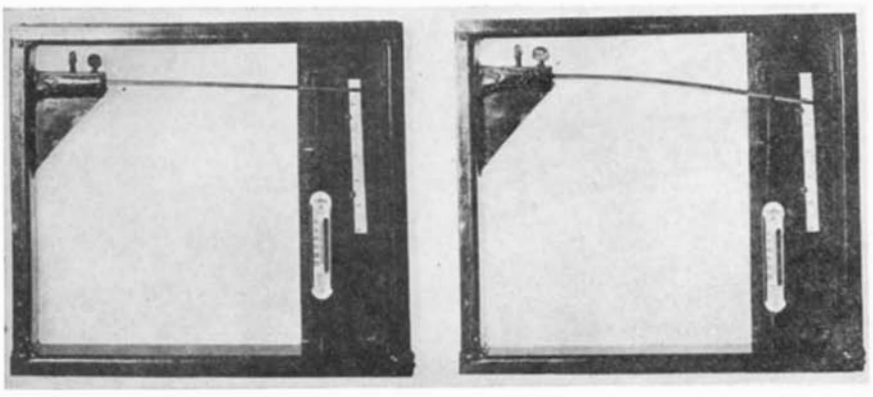
The testing unit was devised by C. W. Lytton, welding engineer of The Lincoln Electric Company. It consists of a square-shaped jig made of 2 by ¾ by 5/32-inch channels welded at the joints to form a 15½ by 13½-inch structure.

In demonstrating, two bars of equal size are used, one of steel and the other of cast iron. The first illustration shows the jig with a 12-inch steel bar, ½-inch wide by ⅛-inch thick, with one end inserted 1½ inches in a clamping support. A load of 2½ pounds has been applied through a rod attached to a small scale, the other end of the rod being attached to the steel bar exactly 9¾ inches from the fixed support.

Deflection of the steel rod under this load is 15/32-inch, as shown by the rule fastened at the right of the jig.

The second illustration shows the results of a similar test using a cast iron bar of the same size with a 2½ pound load applied at the same point. Here, the deflection measures 1 5/32 inches as shown on the rule, thus proving that the steel bar is 2.44 times as stiff as cast iron from the standpoint of deflection.

The results shown by this simple testing jig support laboratory tests of a similar nature which prove that steel is not only stiffer than cast iron but is also more resistant to fatigue, shock, and impact and is extremely ductile, thus fulfilling many design requirements.



A jig for demonstrating stiffness of steel (left) and cast iron (right)

TORQUEMETER

Extends Bomber Range, Has Other Applications

A "MAGNETIC TAILWIND" that will enable American bombers to reach targets 100 miles or more beyond their present range has been developed at the Westinghouse Research Laboratories. The "tailwind" is a new magnetic-coupled torquemeter which makes it possible for a bomber pilot to determine the power output of his engines 10 to 15 times more accurately than with the method now commonly used. With this precise information, it is easy to adjust the engines to achieve maximum fuel economy, squeezing 5 to 10 percent more miles out of each gallon of high-octane gasoline.

The torquemeter conveys its information to the pilot by measuring the "twist" in the hollow steel shaft connecting a bomber engine to its propeller. The amount of twist—it may be only a few thousandths of an inch for a distance of several inches along the shaft—is an accurate measure of the driving force delivered to the propeller by the engine.

Vital part of the torquemeter is a stationary metal sleeve and coil assembly

The torquemeter is sensitive enough to measure the degree of twist exerted in a steel shaft by the hands

which encircles the propeller shaft. Projecting from rings on the propeller shaft are two sets of gear-like teeth whose faces are a few thousandths of an inch apart. As the propeller shaft twists under load, the relationship between these teeth changes. Invisible magnetic "fingers" extending across the gap between the metal sleeve and the shaft detect this change and report it electrically to the dial on the instrument on the board. The torquemeter enables the pilot to figure an engine's horsepower within 1 or 2 percent. With this knowledge he can adjust each engine's throttle, fuel-air ratio, and propeller pitch so all engines are delivering power at the same rate and at peak economy.

Other magnetic torquemeters are destined for use in laboratories where new types of aircraft, truck, and tank engines are being developed, and in naval laboratories, where engineers need accurate measurements of the power transmitted by a ship's propeller shaft, a set of reduction gears, or a whirling turbine.

ACID CARRIERS

Designed for Use on Air-Cargo Transports

ANOTHER knotty problem of air-cargo transportation has been solved with the use of synthetics. Dangerous corrosive acids such as hydrofluoric and a wide variety of solvents may now be transported in collapsible emergency containers as a result of further development by United States Rubber Company of synthetic products.

These containers are made in flexible disk form and measure 56 inches in diameter. They are assembled in two parts in sheet form. One is a light cotton fabric which is treated with vinylite. The other is coated with synthetic rubber. They are held together with small eyelets spaced about three inches apart which are stapled into the material. A light-weight cord is drawn through the eyelets. The completed article is then ready to be placed around either a glass or metal container and drawn tight, much as a tobacco

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Standard Equipment . . . No Extra Cost! Now, to Zenith's famous precision quality, years of research have added another great advance: an entirely new standard of smartness and style!

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How Can $40 Buy This Fine Precision Quality? Because mass production makes possible far greater precision than small production, and at the same time it cuts costs. This is simply Zenith history repeating itself. Zenith portable radios once sold for $200. Mass production made them better, and lowered the price to $29! Zenith's leadership in PRECISION MASS PRODUCTION is the reason you enjoy Zenith's *highest quality* in a hearing aid at $40!

YESTERDAY

Gone is the Old "Black Button and Cord"

Note how Zenith's NEW NEUTRAL-COLOR EARPHONE is scarcely noticeable by comparison with "black button." Complements any complexion. Feather-light, comfortable, made of long-wearing plastic.

New TRANSLUCENT PLASTIC CORD, too, looks well with any apparel. Washable . . . perspiration-proof . . . kink-proof. Will not fray. Also gives less friction or clothing noise than the old type fabric covered cord.

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pouch, to insure against spillage on any part of the plane.

The need for this article was found when Army aircraft engineers found that spillage of acid resulting from accidental breakage while in transit was seeping into the frames of planes which carried this corrosive cargo and doing untold damage to the fuselage. This method of shipping has completely eliminated this hazard.

Should breakage occur or should the caps of the containers become loosened owing to vibration, the acids now spill into the emergency wrapping. A flexible hose is inserted into a rubber disk which is placed into the top of the container before the draw strings are tightened. The acid fumes are carried off through this tube, thereby completely dispelling any possibility of damage from fumes or liquid.

RECORD FILMS

Made Accurately by New Process

A SIMPLE and economical method of condensing and preserving vital records for an indefinite period is announced by Microcopy Corporation in the Microcopy Translite Hi-Reduction process. This is the application of microfilming to engineering drawings, as well as any other valuable record, document, drawing, map, or similar material kept in industrial manufacturing plant files. Because of the high-fidelity translite feature, it is particularly adaptable to engineering drawings, in pencil on transparent paper.

Microcopy, being a photographic record, is a faithful copy of the material microfilmed. The negative can be used to make copies on other pieces of film or to enlarge and make copies of the original in any size desired, whether actual, larger, or smaller. These copies may be made on tracing paper, cloth or film. As many film duplicates as desired may be made. Thus, duplicates made may be transmitted to branches, service depots, and other points.

For reading Microcopy, a Microcopy Multiple-Magnification Viewer is supplied in various models. This Viewer, operated on a motion picture film projector principle, is operated from a control panel. It facilitates finding locations on films by permitting enlargements to be made on the screen, as well as permitting any portion of the frame to be centralized within the frame for easier reading.

Microfilm image projected on screen of multiple-magnification viewer

SCIENCE EDUCATION

Needed to Meet the Coming "Automatic Age"

AGGRESSIVE methods for capitalizing the immense "stockpile" of scientific knowledge built up in accelerated wartime research must include a broad educational program directed to the millions of average Americans who will want and use the improved products of the future, says Ernest R. Breech, president of Bendix Aviation Corporation.

"If industry is to maintain its status, re-established in this war, as the main driving force in American life, it must take the lead in coordinating science with mass education," he declares.

Stepped-up product development and amazing progress in mass production methods to meet war's unprecedented requirements for scientific devices, he points out, has brought the world 10 to 20 years closer to an ultimate "automatic age," destined to "remove drudgery, brute force, and awkwardness from the every-day lives of millions."

"Grappling with the realities of a scientific war for survival," Breech points out, "a large segment of Americans—including millions of American men and women on the battlefront and home production front—have speedily acquired a close-up practical education in basic and even advanced sciences that were little more than words to them a few years ago.

"In many cases, particularly in the armed forces, their intensive streamlined training has given them a more complete and workable practical scientific education than the average college graduate possessed 10 years ago. For they have learned to produce and master the efficient use of equipment which represents the highest peaks of development in electronics, hydraulics, electromechanics, aeronautics, the mechanical arts, chemistry, medicine, and physics.

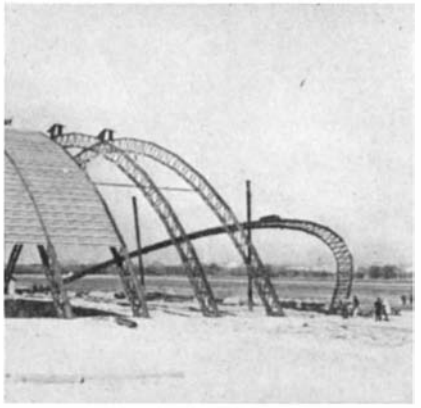
"Their rediscovered faith in scientific progress and the immense stockpile of personal ingenuity and practical knowledge they have built up the hard way in this war constitutes one of the nation's most valuable assets in translating wartime technical advances into terms of the common good.

"But we must plan now to use and expand this tremendous educational force to develop a buying public keenly aware of the new opportunities that will be open," he concludes.

PORTABLE HANGAR

Assembled from Steel Arches and Panels

SIMPLICITY of erection and saving of critical materials are among the advantages claimed for a new portable steel hangar building designed and manufactured by The American Rolling Mill Company. It is reported to be capable of carrying a higher load per pound of steel than any other current designs.



Up goes a hangar arch

Two sizes of hangar have been built to date, one with an inside width at the base of 152 feet and a height of 36 feet, 7 inches; the other with a width of 192 feet and a height of 48 feet. The length may be any multiple of 17½ feet.

The arches, assembled at ground level, are made up of pressed metal units bolted together into segments that are identical and interchangeable. Space between the arches is covered with standard Steelox panels. These span from arch to arch, serving both as purlins and roofing. They are bolted to the top chord of the arches. These panels are the same as have been in use for frameless steel building construction. The ends of the hangar, including the doors, are built of Steelox panels. A new type of multiple door section is supported on a single bottom rail.

ENGINES OF WAR

Provide Power For Global Fighting on Land, Sea, and In The Air

NIGHT and day, America's No. 1 mechanical hero, the internal combustion engine, is blasting away at the enemy's stronghold from land, sea, and air in a mighty outburst of power.

A steady toiler in peace and a raging force in war, the internal combustion engine has taken on many new roles in this global conflict, powering a variety of craft from Ducks and PT boats, to jeeps and 400-mile-an-hour fighter planes.

Engines by the carload have rolled from automotive assembly lines since the war began. Ranging from small stationary engines to the huge power plants of super-bombers and superfighters, they are providing America's fighting men with unexcelled performance on land, on sea, and in the air.

