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JULY
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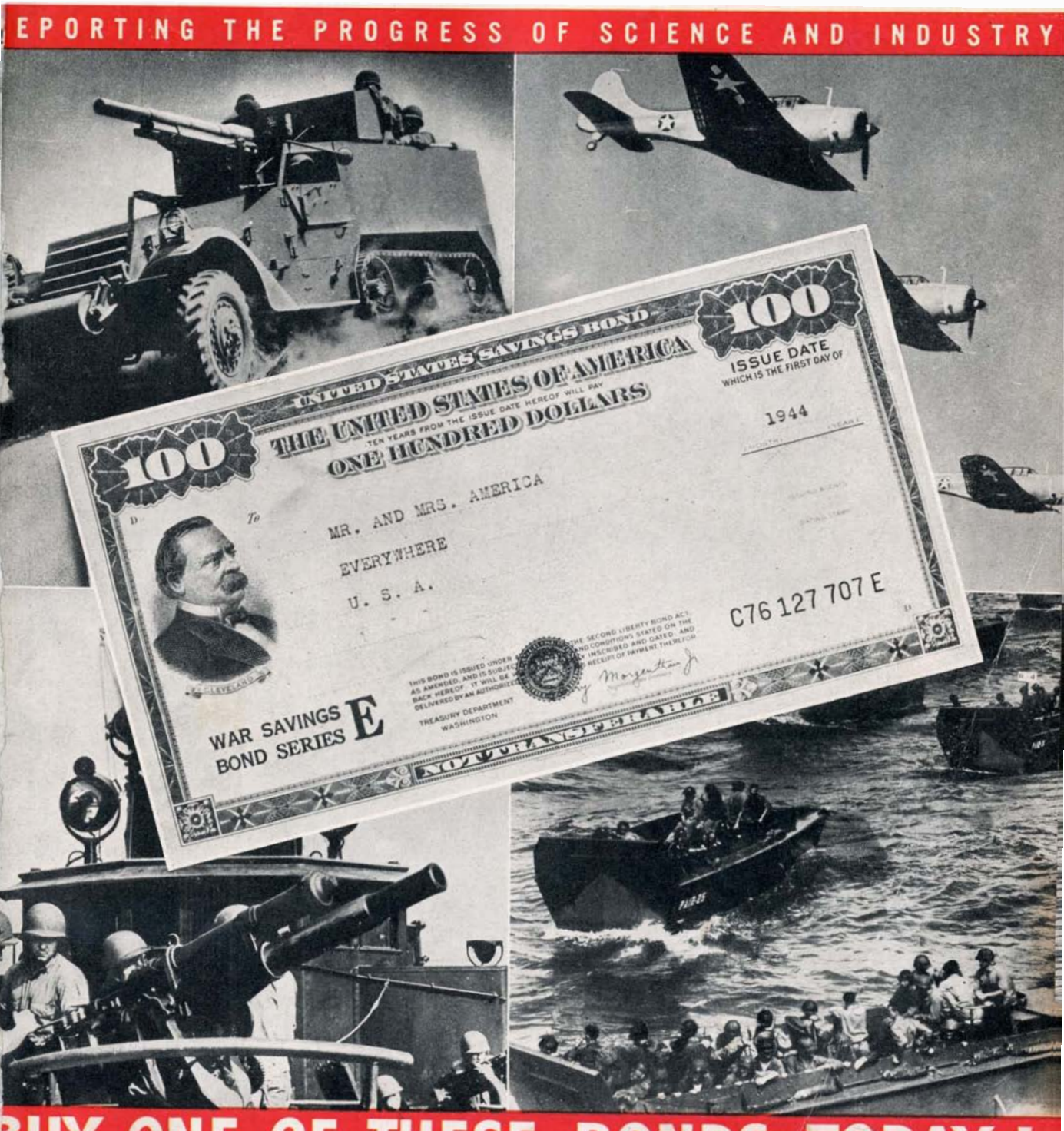

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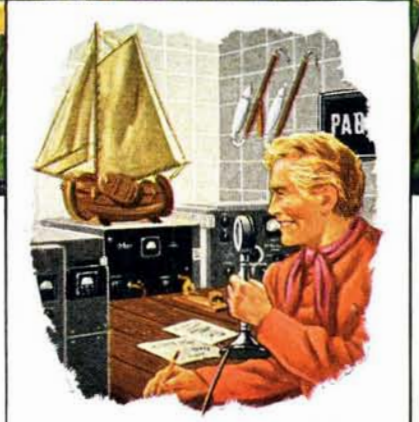

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SCIENTIFIC AMERICAN, July, 1944. Vol. 171, No. 1. Owned and published by Munn & Co., Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N. Y. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Files in all large libraries; articles are indexed in all leading indices. Subscription $4.00 per year. Canada and foreign $5.00.

Previews of the Industrial Horizon

By A. P. Peck

STANDARDS FOR TELEVISION

PROBLEM-CHILD of the radio industry, television has been kicked around by the industry and the press alike for many years. Came the war, and the meager knowledge of television technology, painstakingly acquired during those years, blossomed mightily behind the closed doors of government-controlled laboratories. There the problem-child has given birth to a number of developments which so far can only be mentioned in generalities. But even with war-necessitated research being directed toward military problems, television itself has benefitted. Benefitted, indeed, to a degree where television is now ready for at least a minor boom as soon as the light turns green.

Now, however, come further complications. Television has always been plagued with the necessity for standards that will permit a receiving unit to pick up the vision-broadcasts. Transmitters and receivers must both be designed for these standards and any deviation from them, at either end, makes operation impossible.

Before the war, television was struggling along and had reached the point where standards were set—set in the light of then-available knowledge. Since that time progress has shown that pre-war standards are not good enough for the type of television that can now be offered to the public. What to do? Maintain two standards and sell two types of receivers? Or junk the pre-war standards and set new ones based on advanced knowledge? Here is a problem that has the radio industry up in arms.

If two standards are maintained side by side, everyone will suffer—public and industry alike. If the pre-war standards are kept, in favor of better standards, then the public will have available only an inferior type of television—not the best that can be provided. If revised post-war standards are adopted, it may take a while longer to get television to the public but when they do get it, it will be as high in quality as can be furnished.

No one is going to suffer much if we have to wait a bit longer for television. It has been promised so often that a few post-war months more will make little difference. When television at last becomes "big business"—and it certainly will become just that—it should not be handicapped by antiquated ideas and standards.

More comment on this subject, straight from the radio industry, on page 27.

TRANSPARENT MODELS

NECESSITY for quickly training production employees in war work has given rise to many instruction tricks. Latest of these involves the use of full-sized models of valves, pumps, and the like, fashioned of crystal-clear plastics. Available plastics can be machined to size and shape accurately. Then, when assembled with interior parts made of opaque materials, the plastic exterior enables the student to see just what goes on inside. With such visual knowledge, he is better equipped to do any job connected with the assembly which he has studied in plastic form. That such models are far better than the more conventional cut-aways goes without saying, since the interior parts can be seen from any angle and in true perspective.

ADHESIVES

SPRINKLED through the news of technology for the past few years have been mentions of various advances in the science of adhesives. Edge-glued lumber, better plywoods, metal-to-metal bonds, are only a few of the developments made possible by this progress.

Now comes news of a rubber-like adhesive which is particularly adaptable to use in many branches of construction. By means of this new adhesive it is possible to bond a very thin layer of wood veneer directly to a metal surface and to accomplish this result quickly and with the use of only moderate heat and pressure. The end result is not a new one, since wood-faced metal sheets have been fabricated in the past. But, by the new method, costs and the time factor are radically reduced. Further, the new bonded materials can be stamped, cut with shears, and bent into almost any shape without disturbing the bond or cracking the wood.

The practical and decorative effects of this new wood-metal combination can go far. Home interiors and furniture, airplanes, trains, ships, and so on, are likely places for use of this type of paneling in which strength and weight factors of metals can be combined with the warmth and beauty of wood.

CORROSION CONTROL

DESPITE the fact that corrosion has annually taken its toll of millions in dollar-value, it seems that only desultory attempts were made to control this waste until the fortunes of war were seen, in some theaters, to turn on a film of rust. Vital supplies, piled on some beach in the South Pacific, rusted rapidly, became worthless. Parts of the story of what has been done to combat this waste is told in the article on page 22, where petroleum derivatives are described in their protective role. On other fronts the fight has also been waged. The paint industry has become more alive than ever to the possibilities of paint as a protective medium. Better metal coatings have been devised to keep rust to a minimum. Plastic sheaths, that are removed before an article is placed in service, have been developed to protect highly polished surfaces from corrosion between the final finishing operation and actual use.

All-in-all, industry can see on the peace-time horizon at least partial freedom from the inroads which corrosion has made in the past.

SYNTHETIC RUBBER RECLAIMED

WHEN synthetic rubber first entered the over-all picture of our national economy in a big way, it was considered to be a completely expendable product. None of the formulas applicable to reclamation of natural rubber would work with synthetic. Now, however, formulas and processes have been developed by means of which scrap synthetic can be reclaimed—using the same machinery used for reclaiming natural rubber—and turned back to the manufacture of the identical items for which it was previously used. Already more than a million pounds of synthetic have been reclaimed.

FOR FUTURE REFERENCE

PROBABLY the first commercial post-war use for gas turbines will be as power units for railroads, with airplane drives, ocean ship drives, industrial power, and electric power generation following in that order. . . Chlorine dioxide, valuable as an industrial bleaching agent, can now be made on the premises by a newly developed generator. . . Jets of oil, impinging on the under side of Diesel pistons, hold promise of keeping down excessive combustion-chamber temperatures. . . Chemical engineering is making possible extensive reductions in the cost to the consumer of synthetic vitamins. . . Fire-fighting methods, intensively developed for military purposes, will reduce post-war fire tolls.

No One Need Pay More than $40 for a Quality Hearing Aid!

America's Overwhelming Swing to the New Zenith Radionic Hearing Aid Proves It!

SUCCESS speaks for itself! America's hard of hearing—eager to enjoy a fuller life, to take a more active part in working for Victory—are buying the Zenith at a rate undreamed of before in the hearing aid industry! Here, indeed, is conclusive evidence that no one need pay more than $40 for a quality hearing aid!

How can Zenith bring its finest quality thus within reach of all? One reason, of course, is Zenith world leadership in the exclusive manufacture of radionic products. Another is this: The Zenith is built not to a price, but to an improved, modern *principle* of hearing aid design: INSTANT PERSONAL ADJUSTMENT. You, yourself, "focus" this instrument for your particular hearing needs—for different voices and surroundings—as conveniently as you focus a pair of binoculars!

That's why the Zenith requires no elaborate testing and frequent adjustments by high-paid, high-pressure salesmen... no special offices, home calls or other expensive "trimmings." *Zenith Quality Is in the Instrument Itself!*

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Only Zenith Gives You These Great Advantages

1 New "Self-Focus" Hearing Control

The flick of your finger brings hearing into range for your particular needs—for different voices and surroundings—as conveniently as you focus a pair of binoculars. Outmodes the old-way "fixed-adjustment" principle.

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An exclusive circuit—especially developed by Zenith engineers to insure outstanding performance throughout the life of the batteries. Brings average operating cost to only 3/10 of one cent per hour.

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You get the fine precision that modern knowledge and engineering made possible, at about ¼ the price of other quality vacuum tube instruments! One model—no "decoys." One quality—Zenith's finest. One price—$40.

4 Zenith Guarantee 5-Year Service Policy

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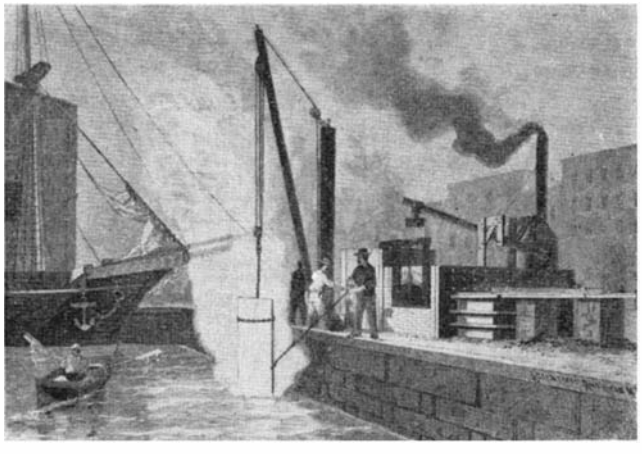
SCIENTIFIC AMERICAN

(Condensed from Issues of July, 1894)

ATLANTIC CABLE — "On the 2d of July the Faraday completed the laying of a new Atlantic cable, the actual time occupied in the work of laying the deep sea portion being but twelve days. When the Great Eastern, in 1866, completed the laying of the first successful Atlantic cable, the entire world joined in congratulations. The event was justly looked upon as marking an era in the progress of the world. Since that time, however, the making and laying of ocean cables has become a practical, everyday business, and the new cable was not only laid in the shortest time, but is a much better cable than any of its predecessors, having the largest copper conductor and being the speediest ever laid for its length."

HARDENING STEEL — "The manufacture of iron and steel burglar-proof vaults for insurance companies, trust companies and similar institutions is one of increasing importance. As the safe maker advances in his processes, and while he is improving the burglar-proof quality of his safes, so fast does



the burglar improve in his method of attack, so that it is often the burglar himself who is in advance of the safe builder. The illustration . . . shows a somewhat curious operation incidental to the manufacture of steel and iron vaults, the hardening of the plates. The process is the one employed at the works of J. B. & J. M. Cornell, in this city, and consists in dipping the hot plates into salt water. Advantage is taken of the water front held by the firm in utilizing *in situ* the salt water of the Hudson River for the purpose, a brine dip being considered superior to one of fresh water. . . Special heating furnaces are built in the open air upon the margin of the river, and plates of steel heated in them are dipped into the river to harden."

GARBAGE UTILIZATION—"The process of garbage disposal is . . . probably carried on now with greater perfection in St. Louis than anywhere else in the world. . . Carts bringing the material . . . discharge into enormous vertical cylinders, which are surrounded by steam jackets. Superheated steam is forced into the jackets, and the water, which constitutes from 75 to 80 percent of the garbage, is thus evaporated. . . After extracting the grease, the residuum in the cylinders is dried a little more. . . It is now a brown mass, free from all unpleasant odor, and apparently dry, although it still contains 5 or 6 percent of water. As it has not been heated sufficiently to cause destructive distillation of the solid portions, it contains practically all the nitrogen of the fresh garbage, with, of course, all the alkalies and phosphates; and, after grinding coarsely and packing in barrels or bags, it commands a ready sale all over the United States."

GAS-ICE — "An Indianapolis . . . firm has constructed a refrigerator for making ice by means of the cold produced by the expansion of natural gas to atmospheric pressure. This is the principle of all artificial ice machines; yet it seems to have only just occurred to some American engineers that natural gas as it issues from the wells at pressures amounting in some instances to 20 atmospheres, and at a temperature of 42° Fah., presents the sole physical condition necessary for the production of cold by gaseous expansion."

ELECTRIC BOATS — "Of the five or six hundred electric roads in this country a large proportion reach natural or artificial waters, such as lakes or rivers, and in all parts of the country a large amount of work is now being done in the utilization of the current from the trolley wires for charging storage battery boats to ply on these waters."

RAILROADS — "The total mileage of railways in the United States on June 30, 1893, was 176,461.07, being an increase during the year of 4,897.55 miles. The corresponding increase during the previous year was 3,160.78, from which it appears that there was some revival in railway construction during the year covered by the report."

PULP PIPES — "Wood pulp is agitated with water and rolled on a tube. After the . . . extra amount of water drains away, it is placed on end and the interior mould is withdrawn, leaving the wood pulp tube. . . The further process consists of dipping it into a very hot solution of asphaltum and other materials, which penetrate the whole substance. The ends are then squared up, and the threads cut, or taper finish is made in the usual manner of wrought iron pipe. This material, when finished, possesses high electrical resistance, rendering it suitable for underground conduits for electric wires."

AUSTRALIAN GOLD—"Some big stories are current of the Coolgardie gold fields in Western Australia, and particularly of one mine in the district discovered by two young adventurers named Bailey and Ford. . . The monthly output from the mine now amounts to 2,000 ounces. From 30 tons of ore picked from a bulk of 1,400 tons, 18,000 ounces of gold was obtained, and the remainder of the stone is expected to yield from five to six ounces to the ton."

STRIKES—"It is to be regretted that the people of the United States should have to recover the use of their ordinary highways at the point of the bayonet, but it is is better to recover and hold them in that way than to give up the control of them, even for a moment, to people so reckless and malicious, or so unutterably base, as those who have managed the great railroad strikes for the past ten years."

TURBINES—"In a paper on the Laval steam turbine, read before the French Society for the Encouragement of National Industries, it was stated that, though invented only in 1891, some 200 of the motors are now at work, ranging in size from 5 to 100 horse power. The speed of rotation ranges from 15,000 to 30.000 per minute, the steam issuing from the guides at the full speed due to its pressure. Owing to this it is not necessary that the wheel should fit closely into the guide chamber, as there is no tendency to leakage."

GLASS BRICKS—"Glass building bricks . . . are hollow, being blown like bottles, and are given forms—such as cubes, hexagons, etc.—that permit of ready laying. A bituminous cement, with a base of asphalt, is used with them. The bricks serve as double windows, giving protection against both cold and heat; they are good insulators of humidity and noise, and they lend themselves readily to the decoration of buildings, either by their form or color."

ARC LIGHT—"The light of the carbon arc is not, and can never be, white, as it is sometimes described as being, but must always be tinted violet by the carbon vapor normally present between the rods."

Courteous Calm *and* Competent

These are traditions of the telephone business.

The courtesy born of competence and the calm, sure speed that comes from knowing how.

Learned in peace, these are valuable traits in war when Bell System people are under more pressure than ever before.

Even in today's rush and hurry, "The Voice With a Smile" keeps right on being a part of telephone service.

BELL TELEPHONE SYSTEM

When you're calling over war-busy lines, the Long Distance operator may ask you to "please limit your call to 5 minutes." That's to help more calls get through during rush periods.

"Quotes . . ."

"UNFORTUNATELY, theorists in government feel that they know just how to run industry so as to produce Utopia. But the operation of an industry, as the industrialist knows, is one of the most intricate problems that man handles. It is obviously impossible to operate industry by rule. The only way, however, that government can run any activity is by dogmatic direction. That must fail in industry as we so clearly see now." James F. Lincoln, President, The Lincoln Electric Company.

" " "

"THE BEST that can be hoped for in a college training is to make the student cognizant of what education means, and to guide him so that he may have the urge through study and reading to become educated." *Dr. Roger Adams, University of Illinois.*

" " "

"THE [POST-WAR] COMPETITION between research departments will be just as keen as that between sales departments. The manufacturer of a finished product will have to pay more attention to and spend more money for research. His organization will not only have to keep currently informed about his own final products, but also will have to keep up with the procession in new knowledge of raw materials and processes." Clyde E. Williams, Director, Battelle Memorial Institute.

" " "

"IT SEEMS PROBABLE that business . . . will not be able without additional financing to produce and distribute the volume of goods and services necessary to provide full employment." *Professor Charles C. Abbott, Harvard Business School.*

" " "

"WE SHALL have been criminally negligent if during these times we fail to plan for the job beyond. In my opinion any assumption is unsafe and dangerous, that we will just automatically have full employment because of the combination of scarcity of goods and high purchasing power." Howard E. Blood, President, Norge Division, Borg-Warner Corporation.

" " "

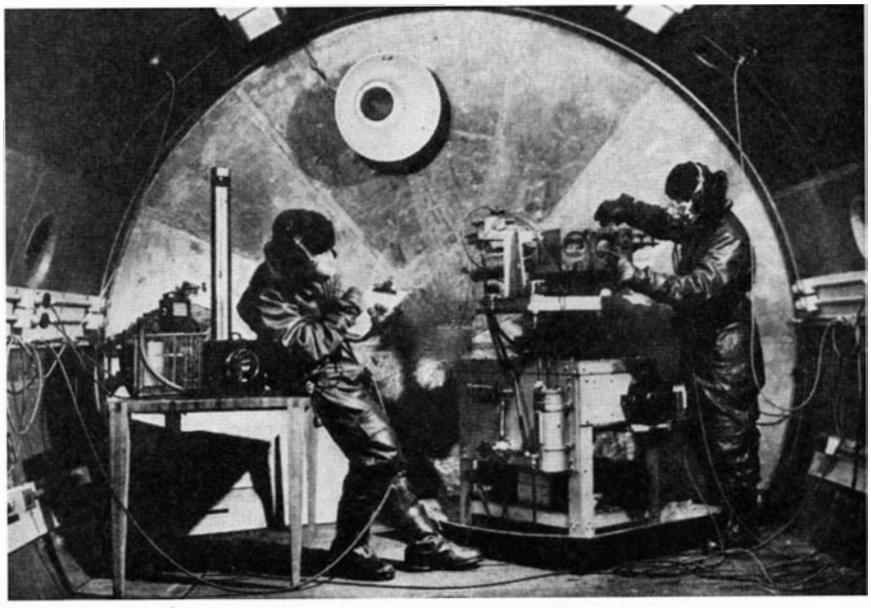
"PASSENGER SERVICE to cities now denied the advantages of direct air travel will be an important factor in post-war traffic increases, provided that we lick the problem of airport accessibility. Within a decade, we should see about 20 million airplane passengers a year, or five times the 1941 number." *Charles I. Stanton, Administrator of Civil Aeronautics.*

" " "

"A LARGE VOLUME of construction ready to start instantly, may be the very thing that can prevent initial post-war unemployment from spiralling downward into a major depression." Major General Philip B. Fleming, Administrator, Federal Works Agency.

AVIATION

Conducted by ALEXANDER KLEMIN



Dr. Elizabeth Newkom, left, records data in the stratosphere chamber

Bringing Down The Stratosphere

In the Sperry Gyroscope Company's New High-Altitude Laboratory Conditions of Low Pressure, Extreme Cold, and Oxygen Lack are Duplicated by Means of Vacuum and Other Equipment, Affording a Peculiar Kind of Research that Combines Aeronautical Engineering, Physics, and Physiology

MAN IS splendidly equipped for life at sea level, at the bottom of a deep ocean of air. His lungs work effectively at the concentration of oxygen produced by this tall air column, the composition of the atmosphere suits him admirably, and the temperature almost anywhere on the surface of the earth permits life without too great discomfort. But man cannot stand the extreme cold, the low air pressure, and the lack of oxygen which are encountered at great altitudes. The problem of altitude is one of the utmost importance in military aviation, particularly for the pilots of the single-seater fighters or medium sized interceptors which are too small to permit the construction of a pressurized cabin. An important research of the day is therefore concerned with the physiology of high-altitude flight, and the behaviour of instruments and equipment under severe altitude conditions.

