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Toughened Glass Shows Its Pattern . . . See pages 49 and 73

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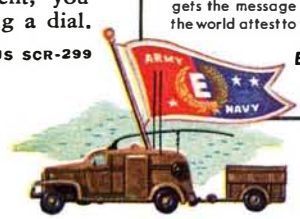

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COVER: Toughened glass, produced through a process of introducing controlled strain by a heating-chilling treatment (see page 73) is widely used today in industrial safety goggles. Our front cover reproduction shows such a goggle being inspected under polarized light. The characteristic black pattern seen in one of the lenses is invisible under ordinary light (note the other lens projecting beyond the front screen), but is revealed under polarized light, the pattern indicating that the glass has been properly toughened.

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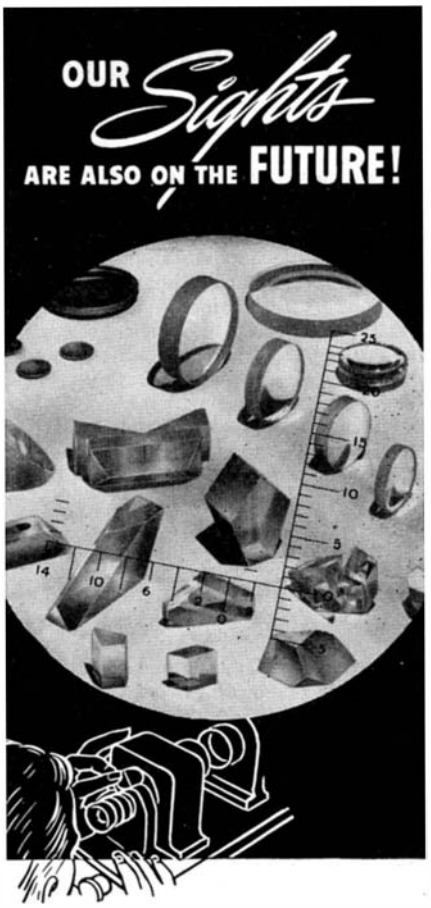

The demands of our Armed Forces still hold top priority on Univis production schedules for precision instrument lenses and prisms. But we have raised our sights above the needs of war to focus them more clearly on the industrial needs of the future.

In the coming battle for markets that will mark the resumption of peacetime production, *quality control* in the manufacture of products will play a major role. And precision instruments involving lenses and prisms are vital to such quality control.

We shall welcome the opportunity to discuss with you and to assist in the development of your post-war products which require the use of precision lenses and prisms.

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IS A HABIT WITH
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INSTRUMENT LENS DIVISION
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Previews of the Industrial Horizon

By A. P. Peck

UP WHERE THE AIR IS THIN

RESEARCH in connection with high-altitude airplanes, such as the B-29 Superfortress that already has proved its military prowess in the Pacific theater, is going to contribute much to the comfort of the air traveler of tomorrow. For many months Boeing has delved into the mysteries of what happens when men and materials are subjected to the low atmospheric pressures and low temperatures of the stratosphere. That they have come up with many of the right answers is evidenced by the success of the B-29. That these same answers will influence the design of tomorrow's air transports is equally evident.

Advantages of stratosphere flying are well known: high speed, freedom from storms, and so on. Equally well known are some of the disadvantages, but the methods of overcoming these drawbacks are not so obvious. Passenger comfort and safety are foremost desiderata of commercial airlines. The same is true in military bombers. The men who have developed the designs which today are bringing our bombing crews back safely from successful missions are the men who are laying the groundwork for the luxury airliners of the future.

Don't look tomorrow for nightmarish super planes that will carry you to London in a matter of minutes, but do look to designs such as the Superfortress for a glimpse of what the airplane industry will be using for your convenience when you can once more step up to a ticket office and buy accommodations on a plane leaving that same day!

PUBLIC RELATIONS

PROGRESSIVE managements are today paying far more attention to the serious subject of public relations than ever in the past. Whether making consumer goods or producing capital goods, these managements are finding that the more the public knows about their operations, the more successful their organizations become. The day of the light under a bushel is past and the tale of the unadvertised mousetrap has been proved fallacious. Find a corporation that has done a conscientious job of public relations and you will find a corporation that has the confidence and understanding of the man in the street. And, at the same time, you will find a successful business organization.

FROM ENGINE TO WHEELS

FOR A WHILE prior to the war, some manufacturers were adapting hydraulic transmissions to motor vehicles, eliminating the conventional gear trains and their attendant mechanical difficulties. These same methods of coupling power plant to driving wheels have been extensively applied to military vehicles with the inevitable result they have been highly refined. Now engineers predict that motor vehicles already dimly discernible on the public's horizon (but don't look for them the day after Tojo and Hitler fold up) will be equipped with hydraulic couplings and transmissions that well set new standards of automatic operation with the elimination of the friction clutch and with new extremes of smooth operation and long service.

MECHANICAL RUBBER GOODS

INDUSTRY in general is becoming more and more conscious of the need for vibration absorption, noise suppression, and shock absorption in machinery. A machine that sets up excessive vibration, that is noisy in operation, that transmits impacts from one part to another or from itself to its surroundings, is an inefficient machine. It is wasting power and is building up within itself an early one-way trip to the scrap pile. Fortunately, research engineers recognize this simple truth and are doing something about it. For example, General Tire and Rubber Company is concentrating on applications of rubber to machine bearings, mountings, couplings, and gear bushings to eliminate those by-product mechanical forces which spell destruction to machinery. This is a phase of research engineering that is going to mean much to industry and consumer alike.

PICTURES FROM THE AIR

TO BRING John Q. Public into the industrial picture for a few more minutes, let's take another look at television. Still a problem-child to many, the romance of pictures from the air has undoubtedly caught the public fancy. If you doubt that John and his family are sold on the idea of television, you have only to look at a recent report made by the Franklin Square (Long Island) National Bank. That institution has inaugurated a unique savings plan in which deposits are earmarked for specific post-war product purchases.

Some 22 percent of the depositors state that they are saving for television receivers, with only 13 percent speaking up for new motor cars! And 5 percent of them are thinking in terms of helicopters!

What the public wants the public usually gets. And the television market that is just over the horizon is going to surprise many conservative people who, mentally and whether they will admit it or not, are still in the hoss-and-buggy era.

INDUSTRIAL RESEARCH

WE CANNOT resist the temptation to quote briefly here from recent statements by Sir Harold Hartley, Vice President of the London, Midland and Scottish Railway Company.

"The prosperity of Britain after the war," said Sir Harold, "will depend more than ever upon the efficiency and progressiveness of our industries. . . This formidable task can only be achieved by using to the full our inventiveness and technical skill both to increase the efficiency of our older industries and to develop new commodities which will hold their own in the markets of the world. . . Only research can refashion existing industries effectively and create new ones. . . . Labour and research must work hand in hand."

FOR FUTURE REFERENCE

TERRORS of the dentist's chair are reduced by the use of chrome-finished drill burrs. By their sharpness they reduce considerably the time required for cavity preparation. . . The extent of that much-talked-about post-war motor-car market is indicated by the fact that nearly 4,000,000 motor vehicles went out of service in 1942 and 1943 and have not been replaced. . . Cereals disguised as candy bars are the latest idea of the food industry, determined to make us eat cereals whether we want to or not. . . Indicative of some of the things that plastics can do is the fact that they have saved seven pounds of weight in magnetic compasses used by tanks and armored vehicles. . . Aircraft power-plant manufacturers have an eye on post-war markets in the field of ground vehicles of all sizes and shapes. They also can teach automotive engineers much about power/weight ratios.

AGAIN. ZENITH MAKES HEARING AID HISTORY!

Brings New Smartness and Style at No Extra Cost with the

New Neutral-Color Earphone and Cord

ZENITH made hearing aid history by bringing fine precision *quality* within reach of all. Now enith follows through—makes history again—brings ou, in its complete production, an entirely new stand-d of hearing aid *smartness and style!*

With the exclusive New Zenith Neutral-Color Ear-none and Cord—developed after years of research—enith now does for the hearing aid what modern yling did for eyeglasses! Now America's hard of earing can wear an aid with visible parts that are *arcely noticeable,* because they blend with any com-exion. Best of all, they are available to present pur-asers at no extra cost—*included* at Zenith's history-aking low price of $40!

With this smart new Zenith ensemble, even the ost sensitive wearer can feel perfectly poised. For it ings an attractive new "look of youth" to the hear-g aid. You'll notice it immediately when you look yourself in the mirror. Now, no one need feel self-nscious about wearing a hearing aid.

See the proof of this today. And *hear* the proof of cellence in performance that has made America ving *overwhelmingly* to the New Zenith Radionic earing Aid. Visit the Zenith-franchised dispenser earest you. Or, for complete information by mail, e the convenient coupon below.

THE NEW EARPHONE

- Smart, modern, scarcely noticeable! Pleasingly neutral in color so that it blends with any complexion.
- Sturdily constructed of beautiful, long-wearing plastic.
- Comfortable to wear because it's feather-light in weight.

THE NEW CORD

- Made of translucent plastic—looks well with any apparel. Friction or clothing noise is less than with any of the old-fashioned fabric-covered cords.
- Slender, light in weight, infinitely smarter and more comfortable to wear. And it lasts longer.
- Perspiration-proof . . . water-proof . . . kink-proof . . . washable. Will not fray, wipes clean with damp cloth.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of August, 1894)

AUTOMATIC PHONE — "The Mutual Automatic Telephone Company . . . has an invention which is designed to obviate the annoyance and difficulty attending the obtaining of connection with other parties through the operations of a central office, as under the present system. With the automatic system a small keyboard, containing four keys, marked respectively 'hundreds,' 'tens,' 'units' and 'release,' is attached to each telephone. These the subscriber manipulates when calling up a correspondent. For example, if he should want '122' he would press the key marked 'hundreds' once, 'tens' twice, and 'units' twice, and then ring the bell. When through with the conversation he will press the next button, which is the 'release.'"

ARTIFICIAL SILK — "In the process of producing 'artificial silk,' invented by Dr. Lehner, waste cotton, wool, jute, or other suitable material is reduced to an emulsion by means of a mixture of nitric and sulphuric acids, when it is formed into threads by forcing it through glass tubes of small bore, and is passed over a series of rollers and wound in the ordinary way on bobbins. Before the artificial silk is used in manufacture, or is sold, it is denitrated to destroy the explosive properties, and is also rendered uninflammable, which will render it suitable for many purposes, especially as it is said to resemble real silk very closely."

FLYING MACHINE — "Fools may laugh at a man who devotes whole years of his life and many thousands of pounds to constructing a flying machine which runs on rails; but it has been said of old, he laughs best who laughs last. There can be small doubt that Mr. Maxim holds in the palm of his hand a contrivance which little more is required to make perfect for aerial flight."

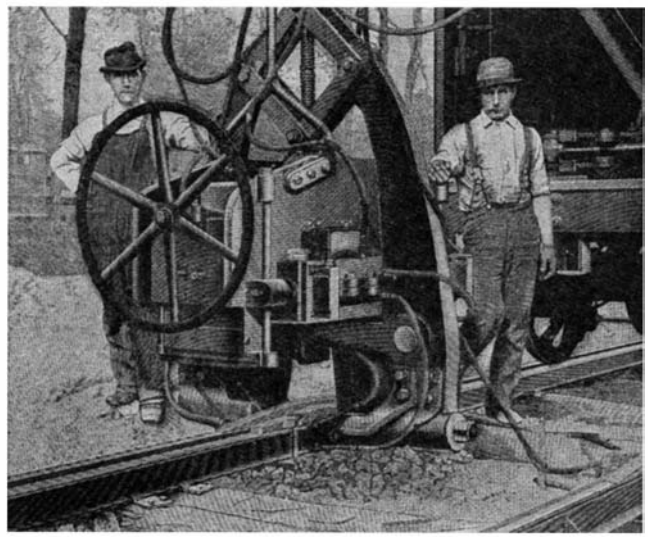
UNBALANCED LOCOMOTIVES — "For the past ten years, and possibly longer, there have been practical evidences, upon certain railroad lines upon which speeds of 70 miles an hour and over are attained, that imperfectly balanced engines are great track destroyers, and that in extreme cases they make a permanent bend in the rails. . . With the increased demand for high speeds, locomotives will have to be designed that are perfectly balanced. The limit of safe speed with unbalanced engines has been reached and passed."

METAL STRENGTH — "When the earth shall have cooled until the air is condensed as a liquid sea above the land and the frozen oceans, the non-crystalline metals, as Professor Dewar has shown in one of his latest lectures, will be much stronger than they are now. Small bars of the metals, cooled by liquid oxygen or air, were stretched in a cement-testing machine until they broke with the strain. At about 290° below zero Fahrenheit, the breaking strain of copper, which is 22.3 tons per square inch at ordinary temperatures, was increased to 30 tons."

MERCHANT MARINE — "The necessity for the immediate encouragement for the building, by American citizens, of a fleet of ocean steamships, capable to the highest speed, and constructed with special reference to government naval service, in case of war, led the Congress of the United States to enact certain special laws upon the subject."

FERRY TRAFFIC — "It is estimated that the yearly passenger trips on ferryboats between New Jersey and New York number 70,000,000; that the total for all New York ferries will exceed 170,000,000; that the number of boat trips equals 1,800,000, and the number of teams carried 5,000,000. This immense traffic is carried on with remarkable safety."

WELDED RAILS — "On the advent of the electric welding, a very obvious application of it seemed to lie in the welding of rail joints. . . The electric street car companies have shown a disposition to adopt welded joints, not only to secure a continuity of track for mechanical reasons, but for electrical ones also. As the track is used for the return current, it is



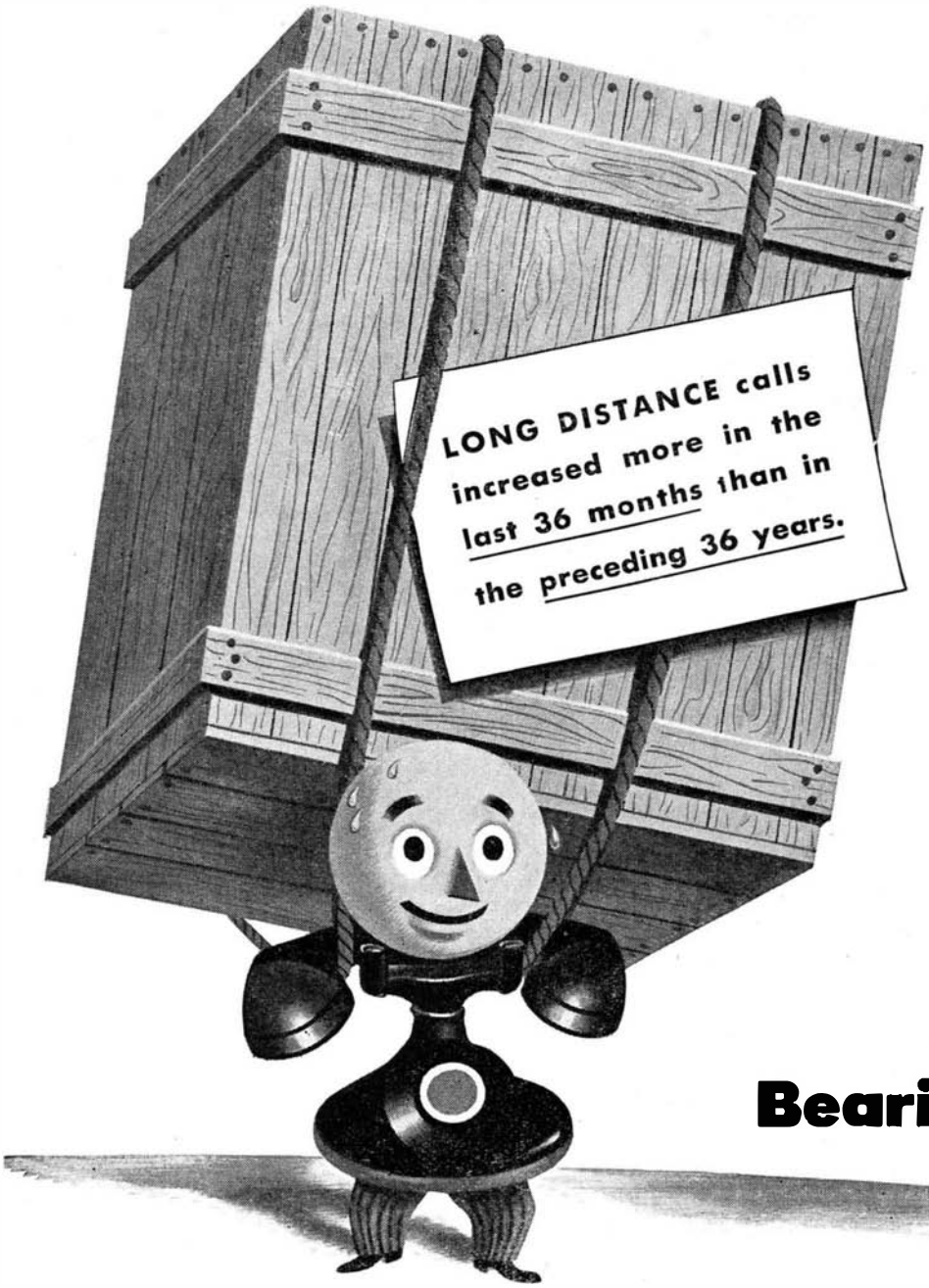
obvious that its conductivity should be as high as possible, and such conductivity is evidently favored by welding the joints together. We illustrate one form of the welding machine . . . which consists of a Thomson welding machine of special construction arranged to be carried on a crane projecting from a construction car. . . The operation is so perfect that after the welding is done and the ground is filled to its level, it is almost impossible to tell where the weld has been completed."

FRUIT SUGAR — "A recent chemical discovery which will be of great practical interest in those portions of the United States where the preservation of fruits has become an established industry is a process by which fruit sugar may be manufactured from beet juice. . . It consists in the inversion of beet sugar at a certain stage of its manufacture by chemical treatment into what is technically designated 'laculose,' which is chemically identical with the natural fruit sugar."

PROPELLER — "The introduction of the screw propeller into use was accomplished simultaneously by Smith in England and Ericsson in the United States. Both were men of great ability. Each considered himself the inventor of the screw propeller. . . Each introduced the screw propeller on war vessels in 1843, Ericsson on the Princeton and Smith on the Rattler."

STORAGE BATTERIES — "Occasionally we read predictions of the possibilities of the coming storage battery. . .Much of the misconception in regard to the power of the storage battery must be ascribed to the sensational manner in which it was introduced to the public by a very great scientist, his statement in regard to holding 'one million foot-pounds of energy' in his hand not yet having lost its effect. The great value of the storage battery in its proper field, which is of vast extent, and as yet scarcely entered in this country, should be sufficient to satisfy its most sanguine friends. Only harm can come from making claims beyond its power to fulfill, and much harm in this way has been done."

BICYCLES — "The sum of 100,000 marks is included in the German army estimates for the present year for the supply of bicycles to the infantry. . . Bicycles are to be used for communications between columns on the march and for communications between advanced guards. When troops are in quarters, bicyclists are to fulfill the functions of orderlies, especially where mounted orderlies are wanting."

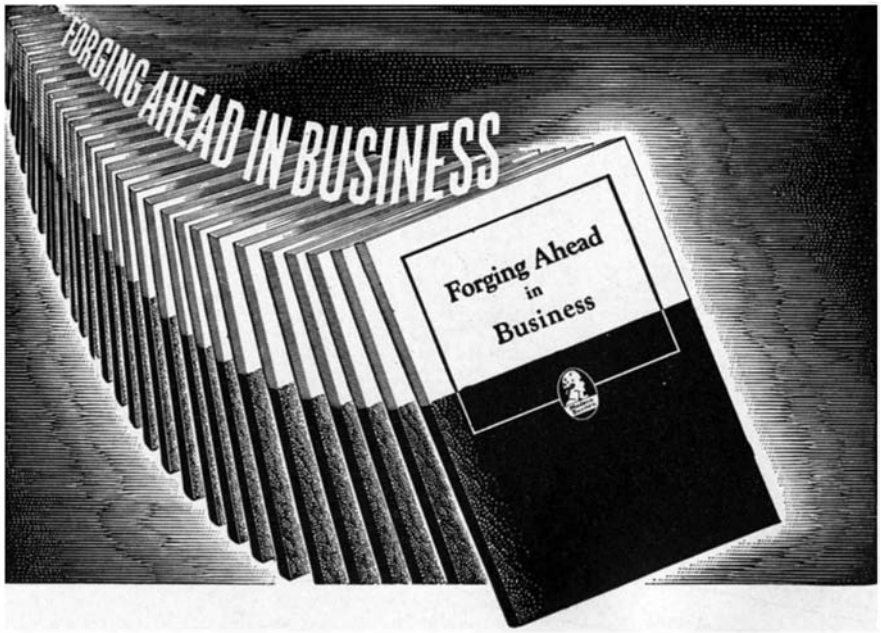


Bearing up well

He's carrying quite a load but he's doing all right. And he's mighty grateful for your help—especially when Long Distance circuits are crowded.

Then the Long Distance operator may say—"Please limit your call to 5 minutes." Saving telephone time is important in wartime.

BELL TELEPHONE SYSTEM



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Frankly, this booklet has no appeal for the immature mind. It does not interest the man who, for one reason or another, is wholly satisfied to plug along in a mediocre job. But, for the alert, future-minded individual—the man with ambition and "drive"—"Forging Ahead in Business" has a message of distinct importance. If you feel that it is intended for you, don't hesitate to send for a copy today. Simply fill in and mail the coupon below.

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"Quotes . . ."

"ONE HIGHLY IMPORTANT objective of post-war planning should be the creation of new opportunities for the productive efforts of our people. This is consistent with the sound principle that America's economy must expand in the future as it has in the past, a principle which the depression of the 'thirties' so convincingly demonstrated." *P. W. Litchfield, Chairman of the Board, Goodyear Tire and Rubber Company.*

" " "

"AN ORGANIZATION of intellectual workers can have the greatest significance for society as a whole by influencing public opinion through publicity and education. Indeed, it is its proper task to defend academic freedom, without which a healthy development of democracy is impossible," Professor Albert Einstein.

" " "

"RENEGOTIATION needs to have the mystery taken out of it. Renegotiation in the mind of the average individual is a means for taking inordinate profits away from war production. Obviously, if this is true every American would be for it. The fact is, however, it does no such thing. It rewards inefficiency and ruins the efficient all at the expense of the taxpayer." *J. F. Lincoln, President, The Lincoln Electric Company.*

" " "

"THE WORD 'BOOM' may be a bit strong, but we certainly do not anticipate a prolonged post-war slump. To meet war's requirements Diesel production has zoomed far beyond the highest point in the industry's history. We expect this production to hold more or less firm." Gordon Lefebvre, President, Cooper-Bessemer Corporation.

" " "

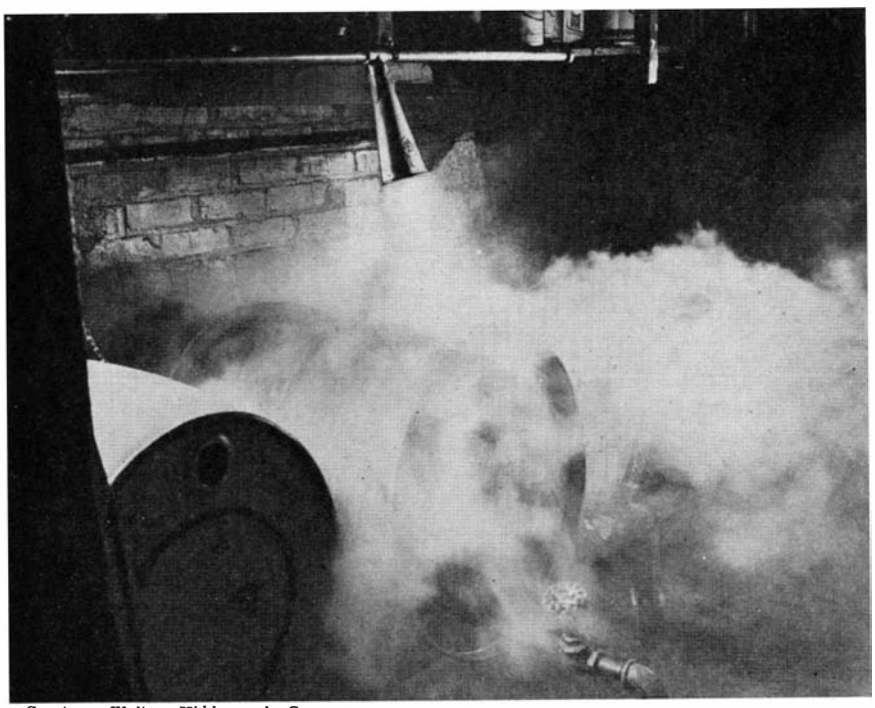
"NEW MARKETS will result from existing and expanding incomes, living standards and credit facilities. This post-war 'look' spells unprecedented United States business prosperity in terms of our average family. Educate and sell the other half of our fellow-beings our industrialized United States and the costs of this war in treasure will disappear." *George W. Bacon, Chairman of the Board, Ford, Bacon and Davis.*

" " "

"WE ARE RIGHT NOW in a period of intense inventive effort and accelerated scientific and engineering developments. The urgency of war has speeded up the clock. In some lines, we are told, the probable developments of 20 or 30 years have been telescoped into three. . . There will be not only a tremendous accumulation of needs for engineers to meet, but also an extraordinary accumulation of new engineering knowledge." Robert M. Gates, President, American Society of Mechanical Engineers.

ENGINEERING

Conducted by EDWIN LAIRD CADY



Courtesy Walter Kidde and Company

CO_2 goes into fire-fighting action

Fighting Factory Fires

Fire Losses Do Not All Appear in the Statistics. Small and Unreported Fires are Quickly Controlled With Portable Equipment. But the Right Kind Must be at Hand at the Right Time, and Employees Must Know How to Use it. Water is Still a Good All-Around Extinguishant

BEFORE 1944 is over, fire losses in the United States will have climbed to another high for the past ten years. And industrial fire losses will have climbed right with them.

Nobody really knows what the fire losses are. Too few get into the statistics. If a loss is so big that somebody goes to his fire insurance company and puts in a claim for it, then that fire is called a "reported fire" and finds its way into the columns of figures. But a single cotton mill has been known to have 2000 unreported fires in a single month—lint around the bearings of a machine became oil soaked and caught fire by spontaneous combustion, and so on. Each of these fires was extinguished without physical damage to the machine—but each of them meant a machine temporarily shut down, men distracted from their work, supervisors dashing up with extinguishers. The total cost was plenty, but none of it was counted into the tables which everybody uses for studying fire hazards.

Taking the figures as they are, then, fire losses cost the nation only $172,000,000 back in 1915. By 1926 they had hit an all-time high of $562,000,000. Gradually they were knocked down to the $235,000,000 of 1935. Since then they have again been growing, and 1943 saw them jump up to $380,000,000 from the $314,000,000 of 1942. They are going at an even hotter pace in 1944.

These figures, of course, do not begin to compare with the $2,000,000,000 per year cost of industrial accidents. (And we will not mention the daily cost of the war this time.) The fact is, the $100,000,000 per year cost of industrial fires—and industrial fires run from 23 to 28 percent of the total—represents one of the greatest triumphs of industrial history.

But, in spite of all this, industry is not regarding its fire situation with complacency. Too much can get out of hand in too short time. Just one good blaze in a big war plant could send the figures soaring.

And there are definite reasons to believe this may happen. The growing number of electrical fires is one of them. Over a ten year average, electricity was a poor fifth in the amount of damage done by fires. Matches (smoking) nearly doubled electrical causes in damage done. But during the past year or so, electrical fires have taken the lead. They are 50 percent greater than their old matches-smoking rival.

Greatly increased use of flammable solvents and other liquids is another hazard. New flammable raw materials —magnesium is one of the most dangerous—present new problems. The crowded conditions of modern factories, with complicated equipment fitted in wherever space can be found from floor to ceiling, and closed ducts threading their way everywhere, do their share to make fire protection men

feel unhappy. This trend increases.

ELECTRICAL FIRES—Even though electrical fires are growing in numbers, they have not grown anywhere near so fast as the amounts of electrical equipment and power used.

One good reason for this is that fighting of the electrical fire starts with the building of the electrical equipment. Modern electrical insulating mate rials are far more fire resistant than their predecessors. And, even more important, thermal protections are built right into equipment—a large generator may have thermal devices which will shut it off if even a few degrees rise in temperature should occur in its interior parts. And the art of using fuses has improved. The time-lag fuse which permits a temporary overload but blows if electrical overload is protracted enough to be a fire hazard, has nearly ended the old time custom of over-fusing to get rid of the trouble of replacing fuses. Quickly replaceable safety fuses and other safety devices have done their share.

Large industrial plants have added the automatic extinguishing set-up which goes into action the minute the fire starts. Perhaps the best of these are the carbon dioxide (CO_2) systems. Nozzles leading from these are mounted not only to extinguish the fire itself, but to put shielding clouds of the carbon dioxide between the fire and nearby materials to which the fire might spread. These nozzles are inside cabinets, behind panels, at large motors—often the nozzles are so inconspicuous that few workers realize they are there until a fire starts.

High pressure, one of the old bugaboos of CO_2 system, has been laid during the war. Pressures of the order of 850 pounds per square inch have long been used for small units, and large units have been built by installing many small ones in series. Now by the use of refrigerating systems the carbon dioxide can be kept at zero, Fahrenheit, and stored at only 300 pounds per square inch. As a result, more than 100 tons may be stored in a single tank—a procedure which was mechanically possible but economically impractical at the higher pressures. This is important to large electrical installations.