Horsepower potential of these engines, not available because of so many weapons still on the secret list, would be almost unbelievable. However, the 220,000 aircraft engines alone, that have been delivered by the automotive industry, represent the astronomical total of 297,150,000 horsepower. This is equivalent to the combined generating capacity of 84 Boulder Dams and 56 Grand Coulee Dams. Or, it is

equal to nearly 30 horsepower for every man in the armed forces.

Automotive research and development in the Diesel type of internal combustion engine is mainly responsible for the startling fact that Diesel power now exceeds steam power in the United States Navy.

All the four major type landing craft, so prominent in current invasion dispatches, are powered by Diesels, 71 percent of which are produced by a single automotive company.

The powerful gasoline engines of the Navy's sensational PT boats are an exclusive product of another automotive firm—a development going back to the Detroit River speed-boat races.

Even the Army's reliable foot soldiers, the men of the infantry divisions, have 400,000 horsepower per division at their disposal. Representing an 11,000 percent increase over the 3200 horsepower of the World War I infantry division, the mobility of today's infantry points up the progress that has been made by automotive engineers since the end of World War I.

More than two and a quarter million military vehicles have been produced by the automotive industry since the present war began in 1939. The horsepower represented in these vehicles, combined with the automotive-produced engines for tanks and ships, planes and submarines, and the thousands of other wartime uses of the internal combustion engine, presents a staggering total. It adds authority to the recent statement of a high Army officer that "this is a war of motors."—*Automotive War Production.*

WATER REPELLANT

Fabric Designed on New Hypothesis

A NEW type of water-repellent cotton fabric, whose water-resisting properties are due largely to the unique construction of the cloth, has been developed by Dr. F. T. Peirce of the British Cotton Industry Research Association, at Shirley Institute, according to *Textile World.* Reports from England indicate that the Shirley method is being employed in the manufacture of fire hose, canvas, and raincoat fabrics, and recently some experiments have been carried out in this country on production of similar types of water-repellent fabrics.

"In his experiments," says *Textile World,* "Dr. Peirce worked on the hypothesis that if the cotton fibers in a fabrics were in such a condition that they could swell when moistened, they would, in contact with water, block up the interstices in the cloth, thereby making it water-repellent and water-resistant."

FIREPROOF UPHOLSTERY

Is Also Resistant to Oil and Gasoline

NEW plastic fireproof upholstery has been ordered by the Navy as mandatory equipment for all combat ships, to provide added protection against fire. The upholstery covering, which will be used on furniture of all new Navy combat ships and old ships returning to service after repairs, is non-smoldering, gasoline and oil-resistant, and extremely durable under wide temperature ranges. It is also being used as turret lining and seat covering in both bomber and fighter planes.

The plastic upholstery will provide for the first time, in peace years, a fireproof upholstery for use in night clubs, theaters, civilian airplanes, passenger ships, buses and trucks, and so on.

Before the fireproof upholstery was submitted to the Bureau of Ships, the United States Rubber Company submitted the material to many rigid tests. In the fire test the material was suspended for 12 seconds in the flame of a Bunsen gas burner. After removal, it burned less than two seconds.

To prove its resistance to high temperature, it was exposed for three hours at 180 degrees, Fahrenheit, without becoming soft and tacky. To prove its resistance to low temperature, it was subjected to a temperature of -40 degrees, Fahrenheit, without cracking when sharply creased. After exposure to oil for an hour, it showed no permeation of the fluid or other ill effect. After exposure to gasoline for a minute, it showed no permeation of the fluid or other ill effect.

Because fire and smoke caused loss of combat ships, the Navy asked United States Rubber Company during the fall of 1941 to develop a fireproof covering for berths that would climinate the haz-

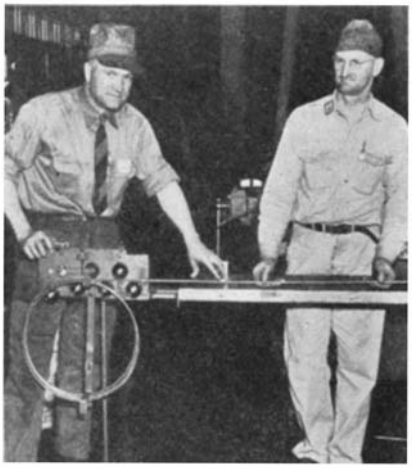
ard of burning or smoldering mattresses and bed covers.

Through the use of synthetic resins, laboratory technicians in one of the company's plants perfected a fireproof compound to be used as a coating on a fireproof base fabric—developing for the first time a coated fabric that was fireproof as well as waterproof. Later the material was improved to include resistance to oil, gasoline, salt water, and perspiration and to provide durability over wide temperature ranges.

TUBING STRAIGHTENER

Saves Valuable Man-Hours in Industry

A DEVICE which speeds up a time-consuming operation—that of straightening rolled steel tubing—has been devised by two employees at one of the plants of The Cooper-Bessemer Corporation. Typical of many practical ideas that have been conceived by workmen and put into use to increase efficiency in various industries, the tube straightener is one of the simplest of labor-saving tools. Made of a few odds and ends of metal and a series of five rollers, the device eliminates former hand-straightening operations which



Worker-devised tubing straightener

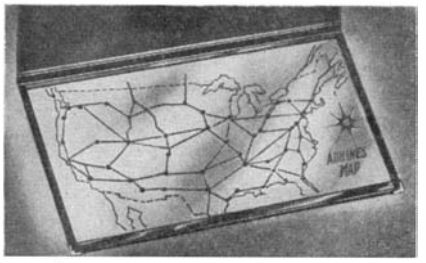
consumed valuable man-hours that can now be utilized in more productive work.

The tubing, of 1/4- and 5/16-inch diameter, is received in large coils and previously had to be unwound as needed, straightened with a paddle, then bent and formed to fit a specific connection. With the device shown in the accompanying illustration, the coil is simply positioned over a bracket at the side of the contrivance, the loose end is threaded through the rollers, and the tubing is straightened by pulling it out along a horizontal tray where it is measured and cut off to the required length.

FLUORESCENT ENVELOPES

Make Contents Visible Under "Black Light"

FLUORESCENT plastic envelopes are making night map reading possible aboard Allied planes, ships, and small boats



The envelope illuminates the chart

without the need of blacked-out quarters in the navigator's compartment.

"Plastacele" cellulose acetate plastic incorporating a fluorescent pigment emits a minimum glow sufficient to make descriptive material covered by the envelope visible under the "black light" of near ultra-violet rays. Visibility of materials enclosed by the envelopes is also good under ordinary white light or in daylight.

Already at least one commercial airline is planning to make use of this interesting war-time development in its post-war operations.

HEAVY-DUTY OILS

Post-War Motorists Will Benefit from Technical Progress

HEAVY-DUTY lubricating oils satisfactory for use in internal combustion engines under extremes of heat, cold, and service have been developed for the United States Army by the automotive and petroleum industries, according to Captain W. B. Bassett, Office, Chief of Ordnance, Technical Division.

Describing the development before the recent SAE National Diesel-Fuels and Lubricants Meeting, Captain Bassett said that the oils, containing complex compounds assuring stability under heat, low pour points in cold weather, resistance to corrosion, and adequate detergency, have been standardized for use in the Army's Diesel and gasoline engines. Some of the oils were ready for public use just before the war, he added, but shortages and military requirements have restricted their use until post-war.

Typical of the performance of the oils in service, Captain Bassett explained, are results of a 5000-mile test run with cargo trucks. Operated without oil change and with crankcase temperatures held at 280 degrees, Fahrenheit, the engines were said to have been found in unusually good condition, with piston rings free, no deposits evident, no sludge accumulated.

UNIT REFRIGERATION

Saves Weight and Space On Board Ship

NEARLY 1600 square feet of vital cargo area and more than 16,000 man-hours of installation time will be saved on 133 of the nation's new Victory ships by a compact new packaged refrigeration plant, a development of the York Corporation engineering laboratories in collaboration with naval architects.

By conserving weight, space, and vital material through the design of the new unit, ample refrigerated stores of fresh foods will be made available even on extended voyages. Outstanding feature of the packaged plants is the combination of twin refrigeration compressors, receivers, condensers, and all refrigerator auxiliaries which, by means of cross connections, can be operated separately on both high and low temperature rooms. In emergencies, either compressor can be connected to carry both high and low temperatures simultaneously.

Refrigerant receivers for the plants form an integral structural part of the base, thus increasing the rigidity of framework at the minimum of weight. Built in the form of a rectangle, all piping and valves are located for easy accessibility to all parts. In addition to their application for ship stores refrigeration on the Victory ships, York is now building similar packaged units for other type vessels.

With the exception of piping connections to cooling coils and water supply, the new unitary apparatus is ready to use when shipped, saving valuable assembly time.

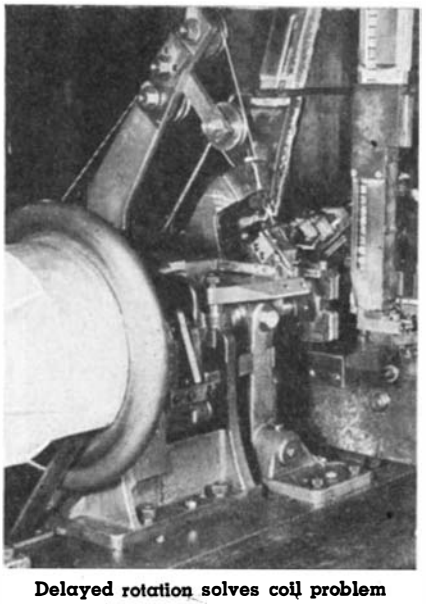
COIL WINDER

Delays First Turn to Meet Specifications

THE PRINCIPLE of the "delayed buck" of the gridiron is helping to produce generator armature coils. As the husky fullback is delayed a second before crashing into the line, so a strand of wire is delayed before it is sent spinning to form a coil.

Engineers of the Electric Auto-Lite Company developed the machine for winding the armature coils of a popular type of generator that has two windings—one of four turns and another of three turns of wire. However, the two windings must be made together so that they can be fastened into one unit before being inserted in the armature.

At first the coils were wound from two stands of wire in a rectangular form, after which the operator cut one turn away—a process which not only



Delayed rotation solves coil problem

delayed production but also necessitated the waste of about 12 inches of wire.

After many experiments a machine design was developed which delayed the rotation of the second part of the winding form until the first wire had made one complete turn.

After this turn had been wound, the three additional turns are wound with both wires to complete the coil. This gave four turns on one coil and three turns of the other coil as specified.

CERAMIC DEFECTS

Revealed by Penetrating Eye of the X-Ray

SOME interesting developments on the application of x-rays to ceramic materials and products have been disclosed as the result of co-operation between 20 ceramic companies and North American Philips Company, Inc., in the investigation of problems involving refractories, glass, insulators, crucibles, and chinaware.

Radiographs show that plate glass and lead glass—which look the same to the naked eye—are radically different when photographed by x-rays. Since lead greatly affects ray absorption, it is possible to detect small differences in lead content. Radiographs of fire brick and refractory furnace orifice rings reveal hidden defects, not visible on the exterior. Bread plates which were radiographed before and after glazing showed the uneven distribution of the glaze after firing. Glaze mixtures usually contain compounds having high atomic weights (high ray absorption) and, though applied in thin layers, differences in thickness show up remarkably well.