In such research there has been developed an altitude-chamber technique which calls for the combined talents of the aeronautical engineer and the medical man. The Vose Memorial High-Altitude Laboratory, recently completed by the Sperry Gyroscope Company, is the most recent and perhaps the most fully equipped of the laboratories dedicated to this type of research.

The work of such a laboratory cannot be fully appreciated without reviewing briefly such matters as the properties of the atmosphere, the elementary physiology of breathing, and the perils and difficulties of anoxia, or shortage of oxygen. Besides a number of severely technical works, we are indebted to Herbert S. Zin's fine book, semi-popular, semi-technical in character, "Man in the Air."

REDUCED PRESSURE—At sea level the pressure of the air is equivalent to that of a column of mercury 29.92 inches high, or 14.7 pounds a square inch. Such figures constitute an enormous load and the reason man can withstand such loads is because he endures the same balancing pressure within his body as externally. With altitude the pressure drops—very rapidly at first, more slowly at great heights. Thus, at 8000 feet, the pressure is three quarters that of sea level, at 18,000 one half, and at 50,000 only one tenth that of sea level.

The distribution of the gases in the air at sea level is surprisingly uniform, winter and summer, pole and equator. The atmosphere is a physical mixture containing about 78 percent of nitrogen, 20.95 percent of oxygen, 0.09 percent of carbon dioxide. It also holds a small amount of water vapor, which is essential to our well-being. The carbon dioxide is not harmful in small quantities; it stimulates breathing and controls normal respiration. The oxygen is an essential element of life, since it produces oxidation of foodstuffs in the cells of the body and liberates heat. Without the beneficient action of oxygen, life is impossible. The nitrogen has little effect besides diluting the oxygen, but the dilution is highly important. Nitrogen, like oxygen, is dissolved in body fluids and in the blood. It is not readily released, but when it is released rapidly it becomes a menace. At sea level the oxygen alone has a pressure of 160 millimeters (compared with the total pressure of the air of 760 millimeters); at 20,000 feet the oxygen pressure is only 73 millimeters. Thus altitude brings a smaller amount of oxygen in each breath, and at the same time

the oxygen there is less capable of doing its work of penetrating through the lining of the lungs to feed the capillaries of the body.

SIXTY SEVEN BELOW ZERO—The temperature also drops, with altitude, about one degree, Fahrenheit, for every 300 feet. When the division between troposphere and stratosphere is reached, at around 35,000 feet, the temperature is lowered to —67 degrees, Fahrenheit, and stays constant thereafter, at least for any altitude with which we are likely to be concerned for many years to come.

Man's adjustment to the lower temperatures of high-altitude flying is well understood. Cold can be met by hot food, warm clothing, and, to a certain extent, by exercise. But lack of oxygen calls for further discussion. Temporary adjustment is possible by the healthy pilot up to 18,000 and even 20,000 feet. At higher levels he loses consciousness unless artificial means of supplying oxygen are provided. The first symptoms of anoxia occur at about 8000 feet and are dangerous and insidious, because the victim may feel more confident and capable than usual, suffering from something like an alcoholic jag at a certain stage of its development.

The process of breathing is an unconscious one, and is explainable in physical terms. The oxygen, when introduced into the lungs, passes through the thin tissues of their air sacs and subdivides into the 25,000,000 tubes of the bronchial system, each tube ending in a dozen or more rounded sacs known as alveoli. These 400,000,000 sacs are arranged like bunches of grapes. The oxygen, with its higher pressure, passes into the thin walls; carbon dioxide, with a lesser pressure, moves in the opposite directions.

Even after exhaling the lungs still contain six to seven pints of air, which is known as alveolar air. The one pint of air which is taken it at each breath mixes with the alveolar residue.

What now happens when there is less oxygen to breathe, and the oxygen, with its lower pressure, loses its penetrating ability? Pulse rate and rate of breathing definitely increase, vision is not so keen, sounds seem faint and far away. Symptoms of anoxia are cumulative and continued exposure makes matters worse. At 25,000 feet the pilot will feel serious effects in 15 seconds. Consciousness will be lost soon thereafter. Pilots flying in formation who do not use their oxygen masks correctly have been known to do the most unaccountable things in the early stages of anoxia—they may break formation or even attempt to machine-gun their own friends.

There have been almost innumerable designs for oxygen equipment. At one time liquid oxygen—compact, easy to handle, but dangerous—was used. It was soon abandoned. Gaseous oxygen has proved far more practicable for aviation use. Yet, when carried as compressed gas in alloy-steel cylinders, it offers another danger—loss under the impact of enemy bullets. For this reason, oxygen is generally carried today in a number of low-pressure tanks.

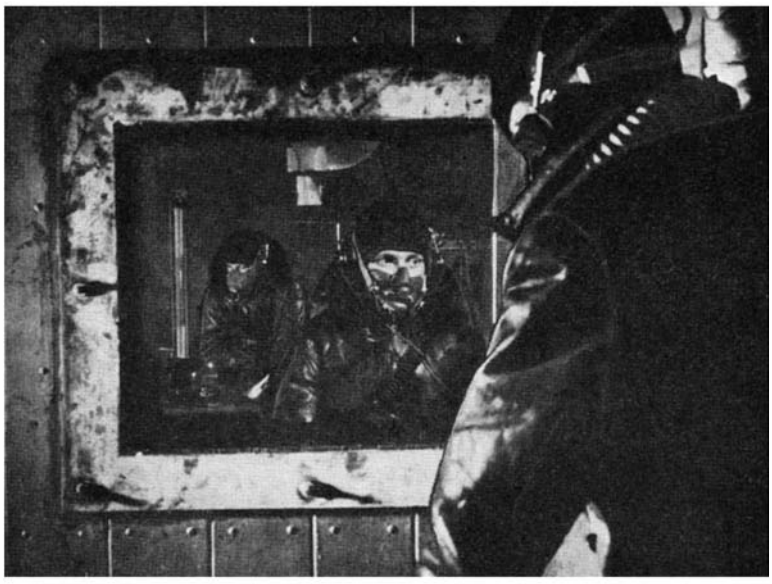
Oxygen equipment having rubber tubes or pipe stems for taking oxygen into the mouth has been tried but the process proved uncomfortable and painful. Masks have been found far more efficient. Theoretically, rebreather masks are most desirable, since they are so economical of oxygen, but they are bulky and require a perfectly airtight mask. Finally, the air services of all nations have agreed upon the demand type of mask, in which the flow of oxygen is regulated by the very breathing of the pilot. This mask fits tightly over the mouth and nose. A sponge-rubber valve and a rubber bag form the essential elements. A rubber tube from the oxygen supply line fits inside the reservoir so that the steady flow of oxygen enters and mixes with the air already present. The rate of flow is controllable by the pilot.

One more physiological consideration of high-altitude flight is aeroembolism, "the bends." Our blood contains dissolved nitrogen and so does the body. Rapid ascent into low-pressure altitudes causes nitrogen and carbon dioxide to dissolve out of the body and form minute bubbles. These bubbles may block circulation of the blood, press on the nerves, cause terrible pains, and produce injury and even death.

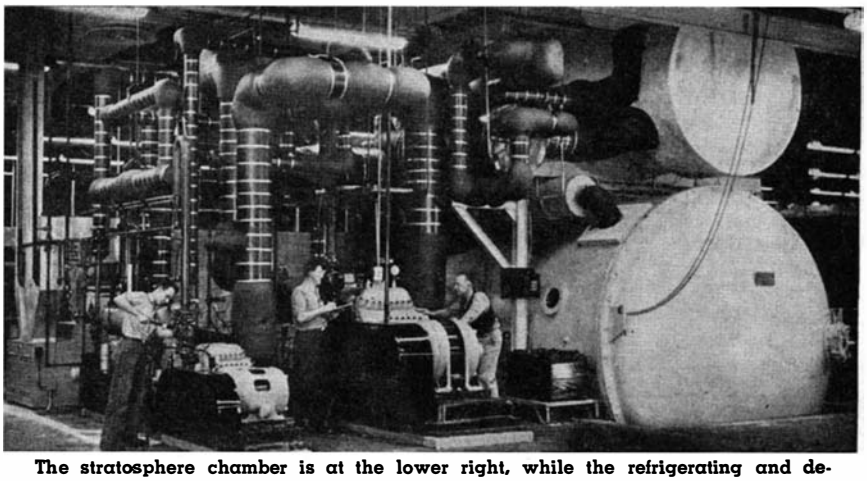
Pressurized cabins avoid all these difficulties, and they can be and have been built with great success in air liners and high-altitude bombers. Pressurized suits have also been developed. Wiley Post used one in a number of his cross-country flights. Using pressurized suits the British have flown to over 53,000 feet. Pressurized suits have used a combination of artificial increase in pressure and artificial supply of oxygen. Yet all the mechanical difficulties have not been solved, and the pilot encased in a pressurized suit becomes so bulky and heavy that his military potential is lessened.

WHAT THEY ACCOMPLISH—The purposes of high-altitude laboratories now become abundantly clear. They are used to study electrically heated suits and gloves. They serve to do research on such vital equipment as air-speed indicators, artificial horizons, the automatic pilot. They give us a vast amount of information on the physiology of the flier. They show us how to train pilots for maximum endurance under high-altitude conditions, and how to select those who may safely subject their bodies to the strains of the stratosphere. And, finally, they teach us how to circumvent high-altitude effects by oxygen masks, by ridding the blood of nitrogen before a flight, and in many other ways.

The new Sperry laboratory is appropriately dedicated to the memory of the late Frederic Blin Vose who, after active service in the Navy, served the Sperry Gyroscope Company in sales engineering and instrument development, was the first American civilian to fly with the RAF over Germany, did much to further precision bombing, and lost his life in an airplane crash on May 1, 1942.



Experimenters in the high-altitude chamber are under constant observation for reasons of safety as well as of research. The illustration at the left is taken from within the air lock at the end of the chamber and shows an observer watching the workers through a window. At the right is Dr. Zand outside the chamber, but in telephonic communication with the workers



The stratosphere chamber is at the lower right, while the refrigerating and dehumidifying equipment, with its attendant coils, pipes, and pumps, is at the left

In the Vose Memorial Laboratory, high-altitude conditions have been duplicated on the ground by means of an insulated steel shell equipped with vacuum pumps for varying the atmospheric pressure inside the shell to a point as low as that existing at 60,000 feet. Refrigeration equipment makes it possible to maintain a temperature of —75 degrees, Fahrenheit, with an air bleed out of the shell of 10 cubic feet a minute. The main test chamber is 16 feet long and 12 feet in diameter. Welded on to one end is a lock chamber eight feet long and eight feet in diameter.

DR. ZAND'S DESIGN—The basic design of the laboratory is due to its Director, Dr. Stephen J. Zand, who has to his credit outstanding achievements in many fields of applied science, in the design of gun turrets, in the development of gun sights, in the sound-proofing of the airplane, in the development of the gyroscopic pilot and, last but not least, in high-altitude research. The strength of the Vose Memorial Laboratory lies in the excellent basic design, the foresight which makes its operation so safe (for example, air can be introduced into the chamber simply and rapidly whenever this seems desirable, and communication between personnel in the chamber and outside the chamber is always maintained), in the completeness of accessory equipment and experimentation, and, above all, in the enthusiasm and skill of the workers in the laboratory.

The accompanying photographs convey a conception of the structure of the laboratory and of its work. In one picture is shown the huge stratosphere tank, with the coils, pipes, and pumps which constitute the refrigeration and dehumidifying equipment. This equipment occupies more space than the high-altitude tank itself and involves a fine application of air-conditioning engineering.

For the sake of safety, workers within the tank are under constant observation from outside. Another of the photographs shows the observer standing in the sealed lock in which the pressure is somewhat higher than inside the actual altitude tank. Should anything go wrong with his co-workers at the higher altitude, the observer can open the heavy door and enter quickly and safely. There is an added element of safety in the fact that Dr. Zand, also acting as observer, can watch the whole course of a test from the open air and take dictated notes, through a portable telephone, from the men inside.

It is one of the most fascinating aspects of the laboratory that it combines engineering and physics with medicine and the study of the human body, and it is a sign of the times that the medical supervisor, Dr. Elizabeth Newkom, is a woman. In another of the illustrations, Dr. Newkom is taking data from Irving Hilliard, an aeronautical engineer, who is adjusting a Sperry automatic pilot.

When workers prepare to enter the tank they must be equipped to withstand intense cold. They therefore don the warmest possible underclothing, which is supplemented by heavy electrically heated outer suits.

Every science is drawn into service in the work of the laboratory. For example, in testing oxygen masks a hypodermic needle is inserted through the soft rubber of the mask to withdraw a sample of breath for a test which reveals instantly if any air has leaked in to become mixed with the pure oxygen. Again, a photoelectric cell mounted near the lobe of the ear measures its transparency to light and thus serves as a check on the oxygen content of the blood.

In yet another phase of the work, an experimenter, completely equipped for ascent to the stratosphere, but prior to entering the chamber, breathes pure oxygen and pedals on an electric "bicycle" for 15 to 30 minutes until the nitrogen vanishes from his blood. This prevents the possibility of aeroembolism in rapid ascent.

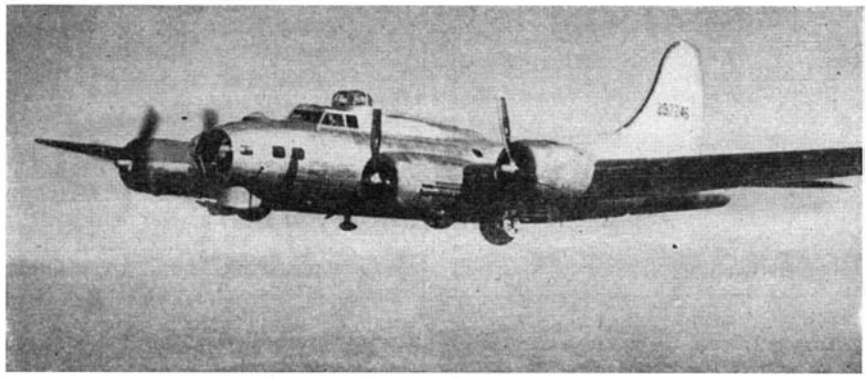
Obviously, work of this kind is not open to every man or woman. A severe physical examination is given to anyone before he or she is allowed to make an oxygen-mask ascent in the chamber. But it is only through such work that the secrets of high-altitude flying are being unfolded. Laboratories of this kind, intelligently applied to the solution of practical problems, will do much to further the cause of stratosphere flight in the future.

✦ ✦ ✦

FOUR MINUS TWO

Engines Bring a Fortress Home

THE FLYING FORTRESS has proved to have remarkable powers in bringing home its crew after severe hammering. Bomber pilots have landed their ships in England with tails partially shot away, with the fuselage riddled with bullets. Some of them have limped back with only two of the four engines still functioning. In our remarkable photograph of the B-17, the latest type of fortress, it can be seen that the two port engines (left side, to the uninitiated) are stilled and the propellers feathered. Feathered means that the blades are turned directly into the wind so that they produce the least air resistance and the least vibration.



Limping home on only two engines, but getting there just the same

TRAFFIC CONTROL

Projected for Post-War Airways

MOST optimistic as to the post-war future of aviation is Charles Stanton, Administrator of the Civil Aercnautics Administration, who, in his annual review, forecasts a great expansion of both scheduled and private flying. The C.A.A. intends to keep abreast of such

(*Please turn to page* 43)

Supersonics at Work

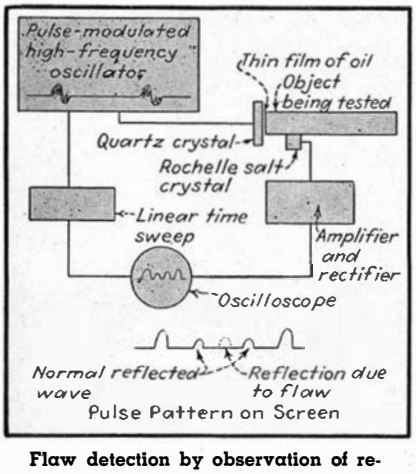
Inaudible Wave Power is Being Used Today to Detect Flaws and Deviations in Manufactured Products, to Measure Underwater Depths and Distances, and to Detect Underwater Objects such as Fish. Principles Have Been Developed Which Have Interesting Possibilities for Future Expansion

IN MANY war plants, workers may be seen tapping objects, one after another, in front of a microphone. Little or no sound can be heard by human ears, yet every now and then a light flashes and the operator tosses a piece aside as defective.

This is just one of several new techniques which utilizes supersonic frequencies for inspection purposes in industry. Cracks, differences in hardness, changes in dimensions, and variations in the composition of many materials can be quickly detected by this method.

The story behind these new supersonic developments dates back to prewar days when research engineers of the Vendo Company were concentrating on the problem of detecting slugs inserted in their coin-operated beverage vending machines. One method proposed for slug detection was measurement of the sound frequencies given off by various coins as they entered the machine and bounced back and forth.

Experiments on specimens of various metals, made into slugs of the same dimensions as genuine coins, indicated that those slug metals having a lower modulus of elasticity than metals in genuine coins would vibrate at lower frequency. A band-pass circuit of about 200 cycles was found to be necessary because variations in thickness of genuine coins due to wear required some latitude in the detection apparatus. A few models of slug ejectors using this principle of operation were constructed and tested, but development work was suspended at the start of the war. Electronic research and development facilities of the company were then utilized to develop instruments for inspection of the thousands of parts which were produced for the various branches of the armed service. Supersonic experiments were conducted on small items such as bullet cores, steel punches, and small caliber cartridge cases.



Flaw detection by observation of reflected supersonic waves. Flaws in the object under test show up as extra pulses in the 'scope pattern

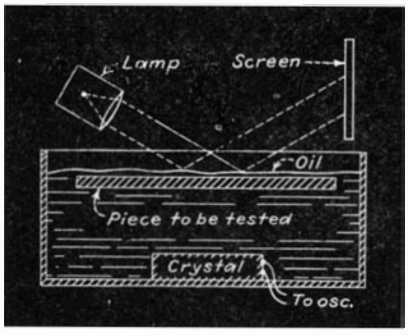
In one method of utilizing sound waves for the inspection of materials, standard specimens are set into vibration and their tones measured to determine the permissible range of tone frequencies. Each piece being tested is then similarly vibrated and its tone checked with electronic instruments or by ear when the items are of such dimensions that the frequency of vibration is audible. Any appreciable difference in tone indicates a flaw. This method is now in use by various industries for testing files, grinding stones, and castings.

HETERODYNE PRINCIPLE USED—When the frequency of vibration extends above the audible range (above 20,000 cycles), an instrument called an audio-heterodyne amplifier is used for making the sounds audible. The circuit consists of an amplifier in which is contained a local oscillator that beats with the incoming frequency to produce a difference frequency that falls in the audio range. This is similar to the superheterodyne principle used in communications.

A satisfactory microphone for picking up supersonic frequencies is a type of crystal cell manufactured by The Brush Development Laboratories. This cell is made from rochelle salt crystals cut to resonate at definite frequencies. Other types of microphones can also be used if the moving element is stretched sufficiently to resonate at the desired supersonic frequency.

The types of flaw which produce deviations from normal frequency in an article are cracks, a change in hardness, changes in dimensions, and changes in composition.

When an article is found which can be tested by measuring its vibration frequency, several good samples are procured and a frequency test is made by striking the article on a hard surface, allowing it to vibrate freely, and picking up and tabulating the sound frequencies. The tabulated frequencies are then analyzed and the band widths established. Some band-width latitude is necessary because of small variations in dimensions in the articles.



Flaw detection by immersing test piece in oil and sending a supersonic beam through it. Amount of light reflected from surface of oil is proportional to amount of supersonic energy passed by the test piece

Next, the production test instrument is constructed. It is designed to pick out any article which does not have the same vibration characteristics as the standard articles, regardless of whether the sound can or cannot be heard.

In the circuit employed for this purpose by Boley A. Andrews of the Vendo Company, the output current of the microphone is amplified by a pre-amplifier tube, fed through a limiter tube that cuts off undesired strong signal peaks, amplified some more in a broadly tuned amplifier stage, then fed into a harmonic generator tube that greatly distorts signals exceeding a certain level, so as to produce many higher harmonics of the signals. The harmonics which pass through the following 175-kilocycle transformer are fed through a conventional intermediate frequency amplifier stage to a diode detector that provides a D.C. voltage for operating a trigger tube. This trigger can be used to close an alarm circuit, turn on a red lamp, or

operate automatic rejection apparatus when the supersonic frequency goes above or below the permissible limits.

The purpose of the tuned amplifier is to allow only those frequencies which are in the prescribed band width to reach an amplitude great enough to operate the harmonic generator.

A typical requirement might be a band width of 100 cycles peaked at 19,500 cycles. The bias supply on the harmonic generator is set so that only those frequencies which are less than about 200 cycles away on each side of the peak voltage will produce harmonics. Thus, harmonics are generated of these acceptable frequencies only. The 9th harmonic of 19,500 cycles is 175.5 kilocycles, which is in the tuning range of standard intermediate-frequency transformers.

The instrument can be adjusted to any frequency merely by changing the microphone and the tuned coil used in the amplifier stage preceding the harmonic generator. The intermediate-frequency stage can remain the same, selecting different multiples of the fundamental frequencies so as to be within the tuning range of the coils.

DURATION OF SOUND—A second method of flaw detection by supersonics involves measuring the duration of sound given off by an article when in free vibration. This system is now being used in its elementary form for testing glasses and goblets. It is also used for testing the bond between two pieces of metals, as in steel-backed bronze bearings. In these applications, the testing is all done by the ear, and the article is struck or dropped to produce vibrations.

When an object is set into free vibration, the amplitudes of these vibrations decrease exponentially. This is due to internal friction of the object and is known as the damping property of vibration.

The specific damping capacity may be determined by measuring the logarithmic decrement of vibration. This can be obtained by vibrating the object first at its natural frequency, than at frequencies on each side of the peak frequency, and noting the amplitudes.

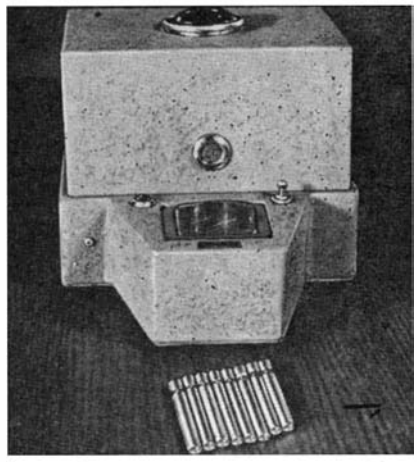
The apparatus required for this type of test includes an audio oscillator, a vibrator, an oscilloscope, and a vacuum-tube voltmeter. The standard specimens are first tested and the decrement noted. Any object that produces a different value of decrement is rejected.