Courtesy B. F. Goodrich Company

This industrial truck tire and wheel will conduct electricity, reducing possibility of static sparks that might start fires in flammable vapors

SOME CHARACTERISTICS OF CERTAIN FLAMMABLE GASES AND VAPORS, AND OF COMMON REFRIGERANTS

Gas or Vapor	Vapor Density (Air=1)	Rate of Diffusion (Air=1)	Explosive Limits % in Air by Volume Lower	Upper
Acetic Acid	2.1	0.69	4.0	
Acetone	2.0	0.71	2.0	9.0
Acetylene	0.90	1.05	2.6	82.
Alcohol (Ethyl Alcohol)	1.6	0.79	3.5	19.0
Ammonia	0.59	1.30	16.0	25.
Amyl Acetate	4.5	0.47	1.1	4.0
Amyl Alcohol	3.0	0.58	1.2	5.0
Benzine	3.0	0.58	1.4	5.9
Benzol (Benzene)	2.7	0.61	1.4	8.
Butane	2.0	0.71	1.6	6.5
Butyl Acetate	4.0	0.50	1.7	
Butyl Alcohol	2.6	0.62	1.7	18.
Carbon Bisulphide	2.6	0.62	1.0	50.
Carbon Dioxide	1.5	0.82	Non-flam.	
Carbon Monoxide	0.97	1.02	12.5	74.
Dichlorethylene	3.35	0.55	5.6	11.4
Dichlorodifluoromethane (F-12)	4.2	0.49	Non-flam.	
Dichlorotetrafluoroethane (F-114)	5.9	0.41	Non-flam.	
Ethane	1.03	0.98	3.3	10.6
Ether (Ethyl Ether)	2.6	0.62	1.9	22.
Ethyl Acetate	3.0	0.58	2.5	11.5
Ethyl Bromide	3.76	0.51	6.0	11.0
Ethyl Chloride	2.2	0.67	3.7	12.0
Ethylene	0.97	1.02	3.0	34.0
Ethylene Oxide	1.5	0.82	3.0	80.
Gasoline	3.5	0.53	1.4	6.
Hydrocyanic Acid	0.93	1.04	5.6	40.
Hydrogen	0.069	3.81	4.1	74.
Hydrogen Sulphide	1.17	0.92	4.3	46.
Illuminating Gas	0.65	1.24	5.0	31.
Kerosene	4.5	0.47	1.1	6.
Methane	0.55	1.35	5.6	13.5
Methyl Acetate	2.6	0.62	4.1	14.
Methyl (Wood) Alcohol	1.1	0.95	6.	36.
Methyl Bromide	3.3	0.55	13.5	14.5
Methyl Chloride	1.7	0.76	8.1	17.2
Methylene Chloride (Dichloromethane)	2.9	0.58	‡	‡
Methyl Formate	2.1	0.69	4.5	20.
Monofluorotrichloromethane (F-11)	4.7	0.46	Non-flam.	
Pentane	2.5	0.63	1.45	7.5
Propane	1.5	0.82	2.3	7.3
Propylene	1.45	0.83	2.2	9.7
Sulphur Dioxide	2.2	0.67	Non-flam.	
Toluol (Toluene)	3.14	0.56	1.4	7.
Turpentine	4.7	0.46	0.8	
Xylol (Xylene)	3.7	0.52	1.0	5.3

‡Practically non-flammable at ordinary temperatures.

Portable carbon dioxide extinguishers have been improved, too, in that the operator has better control; by merely varying the pressure of the grip of his hand he can increase or decrease the volume of CO_2 he directs at the fire. And perhaps the greatest factor in all the CO_2 extinguishers is that over the years so many factory employees have become familiar with them, have learned what they are for and how to operate them. The small electrical fire finds one of these, or a dry chemical or vaporizing liquid type, directed at it at once.

Fear of using water on an electrical fire is being dissipated with excellent results. In former years many an electrical fire got completely out of control just because the fire fighting forces had only water hoses at hand and were afraid of electrocution. But the National Board of Fire Underwriters has found that, on ordinary 120-volt lines, a hose nozzle can be brought to within a few inches of the live wire or device and so long as the nozzle itself does not make an actual electrical contact with the wire the fireman can work in perfect comfort, especially if he is wearing rubber boots.

Higher potentials are more dangerous, but not excessively so. At 600 volts, the National Electrical Code limit for low potential, the nozzle can be brought to within four feet of the charged wire. Even 2200 volts is OK at 11 feet, and 33,000 volts can be squirted upon from 30 to 40 feet.

The modern fog nozzles present an even better picture. If the nozzle is held at least six inches away from the live wire, the fog device is safe up to 7500 volts. And a really hot 220,000 volt job is safe if the nozzle is 11 feet away.

As a result of these safety figures, water streams are being used to cool down electrical fires until the CO_2 or other extinguishant can be brought into play. Fog nozzles are mounted as automatic equipment for the same purpose. Neither water nor fog will penetrate to the inside parts of electrical equipment as carbon dioxide gas will, and nobody wants to get electrical equipment wet if he can help it; the drying out process is too time-consuming and costly. But electrical fires can be cooled with water, they can be stopped quickly with CO_2, and damage from them in industry is being kept astonishingly low.

FLAMMABLE LIQUIDS AND GASES—Flammable liquids are being used in industry in ever-increasing quantities, especially as solvents and refrigerants. Their greatest danger is in the gases they give off—gases which may be explosive if mixed with the correct quantities of air. A spark or other source of fire contacting such a gas at a distance as great as 150 feet from the liquid itself may start a fire.

First step in controlling these fires has been to know the speeds at which the gases or vapors diffuse in air, and the upper and lower limits of vapor-air mixture at which combustion or explosion can take place. Based on this knowledge, devices are used to evacuate the fumes before they reach explosive proportions, or, better still, to recover the fumes and prevent waste. Many systems using these liquids and gases are completely closed; the fumes do not escape to become dangerous.

Chambers, paint spray rooms, and other places where such fumes may gather, often are protected by automatic CO_2, water fog, or other extinguishing systems which act so quickly that the fire may be put out before plant employees find out that it has started. Many of these systems are so arranged that shields of extinguishant are thrown between the fire and nearby equipment: The fire is isolated.

Automatic hoods, louvers, shutters, and doors are arranged to isolate the fire and cut off its oxygen supply. Many of these work by gravity—one of the simplest devices is to have a fusible link of the same metal as that used in sprinkler heads. The link melts from the heat of the fire, and the hood or other device operates by its own weight or by a weight attached to it.

In some of the best systems the extinguisher and the isolating devices are connected. When the fire causes the extinguisher to operate, change of pressure in the extinguisher piping (or some other device) actuates valves which drop hoods, close louvers, shut off ventilating and other fans, and ring alarms.

One of the fastest growing means of control of this type of fire is the increased use of non-sparking tools. Pliers, wrenches, hammers, chisels, almost every kind of tool which might

Dry chemical fire extinguishers are spotted strategically in a paint mixing room, ready for instant use

slip, be struck, or be dropped in such a way as to cause a spark if made of steel, are now made of non-sparking metal.

First used in gunpowder plants but now transferred to industry in general is the static electricity conducting conveyor belt, industrial truck tire, safety shoe for workmen, and factory flooring. Stray electrical currents generated by friction or otherwise are conducted away before they gather enough potential to cause the sparks which would set off explosions and fires.

Portable extinguishers of the dry chemical, CO_2, vaporizing liquid, and foam types are highly developed for controlling these fires. Like other portable extinguishers, one of the chief values of these lies in the fact that factory employees can quickly learn how to use them.

MAGNESIUM FIRES — Magnesium threatens to take the place of celluloid as the most feared flammable material used in industry. Like celluloid it has a secondary hazard. The gas which is a product of combustion of celluloid is itself explosively flammable; magnesium has the property of taking oxygen out of the water used to extinguish its fires and so of propagating and even increasing the intensity of its burning.

The greatest danger from magnesium fires exists, not for the war plants which have learned about magnesium and how to handle it, but for the myriads of small plants which may experiment with this metal to take advantage of its lightness and strength for their post-war products.

The National Board of Fire Underwriters is preparing special data to show factories how to control this hazard. Absent from this will be the weird tales of factories which forbade their women operators to wear silk panties (if they could get any) lest sparks from friction set off the magnesium chips in their lathes. Gone also will be the superstition that water should never be used on a magnesium fire. The fact is, so long as a solid stream of water is not used to scatter the fire, water has the useful effect of cooling down the blaze, cutting off the heat radiation which is one of the principal means by which magnesium fires cause other materials to inflame, and making it easier for the dry chemicals to extinguish the fire.

Many types of extinguishants can be used with success on magnesium fires. Graphite has been used and there are special dry chemicals of water-repellant types. Dow Chemical Company, world's largest producer of magnesium, has an extinguishant.

ORDINARY FIRES—The common fires in wood, rubbish, paper, and so on are being kept down by modern good housekeeping. Factories are kept cleaner than ever before. There are fewer accumulations of rubbish and less dust is permitted to pile up in concealed places. After all, fires must have fuel and the hazards are less when the flammable trash is kept out of the plant.

The increased use of flame-proof or flame-resistant materials is a second step in this control. This includes not only stone, concrete, steel, glass, tile in the walls and floors, but also wood which has been so treated that it will not support combustion.

A third factor in general fire control is the completeness with which wood chips, oil-bearing metal chips, and other scrap is being scavenged at its points of origin. Much of this method originated not as a means of fire control at all, but of salvaging critical materials, keeping process temperatures under control, and keeping operations clean. Fire damage per million dollars' worth of goods produced, or per thousand kilowatts of connected horsepower, or other yardstick, is due to keep on going down in industry—unless somebody gets over-confident and looks the other way while hazards build themselves up.

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MORE LADDERS

Designed for Other Purposes, They Aid Maintenance Men

INDUSTRIAL maintenance men have more types of ladders, moveable platforms, portable man hoists, and so on, available to them than ever before. The result is greater speed in maintenance operations on shafting, fans, blowers, motors, conveyors, and all sorts of devices mounted over head.

These ladders were not developed for industrial maintenance. They have come into existence because airplane maintenance and some parts of aircraft construction require more climbing by more men who must have more portable tools with them than any other task industry has experienced. Speedy equipment had to be developed for getting the men up where they could work, and it had to be equipment which could be removed quickly.

The common extension ladder helped some, and so did the platform or safety ladder. But aircraft plants developed "wheelbarrow" platforms, which are wide portable staircases having two of their supports on wheels and two on ladder shoes. These platforms may be wheeled by hand wherever wanted. The ladder shoes are set on the ground in the regular way and hold the platforms in place while the men work.

Portable and demountable man hoists capable of being erected in odd or tight corners or of being made large enough for several men to work on one platform also were developed. Transferred to the factory for painting and other maintenance work, these devices are time savers.

PERMANENT MOLDS

Produce Satisfactory Cast Iron

PERMANENT mold casting of iron was one of the most talked-of production processes just before the war. Now, with the shortage of brass and bronze, manufacturers have had to turn to this process as the best way to get some of their substitute parts.

The process, developed by Eaton Manufacturing Company, is working. It produces a fine-grained homogeneous metal which compares well with brass and bronze in machinability. Intricate shapes are being produced. Tests show that the metal is practically free from porosity.

Nobody knows how far this process will get in the post-war field—it will have to take what it can grab in the forthcoming battle between nonferrous metals, stampings, forgings, die castings, plastics, glass, and all. But at least permanent molds for iron are well beyond the dream stage.

TUBULAR AXLES

Developed for Railroads, Have Other Possibilities

TUBULAR steel axles, a development of the Pittsburgh Steel Company, are being watched with great interest by builders of heavy machinery. Right now these axles are made only for railroad cars; they save from 25 to 40 percent of the weight of the solid axle and give the locomotive a minimum of 1040 fewer pounds a car to haul.

The manufacturing process includes special rolling to form the axle shape for wheel seats and the like, special upsetting, forging and heat treating. No other industry than railroads provides the volume of business on heavy axles to warrant the working out of this process. But, once the process is in full swing, sizes may be made for makers of chemical machinery, heavy machinery for oil refineries, heavy machine tools, and so on. Some machine designers are thinking of incorporating standard shape railroad car axles into their original products.

Nonferrous Metals Tomorrow

The War Has Framed the Futures of the Nonferrous Metals With a Number of Provocative Question Marks. How Will Aluminum, Magnesium, Copper, Zinc, Lead, and Other Important Metals Fare Individually When Peace-Time Competition Really Gets Tough? Some of the Answers are Clear Now

ONE MORNING last winter the public read with puzzlement that WPB had ordered the suspension of production at one of the East's new aluminum manufacturing plants, because aluminum output had surpassed the demand for the metal in aircraft and munitions.

Then, in March, magnesium production was cut back some 34 million pounds per year or about 6 percent of the total program. Reason: too much magnesium already. Copper became plentiful enough for Ordnance to effect a return to brass shell cases instead of using substitute steel. If the production capacities of these industries are too great now, with war unfinished, what situation will they be in when peace and competitive markets return?

Of course, many factors of a non-technological nature—such as national and international economic policies and politics—may ultimately decide their fates. But assuming a free economy based on "private enterprise" it is possible to make some reasonably safe predictions as to the technical paths the individual metals will follow, the markets they may reach and the extent to which their generally expanded wartime production capacities may be used.

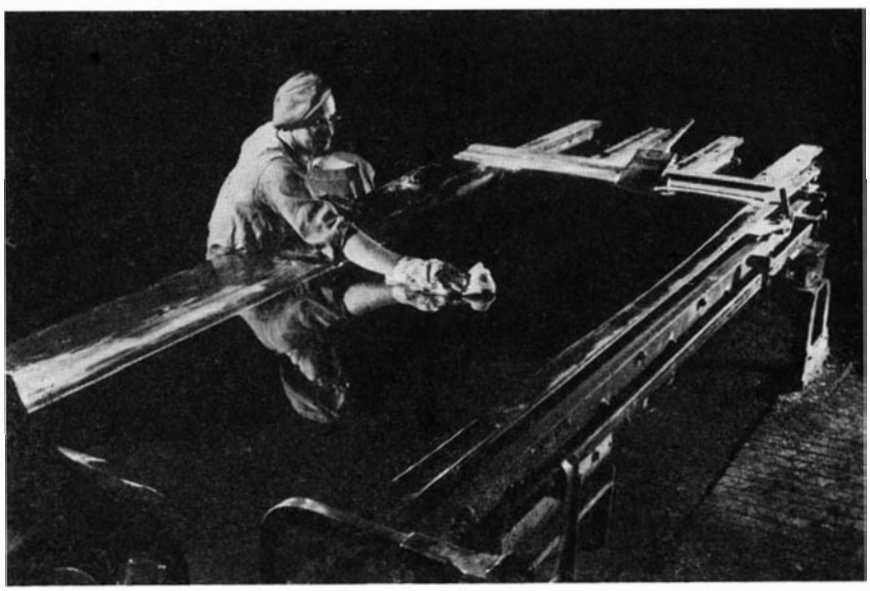
NO THREAT TO STEEL—In the first place, let us dispose finally and briefly of the fear occasionally voiced that the light metals will present a major threat to the steel industry. Today steel production is over 90 million tons of ingots, a figure that utterly dwarfs the light metals total of less than 1½ million tons a year. As a matter of fact, some of the steel industry's specialty items like stainless steel or low-alloy high-strength steel may present a greater threat to the light metals than the latter do to the steel industry as a whole. It is to each other that the nonferrous metals may do the most harm.

The present production of aluminum is in the neighborhood of 1,000,000 tons per year. Its price is now around 15 cents per pound for primary (virgin) aluminum ingot. The expectation is that after the war this price will drop to 11 or 12 cents and that the price of secondary (reclaimed) aluminum may be close to six cents per pound. This price situation places aluminum in a more favorable position marketwise than copper and its alloys, since their prices per pound will be very close together while the price per unit volume of aluminum will be proportionately lower because of its lower specific gravity.

Few, however, expect the production of aluminum to be any larger than it is at present for some time after the war's end. This is because the metal's present chief market (aircraft) will shrink in production to an expected small fraction of its present volume and it will doubtless be some time before that industry re-reaches its present level and before the aluminum and magnesium manufacturers will have developed other markets to occupy their manufacturing capacity completely. In this respect, of course, political developments will have considerable influence, since the question of possible governmental operation or "bargain sale" of the Government-owned aluminum plants is still open.

Despite this, of all the nonferrous metal manufacturers the aluminum industry is expected to be the most aggressive in capturing or developing post-war markets for its materials. The chief advantage of aluminum alloys—their high strength-weight ratio—makes them especially attractive for mobile equipment of various types since it is expected that the post-war period will see rapid expansion in the "vehicular" industries (which profit in proportion to their use of light-weight materials). We may safely predict extensive use of aluminum alloys in railroad equipment, including locomotives as well as freight trains and de luxe passenger cars; in automobile engine parts (but not in bodies for some time); in busses, trucks, and trailers which can carry more payload or operate at higher speeds as they reduce their weight; and in the new civil aircraft industry which, starting from a low level, may be expected to grow over a period of years as did the automobile field.

IN HEAVY MACHINERY—Aluminum alloys will certainly be used in machinery for normally heavy parts (like turret heads for lathes) and for reciprocating parts that must stop fast without loss of energy. Things to be carried will also be a wide-open market for light-weight aluminum—hand tools such as shovels, electrical appliances, cameras, and so on. A very large aluminum market will probably be its use for electrical transmission lines, where its lower weight as compared to copper



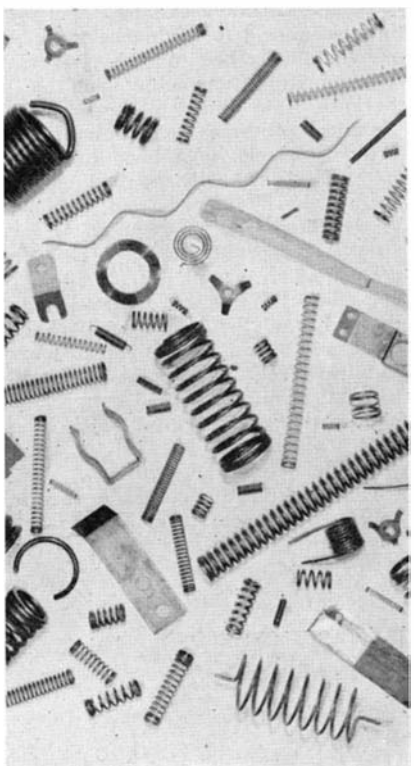
Courtesy Republic Steel Company

Nickel finds a major market in stainless steel, whose applications are expected to expand in many fields after the war. Here a stainless steel sheet is polished

permits the use of fewer steel supporting towers.

In addition to these, innumerable "new" minor markets will be developed, such as cigarette foil, carboys for certain chemicals, heat-conductivity items, mirrors and reflectors, hypodermic needles, toothpaste and shaving cream tubes, milk bottle caps, beer barrels, and so on. A significant feature of the post-war market for aluminum will be the possibility of using large amounts of secondary metal—even larger in proportion than is now possible because of limitations written into aircraft specifications.

Much of what we have said about aluminum applies in a smaller degree to magnesium. Magnesium production is now at the rate of about 300,000 tons per year. Magnesium primary ingots are priced at about 21 cents per pound. After the war the primary price may go down to 15 cents and the price of secondary magnesium to 10 or 11 cents per pound. These prices are very close to those of aluminum on a volume basis, which is the basis on which metals inevitably compete.



Courtesy Instrument Specialties Company

Relatively new member of the family of copper alloys is beryllium copper, whose post-war prospects, especially in the field of fine springs like these, is very bright

It is unlikely that magnesium will be used to anything like the same extent as aluminum for massive structural parts of vehicular equipment since the material does not lend itself to cold fabrication of sheets and bars as easily as aluminum, but it certainly will be a major competitor of the other light metal for the manufacture of countless smaller parts required to be light in weight, especially in the form of castings, die castings, forgings, or extrusions. Magnesium at present lacks some of aluminum's corrosion resistance but this can be corrected by the application of surface treatments.

Courtesy Aluminum Company of America

An aluminum-alloy floor system being incorporated in a bridge reconstruction job. Wide use of aluminum for such purposes is expected in the post-war period

Magnesium will have to fight for its markets and in the opinion of many will have a difficult time keeping its present manufacturing capacity occupied for some time after the war. A problem in this latter respect is the large amount of magnesium-powder production facilities built to manufacture magnesium powder for incendiary bombs and flares, for which there is as yet no visible powder-metallurgy market.

Portable tools, vacuum cleaners, floor polishers, radios, cameras, and similar equipment that benefits from light weight will be a market for magnesium as it is for aluminum. Magnesium does not have aluminum's high electrical conductivity nor its ability to be rolled into foil, so it will not compete for these applications, but it will compete strongly for engine and machinery parts of various types.

The picture for magnesium is fraught with more uncertainties than one finds with some of the other metals whose post-war situation is under study. Many engineers feel that magnesium does have a bright future but that many new ones for it need to be developed, since they have not existed in the past.

COMPLICATED TRANSITION—The future applications of copper are generally expected to be quite similar to those in which the metal was used before the war. Most of these applications are stable and a surprisingly large proportion of them are well able to resist competition from the light metals or from alloy steels. The vast use of copper and its alloys in war production, especially ammunition, will greatly complicate the transition from war uses to peace uses and may even delay considerably the "reconversion" of copper application to civilian purposes.

The important uses of copper that are expected to survive in large measure are as conductive material in electrical equipment, in communication lines, in electrical power lines, in automobiles, and in buildings. Typical of the electrical products in which it will find extensive use are generators, motors, locomotives, switch boards, light bulbs, and so on.

In few of these parts will it be possible to displace copper with a conductor metal like aluminum, for weight is a less important factor than the mechanical and heat-resisting properties of the conductor material. For power lines, however, aluminum will probably challenge copper to a considerable extent although here again copper has other advantages over aluminum that may offset the weight differential in the eyes of some engineers. In general no matter what happens to the specific applications of copper in electrical products and power lines, the whole field of electrical generation, distribution, and use will probably expand so greatly as to assure an expanding field of use for copper therein.

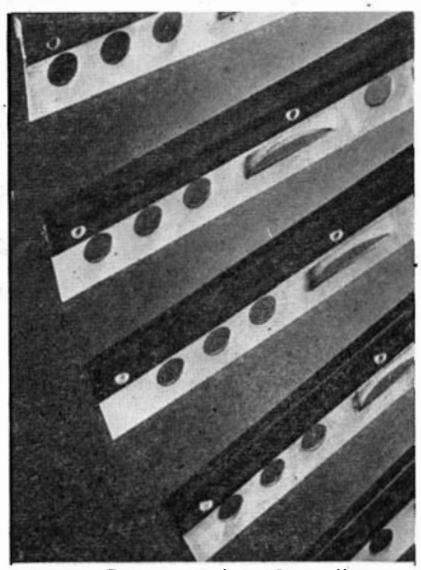
The other two major markets—automobiles and buildings—are universally expected to be among the foremost "boom" industries of the early post-war years and copper should share heavily in the growing markets for materials they provide. In automobiles the copper alloys have many uses, especially in starters, generators, and ignition equipment, bearings, and so on. These will largely be maintained despite attempts to replace them by other materials.

The use of copper in the marine field, which has always been large and represets a considerable maintenance and replacement business for the metal, is also a permanent thing, since the chief property of copper that is applied here is its resistance to sea-water corrosion.

No other material has that kind of resistance to a comparable degree.

One of the most interesting features of copper is that in a majority of the war-time applications of other metals as a substitute for copper alloys, the people who made the substitution are extremely eager to return to the original copper alloy as soon as possible and have generally regarded the substitutes as emergency makeshifts.

The future of zinc at the moment is somewhat complicated by uncertainty as to the amount of first-class ore reserves that will be available for several



Courtesy Tennessee Eastman Corporation

A war-time development that may remain in post-war use is division stripping for Terrazo flooring. Formerly made of brass or bronze, they are now made without loss of beauty or durability in colored plastics attached to galvanized iron strips

years after the war. There is no prospect of exhaustion of our zinc supplies but there is a possibility that the price of zinc may be somewhat higher in time because of the extra cost necessary to extract it. Its major uses—in galvanizing, in brass making, and in die casting—will, however, suffer or enjoy varying fates.

Zinc will lose some of its galvanizing market to lead-coated sheet and to black oxidized sheet, about which manufacturers and users have learned much during the war. But, basically, zinc will retain a large majority of the uses for galvanizing that previously existed and in addition will share to a large extent in the expansion in use of coated materials that will follow the war. War-time restrictions forced many consumers to shift from metals that were corrosion-resistant throughout to those that had a corrosion-resistant layer on the surface, and galvanized steel was applied in many instances in place of stainless steel or brass formerly used. And a powerful factor will be the astonishing backlog of unfilled demand for galvanized sheets in the early post-war years, revealed by one recent survey.

The comments on brass made in the preceding section on copper apply, of course, to zinc in reference to its use as a constituent of brass. With respect to die castings, however, it is difficult to make a prediction. The use of die casting as a metal fabricating process has expanded tremendously during the war and should be on a higher level after the war than in 1940, but a large measure of that expansion is represented by aluminum die castings. It is certain that in the post-war period the proportion of the total tonnage of die castings made in aluminum will be much higher than it was before the war and, in fact, aluminum may in time replace zinc as the chief die-casting metal. On the other hand, zinc is already finding use in tiny die castings like zipper components, where the low melting point and fast-production possibilities of zinc die castings provide an appeal not offered by other die casting metals.

Zinc has many other uses that are somewhat specialized and which may not be seriously challenged by competitive materials. Rolled zinc used for battery cans, photoengraving, in automobiles and refrigerators, and for glass jar tops should retain a large part of its earlier market.

The probable future positions of silver and of lead have been indicated in earlier articles in Scientific American (October 1943 and June 1944).

Nickel stands to benefit heavily from the great expansion in use of electronics, which will continue into the post-war era, for a large proportion of the metal wire and strip in every electronic tube is nickel or a high-nickel alloy. The heater-wire application for 60 to 80 percent nickel alloys will increase, too, as rural America expands its use of electric appliances. The future of nickel's chief outlet—as an alloying agent for steel—is bright, since alloy steels and especially stainless steels (which contain up to 25 percent nickel) are expected to reach new consumption peaks in post-war years.

These are the pros and cons of the expansions or curtailments in use of the individual major nonferrous metals. You may have noted that the picture thus painted is relatively bright. It is so intended; although the transition and early post-war years may be tough, we have faith in an ultimately expanding American industrial economy, with plenty of room for all the important materials of construction.

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STRONG ALUMINUM ALLOYS

Also Have Improved Corrosion Resistance

SINCE the war began, the American aluminum industry has not only boosted its production several fold but has also developed new treatments and alloys to provide higher strength aircraft components. Thus the familiar 24ST alloy, which under pre-war standards could be produced with a tensile strength of 60,000 pounds per square inch and a yield strength of 38,000 pounds per square inch, has had its tensile strength raised to 69,000 and its yield strength to 65,000 through a special heat treatment.

Even more notable are two new aluminum alloys (like the treatment just mentioned, the compositions of these alloys are still military secrets) called XA75S and XB75E, which have higher physical properties than 24S and improved corrosion resistance.

These alloys, now recognized officially through the issuance of Army-Navy specifications for them, are being manufactured in sheet form for skin structures. Their good corrosion resistance is expected to bring sheet aluminum into competition with coated iron and steel and with copper and brass sheet products for many post-war applications.

BLACKENING STAINLESS

Accomplished by New Treatment Method

THE BLACKENING of stainless steel parts, often required for ordnance work, has conventionally been done by japanning, electroplating, enameling and so on, because the chemical and electrochemical processes commonly used on ordinary steels have been unsatisfactory. The externally applied coatings, in turn, have suffered from brittleness, poor adhesion, or inadequate wear resistance, according to *Steel* magazine.

Rustless Iron and Steel Company, however, has recently developed a method for the surface blackening of 18 and 8 and of straight-chromium stainless steels by treatment in molten sodium dichromate at temperatures higher than 615 degrees, Fahrenheit. Best temperatures are 730 to 750 degrees for 15 to 20 minutes.

The black coating so produced is adherent, permanent in color, and actually improves the corrosion resistance of the basis metal in several corrosive media.

ELECTRONIC CONTROL

Automatically Guides Metal Flame Cutter

AN ELECTRONIC control designed to guide automatically a gas cutting machine completely around a template that consists simply of a pencil drawing on white paper is one of the latest time-savers in metal-processing. The operator is relieved of guiding the driving wheel around the template and can instead plan his next job or adjust the torch or cutting speed.

The outfit, described by R. D. McComb in the *Journal of the American Welding Society*, consists of a light source and lens combination that projects a small spot of light on the template. One or more phototubes receive the light reflected back from the template, the amount of which is much more when the spot is off the pencil mark than when it is on it. The amount of light received by the tubes causes them to operate an electric signal that pulls the cutting machine back to its correct position whenever it tends to leave it. A smooth, clean cut results.

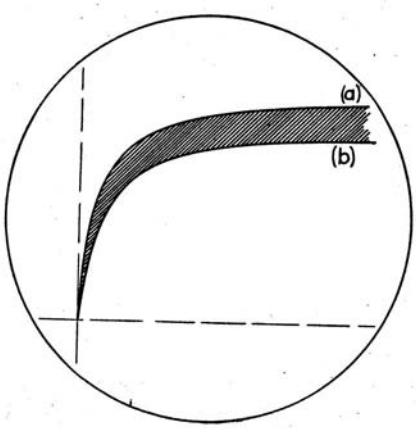
Electronic Sorting

Automatic Operation is Attained With the Cathode-Ray Tube. By Blacking-Out Part of the Tube's Screen, Light Shows Only When Defective Parts Pass on the Production Line. A Photocell Watches the Screen and Actuates a Reject Mechanism When it Sees Light, Giving Highly Accurate Results

IN ROUTINE production tests, occasions often arise where it is desirable to check the entire characteristic curve associated with a product or process. Examples include checking the characteristics of a radio tube, checking the frequency response of a microphone or amplifier, or checking the spectrophotometric curve of a colored object.

Where it is possible to arrange the test so that the variation to be observed is repeated at short, regular intervals, a cathode-ray oscilloscope can generally be used to make the desired curve visible on a fluorescent screen. But this ordinarily means that an attendant must watch the glowing pattern and take suitable action when the curve for a particular object under test deviates excessively from the desired curve. A method developed recently by Leland L. Antes of the Bureau of Engineering Research, The University of Texas, eliminates the need for an attendant, however, by uniquely employing a phototube to watch the pattern.

The automatic electronic method of testing has many production-line applications, dividing into two groups. Electrical characteristics of test specimens are utilized directly in the first group, and testing of vacuum-tubes can be considered as a typical example to be taken up in detail. In the second group of applications electrical characteristics are derived from colors, sound, or other primary factors, and here the sorting of colored tiles has been selected as a representative example.



Cathode-ray oscilloscope screen, showing the mask pasted on the screen between the upper (a) and lower (b) tolerance limits for the plate voltage-plate current curve of a particular vacuum tube under test

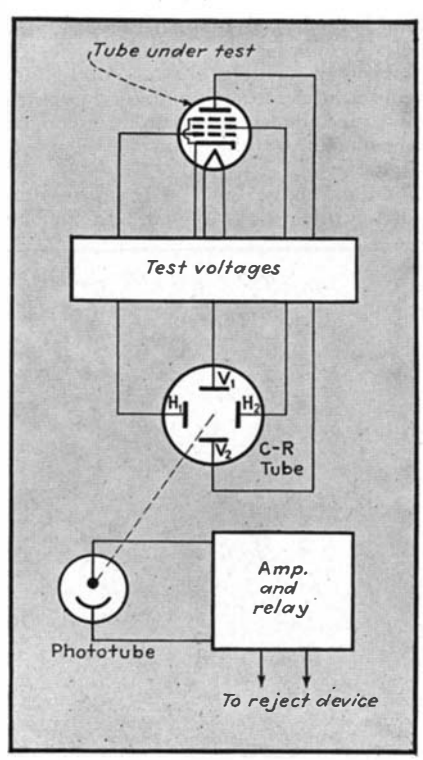
The manner in which the plate current of a vacuum tube varies with plate voltage is one characteristic that is a good indication of tube quality over its entire operating range. These variations of plate current are plotted on graph paper as a curve and normally must be made by connecting the tube in a test circuit where variable controls permit changing the plate voltage in steps. A meter in the circuit then permits readings of the plate current to be made, and these are laboriously plotted as points on the graph to form a complete characteristic curve. Such a procedure requires considerable time to accomplish and cannot be done economically on a mass production basis.