MATERIAL HANDLING

Adds to Cost but Not to Value

MATERIAL handling is the greatest single item of labor cost in most industries, according to Randolph W. Mallick, Section Engineer of Westinghouse. "In the United States alone it constitutes about 22 percent of labor costs and represents approximately a $4,000,000,000 payroll annually.

"Material handling is one very important operation in industry which adds only to the cost and nothing to the sales value of the product. The ultimate consumer is interested only in the quality and usability of the product, and in most instances these things suffer when the product is handled unnecessarily and excessively. In handling, parts are often damaged, lost, misplaced, and require additional use of time and facilities.

"Intensive studies of effective work areas have proved that work areas within the range of a normal sweep of an operator's hands are the most effective for a given performance," Mr. Mallick continues. "Time lengthens the manufacturing cycle. The longer the manufacturing cycle the lower the total output in a given period. The lower the output, the higher the cost.

"We know that if material can be brought to an operator at a steady rate, to a predetermined position, and taken away from an operator at a constant rate, from a fixed discharge point, then the operator's effort will be used in the most effective manner. This is an ideal condition, and while it would not be the answer to every problem, much can be done by using this ideal condition as a nucleus around which to work. Just casually watch some person doing something in the course of his every-day work and mentally visualize how that simple operation could be improved. We must recognize the fact that persons are not normally conscious of doing things in the most effective manner. Habit has much to do with it.

"In many industries today we have such machines whose output is largely dependent upon the effectiveness of the operator. If the operator is burdened with material handling, then he is not producing to the best possible advantage, nor is the machine, which represents a capital investment, and possibly today, a critical part of our war effort. I have seen machines perform operations in fractions of a second while the material handling preparation required ten-fold that amount of time.

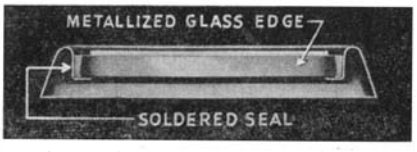
"Although we classify industries as continuous-flow, such as oil refineries, distilleries, certain foodstuff industries, and the like, and intermittent-manufacturing industries, such as most of the equipment and apparatus plants, we are prone to accept these classifications too definitely. It is possible and it should be a goal for all plant-layout and material-handling engineers to try to ap-

ply the principle of continuous flow to as many operations in intermittent industries as possible," Mr. Mallick concludes. "Each time material is stopped in its cycle of process or is set down and picked up, we add to the cost of the product."

GLASS-TO-METAL

Soldering Made Possible By Metallizing

AN EXAMPLE of unusual uses for metallizing is to be found in American Meter Company's soldered seal index box for gas meters. This unit employs a Pyrex glass window which is soldered to its



Sprayed copper permits soldering

metal frame. Gas-tight, air-tight, shock-proof, and unharmed by repeated washing in the cleaning solutions used in meter repair work, this remarkable bond between two such dissimilar materials owes its permanence to metallizing.

Copper is first sprayed on the edges of the glass, providing a perfect surface for the solder which seals glass and metal frame together. In most applications of this type, the only preparation necessary is to heat the glass prior to metallizing. This method of preparing glass for metallizing is used for many other applications, including the sealing edges for double windows used in store refrigerators, and for reflective and masked surfaces on light bulbs.—*Metco News.*

PUMPING WITH AIR

Gritty Liquids Can be Handled With Quickly Rigged Equipment

COMPRESSED air has been applied to actual lifting of water and other liquids from wells for better than half a century, but only in more recent years has engineering knowledge overcome a popular misconception regarding its utility and performance.

The most universal application is, of course, in the pumping of water or oil from wells.

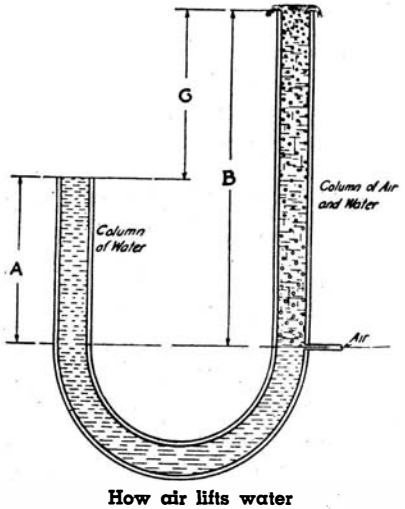
Consider an open well, or any body of water deep enough, regardless of its volume or the nature of its enclosure—a pond, lake, or river. In the water is fixed a vertical pipe for water and a pipe for compressed air. These pipes should be submerged for a certain depth proportionate to the lift when the pump is at work.

It is understandable that the water, being free to enter the lower end of the pipe, will rise to the same height inside the pipe as it stands outside the pipe. Now, if air is introduced under pressure through the air pipe into the base of the water pipe, the result will be an air lift pump. The question at once arises as to what will prevent the air from going down and thus discharging the water from the lower end of the water pipe rather than forcing the water up through the pipe?

The answer is this: The air operates as a pump to lift the water because the unbalanced hydrostatic pressure in the discharge pipe is from a mixed column of water and bubbles of air of lower specific gravity than the water outside the pipe or below the air entrance. Thus the flow is started as this modified water seeks a higher level, due to its lighter weight and the unmodified water is constantly being forced up by its own equalizing pressure into this lighter mixture. A continuous flow of compressed air into the discharge pipe creates a continuous pumping action. The amount of flow is dependent upon the amount and pressure of the compressed air introduced.

Advantages of the air lift include the ability to handle gritty liquids and acids without damage to pumping efficiency.

The principle of pumping with compressed air rather than with mechanical devices, has logical applications in many fields. Contractors who have air compressors also have air pumps. They could use the principle here described for emptying water-filled excavations or for filling supply reservoirs from adjacent streams and lakes. In the oil fields, the compressed air pump can be



How air lifts water

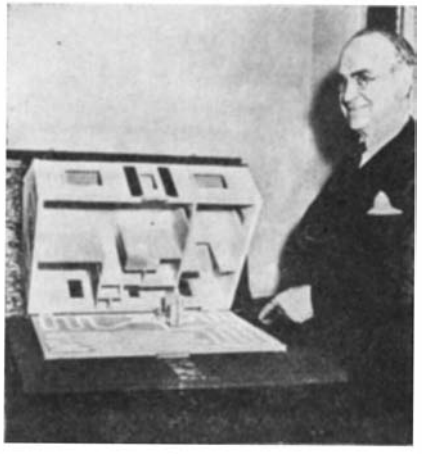
used to transfer impounded oil into storage, to repressure and pump out sluggish wells. An air lift pump can be rigged up quickly to "bail out" ships' holds or to fill tanks of ships operating in fresh water.

RADIANT HEATING

Demonstrated by Hinged Model

RADIANT heating, which some architects and engineers affirm will be one of the three or four revolutionary ideas to be accepted generally by the building industry after the war, already has achieved nearly a thousand recorded installations in this country, according to L. F. Rains, president of A. M. Byers Company, who have pioneered development of the system.

Radiant heating is considered to be particularly applicable to industrial and commercial structures, with special interest being demonstrated by architects and engineers concerned with factory, hospital, school, church, airport, and public building construction, Mr. Rains states.



Display shows heating pipes

To demonstrate in simple manner how the system functions, the company is equipping its staff of field service engineers with miniature displays like the one with which Mr. Rains is shown.

The display, hinged at the back, can be raised to reveal transparent flooring in which is embedded illuminated tubing. This tubing simulates the wrought iron pipe coils through which, in actual installations, hot water is circulated to convert the entire floor into a heat radiating surface.

WATER SOLUBLE

Cellulose Derivative Exhibits Useful Properties

SODIUM carboxy-methyl-cellulose, a cellulose derivative which is soluble in water, introduced by Hercules Powder Company, is undergoing experimental research to determine the suitability of the material in the manufacture of emulsions, paints, and textiles, and in the oil and other industries.

Now in small-scale production, the chemical is available in experimental quantities only. Properties of sodium carboxy-methyl-cellulose make it a stabilizer emulsifying agent.

"The material should be useful where hydrophilic colloids possessing marked suspending, thickening, stabilizing, and film-forming properties are required," the company says. "Some of its possible applications are to thicken textile printing pastes, to emulsify emulsion paints and lacquers, and to provide a protective colloid for oil-in-water emulsions.

"Its film-forming properties make it useful in coatings, particularly for greaseproof coatings. Other uses for the water soluble colloid are in the manufacture of boiler compounds, creaming latex, oil drilling muds, ceramics, can sealing compounds, anti-stick compounds, leather finishes and many other industries.

"Sodium carboxy-methyl-cellulose is supplied as a white, granular powder, odorless, tasteless, and readily soluble or dispersible in water. Very viscous, stable aqueous solutions can be ob-

tained with it. Aqueous solutions can be evaporated, leaving colorless, tough, transparent films which are unaffected by the common organic solvents, oils, fats, and greases. Some salts and acids react with sodium carboxy-methyl-cellulose films insoluble in water."

Tables and data have been prepared by the company showing viscosity, effects of salts and acids, compatibility with various materials, and physical, chemical and other properties.

MILDEW-KILLER

Is Non-Poisonous, Easy to Use

To KILL and prevent mildew is the aim of a new product, called Mil-du-rid, which is believed to be the first fungicide for home use. Hi herto, such fungicides have been for industrial or agricultural purposes and have contained poisonous ingredients unsuitable for household use. Its need and its performance have been amply demonstrated on military fabrics under field conditions in the tropics.

Mil-du-rid can be used safely anywhere in the home . . . on shoes, luggage, books, clothing, rugs, furniture, walls, floors, closets, basements. It can be wiped or sprayed on and will not harm anything water itself does not harm.

Laboratory research has perfected the formula which will kill and prevent the growth of mildew on all types of materials and textiles found in the average home. Mil-du-rid is a highly concentrated liquid which consumers can use either full strength or diluted with as much as 50 parts of water, depending on the specific use.

SPEEDWAY EYES

Necessary for Safety On Post-War Highways

EYES of millions of American automobile drivers would be menaces on the proposed national system of speedways which would be designed for cruising speeds of not less than 75 miles an hour.

Although the visual qualifications of drivers in respect to high speeds are almost wholly neglected by automotive safety organizations, enough facts have come to light to show that eyes of drivers have an important bearing on safety, and that many drivers now are operating their cars at speeds beyond their visual qualifications, says the Better Vision Institute.

A series of studies on the relation of seeing distances to car speeds was made at Iowa State College, which led A. R. Lauer, associate professor of psychology, to conclude that unrestricted driver licenses should be given only to those having "at least 20/40 vision in both eyes, or 20/30 vision in one eye. When vision reaches 20/80 or 20/100 it may be best to limit the applicant to daylight driving or to speeds below 30 miles an hour." For eyes with natural acuity of less than 20/100, he recommends top speeds of under 25 miles an hour, saying that such "recommended speeds will seem quite low, but they are calculated in accordance with the known facts of seeing and stopping distances. They actually represent the safe speeds for the classes of drivers concerned."

COLD TREATING

Develops Physical Changes in Metals

COLD treatment of metals—very cold—ranging from 80 to 130 degrees below zero, was described recently by G. B. Berlien, Chief Metallurgist of the Lindberg Steel Treating Company, at a meeting of the American Society of Mechanical Engineers. In a paper entitled "Sub-Zero Refrigeration Applied to Tool Steels," Mr. Berlien said in part:

"All of us who are working with metals that respond to heat treatment are aware of the fact that various cooling mediums, such as salt brine, water, oil, hot lead, and hot salt, are used to provide suitable rates of cooling for the type of steel being treated. Discussions of the use of these quenching mediums inferred that quenching would reach its ultimate in effect at room temperature or slightly above room temperature.