A third method used in supersonic testing is that in which the supersonic wave is actually passed through the piece to be tested and the resultant reflection or absorption of waves measured. This method is more precise than the two previously mentioned systems, but is more involved and requires a larger amount of apparatus.

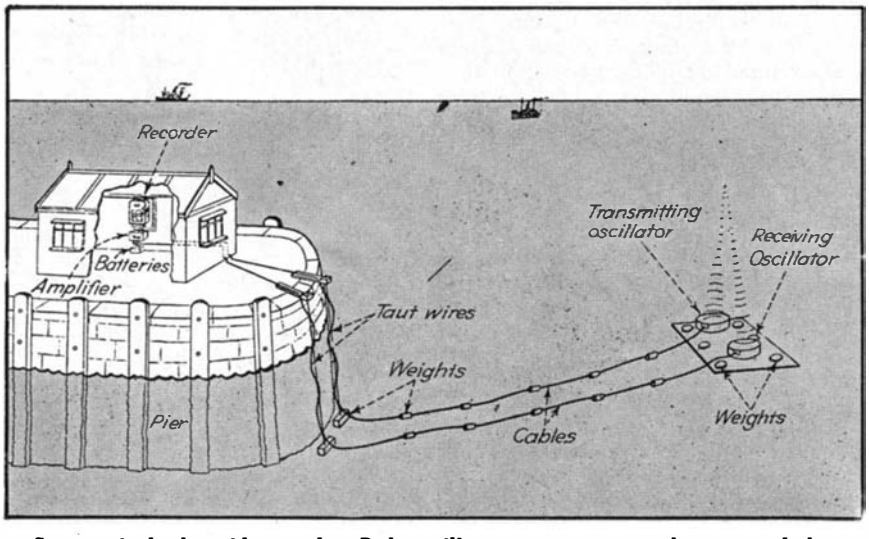
The object being tested is mounted on a suitable support, and a quartz crystal is attached to one end of the test specimen, as shown in one of the illustrations. This crystal is connected to a high-frequency oscillator that is pulse-modulated by a low-frequency oscillator. A rochelle salt crystal for picking up the pulses is also attached to the specimen. This crystal is connected through an amplifier and rectifier to a cathode-ray oscilloscope for visual observation of the reflected waves traveling along the test specimen.

The test is conducted first on several standard specimens, and the reflected waves are noted on the oscilloscope screen. The pattern is a series of reflected pulses which occur at frequent regular intervals when the specimen is flawless. If a flow exists, there will be in the pattern an extra pulse which is not obtained with a good specimen; this is indicated by the dash-dash curve in the illustrated pulse pattern.

In a variation of this method, a quartz crystal which is connected to a supersonic-frequency oscillator is submerged in a pool of oil. The crystal will send sound waves vertically upward in a beam. At the point where the beam hits the surface of the oil, a light ray is focused and is reflected on a screen. The piece being tested is immersed in the oil and placed in the sound beam, and the variations in the intensity of the reflected light on the screen are used as an indication of the quality of the specimen being tested. This method was used experimentally by Sokologg of U.S.S.R. in 1934. More recently, it has been tried for inspecting tires immersed in a tank of water. It was hoped that any change in the transmissibility of supersonic waves through the tire as it was slowly revolved in the tank would indicate the presence of flaws, but early results proved discouraging. Small flaws such as air bubbles did not change the absorption sufficiently to permit detection, but post-war research may well solve the problem and even put supersonic tire-testers in every garage.



Supersonic instrument developed by the Vendo Company for inspecting steel punches. Punches are tapped on the anvil just under the grille protecting the crystal microphone. If the supersonic vibration frequency of a punch is outside the predetermined wave band, indicator lamp is automatically turned on



Supersonic harbor tide-recorder. Both oscillators are on ocean bottom, and the supersonic waves traveling through the water are reflected downward from the water-air junction. Associated equipment measures the time required for the wave to travel from bottom to surface to bottom, converts this data into measurement of the tide level, and records the result on paper tape at regular intervals

WAVE GENERATION—Many methods of generating supersonic waves have been developed. Perhaps the commonest is an oscillating quartz crystal in a vacuum-tube circuit initially developed by G. W. Pierce. A piezo-electric source was developed by the French physicist Langevin for transmission of waves up to 50 kilocycles in sea water for subaqueous signalling. An oscillator making use of the magnetostriction properties of such materials as nickel or iron-nickel alloys is cheap and easy to build but has a practical upper frequency limit of about 60 kilocycles when appreciable amounts of power are required. The Galton whistle can be designed to produce frequencies as high as 100 kilocycles, and is usually built with a micrometer screw adjustment of pitch. Finally, the Holtzmann mechanical supersonic generator uses a glass tube clamped at its center and set into oscillation by friction of two moving silk-covered leather belts.

Some of the most striking experimental results obtainable with supersonic waves depend on the relatively large amount of power which is associated with supersonic waves of moderate amplitude. Waves have been gen-

erated in an oil bath by using a piezo-electric quartz crystal at 50,000 volts and a frequency of about 300 kilocycles. A radiation pressure estimated to be equal to 150 grams was obtained —enough to raise the free surface of the oil into a mound seven centimeters high.

Without especially large vibrations, it is possible to transmit enough supersonic energy through a small rod so that a painful burn is obtained if the rod is squeezed with the fingers. Another direct application of supersonic energy is in making unusual and very fine emulsions.

Reflectors of convenient dimensions may be used to focus supersonic energy or reflect it from a point source such as the end of a magnetostriction rod. Whereas with audible frequencies it is difficult to limit echoes and unwanted reverberations, with supersonic waves the apparatus is small and the reflections can be easily handled.

An immediate demonstration of the realness of the elastic waves that travel through a liquid excited by a supersonic source is furnished by a change in the optical properties of a liquid which is so disturbed. Points along the wave at which the medium is most compressed may become nearly opaque. The presence of the supersonic waves causes the liquid to act like a diffraction grating and the light is diffracted into its characteristic spectrum.

DISTANCE MEASURING—The transmission of sound waves through water for distance-measuring purposes is not new. Lighthouses equipped with radio transmitters and submerged hydrophones frequently send simultaneous radio and sound signals to ships at sea. The radio signal arrives almost instantaneously, while the underwater sound signal travels at the approximate rate of 4800 feet a second in salt water. By measuring the time interval between reception of radio and sound signals, the ship's officer may readily calculate his distance from the shore station.

In a similar manner, a ship can transmit a sound signal downward to the sea bottom and measure the time between transmission of the signal and reception of the echo reflected from the bottom. Supersonic waves could just as well be used for this purpose. In any event, the time interval is very small, a tiny fraction of a second, and its method of measurement must consequently be fairly precise.

Sonic methods of sounding have been in use for a number of years, but the equipment has been relatively complicated. Recent advances in design, utilization of electronic equipment, and successful employment of supersonic waves have brought the equipment into quite general use in at least one European country, not only for sounding but also for detecting underwater objects. Large fishing boats equipped with these electronic fathometers have been able to detect schools of fish swimming many fathoms under water, and increased hauls have undoubtedly quickly paid for the extra equipment.

The complete story of new supersonic applications for use in industry and at sea must wait until restrictions of military secrecy are lifted, but here as in other fields of electronics the future possibilities are bright. With applications already ranging from slug-detectors to fish-finders, the list of possible future applications promises to be quite long and interesting.

HIGH-SPEED SOLDERING

Accomplished Safely With Radio-Frequency Heat

SMALL metal containers used for capacitors are being soldered with radio-frequency power at the rate of 2500 units per hour per operator. The containers, with bottoms and rings of solder in place, are carried by a moving belt through an applicator coil where localized heating induced in the metal causes the solder to flow and seals the bottoms without endangering the capacitor.

AREA MEASURER

Makes Use of an Electronic Calculator

AN ELECTRONIC instrument for measuring areas of flat sections of material is now in use for determining the size of leather hides in the leather industry and for measuring pattern layouts in the textile industry. Other possible applications include measurements of the area of ink on printed matter and measuring the surface enclosed by pinpricks on perforated layouts and outlines.

The hide or other object to be measured is inserted between rollers that transport it through the machine developed by the Stockton Profile Gauge Corporation. Extending parallel to the axes of the rollers is a long narrow slot. As the skin passes across this slot it comes into the path of a scanning beam of light that travels back and forth in the slot.

Since the rate of movement of the beam and the rate of feed of the skin are known, the area of the skin can readily be calculated, when the total time interval during which the beam is on the skin is found by the phototube system.

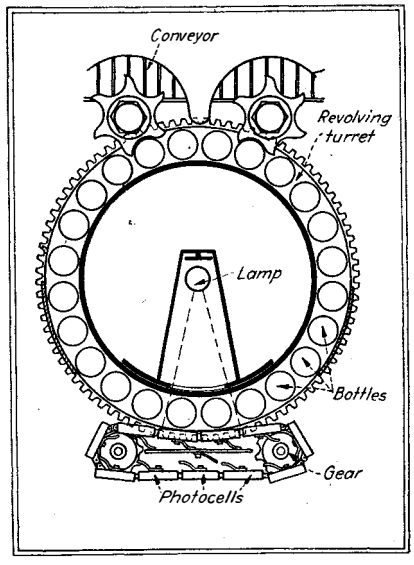
The area of the skin is calculated electronically. Phototubes are positioned above the skin to pick up reflected light, or under the skin to pick up transmitted light, depending on which arrangement gives the greatest change in light when the beam moves onto the skin. Electron-tube amplifiers and indicator lamps provide five electronic-counter visual columns of ten counts each. The numbered lamps flash on progressively from the top of a column as each impulse is received from the photo-electrical equipment in the scanning machine.

Many uses are possible for such a high-speed counter. For example, the speed of missiles could be determined to one fourteen-thousandth of a second by having the missile pass through two loops spaced a definite distance apart. One loop would start to count pulses from a fixed-frequency generator at a predetermined rate, and the second loop would stop the count when the missile passed through.

BOTTLE INSPECTION

Speeded Up by Use of Photocells

PHOTOTUBES have been used for several years for the detection of foreign ingredients in the bottling of soft drinks. A modified and faster system that contains a number of photocells mounted on a roller chain has been designed for the Coca-Cola Company by George P. Stout.



Moving a series of photocells in synchronism with objects being electronically checked, as exemplified by the bottle-contents inspection set-up illustrated, is a scheme that may well be applied, with variations, to other practices, where speed and accuracy are requisites

The roller chain carrying the photocells is driven by teeth positioned around the outside edge of the revolving turret carrying the bottles. As the turret revolves, the teeth engage the roller chain so that bottles adjacent to the teeth travel in synchronized relationship with individual photocells for the necessary interval during the inspection period. When a bottle becomes alined with a photocell, the beam of light from a lamp passes through the whirling contents of the bottle onto the cell. If the beam is interrupted by a foreign particle in the bottle, this change is registered by the cell. The resulting electrical impulse is amplified by electronic means and caused to operate a mechanical method of rejecting the objectionable container.

Insects Can Be Controlled

New Weapons and New Methods of Using Them Have Been Developed by the Chemical Industry. Many of these Have Great Potentialities in the Commercialization of Disease-Ridden Areas Where Insects Have Formerly Prevented Human Exploitation of Rich Natural Resources

By-victories of this global war will do things to and for us long after victories on the field of battle are forgotten. Along with the struggle against the human enemies goes another less publicized but no less fateful war in test tubes and garden plots against our insect enemies. That war, too, moves swiftly to new victories, promises new freedom from disease, and new fruitfulness for farms, orchards, and vineyards.

Miracles in curing disease in this war year parallel important successes in its prevention. The nature of the conflict has taken armies and navies into unaccustomed places where strange insects carry dread diseases. Our men must be protected from insects as well as from human foes lest the disease records of old wars be repeated now on a much grander scale. To insure this protection we have developed new weapons and new and more effective techniques for using them. This secondary war of chemists and entomologists has already chalked up victories of its own, significant alike to the armed services in the field and to generations to come. Mosquitoes, body lice, and a host of other disease-bearing insects face new weapons of unprecedented power in the future. Other insects, which in devouring hordes have eaten or destroyed the produce of our farms, also face destruction by new weapons, by-products of war.

One can scarcely over-estimate the significance of new preventive measures developed in the fight against insects. The familiar historical example is the building the Panama Canal by exterminating the mosquito that carries yellow fever. This great extermination project involved an engineering enterprise too great to be repeated today in all the myriad small islands of the Pacific, the jungles of Africa and Asia, or the slums of great cities. Yet the need now is much greater. Modern swift transportation by air brings all the pest-ridden areas of the world within a few hours of dense centers of population and thus exposes everyone to all the world's diseases by the chance inclusion in any cargo of disease-bearing insects. In this increasingly grave situation the need for effective means to combat plague carriers is clearly pressing.

Vast areas of fertile soil and fruitful climate are prohibited to man by well-established insect families carrying diseases. Areas of Africa in which sleeping sickness (trypanisomiasis) forbids human exploitation are among the richest in the world agriculturally and mineralogically; yet the tsetse fly which carries the disease flourishes there in such abundance that men cannot survive. Similar areas elsewhere are so malaria-ridden as to be equally impossible of human development. The great potentialities of these regions suggest that the conquest of these diseases may well have an effect on the future human welfare equalling or even surpassing that of the discoveries of all the explorers of the Renaissance. Much of that promise seems now to be on the brink of realization.

COMBINED EFFECTS—No single discovery or development will achieve the whole result, but the combined effects of several, now awaiting the end of hostilities to go into action, promise much in that direction. Curative medicine is making vast strides, but prevention also keeps pace. It is worth while in the light of these global problems to look into insecticides as preventives. Their probable effects on the future standard of living are vital in countries now backward in their development because of insects and insect-borne diseases.

One of the most important results of this war is the proof that it is giving people everywhere that insects can be conquered, that the diseases they carry are far from inescapable. The materials and methods used in this fight against insects and disease have undergone extraordinary development under war's impetus and we, already accustomed to the use of insecticides, are in for some important surprises at war's end.

Certain insecticides in mixtures of two or more substances have been shown to accomplish substantially more than either alone or than the expected sum of the actions of the two together. This action, called synergy, finds amazing demonstration in some of the substitutions and economies undertaken as makeshifts to offset war-created shortages. The basic fact that mixtures are sometimes more effective than single materials is not new. Many years ago the convenience of mixing

Dusting a southern cotton field to protect it against boll weevil

intensely cold dry-ice with highly volatile ethylene oxide was discovered to be a more convenient means of introducing the latter into grain elevators to kill weevils. Actually the mixture is more effective than ethylene oxide alone, even though carbon dioxide alone is relatively ineffective. But the explanation was long considered to lie in the low temperature of application which prevented dissipation and loss of the toxic ethylene oxide. Recent discovery of other similar cases of extraordinary action of mixtures has led to a search for more cases with new vigor. The name, synergy, borrowed from medical terminology, signifies working together and defines actions where two and two make five or more instead of the usual four. The whole category of insecticides is being reexamined to find new similar ways to stretch the effectiveness of limited supplies of many of these valuable agents now available.

And not without significant successes. Pyrethrum flowers, formerly grown principally in Japan, supply one of our most effective common insecticides. The extract of pyrethrum, pyrethrin, is highly toxic to insects but relatively harmless to man, and hence is the basis of common fly sprays and like materials. But the flowers were and are stringently scarce and every means possible has had to be sought to conserve and to stretch our meager supply. Sesame oil, expressed from the sesame seeds, produces a remarkable increase in the effectiveness of pyrethrin and allows smaller concentrations to be used without reduction of killing power. That gave the seekers for synergies new hope and led to the discovery that this action of sesame oil is quite general. Further investigations brought to light a series of synergetic actions of other insecticides, until present informed opinion looks primarily to this phenomenon as vital in devising new weapons against our insect foes. Several of the new synthetic insecticides and insect repellents discussed below possess strong synergetic action as one of their important values.

BOMBS AGAINST INSECTS—Much attention has also been given the aerosol bomb as a method of distributing insect-killing products more effectively than ever before. In principle, this consists of a solution of the insecticide in a liquid so volatile that it can be kept liquid only under pressure. When the outlet of the steel cylinder containing the solution is opened, the solution rushes out under pressure and evaporates instantly as it reaches the lower pressure of the atmosphere. This has the very desirable effect of blasting the dissolved insecticide into droplets far finer than can be produced by any atomizer of the usual type. The size of the infinitesimal droplets is so small that they behave almost as a gas and diffuse with great speed and thoroughness into all parts of the enclosure in which they are thus released. Since the dose of insecticide required to kill a single insect is also infinitesimally minute, this method of super-atomizing the killing mixture is especially effective and stretches the available supplies of scarce insecticides far beyond their usual range. The solvent used is dichloro-difluoro-methane, familiar as Freon in the electric refrigerator, chosen for this purpose because it is non-toxic and non-flammable. The most common insecticide dissolved in Freon in the bomb is a synergetic mixture of pyrethrin and sesame oil. However, the method can be equally well applied to others, including DDT discussed further below.

Delousing clothing of soldiers, a ponderous operation as conducted in World War I, when great steam sterilizers were employed, has been greatly simplified. Methyl bromide, long used against weevils in grain elevators, has proved to be effective also against "cooties" and its use requires a minimum of equipment. The clothing to be freed of insects is put into a closed gas-proofed bag and methyl bromide, which evaporates readily, is released in the bag as a gas by merely breaking a small glass ampoule containing it under pressure. Insects are killed in short order.

Most discussed of the new compounds risen to prominence in war service is dichloro-diphenyl-trichlororethane, shortened to DDT for obvious reasons, but also called Gesarol. This compound has remarkable power to kill insects, particularly body lice—the "cooties" of World War I. Prevalence of typhus, carried by body lice, in the Mediterranean theater of this war has emphasized its value. Clothing dusted with DDT powder is immediately freed of lice and retains this killing power over a considerable period of time. DDT's effectiveness now in war may well be overshadowed by its value, as yet unutilized, in peace. Painstaking investigations conducted by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture have shown it to be signally effective against many of the most destructive insects that feed upon the growing crops of our farms. And that is important. Insects eat and destroy something like two billion dollars worth of crops annually in the United States alone. In controlling these pests, the effectiveness of DDT has proved to be so great that entomologists are already counselling caution. Its general use, they fear, may destroy friendly insects as well as destructive ones, bees as well as boll weevils.

In this pest-control research laboratory maintained by Du Pont, actual field conditions are closely paralleled. The light from the large lamp simulates sunlight

THREE IN A MIXTURE—Three other important additions to our weapons against insects have come into special prominence. Dimethyl phthalate, derived from methanol (wood alcohol) and phthalic anhydride, an important ingredient of alkyd resins and made from naphthalene, has proved particularly useful in repelling mosquitos and is harmless and almost odorless when rubbed on the skin. Ethylhexanediol, known also as 612, has similar value and a new compound derived from mesityl oxide and butyl oxalate and called Indalone is also valuable for

Courtesy Westinghouse

A soldier demonstrates how the insecticide bomb is used for defense against malaria and yellow fever

similar purposes. In mixtures, these three materials appear to be synergetic and are far more effective than any of them alone or any mixture.

These are outstanding among currently important developments in the field. Older materials, rotenone particularly, are, like these, stringently short and under strict control until war's end.

It is too early yet to be sure of the future usefulness of these new methods and weapons against insects, but it is clear that they combine to give new power to our fight against insects. One would be foolish indeed to expect them to replace permanently and completely the customary insecticides. But obviously they will supplement existing materials and techniques to make them all more effective. They will thus be immediately useful to agriculture. Their long range value may be confidently expected to lie in opening new areas to safe human habitation and exploitation. Already, backward peoples everywhere are learning that insects and diseases carried by them can be controlled. Soon they will demand help in this respect and will thus be able to raise their own standards of health and of living.

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FLUORINE IN TOOTH DECAY

Controlled Experiment to Determine Real Value

TRACES of fluorine in water supplies have been shown to reduce the tendency of teeth to decay, but positive and final proof has been lacking. This is now to be obtained by a gigantic experiment involving the population of two New York State cities and extending over ten years. Undertaken under the eye of the New York State Department of Health, the experiment consists of adding one part per million of sodium fluoride—an amount too small to be detectable by ordinary means—to the water supply of Newburgh, New York. The neighboring city of Kingston, having a similar water supply but without natural or added fluoride, will serve as a check. A careful inspection of teeth of school children and others in both cities will be made periodically by dental officials and the results tabulated and compared. The experiment is expected to demonstrate within ten years the value, or lack of it, of fluorine in preventing decay of teeth. It is being undertaken to learn whether this or some other factor is crucial in areas already shown to have low rate of tooth decay and traces of fluorine in water supply.

PENICILLIN PRODUCTION

Has Greatly Reduced Cost of the Drug

PRODUCTION of penicillin has soared to a point where the output in March, 1944, was a hundred times that in the first five months of 1943. Civilians are promised supplies of the new drug sufficient "to treat all urgent civilian cases in the relatively near future." The price of penicillin has dropped from an original figure of $20 per 100,000 Oxford units to $3.25, a reduction of 84 percent in a year. In terms of treatment of disease, the present price of penicillin means that the cost of the drug required for a severe case of septicemia is about $35 and for sulfa-resistant gonorrhea, less than $5. In spite of this progress, the actual weight of the drug produced is still small. The completion of the present plant building program is expected to raise the daily output of all plants—costing about $20,000,000—to some nine pounds per day.

COTTON COMPETITION

Can be Met by Introducing Economies

AMERICAN cotton growers have more to fear from the inroads of synthetics than from foreign grown cotton, Ransome Aldrich, president of the Mississippi Farm Bureau Federation, told the National Cotton Council at its 1944 annual meeting. Cheaper production of cotton is necessary to meet the growing threat from rayon, he stated. World rayon production in 1943 reached the equivalent of eight million bales of cotton and is still growing. Economies in cotton farming can take the forms of better, wider, and more efficient use of fertilizers and insecticides, and of mechanization of agricultural operations.

ACTIVATED CARBON

Now Being Produced from Bituminous Coal

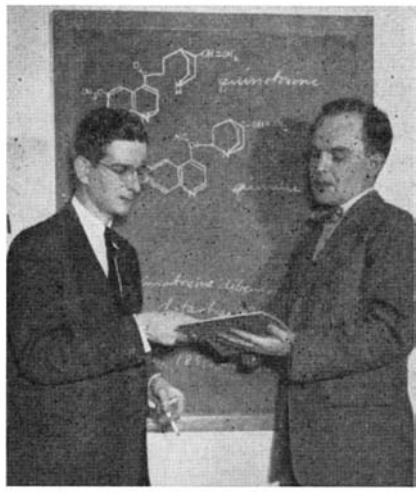
BITUMINOUS coal has been converted by treatment with chlorine into an activated carbon equalling or superior to that formerly made from coconut shells. The operation is still in the early experimental stages but preliminary tests suggest high value for the product. The coal, crushed to pea size, is heated and treated with gaseous chlorine, producing hydrochloric acid and carbon tetrachloride as by-products. The chlorinated coal is pelleted, baked to produce the required hardness, and crushed to the desired size. Subsequent activation is accomplished by treatment with steam at bright red heat. The final product exceeds the specifications of the Chemical Warfare Service, by which such materials are judged, and is expected to have important applications in industry for decolorizing and purifying.