INSTANTANEOUS CURVES—With the cathode-ray tube, the characteristic curve can be plotted instantaneously on the phosphorescent screen. To do this, the tube under test is connected into a circuit where the applied voltage is periodically varying from zero to some high value. Such a voltage can be obtained from an electronic rectifier supplying pulsations of direct voltage. This voltage and another voltage that can be produced by the current flow through the tube under test are applied to deflection plates inside the cathode-ray tube.

The deflection plates, when supplied with the correct potential or voltage, can cause a stream of electrons to move across the screen at the end of the tube. This electron stream or beam is produced by a set of electrodes which are part of the so-called electron gun. The gun consists of a cathode to throw off the electrons, a grid to control the flow, and two tubular anodes that operate in much the same manner as the screen grid and plate in a conventional receiving tube. The additional function of the two anodes is to confine the electron stream into a narrow beam that produces a small dot of light when it strikes the phosphor coating on the end of the tube. The same construction is used in the picture tube contained in all present-day television receivers.

When the cathode-ray tube is mounted horizontally, it is oriented so that one pair of deflection plates is mounted vertically and a second pair is mounted horizontally. The electron beam passes through the center of the rectangle formed by the plates. When a voltage is applied to one pair of plates, the beam is attracted toward the positive plate to a degree determined by the amount of voltage. Thus, the higher the voltage, the greater is the deflection of the beam from the center position, and the greater the movement of the spot of light on the screen. In this manner, the plates mounted vertically are able to deflect the electron beam from side to side across the screen, while the horizontally-mounted plates deflect it up and down.

The material of which the phosphor screen is made is able to retain its glow for a short period after the electron



Block diagram illustrating method of automatically rejecting defective vacuum tubes photo-electronically

beam has passed, and this persistence of glow permits the moving spot to inscribe what appear to be continuous lines on the screen. The shape of the pattern on the screen is controlled by the voltages applied to the deflection plates and, in the case of the television tube, the rapid voltage changes produce the complete picture.

To plot the characteristic curve of a vacuum tube, the vertical deflection plates are supplied with the same voltage as applied to the plate of the tube under test, and the horizontal deflection plates are supplied with a voltage that is proportional to the current flow in the tube. This voltage is easily obtained by inserting a resistor in the cathode circuit of the tube so that the voltage drop across the resistor is proportional to the plate current flowing through it. As a result, the screen of the cathode-ray tube shows the complete curve of plate voltage versus plate current as soon as the tube is connected into the test circuit.

CONVEYOR-BELT TESTING—In production testing of vacuum tubes by this method, the tubes can be fed to the test circuit on a conveyor belt and be automatically or manually connected and removed. Tolerance limits can be set up by marking the screen of the cathode-ray tube with the curves of two tubes, one at the upper limit and one at the lower limit required. The space between the two curves can be covered with black tape so that no glow will show on the screen when the tube is within the proper limits. Tubes exhibiting a characteristic curve outside this covered area are then rejected by the operator.

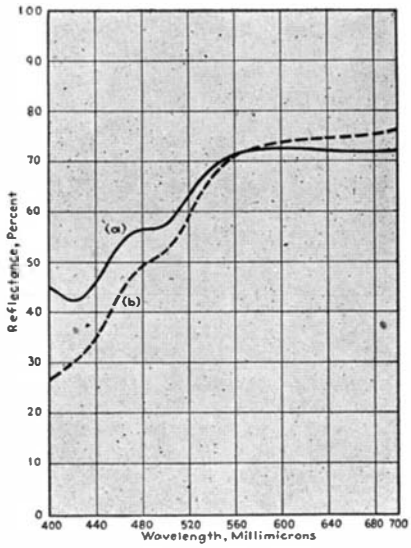
Automatic rejection without an operator can be provided by arranging a phototube in front of the screen of the cathode-ray tube so that the glow of the curve produced by a defective tube will actuate the phototube and cause an electronic amplifier to control the mechanical operation of removing the defective tube from the conveyor belt.

Other applications of the procedure just outlined can be made by engineers who deal with testing or sorting problems in other industries in which an entire characteristic curve of a device must be considered. Thus, the frequency response of sound-producing devices, microphones, amplifiers, and filters can be checked at a rapid rate. Almost any product that can produce a voltage, change in electrical conductivity, or change in magnetic effect can be quickly sorted by this cathode-ray method.

The sorting of colored tiles as they emerge from kilns on conveyor belts is an excellent example for the group of indirect applications. Here the primary factor that determines acceptance or rejection of each object is a very small difference in color, and these color variations must be converted into electrical variations capable of producing a characteristic color curve on the cathode-ray tube screen.

Sorting of tiles is necessary because the different temperature and atmospheric zones in a kiln produce slightly different colored glazes, and because different colored glazes are often placed in a kiln at the same time to utilize the different firing zones to best advantage. The method of sorting the tiles as they emerge after firing must, if it is to compare with the human eye in efficiency, involve a precise method of defining the exact color desired at each sorting station. Since each station will pass one desired color and reject all the rest, the number of sorting stations employed must be one less than the number of colors into which the kiln output is to be sorted.

Probably the most precise method of defining a color is that which makes use of a spectrophotometric curve. This curve gives the percentage of light reflected by the color sample at each wavelength in the visible spectrum. Each wavelength or color of light in turn is directed on the sample and the amount of reflected light is measured. The results are then plotted as percent reflectance against wavelength, for two different color samples of enameled porcelain.

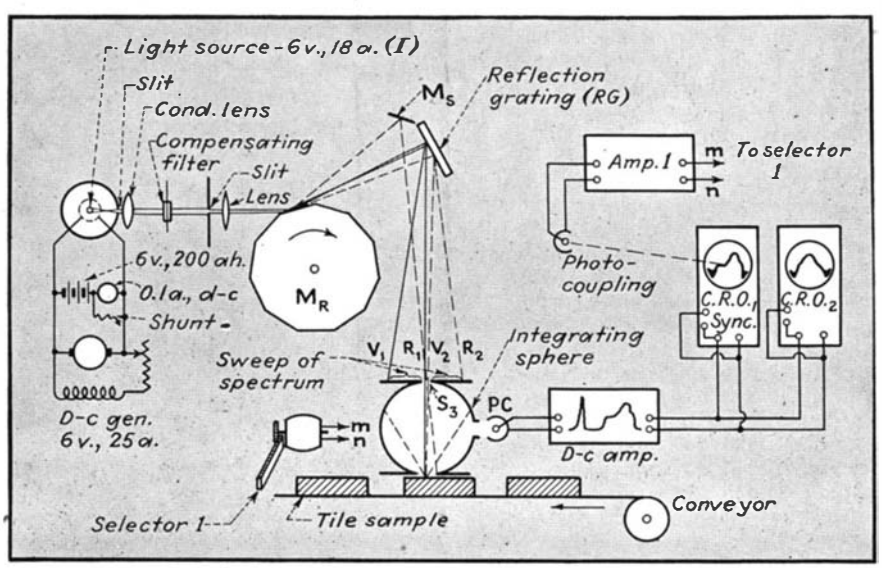


Examples of spectrophotometric curves for colonial ivory (a) and jonquil yellow (b) samples of enameled porcelain. The photo-electronic sorter can readily distinguish between these two almost identical colors. Wavelengths shown are for violet, at left, through blue, green, yellow and orange, to red at the right

MONOCHROMATIC LIGHT USED—The method used for projecting the different colors of light on each tile sample and producing the spectrophotometric curve on the cathode-ray tube screen for observance by the phototube of the sorting system is shown in an accompanying drawing. Light from a six-volt incandescent lamp is projected onto a rotating polygonal mirror M_R as a ribbon-shaped beam by a system of lenses and slits. Each segment on the rotating mirror wheel causes a narrow band of light to sweep from top to bottom across the reflection grating RG and a stationary mirror M_S. The reflection grating has the property of spreading out white light into a spectrum similar to that obtained from a prism or in a rainbow, and this spectrum sweeps repeatedly across the tile sample through top slit S_3 and the open bottom of the integrating sphere as the mirror wheel rotates. During each sweep period, reasonably pure monochromatic light of each wavelength from violet to red successively irradiates the tile under test while this tile is carried past the open bottom of the sphere by the conveyor belt.

Light reflected upward from the tile illuminates the highly reflecting interior surface of the integrating sphere, and the light reflected in turn from the spherical surface is picked up by phototube PC. Fixed mirror M_S is used simply to direct a momentary flash of white light into the sphere and phototube a short instant of time before the start of a sweep period for colored light; this gives a synchronizing pulse that is used to trigger the horizontal sweep generator and make the electron beam sweep horizontally across the cathode-ray tube at the instant when the phototube starts sending color data to the vertical deflecting plates of the tube during each sweep period.

The output of the phototube is a very weak electrical signal that must be built up in strength by a D.C. ampli-



Block diagram showing arrangement used for precision sorting of colored objects

fier before it is fed to the first cathode-ray oscilloscope. The screen of this oscilloscope is provided with a mask designed to cover the allowable variations in color response for the tiles to be selected by the first sorting station. A phototube positioned in front of the screen actuates an amplifier and selecting mechanism that route tiles of the desired color to one bin and route all other tiles to additional sorting stations. Each sorting station contains an oscilloscope, phototube, amplifier, and selecting mechanism, with each oscilloscope screen masked for a different color response. Whenever the moving spot of light moves out from behind the mask on its oscilloscope screen, the corresponding phototube responds to that light and initiates the mechanical action that shoves the tile into its appropriate bin. A lever operated by each tile, as it passes beneath the integrating sphere, switches the oscilloscopes on and off to avoid operation in between tiles.

MANY USES POSSIBLE—Other kinds of colored objects can be sorted as to shades in exactly the same way. Thus, when uniform color shades are important in women's apparel and colors tend to vary slightly due to variations in dye baths or in dye-absorbing qualities of the textile material, the finished products can well be sorted for precision matching. Women's stockings might be one profitable application, permitting the new advertising appeal of electronically matched pairs. Spools of colored thread, colored pottery vases and ornaments, molded plastic products, oranges, lemons, and other fruit, ceramic dinnerware, colored glass products—in fact, any colored object requiring precision automatic sorting into nearly similar shades can be handled successfully by this new electronic development.

Other testing processes that require almost simultaneous checking of characteristics over a wide range of conditions are logical applications. Thus, curves of special steels for radio and electrical coils and transformers can be checked in production. Hardening operations on steel objects can be checked by passing the object through a coil connected to an amplifier that feeds the oscilloscope; color-sorting equipment would here be unnecessary, as the coil would convert the varying magnetic qualities of the object into a varying electrical signal.

The development of this new cathode-ray and phototube technique for intricate sorting jobs has tremendously broadened the scope of applications for automatic electronic sorting. As with conventional electronic sorting equipment such as that for eliminating black and discolored beans from white beans, the introduction of electronic methods gives a tremendous increase in output with improved efficiency of sorting, no lapses due to fatigue or wandering of the human mind, and reduced inspection or sorting costs.

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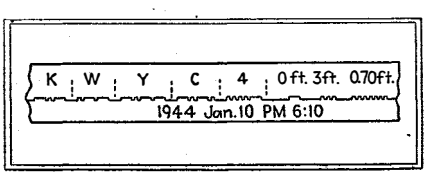
RIVER LEVEL

Recorded By Radio

Remote Control

INCREASES in the levels of the Salt and Verde Rivers near Phoenix, Arizona, are recorded in a central office in Phoenix by a new radio remote registering system. Gages installed in both streams automatically send radio signals from 25-watt transmitters.

The telemark coder in the transmitter is a combination coding device and time switch, actuated by a float. When the telemark is signalling, a motor-driven contact arm sweeps across ridges on disks attached to the float, to produce signals which represent the gage height of the river at that moment.



Typical recording of river height

Before the contact arm passes over the disks, it travels over a bar having the station's call letter cut into its surface in Morse code. When the arm contacts this surface, the station's identification is transmitted, immediately followed by the gage height.

The time of broadcasts is predetermined and controlled by a time switch. This consists of a weight-driven clock which operates a series of switches that turn the transmitter and telemark on and off every 12 hours below a certain critical gage height, and every hour after that height is reached.

MERCURY SWITCH

Supplemented by Electronic

Time-Delay Relay

IN ONE textile plant, cotton is removed from the original bale and then partially cleaned and fluffed up into a loose condition by special machinery. Frequently the cotton being fed into this machine accumulates to such an extent that it overflows from the bin onto the floor, making it necessary for someone to replace it in the feeder hopper.

To shut down the feeding machinery automatically, a mercury switch has been used which trips when the cotton in the bin reaches a predetermined level. At this level, however, the moving cotton in the bin constantly trips the switch. This means repeated starting and stopping of the feeding machinery while the bin is full.

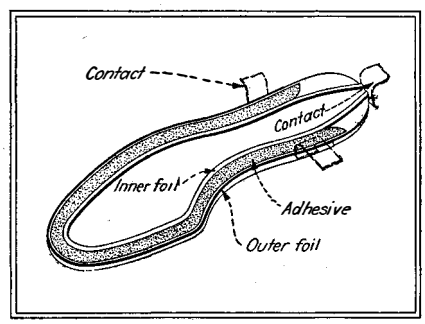
Supplementing the mercury switch with a General Electric electronic time-delay relay solved the problem. Once the mercury switch has initiated a shut-down period, the relay keeps the cotton-feeding equipment inoperative for a preselected period of time, irrespective of the opening and closing of the mercury switch. After the time period has elapsed, the mercury switch again takes over to start the feeding equipment.

SHOE SOLES

Glued by Electronic

Heating Method

A PROCESS of glueing shoe soles by electronic heating consists of attaching to the sole a strip of metal foil running parallel to the inner edge of a band of adhesive and more foil close to the outer margin of the adhesive, preferably upon the periphery of the shoe sole. The two foils thus form capacitor elements which, when connected to a source of high-frequency power, produce electrostatic heating of the adhesive. This quickly sets the glue and secures the sole to the insole of the shoe.



Time saver in shoe manufacture

Invented by G. Hart, Jr. and E. E. Winkley, the method has been adopted by the United Shoe Machinery Corporation, and is expected to save the relatively long period of drying under pressure now necessary in shoe-cementing operations.

MAIL SORTING

Could be Accomplished Electronically

With Suitable Preparation

SORTING of mail electronically could be accomplished if a row or rows of black and white squares were used to designate the first main geographical subdivision in addresses. A second row would identify the postal substation and a third row the city postal carrier district. A form of rubber stamp would be used by the sender or at the first post-office to imprint this design on the letter, utilizing a key sheet to prepare the design from the elements of the address to which the letter is to be sent.

Letter envelopes could then be run through a machine that lines up a photographic scanner along the bottom edge of the envelope and, as the letter whisked in front of the electric-eye, it would do the equivalent of reading the address in the coded squares and then automatically route the letter to the correct mail bag or container. This would be repeated again for the second row and again for the third row when the letter arrived in the final postal sub-district. Thus it would have to be looked at only by the carrier.

Safety with Solvents

Many New Industries Are Using New Solvents in New Processes. In Order That Workers May be Protected Against Possible Danger from these Substances, a Number of Agencies are Co-Operating. Standards of Vapor Concentration are Being Set, and Preventive Measures Developed

By H. P. QUADLAND
Safety Research Institute

SEVERAL decades ago, a mere handful of organic solvents were in common industrial use—the benzol and benzine series, some alcohols and esters, acetone, carbon tetrachloride, and a few others. Today, it is estimated that there are approximately five thousand such solvents, each with its individual abilities for dissolving industrially important materials.

These chemicals are vital to modern industry. They are especially important in the manufacture of plastics, chemicals, pharmaceuticals, and synthetic rubber; in metal degreasing, electroplating, and other processes; in dry cleaning and in making paints and lacquers, explosives, and textiles—to name only a few of their major fields of use.

Organic solvents belong to the group of industrial substances which, when employed with ignorance or carelessness, may endanger their users. They are, however, being utilized safely in huge quantities in modern industry, but only where safeguards are established to protect workmen. Many millions of dollars have been expended for ventilation and special equipment to ensure their safe use, but there is still a long way to go before all industry shall have completely protected its workers from all of the dangers inherent in the use of solvents. Among the agencies co-operating for this purpose are the manufacturers of solvents and of machinery in which solvents are used, the United States Public Health Service, state and city hygiene services, industrial physicians, safety engineers, and insurance companies.

In the use of the solvents there are three principal hazards—flammability, effect on the skin, and toxicity.

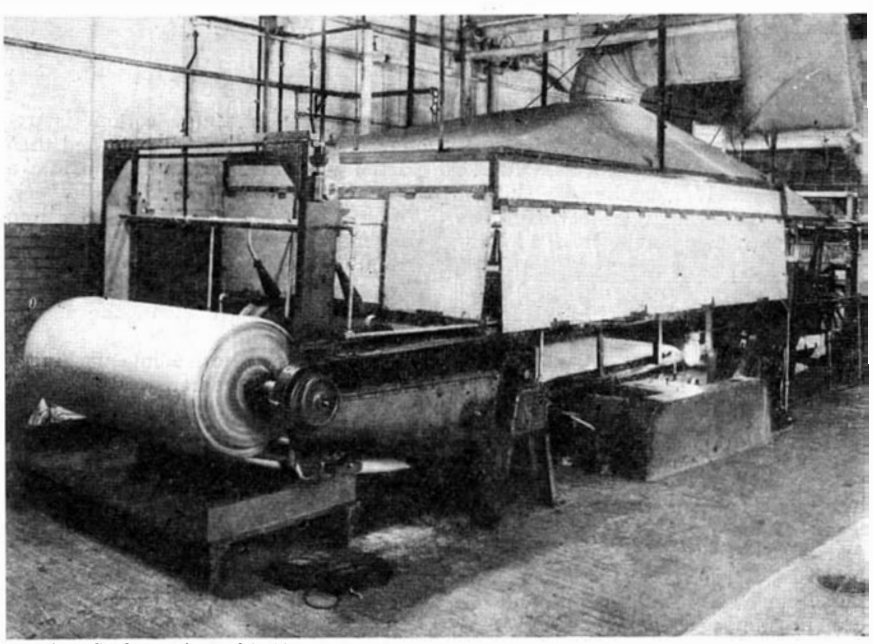
With the exception of certain of the chlorinated solvents, such as carbon tetrachloride, trichlorethylene, and perchlorethylene, which are either completely noncombustible or practically so, most solvents are flammable and explosive. If allowed to collect in the atmosphere their vapors may be ignited by a static spark, a nearby flame, or a careless smoker. Gasoline, acetone, and carbon disulphide are typical solvents of high flammability. The National Fire Protection Association estimates that approximately 24,000 fires were caused in 1941 by flammable liquids. [See page 55 for an account of efforts to reduce industrial fires.—*Editor.*]

The effects of industrial solvents on the skin depend largely upon the nature of the solvent. Prolonged contact may dissolve the natural oils of the skin, leaving it open to infection, or may sensitize the skin and bring on rashes or other eruptions. Skin manifestations account for nearly 70 percent of the occupational disease claims, but, while they may cause loss of time and discomfort, they seldom result in more serious injury. Removal of contact with the solvent is the usual cure. Prevention of dermatoses is accomplished in industry by the enforcement of personal cleanliness and the use of protective clothing and hand creams.

The vapors of all organic solvents are injurious if inhaled in excessive quantities for a sufficient length of time. The types of exposure to solvent vapors are designated as "acute" and "chronic."

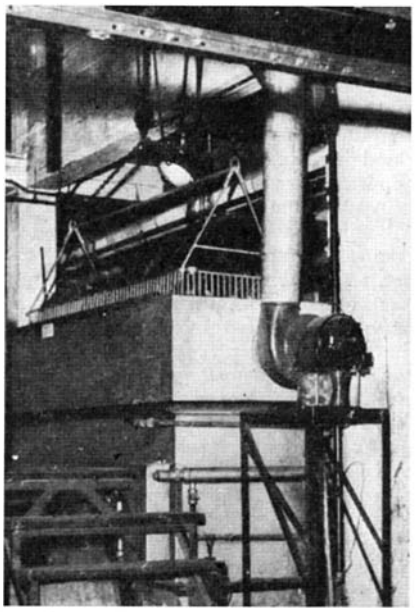
The acute exposure is the result of an accident, or ignorance, by which the exposed person suddenly inhales excessive concentrations of the vapor. Depending upon the severity of the exposure, he may suffer headache, unusual fatigue, dizziness, nausea, vomiting, intestinal pain, or other minor symptoms. The effect is similar to that of ordinary anesthetics. In acute exposure, inhalation of sufficient quantities of the vapors may cause narcosis without subsequent injury, but, if the exposure is severe enough, injury to bodily functions, depending upon the characteristics of the individual solvent, or even death, may ensue.

ACCUMULATED EFFECTS—Chronic exposure is encountered where the exposed person, due to improper ventilating methods, carelessness, or other reasons, over a long period of time in-



Courtesy Goodyear Tire and Rubber Company

Exhaust hood for removal of toxic vapor from the vicinity of a dip tank used in the rubber industry. In this illustration, the inspection door is partly open, but when the flaps are down the flow of air is from the dip tank to the hood opening. The hood is designed to move 9000 cubic feet per gallon of solvent evaporated



Courtesy Division of Industrial Hygiene, N. Y. State Dept. of Health

Ventilation of an industrial degreasing unit is important. In the equipment shown, the solvent vapors are exhausted through the pipe

hales solvent vapors in concentrations below those which will cause immediate effects, but above those known to be safe. The human body has a capacity for withstanding the effects of certain amounts of solvent vapors but if a greater amount is inhaled day after day than the body has the capacity to eliminate, the effects accumulate little by little until injury results. If the person suffering from chronic exposure is detected in time, he generally recovers merely by removal from the exposure, or by medical treatment, or both. However, if the exposure is continued long enough, permanent injury or even death may ensue.

In classifying the toxicity of the different organic solvents, F. Flury, in *Toxicology and Hygiene of Industrial Solvents,* states:

"The only classification is a threefold one, namely, the division into comparatively harmless solvents, solvents with considerable toxic effect, and, finally, strongly toxic substances that are especially dangerous."

Of lowest toxicity, according to Flury's classification, are the majority of the less volatile substances, that is, from the glycol series; among the more readily volatile substances, the solvents of the benzine series, ethyl alcohol, ether, the intermediate acetate esters, and probably also acetone; and among the chlorinated hydrocarbons, dichlormethane, monochlorethylene, and tetrachlorethylene.

In the middle group belong the great majority of the solvents; the amyl compounds; most of the chlorinated solvents, such as chloroform, trichlorethylene and carbon tetrachloride; the benzol homologues, the chlorobenzenes, and the hydrogenated cyclic hydrocarbons.

ESPECIALLY DANGEROUS—The third group consists of the substances distinguished by an especially high toxicity: the methyl compounds, such as methyl alcohol, methyl chloride, dimethyl sulfate; tetra- and pentachlorethane; benzol and carbon disulphide.

Common solvents of high toxicity include the following:

Benzene. Commonly called "benzol," this solvent is not to be confused with benzine, a petroleum distillate. Severe or chronic exposure to concentrations of vapor above those known to be safe may cause hemorrhages and marked but varied changes in the blood picture, such as anemia, leukopenia, and so on. Injury may occur to blood vessels, heart, liver, kidneys, and nervous system, with a marked susceptibility to infection and local irritation. Benzene is also highly flammable and explosive.

Carbon disulphide. In addition to the effects common to early exposure for all solvents, physical effects, such as hilarity, agitation, and hallucinations may be caused by severe exposure. Disturbances of sensation, particularly of sight, polyneuritis, and so on may also occur. Carbon disulphide, also, is a highly explosive and flammable liquid.

Methyl alcohol. Commonly known as "wood alcohol," or "methanol," this substance, in severe exposures, may cause colic, convulsions, cyanosis, loss of reflexes, irregular heart action, and rapid breathing followed by marked drop in temperature. Methyl alcohol has a specific effect upon the optic nerve and can cause optic atrophy and blindness, thus resulting in permanent injury. It is flammable and explosive.

Tetrachlorethane. This solvent is not to be confused with tetrachlorethylene, which is of lesser toxicity. Severe exposure may cause injury to the liver, jaundice, albuminuria, and slight anemia. Tetrachlorethane is completely nonflammable and nonexplosive.

Permanent disability is rare with exposure to the vapors of common solvents of medium toxicity. Cessation of the exposure and proper treatment usually lead to full recovery. This group includes:

Carbon tetrachloride. In severe exposure to this solvent, serious damage to the liver and kidneys may occur. Carbon tetrachloride is completely nonflammable and nonexplosive.

Ethylene dichloride. In severe exposure, it may damage the liver and kidneys. It is flammable and explosive.

Tetrachlorethylene (perchlorethylene). In severe exposure, liver and kidneys may be affected. It is completely nonflammable and nonexplosive.

Toluene (toluol), and xylene. These substances are similar to benzene in their effect upon the bodily organs, but, because of their higher boiling points, their vapors are not so readily volatilized. However, in recent animal experiments, considerable renal irritation from exposure to toluene was found. As with benzene, severe exposure may cause varied changes in the blood picture. Both toluene and xylene are flammable and explosive.

Trichlorethylene. Severe exposure may result in injury to the trigeminal and optic nerves and to the central nervous system. Irritation of the respiratory passages has also been reported. Trichlorethylene is nonflammable and nonexplosive at ordinary temperatures, but may form flammable mixtures with air at elevated temperatures under certain conditions.

Turpentine. In severe exposure, it irritates the upper air passages, with cough and bronchial inflammation, and may cause pre-disposition to pneumonia. It may also cause kidney and bladder irritation. It is flammable and explosive.

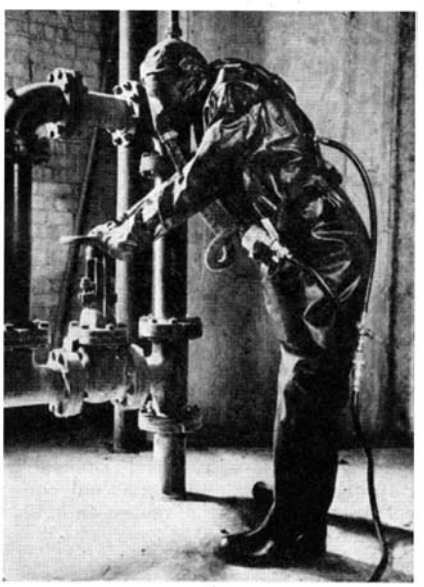
Among common solvents of low toxicity are included:

Acetone. The symptoms of more severe exposure are irritation of eyes and respiratory tract. It is a highly flammable and explosive solvent.

Petroleum solvents. These solvents include naphthas, gasoline or benzine, and solvents of the kerosene class, such as Stoddard's Solvent. Severe exposure may cause loss of weight, anemia, yellow atrophy of the liver, and jaundice. Dr. W. F. von Oettingen, Principal Industrial Toxicologist for the United States Public Health Service, points out that appraisal of these solvents offers considerable difficulties because most of them represent heterogeneous mixtures and their composition is often incompletely known. However, the greater hazard in connection with the petroleum solvents is their flammable and explosive properties and this constitutes their chief problem in industry.

Amyl acetate. This substance may cause irritation of the mucous membranes, oppression in the chest, and cough. It does not appear to cause more severe symptoms, although some persons cannot tolerate the odor. Amyl acetate is a flammable and explosive substance.

Ethyl alcohol. When continuously inhaled in concentrations above those



Courtesy United States Rubber Company

When a breakdown occurs in the piping system of the alkylation section of a high-octane gasoline plant, repair men must be protected against the resulting fumes. One plant uses this type of protective coverall, topped off by a respirator. Air lines already installed in the plant provide air for breathing and also give a constant exhaust flow of air from the suit to keep out the deadly fumes

known to be safe, it may act on the nervous system, or cause narcosis, as with solvents generally. However, the principal hazard of ethyl alcohol as used in industry is its flammable and explosive nature.

INDIVIDUAL SUSCEPTIBILTY—Some persons are more susceptible to solvent vapors than others. It is generally recommended that persons suffering from alcoholism, diabetes, anemia, kidney or liver troubles, and similar disorders should not be allowed to work where there may be potential exposure to solvent vapors. Also, some persons are unusually sensitive, either physically or psychologically, to concentrations of solvent vapors that have no effect on normal persons. Some individuals are nauseated simply by the smell of certain paints, gasoline, amyl acetate (banana oil), or other chemicals. Lowering of the concentration of vapor in the workroom atmosphere may benefit unusually susceptible people, but the more common practice is to assign them to other work.

Skin troubles, too, depend to some extent upon individual susceptibility, although a certain degree of immunity is usually developed, provided protective clothing and personal cleanliness are the rule.

The pre-placement medical examination is important, to avoid placing workers in positions for which their physical or psychic condition is unfitted.

Control of the health factors usually consist of the following:

1. A study of the solvent to be controlled, as to its physical properties and the nature of its toxicity, on the basis of information from the manufacturer of the solvent, federal and state hygiene services, private consultants, or through chemical analysis by the user.

2. A job analysis of the operation in which the solvent is to be used, including a study of operator technique. Certain operator techniques are often adopted that minimize the possibility of contact or vapor inhalation.

3. Development of ventilation, usually local exhaust, which removes the vapors at their source, before hazardous amounts enter the breathing zone of the workmen. Completely enclosed machines are used in many processes, and these are generally preferred, since they provide full safety where the instructions issued by their manufacturers are observed. Where there is any possibility of unsafe quantities of vapors in the atmosphere, periodic air sampling to determine the actual concentration is a matter of course in modern plants.

4. In cleaning tanks and similar operations of an intermittent nature where temporary exposure to high concentration of vapor is involved, air-line respirators and full protective clothing, with a watcher outside the tank, are required. In intermittent operations where, for brief periods, the concentration of vapor is slightly above the safe maximum allowable concentration, organic vapor type masks approved by the United States Bureau of Mines are sometimes used.

5. Especially in the larger plants, medical control supplements engineering control. If early symptoms of exposure to solvent vapors occur, immediate examinations are in order and remedial measures are provided before there is injury.