"Science is seldom satisfied with the ordinary concept of supposed truths and therefore investigators decided to find out whether there could be any further change in the structure of metals that were cooled far lower than room temperature. Early investigations were made using liquified gases, such as liquid air, liquid oxygen, and liquid nitrogen. Solidified carbon dioxide, or dry ice, also served to supply an intermediate temperature between room temperature and the temperature of the liquid gas.

"Several physical changes were noted in metals that had been quenched to very low temperatures. First, there was an increase in magnetic qualities. Also, a volume increase that was permanent at room temperature after such treatment was an important factor. Along with the above two changes, there oc-

curred an increase in hardness sufficient to detect with conventional hardness indicators, such as the Rockwell machine. The temperature required for these changes ranged from 80 degrees below zero, Fahrenheit, to 130 degrees below zero. The temperature requirements are governed by the alloy content of the material in much the same way as the hardening temperatures are governed by the same factor. With these facts in mind, it is then up to those who are actually processing parts to employ the changes that can be made to occur and be beneficial to the part being treated."

DIESEL LOCOMOTIVES

To Be Used in Competitive Experimental Operation

LOOKING forward to post-war improvements in its motive power, the New York Central System has placed in experimental operation two Diesel freight road locomotives of 5400 horsepower each. This is a step in a program of experimentation with various types of motive power on a competitive basis in actual operation on different lines.

Built by the Electro-Motive Division of General Motors Corporation, the two new locomotives are each in four units, every unit having a 2-cycle, 16-cylinder oil engine. There are two four-wheel trucks under each unit and each truck has two traction motors. The total weight on drivers is 451.5 tons for the entire four-unit locomotive.

The program for post-war improvement in motive power also includes the purchase of four 6000 horsepower Diesel passenger locomotives, and a super-steam locomotive of 6000 horsepower, designed by New York Central's Equipment Engineering Department collaborating with American Locomotive Company.

SHEET THICKNESS

Measured by X-Rays in a Steel Mill

WHITE-HOT sheet steel, at a temperature as high as 2000 degrees, Fahrenheit, and moving at a speed of 20 miles an hour as it emerges from a rolling mill, can have its thickness accurately measured by x-rays. This new development is described as follows by Dr. William D. Coolidge, General Electric Vice-President in charge of research:

"X-rays may be used as a thickness gage without the necessity of making mechanical contact with the work as, for example, in the rolling of sheet steel where, through adjustment of the mill, the thickness of the sheet must be kept within certain narrow limits.

"With an x-ray outfit below and an ionization chamber or other x-ray intensity measuring device above the sheet, it becomes possible through the measurement of x-ray transmission to have a constant indication of thickness and, if desired, to have the x-rays themselves control the mill so as to maintain automatically a constant thickness of the steel sheet."

Metals in Industry

(*Continued from page* 105)

matrix surrounding the steel particles.

The resulting parts can then be heat treated (at temperatures below 1650, Fahrenheit) to improve their properties. Sinter-brazed parts are claimed to be as strong as machined steel and, in the case of precise, complex shapes, can be made many times faster.

The other development is the commercial-scale manufacture, by Chrysler Corporation's Amplex Division, of self-lubricating aluminum bearings from aluminum powder. Various technical problems in the working of aluminum powder had to be overcome. Porous, oil-retaining aluminum cylindrical, flange, and thrust bearings are now in regular production and other machine parts can also be made. Aluminum has recently been shown to be a good bearing metal, and its light weight is a real advantage in some types of machinery.

TINNED CAST IRON

Makes Satisfactory Base for Babbit

BABBITTED bearings are those in which a strong-metal shell is coated with a thin layer of soft anti-friction metal, now usually a lead-base alloy. Steel shells are commonly used rather than the cheaper cast iron, because of the difficulty in producing a bond between the cast iron surface and the babbitt layer.

A recently developed process for the preparation of metal surfaces, the Kolene process, has made possible the cheap, quick, and dependable tinning of cast iron, so that the tinned iron may serve as a base for babbitting. So satisfactory has this bonding proved to be in service that Cooper-Bessemer Corporation now uses high strength cast iron (Meehanite) babbitted bearings, without any anchor grooves, for heavy duty use in Diesel engines.

The problem in "tinning" cast iron has been the graphite present in the iron, which prevented metal-to-metal bonding. In the Kolene process the graphitic carbon is oxidized away at the surface of the metal and the iron oxide formed at the same time is later dissolved but without freshly exposing new graphite flakes.

The oxidation is accomplished by immersing the casting in a special molten alkaline salt bath, containing a catalyst, at about 800 degrees, Fahrenheit. Removal of the iron oxides is done in a very hot (about 250 degrees, Fahrenheit) water solution of certain alkaline salts. The work is rinsed in water and in hydrochloric acid and then fluxed prior to tinning.

The process (or an electrolytic modification of it) has other established commercial uses for cleaning metals generally, especially prior to plating, rustproofing, and so on. It is able to remove heavy accumulations of carbon, grease, coked oils, drawing compounds, and so on, but it not applicable to aluminum or magnesium alloys.

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.)

HOME DEHYDRATORS AND HOME DEHYDRATION, by Donald K. Tressler, is a seven-page reprint from *General Electric Review* giving construction details about different types of devices for this purpose, as well as some information as to their application to various foods. Detailed drawings are presented. *Publicity Department, General Electric Company, Schenectady, New York.—Gratis.*

CALLIFLEX BI-METALS is a four-page bulletin giving technical data on the various types, thicknesses, and sizes of these materials as temperature-responsive elements in automatic control. *Calite Tungsten Corporation, 540 39th Street, Union City, New Jersey.—Gratis.*

EMERSON-ELECTRIC AIRCRAFT MOTORS is a 28-page booklet illustrating and describing these motors which feature high-speed operation and light-metal construction. Illustrations, drawings, and several pages of specifications are given. *The Emerson Electric Manufacturing Company, 1824 Washington Avenue, St. Louis 3, Missouri.—Gratis.*

FUEL CONSERVATION MANUAL has been prepared through the co-operative efforts of manufacturers of automatic heating controls. It indicates the purpose and application of various types of controls from the standpoint of heating and maintenance of buildings other than private homes. *Fuel Conservation Council for War, 500 West Oklahoma Avenue, Milwaukee 7, Wisconsin.—Gratis.*

GREENLEE HANDY CALCULATOR is a heavy cardboard, soil-proof rule designed to solve woodworking problems. By adjusting the dial you can find comparative hardness, weights, and shrinkage as well as converting linear to board feet and determining slope per foot in degrees. *Greenlee Tool Company, Rockford, Illinois.—Gratis.*

BAND FILING TO PRECISION TOLERANCES is a four-page bulletin outlining the advantages of continuous file broaching and information on types and specifications. *Continental Machines, Inc., 1301 Washington Avenue, South, Minneapolis 4, Minnesota.—Gratis.*

ALLOWABLE CONCENTRATIONS OF LEAD AND CERTAIN INORGANIC COMPOUNDS is a booklet setting safe limits for the amount of metallic lead, lead carbonate, lead sulfate, lead oxides, lead nitrate, and lead chloride allowable in the air of workshops to safeguard the health and efficiency of workers. This booklet also covers physical and chemical properties, methods of tests, and a bibliography. *American Standards Association, 29 West 39th Street, New York 18, New York.—20 cents.*

MUZAK AT WORK is a booklet based on the opinions of management, labor, science, and government regarding functional music. The data presented are based on research, experience, and actual production. In addition a description of Muzak facilities and service of "planned work music" is given. *Muzak Corporation, 229 Fourth Avenue, New York, New York.—Gratis.*

ADHESIVES is an eight-page catalog containing details, requirements, and classifications of several types of adhesives, fabric coatings, binders, and sealers, together with instructions for application and information on standard containers and approximate shipping weights. *The B. F. Goodrich Company, Public Relations Department, Akron, Ohio.—Gratis.*

WELTRONIC VARIABLE SPEED CONTROL FOR D.C. MOTORS FROM A.C. POWER is a four-page bulletin on this electronic control—a self-contained unit—which eliminates the need for separate transformers for driving lathes, drill presses, conveyors, printing presses, and other types of machines. *Weltronic Company, Detroit 19, Michigan.—Gratis.*

ARO PNEUMATIC TOOLS FOR INDUSTRY is a 32-page catalog containing illustrations and specifications of these rotary pneumatic tools for small tool jobs such as drilling, grinding, burring, and metal sanding. *Aro Equipment Corporation, Bryan, Ohio.—Gratis.*

THE MIDDLE OF THE SHOP, by Tom Saffady, is a 16-page booklet outlining the importance of better human relations as a source of information for the promotion of production efficiency. *Sav-Way Industries, 4875 East Eight Mile Road, Detroit, Michigan.—Gratis.*

VICTAULIC PIPE COUPLINGS AND FITTINGS is a 34-page combination catalog and engineering manual listing flexible couplings and fittings and their use in industrial, mining, petroleum, shipbuilding, and water works. *Victaulic Company of America, 30 Rockefeller Plaza, New York 20, New York.—Gratis.*

AR-MOORED TIES FOR HIGH TRACK CAPACITY is an eight-page booklet outlining and illustrating the advantages of these ties, with a list of the information needed for quotations. *Koppers Company, Wood Preserving Division, Pittsburgh, Pennsylvania.—Gratis. Request this on your business letterhead.*

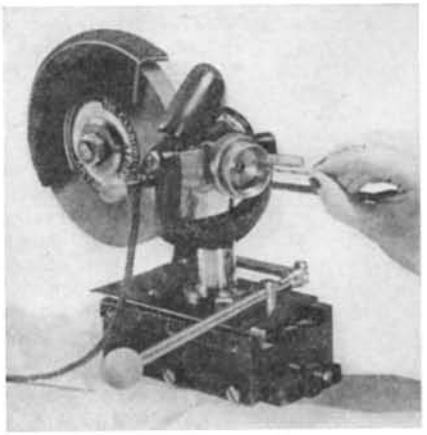
HOLD EVERYTHING is a bulletin presenting a new and improved application of microfilm to pencil engineering drawings made on transparent paper, as well as other valuable papers and documents, and pointing out savings in time, money, and space. *Microcopy Corporation, 2800 West Olive Avenue, Burbank, California.—Gratis.*

New Products

DRILL SHARPENER

SMALL twist drills from Number 70 to 15/64-inch can be sharpened with a new device manufactured by Mercury Products Company. The attachment has no cams. Every rotating movement is on centers and automatically taken up by spring tension. The device can be used with any standard six-inch or smaller grinding wheel.

There are just four simple steps in operating the drill sharpener. First, insert drill, tighten chuck. Second, look through the magnifying glass and line up lip of drill on the alinement bar. Third, depress grinding bar slowly and release. Last, revolve the chuck and repeat the third operation. An inexperienced operator can do a perfect job after a few minutes' instruction.



Fast, accurate drill sharpener

Every size of drill requires a separate bushing, ten of which are supplied with each drill sharpener. Extra ones are available.

ONE-COAT PORCELAIN

REPORTED to be the first commercially successful one coat direct-to-steel white porcelain enamel, Mirac requires no special bond or pickling equipment. Nor does it need special handling. It is reported to have adherence and can be fired at 1500 degrees, Fahrenheit with a brilliant highly opaque finish as the result.