QUININE SYNTHESIZED

But May Not Get into Production in War-Time

SUCCESS in one of the longest and most persistent searches of chemists was realized recently with the announcement of the synthesis of quinine by two American chemists, Robert B. Woodward, of Harvard University, and William E. Doering, now of Columbia University, consultants for the Polaroid Company. Details of the synthesis include a long series of successive steps leading to the final product. The discoverers in their announcement state that there is doubt whether their process can be put into production in war-time and they do not estimate costs.

The problem of synthesis of quinine has been unfinished business with chemists for more than a century. One of the early attempts to produce this important alkaloid led Sir William Perkin to produce the first synthetic dye in 1856 and thus laid the foundation of the modern dye industry. Numbers of chemical compounds studied in the long course of the search have proved highly valuable in fighting malaria, principal use of quinine, and for other purposes. Atabrin and Plasmochin, two trade-marked synthetics, have proved particularly valuable during the dearth of quinine caused by seizure of the Netherlands East Indies by the Japanese in this war. But none of the compounds heretofore produced has exactly duplicated quinine as the present one is said to do.



Chemists Woodward (left) and Doering, pioneers in synthesis of quinine

Highways After the War

Short-Haul Motor-Vehicle Traffic Requirements Will Probably Dominate Post-War Planning in this Field. The Report of the Interregional Highway Committee Shows the Trend Which May Be Expected. Separation of Traffic Flow and Elimination of Grade Crossings are Important Elements

By V. T. BOUGHTON
Associate Editor, *Engineering News-Record*

WHAT FORM will our highways take after the war? Will the new ones be similar to those built just previous to the war, or can we expect to see the widespread construction of a network of superhighways similar to those visualized by Norman Bel Geddes in the General Motors' Futurama at the New York World's Fair?

Such questions arise in the minds of many people who attempt to look beyond the war to the day when tire and gas rationing will be but a bad dream and when war bonds can be converted into new automobiles to be used at will. The answer appears to be that the dream highway of the Futurama type will still be dream highways and that post-war highway designs will not depart radically from the types with which we are familiar.

The dream highways of men whose thinking is unhampered by practical considerations have been shown on analysis to be of less real service to the public than the simpler designs of highway engineers experienced in fitting abstract theories to practical limitations. This is not to say, however, that the post-war years will not see many major improvements over existing highways and the construction of many miles of superhighways such as the Henry Hudson Parkway at New York, the Outer Drive at Chicago, the Detroit Expressway, and the Arroyo Seco Parkway at Los Angeles.

There are two main reasons for this conclusion that the early post-war years will bring no radical change in highway design. The first is that our state highway departments will come to the end of the war with a vast accumulation of urgent replacement work that must be done to keep the highways we now have in safe operating condition. These departments are now engaged in making plans for that work and for such new construction as is urgently needed.

The situation with respect to roads is not unlike that with respect to cars to operate on those roads. Replacement of worn-out vehicles will be the major problem of the automobile manufacturers as soon as they can resume normal operations, and the speediest way to replace is to work to existing designs, letting experiments with new models wait.

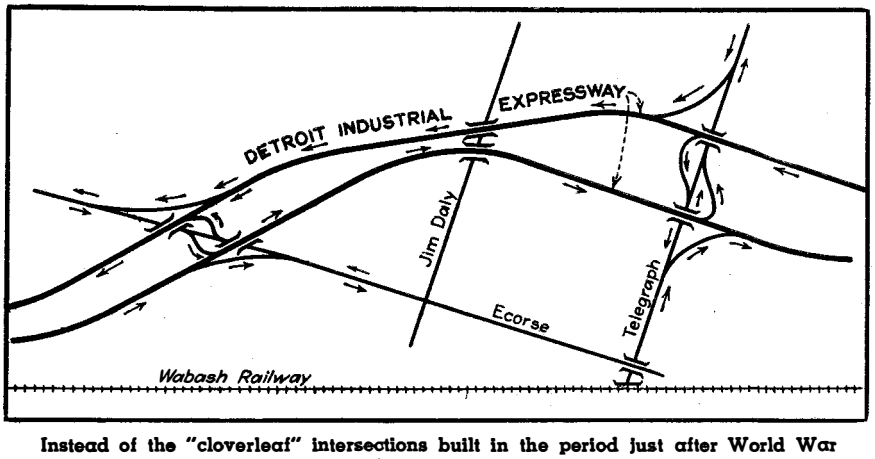
SHORT-HAUL TRAFFIC—The second consideration that will control post-war highway work is even more basic. It finds its origin in the fact that 85 percent of all trips by automobile are for distances less than 20 miles. Long-distance travel that would be served by superhighways running from coast to coast and from the Canadian border to the Gulf states and Mexico, which have been proposed by visionary highway planners for many years, actually would serve only a small percentage of the population. The nation's greatest need, as anyone who drives a car in the densely populated areas will recognize, is for better highways into and through our centers of population.

If the post-war transportation situation is viewed broadly, a clear indication will be found that the percentage of long-distance auto travel after the war may decline rather than increase. Without doubt, air transport will go forward with great strides after the war, and its chief service will be to long-distance travel needs. Also, the railroads are becoming acutely aware of the wants of the traveling public. Hence, post-war transportation trends may be expected to emphasize the need for better highways to serve the short-haul traffic in and around our cities.

Construction of highways into and through populated regions is a great and costly undertaking that cannot be inaugurated quickly and pushed to early completion. Involved is the purchase of wide rights-of-way through built-up communities, removal of buildings on those rights-of-way, changes in utilities, and the construction of four- and six-lane roads, which generally must be depressed or elevated to eliminate all grade crossings and therefore require an abnormally large amount of bridge construction per mile.

Much study is being given to this type of highway, and those that are to be built will have incorporated in them the latest ideas in highway design. Many will be what are known as limited-access highways, that is, highways which can only be entered or left at certain designated points. In a number of instances, this will result in the construction of parallel roads to serve the adjoining properties cut off from free access to the main road.

Where these highways are to be built through highly developed regions, an effort will be made to disturb the existing developments as little as possible. Where they lie through run-down areas in large cities, much thought is being given to proposals to make them the starting point for a rejuvenation of those areas. In some cities it has been proposed to take rights-of-way



Instead of the "cloverleaf" intersections built in the period just after World War I, those built following the present war will probably be designed for "directional flow" of traffic similar to the design of the Detroit Industrial Expressway, above

Sodium-vapor lamps were installed to light intersections on the Pennsylvania Turnpike. The post-war era may see some radically new applications of fluorescent lighting

A three-level crossing at the Ford Willow Run plant on the Detroit Industrial Expressway. This highway was designed as the initial part of a future limited-access road

much wider than actually needed for the highway, in order to be able to control the redevelopment of the area.

Also having a significant bearing on what highway work will be undertaken after the war is the fact that the Interregional Highway Committee, set up by the President in 1941, has submitted its report to Congress, proposing that after the war an immediate start be made on the development of a 33,920-mile system of interregional highways as part of the so-called federal-aid highway system. This proposed system will not be made up entirely of additions to our present highways; in large part it will be created by the reconstruction or relocation of existing highways. Many limited-access roads will be part of that system.

TOLL ROADS FROWNED UPON—Few toll roads, of which the Pennsylvania Turnpike is an outstanding example, will be built after the war. Congressional road policy has long been opposed to toll roads on the basis that state and federal funds used to build highways now come in larger part from gasoline and motor-vehicle taxes, hence the road users already have paid for the highways through such taxes. It is of interest to note that the Pennsylvania Turnpike is not included in the Interregional Highway System plan, presumably because it is a toll road.

Motor parkways were built in some parts of the country in pre-war days largely for recreational use, but also to facilitate long-distance travel by private automobiles. Some further extension of these highways may be expected after the war, but it probably will be only in regions where special considerations such as a predominance of pleasure driving make that necessary. Roads of this type, such as the Merritt Parkway in Connecticut and the Eastern State Parkway in New York, roughly paralleling the Boston Post Road and the Albany Post Road, respectively, have been a great boon to private automobile drivers wishing to escape the dense commercial traffic on the older roads, yet they have not solved the traffic problems on the older highways. Those roads must still be rebuilt or supplemented by parallel highways open to all types of traffic in order to end the intolerable traffic congestions and accidents in the communities through which they pass at present.

This condition serves again to emphasize the fact that it is the short-distance movement of either private or commercial vehicles that make up the great bulk of road traffic.

Probably the best indicator of design trends is the report of the Interregional Highway Committee, which set the basic standard for the highways that are to make up that system.

All rural sections of the system are to be limited-access highways, and on all sections where the average daily traffic exceeds 5000 vehicles, all crossings with other highways or railways are to be separated. Where four or more traffic lanes are required, two distinct one-way roads are to be provided rather than a single divided highway.

An example of this type of separated roadways is found in the newer sections of the Eastern State Parkway in New York on which, in hilly country, the opposing traffic routes at times are so far separated as to be out of sight of each other.

Curvature on the inter-regional highway is to be kept as flat as possible, and all but very flat curves are to be superelevated to permit comfortable operation around the curves at high speed. No speed limits are set, but the design speed used in fixing curvature, superelevation, and sight distances range from 50 to 75 miles an hour, depending upon the character of the country—whether flat or mountainous.

Modern practice in the construction of main highways through built-up areas is to depress the roadway below intersecting streets, to restrict access to points where ingress and egress will not interfere with highway traffic, and to provide parallel roads which will serve local needs

At least two 12-foot wide traffic lanes in each direction are to be built on the inter-regional system on all rural roads carrying from 3000 to 15,000 vehicles a day. Not more than three lanes in each direction are to be provided on roads carrying more than 15,000 vehicles a day. Opposing traffic on these latter roads must be separated by median zones not less than 15 feet wide. Shoulders, except in mountainous territory, are to be 10 feet wide.

Advertising signs and all structures are to be kept out of a zone 100 feet wide beyond the edge of the pavement by outright purchase of the land or by acquisition of highway development rights. It is proposed that, wherever possible, there be public control along the interregional highway system over a strip of land at least 300 feet wide.

At the separated intersections with other highways, where interchange is permitted, acceleration and deceleration lanes are to be provided outside the regular traffic lanes. Sharp turns requiring sudden reductions in speed on these interchange roads are to be avoided, and the designs are to be such that diverging lanes are to follow as closely as possible the normal direction that a vehicle would follow in moving from the main highway to the intersecting highway.

PROTECTING PEDESTRIANS—Pedestrians are not to be permitted on the pavements or shoulders. In rural areas, where necessary, pedestrian paths and overpasses are to be provided. In urban sections, sidewalks will be provided along the parallel service streets.

It is too early to predict what highway lighting developments after the war will be, because the strides made in the development of fluorescent lighting for war plants seems to indicate that there will be much wider use of that type of lighting after the war. Such a development is bound to have

its effect on highway lighting. Indicative of this is the design of a bridge being made for the California Highway Department in which the sidewalks and roadways are to be lighted by fluorescent tubes underneath the handrails and so placed as to light the roadway and walks without being visible to automobile drivers. This development is more fully described and illustrated elsewhere on this page.

All in all, such factors in highway construction as will contribute to public safety and convenience will appear largely in post-war planning, with emphasis on practical rather than spectacular aspects.

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BARGES

Have Welded Steel Frames Encased in Concrete

A NEW type of barge consisting of a welded steel frame of lightweight H-sections tied together with reinforcing bars and encased in concrete has been built in England. The barges are of two sizes, 200 and 400 tons dead weight, the smaller size having a length of 85 feet, a deck width of 22 feet, and a draft of 8½ feet. British patent rights have been granted for this type of ship construction, and American and other rights are pending.

The steel frames are of 6 inch, 12 pound sections, and are spaced on 1.25 foot centers. Concrete panels are cast between the steel frames, the concrete surfaces being flush with the surface of the steel section flanges.

BRIDGE LIGHTING

Accomplished from Concealed Sources

EXPERIMENTS are being conducted by the California Division of Highways that promise to provide a novel method for lighting the sidewalks and roadways of bridges. The plan involves the installation of a continuous line of reflectors on the hand rails, from which concealed sources of light will emanate their rays. Thus the lights will not shine into the eyes of motor drivers but will give maximum illumination on the sidewalks and at the edges of the roadway.

Final decisions have not yet been made but it is expected that the most economical source of light will be luminous tubes mounted horizontally in a position of maximum security and protection beneath the hand rails.

HIGHWAY PROGRAM

Would be Carried Out as Post-War Project

CREATION of an interregional highway system of 33,920 miles has been proposed to the Congress by President Roosevelt who has approved a report made by the National Interregional Highway Committee. The committee, which was appointed by the President in 1941, stated that work on the system should be undertaken as a post-war project and carried forward at the rate of about $750,000,000 a year for several years.

The proposed work would include modernization of some existing routes and construction of new highways that would connect directly all cities of 300,000 or greater population. [See also feature article, page 16.— *Editor.*]

CONCRETE STRENGTH

Retained Despite Long-Time Mixing

SAMPLES taken at 30-minute intervals from a batch of concrete that was mixed over a four-hour period indicated that there is little loss of strength through long-time mixing, as measured by standard test cylinders broken after a 28-day period of setting.

The test was made by the Department of Public Works of New York City, and was intended as a guide to the effect on slump and strength of abnormally long-time mixing in truck-mounted mixers.

WASTE CONTENT

Determines Charge for Use of Sewer

INDUSTRIES that discharge their wastes into the municipal sewer system in New Brunswick, New Jersey, must now pay a special charge for this service, the rates being based on the volume of flow, solids content, and the chlorine demand of the waste.

This three-part rate schedule is intended to provide a fair measure of the "load" placed on the municipal sewage treatment plant by individual industries. According to Chester W. Paulus, mayor of the city, New Brunswick was forced to take this action because excessive waste discharges from war industries had greatly increased operating costs at the city's disposal plant.

The ordinance setting forth the established industrial waste rates provides charges based on $22 per million gallons of flow, $5 per ton of solids in the wastes, and $5 per one hundred pounds of chlorine demand exerted by the waste liquid.

ARMY BRIDGE BUILDERS

Use Special Trucks for High-Speed Operations

A COMBINATION equipment carrier and erection unit is being used by the United States Army combat engineers to expedite temporary bridge installations. In a recent test a 330-foot pontoon crossing was completed in three hours and two minutes.

The unit consists of a heavy army truck on which is mounted a special steel carrier body and an 8000-pound capacity crane. Each unit carries pontons, steel saddles, and four 2000-pound treadways for 30 feet of bridge. The trucks are 31 feet long and weigh 26 tons loaded.

One of the features of the unit is the 14-foot crane at the back of the truck. This is hinged at its base, and is hydraulically controlled. Swinging from its traveling position along the outside of the body, it is designed to pick up the heavy steel treadways, two at a time, and unload and position them for subsequent attachment to the pontons.

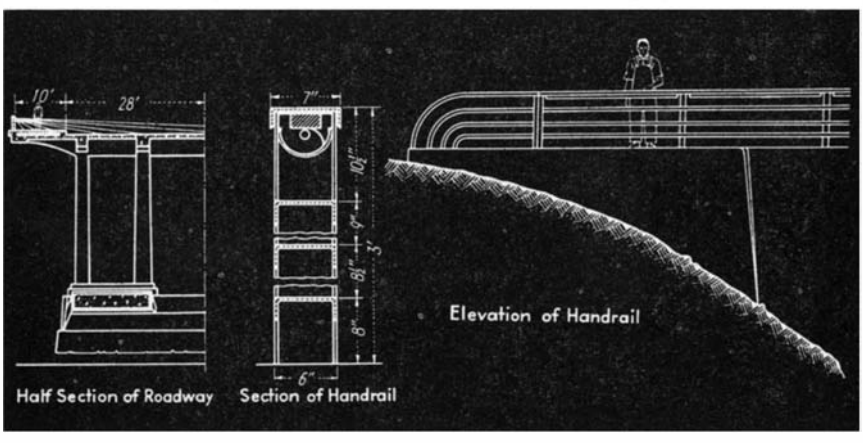
WATER SUPPLIES

Will Be Widely Extended After the War

ADDITIONAL water-supply facilities that are needed in the United States will cost more than $683,000,000, according to an inventory compiled by the United States Public Health Service. Extensions in 6455 communities will cost an estimated $502,000,000, and new systems in 4863 places will require an expenditure of $181,000,000.

Although more than 99 percent of the communities in the largest population groups (5000 and over) are served by public water-supply facilities, only 43 percent of the towns with less than 1000 population are so provided.

Public water supplies date historically from the year 1652 when the first system of its kind was instituted at Boston. In 1900 there were about 3200 systems, and in 1940 the number approximated 14,500. At the present time about 84,500,000 people are served by public water supplies.



How fluorescent lamps provide concealed lighting for bridges

Continuous Casting

A Number of Relatively Simple and Inexpensive Machines Have Been Perfected in which Molten Metal is Poured into One End and Continuous Lengths of Billets, Sheet, or Strip Emerge from the Other End. Practically All Aluminum, Magnesium, and Copper Alloys are Now Cast in this Manner, and Experiments Currently Under Way with Steel Show Great Promise

By T. W. LIPPERT
Editor, *The Iron Age*

FOR CENTURIES metal has been poured into molds to solidify into ingots. These ingots are subsequently heated to a plastic temperature, and rolled through many stands of rolls into sheet or strip; or rolled into tubing, bars, and structural shapes; or rolled into bars which later are drawn into wire or forged into a variety of machine or equipment parts.

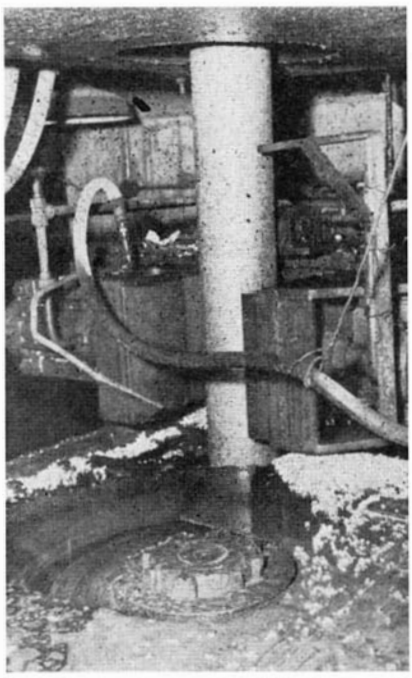
Today, one single ingot of steel may weigh 5, 10, 20, or 30 tons. This large mass of metal must later be heated to plastic temperature and gradually worked down until the final finished product becomes a thin sheet or strip, or even a wire hardly thicker than a human hair. This working-down process involves a great many operations, equipment valued in the many millions of dollars, high metal scrap losses, and infinite care to assure comparable physical properties from ingot to ingot.

It has long been a dream that perhaps this large ingot could be avoided, that perhaps all these expensive and time-consuming working operations could be minimized. To this end, a number of machines have been perfected, whereby molten metal is poured into a simple and compact mold and the heat extracted by high-velocity water sprays. The products emerging from this mold are continuous, uniform as to physical and surface conditions, and of such a size that only a relatively few additional rolling operations are necessary to get the metal into final form of strip, sheet, bar, or structural shape.

These machines, being compact and relatively inexpensive, greatly reduce the equipment necessary to fabricate metals. Furthermore, scrap losses are very small, and quality of metal frequently is superior to that turned out in the conventional manner.

Two general classifications of continuous casting machines are in operation. The most common type turns out solidified metal in the form of round, square, or rectangular billets. This metal goes to rolling or extrusion machines for reduction into a finished form. Another, less successful, type converts liquid metal directly into strip or sheet that requires only a few simple additional cold-rolling operations to produce a finished metal.

Based solely on the criterion of tonnage of commercial metal produced, the Alcoa DC (direct casting) equipment is by far the most successful in operation in this country. Every ounce of aluminum and magnesium extrusion rounds and sheet ingots produced by the Aluminum Company of America, with the exception of the simple 2S and 3S analyses, passes through this type of continuous casting unit.



A 14-inch round billet of aluminum alloy being continuously cast at a speed of 12 to 15 inches per minute in a Rossi machine at an Extruded Metals Corporation plant. The solidified metal comes from the mold chamber and is cut into two-foot lengths by the horizontal saw, which moves with the billet while cutting

TRANSITION IN CASTING—Large tonnages of aluminum and magnesium similarly are handled in Alcoa-licensed machines in the plants of Extruded Metals, Revere, Bohn, and Tube-Turns. Thus it is apparent that the bulk of the country's light metals has passed from conventional casting equipment into continuous casting machines during the past several years.

For example, a DC unit at an Alcoa plant is now producing at a rate of about 25,000 pounds of metal every eight-hour turnout, but this output can vary considerably, depending on ingot size, number of molds being poured simultaneously, and analysis of metal being poured.

In the case of this particular machine, the melt has a furnace temperature of 1375 to 1385 degrees, Fahrenheit, and passes down a runner to a cast-iron distributor pan, equipped with four cast-iron nozzles, individually controllable, each of which feeds a casting chamber. Metal temperature in the pan is, say, 1270 to 1325 degrees, Fahrenheit, and a metal head of about 5 inches is maintained in the pan.

The molds are simple aluminum tube sections 10 inches in length, set into a steel plate framework. About one quarter of the heat of fusion is extracted through the mold wall, which is cooled by water sprays or jets. The remaining heat is extracted by multiple water sprays directed around the periphery of the ingot shell.

A hydraulic platform underneath the molds drop down at a speed of about 3 inches per minute, carrying the four casts with it. The entire cast (or drop) takes about 40 or 50 minutes, at which time the ingots are some 10 feet or more in length, depending upon the size of the heat. At the end of the cast, the distributor pan is removed, the platform is lifted sufficiently to loop crane slings around the ingots and lift them from the pit. Subsequently the platform is again lifted to floor level, the distributor pan again set in place, and everything readied for another cast. Of course, if so desired, the platform arrangement could be replaced by pinch rolls and automatic cut-off saws.

Well over 60 DC units are in continuous commercial operation in this country. The mold sizes vary from 8 inches to 16 inches in diameter for round

extrusion ingots; sheet ingots vary in cross-section from 6 by 22 inches to 12 by 48 inches; and sizes for blooming-mill work vary from 8 by 8 inches to 18 by 20 inches in cross-section. Some of the older units cast in 90-inch lengths, whereas the newer units cast in lengths in the neighborhood of 140 inches.