Where flammable liquids are employed as solvents,, the following rules are generally observed:

1. All fires, flames, and high temperatures in the vicinity are eliminated. Non-sparking shoes are provided, as well as safety containers for the solvent. The National Fire Protection Association code for handling flammable liquids is observed.

2. Electrical equipment, including vapor-proof safety lamps, is installed in accordance with the National Electrical Code for hazardous locations.

3. Equipment, including funnels and portable containers, is grounded when in use, to prevent ignition from static electricity.

4. Ample ventilation is provided to keep the concentration of flammable vapors well below their explosive limits in all locations, including low places such as shafts, pits, basements, and so on.

5. Adequate fire protection equipment of the correct types is provided and workers are trained in its use.

ALLOWABLE CONCENTRATIONS—In recent years, through the machinery provided by the American Standards Association, manufacturers of solvents, public health authorities, and insurance companies have been co-operating to develop national industrial standards for a number of the more common solvents. These standards establish, in terms of "maximum allowable concentrations," the maximum amounts of solvent vapors in the workroom atmosphere to which workers may be exposed throughout the working day. A.S.A. standards have been established for methyl alcohol, toluene, xylene, benzol, and carbon disulphide. Standards for carbon tetrachlorides and trichlorethylene are now in progress.

In addition to the standards set up by the A.S.A., the United States Public Health Service has listed the most widely accepted maximum concentrations, for an eight-hour working day, for amyl acetate, butyl acetate, butyl alcohol, carbon tetrachloride, ethylene dichloride, gasoline and petroleum naphthas, monochlorobenzene, nitrobenzene, tetrachlorethane, tetrachlorethylene (perchlorethylene), trichlorethylene, and turpentine.

Some states have set up their own standards, which must, of course, be observed in those states.

The method of control must be as simple as possible, yet provide effective protection. With some processes, however, the method is necessarily complex, as in the case of the synthetic rubber and similar large industries, where controls are carefully designed by competent industrial hygiene and fire protection engineers.

In all safety work, including the safe use of solvents, the human factor plays a leading role. Elaborate machinery and ventilating devices to assure safety are of little avail where operators do not use them to advantage.

A case in point is that of a foreman of a crew painting the inside of a tank car with an acid-resistant paint containing a solvent. The foreman provided his crew with all the protective apparatus required by the company to assure complete protection from the solvent vapors. They had air-line respiratory equipment, protective clothing, a rope down into the tank car, and men outside to pull out anyone who might be affected in the slightest by the vapors. After seeing that his men were protected beyond all possibility of injury, the foreman himself walked down into the tank without any protective equipment and died before they could get him out.

In addition to providing the proper engineering controls, education of workers is necessary to assure safe use. Not only the operators of the processes, but janitors and maintenance men as well should be thoroughly instructed.

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SKIN CREAMS

Give Protection Under Wet and Dry Conditions

THE NAME Clad has been given to a new line of protective skin creams, made in two types, for dry and for wet working conditions.

The dry cream is of an improved type which has been made as nearly neutral to the skin as possible. These properties eliminate skin drying or any tendency to cause burning or irritation even under prolonged usage. Use of the dry cream protects exposed portions of the body against dirt, grease, grime, and any other hard-to-wash-off substances.

The cream for wet use is made for protection of the skin where water and other dilute aqueous and mild chemical solutions are present.

Both the wet and dry types leave the skin soft and smooth even after the cream is removed. Both have been constantly tested under regular operating conditions.

The dry type cream is finding wide general household usage, in addition to its industrial applications.

Industrialists report that use of protective creams, while not as effective as rubber gloves, greatly assists workers to reduce hazards from dermatitis and reduces "wash-up" time. This is especially true of the newer workers being drafted from the home and the white collar groups into industrial plants, who find it necessary to protect hands and other exposed parts of the body against working conditions.

"PLANT INOCULATION"

Bigger Yields Result From New Chemical Soil "Serums"

SPRAYED on the ground and absorbed by food-producing plants to render

(*Please turn to page* 85)

Keep Them Tight

Though the Bolt Designers Most Diligently Design, and the Metallurgists, the Engineers, and Manufacurers do their Utmost to Provide Excellent Bolts, the Bolts that Carry Dynamic, Fluctuating Loads in Severe Service will Fail from Fatigue unless Science is Correctly Applied in Tightening Them

WHICH of two bolts or studs in exactly the same highly-stressed, dynamically loaded, severe service will be the first to fail from fatigue—one whose nut has been set up so tight that the yield point of its metal is closely approached, or one whose nut has been tightened only lightly?

You may try this question on engineers or metallurgists and expect a high percentage of correct answers; or on a shop superintendent or foreman or machinist; or in the office of the same shop (where your answers may perhaps prove somewhat less uniform); or if you should meet with an unexpectedly high engineering I.Q. everywhere else, you may finally have to try it on your long-suffering wife who, even then, would have one chance in two of getting it right merely by guessing. Yet the chances are that a goodly share of all the people you ask will plump for "the bolt that hasn't been set up tighter than Tophet by some big strong lummox with a long-handled wrench. For isn't the bolt's external load enough for it to carry without giving it a big internal load too?"

The correct answer is that, for service such as was specified—that is, for highly stressed, dynamic or stress *changing* service (the italicized word is the crux of the argument)—the bolt that has been set up close to the yield point of its metal and sometimes even past that yield point, will far outlast the one that has apparently been babied. You may argue that every engineer and every good mechanic already knows that fact, yet if they know it, not all of them practice it with conviction equal to their knowledge. Many who "know" it only half believe it.

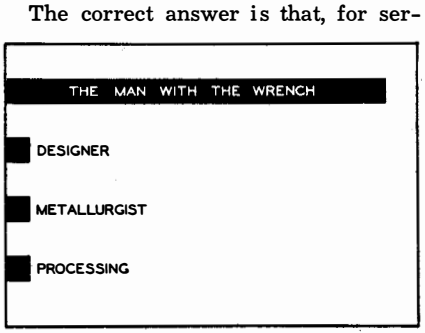


Figure 1: The elevation of the humble to the ranks of the nobility

There will, of course, be no point in asking the above question unless "dynamically loaded" is stipulated. In other words—to bring the matter sharply into the clear—for non-dynamic loads, non-changing loads, dead loads, like those, for example, on the king-rod in a wooden roof truss, the two bolts would be on a par. Chose, instead, some such example as the bolts that hold the bearing caps on a reciprocating connecting rod.

A QUESTION OF MOMENT—The importance of bolt tightness has been discussed in detail by J. O. Almen, Head of Mechanical Engineering, Laboratories Division of General Motors. Far from being merely an interesting catch question, the one stated above is of large moment in the whole of industry since

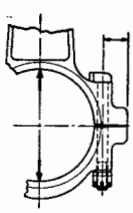


Figure 2: A typical example of a bolt subject to dynamic stress

bolts, next perhaps to welding, are the most widely used fasteners for holding machine parts together against dynamic, live loads.

Many engineers, Almen contends, fail to appreciate the importance of nut tightness; or if they do appreciate it they sometimes specify for a given job the use of torque or tension wrenches designed to assure the correct tension on nuts by means of indicators embodied in them. Yet, according to Almen, who backs up his assertions with reasons, "a good mechanic who has developed wrench 'feel' is more reliable than the most elaborate torque wrench." In fact, he emphasizes as the main point of his thesis, this man with the wrench, far more than the designer of the bolt with all his fine technical analysis—or the metallurgist, or the manufacturer with his most careful processing—is the factor which determines the strength of most of the highly loaded bolts and studs used in machinery. Just how much more is graphically and quantitatively indicated in Figure 1. Therefore, Almen urges, industry should be less concerned with the design details than it now is—and nearly everybody knows how much applied science, and fundamental science too, lies behind the design of so commonplace a thing as a bolt and nut—and should give more attention to the technique of tightening nuts. In fact, in highly loaded bolts and studs the design is rarely found to be so bad, the fabrication practice so poor, or the material so weak as to cause failure in service, providing the nut is correctly tightened against reasonably rigid bearings.

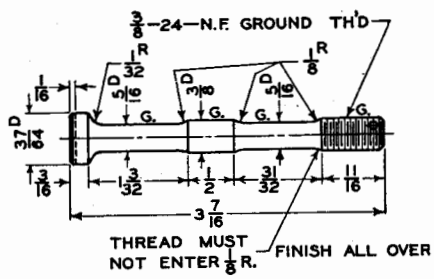


Figure 3: Detail of test bolt

Numerous tests have shown that the fatigue strength of metal decreases as the stress change to which it is subjected is increased; and, conversely, that the fatigue strength is increased as the stress change, or range of dynamic stress, is decreased. As the stress approaches zero, the dynamic load that can be supported approaches the tensile strength of the metal.

Consider as an example the case of the bolt in the connecting rod cap in Figure 2. As the connecting rod reciprocates, this bolt is subjected time after time to a fluctuating load. To make clearer the point of the argument for correct tightening of nuts on such bolts, take three separate and different conditions concerning this bolt.

In the first the nut is tightened just enough to make contact with the bearing caps.

Based on a paper presented before the Society of Automotive Engineers, Detroit.

In the second it is tightened enough to load the bolt to one half of the load caused by the tension due to inertia of the connecting rod and piston as their direction of travel is reversed.

In the third the nut is tightened against reasonably rigid abutments to produce a tension in the bolt equal to or even greater than the load just described.

What now will be the effect in each instance?

In the first instance—that of the nut barely tightened—the strength of the bolt will be less than one fifth of what it would be under a static or dead load.

In the second—the nut tightened to take up half of the external load—the strength may reach one third to one half the static strength.

In the third—the nut tightened enough to produce bolt tension at least equal to working load—the bolt's dynamic strength will approach its static strength.

The underlying reason is that, when the tension produced in the bolt by tightening the nut against reasonably rigid abutments equals or exceeds the working tension load, there will be practically no change of stress in the bolt at any time. In such circumstances the metal of the bolt will not fail from fatigue.

These effects on bolt strength are not merely theoretical; General Motors laboratories ran a series of fatigue tests on 50 bolts, each dimensioned as shown in Figure 3 (where the bolt is shown relieved to the same depth as the root diameter of the thread). The 50 bolts were divided into four groups, respectively of 17, 16, 15, and 2 bolts.

All the bolts were subjected to the same maximum external load, 9215 pounds.

In Group 1 each bolt was tightened to a tension of 1420 pounds, in Group

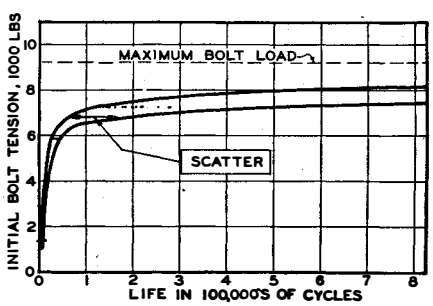


Figure 4: The effect of initial tightness on the life of bolts

2 to 5920 pounds, in Group 3 to 7220 pounds, and in Group 4 to 8420 pounds—corresponding respectively to 15, 64, 78½, and approximately 91 percent of the 9215-pound maximum load applied to the bolt by the fatigue testing machine.

WAY OUT OF PROPORTION—The results were far, far out of direct proportion to the bolt tension figures.

In Group 1, where only 15 percent of the external load was taken up by nut tightening, leaving a net load change of 85 percent to get in its evil work of fatiguing the metal, the fatigue durability of the bolts proved to average only 5960 cycles. That is, after that number of successive applications and removals of load the bolt broke.

In Group 2, where 64 percent of the load external to the bolt was counteracted by tension within it, produced by the tightened nut, the bolt lasted 35,900 cycles.

In Group 3, where the nut was tightened enough to account for 78½ percent of the external load, 214,500 cycles of stress change were run off before the bolt failed from metal fatigue.

Finally, when 91 percent of the load applied by the testing machine was balanced by internal tension of the bolt, one of the two bolts tested stood up for 4,654,000 cycles and the other to 10,000,000 cycles, at which point the test was stopped.

The same data look even more impressive in the form of Table I.

In graphical form, Figure 4 tells the same story but the scale of the layout prevents inclusion of the fourth group of bolts which, if shown, would be plotted about one foot to the right of the graph, but almost no higher than the end of the curves as now shown. The two curves of this figure show the variation ("scatter") in durability between the individual bolts in each of the groups tested; naturally, not all bolts are exactly alike.

Why not, then give the bolt an even higher tension, before applying the external load to it, than that load will be? Nothing looks simpler, but it won't work even if you plan it that way. Obviously, if it would work, that is what would be done and the whole matter easily ended.

When the nut is insufficiently tightened, each load application will elastically elongate the bolt, and a gap will be formed between the bolted members. The magnitude of that gap will be reduced as the nut tightness is increased. When the nut tightness is brought near the operating load, this gap will not occur. Nevertheless, there will be a small elastic elongation of the bolt. But when the bolt is tightened and thus elongated, the abutments against which it bears are elastically shortened. When the external or operating load is put on the bolt, the bolt is acted upon by that load plus the load of elastic recovery of the bolted assembly. The sum of these forces will always be greater than the tension given the bolt by the nut.

Therefore, no matter how hard you try to catch up with the external load by tightening the nut, you can't reach your goal, and the bolt will therefore undergo a change of stress at each application of external load. But that change of stress will be reduced in magnitude as the rigidity of the bolted assembly is increased by tightening the nut. Both the recent tests described, also a century of empirical practice before the subject was made the object of scientific investigation, bear out this fact. Thus, when the load change is reduced to small proportions the fatigue strength of a bolt approaches the life of the assembly of which it is a part.

The graph, Figure 5, relates to another aspect of the subject of bolt

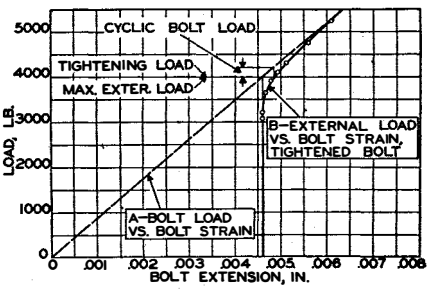


Figure 5: A typical plot for the determination of bolt cyclic load

tension—the determination of cyclic bolt load.

STRESS-STRAIN MEASUREMENTS—As a preliminary to the fatigue testing of the 50 bolts, stress-strain measurements were made for each bolt, using facilities which the testing machine employed affords for accurately weighing the load applied to the specimen at any position of the load-applying device. In Figure 5 the long inclined "curve" (which happens to be straight) is the load extension curve of the bolt alone—so much load put on the bolt by the nut, so much extension of the bolt. The second curve, *B*, on the same graph, contains several plotted points which were taken from a bolt that had been tightened against relatively rigid abutments to a load of 4000 pounds. Under that load the bolt elongated in the tests, as the vertical part of the graph shows, 0.0046 inch. As the external load was applied to this already tightened bolt, the external load extension curve *B*, as revealed by the plotted points, did not rise vertically to join the curve of the bolt alone—that is, curve *A*—as would be the case under ideal conditions of an elastic bolt and perfectly rigid abutments. The plotted points *B* join the vertical line at 0.0046 inches elongation and the inclined line *A* by an easy curve. This shows that the bolted members are elastic, and that the load on the bolt is augmented by the elastic recovery of the bolted members.

What of the effect of this elastic recovery? The added load increment due to the elasticity of the bolted members can be measured direct from the curves. For a special case in which the external load is equal to the initial bolt tension, the horizontal 4000-pound

TABLE I

Initial Tension (Nut)	Operating Load	Load Change	Stress Range	Average Life
1420 pounds	0 to 9215 pounds	8000 pounds	.85	5,950 cycles
5920 pounds	0 to 9215 pounds	3300 pounds	.36	35,900 cycles
7220 pounds	0 to 9215 pounds	2000 pounds	.215	214,500 cycles
8420 pounds	0 to 9215 pounds	800 pounds	.087	5,000,000 cycles+

line representing the initial load due to the nut is extended to the right till it intersects the curve of the several plotted points. This will be found to lie at a bolt extension of 0.00485 inch. Now, since the extension under the preload (nut load) was 0.0046 inch, the bolt elongation has increased 0.00025 inch; that is, the difference between the two figures. Now the new line on that figure—namely, 0.00485 inch—is projected vertically to intersect the long inclined curve *A*. This will correspond to a load of 4220 pounds, or a load increase of 220 pounds over the initial 4000-pound bolt tension.

The load range experienced by the bolt under these conditions would be $1 - \frac{4000}{4200}$ or 0.052. This is so small a stress range as to be practically zero, and thus the bolt load is therefore almost static.

In the same manner the resultant bolt load may be found for any external load, whether greater or less than the internal load.

Other evidence, too detailed for the space available here, leads to the conclusion that the materials in a machine assembly, and its design, have large influence on bolt strength. Even if the nut is correctly tightened, the bolt will be weaker when used, for example, in combination with aluminum abutments than with steel. This is because of the greater elastic deformation of aluminum. Similarly, if the abutments are of small area the bolt will be weaker. Similarly, too, the more parts the bolted assembly contains the weaker will be the bolt, because mating parts never fit perfectly.

ARRANGEMENT AFFECTS BOLT STRENGTH—Another fundamental principle, related closely to the one just described, and set forth by Almen, is shown in abstract form in Figure 6 and in application to everyday realities in Figure 7, which represents two elastically deformed plates and a gasket, also two plates in a bolt and spring washer assembly.

The fundamental which Figure 6 rather abstractly illustrates—since such a set-up will not often be found in an actual mechanism—is that the arrangement, good or bad, of the parts in a

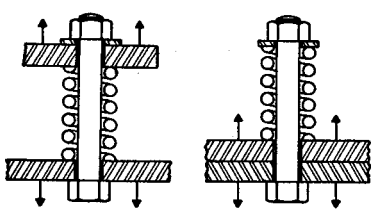


Figure 6: In first drawing, bolt is weak, in the second strong. Why?

bolted assembly can exert enormous effect on bolt strength. Both of the assemblies in Figure 6 may be seen to contain identical parts. In both, the external load (arrows) is applied against the bolt by the two stiff plates. But in the first the bolt will be weak and in the second the same bolt will be strong. Why?

The reason is that, in the first bolt, when an external load equal to the internal load—that of the bolt's tension caused by the spring—is applied, the total load on the bolt will be twice that tension: once for the spring and once for the external load. The stress range experienced by this bolt will therefore be 1 — ½, or 0.5. If this magnitude of

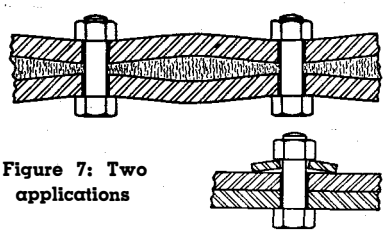


Figure 7: Two applications

stress range is now compared with the figures in the stress range column in the table it will be found that it is similar to the stress ranges of bolts that failed relatively early. Thus, in this set-up, the bolt is weak.

In the second set-up the bolt is strong, as already stated. Just what, then, is the essential difference between the two arrangements, so far as the bolt is concerned? In the second set-up the spring, which formerly was a part of the abutments, is now a part of the bolt; hence, now a very elastic bolt (elastic because of the part of it which consists of a spring) is tightened against relatively rigid members, the plates. When an external load, equal to the tension of the spring, is applied to the plates, the load between the plates is reduced to zero, but the bolt still has its original load—that of the spring—and there now is no stress range. Hence the bolt rates as static and failure from fatigue cannot occur, no matter how many times the stress is applied to the plates.

Now for the practical applications of these principles.

Figure 7, top, represents a condition often met with in practice, a gasket clamped between two mating plates. The gasket is compressed locally near the bolts, and the plates are bent until they act like the spring in the first set-up of Figure 6. When, in addition to this initial load, the external load tending to separate the plates is applied, the bolt will feel both loads. Usually, also, such bolts are short and therefore they have small elastic elongation. Thus in this kind of arrangement the stress range will be large and this will be an invitation to failure from metal fatigue.

REMEDY—The remedy offered by Almen consists of minimizing the spring-like bending of the bolted surfaces by allowing large gasket area near the bolt, and relatively smaller area in proportion to distance from the bolt, also in making the gasket as inelastic as possible, in order not to let the bolt down.

The lower part of Figure 7 shows one way to increase bolt life. The spring washer increases the effective elasticity of the short bolt, and thus the fatigue strength of the bolt is increased. This arrangement corresponds to the right-hand sketch in Figure 6, in which the spring is a part of the bolt and the bolt is strong. Any other expedient that will increase the rigidity of the bolted assembly will increase the fatigue strength of the bolt.

Bolt tightness must not only be provided but must also be maintained during service. A bolt or stud that is incapable of permanently maintaining a tension equal to the external tension load is likely to fail in severe service. The bolt must be able to take up the external load and still be tight. Thus, because of their greater elastic yield, there is a higher mortality among short bolts and studs than among long ones. For example:

An engine cylinder is attached to a crankcase with short studs, the thickness of the cylinder flange plus the washer being often less than half an inch. If now the elastic elongation of the stud is 0.002 inch, and during operation such factors as wear, corrosion, embedding, or displacement of material such as soft plating, reduce the bolted assembly by only half that much, the stud will lose half of its required tension. Fatigue failure will follow.

In a case like the one just described, if a longer stud can be used, greater safety will be assured; the loss of stud tension due to elastic elongation will thus be considerably reduced.

At least one manufacturer tightens connecting-rod bolts actually past the yield point. This is far better than to risk undertightness—at least provided

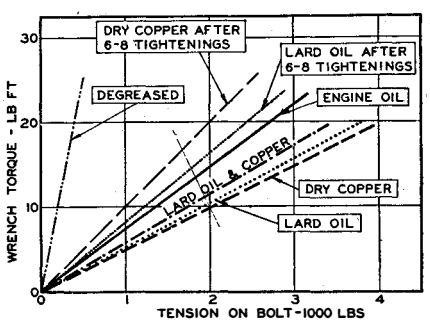


Figure 8: The effect of lubricants on bolt tension upsets precautions

correct caution is used and other factors too detailed to be presented here are considered.

Mention was made of the torque wrench, and the statement by Almen, that a good mechanic who has developed wrench "feel" is more reliable that the best of such wrenches, was cited. His explanation of this is that friction between the threads of the bolt and the nut is so variable that, even with such wrenches, supposedly giving automatically the same tension to every bolt because of controlled nut tightening, bolt tension will vary over wide limits—as much as 10 to 1 in extreme cases.

Figure 8 exhibits this graphically; it is simply a matter of varying coefficients of friction. In actual practice this variation will run between 3 to 1 and 2 to 1, but even this is too wide a spread for so critical an operation as pre-loading severely stressed bolts. It would mean much to industry, Almen urges, if this variability of nut friction could be reduced, thus admitting use of the torque wrench as an accurate tool.

Safety In The Air

In the Science of Biomechanics, Combining the Knowledge of Surgeons and Engineers, is to be Found at Least a Part of the Answer to Fatal Aircraft Accidents. An Understanding of the Strengths and Weaknesses of the Human Body can Aid Aircraft Designers in Building Safer Ships

WHILE safety in civil flying has increased enormously since the early days and is now satisfactory on the airlines, it is not comparable in private operation to the safety of the automobile. In 1941, for example, there were approximately 164 fatalities for each 10,000 privately owned aircraft, against eight fatalities for each 10,000 automobiles similarly owned.

In the problem of airplane safety, there is no one great invention which can bring a complete solution; there are many causes and many remedies. Spins and stalls predominate in fatal air accidents, but can be reduced to a minimum. Accidents sometimes occur where airplane collides with airplane, but radar will undoubtedly give birth to collision indicators. Accidents occur when a pilot shows off in a series of acrobatic maneuvers over the house tops. Training, punishment, and social reprimand are in order here.

NATURAL HAZARDS OVERCOME — Weather service is now excellent but the pilot must be made to understand that he cannot venture forth in the face of adverse weather reports. Fog and low visibility are real hazards, but radar, television, and blind landing systems at airports and airfields can make even the worst fog innocuous.

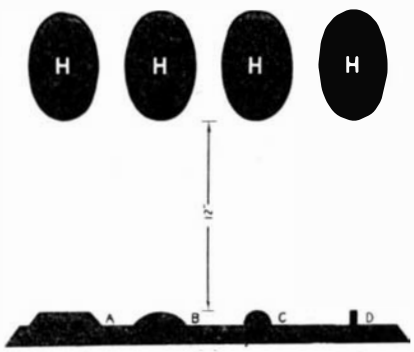
Structural failures have fortunately become very rare in modern designs, though poor maintenance may indirectly cause structural failures. In the power plant, progress has been made by better fuels, greater reliability of the engine itself, provision against carburetor icing, and so on. Recently there have come such aids to safety as the tricycle or nose wheel landing gear which prevents the machine from nosing over on landing, and eliminates "ground looping" when landing in a cross wind.

But mere consideration of these and other devices for safety indicates that, owing to the variety of causes, air accidents will never be wholly eliminated any more than they have for the motor car.

The next thought is, therefore: How can crashes be made to give the fewest fatalities? The answer is that airplane design and the science of biomechanics are now being so correlated that even bad crashes are no longer necessarily fatal.

Dr. Charles Murray Gratz, a surgeon who has made many contributions to this new field of science, writing in *Mechanical Engineering*, describes biomechanics in a few words as follows:

"Successful co-operation between surgeons and engineers leads to an exchange of techniques known as biomechanics. Biomechanics is a division of the larger field of biological engineering. The term was used in describing the original mechanical heart. Our Russian allies have successfully coordinated surgical and engineering studies. Their perfection of the artificial heart, successfully used in the revival of dogs for periods up to 15 minutes after cessation of circulation, has received due recognition. Surgeons have also used engineering methods to determine the elastic properties of human fibrous tissues, which compare favorably with many structural materials. Shear in human tissues is one of the most important variables in surgery and the biochemical study of shear has greatly reduced the percentage of complication in certain branches of surgery."



Courtesy American Society of Mechanical Engineers

Figure 1: To illustrate pressures when head strikes various surfaces

This co-operation between the engineer and the surgeon is now carrying over into aviation, with the airplane and its human cargo being considered as a unit. As a result, loss of life in crash landings is being steadily reduced and the defenses of the human body are being coordinated with the structure of the airplane and the layout of the cockpit.

A more detailed study of biomechanics as related to airplane safety is to be found in the writings of a research worker in physiology, Hugh De Haven of the Cornell University Medical School. Mr. De Haven has published in *Aero Digest* an illuminating article on the cause of injuries in lightplane accidents.

There is one most important observation in De Haven's studies. In the same crash, one man may escape with minor injuries while another is killed instantaneously. Back in 1908, Lieutenant Selfridge, the first American army officer to lose his life in an airplane accident, was killed at Fort Meyer in an early Wright biplane. The aircraft plunged almost vertically downward from a height of 75 feet. Lieutenant Selfridge's skull was fractured by a blow against one of the wooden uprights of the framework, while Orville Wright, who was flying with him, suffered painful but not dangerous injuries. Such unequal chances of survival in crashes have been noted again and again.

Another observation is that the human body can survive almost miraculously in crashes which far exceed the present strength of aircraft structure. A 1943 accident analysis made by the Safety Bureau of the Civil Aeronautics Board showed that 77 percent of the aircraft involved in spin-stall accidents were rated as "washouts" and 19 percent were so damaged as to require a complete overhaul. Yet only 47 percent of the spin-stall accidents were fatal. How is it that pilots can so often walk away from washout crashes in which survival seems impossible? The answer lies in the fact that the human body is tough, that fatalities often result only from faulty structural and seating arrangements, and that good structural, seating, and instrument arrangements give a chance of survival even in a terrible wreck.

ACCIDENT ANALYSES—Fortunately the Civil Aeronautics Board has analyzed a number of lightplane accidents as a preliminary to remedial design.

One bad contributing factor is found in the egg-shell structure of the semi-monocoque, plastic-plywood structure. If safety is a major consideration, fuselages must be more rugged, possibly reverting to metal or turning to

a better reinforced plastic, which should be resilient and hold together in case of crash.

Another important moral of biomechanics is that shoulder harness, as used in military aircraft, is the most effective defense against injury of the head, spine, and chest. Shoulder harness cannot be used on civilian airliners because of its psychological effect, but even the lap type belt can be an effective safety measure, especially if coupled with better arrangement of the structure and more headroom.

Apparently, serious injuries from the action of the safety belt on the abdomen are few. The abdomen can withstand the violent action of the safety belt and survive, the momentum of the body can be readily checked at the hips and, what is more, the spine itself can stand extreme forward flexion. Structural elements and instrument panels are the factors that cause injuries to the head and chest when the body is held at the hips and thrown violently forward. Here, then, is an important consideration for aircraft designers.

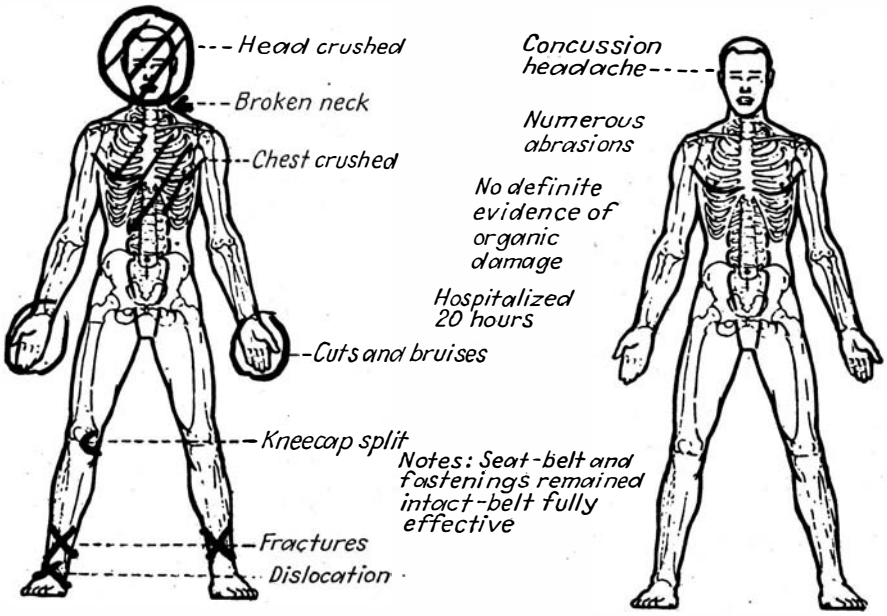


Figure 4: Difference in injuries sustained by two men in same airplane accident

DEATH CAUSES—Under ideal conditions, a human being can withstand decelerations as high as 100 times those of gravity. A car can be stopped from a speed of 50 miles an hour in a distance of six inches without killing the occupants. On the other hand, death can follow an automobile accident at 15 miles an hour if head or body strikes a hard, sharp, unyielding obstruction. The diagram in Figure 1 emphasizes this point. Here *H* represents a human head, which weighs about 10 pounds. The distance between the body and the ground is taken to be 12 inches. If the head drops and strikes the flat surface *A*, the pressure on the distributed area would be 480 pounds per square centimeter. If it strikes the convex surface *B*, the pressure becomes 960 pounds per square centimeter, and if the unfortunate human head should strike the steel projection shown at *D*, the average pressure would become 2800 pounds per square centimeter, so that in this instance the chance of survival would be nil!