METALLIZING GUN

ESPECIALLY engineered for high-speed production spraying of low melting point metals, a new metallizing gun which uses ⅛-inch zinc, tin, lead, solder, babbitt, cadmium, or fine gage copper and copper alloys, exhibits spraying speeds which exceed by far any yet attained with these metals. Rates of deposition, in pounds per hour, include: zinc, 40; tin, 70; lead, 110; solder, 90; babbitt, 75.

Regardless of the type of wire employed, no gear changes are necessary to achieve these high speeds. Any spraying speed within the prescribed ranges is automatically obtained, and maintained hour after hour. Air pressure fluctuations, it is reported, do not affect operating efficiency.

In common with all Metco metallizing guns, this Type 3E is equipped with a Universal Gas Head, which allows the tool to be operated on any commercial gas—in conjunction with oxygen and compressed air.

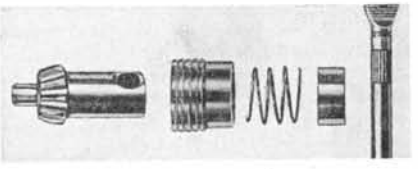
Typical applications where this gun will cut manufacturing costs and broaden the opportunities for spraying low-melting-point metals on a production basis include: corrosion-resistant coatings on iron and steel structures and equipment; water- and chemical-resistant linings for storage tanks and degreasers; conductive and soldering surfaces on glass, plastics, and carbon products.

APPLIANCE TESTER

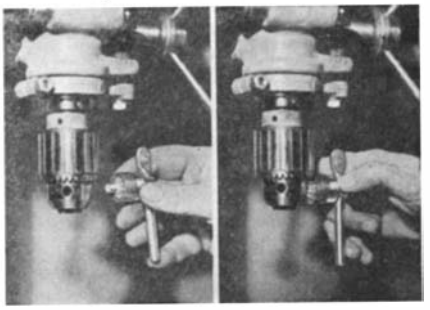
BUILT to operate at the extremely low range of 0—20 watts as well as a high range to 2000 watts, a new device tests all electrical appliances from bell transformers and clocks to electric ironers and ranges operating on the 220-volt three-wire Edison system. This tester measures actual load values of volts, amperes, and watts and quickly locates trouble in A.C. appliances while in actual operation.

CHUCK-KEY SAFETY

A NEW safety device called the "Kee-Jector," which is applied to the standard lathe or drill-press chuck key, has been developed by Lee H. Jernigan, of Safety-Specialties. Designed to prevent accidents which occur when machine-tool operators neglect to remove the chuck key from the chuck before the power is



Above: Standard chuck key and parts of the ejector. Below: When key is inserted, spring is retracted

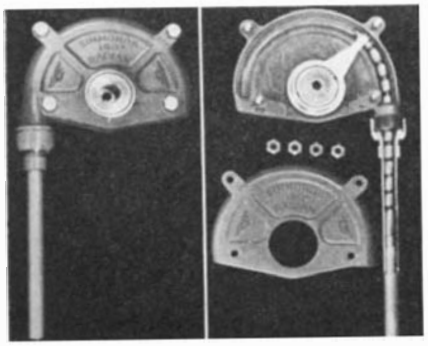


turned on, the Kee-Jector, made in a complete range of sizes, fits as a guard on the chuck key of any sized drill press or lathe and "ejects" the chuck key the moment its job is done. It is impossible to leave a chuck key engaged in the chuck when this device is used. The device is simple and foolproof and in no way handicaps the worker in the proper use of the key.

PUSH-PULL CONTROL

PROVIDING positive rotary-motion action from push-pull operation, a new Radian unit was specifically designed for use in connection with propeller governors, carburetor air controls, supercharger controls, and similar aircraft installations. Made by Simmonds Aerocessories, Inc., as an adjunct to the Simonds push-pull controls, the versatility of the device points to many post-war marine, automotive, and industrial uses.

Compact, strong, and weighing approximately 12 ounces, the Radian unit, which replaces the more cumbersome pulley-and-cable and rod-and-bell-crank assemblies, has but three basic parts: a housing, a lever-arm, and a bushing. The housing contains the



Left: Assembled push-pull control. Right: Interior of the control, showing how rotary motion is produced

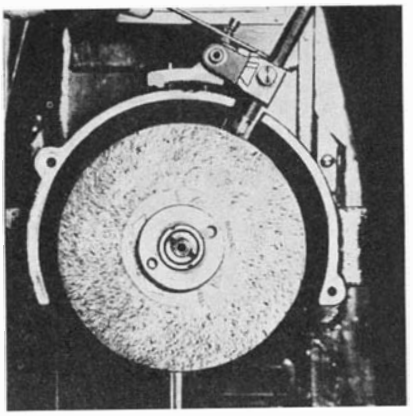
track of the linkage path, the lever-arm carries out the angular travel, and the bushing transfers the angular travel to the shaft to be actuated. Serrated teeth provide for fine adjustment between the lever-arm and the shaft it actuates.

WINDER ROLLS

ONE COMMON application of industrial wood rolls is for winding goods of one kind or another as they involve a manufacturing cycle. Recently the Rodney Hunt Machine Company has standardized on two types of constructions for such rolls. One type embodies "shaftite" anchorage of shafts to the wood. The other type (for especially low cost) employs a simple countersunk ring in the end of the wood that helps to reinforce the shaft. The wood used is especially selected for its light-weight and well seasoned qualities.

WHEEL DRESSER

THE "Jiffy" grinding wheel dresser, designed for mounting on any standard toolroom surface grinder, becomes an integral part of the grinder on which it is mounted and is always ready for



"Built-in" grinding wheel dresser

wheel dressing, regardless of the position of the wheel relative to the table.

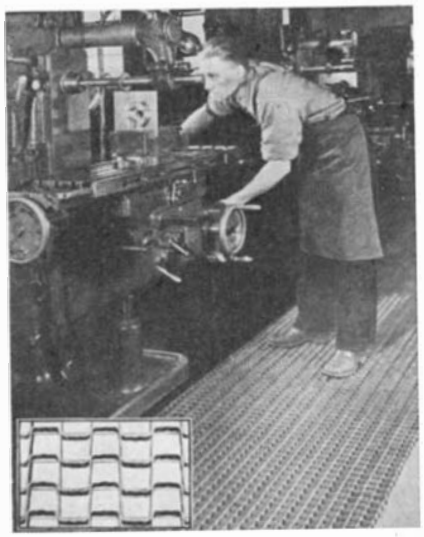
When using this attachable dresser, made by the Florian Manufacturing Company, it is not necessary to disturb the work set-up. As occasion demands, the wheel can be dressed in five seconds. Adjustable to dress absolutely true, it is simple to mount and fits all standard surface grinders.

PIN SETS

STRONG, compact cabinets completely furnished with precision pin sets in number drill, letter drill, and fractional sizes are announced by United Precision Products Company. The pins are of the finest quality gage steel, hardened to 60-63 Rockwell C scale. Brass strips with letter, number, or fractional size permanently fixed in clear easily-read white, identify each gage at its position. Gages are progressively stored for instant pickup. Complete protection is afforded the gages from moisture, corrosion, and dirt, and the complete sets are at hand for immediate selection and use, without loss of time.

SAFETY MATS

IMPROVED steel safety mats, manufactured by William F. Klemp Company, include a design feature which has proved a decided addition to non-skid protection. This is a slight crimp or center bend in one side of the strong steel mesh. These steel mats, which



Steel mat (inset) promotes safety

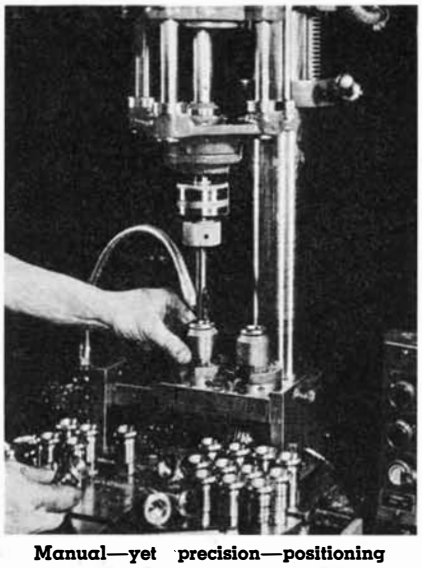
roll up like a rug and can be placed anywhere, are in wide use wherever men work at machines and equipment. They prevent slipping and falls, keep feet dry, make lifting safe, reduce fatigue, and prevent accidents.

Made of steel, they are non-absorbent and easily cleaned in hot water or cleaning solution. They are made in any length up to 25 feet, any width to 6 feet. An area can be covered by joining multiples on the job without special tools.

PRECISION TAPPING SPEEDED

USE OF manual positioning and elimination of chucks or clamps on a simple, new non-locking slide type fixture has speeded up precision tapping of ordnance parts at Manufacturers' Machine Service Company. This fixture, incorporated on a "Detroit" light duty lead screw type tapping machine, permits tapping on a continuous basis. The simple slide fixture, built in the company's tool room for holding and positioning the work, was arranged to operate on an automatic tap and return stroke cycle stopping at the top. The fixture incorporated two non-locking work holders mounted on a slide that can be moved "right" or "left" on ground ways below the tap. The work in either work holder will be accurately located below the tap when the slide is moved from one side to the other against the stops.

All the operator has to do is to remove a finished piece and place a new



Manual—yet precision—positioning

piece in the same work holder while the other piece is being tapped. He then moves the slide over as soon as the tap clears the finished piece in the other work holder. With this arrangement it is possible to operate the machine on a "continuous repeat" cycle, reducing floor to floor time to less than 10 seconds per piece. It thus speeds up production by actually making the operation *less* automatic.

SHROUDED COUPLING

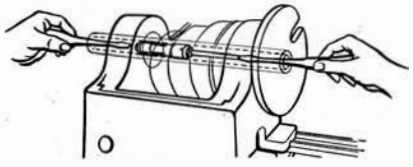
PROTECTION of operators against catching of clothing or incautious handling is embodied in a new shrouded flexible coupling announced by Lovejoy Flexible Coupling Company.

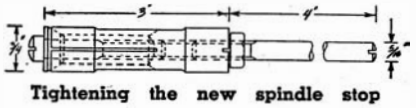
The essential feature of this new protection is an outside steel collar which holds the load cushions of the coupling in place. An extension of this collar, which encircles the coupling, safeguards material and fingers from the heads of the bolts that secure the load-cushion retainer. The bolt heads are concealed, yet easily and conveniently reached when necessity arises.

This improvement effects more compact design with over-all smoothness of external surface.

SPINDLE STOP

PRINCIPLE feature of the new Rieger spindle top is its expanding collet action. While the front end of the device is held in place with one screwdriver, a turn on another at the rear end makes the stop expand to tighten itself in the hole of the headstock spindle. This is said to avoid the scarring or burring of the walls.





Tightening the new spindle stop

The spindle stop is equipped with a 5/16 by 4 inch extension for limiting hollow work and for protrusion into the chuck for stopping short pieces. The extension is soft so that it can be turned down to a smaller diameter if desired. It can be removed for positioning solid pieces. The body of the device is 3 inches long and slightly under ¾ inch in diameter when contracted.

Used for repeat operations on the lathe, the spindle stop limits the entrance of work into the spindle hole. It can be utilized with or without a chuck.