These sizes apply for both aluminum and magnesium, although magnesium sheet ingot cross-sections are usually of the smaller size mentioned above. In magnesium, emphasis on round castings for extrusion is expanding considerably with the growing tendency to pre-extrude all strip billets, a practice for years common with I. G. Farbenindustrie in Germany.

FOR DAYS AT A TIME—The Junghans (Rossi) method of continuous casting makes use of an orthodox unit in which casting of large billets may continue uninterrupted for days at a time, the metal being cut into billet lengths by means of a flying saw while in motion. In 1940 only one American company, the Scovill Manufacturing Company, had a Junghans machine in operation, and it had already cast some 60,000,000 pounds of commercial brass, mostly in 7⅞-inch round sizes. This cumulative figure is currently approaching 400,000,000 pounds.

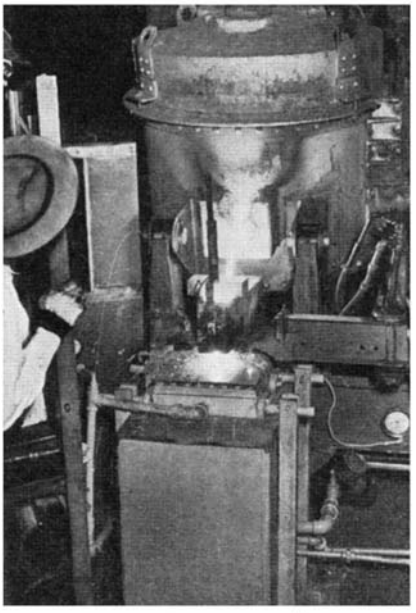
In April, 1940, James Booth, Ltd., Birmingham, England, had just initiated production in a larger Junghans machine, casting aluminum alloys, mostly extrusion rounds up to 16 inches in diameter. A few Junghans units are also in regular use in Germany on aluminum alloys and brass. Although most of the German plants have been bombed repeatedly over the past six months, some information coming out of the country via Switzerland since the war leads to the belief that there has been great expansion in Junghans installations all over Germany, designed primarily to supply light-metal extrusion rounds for the aircraft industry, and cartridge brass rolling ingots for the ordnance plants.

Since 1940, a number of larger and better engineered Junghans-Rossi machines have been built in the United States, for use primarily in the brass industry. In addition to the original Scovill unit working on extrusion rounds up to a maximum of 10 inches in diameter, the same company has since 1940 installed a larger machine primarily for brass sheet slabs up to a maxium width of 24 inches.

A neighboring company, the Bridgeport Brass Company, has installed three Junghans-Rossi machines, one for slabs up to 30 inches wide, and two for extrusion rounds up to 10 inches in diameter. The Extruded Metals Corporation over a year ago initiated production in a unit for aluminum rounds up to 14 inches in diameter.

An accompanying photograph of the Extruded Metals Corporation unit illustrates the use of the Junghans-Rossi machine on aluminum alloy extrusion rounds. Delivery speed of this machine is anywhere from 5 to 20 inches per minute, equivalent to some 100,000 or so pounds of aluminum alloy billets per eight-hour turn.

As new Junghans-Rossi machines are developed, the casting speed is slowly rising. Scovill is now casting eight-inch diameter brass billets at the rate of 16,000 pounds per hour, or about 360,000 pounds per day, and this rate is maintained for days on end. At the Bridgeport Brass plant this hourly rate has been greatly increased though not for such extended periods. The rates for aluminum run about 40 percent higher. Each machine normally requires three men for operating it.



Continuously casting a six-inch square billet of steel in a Williams machine. The molten steel pours from the electric furnace and is cooled in the mold in the foreground by means of high-velocity water flow. The billet comes from the mold at about 10 feet per minute and is cut to length by an oxygen lance

The conspicuous and unique characteristic of the Junghans machine is that the entire mold, water jacket and all, moves down at the same speed as the emerging billet for a distance of several inches, and then snaps back to its original position, the snap-back speed being about three times the speed of the billet. The function of this movement is to present a constantly changing section of the mold wall to the molten metal, which in turn facilitates freezing a skin onto the molten metal. The infrequent relative movement between mold and metal also tends to minimize skin ruptures.

After the cast ingot leaves the mold (or, rather, the mold moves upward away from the cast metal), the metal obviously requires considerable additional cooling. This takes place in a circulating body of water, fully enclosed and at the bottom of which is a rubber squeegee seal, which prevents water from running down the ingot and messing up things below the casting floor. The ingot, as it emerges from the squeegee, is both cool and dry.

At the American Smelting and Refining Company plant, an experimental-commercial continuous casting machine has been in operation for some four years, turning out large tonnages of oxygen-free (phosphorized) copper billets up to three inches in diameter, which are sawed into 50-foot lengths for use primarily in the production of seamless tubing. The surface condition of this metal is smooth and free from flaws, the metal is dense and uniform, and in general it is a high-quality product superior to that produced in prior conventional equipment.

This machine is essentially a refractory (graphite) chamber holding a sizable quantity of molten metal, with automatic temperature recording auxiliaries for holding the metal within close limits and with facilities to protect the metal against oxidation. In the bottom of this chamber are set four graphite dies along with their individual cooling arrangements. The continuously cast rods are individually withdrawn from these dies and either reeled or cut into lengths by saws.

The machine works continuously, day and night. If, after several hundred hours of service, a particular graphite die should wear it can be removed and a new one replaced without interrupting the casting in the other dies. The multiple die arrangement overcomes the disadvantage of the very slow production of a small cross-sectional cast of metal from each die, and the unit as a whole has a most respectable hourly output—on the order of several thousand tons monthly.

PROCESSES FOR STEEL—All the machines so far described have dealt with continuous casting of non-ferrous metals in ingot or billet form. Whereas the Junghans-Rossi machine has been used in Germany for casting steel, surprisingly enough no effort so far has been made to give it a trial for steel in this country.

In the continuous casting of steel ingots or billets in the United States, by far the bulk of experimental work has been carried out by the Williams Engineering Company, under the direction of Edward R. Williams, president of Vulcan Mold and Iron Company. The Williams patents are concerned principally with mold design and methods of mold cooling and lubrication.

Williams makes his mold of commercially drawn copper or brass tubing of about ¼-inch wall section, which mold is fastened into an accurately machined cooling chamber. The wall of the heavy steel cooling chamber is separated from the inner mold wall by only a fraction of an inch, and a multitude of flutings in the cooling chamber press against the mold wall, keeping it in shape and directing a high-pressure water flow along the mold wall to scour the heat away rapidly.

The Williams mold does not move. As the billet or ingot emerges from the bottom it passes through a series of sizing rolls that prevent bulging of the walls by ferrostatic pressure from the molten chamber. Water sprays surround these sizing rolls and the

ingot is almost cool when it gets down to a set of pinch rolls which withdraws the ingot from the mold. Mold lubrication is frequently used, and this is automatically introduced around the edge of the molten metal pool by a multitude of orifices, the volume of lubrication being controlled by the speed of the pinch rolls withdrawing the billet.

About a year ago, the Williams process was taken over by the Republic Steel Corporation for extensive experimental investigation at the Cleveland Corrigan-McKinney plant.

It is believed that present mold design limits the casting of, say, a 3 by 8½-inch section to speeds of from 5 to 8 feet per minute. Since faster speeds are desirable, some alteration in mold design may have to be evolved. Republic is currently constructing new molds incorporating many refinements.

The only other equipment in experimental operation with steel is that designed by Norman P. Goss, of the Cold Metal Process Company. A machine has been built and operated at intervals at a plant of the American Steel and Wire Company. Goss provides for a mold made up of numerous sections, each section individually cooled.

Particularly interesting is the means provided whereby, as the metal skin freezes and pulls away from the mold wall, a finely divided solid material is introduced through many orifices in the mold wall. This material is capable of remaining solid during the casting operation and also capable of accommodating itself to the interstices between the cast metal and die wall. In this manner the walls of the die are protected from abrasion and galling, and the congealing metal is also protected from run-outs and abrasion. This material also maintains a heat-conducting contact between the ingot skin and the die wall. Like the Williams process, the Goss method of casting steel needs considerably more experimental investigation, but can well be a method very much worth watching for the effect it could possibly have on the economics of steel production.

FROM LIQUID TO STRIP—All the previous methods of continuous casting have turned out ingots or billets that are subsequently extruded into structural sections or rolled into strip. The C. W. Hazelett process, however, converts liquid metal directly into sheet or strip, by pouring the molten metal between two water-cooled revolving rolls. Several units are installed and in varying stages of activity or experimentation.

Results to date have been encouraging. A great deal of excellent brass has been rolled on one unit for the Army, in six-ton heats, the continuous strip being up to 30 inches wide and 0.012 inch thick. The mill is now working on copper, and probably will handle large copper strip requirements after the war.

In addition to the interest that one United States Steel Corporation subsidiary has in the Goss process, the corporation also has patented a somewhat unusual continuous casting machine, and intends to give it an experimental whirl. The significant feature of the machine is the casting (or extrusion) of a ceramic mold around the liquid metal as it is cast into a billet.

Dow Chemical Company and Reynolds Metals Company have developed machines similar in some respects to the Alcoa equipment previously described.

A bar and billet casting machine has been devised by the International Nickel Company of Canada and is in use at one American Metals Company plant. Inco of Canada has one unit in operation on copper at Copper Cliff, Canada. The American Metals machine continuously casts three-inch square copper wire bars or three-inch piercing billets at a rate of about 4000 pounds per hour. The copper is continuously fed from one of two melting furnaces, through a closed runner to the mold chamber. The mold is copper, with many internal passages for coolant.

Particularly interesting is the fact that the mold is split in two parts axially, and these parts vibrate very rapidly to overcome friction, the amplitude of the vibration being very small, or less than enough to break the surface tension of the molten metal pool on top. Metallurgical characteristics of the metal are excellent and surface condition of the bar is so good as to not require scalping prior to subsequent manufacturing operations. This machine is very successful in all respects, and additional installations are to be expected.

The outstanding features of this overall development of continuous casting are the tremendously accelerated rate of installation and technical progress in the last ten years and the positive interest now being shown in the process by some of our largest metal-producing companies.

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SMALL DIE CASTINGS

Made Rapidly by New Process

EXTRAORDINARY possibilities for postwar designers have been opened by the recent development of a process for die casting tiny parts at remarkably high rates. Costs are so low that the die-cast products may successfully compete with virtually identical items heretofore made on cold headers, wire-forming machines, screw machines, punch presses, and so on.

The die casting machines used not only operate automatically but are equipped with supplementary attachments that remove the casting from the die, cut off the gate, trim the flash, and so on. Despite their small size, many of the castings are precisely cored.

The process, developed by Crown Fastener Corporation in conjunction with Gries Reproducer Corporation, is in use for the production of zinc-alloy slide fastener elements die cast directly onto the tape, for separately die-cast fastener slides, stops, and locking parts, and for other small zinc alloy castings such as brads, rivets, various types of pins, rings, buttons, and so on. The machines operate at the rate of several hundred shots per minute.

Die castings as small as ⅛ inch long and ⅛ inch in diameter have been made by this process. In general, it has demonstrated its utility for parts weighing less than ½ ounce and not over ¾ inch in maximum dimensions. Tolerances can be held from minus 0.000 to plus 0.003 inch across a parting or down to ±0.001 inch within integral portions of the die.

STELLITE REFLECTORS

Stand Up Under Naval Service Conditions

PARABOLIC reflectors for Navy use in sizes up to 36 inches in diameter must meet rigid requirements—high reflectivity; permanent resistance to tarnishing by salt air, spray, powder fumes; resistance to shattering; resistance to pitting from hot particles of the searchlight electrodes and to oxidation from the heat of the nearby arc.

Trials with silver- or chromium-plated steels and other reflector materials were unsatisfactory. The Navy finally decided upon the heat- and corrosion-resisting Stellite alloys (nominal composition 55 percent cobalt minimum, 33 chromium maximum, and 6 tungsten maximum), which were found to be free from corrosion, pitting, and dulling, and to withstand several months of outdoor exposure without loss of reflectivity.

The Stellite alloys, long used for cutting tools, are generally considered difficult or impossible to form in sheet metal and to machine. Actually these reflectors are far and away the largest parts requiring forming, machining, and polishing in which these alloys have ever been made.

While the reflectivity of Stellite is only about 68 to 70 percent, it has the great advantage of maintaining that reflectivity under service conditions. Silver's reflectivity of 95 percent is much higher but it tarnishes and scratches more readily. The whole development is a step forward in the working of hard materials that will be adaptable to peacetime production.

NATURAL-AGING ALLOY

Requires No Heat-Treating to Develop its Properties

DEVELOPMENT of a sand-cast aluminum-base alloy containing 0.5 percent magnesium, 5.25 percent zinc, and small amounts of titanium and chromium, that provides high physical properties without a prior solution or quenching heat treatment was described by Hiram Brown, metallurgist of Frontier Bronze Corporation at the recent annual meeting of the American Foundrymen's Association.

Known generally as A.F.A. alloy, B-81, the alloy meets Army-Navy-Air

(*Please turn to page* 42)

Man Against Oxygen

In the Perpetual Struggle to Prevent Oxygen from Combining with Man's Best Metals, Such as Iron, the Petroleum Corrosion Preventives, Now Proved Up in the War, are Shouldering their Way into Wider Use—Just as They Shoulder their Way Under the Water that Causes Rust

By R. G. SLOANE
Technologist, Standard Oil Company (New Jersey)

PEACETIME toll of corrosion in industry runs into many millions of dollars. Some of the corrosion comes from contact with corrosive chemicals in process industries, some from contact with water or steam as in the boilers in power plants, and some simply from exposure to the air which, in industrial areas, is particularly corrosive because of its content of sulfur-containing gases. Protection against corrosion from exposure to the atmosphere or from immersion in water may be obtained by coating metal surfaces with a film of specially prepared petroleum products.

A number of theories have been advanced in explanation of corrosion. In the case of iron exposed to moisture, the corrosion manifests itself by the formation of rust. When iron is immersed in water, iron ions, or electrically charged iron particles, travel into the water. The iron ions are positively charged and combine with negatively charged hydroxyl ions to form iron hydroxide. Oxygen dissolved in the water oxidizes the products, resulting in the formation of a mixture of iron oxide and hydroxide recognized as rust.

IMPURITIES HASTEN BUST—The rusting, or corrosion, of iron is accelerated by heterogeneity in the iron; that is, by the presence of small amounts of other metals. When iron containing small amounts of other metals is immersed in water, electric currents are set up between the different metals, and the resulting electrochemical action carries the electrically charged iron particles into the water. Samples of extremely pure iron have been found that have survived many years with little corrosion.

The corrosion-resistant properties of some metals result from the formation of protective films on their surfaces when they are exposed to moisture or to a corrosive atmosphere. For example, on tin and aluminum extremely durable transparent films are formed which do not greatly impair the luster of the metal. In the same way nickel and chromium surfaces are protected by unnoticeable impervious films. Copper on exposure to the air develops a protective coating of the green carbonate of copper often seen on old roofs.

Iron and steel may be protected from corrosion where structural limitations permit by plating with a resistant metal. For example, corrosion-resistant galvanized iron, made by dipping iron into molten zinc, is familiar to all, and so is tin-plated iron made by dipping iron into molten tin in the form of the tin can. Less extensively used, but finding considerable application for decorative and special purposes, are nickel and chromium plating as means of avoiding tarnishing or corrosion.

The extent to which alloys and plating may be employed as expedients for protection against corrosion is limited by the use to be made of the finished metal. A razor blade, for example, must be made of a material adapted to yielding a sharp edge that will not dull rapidly in use. For this purpose there is no alternative to the use of steel. Neither alloying nor plating are possible.

Ball bearings must also be made of steel to withstand the loads to which they are subjected in service. The ball bearings for delicate instruments are precision machined and polished to a mirror-like finish, and must be carefully protected from corrosion throughout all handling operations. However, the use to which ball bearings are put makes it impossible to resort to alloys or plating to circumvent corrosion. Some alloys would be costly, some would be difficult to manufacture into bearings, and many would lack the needed mechanical strength. Metal plating would be difficult to machine and polish, and might peel off in service. For many purposes, iron and steel must be used in spite of their susceptibility to corrosion. Thus cast iron and steel are used for automobile and aviation engine parts such as the block, crankshafts, and connecting rods. Where conditions permit, however, as in the case of carburetors, corrosion-resistant alloys are used.

Because of its inherent elasticity or strength, steel is used in springs, wire ropes, and other objects subject to continuous flexing in normal service. Here plating, even where it does not impair the characteristic properties of such objects, still has objectionable features as a means of protecting from corrosion—for example, it is likely to be cracked and destroyed by the flexing. For objects of this sort an adherent protective coating that offers no resistance to the motion of the steel is needed.

Petroleum products offer ideal means of making adherent, flexible protective coatings. Everyone knows that an object dipped in a petroleum product such as lubricating oil becomes covered with an oily film that is difficult to remove. The object may be wiped with a cloth but the final trace of oil remains firmly attached to the surface. The object may be placed in a container of water or held under a stream of water and still the oil refuses to leave the surface. Moreover, there are many types of petroleum products, some of which give more tenacious films than others. Kerosene will give an object an oily feel, but the oil film may be removed without too much effort. A lubricating oil is much more difficult to remove. Heavy, tarry residual oils of a semi-solid nature must be heated to be removed from a metal surface.

TWO IMPORTANT FACTORS—Two factors that enter into the ability of an oil coating to resist removal by external influences are fluidity and adhesiveness.

A fluid product will eventually flow off a metal to which it has been applied. The more fluid it is the more quickly it will flow off, leaving behind the exposed metal. A less fluid, or viscous, material will flow off much more slowly. A solid, such as paraffin wax, applied to a metal surface, will not tend to flow off, but may crack and chip off. To be satisfactory, a protective coating should have the permanence of a solid, combined with the flexibility of a fluid. Coatings that approach this characteristic can be prepared from petroleum by combining solid and liquid products into semi-solid materials.

Adhesiveness, the second of the two factors just mentioned, is important if the protective coating is to withstand severe external influences. Some oil coatings might resist removal in a

moderate stream of water but not withstand the effect of sun, wind, and rain when applied to outdoor equipment. Coatings that are to be used for protecting military and industrial equipment under severe exposure conditions for prolonged periods of time must possess a high degree of adhesiveness.

Objects requiring corrosion-protective coatings vary from parts for precision instruments, on which the corrosion from a finger-print is objectionable, to heavy machinery and pipes in storage exposed to severe atmospheric conditions. No single kind of coating would adequately serve all purposes. A large series of different coatings is required, and such a series may be made from the many fractions derived from petroleum.

Petroleum protective coatings may be classified according to their consistency into fluid and semi-fluid, or "hard," coatings.

Fluid petroleum coatings with widest range of application are the so-called non-drying coatings. They impart excellent protection, good durability, and freedom from hardening, cracking, or peeling. Yet they may readily be removed by wiping off with a petroleum solvent. These protective coatings are generally applied as temporary corrosion preventives with the intention of removing them at some subsequent time and, being of non-drying type, they can easily be removed when desired.

Some of the Rust-Bans[1] of the Standard Oil Company (New Jersey) are examples of non-drying petroleum coatings. They have the advantage over simple petroleum coatings that they contain rust inhibitors to offset the electrochemical conditions that cause rusting; and some of them also contain ingredients with high affinity for metal surfaces, that enable the coating to displace water when applied to wet metallic surfaces.

A good fluid-type protective coating on a metal should tend to spread over the surface and adhere to it tenaciously. The power to spread is related to surface tension. The surface of a liquid behaves like a stretched sheet of rubber. That is, it appears to have a definite tension. This results from the fact that there are no molecules of the liquid beyond the surface to counteract the molecular attraction from within the liquid. The unbalanced attraction gives the surface a film-like property which, like the skin of a balloon, holds liquid drops together. The same property makes it possible to "float" a needle on the surface of water, and makes it possible for insects to travel over the surface of a pond or lake. For good spreading power a fluid should have low surface tension, so that when the fluid is brought in contact with a surface it will not tend to retain the form of discrete droplets but will collapse into a film, spreading over the surface. Water does not readily spread over a metal because it has high surface tension but when soap is added to the water, thereby lowering the surface tension, the soapy water spreads easily over the metal. Since the surface tension of petroleum oils is low they tend to spread, forming a film over metal surfaces to which they are applied.

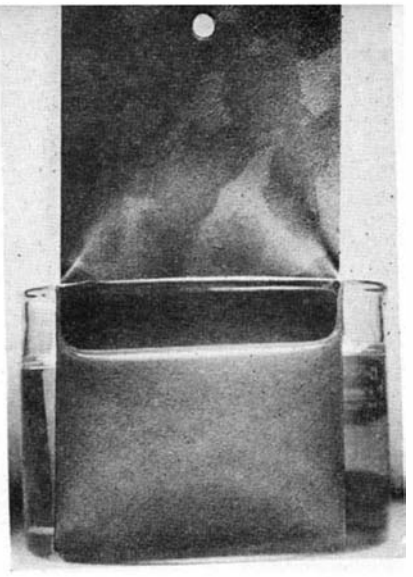
After good spreading power, a second requirement of a fluid protective coating is that it adhere firmly to metal surfaces. The ability to adhere may be attained by incorporating in the coating a substance having chemical affinity for both the petroleum coating and the metal surface. A number of substances like fatty acids consist of long chains

If a piece of metal is wetted with water and dipped in ordinary petroleum oil, the water remains and the metal rusts. Obviously, therefore, a Rust-Ban is more than simple oil

of carbon and hydrogen atoms, one end of the chain having oxygen or other atoms. The carbon-hydrogen chain is chemically quite unreactive, while the oxygen-containing end is reactive and has an affinity for metals. Such substances, if present in a protective coating on a metal surface, become oriented, the active end of the molecule becoming chemically attached to the metal, while the carbon-hydrogen portion of the molecule dissolved in the petroleum holds the petroleum to the metal surface. (A similar explanation has been advanced for oiliness in lubrication. Superior oiliness, which depends upon resistance to rupture of the lubricant film, is effected by fatty acids in lubricants because the oxygen end of the fatty acid molecule attaches itself to the bearing surface, while the body of the fatty acid molecule extends into the lubricant—like blades of grass in a stream of water.)

Molecules of the type of fatty acids are called polar compounds. As with magnetic needles, one end is attracted by its chemical affinity to metal surfaces. When a coating of a corrosion preventive containing polar compounds is applied to a metal surface, the affinity of polar compounds for metals causes them to migrate through the petroleum vehicle to the metal surface.