Accident analysis and theoretical calculations of the above type both indicate, then, that aircraft designers should avoid projecting compass cases, hard control knobs, steel tubes, and the like in regions likely to be struck by the face or head.

Figure 2 gives an interesting example of the importance of seat location. After the accident which this photograph illustrates, the passenger in the rear seat walked away from the scene. The pilot in the front seat was instantly killed by a frontal fracture of the skull; the diagonal brace of heavy tube steel was struck and dented by the impact of his head.

Figure 3 shows an accident of equal severity but more happy results. The pilot's head struck and dented the instrument panel. But there was no sharp projection to injure him and no heavy structural members behind the panel to prevent it from yielding.

Another example of the differing hazards of seat position is found in an accident in which the airplane stalled at a height of 100 feet and struck the ground almost vertically. The man in the front seat was killed instantly. The somewhat gruesome labels in Figure 4 explain the different fates that awaited the two men. In the rear seat the full force was taken by the safety belt, the head missed deadly obstructions, and hence no fractures or internal injuries followed. The man in the front seat received the full force of the accident; his head was crushed, his neck was broken, and his chest crushed.

SURVIVAL IN FALLS—In "War Medicine," another paper by Mr. De Haven deals with the subject of falls from heights of 50 to 150 feet. Mr. De Haven

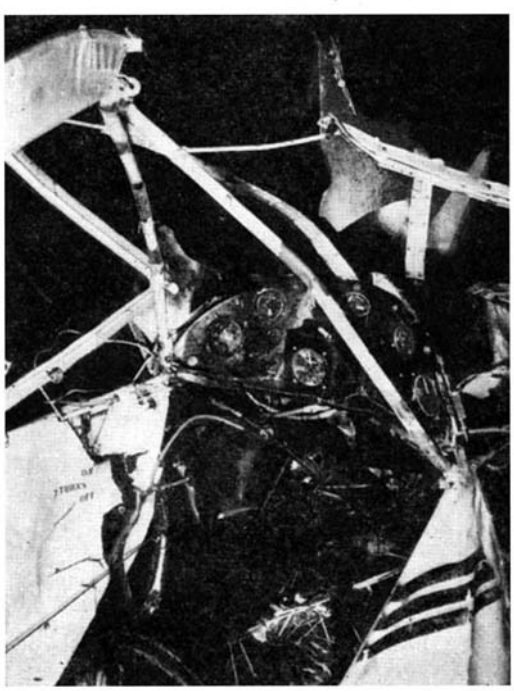


Figure 2, left: A fatality was recorded in an airplane accident when the pilot's head struck the diagonal brace shown, bending it and fracturing his skull. The passenger in rear was uninjured

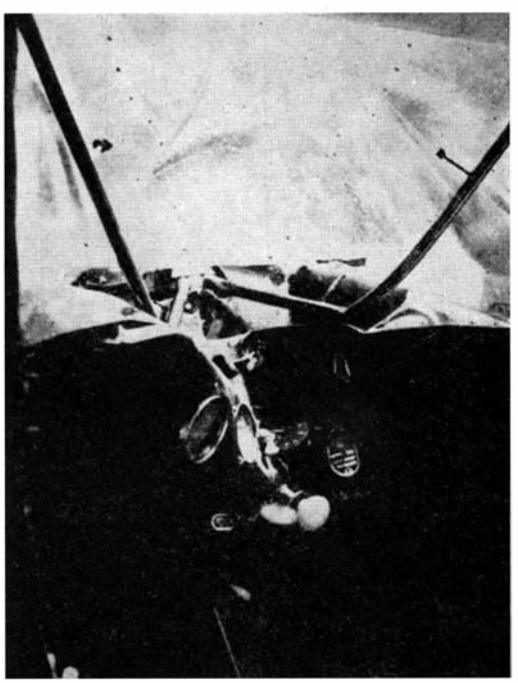


Figure 3, right: The instrument panel in this accident yielded when struck by the pilot's head, and he survived the severe crash

cites some extraordinary examples of survival. Here is one: "A woman, aged 36, 5 feet 4 inches tall, and weighing an estimated 115 pounds, jumped from an eighth floor and fell 72 feet onto a fence, face downward. Velocity at contact was 65 feet per second or 44 miles per hour. There was no evidence of material injury. The victim was seen during the fall and landed 'jack-knifed' over the fence, which was constructed of wood and wire. The fence was broken down part way and the victim tumbled to the ground. She immediately picked herself up and walked to a nearby clinic for first aid."

From the reports of this and similar accidents, the author draws the conclusion that the human body can tolerate and expend a force as great as 200 times the force of gravity for brief intervals during which the force acts transversely to the long axis of the body. What is of even greater interest is this statement: "It is reasonable to assume that structural provisions to reduce impact and distribute pressure can enhance survival and modify injury within wide limits in aircraft and automobile accidents."

The main conclusion to be drawn from this combined work of the biomechanic, the surgeon, and the accident investigator is that a serious crash need not be necessarily fatal. The airplane designer has been prone to assume that if a bad crash did occur, there was nothing to be done about it. The occupants would be killed anyway.

CONCLUSIONS EMERGE—This defeatist attitude should disappear as certain conclusions emerge from the study of biomechanics.

Everything possible should be done to avoid crashes, but there is more to be done by designers in lessening the chance of fatal injury in really bad crashes; the airplane designer should take an interest in biomechanics and should study accident analyses. The safety belt does not injure the abdomen and, provided it is solidly anchored, is a valuable safety device, but its greatest benefit can be reaped only after redesign of the cockpit. The instrument panel must offer no knobs or projections or sharp corners to hit the pilot in the head, face, or chest. The instrument panel should "give" on impact and should not be backed up by too rigid a structure. Finally, ahead of pilot or passenger there should be no clusters of dangerous and unyielding steel tubes.

All these are simple, commonsense measures, much easier to understand and apply than the formidable title of biomechanics would seem to indicate. It is gratifying to know that the American Society of Mechanical Engineers is doing much to bring the sciences of biomechanics and airplane design closely together.

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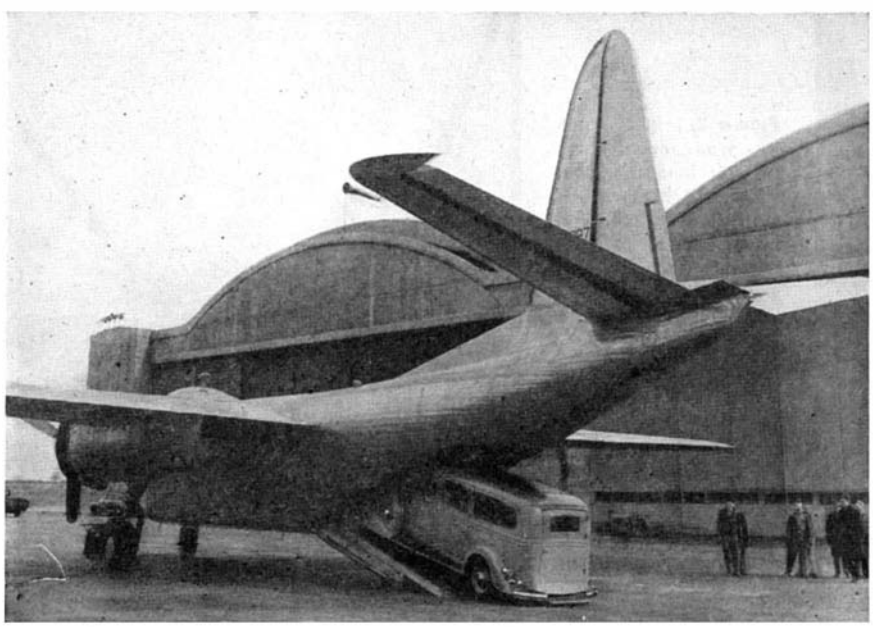
A FLYING FREIGHT CAR

Built of Stainless Steel, Has Huge Cargo Capacity

UNDER Navy auspices, the Edward G. Budd Manufacturing Company has built a most interesting cargo plane, for whose design their Chief Engineer, Dr. Michael Watter, has been mainly responsible. The new plane is of especial interest for a number of reasons. It is, to begin with, one of the few American aircraft built completely of stainless steel, a material which can be spot welded (thus eliminating the rivet) and which withstands corrosion. Another feature of interest is that the engineers had a single purpose and concentrated on a flying freight car which would carry cargo economically on flights of moderate length and would also permit loading and unloading cargo with ease and speed.



The rear of today's "Conestoga wagon" is designed for easy loading

The plane, known as the *Conestoga*, is a twin-engined machine, 68 feet long, with a wing spread of 100 feet, capable of transporting 10,400 pounds of cargo over a range of 650 miles. Each of its 14-cylinder radial air-cooled engines delivers 1200 horsepower for take-off and has a normal rating of 1050 horsepower. Tests show that the plane can take off from a landing strip only 920 feet long.

The main interest in the *Conestoga* lies in the special cargo features. Because of the width of the fuselage and the way in which the rear is swept upward, the plane itself could be designed to carry a ramp at the rear to facilitate loading and discharge. The cargo compartment is 25 feet long, 8 feet wide, and 8 feet high and is wholly unobstructed by structural members. Another interesting development is that all loading is done on the level. On the ground and in the air the floor of the cargo compartment remains horizontal. An enormous cargo space has been made possible by the method of attachment of wing to fuselage. The wing structure does not pass through the fuselage in conventional form, but is attached to five special side frames joined across the body by shallow but rigid transverse members.

In spite of its size and loading capacity, the plane requires a crew of only two, a pilot and a co-pilot, provided with dual controls. Cruising speed is said to be around 165 miles an hour.

"FLY-IT-YOURSELF"

Aviation Service Planned for Plane-Less Flyers

IN SPITE of all the remarkable things that have been accomplished by American aviation, the opinion is justified that we are only on the threshold of the air age. Signs of such an age are not lacking. Thus from Boston comes the announcement that R. S. Robie is planning a fly-it-yourself service for use by air-minded men and women. Mr. Robie expects that young men who have been engaged for two or three years in war-time flying will come back fully ready to patronize such a service. Here is his plan:

"The 'fly-it-yourself' plane will be rented on an hourly basis. You will pay only for the amount of hours you use in actual flight. The cost per hour for a small plane will be $3.50 to $5.00. The airplane will be equipped with a three-way radio (receiver, transmitter, and direction finder)."

All this sounds too good to be true, but Mr. Robie adduces some sound arguments. There are now scarcely any cities or towns of any size in which an airport or at least a landing field is not available. In addition, appropriations are forthcoming for "flight strips." These flight strips consist of concrete runways from 500 feet to a mile in length, running parallel and adjacent to large highways at points close to cities and towns. These will, in effect, be small airports which will multiply our facilities many times.

Detenderizing Glass

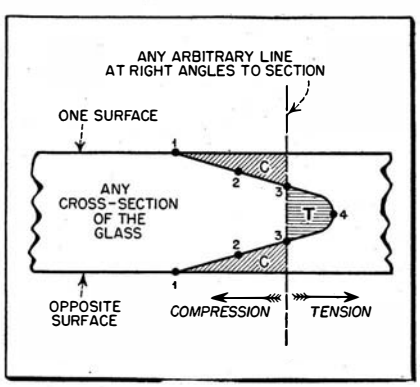
Not All Glass is Fragile. Glass Intended for Safety Lenses is Changed from Tender to Tough by the Comparatively Simple Application of a Trick That Reverses its Normal Stresses and Puts the Surface Under Compression Balanced by Internal Tension. Industrial Eye Injuries Can be Reduced

By T. A. WALSH
Manager, Safety Engineering Service Bureau
American Optical Company

EACH year, thanks to optical science, thousands of eyes are saved by safety goggle lenses which are scientifically toughened to resist the impact of flying objects often encountered in certain types of industrial operations. From an economic point of view, a safety goggle that saves an eye pays for itself about one thousand times over, and a goggle that prevents the most trifling eye injury pays for itself several times over.

Eyes are the most vulnerable and the most expensive targets which workers present to industrial hazards. The smallest chip, the smallest spatter of acid or molten metal, can score a bull's-eye, rob a worker of his sight, and cost his company $1800 or more in compensation alone, not including the indirect costs which invariably follow. Even a trifling injury, only serious enough to cause a single trip to the infirmary or first-aid station, may run up serious "hidden" costs in idle machine time, lost production, disrupted production schedules, and in lowered efficiency of the man involved and of neighboring workers.

To protect the eyes of war production workers, millions of toughened lenses have been turned out since Pearl Harbor. The need for these lenses will increase as new manufacturing processes which create eye-injury exposures are expanded in plants now generally considered as having a low eye-injury hazard.



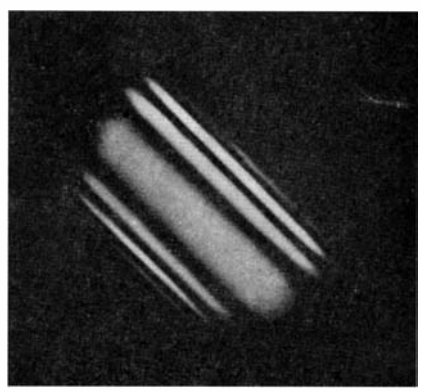
If a piece of toughened (tempered) glass is sectioned, the following condition will be found, according to C. J. Phillips, a Corning Glass Works physicist. At points 1, on the outside surfaces, there will be a maximum compression perhaps as high as 15,000 pounds per square inch or even more. At points 2, just inside each surface, there will be a smaller stress in compression, perhaps 7500 pounds per square inch. At points 3, there will be zero stress. But at point 4 there will be a tension which may be roughly 5000 pounds per square inch. Area *C* is in compression, area *T* is in tension

How is fragile glass made tough enough to ward off flying chips of metal and thus protect the eyes of industrial workers?

To explain and understand the art of toughening lenses it is first necessary to discuss glass annealing. Briefly, annealing is a scientifically controlled heat treatment to make glass optically homogeneous. The glass is brought to the top of a certain temperature range, kept within that range for a long period of time, and then allowed to cool. This procedure eliminates mechanical strain and stabilizes the internal structures of the glass.

Incorrect annealing may permit dangerous concentrations of internal stresses and strains to exist or to develop later after the annealed glass has reached room temperature. It is these uncontrolled stresses and strains, often developing in after years, which may cause glass to break, frequently for no apparent reason—as in the case, for illustration, of a cut-glass goblet that may suddenly crack while resting on a shelf.

HOW IT IS DONE—In toughening glass, as C. J. Phillips points out in his book, "Glass: The Miracle Worker," it is deliberately disannealed, under controlled conditions, so that when the glass cools it contains desirable permanent compressive stresses in all its outer surfaces. Controlled strain is introduced by reheating the annealed glass, after it has been formed, to a temperature just below its softening point and then rapidly cooling the surfaces. This chilling process is accomplished by means of jets of compressed air, immersion in oil, or plunging in various molten salts. In practice, all three procedures are used in toughening lenses.



A section of toughened safety lens, taken under polarized light, which reveals the tension (inner band) and compression (outer bands) in it

Correctly done, this rapid chilling places the exposed surfaces in compression, balanced by tension inside, and this system of stresses is as permanent as the glass body itelf. Actually, the outside of the glass—its weakest part—is strengthened by the process, as explained below.

To understand what happens it is necessary to have a clear picture of compression and tension. Suppose we take a rubber band and stretch it. It is now in tension—that is, the atoms are being pulled down. Continue to stretch the same band and eventually there is so much tension that the atoms part company and the band breaks.

Compression is the exact reverse of tension. By pressing together a substance—a rubber eraser, for example—we move the atoms closer together despite repulsion forces existing between them. Continue to compress the eraser and it is found almost impossible to reach a pure compression force large enough to cause a rupture.

In toughening glass, according to J. T. Littleton, of the Corning Glass Works, the simple principle is applied of creating a stronger body by generating an internal tension, in order to furnish a region under compression.

Delving deeper into the process, it is found that, by controlling the rate of cooling of the glass from a temperature sufficiently high to render the glass slightly plastic, an internal tension results. This is because, during the cooling process, the surface of the glass cools more rapidly than the inside of the glass and therefore becomes rigid first.

This would cause a differential contraction, except for the fact that the interior of the glass is still plastic and yields to the stresses set up in the cooling. However, as the glass continues to cool, its inner part becomes hard and can no longer yield.

Finally, as the glass becomes cooled to a temperature near that of the room, the temperature difference between the surface and the inside gradually disappears. At the moment when the cool outside surface of the glass becomes rigid the hotter inside, because of its plastic condition, will still be contracting as its temperature falls. The inside is, therefore, put under tension. However, since the glass is a continuous solid—and, according to Newton, to every action there must be an equal and opposite reaction—the outside surface must from necessity resist and balance the contracting pull or tension of the inside, hence it is compressed and thus toughened.

One of the rotary-type heating and chilling units mentioned in the text. Note radial rotating arms below. Each arm carries three lenses through an electric furnace

ANOTHER EXPLANATION—Here is another way of explaining what happens. Glass bodies ordinarily break only when some point on their surfaces reaches a tension exceeding a certain amount. If these surfaces are normally in a state of compression before loading, this compression must be overcome and then tension built up, before breakage occurs. The surfaces of toughened glass are therefore stronger by about the amount of the compression introduced by the cooling.

As the permanent compression can easily be 7000 pounds per square inch and may be as much as 20,000 pounds per square inch, thermally toughened glass may be several hundred percent stronger than annealed glass. For example, comparing the strength of annealed glass plates and thermally toughened plates of the same composition, the annealed glass gives strength values from 5000 to 7000 pounds per square inch and the thermally toughened glass 25,000 to 27,000 pounds per square inch.

Great mechanical strength, as the above figures show, is provided by the toughening process, which produces a glass having remarkable flexibility and resistance to impact and other mechanical shock. Furthermore, if the glass does break, it does not shatter into long sharp splinters but crumbles into small cubical pieces. This is because toughened glass takes on the characteristics of crystals which break along their planes.

To turn out toughened lenses in the quantities needed in the modern industrial world, American Optical Company engineers have designed rotary-type heating-chilling units, each of which, in the hands of an expert operator, can toughen thousands of lenses a day. The machine is composed essentially of an electric furnace, rotating arms which carry lenses through the furnace, and jets for compressed air used in the chilling operation. These jets are especially shaped to provide the desired distribution of air over the heated lenses, an exceptionally important part of the toughening operation.

DONE IN FIVE MINUTES—In one revolution of the rotating arms, which takes approximately five minutes, 60 lenses are toughened. Heating temperatures range from 1200 to 1600 degrees, Fahrenheit, and different temperature cycles must be determined for various types of glass used in manufacturing toughened glass.

A brief description of a typical safety lens is as follows: Super Armorplate lenses, chosen as the example, are available in two forms—1.25 curve and 6.00 curve—optical designations which indicate the degree of curvature of the lens surfaces. Both forms are made from ophthalmic crown glass, optically ground and polished. Toughened by the above method, these lenses are fracture-resisting to the highest practicable limits obtainable by modern science. They exceed the National Bureau of Standards requirements for a protection lens.

Testing safety lenses for toughness. As each lens is positioned under the pipe column at the right, a 5/8-inch steel ball weighing over half an ounce is dropped from a height of six feet and strikes it

Safety goggle lenses ground to prescription to correct defective eyesight can also be toughened. In two minutes the above special heating-chilling machine tempers a prescription safety lens so that it resists breakage. The girl wears a pair of these corrective-protective lenses

The 6.00 curve Super Armorplate lenses are deep curved for extra strength. They provide even more resistance against impact than 1.25 curve protection lenses, plus greater likelihood of deflecting flying particles. The deep curvature permits them to fit closer to the eye, yet give greater eyelash clearance. Reflection from the back of the lenses is reduced.

For workers exposed to both impact and glare hazards, there have been made available lenses combining the impact resistance of 1.25 curve or 6.00 curve Super Armorplate plus the glare-free qualities of colored absorptive glass. These lenses screen out ultra-violet and infra-red rays and reduce glare.

Safety goggle lenses are now ground, polished, and edged before they are toughened, a comparatively recent innovation and one that has improved the quality of the lenses and lessened their breakage during production. Previously, the finishing operations were performed after the lenses had been toughened, a method which thinned the compression band of the lenses and thus frequently caused breakage.

GROUND FOR EACH USER—Several years ago there was developed a method of toughening safety goggle lenses ground to prescription to correct defective eyesight. Small toughening units were designed for the purpose and after many months of research a comprehensive chart was worked out, providing heating-chilling data for toughening white and colored prescription safety lenses of different thicknesses and curves. Because each prescription lens is individual, prescribed

for one person's eye, compilation of data for a chart covering all thicknesses of lenses represented a monumental research task.

The importance of this latter development lies in the fact that many of our industrial workers are now men of middle age or beyond who seek safety goggle lenses which protect their vision and correct it also. When elderly workers wear such eye-protective and eye-corrective goggles their production naturally increases, and they achieve greater eye comfort, efficiency, and safety.

A few figures reveal the importance of safety goggles in dollars and cents. In 1929, a company in the metal working industry employed 41,500 people, and its bill for eye accidents in that year alone was $51,000. An eye protection program was inaugurated. In 1936, the company employed 43,500 employees or 2000 more people than in 1929. The bill for eye injuries, however, dropped to $5800.

In another plant, the cost of eye injuries was reduced through the medium of an eye protection program from approximately $2.70 per employee to 7 cents per employee in the period of 1943 over 1942.

In the 1943 edition of "Accident Facts," published by the National Safety Council, it was shown that the total economic costs of 1942 occupational accidents are estimated at approximately $2,300,000,000. Industry's burden through these injuries is estimated at $1,900,000,000, of which $95,000,000 can be attributed to compensation paid for eye injuries.

This is an unnecessary economic loss.

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"ONE ESSENTIAL INGREDIENT"

Controls Size of Molecules In Synthetic Rubber

NO LONGER of value to the enemy, one of the prime secrets of the success of the entire Government synthetic rubber program can now be told. It rests with three little letters chemically termed OEI, and is called the "One Essential Ingredient."

This chemical, extracted from a natural oil, acts as a regulator to control the growth and structure of the giant molecules which, in turn, determine the properties of the finished synthetic rubber.

OEI, the chain modifier or regulator which governs the properties of the finished products, was experimented with and produced by United States Rubber Company long before Pearl Harbor.

This modifier, which has a base of natural oil, was the only chain modifier suitable for the rubber program. The supply of raw material was accessible and the methods by which the finished chemical was produced, while elaborate, were more efficient and time saving than any other known method of manufacture.

While other essentials in the manufacture of synthetic rubber, such as butadiene and styrene, are derived from coal, oil, alcohol, and gases, OEI is made from chemicals which are extracted from natural oil. Added to the mixture of butadiene and styrene, this chain modifier controls the lengths of the chains formed through the marriage of the butadine and the styrene. Too much of this chemical added to the mixture keeps the molecules too small, thereby producing a mixture which becomes soupy and of no practical use. Too little added to the mixture allows the molecules to become too large and to create cross linking of molecules instead of chains, thereby making the mixture too stiff.

Proper control of the modifier governs the mixture to a point where polymerization is accomplished with chains of molecules produced at desired lengths. This consistency of production assures a standardized mixture at all times and permits the manufacture of completed tires, tubes, and other finished articles of war to meet stringent usage tests.

Since this rubber program for GR-S has been initiated, other modifiers have been found but to date OEI is still being used in practically all manufacture of Buna S synthetics.

POST-WAR EDUCATION

Needs Intelligent Planning and Directing

HIGHER education after the war is likely to become more "vocationalized" than ever before and its products more narrow and technical, Dr. Walter M. Kotschnig, professor of education and child study at Smith College, declares in a survey of "The Professions" reported to the American Chemical Society.

There is real danger that returning members of the armed services will crowd into all kinds of "practical" courses which would appear to lead almost at once to remunerative positions, Mr. Kotschnig warns.

"Those of college level are likely to storm the vocational and semi-professional courses in our undergraduate colleges," he says, "and they will flood our graduate schools, even though the war prevented them from acquiring the broad education offered in the past by the liberal arts colleges. The cussedness of the whole situation stands revealed when we realize that this very trend towards the vocational and narrowly technical will result in more rather than in less unemployment.

"There are definite limits set by the laws of demand and supply beyond which no profession can expand at a given time. The artificial wartime expansion of the various technical professions, including medicine, is bound to result in an overcrowding of these professions under peace-time conditions, even without counting those who will try to prepare for these professions during the first years after the war.

"Undoubtedly many will take a more optimistic view. They will point to the fact that America is starved for consumer's goods and services, and that American products will be in demand for reconstruction purposes throughout the world. However, it must not be forgotten that many of the discoveries of war-time research are easily applicable to a peacetime economy. Put differently, a backlog of discoveries and inventions has been piled up on which we shall be able to draw for some time to meet the fondest hopes of the American consumer."

Real foresight on the part of educational and professional leaders during the early post-war years will be required, Dr. Kotschnig believes. There is no quarrel, he says, with a program to enable ex-service men to complete their interrupted formal education, but there is a real danger, he insists, in ever more "vocationalizing."

"In order to avoid much individual misery and minimize any possible threats to professional standards and possibly even the stability of American society, long-range planning is necessary," he continues.

"The first great need is to avert a rush toward training for overcrowded vocations among returning ex-service men through organized action and guidance arising from within the professions themselves. By this I do not mean the day dreams of starry-eyed reformers or the abstractions of theoreticians. It is for those who are closest to the situation to size up the problems and to devise ways and means of meeting them. This means the leaders of the professions themselves and educational statesmen who determine the policies of our institutions of higher learning."

ENGINE INDICATOR

Measures and Photographs Interior Details

ANOTHER progressive step in the process of revealing to automotive engineers what really goes on during the operation of the engines they design and build was reported to the recent SAE National War Materiel Meeting. The meeting was told that an improved indicator for measuring both static and dynamic pressures can be applied to the various tasks of measuring vibration in engines; determining pressure surges in oil-circuit breakers; ascertaining deflection in engine flywheels, cylinder heads, and blocks; recording detonation; measuring pressures in guns; and even making jet-propulsion studies.

Not only does the indicator make measurements, it was explained, but, used in combination with a camera, it creates permanent visual records.

Design, development, and operation of the indicator were described by C. E. Grinstead, R. N. Frawley, F. W. Chapman, and H. F. Schultz, all of Research Laboratories Division, General Motors Corporation

Presenting results of tests demonstrating the efficacy of the indicator in probing the secrets of engine operation, they showed a calibrated, high-pressure, combustion-chamber record of an aircraft engine running at 2600 revolutions a minute. Other records

showed pressure changes within an engine manifold.

The electrical condenser-type indicator was described as sufficiently small to permit installation on modern engines, so rigid as to minimize the effects of vibration, and so critical as to register manifold pressure changes of as high as 6000 cycles per second.

NEW ELECTRON MICROSCOPES

Extend Field of Usefulness of This Important Scientific Tool

TWO NEW RCA electron microscopes —one a universal model which incorporates an electron diffraction camera and the other a smaller console model of an entirely new type—were announced recently in a paper presented jointly by V. K. Zworykin, James Hillier, and Perry C. Smith of the Radio Corporation of America before the National Wartime Conference of the Society of American Bacteriologists.

In the first part of the paper, comprising a review of recent developments in electron microscopy pertaining to the field of bacteriology, Dr. V. K. Zworykin, Associate Director of RCA Laboratories, and Dr. James Hillier, pioneer in the development of electron microscopes, disclosed important new applications of the electron microscope in this field, among them the use of this powerful electronic magnifying device in a study of the effects of disease-inhibiting drugs such as penicillin and sulfanilamide. Also exhibited for the first time were electron micrographs of high magnification which showed minute anatomical details of *Anopheles quadrimaculatus*, the malaria-carrying mosquito.

Speaking to a large audience of the country's most eminent bacteriologists, Dr. Zworykin and Dr. Hillier pointed out that since its introduction in 1940, the RCA electron microscope has grown steadily in prestige and usefulness until today there are more than 60 in use, with many more on order. The experience gained with this group of instruments, practically all of which are located in leading research laboratories, has made it possible to define more accurately the advantages of the electron microscope, the results which may be expected, and the fields in which it will find greatest application.

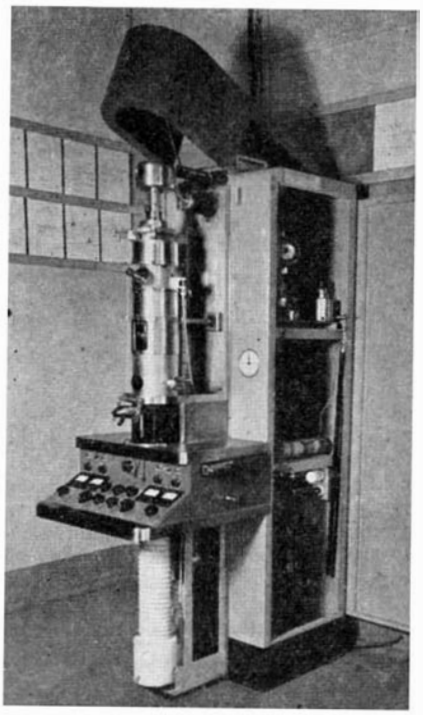
Above: Drs. Zworykin (seated, left) and Hillier (right), and Mr. Smith, with the new small sized electron microscope. Right: The new universal electron microscope incorporating many recent improvements

The new universal model of the RCA electron microscope represents a complete redesign of the laboratory type instrument which has been in production for the past four years. It incorporates many improvements and simplifications in mechanical and electrical design which make for more convenient operation, more consistent results, and greater ease in servicing. The field of application has been broadened and the usefulness increased by including an electron diffraction camera as a built-in unit. Thus, it is now possible to make electron micrographs and electron diffraction patterns of the same specimen in a matter of minutes. The extra information gained is often of great value in determining the molecular structure of a substance. The electron diffraction unit alone may sometimes be used in identifying unknown substances and in detecting impurities in known materials.

In the universal model the electron optical system is contained in the vertical column at the front of the instrument. The airlocks formerly used for inserting specimens and film plates have been eliminated, this being made possible by the fact that the whole column can now be pumped down in a minute and a half. The pumping system consists of an oil diffusion pump located in the lower part of the column, and a mechanical fore-pump mounted externally.