AIR SEPARATOR

A SELF-DRAINING compressed-air separator, which eliminates the need for external traps or the uncertainties of manual draining, has been developed by the Johnson Corporation. It has a complete trap mechanism built in, which releases from the separator, automatically, all the water, oil, and other moisture that has been removed from the compressed air. The entering air is first allowed to expand slightly, thereby precipitating most of the entrained moisture. Then it passes through a labyrinth of coarse wire mesh, changing direction of flow abruptly many times, and surrendering the remaining particles of foreign matter.

The trap mechanism is simple and compact, with spherical float and chrome steel valve and valve seat. It

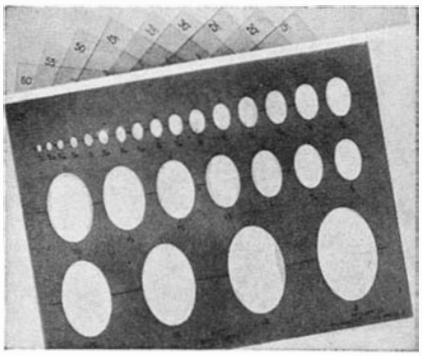
is mounted on the bottom plate of the separator body, and can be quickly and easily removed for inspection or cleaning. All the moisture that has been removed from the compressed air drops to the bottom of the separator, and when the level of the accumulated liquid is sufficient to raise the float, the valve opens and the liquid flows out the drain.

SUPER TEMPERING

A FURTHER development of the quench tempering solution, reported in these columns in our February issue, makes it possible to impart instant maximum hardnesses to friction wearing parts and high speed steel tools that operate with a uniform or rotary motion. This hardening solution, known as Super Temp, by which both hardening and drawing are accomplished simultaneously, will produce "glass hardness," but at a sacrifice of toughness. Therefore, the use of Super Temp is not recommended for impact tools but has proved particularly valuable for handling steel gears, pinions, axles, and high speed cutting tools. The resulting wearing surfaces are claimed to be friction and abrasion resistant.

ELLIPSE GUIDES

SAVINGS up to 50 percent in time on production illustration jobs ("visuals") are being effected through use of a new series of precision-cut ellipse templates. Meeting professional accuracy requirements, these guides are .020-inch-thick celluloid templates and are made in a set of 10, with angles from 15 to 60 degree by 5 degree increments.

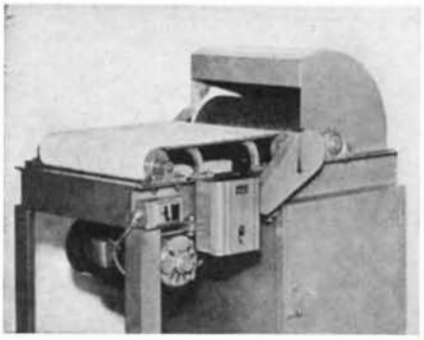


Available in sets or separately

Equally efficient for either pencil or ink, they eliminate the time-consuming geometrical development of ellipses by the plot method. They enable the untrained as well as the professional to draw ellipses with equal accuracy and speed in a small fraction of the time ordinarily required. Vertical and horizontal axes are clearly indicated for ready location and adjustment to position.

DISINTEGRATOR

A NEW development in disintegration of materials and food stuffs is a machine, manufactured by the Franklin McAllister Corporation, which includes a steel drum containing thousands of teeth on its outside diameter. These will disintegrate almost anything that a steel saw will cut, from hard metals to soft food stuffs. The list of materials which it has disintegrated successfully ranges from nickel and stainless steel to wood, rock wool, and chewing-gum base.



One type of disintegrating unit. The head can be designed for any job

The picture shows a small, automatic feed unit with a 20-inch drum designed for a food product. The disintegrator head can be made in practically any size and assembled into almost any machine that best suits the particular product requirements.

RUST PREVENTIVES

Two types of rust preventives, released by the Technical Processes Division of the Colonial Alloys Company, actually are metal cleaning solvents which leave protective films that prevent rust and tarnish. They are identified by the names Cyclodiene and Percyclodiene.

Both are used as short-time simple immersions at room temperature and are used in an open tank made of metal, glazed ceramic, or other material. Neither will attack metals, as they are neutral and contain no acids or alkalies. Cyclodiene films dry in about 20 minutes, leaving rust-inhibited clean surfaces for a short time thereafter. Percyclodiene films will remain for about 30 days, leaving rust-inhibited clean surfaces for quite some time thereafter.

A quick dip into either one of these rust-inhibitive solvents prior to or between inspection and final finishing operations, will protect the work from rust and corrosion. Penetration is excellent, and protection is afforded to threaded parts, joints, interstices, and crevices.

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, Marines, or Coast Guard, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 10¢ additional; from $5 to $25, 20¢; from $25 to $50, 30¢.

AEROSPHERE, 1943

Edited by Glenn D. Angle

THIS enormous volume, finely edited and bound, is a true encyclopedia of aeronautics. It contains, first of all, descriptions of all current types of aircraft, well illustrated with adequate specifications. Modern aircraft engines are similarly treated. A third section is on aircraft statistics, which provides information on all sizes of aircraft and their operation. The fourth section is a buyer's guide, which constitutes a really fine aircraft directory. The whole constitutes a splendid work of reference. (1042 pages, 8½ by 11½ inches.) —$15.00 plus expressage on 8 pounds.—*A.K.*

THE OXY-ACETYLENE HANDBOOK

A Manual on Oxy-Acetylene Welding and Cutting Procedures

THE entire range of the oxy-acetylene process is covered in this comprehensive and authoritative text book on basic welding and cutting procedures. Designed as a guide for self-instruction as well as a standard class-room textbook, the subject matter will also serve as a reference book for plant management people, engineers, designers, and shop superintendents and foremen who have use for oxy-acetylene either as a production or maintenance tool. This is entirely a how-to-do-it book, practical and down to earth in every respect. (587 pages, 6½ by 9½ inches, 405 illustrations, 35 comprehensive tables, completely indexed.) — $1.60 postpaid.—*A.P.P.*

OPTICAL WORKSHOP PRINCIPLES

By Col. Charles Dévé

WARTIME translation of a French work on precision shop optics, with heavy emphasis on actual handiwork. Content: glass, abrasives, cements, tools, polishers, surfacing, spectacle lenses (14 pages only), mechanical theory of working optical surfaces, tests, crystal shaping, centering, edging, cementing, reticules, aluminization. Opinions of three advanced amateur telescope makers who secured copies early: F. B. Ferson.—"It is a book to round out an optical library with a few techniques, also analysis, not found in other books." R. O. Sinclaire.—"Contains a large amount of information that will be useful to practical optical workers." Henry Paul.—"The more advanced amateurs will find in it new ideas. Most completely covered is 'The Mechanical Theory of the Working of Optical Surfaces.' Study of this chapter should enable many to avoid trial and error methods." (306 pages, 5¼ by 8½ inches, 120 illustrations.)—$6.10 postpaid.—*A.G.I.*

MIRACLES AHEAD!

By Norman V. Carlisle and Frank B. Latham

HERE YOU can obtain a bird's eye view of the possibilities for your future living which may be brought to fruition by the forward march of science and industry. Homes and the appliances to be used in the homes, motor cars and aircraft for the future, the battle of transportation, electronic and radio services, chemical developments, metals of tomorrow, foods of the future, agriculture, and a number of other things are skimmed over briefly but with sufficient substance to give a fairly well defined picture of what may happen to your life tomorrow. (288 pages, 5½ by 8½ inches, unillustrated.)—$2.85 postpaid.—*A.P.P.*

THE ELEMENTS OF AEROFOIL AND AIRSCREW THEORY

By H. Glauert

AMERICAN edition of a standard British work, written in a form suitable for students of airfoil theory who do not possess a previous knowledge of hydrodynamics; it includes five preliminary chapters on that subject. Mathematical, of course. (228 pages, 5½ by 8½ inches, 116 illustrations.)—$3.60 postpaid. — *A.G.I.*

ELECTRONICS TO-DAY AND TO-MORROW

By John Mills

IF YOU have a desire to obtain an intelligent speaking acquaintance with the overall subject of electronics, this is the book for you. Written by a well-known oldtimer in the radio and elec-

trical field, it tells the running story of electronics from the fundamentals of the electron theory through the various types of electron tubes to those electronic devices which have contributed largely to both pure and applied science and which hold tremendous possibilities for the future. (178 pages, 5½ by 8 inches, unillustrated except for chapter headings.)—$2.35 postpaid.—*A.P.P.*

MR. TOMPKINS EXPLORES THE ATOM

By G. Gamow

SCIENTIFIC FICTION that is really scientific, yet also is entertaining, is rare. In these dreams the noted Russian-born American professor of theoretical physics shrinks to the bodily size of electrons and explores the insides of atoms. The adventures are humorously, whimsically told as naratives, while the reader effortlessly picks up accurate insight into atomic physics as he goes. Later, the science behind the dream adventure is more fully elaborated. (97 pages, 6½ by 8½ inches, illustrated.) —$2.10 postpaid. —*A.G.I.*

PRINCIPLES OF POWDER METALLURGY

By Franz Skaupy

TECHNICAL men in the metal and allied industries will find in this translation from the German a wealth of compact factual material regarding production and properties of metal powders and production and properties of finished objects made by the powder-metallurgy process. (80 pages, 6 by 9 inches, a few illustrations.)—$3.10 postpaid.—*A.P.P.*

SPHEROGRAPHICAL NAVIGATION

By Brouwer, Keator, and McMillen

BY PLOTTING observed altitudes on an actual sphere, rather than solving spherical triangles on two-dimensional paper, navigation is greatly simplified. This treatise teaches that method, which is simple to learn. (200 pages, 4½ by 7¼ inches, 21 illustrations.)—$5.10 postpaid.—*A.G.I.*

HACKH'S CHEMICAL DICTIONARY

Edited by Julius Grant

THIS illustrated volume contains the words generally used in chemistry and many of the terms used in the allied sciences of physics, astrophysics, mineralogy, agriculture, engineering, and so on. (925 pages, 7 by 10 inches, a number of tables, diagrams, portraits, and other illustrations.)—$12.10 postpaid.—*A.P.P.*

MANKIND SO FAR

By William Howells

EMINENTLY readable and relatively non-technical account of the evolution of man from his pre-ape ancestors to his early species and present races, written by a well-known anthropologist whose style is so entertaining, natural and friendly, and at times witty, that the book almost reads itself. Among books having similar coverage in this

branch of science each stresses some parts, touches others more lightly; this one stresses the origins of the living races, touches more lightly Old and New World finds of early man. (319 pages, 6 by 9 inches, illustrated.)—$4.60 postpaid.—*A.G.I.*

RADIO DIRECTION FINDERS

By Donald S. Bond

ELECTRICAL engineers specializing in the design or theory of direction finders for aircraft, shipboard, or fixed station use will find in this text a comprehensive description of the practical systems, plus an analytical study of the under-lying phenomena. (287 pages, 5½ by 8½ inches, a large number of half-tone and line illustrations.)—$3.10 postpaid.—*A.P.P.*

PRE-SERVICE COURSE IN SHOP PRACTICE

By William J. Kennedy

BASED on the requirements of the U. S. Army for pre-induction training to be offered to high-school seniors and prepared at the request of the War Department, this book treats shopwork—hand and machine tools for wood and metal, soldering, wiring, wire splicing, ropes, splices and knots, blocks and rigging—in an elementary manner. Equally suitable for the man who wishes to understand the use of various tools. (337 pages, 5½ by 8½ inches, 329 illustrations.)—$2.10 postpaid.—*A.G.I.*