To insure that the attachment will resist rupture when in contact with water, Rust-Bans contain polar compounds that have a partial affinity for water as well as for the petroleum and the metal surface. Consequently



Here the only difference is that the petroleum oil now contains Rust-Ban, which has crept under the water and shouldered it off, also coating metal

any water droplets that find their way into a protective coating are surrounded by the polar compounds, forming a water-in-oil dispersion which prevents further movement of the water through the protective film. The dispersion is semi-rigid in nature, forming an effective barrier to the passage of water and affording protection from corrosion for a long time.

As a rule protective coatings are applied to clean, dry, metal surfaces immediately after they have been finished or polished. When a surface has been in contact with water, it is generally dried before the application of a protective coating. However, a special coating, Rust-Ban 392, is applicable to wet surfaces, as it possesses the ability to displace the water and replace it with a film of rust preventive.

An illustration of the application of petroleum products having water-displacing properties was their use for the protection of fittings and machinery on the Navy transport, the *Lafayette*, formerly the French luxury liner *Normandie*, after the ship had burned and turned over at its berth in the Hudson River, New York.[2] Without such protective coating a heavy loss to the machinery would have inevitably occurred. A series of protective products were used in the salvage operations.

LITTLE RUST IN THE DEPTHS—Little rusting ordinarily occurs on metals which are deeply submerged, as was most of the equipment on the *Normandie*. As has been indicated, oxygen plays a part in rusting, and the content of oxygen dissolved in water decreases rapidly with depth. However, as soon as submerged metal is brought to the surface it is attacked by oxygen and rusting occurs at an almost visible rate.

Much of the *Normandie's* equipment was of such a nature that it could not readily be dried. Encased or com-

1 The Rust-Ban trademark is registered in the United States and elsewhere by the Humble Oil and Refining Company.

2 Scientific American, November 1943, page 223.

plicated machinery, for example, could not be disassembled promptly enough to be protected from rust in that way. It was for this reason, and to assure more certain protection, that equipment was dipped, swabbed, or sprayed with the rust preventives. Even electric motors were so treated, although ordinary oils are injurious to motor armatures.

The ship's gyroscope compass, a delicate and complex piece of equipment, was so successfully protected that replacement of only two parts and a motor was required. The gyroscope was then ready to be installed in the vessel after being taken from its long soaking in the depths of the river.

In addition to main turbines, motors, and gyroscopic control devices, the equipment treated with rust preventive included hundreds of tons of pumps, lamps and lighting fixtures, kitchen utensils, laundry equipment, ice machines, and a great variety of other mechanisms. By preventing destruction of these materials from corrosion, a great quantity of critical material and innumerable man hours of manufacture were saved, and the return of the *Normandie* to service has been greatly hastened.

TOUGH TESTS—Petroleum rust preventives are subjected to a number of tests designed to simulate conditions under which they will be used. It is considered more reliable to test finished materials in this way than to attempt to measure fundamental properties. A large number of tests have been devised, the more important being the humidifier test, the water spray test, and the salt spray test.

In the humidifier test, metal panels with uniformly prepared surfaces are coated with rust preventive and placed in a special cabinet through which air passes at the rate of 12 cubic feet per hour. This air is maintained at 100 percent humidity, heated to 100 degrees, Fahrenheit, and directed into the cabinet against baffle plates which insure uniform air distribution. The rate of flow of air through this cabinet is critical in determining the breakdown period of a coating. Under static air conditions certain coatings may last months in this cabinet. With air circulating, the time of breakdown is accelerated to a matter of hours.

Coatings comparable in purpose and consistency are placed on special test panels and the measure of quality is the number of hours that elapse before initial corrosion takes place, as determined by visual examination.

In the water spray test, panels are placed at a 30-degree angle from the horizontal and subjected to a two-foot fall of tap water. This water is maintained at 75 to 80 degrees, Fahrenheit, and allowed to "rain" on the panels for three minutes, then is turned off for three minutes. The cycle is repeated until the coatings fail and the first visible signs of corrosion appear. This test evaluates the strength and resilience of the protective film against the impingement of water.

Strangely, some products which protect nicely from heavy weathering (as rated on the water spray test) are not outstanding in humid atmospheres. This is because at the higher humidifier test temperatures some protective coatings are destroyed relatively faster than at the lower water spray temperatures. For full outdoor exposure the best protection will come from a product that rates good in both the humidifier and the water spray test.

For the salt spray test, another specially constructed cabinet is used. Panels are hung vertically and subjected to a spray consisting of a 4 percent salt solution of water. This spray is highly atomized by impingement against a baffle plate and then passes over the panels.

The salt spray test simulates in an accelerated manner the severe conditions found near the seashore or aboard ship. Salt water stimulates corrosion more than fresh water, since it provides a better medium for electrochemical action.

The coatings discussed so far have all been of the type classified as fluid, non-drying coatings. Another type is the hard-drying, transparent coatings. This type is intended for use where the coating need not be readily removable. It is normally expected to act as a rust preventive only during the interval between its application and the final assembly and use of the metal parts. After parts are assembled the coating may be machined off, left to wear off, or painted over with pigmented products. Where surface markings, numbers, imperfections, and so on must be visible, transparency of the coating is obviously important.

The hard-drying coatings are applicable to structural shapes, boiler plates, machined surfaces, pipes, and castings, between the time of their fabrication and the time of their assembly. Every branch of heavy industry has equipment requiring this type of rust preventive. In addition, certain special uses for these materials have developed. These uses include waterproofing awning, canvas, and tarpaulin stock, and treating the muslin used by sweet potato growers. One Rust-Ban of this type can also be added to oil paints, notably improving the weather resistance of the paint.

Because of the versatility of petroleum products, special coatings may be prepared for special purposes. There are, for example, compositions of asphalt in varnish solution that yield coatings having self-healing properties. Some of these may or may not contain rust-inhibiting agents. Where it is desired to apply a corrosion preventive that will at the same time leave a bright surface, flake aluminum pigment may be incorporated in the fluid base. This type of coating achieves both unusual heat-resisting properties and high-heat retention. It consequently is particularly useful for coating tanks and the like, which contain material whose temperature it is desired to hold as constant as possible.

WAR AIDED THEM—Petroleum corrosion preventives are not new, but it has taken the stress of war to show their critical importance. For the erection of military bases throughout the world in the early days of the war it was necesary to transport structural steel over long ocean voyages, and often to drop the steel on the beach at its destination. When picked up for use the steel was frequently found to be heavily caked with rust. Badly needed cargoes of airplane engines often became corroded en route to distant ports. Costly precision instruments had to be discarded because a finger-print at the factory became corrosion by the time the instrument reached the assembly line. Searchlight parts were ruined by exposure to air. It therefore became important to devise a protection against the ruthless destruction wrought by corrosion.

Simultaneously with the external corrosion, serious internal corrosion was found to occur in aviation engines. The highly machined interiors of engines are extremely susceptible to corrosion; and it was observed that airplane engines might show signs of becoming corroded within 30 minutes after the engine had stopped running.

Both the external and internal corrosion could be substantially overcome by the application of a variation of the coating that was used so effectively in protecting the turbines and boilers of the *Normandie*. At the present time airplane engines that are shipped abroad are carefully wrapped after having been thoroughly coated with a rust preventive. Every engine is given a test run, then disassembled, overhauled, reassembled, and given a final run. During the final run a rust preventive is injected into both the lubrication and the carburetion system, thereby coating every part of the engine with a fine protective film. Then dummy plugs, containing silica gel, are inserted in place of the spark plugs, and the silica gel absorbs any moisture present in the air in the engine. Finally, the whole engine is wrapped in Pliofilm, tied, and crated. With both the exterior and interior protected, every chance of corrosion has been eliminated.

Petroleum corrosion preventives have served an important function in preventing waste and in guaranteeing that military equipment will operate properly even after storage over long periods when exposed to the elements.

The formulation of the preventives represents the combined application of well-known fundamental physical principles and less well understood empirical relationships. Factors governing the adequacy of protective coatings include surface tension, polarity, corrosion-inhibiting ability, volatility, and consistency. Some day it may be possible to explain the exact mechanism of corrosion preventives and the interplay of every factor. In the meanwhile the preventives are effectively serving the war effort, and after the war they will serve to protect the machinery of industry, the tractor and other equipment of the farmer, and the lawn mower, bicycle, saw, and general gadgets of the householder.

Meet Melamine

A New Family of Resins, Dating Back Only a Few Years, Has Invaded Fields Ranging from Textile Finishing to Complicated Moldings. High Strength, Good Electrical and Heat Resistance, and Amenability to Diversified Applications are Outstanding Characteristics for Post-War Work

By CHARLES J. ROMIEUX
Plastics Division, American Cyanamid Company

JUST AS World War II broke out, a new family of resins derived from melamine* was making its first bid for public acceptance. Fortunately, these new resins were ready to meet new requirements well as old ones made acute by war conditions.

Like many other developments in plastics, this one had to await a need to bring it out of the chemical laboratory. Characteristically, the evolution of plastics is fostered by changing demands that cannot be fully met by existing products.

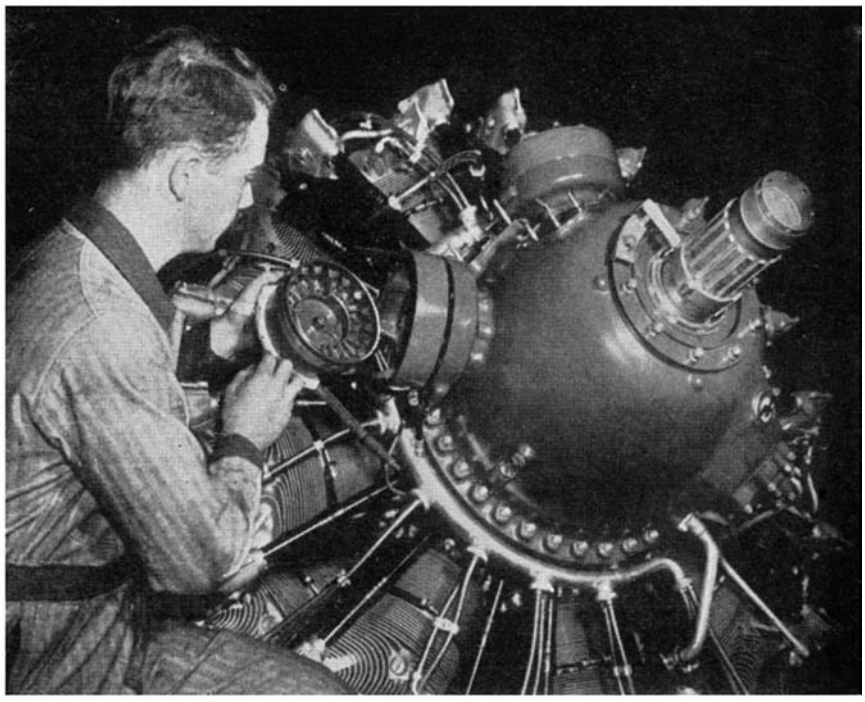
Automobile safety glass provides one of the best examples of this evolution. After World War I, a large producer of cellulose acetate sought a new source of acetic anhydride at a price which today would be very attractive. In spite of every effort, the company approached could not meet the desired cost. Side reactions interfered. One of these formed vinyl acetate for which at that time there was no market. Some 15 years later, the automotive industry sought a new interlayer for safety glass which would be better than the cellulose acetate sheet then in current use. The chemical industry, as a result of the pioneering efforts of years before, offered polyvinyl butyral produced from vinyl acetate, the very product which 15 years before caused so much trouble. Soon the vinyl derivative completely replaced cellulose acetate in safety glass.

The rapid growth in the use of the resins produced from melamine is an outstanding example of how the science of chemistry and the chemical industry have contributed to the spectacular progress of the plastics industry.

The chemical compound "melamine," $C_3N_3(NH_2)_3$, has been known for many decades; it was originally synthesized by Liebig over a century ago. It was also known that this compound could be produced from calcium cyanamide, once only a fertilizer but now parent of a growing list of important chemicals. The reaction of melamine with formaldehyde was found to yield a soluble and fusible resin, colorless and water-clear when made from pure materials. This product is hygroscopic and miscible with water and water-alcohol mixtures. When subjected to heat, or under the influence of certain chemicals, it becomes insoluble, infusible, and, as compared to its unconverted form, relatively tough. This change can occur over a wide range of acidity and basicity, in contrast to other thermosetting resins. The unconverted resin will react with alcohols to form resins soluble in a wide variety of organic solvents. Furthermore, melamine resins can be used in combination with either mineral or cellulosic fillers to produce molded and laminated articles.

DIVERSIFIED USES — The chemical, mechanical, and electrical properties of melamine resins are best illustrated by the considerable diversity of articles into which they have so far been incorporated and to which they have imparted certain specific and desirable properties.

Electrical equipment is an essential component of many of the weapons of modern war. It must operate under conditions of service far more severe than are normally encountered in peace-time. These conditions require improved insulating materials. Increased resistance to fire and heat, and to the carbonizing effect of the electric arc are particularly needed. Melamine resin in its cured form is useful in these applications since it will not continue to burn after the source of heat has been removed, nor is it readily carbonized by the electric arc. Combined with these special properties, it



Melamine resins find wide application in aircraft engine ignition parts

*See also "It's Done With Melamine," page 204, April 1941 issue of Scientific American.

A plastic composition of melamine resin with a filler of chopped cotton is used in making compartment trays such as this. The composition is high in flexural and impact strength, resistant to heat and cold

is a good electrical insulator. Melamine resins will also cure in contact with heat-resistant inorganic fillers, asbestos, glass, and silica. Asbestos-filled molding compounds were consequently developed and have extensively replaced hard rubber and other plastics in parts of ignition systems of aircraft engines. These are being used on many combat planes and have contributed to their improved performance.

At high altitudes, arcing in electrical equipment is increased by the rarity of the atmosphere, and ignition parts are frequently surrounded by corona discharges. Melamine resins perform equally well at the extremes of temperature and humidity encountered in this service, and are not damaged by the action of nitric acid, formed within ignition parts at high altitudes.

Co-operation by molders and laminators has made it possible to produce from such a new material as melamine resin the required complicated parts meeting extremely rigid specifications. Many of these applications require large parts weighing several pounds and containing numerous metal inserts. Transfer molding is required in their production. Without this special technique it would hardly be feasible to produce such intricate parts.

COMMERCIALLY AVAILABLE—Melamine laminated products possessing the added advantages of arc- and heat-resistance are now commercially available for use in electric insulation. Even the fabric base material containing the resin is self-extinguishing. The glass cloth and asbestos yield products which are, naturally, more highly heat- and fire-resistant.

Prior to the war, melamine resins were used somewhat extensively in paper laminates to impart hardness, scratch resistance, color stability, heat resistance, and protection against the action of cleaning agents. These laminates have been extensively used for bright colored table and bar tops. The manufacture of laminates for this type of application was discontinued with the advent of the war.

However, a similar technique has been utilized during the war to produce name plates for machines (to replace those hitherto made of critical metals), translucent instrument panels, and permanently mounted diagrams and instructions for servicing military equipment.

The heat resistance of melamine laminates, particularly in translucent form, will undoubtedly expand their use in the field of lighting, and the improved weather resistance imparted by melamine will permit post-war use of laminates for exterior applications.

Other pre-war possibilities are contributing to the war effort. In combination with alpha cellulose, molding compositions were developed before the war in pearl and a limited range of bright stable colors. These were used for molding wash buttons, which retained, even after repeated laundering, their original gloss and general appearance. The alpha cellulose molding material was also found well suited for molding tableware where its hardness and stain resistance were advantages. The military services now utilize melamine buttons for wash garments. Light

Upper unit of this coffee maker is molded of a new melamine plastic

weight, combined with relative lack of fragility, has prompted the Navy to supply melamine molded tableware for overseas stations, light vessels, and aircraft use. A number of the molders produce compartment mess trays from a medium impact, fabric filled melamine molding composition.

Although there is no apparent relation between a heavy-duty circuit breaker for electric power lines and a mess tray, both are produced from the same fabric-filled material. This material has been selected for circuit breakers because of its resistance to shock, to arcing, and its relative fireproofness. Applications of this type will undoubtedly create a considerable civilian demand. The improved heat resistance of the cellulose-filled molding material will broaden the peace-time market for plastic reflectors.

A more recent application for melamine resin is in hot-set waterproof glues for plywood and laminated wood. Its outstanding characteristic is the strength of the glue line when under tension and in shear. This is combined with water resistance far surpassing the requirements for aircraft plywood.

The use of melamine in glues provides an excellent example of another unique property of melamine. The addition of relatively small proportions of melamine resins to urea resins produces glues of bonding quality much superior to that of the urea glues themselves.

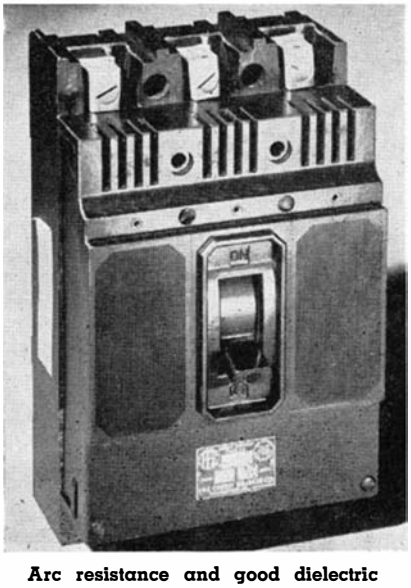
The effect of increasing additions of melamine is shown by breaking test samples in shear after 24 hours of soaking in water at 75 degrees, Fahrenheit. In all cases the loadings at which failure occurs are well above the values specified for plywood bonded with urea resins. Urea resins without melamine provide a strong bond but one which under these severe test conditions usually fails before there is a break in the wood. The addition of relatively small proportions of melamine resin to the urea resin so strengthens the bond that failure occurs in the wood itself in preference to failure of the bond.

Not only do additions of melamine provide increased strength necessary to wood failure in tests carried out after a period of soaking in water at ordinary temperatures, but they also impart to the bond the desirable characteristic of resistance to boiling water.

Utilizing this property, melamine-modified urea resin glues for the hot press assembly of plywood are now on the market surpassing all requirements of Army and Navy specifications for aircraft plywood. These resins provide a bond in plywood which fails only at high loading and exhibits substantially 100 percent wood failure in both shear and tension breaks.

Numerous other applications outside the plastic field demonstrate the ability of melamine in small proportions to impart special properties to other products without modifying their fundamental characteristics—texture, form, color, and so on.

WET-STRENGTH PAPER—Melamine resin added in small amounts to paper during manufacture imparts remarkable wet strength to the finished sheet. Two samples of white absorptive paper are



Arc resistance and good dielectric properties of melamine plastics are used to advantage in circuit breakers

of similar appearance and of identical composition, except that in the manufacture of one about 3 percent melamine resin has been incorporated. This small amount of melamine resin does not perceptibly affect the absorbency of the paper. However, the untreated paper scarcely holds together when wet, but the one containing melamine resin is over 60 percent as strong wet as it is dry. In addition to imparting wet strength, melamine resin greatly improves the wet rub-resistance of the sheet. Contrary to what one might expect, the addition of this resin does not embrittle the paper, but actually improves the dry tensile strength and increases many times over the resistance of the paper to repeated folding. These improvements are retained even on prolonged storage of the paper under conditions of high humidity and temperature. Paper so treated has been used for such purposes as toweling, blueprints, maps, heavy-duty paper packaging, and in numerous other applications. Melamine resins thus make paper useful in applications heretofore closed to it because of its great loss of strength upon becoming wet. Most spectacular of these is in paper packages for products hitherto packed only in drums.

Another example of the use of melamine resins in relatively small proportions to impart specific properties is in the treatment of textiles. These resins, in water solutions, have been used to render fabrics creaseproof, that is, to increase their resiliency; to produce semi-permanent glazed chintz which can be laundered as those glazed with starch cannot; to act as stiffening agents in mosquito and camouflage netting; and to serve as hardening agents to modify polyvinyl butyral and other elastomers in impermeable coatings.

The alkylated melamine resins produced by reaction with alcohols have been used extensively, particularly before the war, as components of baking enamels for finishing automobiles, refrigerators, bathroom and kitchen cabinets, washing machines, and many other metal articles. In these applications resistance to heat and hardness, and the permanent light color of the finish are important. In the post-war period, this application is expected to increase in volume. In these enamels, melamine resins contribute not only extreme hardness, but also to curing speed, color retention, and resistance to heat, weather, and many chemical solvents.

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THE TELEVISION CONTROVERSY

By E. F. McDonald, Jr.

President, Zenith Radio Corporation

TELEVISION has cried "Wolf! Wolf!" many times in the past 14 years. The public has been fed with fables, plied with promises, enticed with the "Thousand and One Night Tales" of the miracles to be wrought. The bright stories so gaily scattered to the press on the least provocation, one after another, becomes the legends of a phantom —television.

Now comes another new problem, posed by the developments of the war. Some very pertinent questions are raised in a recent statement of the Columbia Broadcasting System. Shall television come to the public in its pre-war state? Shall television incorporate important technical improvements growing out of war experience, and launch itself in this improved state even though this may take a year or two longer? Or, shall television launch itself with two systems as some have advocated, specially those with investment in pre-war television systems at stake and those who feel we should wait not a minute longer than necessary after the war to introduce television?

Mr. Paul W. Kesten, Executive Vice President of the Columbia Broadcasting System, points out that we must start with improved television. Columbia's publicly released query, "Will pre-war television be good enough after the war?" almost answers itself.

Of course, it won't be good enough! Today research and science move at a rapid rate, accelerated tenfold by the crying necessities of war. Things obsolete themselves more rapidly than at any time in our history. New processes in every field, new uses for materials, new methods, have resulted from the experiences of war. I, for one, say in regard to television after the war: "Why dig up the bones of dead pre-war television for reincarnation when there is a new baby on the way!" Shall we delay television improvements by again making a false start? Glowing promises have been made to the public of the feast to be spread before it. Let's not warm over last night's dinner to regale the hungry and expectant guest.

The Columbia Broadcasting System suggests also that it is the duty of prospective television makers, and broadcasters, too, to explain to the public that better television than the pre-war system can provide is now made possible by recent radionic developments not incorporated in the old system, and what is more, to back up explanation with action.

I agree with Columbia, or rather I should say they agree with me, for I have always pointed out to the public that until standards are fixed for television that is worthy of public support, money paid out for a television receiver is money thrown out of the window.

I agree, too, with Chairman James Lawrence Fly of the Federal Communications Commission, when he is reported as saying that he is "opposed to any move to freeze television standards at the present level." This statement is reported to have been accompanied by a criticism levelled at those who hope to sell post-war receivers that would not give the best possible service. From the words of its chairman, I know that the Federal Communications Commission will protect the public.

The idea of public service in television is hardly new, as recent announcements might lead one to assume. In Chicago, television was introduced to the public in 1928 by radio station WCFL, in 1929 by the Western Television Company, and in 1930 by the *Chicago Daily News* station WMAQ. Television programs were broadcast during those times. More than a thousand receivers were sold in the Chicago area. They are useless today, or had to be rebuilt as standards were changed.