The console model of the electron microscope is an entirely new type of instrument designed to meet the need for a smaller, less expensive unit. It employs the same type of circuit as the larger microscope (including the highly desirable feature of magnetic lenses), is built to the same quality standards, and provides performance of the same order as its bigger brother. It does not, however, have a diffraction unit, has only two magnification steps (500 X and 5000 X) and lacks some of the convenience features of the big model.

In the console model the electron optical system is mounted horizontally and the image appears directly on the screen at eye level. The whole equipment, including oil and mechanical pumps and power supply, is mounted in a desk-type console.



The console model is especially suitable for use in small laboratories, schools, and hospitals, and for process and material control in factories. Because of its simplicity, it can be operated with a minimum of training. It is particularly well suited for control and analysis operations which have been more or less standardized. It is expected to find widespread use for this purpose in the chemical, metallurgical, textile, food, and petroleum industries as well as in the bacteriological field.

PLANT SAFETY

Maintained by Direct Contact With Workers

THE experience of the Ford Motor Company in 30 years of safety work has shown that best results are achieved by direct contact between trained safety inspectors and employes. These safety inspectors are carefully selected. Many are designers or engineers, others are former tool and die makers, maintenance men and chemists. All have had a rich background of practical experience.

Maintaining personal contact between safety engineers and employes is no

simple task, but it has paid dividends, not only in property, but in lives and limbs. Difficulties have multiplied as a result of the rapid labor turnover caused by war conditions. The influx of women and former white-collar workers has intensified the problem of educating employes and keeping them safety-minded, but the company's high safety record has been preserved.

Safety department inspectors keep constantly on the move. They talk to foremen and employes, study machines and operators' habits, and make suggestions.

Safety devices installed in the Rouge soybean plant are illustrative of the safety department's ingenuity. The problem was to detect the possible escape of hexane, a highly explosive liquid used in soybean processing. After checking the equipment and noting the points of potential danger, safety engineers placed suction pipes at each point. Through these a sample of air is drawn once every three minutes, and if hexane is present the machine sets off an automatic siren. At the same time a light flashes on an instrument panel showing the location of the leak.

Ford safety engineers must approve all new equipment before it can be purchased. If specifications are approved, the buyer places his order. Upon arrival of the shipment the safety inspector again checks the machine to make certain it meets specifications. Alterations are frequently needed. But in no case is any machine installed until it is approved by the safety department, even though a major change in design is necessary.

CAR VS PLANE

Two Experts Discuss Possible Post-War Features

THE DEVELOPMENT of radical automobiles has quite definitely been assigned to the post-post-war period. The reasons: Automotive engineers now are too busy with the production of war materiel to bother with advanced designs. Immediate post-war demand will be for modified 1942 models—in a hurry. The public accepts revolutionary automotive engineering and design slowly and in mild doses.

Any automobile even bordering upon the revolutionary must be a post-post-war model, says Brooks Stevens, industrial designer, adding:

"It is unfair and unwise to lead the public to believe that the day after our final victory it can be assured of plastic automobiles for $400 each, privately-owned helicopters within the automotive price range, and household appliances that will almost eliminate the necessity for domestic help."

Future automobile design rests entirely with the consumers' ideas, says W. B. Stout, of Stout Research Division, Consolidated-Vultee Aircraft Corporation. He expresses the opinion that the future car must serve the public's urge to travel, declaring. "The most startling post-war car will have wings."

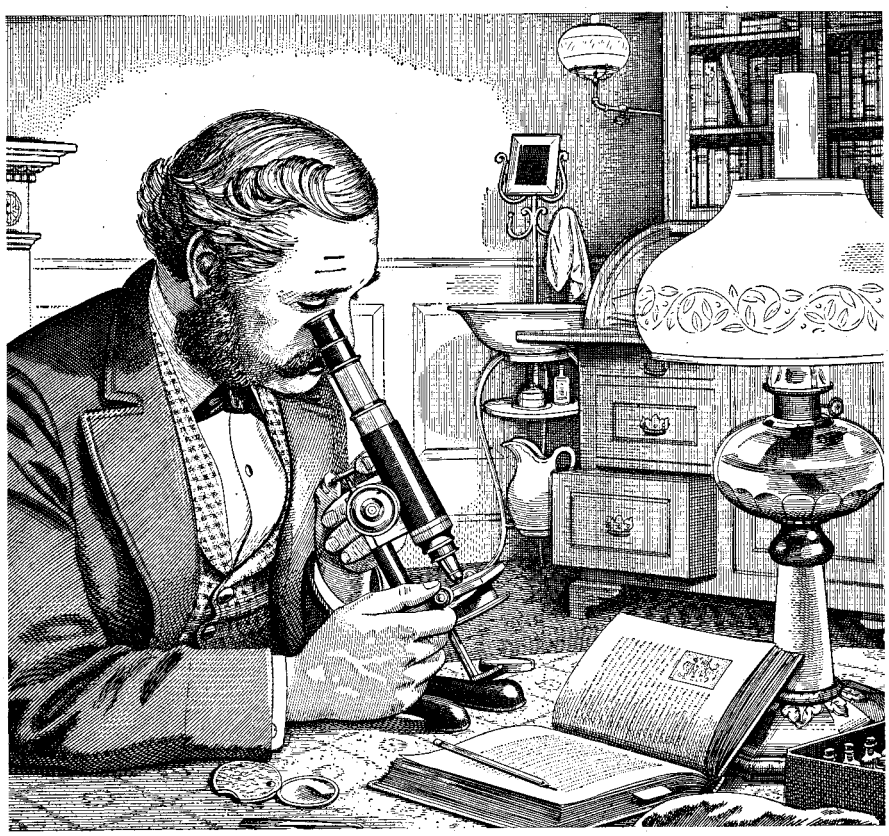
Insisting that production practicalities largely will discount the unrealities of post-war dream products, Mr. Stevens deflates proposals for radically-styled, all plastic, rear-engine, post-war cars. He says that the public likes to look at such vehicles, but won't buy them, and predicts that the first post-war cars will be revised 1942 models, available possibly six months after peace begins.

In the subsequent period of transition, suggests Mr. Stevens, designs may change. Fenders may disappear into smooth, simple, steel bodies devoid of chromium ornamentation, but transparent "goldfish bowl" bodies are out. They're too revealing, too hot, and so difficult to repair that the wife who is prone to dent fenders would be unable to get the marks erased before her husband discovers the damage.

Mr. Stevens looks for smaller, lighter cars to meet rising costs and taxes, but with increased passenger space and riding comfort. Adequate reasons for rear-mounting of engines may be found; otherwise design details probably will follow the sound 1930-1940 engineering trend.

The modern automobile, while satisfactory for city driving, is too slow for the open road, asserts Mr. Stout, who sees the needs of the post-war American for either a "roadable airplane" or a "flyable automobile."

"It is my belief," he says "that the first step will not be so much a roadable airplane as a flyable automobile. First, it must be a good city automobile that the purchaser can buy and use four or five days a week driving back and



The Microscope That Changed the Course of Science

Here you see one of the earliest Bausch & Lomb microscopes.

This was the first microscope produced by quantity production methods . . . the first precision compound microscope to be made at a price which the average research worker, educator or medical man could afford. These microscopes made research and study possible in America on an unprecedented scale.

Prior to this development of the mass production of precision optical instruments by Edward Bausch in 1876, the use of the microscope was restricted by high cost. Today the microscope is a familiar laboratory instrument in nearly every field of scientific endeavor.

With this rich background of experience, Bausch & Lomb makes the most complete line of optical instruments built by anybody anywhere, setting the pace in pioneering optical research, development and manufacture.

This is the experience that can be applied to the solution of your optical problems whether through a standard Bausch & Lomb instrument for research or control, or a completely new optical development for your specific needs.

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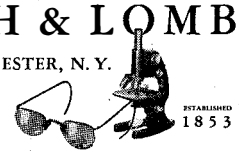


Makers of Optical Glass and a Complete Line of Optical Instruments for Military Use, Education, Research, Industry and Eyesight Correction and Conservation

forth to work, but on the week-ends, or vacation, one which he can drive to the airport, put on his wings, and go 1000 miles. Once on the ground again, he must have a good automobile with regulation motor-car transmission, brakes, tires, and so on, such as fit road problems."

Wartime manufacturing developments are said by Mr. Stout to make it possible for many firms, contemplating diversified post-war products, to enter the automobile field. He declares that the flexible operations of the aircraft industry are particularly adapted to this purpose, and they can produce new models every few weeks until the public is satisfied.

SYNTHETIC PACKING

Resists Strong Acids and Alkalies

Now being used as packing material in pipe lines carrying the hydrofluoric acid used in the manufacture of high-octane gasoline, "Vinyon" is ideally suited for the purpose, according to the American Viscose Corporation. It has the ability to resist strong acids and alkalies, such as sulfuric, nitric, and hydrofluoric acids, aqua regia, caustic soda, and potash.

YARN TWIST

Setting Expedited by Electronic Heating

All rayon tire cord manufactured by Industrial Rayon Corporation is subjected to electronic heating in a new process invented by the company's technical staff to solve problems in the twist-setting of textile yarns.

The twist of the rayon tire cord is set by placing packages of the cord in a high frequency electrical field. Heat generated in the cord by this operation is distributed so uniformly that cones containing 18 pounds or more of rayon tire cord may be effectively treated. Such giant cones are used in the weftless method of tire construction.

The process is completed in a matter of minutes and results in the production of a cord in which the twist is uniformly set. Control of the moisture content of the cord may be facilitated by wrapping the cones of cord in moistureproof paper and processing them in this form.

The equipment originally installed for this process has been in operation at one plant for more than eight months and includes high frequency power generating units having outputs of approximately 22,500 Btu per hour each. They were furnished by the Girdler Corporation, through its Thermex Division, and each unit is capable of handling several thousand pounds of packaged tire cord in a 24-hour period.

THERMAL SHORT CIRCUITS

Are Important to Industrial Desginers

When you "blow a fuse," the lights go out. When you break the handle of your coffee pot and try using it without adequate thermal insulation, you burn your fingers. There is an important analogy between these two phenomena, according to a paper entitled "The Influence of Through Metal on the Heat Loss from Insulated Walls," by Victor Paschkis and M. P. Heisler, delivered at a session of the American Society of Mechanical Engineers.

"Everybody knows, by experience, 'short circuits' in electric systems," the authors declared. "They occur when the 'hot wire' part of a circuit is connected, through a low resistance, to some metallic body like a house plumbing fixture. In the realm of heat flow quite similar phenomena occur.

"While electric 'short circuits' have been studied extensively, 'thermal, or heat, short circuits' have been more or less neglected, probably because of the difficulties of an exact analysis. These difficulties have been largely overcome by the recently developed 'Electric Analogy Method.'

"This method," the authors continued, "underlies the work of the heat and mass flow analyzer laboratory in the Mechanical Engineering Department at Columbia. Extensive experiments have been carried out on the heat and mass flow analyzer which have resulted in better knowledge of 'thermal short circuits.' This analyzer, along with so many other devices, has been named an 'electrical brain.'

"There are innumerable cases in industry where 'thermal short circuits' occur—ships hulls, metal encased refrigerators, domestic and industrial furnaces and ovens, both electric and fuel-fired, strato chambers, and brick-mortar structures. Nearly all insulated structures involving the use of materials of widely different thermal conductivities suffer from it."

The authors explained the application of their research to one industrially important "thermal short circuit." While the research is incomplete, the paper said, the work already carried on has been of value to the individual industrial concern, in that it gives the designer the possibility of calculating the effects of heat loss. Further experiments are planned, extending to other design patterns.

GASOLINE INJECTION

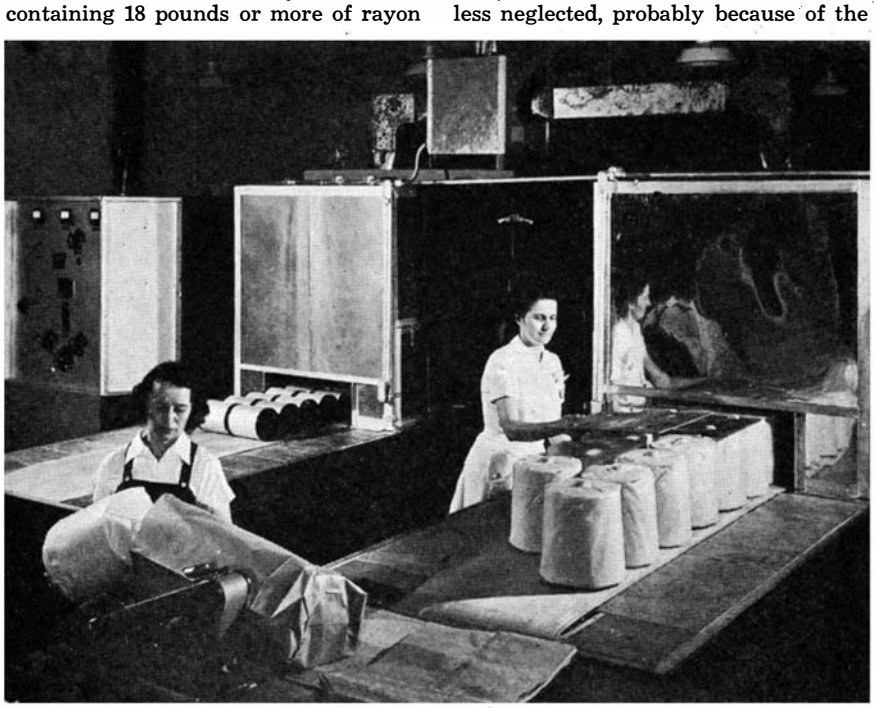
Reported to be Perfected

Engineers for years have sought for a practical method of gasoline injection for supplying fuel to the cylinders of gasoline engines. Such a method has now been perfected and is in production, according to Donald P. Hess, President of American Bosch Corporation.

Higher efficiency, even with lower-grade gasoline, greater responsiveness, smoother power delivery, and elimination of the fire hazard of an explosive mixture of gasoline and air in the induction system, are some of the advantages for the new fuel distribution system, which replaces the conventional carburetor.

"The gasoline, by this system, is delivered uniformly to every cylinder of the engine. The result is that all cylinders pull together in harmony, producing a smoother flow of power and quieter engine operation than has ever been possible with any other method," Mr. Hess states.

"The engine equipped with gasoline injection responds instantly to the touch of the throttle. Time lag is eliminated, acceleration is smoother, and the engine performs more surely under all conditions. The safety factor is important in wartime, and will be equally so when applied to busses, trucks, and other types of public carriers in the post-war world," Mr. Hess adds. "Backfires are eliminated by this method, because the fuel, either in fuel or vaporized form, is confined within the engine cylinders. The air induction



Twist of rayon tire cord, in 18 pound cones, is set in electronic heater at right

system carries air only, which is not mixed with the fuel until it reaches the cylinders. By the use of this system, all fuels, even lower grades, burn more completely and efficiently. Thus, a greater proportion of their potential power is delivered in the form of useful energy. Mileage per gallon increases, cost per mile decreases."

Gasoline injection is a method of fuel delivery adapted from the Diesel engine, in which fuel is delivered to the cylinders in much the same way. Military uses of gasoline injection are shrouded in secrecy, but they are said to be many and varied.

WATER PIPE

Gives Long Service

When Rubber Lined

RUBBER lined pipe has shown its value in coal-mining operations in certain territories, according to a report just received by The B. F. Goodrich Company.

In one of the West Virginia mines, a pipe line which carried water out of the mine had to be repaired or replaced every five or six months because the water picked up sulfur and this created an acid which corroded and ruined the pipe.

Several sections of this pipe line were replaced by rubber lined pipe; this has now been in service five years and is still in excellent condition, the report says.

PEACE THROUGH SCIENCE

Possible Only if Technologists

Assume Responsibility

LASTING peace through science was envisioned by Walter J. Murphy, editor of *Industrial and Engineering Chemistry*, in an address recently delivered before the University of Michigan Section of the American Chemical Society.

Scientists and technologists, by bringing abundance to all peoples, can overcome the predatory forces which, exploiting economic unrest, foment wars. They must participate in the making of a peace to end "the unholy wedlock of science and the base instincts of man, a tragic and unhappy union from which has stemmed most of the misery of mankind," Mr. Murphy declared.

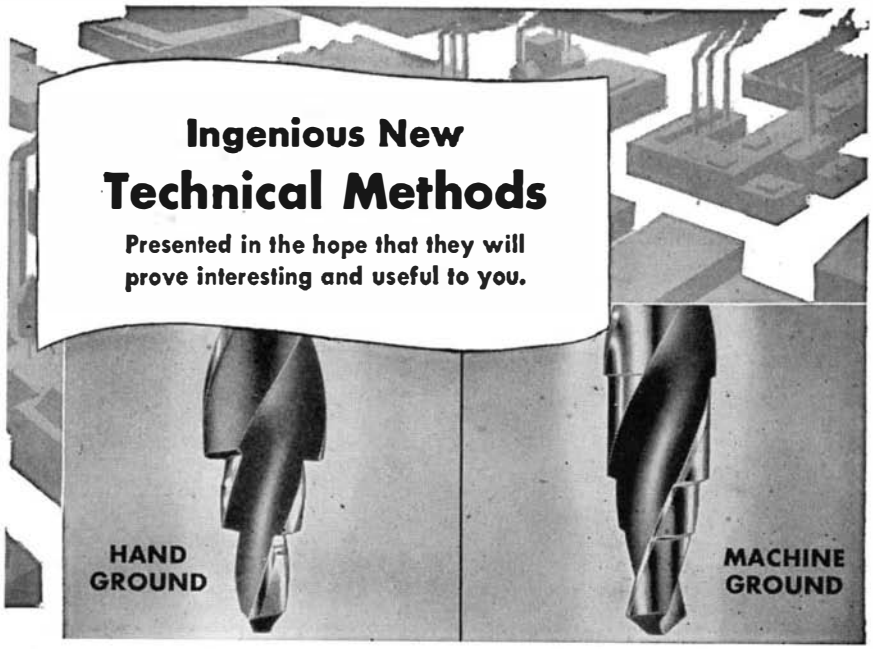
Science and technology alone can bridge the gap between the "have" and "have-not" nations, said Mr. Murphy. Failure to employ a scientific approach in writing the peace which followed World War I made inevitable the global conflict now in progress, according to Mr. Murphy, who asserted that war can be prevented only by the technologists of the world working in unison.

"For centuries discoveries of scientists have been basely prostituted by politicians and dictators bent on personal glory and national aggrandizement," continued Mr. Murphy, whose subject was "The Chemist's Responsibility in War and Peace." "For hundreds of years Napoleons and Hitlers have seized upon the work of the technologists in the hope of conquering their fellowman and subjecting him to abject slavery. Scientists have failed to control the fruits of their discoveries for the betterment of mankind through failure actively to assert their proper rights.

"To obtain the opportunity, however, of applying the scientific approach to writing the kind of peace that should follow World War II we must first destroy the evil forces now loosed upon the world. Without the American chemical industry as we know it today the task would be hopeless. The contributions of the chemist, the chemical engineer, and the chemical industry to the winning of World War II constitute one of the most dramatic stories of all time.

"When details can be told of the programs for synthetic rubber, 100-octane gasoline, toluene, alcohol, light metals and alloys, plastics, and a thousand and one other essentials of moddern all-out-war, the American populace will appreciate that the men of science, quietly working in their laboratories without spectacular fanfare, have contributed tremendously to the saving of mankind and to the prevention of a return to the Dark Ages.

"In attempting to take practical steps toward refuting the impression that technologists are all 'shrinking violets' and that scientists cannot take a more active role in controlling the uses of technological advances, reserving them for the betterment rather than the destruction of mankind, we must make a determined effort to refute the generally-held belief that to



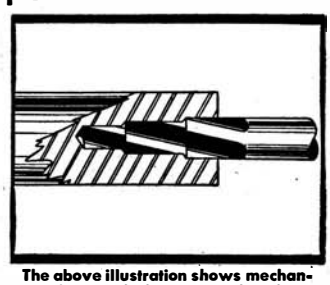
New Precision Step Drill Grinder Simplifies Production and Maintenance of Step Drills

The quality of a step drill produced by common methods depends almost entirely on the skill and attention of the individual tool maker. However, with the development of the precision step drill grinder, the human element has been entirely eliminated, the characteristics of the step being completely controlled by the grinding machine without adjustments during the course of grinding. This automatic feature insures absolute uniformity, regardless of quantity, and permits large-volume production of step drills.

The apparent advantages gained through the use of the step drill grinder are: Permits mass production of drills ground to exact specifications, entirely independent of the human element. Maintenance, too, is no longer an obstacle as step drills produced by this method are quickly sharpened by the same uniform machine-controlled operation. With the step drill grinder step drills can now be made from standard drills. These advantages result in a wider application of step drills which provide a definite saving of machine tools, man-hours and cost; this in turn results in greater production.

You know there are plenty of benefits in chewing gum, too. That's why all of the Wrigley's Spearmint we're able to make from our available stocks is going overseas to our fighting men and women. You know what a lift it's been on the job and we wish we could supply everybody, because we have pride, too, in our workmanship and productivity. But there just aren't enough available top quality raw materials right now to do it. When we can produce it in sufficient quantity, it will be back to you with the same fine flavor and chewing satisfaction ...Wrigley's Spearmint has never been changed!

You can get complete information from Spiral Mfg. Corp., 5022 North Kedzie Avenue, Chicago 25, Ill.



The above illustration shows mechanical design which requires a hole having diameters diminishing in steps. This is an operation for step drills which has often been neglected due to difficulty in obtaining and maintaining step drills.

Step drills produced by our method are quickly sharpened by the same uniform, machine-controlled method.

Y-125

be a highly successful scientist an individual must be an extreme introvert.

"The technologist must and will assume a much more important place than he has heretofore asked for or enjoyed, and when he has the courage to assume these greater responsibilities he will make it possible for the people of the earth to live constructively, sharing the abundance which science and engineering skill have developed. To do otherwise means physical, social, cultural, and moral bankruptcy for millions of human beings now alive and countless generations yet to come."

POWER BRUSHING

Reclaims Auto Parts Quickly and Efficiently

THE APPLICATION of power brushing to the salvage of parts from wrecked or otherwise junked automotive vehicles for re-use in service for which new parts are unavailable due to lack of production during war time has been largely responsible for keeping many

A wire brush reclaims auto parts

passenger cars, trucks, and busses in operation which, otherwise, would have been out of service. It is reported that this parts salvage activity is carried on by leading garages throughout the country in order to maintain some semblance of replacement parts inventory.

As used in automotive parts reclamation, power brushing does in two or three minutes the work of removing rust, grease, scale, and dirt that would take 15 to 20 minutes by the former hand method.

The parts to be cleaned are simply gone over with a power-driven brush, spinning at 3600 revolutions a minute. In addition to doing the job eight to ten times faster than other methods, power brushing provides the further benefit of removing burrs, nicks, and so on. In this respect it can be said that certain parts are even better after power brushing than when new.

The equipment used for the work consists of either a portable hand tool, electric or compressed air operated, or standard polishing jack in which is mounted a wire brushing wheel. Held so that the wire ends contact the surface to be cleaned, the spinning wheel makes short work of grease, scale, and rust removal, according to The Osborn Manufacturing Company, producers of power brushes.

ALCOHOL FROM WOOD

Is Good Insurance Against Grain Crop Shortage

A POSSIBLE non-grain source of alcohol to the extent of one hundred to one hundred fifty million gallons per year for essential uses such as synthetic rubber production is predicted by Professor Donald B. Keyes, University of Illinois chemical engineer on war-time leave as Chief of the Chemical Industries Branch of the Office of Production Research and Development.

This additional amount of alcohol, obtainable as a direct product of wood, might be needed in case of a severe drought and a grain shortage this summer, since the principal source of alcohol today is grain. To acquire the necessary "know how," Dr. Keyes points out that the War Production Board has approved the construction of a full scale commercial plant based on processes already developed by his organization and the Department of Agriculture's Forest Products Laboratory. It will serve as an "insurance plant."

"It is recognized that this particular plant will not be a peace-time success until the lignin by-product can be sold at a profit," Dr. Keyes says. "Once the plant has been built and operated, lignin will be available in quantities for further experimentation and the results of study and development may make the whole process profitable in peacetime.

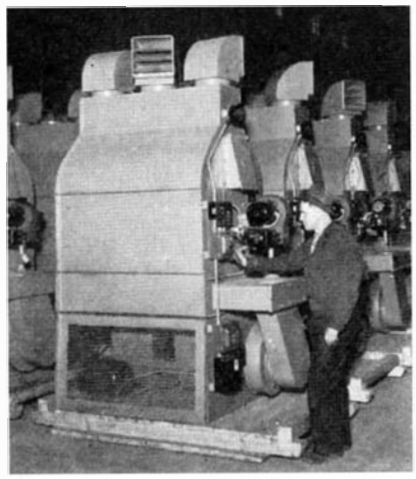
"Even if further development of plants is not justified, this one plant will be worth while by giving us the necessary know-how to build duplicate commercial plants without delay," he states. "This will mean that from an insurance standpoint we shall be well protected in any future emergency so far as alcohol from non-grain sources is concerned."

UNIT HEATERS

Designed to Burn Either Gas or Oil

TO MEET the problem of heating small structures and providing additional heat for limited areas, a direct fired heater with capacities ranging from 300,000 to 850,000 Btu output per hour has been developed.

This new model is one which the Dravo Corporation is supplying to the armed forces to heat steel service igloos at advanced bases. It retains the principal characteristics of the regular line of Dravo Direct Fired Heaters but on a scale in keeping with the smaller Btu output, Over-all size has been reduced in proportion, so that floor space requirements are now just 5¼ by 3 feet. It can also be suspended from the wall where floor space is not available. This model can be equipped to burn either gas or oil. Oil burners may be quickly removed and gas burners and controls substituted as conditions direct. The heater is thermostatically controlled and requires a minimum of manual attention. A small unit of this size can be used to complement present heating systems to provide additional warm air in remote parts of factories and other buildings.



Unit heaters ready for delivery

COPPER ACCELERATORS

Speed Vulcanization of Synthetic Rubber

COPPER, long avoided by the natural rubber industry, was disclosed as a new and powerful agent in the production of synthetic rubber, at a recent meeting of the Division of Rubber Chemistry of the American Chemical Society.

This discovery, reported by Dr. A. A. Somerville, vice president of the R. T. Vanderbilt Company, will, it is believed, increase the output and improve the quality of synthetic rubber. Two new vulcanization accelerators for synthetic rubber, both chemical compounds of copper, were announced in a paper on "A GR-S Vulcanization Catalyst," by Dr. Somerville.

"These two accelerators, known as 'Cumate' and 'Cuprax,' are several times as powerful as the conventional type now in use in the rubber industry; and we believe that this greater activity is due to the fact that they are compounds of copper," Dr. Somerville declared.

"We hope that our discovery of the use of certain copper compounds will help the rubber goods manufacturers to increase output by increasing mold turnover, and possibly also to improve the quality of synthetic rubber products. We have some reason to believe that the quality of products may be improved because one of the effects of adding copper is that less heat is built up in a Buna S compound under dynamic testing conditions."

"Why copper speeds vulcanization is still a mystery," Dr. Somerville said, in explaining the new development. "If you add a very small proportion of ordinary 300 mesh copper powder to properly compounded Buna S, the big tonnage synthetic rubber, and vul-

canize the mix in a mold in a laboratory press under standard conditions, you will find that this addition of copper has shortened the time of vulcanization to less than one half the normal time," Dr. Somerville said.

"The word 'copper' has been a 'hush-hush' word in the rubber industry until now because this metal and certain of its compounds act as catalysts of the oxidation of natural rubber, thereby greatly accelerating the rate of deterioration or perishing of natural rubber due to aging. The use of copper in any form in natural rubber has therefore been carefully avoided, or if the presence of copper in natural rubber compounds was suspected copper antidotes have been deliberately added.

"In Buna S, however, all this is apparently quite different. In Buna S, copper acts as a catalyst of vulcanization, not as a catalyst of oxidation. Buna S does not oxidize nearly so readily as natural rubber, and the presence of copper does not spoil the aging properties of Buna S. On the contrary, the aging properties of Buna S compounds, accelerated with the new chemical compounds of copper 'Cumate' and 'Cuprax,' are actually better than when conventional accelerators are used exclusively.

CORROSION RESISTANCE

Said Due to Vacant Electron Spaces in Atoms

VACANT spaces in the atoms of nickel are responsible for its resistance to corrosion or "rusting," according to Dr. Herbert H. Uhlig, Metallurgist of the General Electric Research Laboratory. In earlier researches, Dr. Uhlig found that the stainlessness of stainless steel is not due primarily to the formation on the surface of a film of oxide, as formerly supposed. Instead, it results from the electronic arrangement in the atoms of the alloy. Now he finds that the same thing is true for two other widely used corrosion-resistant alloys. One is copper and nickel (Monel) and the other molybdenum, nickel, and iron (Hastelloy).

An atom may be thought of as a nucleus around which revolve, somewhat in the manner of planets around the sun, from one to 92 electrons. These move in from one to seven different orbits or shells. Ordinarily one shell is filled with electrons before the next one begins, though in the case of certain "transition" elements there are vacancies in the shell next to the outer one. In nickel, for example, there are only eight electrons in the third shell, instead of the 10 it could hold, despite the fact that there are two electrons in the fourth and outermost shell. With inner shells completely filled, a metal is more subject to corrosion.

Because of the vacancies nickel is very resistant to corrosion, but it is too expensive for many applications, and so it is alloyed with copper which is lower in cost. The atom of copper has one more electron than that of nickel. In the alloy these extra electrons go to fill the vacancies in the nickel atom. However, as long as any vacancies remain in the nickel the alloy still resists corrosion as well as pure nickel.

Finally, when the proportion of 60 percent copper and 40 percent nickel is reached, all the nickel vacancies have been filled. Further increasing the proportion of copper makes the alloy less resistant until pure copper is reached, which corrodes much more readily than pure nickel. In the alloy of nickel with molybdenum and iron a similar effect occurs, says Dr. Uhlig.