JUDO

By T. Shozo Kuwashima and Ashbel R. Welch

FORTY-ONE lessons in the modern science of jiu-jitsu are here presented in such form as will enable any physically capable person, practicing with reasonable diligence, to develop the speed and finesse necessary for mastering the science. Every step is illustrated. (146 pages, 7 by 9 inches.)—$2.00 postpaid.—*A.P.P.*

JAPAN'S SECRET WEAPON

By Barclay Newman

GERM WARFARE with fancy trimmings—virus and spirochete infections, kala-azar, tsutsugamushi fever, black death, leprosy, Japanese encephalitis, these and cancer-causing chemicals—are some of the horrors we must expect, according to this author, a biologist. For years, as a part of their evil plan, the Japs have studied these and tried some of them experimentally in China. Pearl Harbor tells us they will not hesitate to try them on us. Whether they will work remains to be seen. This book, for general readers, discusses each weapon. (223 pages, 5 by 7¾ inches, unillustrated.)—$2.60 postpaid.—*A.G.I.*

PEACE, PLENTY, AND PETROLEUM

By B. T. Brooks

YOU will be in a better position to form opinions about day-by-day developments in all the aspects of the petroleum situation after you have read the concise text of this volume which reviews recent developments and presents the geography of oil production as it is now known. The situation with respect to petroleum today is "no occasion for alarm, but there is much reason for serious concern," says the author. (197 pages, 5½ by 8 inches, 7 figures.)—$2.60 postpaid.—*A.P.P.*

THE PACIFIC WORLD

Edited by Fairfield Osborn

IN THIS work it is possible to find the whole range of elementary scientific fact about each island area in the Pacific—Australia and New Zealand, the Netherlands Indies, the Philippines, Micronesia and its main subdivisions, Polynesia and its subdivisions, the Aleutians, Formosa and Japan—covering discovery and exploration, plant and animal life, ocean life, peoples, stars, climate, and winds. Scientists from nine important American institutions pooled their data to make possible this general work for reading or reference. Good book for soldiers, sailors, mothers, and dads. (218 pages, 6 by 8¾ inches, illustrations.)—$3.10 postpaid.—*A.G.I.*

INTRODUCTION TO MICROORGANISMS

By LaVerne Ruth Thompson

TEXTBOOK for student nurses. Such a book is almost ideally adapted to the average scientifically inclined reader who wishes a more solid knowledge of disease germs than light popular books give, yet doesn't wish to wade all the way into professional bacteriology. This book gets down to solid cases yet isn't formidable. And it is dependable. Author is instructor in microbiology at Teacher's College, Columbia University. (445 pages, 5¼ by 7¾ inches, 54 illustrations.)—$2.85, postpaid.—*A.G.I.*

WARSHIPS OF THE WORLD

Edited by Roger Kafka and Roy L. Pepperburg

THE latest available technical data outside the field of "restricted" and "confidential" material are here arranged for quick and complete reference. The text covers all the world's navies from Argentina to Zanzibar and presents details of 7000 ships with 500 photographs and 200 profiles. Included are more than 900 stories of battle action. (1056 pages, 7¼ by 9⅝ inches.)—$15.25 postpaid.—*A.P.P.*

ONE HUNDRED YEARS OF PSYCHIATRY

By Thirteen Authors

CENTENNIAL volume of the American Psychiatric Association, a historical synthesis in which Hall, Shyrock, Sigerist, Overholser, Hamilton, Whitehorn, Bunker, Malamud, Deutsch, Strekker, Moore, Zilboorg, and Kluckhorn—most noted names in American psychiatry—develop the evolution of psychiatry, each with a contributed section. A large, heavy, impressive volume (also wasteful of scarce paper), of interest to medical and lay readers alike. (649 pages, 7 by 10¼ inches, 35 illustrations.)—$6.10 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"

YEARS AGO John C. Lee devised and made a grinding and polishing machine (see "A.T.M.," page 160) in which the telescope mirror moved in a bath of liquid abrasive. He could start it running, go to bed, and get up to find the main part of the roughing-out job finished. Now comes O. Magnussen, 514 Ricketts St., Danville, Va., with the semi-automatic machine shown in Porter's sketch (Figure 1) drawn from the original.

Magnussen writes: "I made this machine from worm gears and shafting, and a novel feature of it is the automatic abrasive feeding device. The grease cup fastened to the cast iron lap makes 1/6 turn during each revolution of the lap. The abrasive is mixed with soap, which acts as a vehicle. The parts are easily removed and cleaned between grinds. I use a similar cup for polishing, except that its threads are finer (40 per inch). This method doesn't seem to leave zones, since the rouge mixture is spread through channels in the lap."

Figure 2 shows a neat 6″ reflector

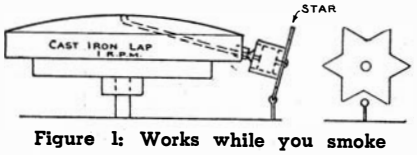


Figure 1: Works while you smoke

with drive made from a hand-wound phonograph motor, built by Magnussen, who teaches machine shop work.

H. H. SELBY contributes the following note:

"In using a slit or a pinhole for testing precisely on the axis, the usual method, which I have used for ten years and which Gaviola published a few years ago, is as sketched (Figure 3): A is a fairly plane-parallel, unsilvered diagonal, such as a 20 x 26 x 0.5mm. hemocytometer cover glass. B is a plate containing the slit or hole. C is ground or opal glass. D is the illumination system. E is the eye.

"When A is unsilvered, a reflection occurs at each surface, giving an overlapping of shadows which can be confusing. Also, only 0.5 to 1.0 percent of the light at the pinhole reaches the eye when testing uncoated mirrors and, if the diagonal is thick, aberrations are introduced. This doubling of the beam, also spherical aberration and astigmatism, can be minimized by making the diagonal thin, but 0.5mm is nearly the limit for glass, considering that the surface should be plane within, say, 2 to 4 fringes. Pellicles are admirably thin, but are fragile, and interference phenomena within the membrane are troublesome.

"The second surface can be coated with a non-reflecting film of fatty acids or fluorides. The fluoride films are particularly satisfactory and commercially available. If a 0.5mm diagonal, flat to ± 3 fringes on one side and fluoride coated on the other, is employed, no troublesome doubling will occur and illumination will be uniform, but relatively weak. By applying a 50 percent reflecting coating of aluminum or silver to the flatter surface, the light reaching the eye will be the maximum possible—3.5 times that from an untreated surface. The remaining imperceptible residual doubling is also reduced in like ratio.

"From the above, it is seen that the ideal arrangement is a thin, flat-surfaced diagonal, having the flat side 50 percent reflective, the reverse side nonreflective. With such an arrangement, the lowest focal ratios found in objectives can be examined with complete freedom from artifacts."

IN THIS department, September 1943, appeared a note by Haviland, on the Barlow lens, and in the May number succeeding there was one by Wates. It turns out that these were partly erroneous. Since an editor is supposed to edit, these errors become automatically your scribe's—which makes three of us for you to boil in oil, so light up the fires and pile on the faggots. Note however how frankly—almost gleefully—we three villians admit our errors and please be good to our families after we have expired.

The detective who spotted the errors

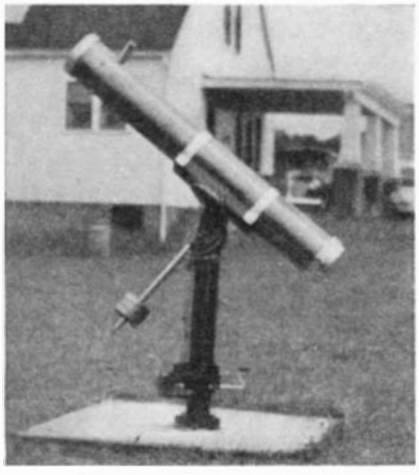


Figure 2: Machinist's job

is C. R. Hartshorn, 1244 W. 109th Place, Los Angeles, California, and he didn't want his name mentioned. He said he didn't want readers to think him one of those disputatious, contentious persons who miss no chance to jump on others. However, your scribe, who dealt with Hartshorn for a long time when he was in the famous Amateur Roof Prism Gang (where he wanted to make roof prisms gratis for Uncle Sam, just to take a punch at the Krauts and Japs), can testify to the contrary, and gives his name for another reason—because he appears to have had experience with Barlows and should in future be made to work for other amateurs who may need help on them. It is the custom of this department, when questions arrive on some special phase of the

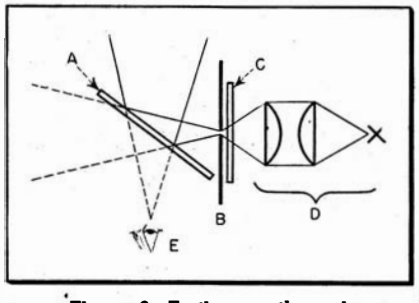


Figure 3: Testing on the axis

hobby, to pass them to other amateurs who are known to have gained experience in those phases.

Hartshorn writes: "I thought some of your regulars would rise to the occasion and point out the errors but, as they haven't, I am sticking my own neck out. Haviland proposes a Barlow of —18″ f.l., to be placed 2″ inside the focus of a telescope of 48″ f.l. He figures correctly that the e.f.l. of the combination will be 54″, but then goes on to assume that the eyepiece will move out 6″, and that the magnifying power will be quadrupled. Actually, the eyepiece will move out only ¼″ and the amplification will be only 12½ percent. He is just dealing with the tip of a theoretical cone of light 54″ long. The ratio is 2¼: 2: : 54: 48.

"As a check, although the formula Haviland used is entirely adequate, I have just traced the paths of the rays trigonometrically through a hypothetical —18″ Barlow and it came out 2.249″. I have used a Barlow for years, designed and made my own—flint and crown—and observed with it and others with sundry eyepieces.

"Perhaps Wates also is a little off the beam. If you had a Barlow that would amplify X4 at 2″ inside focus, the f.l. of the Barlow would be —2 2/3″. If you then moved it to 1″ inside focus, the amplification would be X1.6. If you moved it 6″ inside focus you would see nothing at all through it, because the rays would then be divergent. At 2 2/3″ inside focus they would be parallel, the secondary focus at infinity.

"Any particular Barlow has the same amplifying power when placed at the same distance inside focus, no matter what the telescope."

Hartshorn gives some specific figures. For a primary focus at 48″, Barlow of —2 2/3″ f.l., 1″ inside focus, amplifica-

tion is, as already stated, X1.6 and power of telescope with 1" eyepiece is 76.8. Corresponding figures for 2" inside focus are X4 and 192; for 2½" inside focus, X16 and 768; for 2⅝" inside focus, X64 and 3072.

Haviland's response to Hartshorn's letter is candid: "Hartshorn is right. I have a string of alibis as long as your arm, but Hartshorn is right. Here is the correct solution:

"Suppose that a Barlow lens (Figure 4) of focus $-F$ is placed p inches inside the focus, A, of a telescope. The new focus, B, will be at a distance q from the Barlow. The relation between these distances is $1/q + 1/p = 1/f$.

"The ratio q/p = magnifying power.

"If we have a Barlow of $-2\ 2/3$" focus, placed 2" inside the focus of the telescope objective, we get $1/q - ½ = -1/2⅔$ and q therefore = 8.

"In the above, ½ takes the minus sign, in accordance with the direction of light

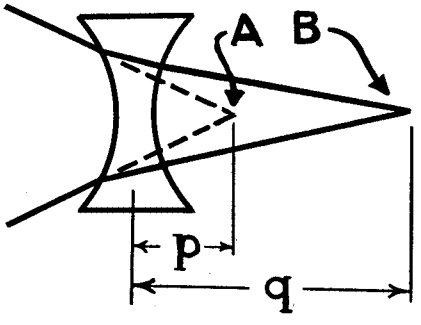


Figure 4: Haviland's drawing

from A toward the left (both images on same side of lens).