In the intervening 14 years, from 1930 to 1944, there have been periodic television publicity booms, in which the public has again been urged to buy. Television receivers sold as late as 1940 shared the fate of the earlier ones. Their screens remain dark unless they were rebuilt. I make this point to tell how vital it is to adopt standards embodying the important contributions gathered during the war years, so that we may have good life-expectancy in television receivers, and the public may get its money's worth when it buys one.

In the face of the experience I have just related, I ask: "Can the public be asked to accept pre-war transmission standards?" I say they cannot. Not if they believe the advertisements and the publicity stories. Not if they are conscious of the developments of the war, and the advertisements have certainly made them conscious.

The public may get pre-war automobiles, pre-war refrigerators, pre-war washing machines. You can turn these in for a fair trade-in value and they will still run and give service. Not so with television sets. When standards are radically changed as they again must be changed, if we are not going to throw out all that we have learned in the past few years, television is to become junk, just so much wood and wire inoperative unless rebuilt at great expense. The past has proved that.

I have stated I am against pre-war standards or warming over last night's dinner. I am for starting at the farthest possible point ahead in television development. With these viewpoints I can not entertain the thought of supporting two systems of television broadcasting and reception, which have been advocated—one the pre-war system, the other the improved system.

Such dual operation would be most illogical, confusing, and would certainly be impractical on a nationwide basis when chaining operations are envisioned. Its only good point would be to create public consciousness of the better system. That investment which proponents of the old system now seek to protect, would be so injured by competition of the better system that the finger in the dike would hold but a very short time.

Someone may point out that receivers could be built to receive both systems. My answer to that one is: "It's going to be a big enough problem to build a moderate priced receiver to operate on the better system. Dual operation receivers would be costly and wasteful of the public's money."

The television problem is now again before industry, government, and public. We are on the eve of writing a pre-

scription that should serve for a long time to come. The stake in television of my own organization is great. It has been in business for over a quarter of a century on only one basis, that of being fair with the public. I want television as eagerly and as soon as anyone wants it. I have everything to gain from its coming into public use quickly. But if we are not coming out with improved television after the war, the public and the dealers should be told now.

CAROTENE

Extracted from Sweet Potatoes By Use of Acetone

RECOGNIZING sweet potatoes as an important potential source of carotene, or provitamin A, government researchers have been investigating possible methods of large-scale extraction. One of these methods, employing acetone, gave a product of 90 percent purity in a yield of about 39 percent.

The acetone extraction was carried out in four or five stages, the first two serving to dehydrate the potato pulp but absorbing little carotene. The third and fourth stages, in which a larger volume of acetone was used, extracted most of the carotene which was subsequently crystalized out.—*U. S. I. Chemical News.*

GLASS-REINFORCED PLASTICS

Offer Possibilities for Production Processes

SUCCESSFUL flight tests of an Army basic training plane equipped with a glass-reinforced plastic fuselage, side panels, and tail cone, have culminated a research program, initiated by the Army Air Forces Materiel Command, Wright Field, aimed at developing high-strength plastic structural materials for use in aircraft construction.

The experimental plastic fuselage is of sandwich construction. The sandwich consists of a balsa wood core between an inner and outer skin of plastic reinforced with fibrous glass cloth. Ground destruction tests of three fuselages of the same design—one of glass-reinforced plastic, one of metal, and one of plywood—indicate that for equivalent weight the glass sandwich fuselage is considerably the stronger.

On a strength-weight basis the glass-reinforced fuselage is 50 percent stronger than the metal fuselage and 80 percent stronger than the wooden fuselage now in service. Firing tests have indicated that the glass-reinforced fuselage would be satisfactory under gunfire. The material did not flower and high explosive projectiles failed to detonate because of the low density of the material.

While plastics, including glass-reinforced plastics, are now widely used in aircraft construction, they have been employed in non-structural applications. The Army Air Forces and the aviation industry have sought a high strength, light-weight plastic material that can be molded into intricate shapes without high pressures, high temperatures or expensive molds, and that can be used for structural or non-structural parts.

Until now the project has been closely guarded but a part of the data developed by the Air-Forces-initiated research program is being revealed in the hope that it will provide a basis for factory production of high-strength plastic structural materials. While the program was undertaken primarily because of its potential contribution to aviation, results are expected to influence developments in other fields, including the automotive, marine, and building.

The glass reinforcements employed in fabricating the laminates were heat-treated Fiberglas cloths and short, fine fibers known as Fiberglas flock. The resins were Plaskon 900, Laminac P-4122, MR-1A, Monsanto 38691, CR-39, and CR-149.

The sheets were cured at a pressure of 15 pounds per square inch in an electrically heated hot-air oven. Specimens were cut from the cured sheets and were machined and tested. Test results indicate that on a strength-to-weight ratio, glass cloth laminates possess physical properties comparable to those of a number of the metal alloys now used for aircraft structural parts.

Tensile strengths were found to be proportional to the amount of glass present in the laminates, and varied from 45,360 to 54,720 pounds per square inch. Compression strengths as high as 56,820 pounds per square inch were obtained. Flexural values ranged between 45,350 and 84,600 pounds per square inch. Impact strengths of unnotched specimens were from 28.82 to 31.25 foot pounds. Modulus of elasticity was 2,200,000 pounds per square inch. Average specific gravity was 1.75. These values are for cross-laminated glass cloth. Strength values approximately twice as high may be obtained with parallel-laminated cloth.

RAIL TRAVEL TOMORROW

Will Place Greater Emphasis on Passenger Comfort

IT'S GOING to take comfortable, attractive, fast, and safe trains and low fares to win a fair share of the post-war travel market, railroads agree, but they have many different ideas about the specific ways of meeting the problem.

That is the substance of a recent report released by Pullman-Standard Car Manufacturing Company based on personal interviews with high officials of 71 Class I railroads owning 92 percent of the passenger cars of the country.

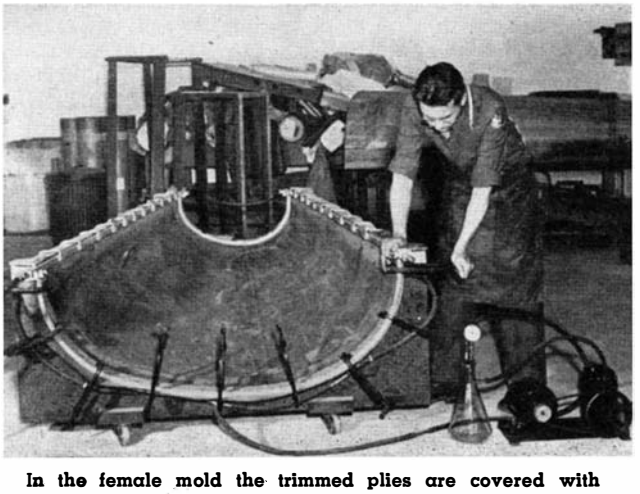
One subject on which there is no argument whatsoever is weight. Every road responding to the question was of the opinion that all future equipment would be of lightweight construction.

A nearly unanimous opinion in favor of standardization of equipment was returned by the roads. They felt that many benefits could be derived if at least basic cars could be standardized, thus eliminating the need for custom engineering, but they advanced no suggestions as to how this could be achieved. Car interiors, they thought, would remain individualized.

In the opinion of all respondents to the survey the most important single factor that will determine the success or failure of post-war passenger business is passenger comfort. In this category were included such items as riding qualities, reduction of noise, comfortable seats, adequate lighting, improved washroom facilities, adequate luggage space, and better heating and air conditioning.

A need for extra seat comfort is im-

Plies of glass cloth for fabricating an airplane fuselage are impregnated with resin, then laid over a male mold, and trimmed before transfer to the female mold



In the female mold the trimmed plies are covered with a rubber sheet which is sealed at the edges. By creating a vacuum, atmospheric pressure replaces autoclaves

perative, especially on long hauls, those discussing this subject declared. Three fourths of them voted for reclining seats, with a greater degree of recline on long-distance trains than on short-haul runs.

Better lighting is also needed, in the opinion of the majority. Although some held that this could best be accomplished by general overhead illumination, others thought that supplementary individual lighting was necessary.

The question of what to do about more luggage space brought a variety of answers. They included larger overhead racks, space under the seat, a compartment at the end of the car, and a well in the floor. Two roads, describing overhead racks as unsightly, would eliminate them entirely and make other provisions for luggage.

The railroads expect to stay in the passenger business and they intend to go after it with the best equipment available, according to the survey. They feel that air competition can be met to some extent on a cost basis, while the challenge of buses and private automobiles can be answered on a cost. comfort, and time-saving basis.

BRITTLE STEEL

Often Results in Presence of Hydrogen

TINY amounts of hydrogen in steel, even as small as one two-thousandth of a percent by weight, can make steel brittle, and should be avoided in making metal for important war uses where toughness or ductility is essential. This is indicated by researches performed by Dr. Herbert H. Uhlig, metallurgist in the General Electric Research Laboratory.

While the effect of hydrogen is evident in ordinary steel, it is exaggerated in most steels containing manganese, Dr. Uhlig says. On the other hand, certain special manganese steels do not show it. This is attributed to a different arrangement of the molecules in the lattice that makes up the metal crystals. In general where they have the arrangement known as "face centered," more hydrogen is dissolved than in the alternative "body-centered" lattice.

In the body-centered lattice, the atoms are arranged in cubes, one at each corner and one at the center. The center atom of each cube forms a corner of adjacent cubes, and so they interlock. The face-centered arrangement, on the other hand, has an atom in the center of each face of the cube, and there is no interlocking.

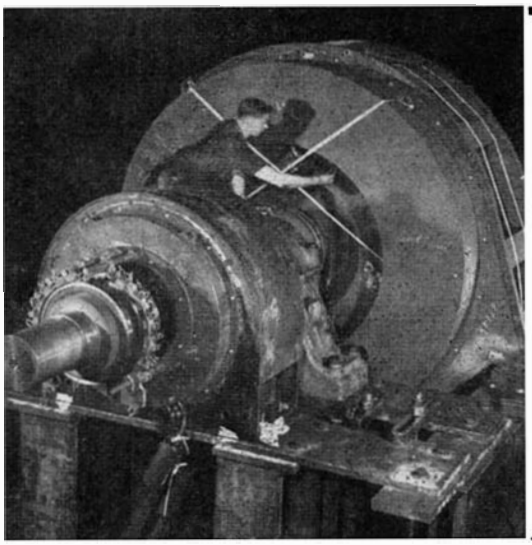
GLUE-LINE TEMPERATURE

Highly Important in Gluing Technique

IT IS NOT always too well recognized that temperature plays a most important part in gluing operations. It affects the working life of the glue and also the time required to develop a glue bond after assemblies have been made. With hot-press resins, it requires a definite temperature or degree of heat at the glue line to convert the resin glue. With cold-press resins and warm-temperature-setting resins, the bond is developed by a chemical reaction which takes place in the glue. The application of heat accelerates this chemical action and, inversely, low temperatures retard the chemical reaction often to an extent that the resin is not converted and a satisfactory bond is not produced.

For cold-setting urea resins it is generally recognized that a minimum temperature of 70 degrees, Fahrenheit, is desirable. In fact, when gluing with cold-setting urea resins is done at lower temperatures, frequently proper water resistance is not developed. What is actually desired is a minimum temperature of 70 degrees at the glue line.

Today practically all synthetic resins are formulated to meet certain government specifications and in most cases there are performance standards to be met, while in others, process specifications must be followed. The purpose of these specifications is to insure a satisfactory bond with the required water resistance so that the assemblies will meet all field requirements. It is common knowledge among synthetic resin manufacturers that cold-set bond may have good dry strength and yet be lacking in water resistance. This may be true for either fresh or salt water exposure. This does not mean that the resin supplied does not meet the specification, but rather that the resin was not used in accordance with established



This giant motor, that will develop 18,000 horsepower at 514 revolutions per minute, will drive the 24-foot fan in a new Boeing wind-tunnel. In the photograph, taken in the Westinghouse shop, a workman is shown checking the temperature of the air stream which cools the inner parts of the motor when in operation

procedures for the particular type of resin.

Warm-temperature-setting phenolic resins are entering the market, particularly for marine use. It is important that these glues be subjected to properly controlled conditions, most important of which is the final temperature of the glue line. A good dry bond that has been produced at temperatures too low to fully convert the resin does not insure satisfactory water resistance, particularly for marine uses.

With some glues, and under adverse conditions, kilning after clamping is used to insure proper glue line temperature.—*L. W. Eilertsen, in "Construction Glues."*

TIME SAVINGS

As Developed by a Welding Shop Foreman

ANY method that promises to save time and makes work easier for the shop men is encouraged in the welding department of Republic Structural Iron Works. In the fabrication of welded steel bases which are designed with numerous ribs welded at right angles to steel plates, the cleaning of weld spatter was a considerable item in labor costs. This was solved by using a spatter-proof liquid, called No-Spat, which was brushed on the steel, covering about two inches on each side of the weld.

Alex Dawson, welding foreman, decided that brushing was too slow so he designed a simple air-operated spray to eliminate the brushing. Obviously, when the steel base was sprayed a larger surface was covered by the No-Spat liquid. This led to an even more important time- and labor-saving discovery.

After these bases are fabricated they are placed in a furnace, given a stress-relief heat treatment and then cooled slowly in still air. This treatment removes shrinkage stresses in the welded steel. But this treatment also leaves an oxide film on steel and seems to make mill scale harder to remove. Dawson noticed that surfaces covered by No-Spat left the mill scale much looser on the steel and the oxide film was much easier to remove. Now all steel structures are sprayed completely before and after welding. Even though they may remain in an open yard for several days, waiting their turn to go in the furnace, the surface is protected from rusting. Instead of the usual three-hour cleaning time per base after heat treatment, the time has been reduced to 1¾ hours and a much cleaner and smoother surface remains to receive the priming coat of paint.

WIND-TUNNEL MOTOR

Uses Magnetic Coupling to Vary Speed of Fan

AN ELECTRICALLY driven hurricane—a powerful flow of air which may travel nearly as fast as sound—is helping Boeing aeronautical engineers design future descendants of the famous Flying Fortress for war or peace-time use.

Power center of this man-made gale is an 18,000 horsepower electric motor which, while capable of developing as much power as 225 automobile engines, takes up little more floor space than a single five-passenger sedan. It has been installed to drive the fan in the concrete wind tunnel where Boeing engineers will investigate the behavior of planes, wing shapes, airfoils and other parts or sections of aircraft, at any desired speed up to approximately 700 miles an hour. Sound travels about 741 miles an hour in dry air at a temperature of 32 degrees, Fahrenheit.

At top speed, the rotor—rotating central portion—of the Boeing wind tunnel motor revolves 514 times a minute to turn a multi-bladed propeller-like fan 24 feet in diameter in the back section of the tunnel. Tips of the 16 fan blades at this speed are traveling more than 442 miles an hour.

The motor is connected to the fan by a magnetic coupling and a 10-ton steel shaft 37 feet long. Motor, shaft, propeller hub, bearings, electric power transformers, and much of the other electrical apparatus for the tunnel, were made by Westinghouse. The magnetic coupling and its control were supplied by the Dynamatic Corporation.

By using the magnetic coupling, it is possible to vary the fan speed while the motor continues at a steady pace. Inside the coupling are two revolving metal rings, separated by an air gap and having no mechanical connection. The ring on the motor side is electro-magnetized so that when it turns it pulls the other ring around in the same direction, thus transmitting power from the motor to the fan shaft through air.

By increasing the amount of electricity passed through the electromagnet, its pull on the fan shaft ring is stronger, hence more of the motor's power goes into turning the fan. Thus the speed of the fan and the speed of the air stream in the tunnel can be controlled without varying the speed of the driving motor. When the propeller speed is reduced, the extra power produced by the motor is converted into heat in the coupling, and is removed by water flowing through the coupling jacket.

STEEL MILLING

Improved by Reducing Number of Cutter Teeth

IN MILLING steel with cemented carbides, one of the most important considerations is the selection of the correct number of teeth on the cutter. Since increased cutting speed means more cubic inches of metal removed per minute, and therefore greater power consumption, it frequently becomes necessary—due to power limitations—to reduce the load in some manner. It usually proves to be better practice in such a case to reduce the number of cutter teeth rather than either the feed or the cutting speed. Maintaining sufficient feed per tooth is important in steel cutting—particularly in roughing—to provide both sufficient tooth loading and adequate load distribution back of the cutting edge.

This is well illustrated by a typical milling operation on steel parts. This concerned the milling of master connecting rod steel forgings by six-inch diameter inserted blade face mills having 14 cemented carbide-tipped blades. The cutters used were standard type face mills operated at a peripheral speed of about 400 feet per minute and with a feed of .0015-inch per tooth. After milling about ten connecting rods, the cutting edges were chipped badly, several of the cemented carbide tips being in such a condition as to make desirable the installation of new blades. This meant that after the damaged blades were replaced, the blades had to be re-set in the proper relation to each other and extra time had to be spent in grinding to put the cutter in good working order again.

An examination of the less damaged cutter teeth showed that the light feed for each tooth being used had increased the width of the "wear land" behind the cutting edges sufficiently so that the increased pressure due to dulling of the cutting edges was beginning to cause portions of the cutting edges to chip out.

In an attempt to increase production per grind and to cut down the time spent in repairing the damaged cutters, every other tooth was removed from

each cutter. The remaining teeth were then resharpened exactly as they had been previously, an operation requiring a relatively shorter time than before. The same speed in feet per minute and the same table travel in inches per minute were used in these trials as had been previously employed. This, however—due to the number of teeth which had been removed—resulted in a feed of .003-inch per tooth rather than the original feed of .0016-inch per tooth.

The increase in feed per tooth enabled the cutters to machine some 30 connecting rods per grind instead of the previous total of ten. On inspection, the cutters showed merely a normal dulling of the teeth. No chipping of the cutting edges and no broken teeth were in evidence. The teeth required only a slight "touch up" with a diamond impregnated grinding wheel to put them into first-class condition again.

Furthermore, with this change only three face mills per machine were needed to keep the operation going, one cutter being on the milling machine; one at the milling machine ready to be used; and the third in the grinding room being re-sharpened.

ROCKET POWER

Has Bright Future, Says Authority

POST-WAR industries will spring from wartime development of rockets, jet-propulsion planes, and gas turbines, according to G. Edward Pendray, a founder and former president of the American Rocket Society, who recently told the New York Electrical Society that the size of these new industries will depend largely upon the progress that scientists and engineers are able to make during the remainder of the war.

"There is nothing fantastic about rocket power any more," he said, "and the rocket is no longer merely an entertaining addition to a fireworks display. The rocket gun has been made a deadly weapon. The bazooka and the Russian Katiusha knock tanks out of battles while the Germans mount similar guns on their fighter planes in an attempt to smash the formation of our bombing planes.

"The jet-propulsion motor, close kin to the rocket, has been brought to the point where both Britain and the United States are using it as the power plant for fighter planes. And the gas turbine is maturing so rapidly that in a very few years we may see it driving planes, locomotives, and electric generators."

Eventually, Mr. Pendray said, rocket power may enable man to build a 1500-mile-an-hour plane which will whisk a businessman from a Montreal breakfast to lunch in London and have him back in Canada by nightfall after an afternoon conference in the British capital.

"But before that day arrives," he said, "the rocket will have to go through a long series of improvements. In the meantime it will do many less thrilling but just as useful tasks—for example, assisting conventionally powered planes during the take-off. A plane can fly with a 50 percent greater load than it can lift off the ground with its own engines. Rockets, therefore, may increase each payload of bombs, passengers, or cargo by several tons. Weather-rockets carrying radios may be shot into the upper air at hundreds of points to provide forecasters with instantaneous and highly accurate reports about the huge masses of air that govern the climate on earth."

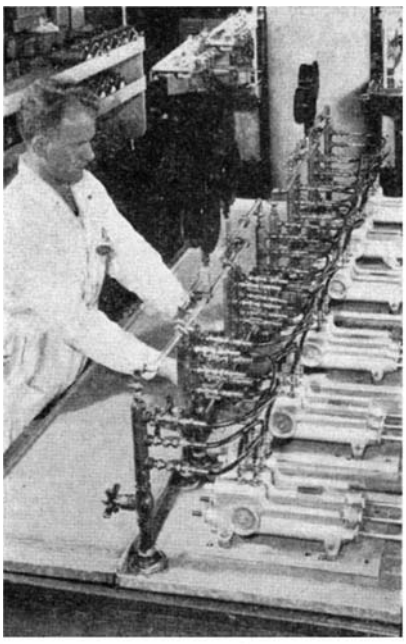
The gas turbine, a multi-bladed "windmill" driven by a blast of hot, rapidly expanding gases created by burning oil or gasoline, may eventually replace the conventional reciprocating gasoline engine in very large airplanes, Mr. Pendray said.

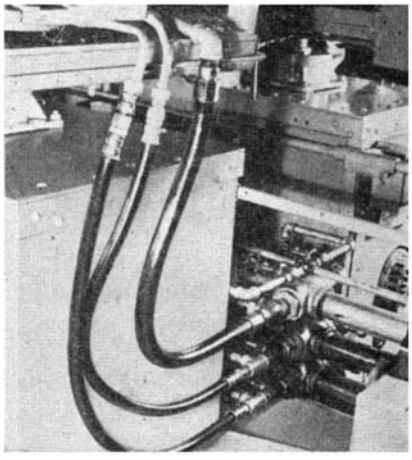
"For war planes and transports, we are now building gasoline engines of 2000 horsepower or more," he said, "but those power plants are rapidly approaching their maximum practical size. They are made up of thousands of finely machined, costly parts which require constant maintenance and replacement.

"The gas turbine promises to step in at the point where the gasoline engine leaves off. Although it is a simple machine, the turbine can deliver large amounts of power dependably and efficiently."

The ultimate field for rockets and jet propulsion will be in super-stratosphere planes of the future, he said.

"Both the gasoline engine and the gas turbine require oxygen to support combustion," Mr. Pendray explained,





Above: Hoses made of a synthetic resin are important parts of this stand for testing automatic pilots. Right: These flexible hoses withstand hydraulic pressure and flexing

"while the rocket packs its own oxygen in the explosive mixture that is its fuel. Even more important, man may eventually travel at extreme heights where there is not sufficient atmosphere for propellers to bite into or for wings to push against."

RESIN HOSES

Solve Problems in Production Testing of Instruments

TWO SMALL instruments responsible for precise aerial navigation—the Sperry directional gyro and gyrohorizon—together form the gyropilot which automatically keeps a plane in level flight and on steady course. The unvarying performance of these vital gyroscopic instruments must be absolutely dependable, and to assure this dependability spot-checking of instruments will not suffice. It is necessary to test each instrument, each component part of it, as well as each function it must perform.