FERRETS AT WORK

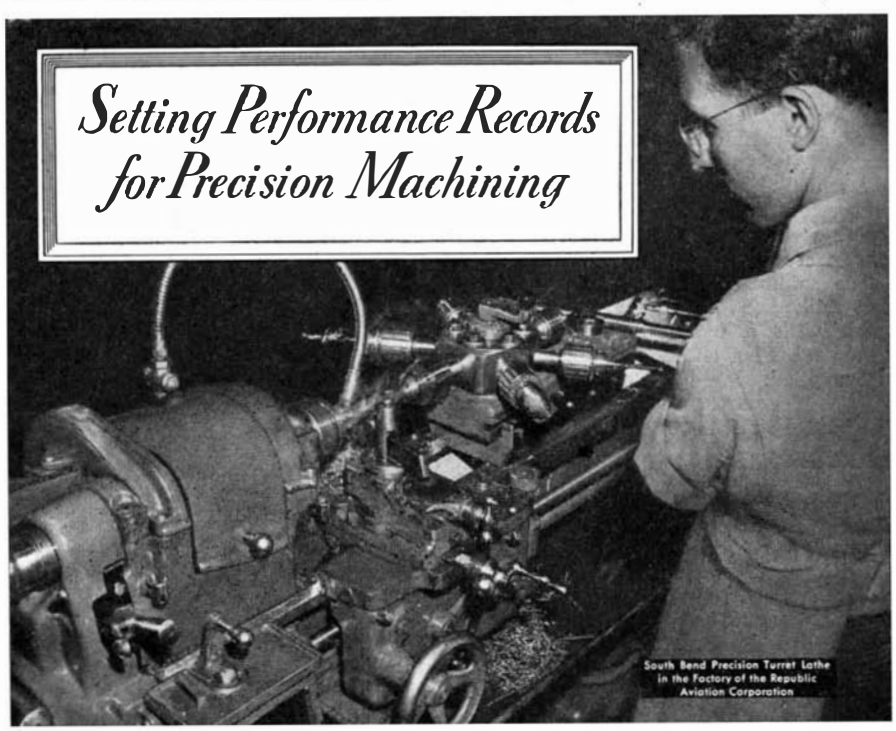
Hold Down Sabotage By Rats and Mice

SABOTAGE is an all-inclusive term which runs the entire gamut of willful acts to destroy property or slow up production in war time. Successful defense against sabotage requires the co-operation of the general public as well as the law-enforcement agencies, and it even drafts into service many furred and feathered creatures. Animals in particular have had quite a part in safeguarding various phases of war production.

An unusual application of animals in war plants may be cited in the use of ferrets to kill off vast hordes of destructive rats and mice. The bill against such vermin each year is a big one. Rodents eat through wood, paper, textiles, and similar materials to ruin valuable products, not to mention the diseases they may carry to working crews, necessitating the loss of many man-hours a year. In the war against these unhealthy saboteurs, the rabbit hunter's bosom companion of bygone days—the ferret—is the number one police officer and detective. Sherlock the ferret tracks 'em down in their own lair.

An example of the importance of ferrets in industry today is found at one of The White Motor Company plants, where a posse of five ferrets has taken up the rat trail nightly for several months. The score against the rodents has amounted to some 40 to 50 dead rats a week. This is an average.

Setting Performance Records for Precision Machining



South Bend Precision Turret Lathe in the Factory of the Republic Aviation Corporation

High precision and close tolerances have always been the watchwords of the aviation industry. But with the war came demands for higher speeds and better performance. This meant that even closer tolerances had to be established and maintained. We are proud that providing lathes to meet the exacting needs of warplane production is one of our important assignments. Throughout the aviation industry South Bend Lathes are setting enviable performance records for precision machining.

In all metal working industries, South Bend Lathes are giving the same dependable service that they are giving in the aviation industry. Versatile and efficient, they are also used for emergency service work in the Armed Services.

Now, as before Pearl Harbor, our entire factory is devoted only to the production of South Bend Lathes. There has been no lowering of standards because of wartime restrictions and shortages. The use of substitute materials is negligible, limited to non-essential parts. Improvements have been accelerated. Today, South Bend Lathes are better in every way.

South Bend Engine Lathes and Toolroom Lathes are made in five sizes: 9", 10", 13", 14½", and 16" swing. Precision Turret Lathes are available in two sizes. Write for Catalog 100-C.

POST-WAR PRIORITY PLAN

To those who cannot qualify for a wartime priority, South Bend Lathe Works offers a practical Post-War Priority Plan. You can place your order now for any South Bend Lathe. No deposit or down payment is required. We ask only that the order be placed in good faith. When civilian production is resumed, orders will be filled in the sequence established by the numbers of the Post-War Priority Certificates. Should conditions necessitate, the order may be cancelled at any time. Write for details of this plan.

BUY WAR BONDS NOW...SAVE FOR LATHES

SOUTH BEND LATHE WORKS

LATHE BUILDERS FOR 37 YEARS • SOUTH BEND 22, INDIANA

Bathing an industrial ferret. Inset: Susie, one of White's rat catchers

Naturally the toll showed a favorable decrease as the ferrets secured their beachhead and gained control of the situation. But the job goes on because outside rodents can move in with crated shipments which arrive daily.

The ferrets are kept in special cages during the day, and at night they are released to go their way in quest of rats which they follow through partitions, under floors, and into shipping crates. Always they return to their cages in the morning. When they were first released, signs were put up informing workmen that the furry creatures were on special rat mission.

The animals are fed a diet of bread and milk and given a bath twice a week with a mercury solution and castor oil. Flea and louse powder are also applied.

GAS TURBINE FUTURE

Holds Possibilities in Ships, Locomotives, and Planes

THE GAS turbine, old in principle but not deemed practical as a prime mover until recently, now offers attractive post-war possibilities for hauling of railroad trains, propelling ships, and driving airplanes, according to J. Kenneth Salisbury, General Electric turbine engineer. However, he points out that it is improbable the gas turbine will replace large steam turbines in central stations.

"The large volume of air required by the gas turbine tends to limit its size at present," Mr. Salisbury says. "The gas turbine is not considered to be a competitor of the large, efficient steam plant, but rather as a reliable simple prime mover of intermediate capacity."

In discussing possible applications of the gas turbine, Salisbury states that General Electric has recognized its particular adaptability for use in locomotives and has made rather extensive studies of a 4500-horsepower locomotive powered by a single gas-turbine unit, with a regenerator and waste heat boiler.

"The thermal efficiency of this locomotive, its ease of assembly, accessibility, lightness of weight, and smooth flow of power, all indicate that it is an attractive application," he says.

Discussing aircraft application, Salisbury says that the experience of the present war has indicated that the future range of size required for aircraft engines may be from 2000 to 8000 horsepower.

"The light weight internal-combustion engine seems to be approaching a rather definite limit in rating," he states. "The gas turbine, on the other hand, just comes into its own in the sizes at which the gasoline engine seems to be approaching a limit. Furthermore, it does not require expensive high-octane fuel for its operation. It is quite apparent that one potential gas turbine application is in the post-war cargo and transport plane field.

"What new uses will develop as time goes on depends only on the ingenuity of application engineers, together with the zeal and courage employed by the developmental engineers in perfecting this attractive prime mover," he concludes.

SYNTHETIC TIRES

Now Giving Satisfactory Wear on Passenger Cars

OF INTEREST to civilian passenger car drivers, concerned over the possibility that they might not be able to obtain new tires when their present tires wear out, is the announcement that Goodyear has already produced its 1,500,000th 6.00 by 16 GR-S synthetic rubber passenger tire—the popular size used on Fords, Chevrolets, Plymouths, and Dodges.

Satisfactory performance of these tires is shown, Goodyear officials say, in the result of a recent survey among users of more than 8000 of the tires. These users reported them to be 96 percent as satisfactory as natural rubber passenger tires.

While the milling of synthetic rubber takes longer and presents more problems than does natural rubber, other tire production operations take no more time. Dealers report a lower percentage of adjustments on GR-S passenger tires than on natural rubber tires, with many dealers asserting that the synthetic rubber passenger tires are of better quality than second and third line pre-war tires made of natural rubber.

Good news for passenger car drivers

Operators of a large fleet of taxicabs in a midwestern city, who use more than 3000 GR-S tires on their cabs, reported that the tires averaged 30,000 miles before recapping was necessary. This approximate mileage figure has also been reported in other parts of the country.

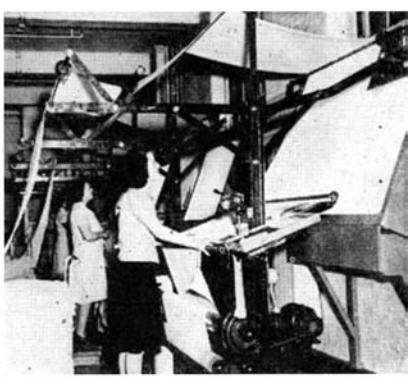
FLUORESCENT INSPECTION

Speeds Textile Output, Can Be Used Elsewhere

DEVELOPED for inspecting fabrics in textile mills but potentially useful in similar inspection of other translucent materials, a new fluorescent lighting device has been originated by Sylvania Electric Products Inc.

Catalogued as the "T-1 Sylvania Inspection Fixture," the device replaces former inspection methods which were unsatisfactory. The initial user, the Verney Mills, reported greatly improved quality control. It was also reported that each operator's daily output was increased by 1000 yards, or from 20 to 25 percent.

The unit consists of a box four feet long, three feet wide, and one foot deep,



Faster, better textile inspection

containing eight 40-watt fluorescent lamps. The face of the box is a large sheet of opal glass, which diffuses the light so completely that it is not possible to tell how many lamps are beneath it. Alternate lamps may be extinguished to reduce the brightness, without causing any noticeable shadows on the glass.

Lamps and ballasts are mounted on the back of the box, easily removable for servicing. Installation is a simple matter of mounting the fixture where wanted and plugging the extension cord into a current outlet.

Standing in the "perch"—the textile industry machine for unrolling a bolt of cloth for inspection—the operator views the fabric as it passes over the "T-1" and he marks the cloth where defects are seen.

The fluorescent device is used for inspecting various types of cloth "in the gray," or before bleaching, dyeing, or printing. It displaces the two former inspection methods—viewing the cloth stretched across the face of a window

opening on the north for the sake of the relatively even "north light," and across a horizontal, flat bed using incandescent lamps.

The "window" type of inspection is unsatisfactory because the quantity and quality of natural light varies during the hours of a day, and even more because of weather and the changing seasons. It also is a bottleneck in war production because 'round-the-clock inspection is impossible.

The incandescent lamp apparatus increased the fatigue factor for employes because of heat and glare conditions, and where flat-bed tables were used, operators complained of cramped and stiffened muscles. The new device is easily set up in a slanting position.

MAGNETIC FLOW THEORY

Refuted on Basis of Experimental Evidence

THE RECENTLY revised theory of magnetic current—which if true would revolutionize century-old concepts of electricity—has been refuted by a Pittsburgh scientist who claims that rigidly controlled experiments have proved that magnetism does not flow in the same manner as electric current.

Dr. Jacob E. Goldman, of the Westinghouse Research Laboratories, speaking before the American Physical Society, said that the experiments—conducted along the exact lines of those of Professor Felix Ehrenhaft, Viennese physicist and leading proponent of magnetic current—had produced conclusive negative results. The age-old theory, held by nearly all scientists, is that magnetism has force and power, but no movement—unlike electric current in which electrons flow along a copper wire. Professor Ehrenhaft's theory that magnetic current can be generated by a permanent magnet, if proved correct, would mean the establishment of an entirely new source of power and would necessitate a complete revamping of currently held theories in physics.

A RESPECTABLE WEED

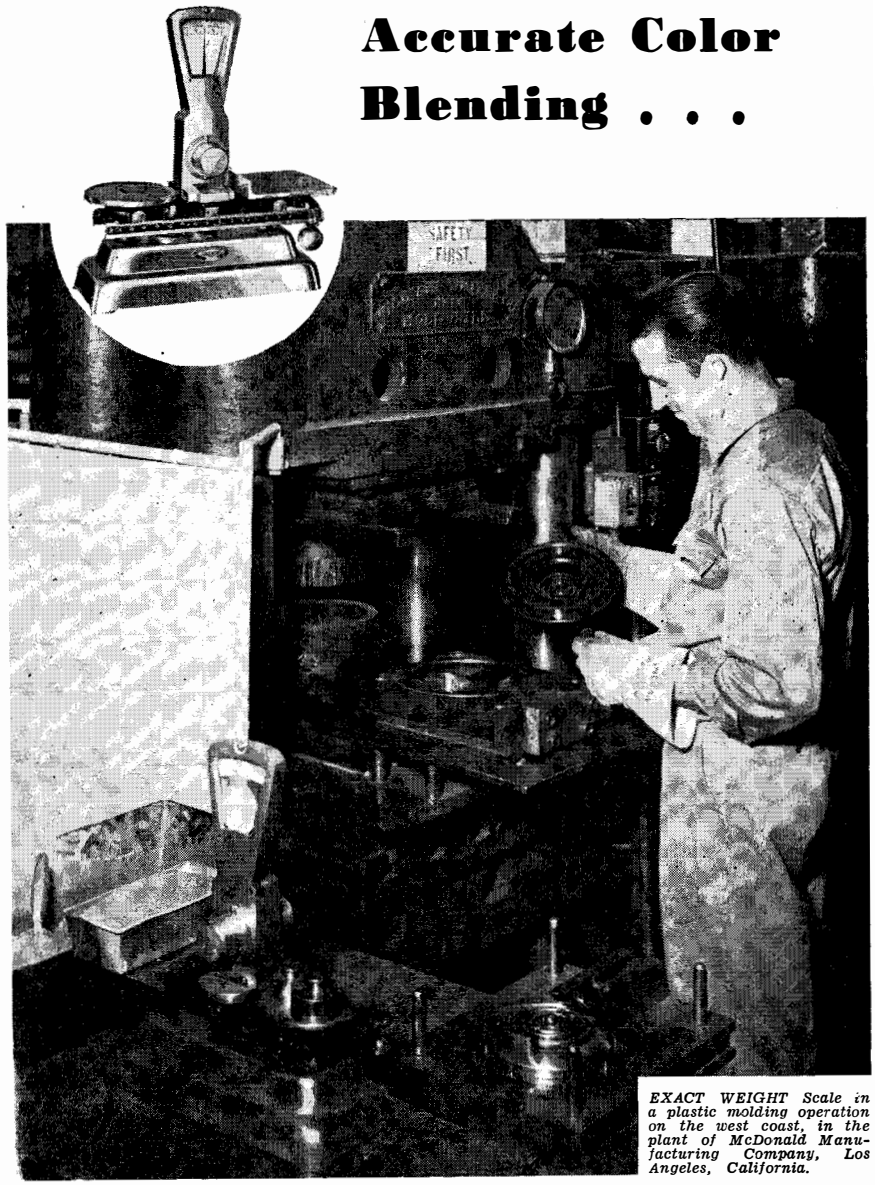
Is Being Used to Anchor Embankments

QUACK grass (*Agropyron repens*) is one of those weeds which get thicker and thicker and thicker as time goes by and become too coarse for a lawn Once it gains a foothold, quack grass is not easily discouraged since it has an underground root system like a telephone cable. Every time a root is cut, a new succession of shoots are given an excuse to put in their appearance.

Thus far, quack grass has been put to at least two practical uses. In the northwest it has been assigned to the task of holding railroad embankments along the Columbia River and it has been used for airfield turf. It has been found to thrive in sections extending from North Carolina, Arkansas, and New Mexico, north to Newfoundland and Alaska.

Quack grass is hardly in a position to be chosen for agricultural preferment

for Plastic Molding Operations— Accurate Color Blending . . .



EXACT WEIGHT Scale in a plastic molding operation on the west coast, in the plant of McDonald Manufacturing Company, Los Angeles, California.

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but it may have a future in areas where a tenacious turf is required and where dust must be kept down. For airfields, army camps, athletic fields, banks of streams to prevent erosion, and steep, uncultivatable hillsides in general, it might be the dark horse.

SAND "JEEP"

Developed for Use by Coast Guard

A SAND-AND-SWAMP version of the "Jeep," which can carry eight men over soft beaches at 50 miles an hour, has been developed for Coast Guard patrol

A beach-going version of the Jeep

duty and personnel carrying in areas where the terrain is predominantly loose and sticky. The newest offspring of the Jeep, it is explained by Ward M. Canaday, president, Willys-Overland Motors, features a lower gear ratio than the standard model; this gives it greater efficiency on beaches and in swampland.

The sand Jeep is 12 inches longer than its parent vehicle and has two inches more clearance. It utilizes special jumbo-balloon tires which act as "snow shoes" on soft surfaces. The new vehicle is equipped with a rotary hoisting device which enables the scout car to extricate itself or other vehicles from stubborn mud and sand. The apparatus has a minimum hauling power of 2000 pounds when mounted on the front end of the Jeep, operating from its 63-horsepower engine.

The sand Jeep, which carries two men in the front seat and six in the rear, can lighten considerably the work of the Coast Guard in guarding long stretches of soft beaches, since it is virtually a rolling patrol station.

ASPHALT IN PACKAGES

Gives Advantages of Waterproofness and Adhesiveness

ASPHALT is commonly thought of only as a paving material, but actually it has many other invaluable uses, one of the most important of which is as a waterproofing and sealing agent in new types of packaging developed during the war.

The war has greatly intensified the demand for asphalt-laminated papers used in the walls of solid fiber containers for military and lend-lease items; as an outside lamination for waterproofness of paper containers for motor oil, paints, printing inks, and so on; for waterproof flexible films combined of kraft, metal foil, cellulose acetate, cellophane, and the like; and for treatment of sealing tapes. Asphalt gives waterproofing comparable to that wax at about one tenth the cost and, in addition, is highly adhesive. One of its commonest current uses is in the thin laminated paper which has replaced metal foil as the protective inner wrapper in cigarette packages.

The study of asphalt for packaging has become one of the major research projects of the year, and new uses constantly are being found.—*Modern Packaging.*

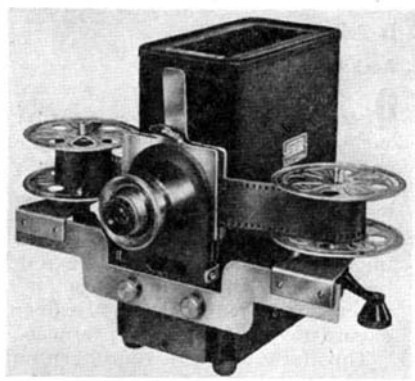
MICROFILM READER-PROJECTOR

Now Available in Compact, Portable Form

A PORTABLE microfilm reader-enlarger, weighing only 8½ pounds, has been released to industry and is now available.

In contrast to the usual library-type microfilm reading machines, this device is carried in a fitted case, like a portable typewriter. It makes possible the study of microfilm records at one's desk, showing of microfilm enlargements of records, charts, blueprints, and so on, before groups, and opens up a great potential for the use of microfilm for inexpensive but effective sales presentations, engineering department drawing and specification study, employee training, and group instruction.

This reader-projector, manufactured by Federal Manufacturing Engineering Corporation, requires only three or four feet projection space and permits 24-time magnification without loss of sharpness. It is made to accommodate 35mm roll or strip microfilm. In engineering design the instrument is exceedingly simple. Two thumbscrews unfasten the steel reel winder-holder.



Portable microfilm reader-projector

Two more unlock the enameled main assembly case. Important feature of this microfilm reader is that it can be used for short length microfilm projection by unscrewing the reel holder. No special accessories are needed. Standard projection lamps up to 200 watt are used.

Chemistry In Industry

(*Continued from page* 66)

them immune both to insect and fungi destruction, a new chemical compound has been shown to increase potato crops as much as 25 to 100 bushes per acre, according to Rohm and Haas Company. The "plant inoculation" possibilities of the new synthetic, known professionally as "diethylene-sodium-bisdithiocarbamate" and familiarly as "Dithane," were

Here is what the fungus known as "late blight" can do to potato plants. Dithane will control it

discovered by accident, and later tests proved it to be fatal to both chewing and sucking insects but harmless to plants and non-toxic to man.

In recent field tests in Florida and Texas, Dithane has not only proved deadly to such fungi menaces as late blight which swept many food-producing areas of the South last spring, but also made possible potato yields running from 25 to 100 bushels more per acre than plots sprayed with conventional fungicides. Further proof of this chemical's remarkable powers is revealed by the fact that it not only acts as a repellant to certain insects—unlike such standard fungicides as Bordeaux Mixture which actually builds up aphid infestations—but actually kills them. The serum-like effect of the chemical was discovered after unsuccessful attempts to grow beetles on a plot which had been sprayed with the experimental "fungicide."

PURE CELLULOSE

Needed in Large Quantities by the Rayon Industry

THE STEADY growth of the rayon industry has created an important market for agricultural and forestry products such as cotton linters and wood pulp, both of which are used to provide pure cellulose for rayon manufacture, it is pointed out by Louise Whitney of the American Viscose Corporation.

In 1943 the rayon industry used 55,000 tons of cotton linters pulp, equivalent to 237,000 bales of raw cotton linters, and 281,000 tons of wood pulp. The use of cotton linters is increasing, Miss Whitney says, because they are used in making the high-strength rayon yarns of the type used in tire fabric.

The discovery that southern slash pine could be used to produce pure cellulose, a result of the research work done by Dr. Charles H. Herty, created a new source of income for the South, according to Miss Whitney. The rayon industry is using increasing amounts of this cellulose, and reforestation programs insure a permanent supply.

Referring to the possibility of developing special types of cotton as a source of cellulose for rayon manufacture, Miss Whitney says: "The rayon industry's need for alpha cellulose offers some interesting prospects for chemurgic development. Cotton is one of the best sources of cellulose and it has been thought possible that a cotton plant with a large concentrated boll that would be a super producer of cellulose might be developed."

INDUSTRIAL ENZYMES

Help Man to Improve Many Products

DEVELOPMENT of the wonder drug penicillin has focussed attention on a group of laboratory-cultured fungi or non-flowering plants similar to mushrooms which yield a group of mysterious and complex chemicals known as enzymes. These chemicals, whose name is derived from the Greek "en" meaning "in" and "zyme" meaning "yeast," are now performing miracles for industry similar to the ones they have wrought for medicine and their remarkable capacities suggest a host of new uses which have scarcely been tapped. Enzymes are "harvested" from the fungi and are today known to turn wood into sugar, sugar into fat, to help make buttermilk, cheese, beer, sweeter sugar syrups, clearer full-flavored wines and ciders, stronger textiles, and better leather and paper.

Normally enzymes work at the temperature of living organisms and, when used commercially, their actions can be stopped at will by raising the temperature of living organisms and, when done. At the laboratories of Rohm and Haas Company, growers of industrial enzymes, the fungi are grown to form "seed" which are "sown" on appropriate mediums under carefully controlled temperatures, and finally "harvested." The culture is then dried, ground, and the enzyme extracted for commercial use. Enzymes are soluble in water and insoluble in alcohol. Being catalytic in character, they speed-up chemical changes without themselves being consumed by the reaction.

Through the development of Pectinol enzymes, the muddy looking cider which used to appear around Halloween time has been largely replaced by a golden-colored, appetizing apple juice, free from discolorings and sediment. Other Pectinols have given permanent clarity to Concord grape juice and wines, and to blackberry, peach, and citrus juices. The enzymes leave the vitamin and mineral content of the original juice unimpaired.

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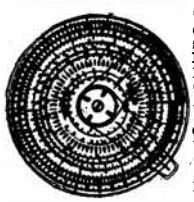

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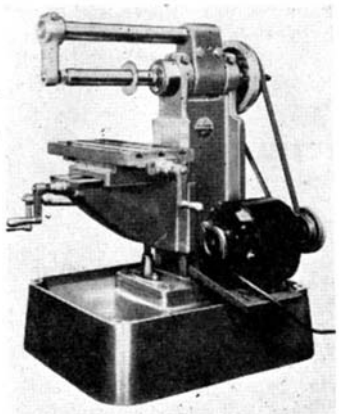
New Products

OVERARM

A REMOVABLE overarm that will greatly increase the versatility of combination, horizontal, and vertical milling machines has been developed by the Benchmaster Manufacturing Company. Consisting of three parts, this overarm makes it possible to use a regular milling machine arbor in a horizontal mill. It is readily mounted on the machine by removing



An easily attached overarm

the driving pulley from the rear of the horizontal spindle, slipping out the spindle itself by releasing two accessible screws.

A heavy semi-steel casting is mounted on the horizontal spindle which holds a precision-ground stress-proof overarm carrying the outboard support. This attachment is desirable because it is very easily attached to the machine, and at the same time creates extra rigidity and support for arbors, boring bars, and special tools.

This new attachment can be used on old as well as new machines.

WELDING CALCULATOR

DESIGNED for readily determining the welding preheating and interpass temperatures of steels in those few cases where experience indicates the need for preheating to obtain best welding results, a new calculator has been announced by The Lincoln Electric Company.

Temperature calculator for welders

This useful calculator is 6¼ inches in diameter and consists of four movable sections of heavy cardboard stock. Complete instructions in the form of six simple steps are printed on the outside sections.

Although most steels are readily weldable and require no preheating because of low carbon and alloy content, this calculator will serve as a convenient guide in instances where steels have a higher content of carbon and other alloys and require preheating to minimize the tendency toward excessive hardening and possible cracking of the base metal adjacent to the weld.

FILING TOOL

A NEW pneumatic hand tool for doing fine finish filing in shops making die casting dies, plastic molds, and airplane parts, can also be used as a portable power saw for making irregular saw cuts by substituting a hack saw blade for the usual file.

The new filing tool includes a Keller rotary air motor together with a new cam and piston utilizing a ball-bearing assembly to transfer the rotary motion of the motor to the reciprocating motion of the file. The use of a

Reciprocating tool for filing

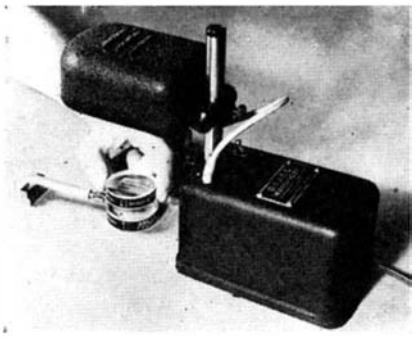
standard ball bearing set at an angle of 27 degrees with a cam angle of 25 degrees assures contact between the cam and the outer ball race, while the inner race is fixed to the piston and does not contact the cam surface. Wear on the cam and piston is thus materially reduced.

Being an air-operated tool, it runs cool even under heavy load and is therefore comfortable to handle.

This new tool is made with a free speed rating of 1500 strokes per minute and with a fixed length of file stroke of 7/16 inch.

FLATS AND MONOLIGHT

GREATER wearability and lower coefficient of expansion are reported features of the new DoAll optical flats made from fused Brazilian quartz which has a hardness of seven on the Moh scale as compared with six for optical grade glass. Six sizes are available, each flat being marked with accuracy guarantees showing variance in absolute flatness. They may be obtained with two grades of accuracy: one millionth accuracy for laboratory gage block and



Optical flats and monolight source

instrument inspection, two millionths for checking instruments and fine tools.

These optical flats, used with monochromatic light, provide industry with the greatest accuracy for making fine measurements. For a monochromatic light having large adjustable capacity as well as compactness, the same manufacturer offers the DoAll Monolight using a helium-filled tube to give yellow light of one wavelength only. The light is high in intensity which concentrates the light on a smaller area, giving greater illumination for distinguishing the light-wave unit known as the "fringe" or interference band.

PRECISION MANOMETER

A NEW mercurial manometer has a wide variety of uses, functioning equally well as a manometer, barometer, differential pressure indicator, and differential vacuum indicator. Among its advantages is the speed and ease with which observations can be made, giving it special utility in the chemical industry. In infra-red spectroscopy, it has proved superior to instruments of conventional design. It is especially well adapted to checking and calibrating aneroid instruments.

Full temperature compensation over any selected range of 30 degrees, Centigrade, is easily obtained by setting a graduated, knurled nut to the ambient temperature, thus doing away with the need for applying temperature corrections to scale readings. Another feature is a new type indicator. A thin, horizontal steel disk is mounted on top of a stainless steel float which rides on top of the mercury column. The thin edge of the disk gives hair-line indication.

Readings, accurate to the nearest tenth of a millimeter, are made possible by a built-in, focusing magnifier.

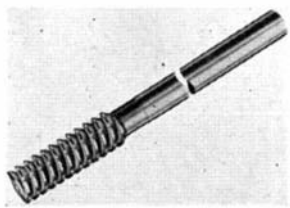
HYDRAULIC TESTERS

A NEW line of machines which test all types of production hydraulic devices and components, and which fill, filter, and check hydraulic systems, comprises various types and sizes, including stationary and portable models, driven by gasoline or electric motors.

Four types of the machines, which embody novel features, are announced by Greer Hydraulics, Inc. Model HS101 is designed for inspection and operational testing of any single or complete line of hydraulic components, and for research and development testing. Model HS100 was developed specifically for testing airplane hydraulic systems and their components. Models HS102 and HS105 are both portable, and are designed for testing airplane hydraulic systems on the final assembly line or on the field.

ROTARY BROACHES

A TOOL that is in effect a broach that rotates as it cuts, makes possible the production of perfectly round holes. The Shearmaster "Rotary Broach" removes metal by a true shearcutting knife-like action, and the chips resemble steel wool in form and texture. Because the cutting edge is in the form of a circle, there is no tendency to produce elliptical or uneven holes. These broaches, it is said, may be sharpened from five to thirty times before they wear under-size. They are being marketed with straight shanks only in sizes from ¼ to 1 inch by sixteenths, and from 1⅛ to 1½ inches by eighths.



For making perfectly round holes

Larger sizes up to six inches can be supplied on special order.

Shearmaster "Rotary Broaches" may be used in any machine to take the place of a reamer, but should always be mounted in a floating holder in order to secure the accurate holes that are produced when the tool is properly used.

LENS CLEANING

A SIMPLE system for cleaning goggles, glass faced dials, microscope and inspection lenses, and so on, in industrial plants includes hermetically sealed ampoules of Brite-Ize Concentrate, each of which when mixed with distilled water makes a gallon of lens cleaner, and "cleaning-station" dispensers.

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The only book based on the Henry System is Frederick Kuhne's.

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In this 182-page book, written by a noted finger print expert who was for many years in the Bureau of Criminal Investigation, New York Police Department, will be found complete instructions on every phase of the work from taking the prints to final identification. Numerous photographs and reproductions of prints make all details clear.

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reduction in accidents, and elimination of eye-strain and resulting fatigue.

The dispensers are of the pressure type, "charged" with air, either from any standard air line or with a small hand pump.

INTERNAL GRINDER

WHAT IS said to be the first internal grinder to utilize a combination of hydraulic operation and electric control has just been announced by Sav-Way Industries.

Outstanding features are short table stroke—5/32-inch minimum—and extremely rapid table feed and reverse which combine to give the machine almost machine-gun speed on short work.

Solenoid operated valves and aircraft type micro-limit switches provide constant control and reduce time lag to a negligible minimum.

In addition to electro-hydraulic control, the machine is also equipped for

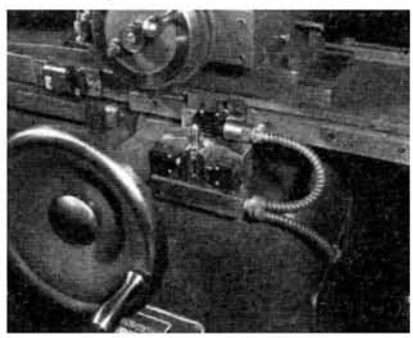


Table controls on internal grinder

hand table feed, a time-saving convenience when setting up. The hand feed is engaged by moving the hand wheel out to engage a rack and pinion. To disengage the hand feed, the hand wheel is pushed in.