"The magnifying ratio then is $q/p = 8/2 = 4$.

"Caution: In using a Barlow with reflecting telescopes, avoid high amplifications, else the color correction will be poor. A -3" focus Barlow to give an amplification of not more than 1.5 or 2 will be the top useful limit. This works out to $p = 1½$" (inside focus), $q = 3$" (new back focus) and $q/p = 3/1½ = 2$ (amplification)."

Wates, to whom Hartshorn's letter was next passed, writes: "Hartshorn is right, I was off the beam—I took Haviland's formula as my premise. I must admit I was surprised that the result of moving the lens within reasonable limits is very small, as I had understood that one could produce any amplification by moving the Barlow back and forth."

And thus the sins of Wates pass into the body of Haviland, and then the combined sins pass on into the frail body of your scribe, for letting the errors get by, just as in the 21st verse of the 16th chapter of the biblical Book of Leviticus ("The Devil can quote scripture."—old proverb): "And Aaron shall lay both his hands upon the head of the live goat, and confess over him all the iniquities of the children of Israel, and all their transgressions in all their sins, putting them upon the head of the goat, and shall send him away . . . into the wilderness."

Your goat, only too glad of a pretext to hunt up a good wilderness, goes willingly—tail up in the air.

RIGHT in the middle of a war there has been a rush among Englishmen to join the British Astronomical Association, mainly by persons who, because of the blackout, have discovered that above modern city streets there are stars. The new List of Members recently received in this country contains about 1200 names, mainly British but also scattered all over the planet. Of these, only 30 are Americans but there no doubt would be more if more of us were familiar with the Association's good publication, *The Journal.* To obtain it, the easiest way is to seek to join. Nominations must be signed by one member from personal knowledge and your scribe would try to contribute that help for any except convicts or those who should be. The costs are about $6 for the first year and about $4.25 a year thereafter. Over there they really go in for astronomy, and a few of them for telescope making, about which there are occasional articles. The monthly meetings of the Association are reported verbatim—oral discussion by this member and that—in each number.

COARSE diffraction gratings may be made at 10 or 20 cents apiece if made in quantities, by a method described in a short article in *American Journal of Physics* (57 East 55th St., New York, N. Y.), April 1944 by Warner W. Schultz, Reed College, Portland, Oregon.

He knew that gratings had been made by photographing a series of parallel lines but getting such lines is not easy. Easier, it occurred to him, would it be to stack up alternate layers of black and white sheets of paper and photograph these.

A simple rack was built, one face of it being of glass, tilted at 45 degrees, and the papers were stacked 6" deep against this. It then was placed vertical, clamped, and the glass removed.

Focussing the camera was critical, so a finer screen was made by grinding the glass with No. 600 Carbo or finer, and focussing was done with an eyepiece (details of an even better method of focussing are described in the original article). Special film of high resolving power, lantern slide plates, or microfilm, may be used. It is also hoped that gratings of 10,000 lines an inch may be produced using a new Eastman film of high resolving power.

Such gratings may be used for direct observation of spectra.

AUTHOR of the well-known book "Applied Optics and Optical Design," Professor Alexander E. Conrady, died June 16 at his home in London, aged 78 years. He was formerly Professor of Optical Design at the Imperial College of Science and Technology, London, and previously lens designer at W. Watson and Son, Ltd., of London, manufacturers of microscopes. He is survived by three daughters, one of whom, Hilda G. Kingslake of Rochester, N. Y., the wife of Professor R. Kingslake, is herself the author of several optical papers. She is also the mother of Professor Conrady's only two grandchildren, both of whom were born in the United States.

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TRADITIONALLY a welder is surrounded by the haze of smoke. Now a portable Precipitron*, the electrostatic air cleaner, is used by industry to eliminate the welding smoke. The unit clears 600 cubic feet of air per minute.

COUNTING THUNDERBOLTS is the task of a new device which has been thrown into the campaign to protect power lines from damage by lightning. It consists of a saw-toothed and a straight-edged strip of metal foil between two layers of transparent plastic, and is about the size of a playing card. When lightning strikes a power line, a bit of the lightning is deflected to the foil, jumps the gap from one tooth to the straight-edge. In so doing it scorches a black spot on the plastic and also burns away that saw-tooth, so that the next discharge must travel by another path. No two teeth are the same size; each discharge picks the shortest path and thus is registered only once.

ARCHERY AND ELECTRONS are working together in that most modern of scientific instruments, the electron microscope. Quartz filaments 1/30,000 of an inch in diameter—one-sixteenth the thickness of a human hair—are used to calibrate the magnifying power of these microscopes. Westinghouse engineers have found that a modification of the medieval cross-bow is the simplest and most efficient device for drawing out molten quartz into such a filament before it can cool or harden.

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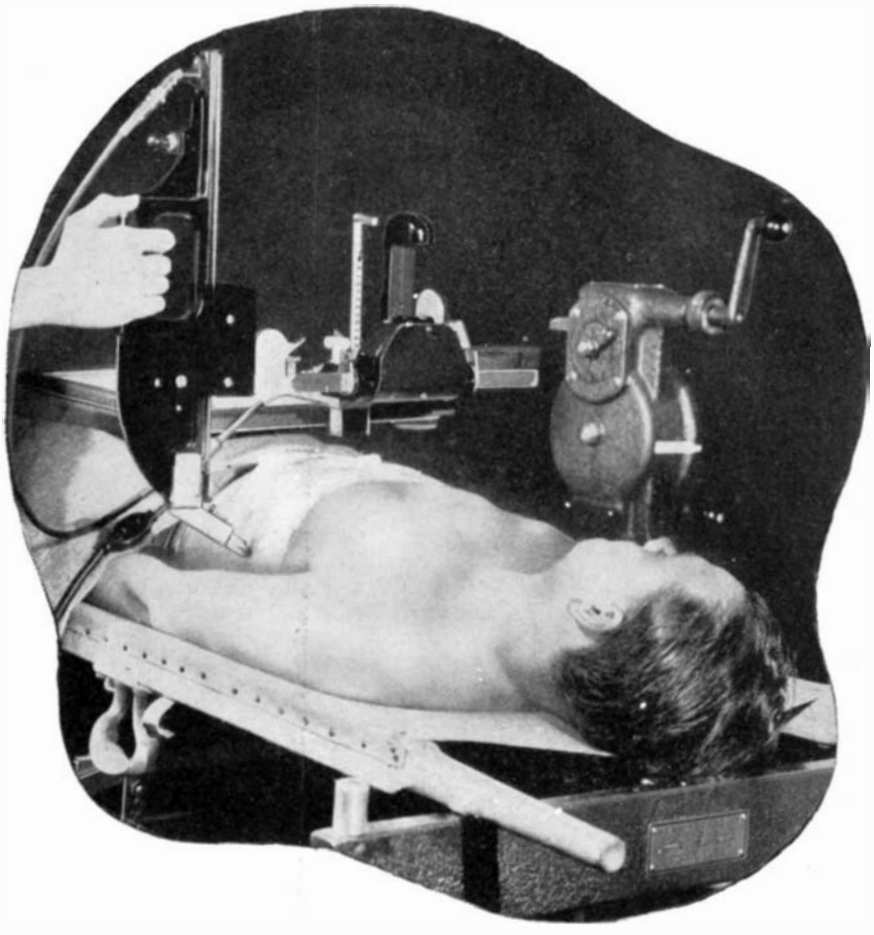

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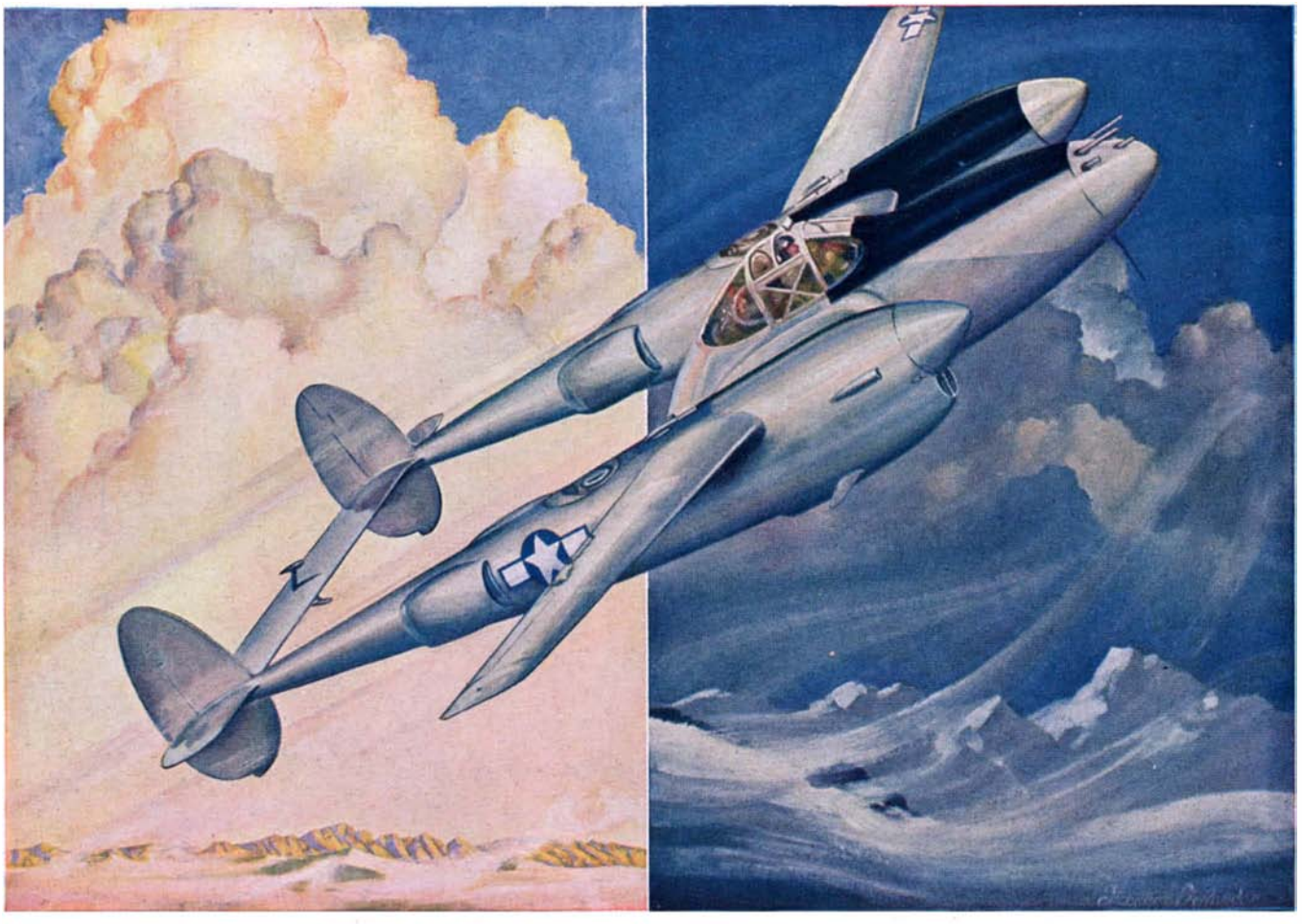

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