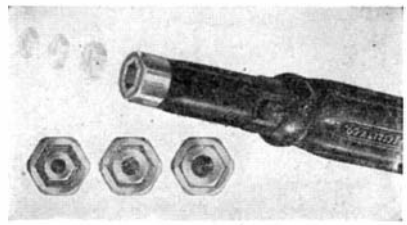
WELD TIMER-CONTACTOR

COMBINATION timer-contactor "package" units designed to provide simple, low cost, automatic, electronic control for resistance welders may be used with new machines or to convert manually or cam-timed welders for electronic control. When used with air or hydraulically operated welders, the new "package" units eliminate inter-unit wiring, simplify installation and maintenance, and permit mounting of all controls on a machine if desired.

Ignitron contactors in these Weltronic units provide high current capacity contacting at practically unlimited speeds for the most critical welder operations such as welding thin sections and aluminum or aluminum alloy metals.

THREE-IN-ONE WRENCH

HAVING the same approximate dimensions as a single socket wrench and but little additional weight, the new Tesco multi-socket wrench automatically accommodates No. 10 standard, No. 12 standard, ¼-inch standard and light, and 5/16-inch light hexagon nuts. Merely by pressing the wrench over any of the three sizes of nuts automatically selects the correct nested hexagonal tube suited to that nut.



Three socket wrenches in one

This wrench is designed for heavy-duty service, making it available for factory production or servicing work of any kind. Its design is such that any stress incident to turning a nut is transferred to the outer hardened-steel casing. It is also designed to provide a clearance through the barrel for studs up to 5½-inch length.

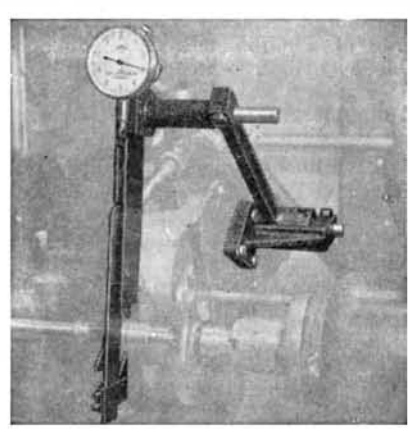
REFRACTOMETER

REFRACTIVE index provides a means of controlling many processes in the food, petroleum, chemical, and other industries. Very little material is needed to obtain a refractive index reading and results are obtained immediately. Now there is available a new Spencer refractometer which, because it has no compensating prisms, is used with a monochromatic light and provides an extremely sharp dividing line which promotes accuracy in use. Scales read the refractive index directly when a sodium vapor lamp is used with the refractometer. Special correction charts are used when a mercury vapor lamp or hydrogen discharge tube is employed as the light source.

GRINDING GAGE

ACCURACY and speed in precision grinding operations can be increased with the new visual grinding gage illustrated here. The gage is applied to and taken off the work while the machine is in operation, and "miking" is eliminated. The dial indicator guides the operator as the work is ground to size. The gage indicates the correct size even though the sizing controls of the machine may be worn. Grinding tolerances of plus or minus .0001 inch are easily maintained.

The Stuart Micromatic gage has no gears, levers, or angles, the dial being



Reading of the dial indicator acts as guide during grinding operation

actuated by direct parallel thrust. Contact points of the caliper measuring bar are of tungsten carbide for long wear.

PROTECTIVE HOOD

A LIGHTWEIGHT, air-supplied hood to protect workers in paint, chemical, woodworking, metallizing, finishing, and allied industries, guards the eyes, ears, face, neck, and respiratory organs from harmful and irritating substances, mists, vapors, fumes, and dusts. It is designed to afford safety, comfort,

Safety and comfort on the job

and freedom of body movement and to allow easy replacement of all parts. This pliable hood weighs only slightly more than a man's felt hat and is fitted with replaceable forehead pads.

Compressed air at low pressure, from the same supply used to service a spray gun or similar equipment, is fed into the hood through a distributing tube which is held in position at the operator's waist by a belt clip. A removable diffuser allows the air to expand and discharge at the top of the hood from where it floats down over the operator's head.

DETACHABLE COUPLING

A DETACHABLE brass coupling for helical flexible metal hose in sizes from ¾ to 1½ inches inside diameter, offers the advantage of being mechanically self-sealing. No brazing is employed—no heating of the hose to weaken it at the point where flexing and vibration place the greatest strain on the hose.

The unit consists of only four parts—the nut, back, stem, and split ring. When assembled, the convolutions of hose and the metal braid are securely held by pressure between the members.

The coupling withstands pressure tests of up to 800 pounds.

A further feature of design, developed by Packless Metal Products Corporation, is the self-contained union which permits the pipe thread end of the coupling to be screwed directly into the machine fitting and the union tightened without twisting the hose.

EXPANSION REAMER

AN ADJUSTING lock-nut is used to hold the three cutting blade segments absolutely rigid in a new Lempco high-speed expansion reamer. This prevents any possibility of an oversized bore resulting even when the reamer blades are subjected to excessive pressures. Of the three blade segments, two spiral

Reamer blades are rigidly locked

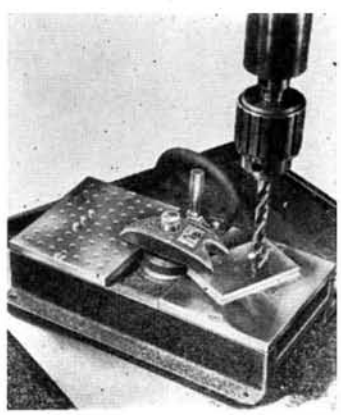
simultaneously in a direction opposite to that of the third. This opposite-spiralling effects a shearing action which finish-reams mirror-smooth any machinable metal, ferrous or nonferrous, as well as laminated phenol-formaldehyde and other fibrous plastics ordinarily difficult to machine smoothly.

The removable blades are quickly and economically resharpened. They maintain their size and keep cutting edge much longer than ordinary reamers, because from .035 to .080 inch straight-line expansion is provided.

"FLAT TOP" FIXTURE

HOLDING small flat work for toolroom use and certain other types of production operations is accomplished with a simplified fixture recently announced by Mead Specialties Company. It was developed to overcome difficulties encountered in drilling, countersinking, and tapping small precision parts in which highly accurate perpendicularity was essential.

This fixture is instantly ready to



Universal holding fixture

hold any type of work which is flat on the bottom, varying in thickness from a few thousandths up to a couple of inches, and in area from the size of a dime up to several inches square. The

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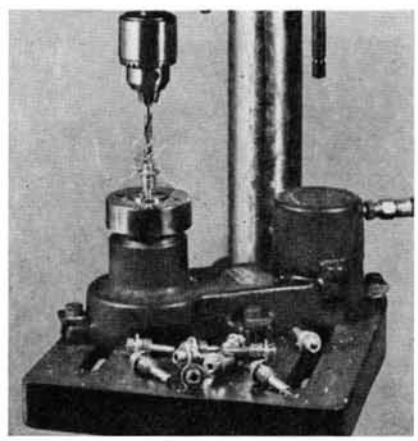
peripheral contour of the work makes no difference.

But the utility of the "Flat Top" fixture is not limited to drilling and tapping operations alone. It is also useful for many operations on small shapers and bench milling machines. One of the supporting plates is perforated and provided with three studs. This end of the fixture is used for milling and shaping work. Two studs are set in position to locate the back of the work, and the third is set at the end to support the work against the pressure of the cutting tool. This arrangement automatically makes a high-speed precision fixture for production work. The "Flat-Top" is a universal jig which can be changed from one set-up to another simply by dropping three studs into three holes.

COLLET AIR CHUCKS

NEW MODELS of an air-operated chuck have a collet capacity up to 1¾ inches. These models also use Brown and Sharpe type screw machine collets



Air pressure actuates this chuck

by which work can be held to center and depth. The collet remains stationary, thereby eliminating any possibility of variance due to variations in the diameter of the parts to be held.

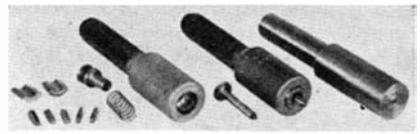
The Redmer air chuck is a precision-holding fixture for holding parts for milling, drilling, tapping, threading, assembly, and so on, and eliminates in many cases the making of special fixtures.

SHAFT MARKING

DESIGNED expressly for marking the ends of shafts and other parts having a center hole, an improved steel type holder (center of illustration) which may be used either with individual type or with logotypes made to specifications of the user, has been developed by New Method Steel Stamps, Inc. End marking is often desirable, since the end of a shaft or other part is frequently visible when the outside surface is enclosed in a housing or is otherwise poorly exposed.

When furnished with a knurled shank the holder is used for hand stamping, and with a turned shank it may be mounted in a press.

The holder is equipped with a floating locating pin backed up by a light



Marking device for shaft ends

spring to insure proper register of markings around the center. Individual steel type or logotypes (lower left of illustration) are made in tapered segments to form the proper radii.

PLASTIC PREHEATER

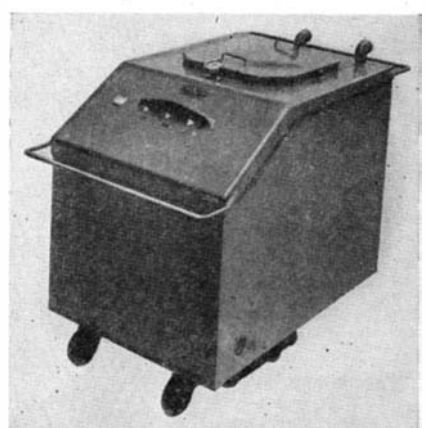
PLASTIC preheating time is reduced to a matter of seconds with a new machine designed specially for easier, faster preheating of plastic preforms—wood flour, rag, and mica filled phenolic.

The heating is done between plates which are built into the cabinet of this Illitron unit. The plates are opened to receive the preforms and closed for heating, similar to the operation of a waffle iron. These plates are self-adjusting to accommodate preforms of various thicknesses. The movable plate has a heat retainer which maintains the temperature in the preform after the high-frequency heating is off, so that greater time is permissible between the pre-heating and loading of the press. An automatic timer cuts off the heating after a predetermined time and simultaneously turns off a light on the panel board. A meter indicates in watts the amount of heat per second that is generated in the preforms, so that a close temperature control can be maintained.

A manual adjustment can be made whenever the operator changes from one type of preform to another, and a marking on the heat-rate meter will indicate the correct adjustment for the change to be made.

PORTABLE HEATING TANKS

ONE of the many types of special heating tanks for industrial uses, now being built by the Youngstown Miller Company, is a portable unit which consists



Heater for special shop jobs

of an insulated heating tank equipped with electric heaters, a motor and pump for circulating the oil, thermostats for maintaining the oil temperature within certain limits, and complete with electric controls and valves.

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.)

B. F. GOODRICH BRAND INDUSTRIAL RUBBER CLOTHING is a four-page catalog section which illustrates and describes their fire coat, general purpose work coat, double back industrial coat, standard police coat, universal work pants and jacket, workers' leggings, work 'n weather hats, and aprons—all coated with rubber or rubber-like materials. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

OCCUPATIONS IN PLASTICS is a six-page folder outlining 15 different jobs in the plastic field that offer possible post-war employment. Also presented is information on average earnings, principal manufacturing areas, methods of getting a job, and the abilities and preparation required. *Occupational Index, Inc., New York University, New York 3, New York.—25 cents.*

WOOD'S TECHNOLOGICAL COMING-OF-AGE is a booklet which reviews many new wood derivatives and modified wood products. Included are: Impreg, Compreg, Hydroxylin, Papreg, and Uralloy. Request Report 1442. *Forest Products Laboratory, Madison, Wisconsin.—Gratis.*

WAXES FOR TODAY AND TOMORROW is a booklet which affords a ready reference for production men and which lists 36 different kinds of waxes with their specifications and prices. *Distributing and Trading Company, 444 Madison Avenue, New York 22, New York. —Gratis.*

CONVERSION TABLES FOR RAKE ANGLES is a 16-page manual on sharpening milling cutters, gear hobs, and so on. It contains tables of offset distances for rake angles in 1 degree steps from 1 to 25 degrees. A formula is given for the computation of special angles; also many helpful suggestions on grinding, set-up, and the prevention of run-out. *Detroit Tap and Tool Company, 8432 Butler Street, Detroit 11, Michigan.—Gratis.*

HOW TO PUMP IT is a 20-page catalog giving complete information on several Rex pumps—their construction and operation. With capacities of from 3000 to 125,000 gallons per hour, they are useful in many different industries. *Chain Belt Company, 1600 West Bruce Street, Milwaukee, Wisconsin.—Gratis.*

POWER CENTERS is a 25-page booklet presenting a guide to the selection and specification of power centers which, combining transformer and switching material in one unit, save time, labor, and critical materials. Minimum space requirements, additional safety, and other advantages are listed. Request Booklet B-3224. *Dept. 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—Gratis.*

STANDARD METHODS FOR THE SAMPLING AND ANALYZING OF ALUMINUM AND CERTAIN ALUMINUM ALLOYS is a book containing tested and proved chemical methods for the determination of various elements in aluminum alloys. *Aluminum Research Institute, 111 West Washington Street, Chicago 2, Illinois. —70 cents.*

HOW TO USE FLUORESCENT ACCESSORIES FOR BEST LIGHTING RESULTS is a 16-page catalog giving technical information on three auxiliary devices—the lamp-holder, the starter, and the ballast—with illustrations and descriptions of each. Several pages are devoted to the Watch Dog starter. *General Electric Company, Bridgeport 2, Connecticut.— Gratis.*

YM ROBOT REFINER is a four-page folder which describes, with the aid of a flow chart, this improved oil reclaimer which is automatic and continuous. This unit removes fuel dilution, acids, solid and colloidal carbon, dirt and similar matter, as well as restoring emulsified oils. Capacities range from four gallons per hour to 300. *The Youngstown Miller Company, Sandusky, Ohio.—Gratis.*

HOW TO DESIGN A BUSINESS FORM is a 16-page booklet which discusses the use, design, nature, and improvement of business forms together with many suggestions and a handy form-check. *Hammermill Paper Company, Erie, Pennsylvania.—Gratis.*

DUPLEX TUBING is an eight-page bulletin on the applications of this tubing, developed to overcome corrosion problems, with cross-sectional views showing different methods of installation. *Bridgeport Brass Company, Bridgeport 2, Connecticut.—Request this bulletin on your business letterhead.*

JESSOP STAINLESS-CLAD STEEL is a catalog which contains information on the applications, manufacture, fabrication, styles, and sizes of this stainless-clad steel. *Jessop Steel Company, Washington, Pennsylvania.—Gratis.*

THE STORY BEHIND THE TURNER BRASS WORKS is a 16-page booklet outlining the history of the company and its war record, with illustrations of some of its war-time and peace-time products. *The Turner Brass Works, Sycamore, Illinois.—Gratis.*

CEMENTED CARBIDE TIPPED CUTTING TOOLS is a 48-page catalog outlining types and specifications of many carbide tools, including spiral reamers, side milling cutters, router bits, boring tools, jobber reamers, and others. *Wendt-Sonis Company, Hannibal, Missouri.—Request this catalog on your business letterhead.*

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Telescoptics

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OFTEN this department is asked for instructions for making a binocular. No such thing exists, nor would the job be very simple on a single instrument. Quite the contrary. The optics would be those of two refracting telescopes of short focal ratio; plus two Porro prism systems which erect the image, shorten the tube and, by encreasing objective separation, enhance the stereoscopic effect (the dear public largely thinks they are put there to magnify); plus a mounting. In time and money, too, the job would far outcost a purchased instrument, and thus is practically impracticable. That is just why some enterprising, nose-thumbing amateur will ultimately make a binocular. While the following résumé of recent improvements in U. S. Army binoculars, which was obtained from Frankford Arsenal, Army Ordnance Department, gives no how-to-make-it instructions, its background data should interest all readers.

THE EMERGENCY precipitated by the impending World War II presented the United States Army Ordnance Department with the problem of immediate procurement of a large quantity of binoculars. Because of the urgency for setting up production it was necessary to select the most adaptable model for which tooling existed and to produce approximately 350,000 instruments as quickly as possible. The model selected was the 6 × 30 commercial binocular being manufactured by the Bausch and Lomb Optical Company with whom an initial order for 20,000 binoculars was placed. This binocular was given the official nomenclature "Binocular, M3," indicating Standard Army Issue model No. 3 in the "M" series of binoculars. The 6 × 30 denotes six power magnification and 30mm objective diameter.

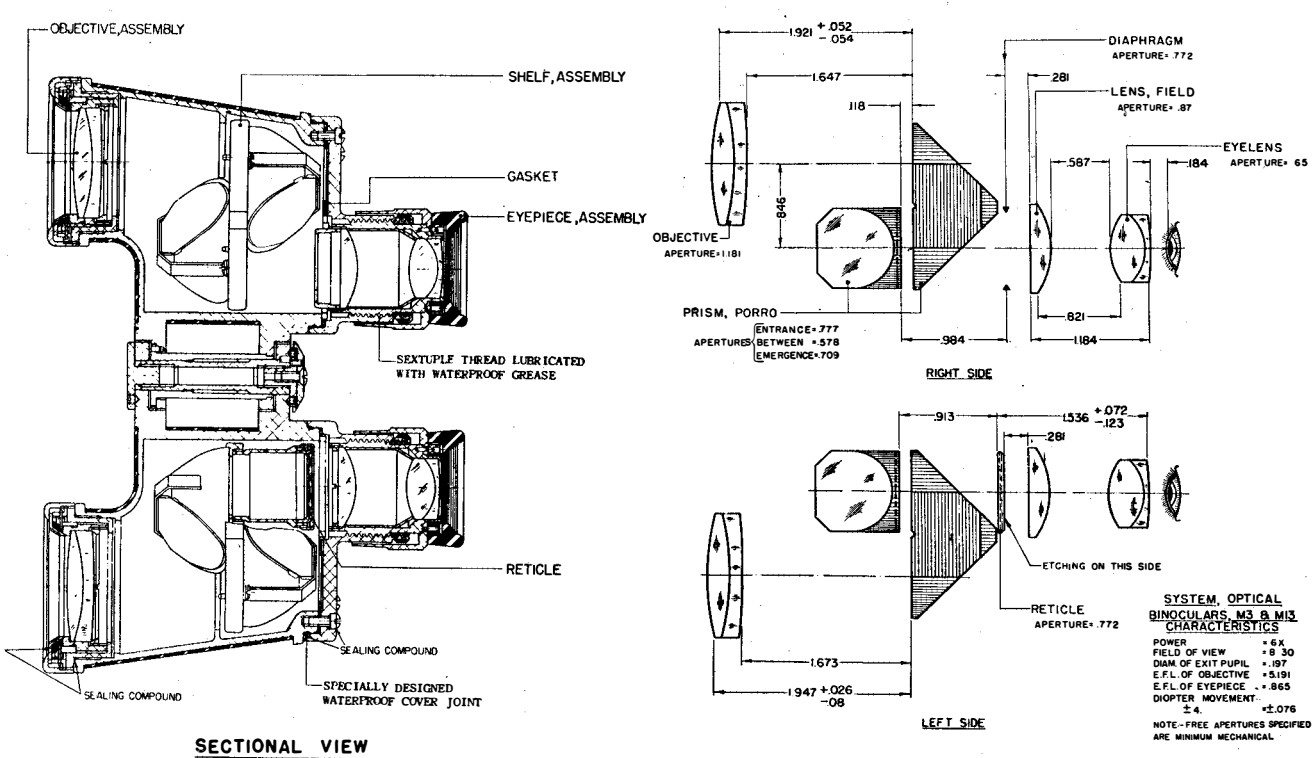
The only change necessary in the commercial model was the incorporation of a military reticle. The reticle shown below is a glass disk, both surfaces of which are polished parallel to within two minutes of arc. On one surface lines and figures, presenting a graduated scale, are etched and filled with an opaque material to make them visible. The crossline pattern and the dimensions of the reticle are determined by the type of binocular in which the element is to be used. The element is usually made of baryta light fflint or spectacle crown glass. The function of the reticle is to place the crossline pattern in the same focal plane as the real image formed by the objective so that the distance between two points or objects in the field of observation may be calculated.

Since it was apparent, even prior to placing the initial order, that the resources of the experienced Bausch and Lomb Optical Company would be necessary for the production of more critical precision optical instruments than binoculars, arrangements to set up separate facilities to produce binoculars, solely and on a large scale, were inaugurated. Nash-Kelvinator, Ranco Division, and Westinghouse Electric and Manufacturing Company were selected on the basis of Industrial Service surveys indicating their ability to utilize their existing equipment.

As neither Nash-Kelvinator nor Westinghouse had previous experience in making military optical instruments or the facilities for the manufacture of the optical elements, the Ordnance Department instituted an elaborate program for procurement of the essential optics to be furnished to the two companies for assembly with the mechanical elements into complete binoculars. Optical elements included in the binocular are Porro prisms, spherical lenses, cemented doublets—that is, a crown and a flint lens cemented together—and a reticle. The complete assembly is shown below.

Fortunately, binocular optics do not require the extreme accuracy of optics such as Amici prisms and other special elements used in higher powered intruments.

Despite the fact that optics were being manufactured by approximately 50 different companies, surprisingly little difficulty through rejections and disputes between the optics processors and the instrument assemblers was experienced. This may be attributed largely to an efficient inspection system. Inspectors especially trained at Frankford Arsenal for inspection of fire control instruments were sent out to each one of the 13 ordnance districts in the United States. Since inspection of an optical surface cannot be measured with a graduated instrument, but



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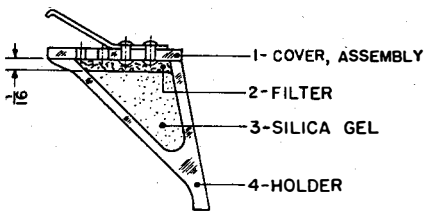
must be based on the judgement of an inspector, occasional controversy arose regarding acceptability. In such case, a standardization meeting was held, whereupon master inspectors from Frankford Arsenal rendered final decision.

Today's Army operates in the humid, moisture-laden climate of the South



DESICCATOR, ASSEMBLY

Seas, in the icy climates of Greenland and Alaska, and in the African desert where night temperatures are below zero in sharp contrast to the extreme heat of the day. Binoculars used in World War II are subjected to terrific vibration and shock in transport and in action and often are completely immersed during military surf landings. From the viewpoint of World War I, Binocular M3 is a superlative instrument. However, after a quantity of the M3 binoculars were issued and in use, many difficulties due to the nature of military operations of World War II were reported.

As a result of these reports, a concentrated study of the most minute details of Binocular M3 was conducted, which eventually resulted in the development of Binocular M13.

The first problem to be considered in the development of the M13 from the basic M3 was that of waterproofing the instrument to withstand submersion. This was accomplished by redesigning the cover plates to provide for the use of a synthetic rubber gasket and a greater number of fastening screws. In addition, a new military wax, capable of withstanding extreme high and low temperatures, for sealing the objective lens and objective assembly was developed by the Ordnance Laboratory. This compound, Specification FXS, replaces Navy Black Sealing Compound No. 3A. It resists cracking at —50°F. and has a melting point of 210°F., as against 150°F. for No. 3A compound. The formula includes a fungicide to repel molds and insects.

Shock and vibration tests revealed that severe shock caused shifting of the original prism mounting, affecting the optical alinement of the instrument. Experimentation with methods of mounting prisms resulted in the use of a dental cement. This cement is a blend of cupric oxide powder, phosphoric acid, and zinc chloride in solution. The ingredients are mixed in the ratio of three parts of powder to one part of liquid. Additional tests proved that prisms mounted with this agent were locked firmly against all shock, remained free of strain, and could be removed readily for cleaning.

Another very serious problem, applicable to all telescopes, was the formation of moisture on the optical elements within the finished instrument. In any binocular, moisture may eventually enter and condense on the optics, because no instrument with an adjustable threaded eyepiece movement can be sealed perfectly. Such formation is most objectionable on the graduated reticle, upon which the most trifling speck is visible and distracts the user. A plane high in the sky first appears as a tiny pinpoint which looks very like a fleck of dust under the magnification of the binocular eyepiece.

Experience gained in packaging complicated items for export, using dehydrating agents, was utilized in solving this problem. A special cartridge, shown in the small illustration, containing a small amount of silica gel, was placed within the body of each binocular. The instruments so treated were tested by subjection to most adverse conditions of humidity and rapid changes in temperature, which proved that the desiccant eliminated formation of moisture on the optics over an extended period of time.

A means of making the binocular more usable under conditions of fading light was undertaken. American binoculars effective an hour later in the evening than those of the enemy would be of great advantage to American soldiers. Therefore, a development of the optical industry—coating optical surfaces with a magnesium fluoride film to reduce loss of light by reflection—had been under study by the Army and Navy for some time. By exerting the full power of research of the Army, Navy, and associated commercial facilities toward perfection of magnesium fluoride and other coating techniques, coatings were produced to withstand cleaning and all field conditions. The magnesium fluoride coating is applied to the optical surfaces at high temperature under a high vacuum, the fluoride becoming a part of the glass surface. This coating reduces light reflection and permits a greater amount of light to pass through the optical system, enabling the use of the binocular at dusk, when light is fading.

After the time and money spent in producing a fine binocular, an improvement in the export method was incorporated as further insurance that the binocular will reach the ultimate user in factory-new condition. The binocular is placed in its special leather carrying case and sealed, together with five ounces of silica gel, in a moisture-vaporproof bag and cushioned in a corrugated carton. Twenty-four such cartons are then packed in a steel-strapped wooden box having a submersion-proof bag lining.

This new M13 binocular is now in mass production. Thousands of them are being shipped every month to American fighting men overeas to aid them in seeing the enemy before the enemy sees them. Of course, the Ordnance Department is never satisfied with the degree of perfection of the fighting equipment of our Army. Even now, additional improvements to assure that the American binocular is the best in the world are in progress.

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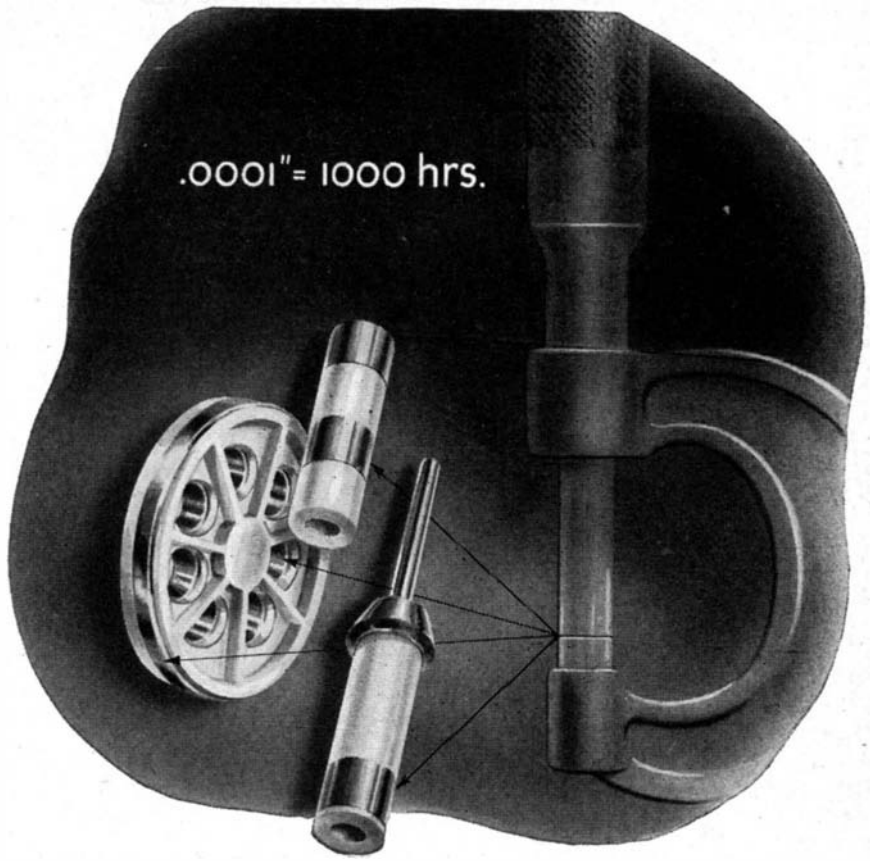
ELECTRONS BY THE POUND. One of the slide rule boys has figured out that nearly 4 pounds of electrons pass through each of the d-c terminals of a 10,000 ampere Ignitron rectifier in the course of one year. That's about 2,000,000,000,000,000,000,000,000,000,000,000 electrons, they tell us.

"MAKE WAY FOR A SAILOR" may be the new slogan in locomotives. Steam turbines, so efficient in ship propulsion, are being adapted for railroad use. Tests of one Westinghouse experimental 6,500 hp unit indicate a saving of one-fourth in steam required, compared to conventional reciprocating engines of the same power.

INSPECTING THE INVISIBLE. Tiny pinholes, invisible to the naked eye, mean defective tin plate and possible spoilage of badly needed food. A Westinghouse photoelectric device detects these defects every time, though the tin plate rolls past at 1,000 feet a minute. Flawed sections are automatically marked, to be later cut and removed.



When .0001 inch = 1000 hours

Problem: To provide an air-tight joint where the insulated connectors of an airplane radio vibrator project through the metal shell. (Vibrator contacts disintegrated in *ten hours* at high altitudes, when shells were not air-tight.)

Westinghouse research engineers were ready with the answer—a method of *soldering* metal to porcelain.

The porcelain piece is painted with a solution of gold and platinum and is then fired. This reduces the metal to a firmly adhering glaze, which is coated with a flux and tinned for soldering.

This gold-platinum film—barely one ten-thousandth of an inch thick—is the reason radio vibrators today last as long as the plane.

Solder Seal is the only known method of completely and permanently hermetically sealing a porcelain-to-metal joint. It is another example of Westinghouse leadership in every phase of electrical development.

Westinghouse Electric & Manufacturing Company, Pittsburgh 30, Pennsylvania.

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This great fighter, made still greater with a sensational increase in speed, is *easier to handle* because it is now equipped with "finger-tip control" made possible by aileron boosters—a unique improvement developed by Lockheed engineers.

These boosters are actuated by the revolutionary Hycon "Stratopower" hydraulic pump, which also provides quicker response of other control surfaces. As a result, the plane is *twice as maneuverable* as previous models . . . the pilot can aim and fire his guns more accurately and can out-fight many single engined ships, even in the thin air eight miles up in the stratosphere.

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