Description of one item will illustrate the painstaking search that Sperry has made for the material best suited to perform each particular function in the testing procedure. This item is the hose used for all connections on test stands. Five years ago, after a long process of elimination, it was found that a hose with a core of compar, a vinyl resin derivative developed by Resistoflex Corporation, was the only hose capable of meeting satisfactorily the rigid requirements of production testing. Compar hose, the same as that used in many installations of gyropilots in aircraft, now is the only line used by Sperry in testing of gyropilots. Not only does it meet the demands of an oil-proof flexible hose that is impermeable to oil; it is so wear-resistant that in some cases a single line has served for the entire five years without showing signs of bulging and without loss of tensile strength or flexibility.

In testing instruments for torque, hammer pressures between 150 and 200 pounds are exerted upon the short flexible line 12 times every minute. Hammer pressure, which is the sharp, almost instantaneous increase in the pounds per square inch exerted against the wall of the hose by the hydraulic oil, has a tendency to cause hose expansion and to aggravate the effect of oil flow. With the oil flow varying from 1.8 to 3 gallons per minute at a temperature around 135 degrees, Fahrenheit, the compar hose can be seen to writhe under the sudden pressure exerted upon it, but without any loss in tensile strength.

Added to this rigid requirement is the need for a short flexible line that will retain its flexibility despite constant coupling and uncoupling, with resultant splashing of hydraulic fluid. Lines must be bent on a five-inch radius to permit cleaning of machines and to make certain connections at sharp angles. In testing gyro control units, a number of them are secured on a large oscillating platform. Simulating the conditions in flight, this platform rolls, pitches, and yaws, causing a constant flexing of the short hose.

Another problem reported solved by the adoption of plastic hose is that of erosion. Formerly instruments had been rejected frequently for malfunction during tests. It was found that minute flecks or particles had become removed from the inside of the hose by the high velocity of the oil flow and had been trapped in sensitive mechanical elements of the system. This condition of erosion was rendering instruments inoperative, but was immediately beaten when compar hose was adopted.

AERIAL SURVEYS

Yield Information of Value to Engineers

IF YOU want to know what's under the ground, go up in an airplane to find out, is the advice of Fred Grieme, Chief of the Civil Aeronautics Administration Airport Development Section.

Aerial photographs can reveal to the trained engineer soil characteristics which may be all-important in the choice of an airport site, as proved by successful tests at some 25 CAA airport construction jobs.

By the interpretation of aerial photographs alone, it can be determined what the soil texture of a particular area is —whether clay, silt, sand, or gravel— and whether its natural drainage is good, poor, or non-existant. These two factors are vital to choice of an airport site which will not require expensive fill initially or rebuilding of unstable runways later.

Approximately $150,000 was saved by use of aerial photographs at one CAA airport project, according to Mr. Grieme. Estimates had indicated that it would be necessary to pay a high price to bring gravel to the airport site, until study of photographs showed that there was a large deposit beneath the surface on a nearby farm. The owner believed that the CAA representatives were crazy when they made an offer for the gravel pit which he didn't know existed on his farm. A little digging confirmed their assumption.

Use of aerial photographs supplements rather than replaces actual soil tests, Mr. Grieme points out. Borings are still necessary for obtaining detailed information such as depth of various strata and bearing strength. Preliminary study of aerial photography, however, is a more economical method of selecting a site and locating the runways on stable soil than making innumerable borings. General practice at present is to make borings only after runways have been laid out. Sometimes this results in runways which need continual patching, when aerial photographs might show that placing the runways 200 yards away would eliminate this difficulty.

RUBBER SECRETS

Solved by Use of the Electron Microscope

NATURAL rubber, it has long been known, can be separated by suitable solvents into two parts, or fractions, which differ in their comparative ruininess, or viscosity. The fraction of less viscosity is considered to have lower molecular weight, and is called the sol. That of greater viscosity and higher molecular weight is known as the gel. Rubber mixtures in which the sol constituent is greater are more plastic or putty-like than mixtures consisting mostly of the gel fraction, which are tougher and more elastic. The process of vulcanizing is basically one of converting much of the sol fraction of natural rubber into gel, thus making the material longer wearing in such applications as tires.

Theoretical explanations for these differences are numerous. It has remained for the electron microscope, however, to give direct visual evidence on which more thorough-going explanations may be based.

Utilizing techniques developed in the biological laboratories of the Massachusetts Institute of Technology for the employment of electron microscopy in investigating long-chain molecules

characteristic of protein fibers such as muscle, a research group at the Institute under the direction of F. O. Schmitt, has ascertained facts about the structure of rubber which go far toward showing how and why natural rubber gets its valuable property of elasticity.

The extremely high magnifications obtainable with the electron microscope —as high as 100,000 diameters were used in this study—make it possible for the researchers to look into the innermost structure of rubber and thus to see directly the physical situation which hitherto could be visualized only in theory. The work of the Technology group, which also includes E. A. Hauser, D. S. leBeau, F. O. Schmitt, and P. Talalay, was reported in a paper to the American Chemical Society by C. E. Hall, entitled "Electron Microscope Studies of Natural and Synthetic Rubber Fibers."

When fine fibers of rubber are analyzed by electron microscopy, the paper stated, the long, flexible molecular chains composing the rubber are found to be of two structures. The first consists of single thread-like filaments, along which are strung rounded nodules. Both thread and nodules, of course, consist of rubber molecules. In the nodules, the groups of chains are bound by so little cross-linking of one chain to another that they may slip freely over and about each other, so freely in fact that the nodule may be referred to as "fluid."

The second kind of structure which the molecules may form is a highly branched network of filaments, crisscrossed and cross-linked into a tight-meshed maze, with fine beadlike knots of material strung along the meshed fibers. The molecules making up these beads are packed far more closely than are those composing the nodules of the first type of structure, and they are cross-linked to each other. Consequently, they cannot slip about each other freely, and rubber in which this second structure predominates is therefore far tougher and more resilient than is the softer, putty-like rubber composed principally of the "soupy" nodular structure.

The sol fraction of natural rubber, these studies have shown, consists mainly of nodular structures of the first type. The gel fraction has been found to consist entirely of the beaded networks of the second structural type. In these findings is the electron microscopic explanation of why sol rubber is putty-like and plastic and why gel rubber is tougher and springy.

From the point of view of manufacture, these findings are significant. Before it is vulcanized for the production of tires or other goods, natural rubber is milled, or ground. The milling process breaks down the gel portion of the original rubber, increasing the sol portion and bringing the whole nearer to a completely plastic or putty-like state in which it can easily be molded to desired shapes. The vulcanizing process which follows has as its primary purpose that of driving the loose sol portion back to the tighter gel state, increasing the proportion of gel by decreasing the proportion of sol, and thus bringing the whole back nearer to a nonplastic, nonputty-like, elastic condition. That this is the result of the process of vulcanization is demonstrated by the electron microscopic studies, which show vulcanized rubber to consist almost wholly of gel structures.

AIRCRAFT PUTTY

May Find Application for Other Purposes

ALTHOUGH Army planes have shed their relatively rough coats of camouflage paint, the aerodynamic dream of perfect wing-surface smoothness is yet unrealized. An important step toward the irreducible minimum of "skin friction" is seen, however, in a flexible, high-adhesion aircraft putty which has been developed by Du Pont for filling dents and cracks between riveted aluminum sheets forming aircraft wings.

So important is wing-surface smoothness in fast fighter planes that it has been seriously suggested they be wiped free of dust and other small particles by service crews before each takeoff. Some idea of the toll taken by any departure from smooth-as-glass surfaces may be had from the Langley Field report that a transport flying at 225 miles per hour expends 180 horsepower pulling rivet heads and lap joints through the air.

Aircraft putties heretofore in use either shrank considerably, became brittle with age, or were not flexible enough to withstand vibration, particularly at the low temperatures of the stratosphere. Also, finishing operations were retarded because previous putties dried slowly. Synthetic resin types stick to the putty knife during application.

The new Du Pont aircraft putty, it is reported, has a buttery consistency and stays in place. It displays no tendency to flow and therefore maintains the desired surface contour. It does not sag on vertical surfaces. Both fast-drying

and exceptionally low in shrinkage, the putty weighs about one fifth less than conventional putties, always an important factor in aircraft.

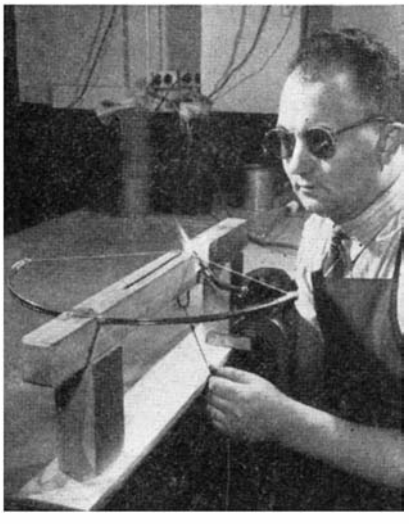
Now available only for war uses, the new aircraft putty is expected to have post-war value for such applications as the finishing of rough metal castings and railroad coaches.

QUARTZ FILAMENTS

Used as Gages in the Electron Microscopes

THE CROSS BOW, storied weapon of medieval times, is being used by research engineers as a helpmate to one of the most modern of scientific instruments, the electron microscope.

Fashioned from tough, flexible steel and mounted on a wooden stock, the



An ancient weapon, the cross bow, now draws delicate quartz filaments

cross bow shoots an arrow that draws out quartz filaments so fine it would take 60 of them to make the thickness of a human hair. The filaments, 1/30,000 inch in diameter, are used to calibrate the magnifying power of the electron microscope.

"To make such a very delicate thread," explains Dr. Alois Langer of the Westinghouse Research Laboratories, "requires a high initial burst of speed that 'spins out' the quartz while it is in a hot, fluid state and before it has a chance to cool and harden. The cross bow is about the simplest and most efficient instrument for doing this."

Since the electron microscope magnifies objects many thousands of times, scientists need a very minute "measuring stick" by which to gage its power. A human hair, for example, seen under the microscope at its greatest magnification, would resemble a cable almost two feet thick.

Some of the filaments drawn by the bow are so delicate that they are invisible to the naked eye when viewed under direct light, the engineer reports. In order to be seen they must be held at eye-level against a strong light. The light glances off the shiny filament, scattering its rays in different directions and making the filament appear much larger than it actually is.

When the Westinghouse engineer wants to replenish his supply of filaments, he places the cross bow in firing position and attaches a small, cylindrical piece of quartz to the end of the arrow. Using a very hot flame from an oxy-hydrogen torch, he heats the quartz until it is just about to melt.

Then he pulls the trigger. The arrow darts from the bow at high speed, trailing behind it gossamer-like threads of quartz. Unbroken pieces up to 20 feet in length are not unusual, but more often the filaments are dispersed in smaller sections throughout the route the arrow takes. They are extremely flexible and can be wound round the finger like thread.

To measure the actual thickness of the filament, it is first put under the electron microscope and gaged by other methods of comparison. Once its diameter has been fixed accurately, it becomes a "measuring stick" for determining the magnifying power of the electron microscope.

X-RAY INSPECTION

Expedited by Compact Equipment

A SAFE, self-contained, easily operated x-ray unit for industry is designed for inspection of parts, assemblies, and finished products of metal, hard rubber, plastics, ceramics, dielectric materials, and so on. It makes possible taking of high quality sharp radiographs quickly by plant personnel under controlled conditions, without the expense of a skilled x-ray technician or the cost of a lead-lined room.

The Searchray Model 150, as the unit is called by North American Philips Company, Inc., is simple to operate because of fixed milliamperage over the entire kilovoltage range. An electrical interlock, which interrupts the circuit while the radiographic compartment is open, eliminates any danger to the operator from x-radiation.

Searchray has a continuous kilovolt regulator which permits adjustment during viewing operation at any point from 0 to 150 kilovolts, so that, depending on density and thickness of the part under observation, greater clarity on the fluoroscopic screen can be obtained. The apparatus can also be set for correct metal thickness on a direct reading scale when radiographs are to be taken. A cassette tunnel at the bottom of the radiographic compartment makes possible the insertion and removal of x-ray film or paper without disturbing the position of the object.

Simplicity of operation is one feature of a new industrial x-ray unit

Under this cassette tunnel a fluoroscopic screen is mounted. The image of the object can be viewed in a mirror through a folding eyepiece. The operator looks into this while seated in front of Searchray. This facilitates the positioning of an article before taking a radiograph.

RUBBER PRODUCTION

Merits of Two Natural Sources Being Tested in Haiti

HAITI, a proving ground for commercial development of natural rubber production in the Western Hemisphere, expects to be producing hevea sheet rubber at the rate of at least 1600 tons a year by 1954.

This estimate of Haiti's prospective hevea rubber production is made in a report on the island republic's expanding rubber operations by "A Propos de SHADA," publication of the Haitian-American Agricultural Development Corporation (Societe Haitiano-Americaine de Developpement Agricole), better known as SHADA from the initials of its French name.

SHADA has been harvesting rubber from 90 acres of rubber trees that were planted at Bayeux in 1903 by two Belgian brothers, Fritz and Max Hermann. There are 700 hevea and about 5000 castilla trees. Although around 1914 there was some tapping of these trees, the first interest in rubber died out and since then they were left untended and utilized as shade for cacao until April, 1942, when SHADA resumed tapping of these trees.

SHADA, however, is counting for its major share of hevea rubber production on some 3200 acres of new hevea trees, now eight feet tall, growing in the Bayeux area. From these trees it expects to get 1600 tons of hevea sheet rubber a year by 1954.

The merits of the quick-growing cryptostegia vine are being weighed with those of the slower-growing hevea tree to determine the better long-range source of natural rubber. The cryptostegia vine can be tapped within a year after planting. In the case of hevea, however, the tapping is not usually begun until the trees are eight to ten years old.

"SHADA believes that rubber has a real future in Haiti," says "A Propos de SHADA," in commenting on the test between latex-yielding vines and latex-yielding trees.

"If soil, climate and other conditions prove as favorable as we expect them to be, our plantations at Bayeux and Grand Anse may be but the beginning of hevea rubber production in Haiti.

"Indeed, the coming decade will offer an interesting race between the merits and economic value of hevea and cryp-

tostegia as sources of rubber for Haiti, even though our main project is now quick-growing cryptostegia whose wartime crops can be harvested while the slower tree rubber is growing up."

SOYBEAN OIL
Production Increased by New Varieties

FOUR FIFTHS of the fats and oils the United States imported in pre-war years will be replaced by the oil from the home-grown crop of soybeans, according to figures developed by Dr. M. A. McCall of the United States Department of Agriculture in a recent review of some of the services of the scientific crop improvement activities of the Department and the state agricultural experiment stations.

"The critical wartime fat and oil situation has given added pressure for soybean production," he said. "In 1941 the acreage harvested for beans was 5,855,000 acres; in 1942, it was 10,762,000 acres; 11,492,000 acres were estimated for the 1943 harvest; and a goal of 14,000,000 acres has been requested for 1944. The increase in the production of this crop as a wartime necessity has been remarkable.

"Newly introduced varieties maturing satisfactorily in the several areas, yet utilizing the full growing season and higher in oil content than others previously available, have been a contribution to our war economy hard to overvalue.

"The 14,000,000 acres of soybeans requested for 1944, estimated to produce 17.3 bushels to the acre on the average, should give 242,500,000 bushels of beans of which 180,000,000 should be available for crushing. This should produce 1.6 billion pounds of oil."

TOOL LIFE LENGTHENED
By New Method of Chromium Plating

A METHOD termed "wholly new in metallurgy" which lengthens the life of cutting tools from two to fifty times by means of chromium plating and an after-treatment of soaking in hot oil at 350 degrees, Fahrenheit, for an hour, was described before the American Society of Mechanical Engineers by Axel Lundbye, Chief Engineer of the Crowell-Collier Publishing Company.

Mr. Lundbye, originator of the Lundbye process, explained that plating chromium onto steel, with the after-treatment to release hydrogen, results in the chromium becoming an integral part of the underlying material. The process avoids the peeling and scaling from the base metal when pressure is applied. This had formerly prevented wider use of effective plating. He stated that, by chromium plating blades only a few micro-inches thick, and giving them the oil treatment, the life of the blades was increased from 8 hours to 110 hours minimum. Many companies have found, he declared, that tool life has been increased two, three, four, and up to fifty times.

Several hundred manufacturers are now using this process in their plants. It is especially adapted to tools and machine parts which are subject to wear, corrosion, bending, shock, and heavy load. The process results in an increase in the wearing quality of machine parts, less friction, and easier and smoother operation.

PLIABLE FABRIC
Can be Used in Ventilating Ducts

MILLIONS of man hours have been saved, and practically all metal has been eliminated from heating and ventilating air-duct systems of aircraft by the development by United States Rubber Company of a fire-resistant asbestos product made of less critical ingredients. Welding, die casting, riveting, intricate metal processing, pattern making, leather and fabric pipe covering, and metal forming, previously all essential musts in the building of these systems, have been eliminated.

The development of this pliable fabric has made possible high speed production schedules in the aircraft industry for it can be twisted and turned or completely deformed, yet easily returned to its original shape without effort.

The simplicity of construction and the ease of application and installation of this new system allows this material to be formed into radii and intricate

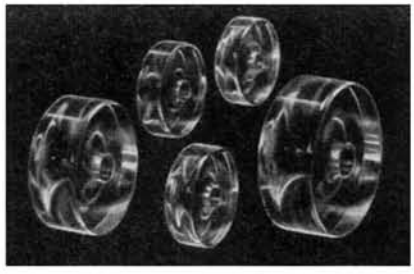
angles and shapes for fittings in a matter of minutes. It eliminates the necessity of making patterns and bending and fitting joints and elbows with strategic materials. These systems are assembled and cemented together with a special synthetic rubber compound.

GLASS "ROLLER SKATES"

Are Actually Miniature

Bearings for Instruments

THEY LOOK like streamlined roller-skate wheels, but they're actually molded glass bearings no bigger than



A miracle of molding—glass bearings as small as the head of a pin

the head of a pin. Enlarged hundreds of times in the accompanying photo, the smallest bearing is about .006 inch in diameter. Developed to replace sapphire bearings formerly produced by Swiss craftsmen using horsehairs as drills, they support spinning metal parts in miniature General Electric communications and aircraft instruments for the armed forces.

VULCANIZING SYNTHETIC RUBBER

Improved Through Use

of New Agents

SINCE the general-purpose synthetic rubber, GR-S, made its formal debut, chemists have been concerned with two vital problems: They have striven to improve the tack of this polymer and to achieve precise control of its vulcanization.

Extensive tests have shown that alkyl phenol sulfides serve the dual purpose of imparting tack and acting as vulcanizing agents for GR-S rubber. One method of imparting tack to synthetic rubber has involved the addition of organic materials. To overcome the second problem, the approach followed by rubber chemists has been the correct choice of accelerators to be used with sulfur vulcanization as well as careful adjustment of quantity used.

p-tertiary-amylphenol-disulphide is an example of the alkyl phenol sulfide class of vulcanizing agents which mixes readily with synthetic rubber of the butadiene type to impart upon vulcanization superior tensile strength and improved elongation, together with greater resistance to tear and cracking under flexure. All these factors contribute to the improvement of GR-S synthetic rubber.

The improved synthetic rubber compositions made available through the use of these new organic vulcanizing agents are outstandingly resistant to deterioration by heat and, as such, give promise for such applications as inner tubes and the carcass section of tires. These agents, by virtue of both their tack-imparting quality and vulcanizing power, are proving of interest in the formulation of rubber footwear stocks. They are also adapted to the manufacture of improved synthetic rubber goods for industrial uses.

The basic raw materials used in the manufacture of the new vulcanizing agents are readily available. Marked improvement in the present synthetic rubber, without changing the present method of manufacture, may be realized through use of alkyl phenol sulfide vulcanizing agents.

TRUCK TIRE

Life Extended by

Improved Design

NEW design and construction of a Goodrich truck tire make it run cooler than ever before. Reduced tread thickness at the shoulders and addition of new ventilating grooves in the shoulder blocks, are the principal changes in the tire construction which

Cross-section of the new truck tire, showing shoulder ventilating grooves

lessen operating heat, while other improvements in design reduce dangers of sidewall cracking. The sidewall has been made thicker at the base of the grooves between the shoulder blocks, and the ornamental rib on the sidewall constructed shallower to provide better distribution of stresses.

INDUSTRIAL TELEVISION

Can Serve to Improve

Process Control

POTENTIALITIES of television as a new and effective aid to industry after the war have been described by Ralph R. Beal, Assistant to the Vice President in Charge of RCA Laboratories, who envisages television as the coming "eyes" of factories, the "means of coordinating activities in giant manufacturing plants, and the means also of peering into places and situations that might be inaccessible or extremely hazardous to man."

"We know now," the research engineer declares, "how it can be used to

extend the eyesight of the plant manager to critical operations that ordinarily would require much time and effort to reach for personal inspection or which might even be inaccessible—how television can aid immeasurably in plant control.

"Television cameras at strategic points can be connected by wire to receivers where production experts, foremen, and supervisors can follow the flow of fabricated or raw materials and watch the progress of the work. Such setups will be particularly valuable in mass-production assembly lines, and they may be extended to include loading platforms and shipping rooms."

According to Mr. Beal, television cameras may be used in connection with chemical reaction chambers, making visible to the operator without personal risk the chain of events occurring in complicated chemical production units, and thus enable him to control the process with optimum results. He says that specially-built cameras may be used in furnaces to observe steps in the formation of alloys, and that others may solve vital problems of analysis in important industrial processes.

CAUSTIC REMOVAL

Facilitated by Use of Bicarbonate of Soda

REMOVING excess caustic from goods in various textile finishing operations by a new process makes use of bicarbonate of soda instead of sulfuric acid, which has been employed heretofore. It is claimed that the new process makes unnecessary the use of acid-resistant equipment, minimizes hazards to workers, reduces the number of steps in some processing operations, and improves the quality of the goods.

The applications in which the process, developed by The Mathieson Alkali Works, has thus far been found successful include removal of caustic after continuous jig scouring or mercerizing of open-width heavy fabrics, after warp yarn mercerizing, after kiering, and after caustic steaming.

PROTEIN CONCENTRATE

May be Used as an Ingredient in Animal Feed

IN TIME of protein shortage, high-protein concentrate can be obtained by means of alkali extraction from grass and used an an animal feed ingredient, according to an article in *Food Industries.*

"Of value as a concentrate for animals requiring low-fiber, high-protein diet may be the extraction of dried grass which, with sodium hydroxide solution and the neutralization of the resulting solution with acid, yields a precipitate containing a high concentration of protein, a considerable amount of carotene, and an insignificant amount of lignin and cellulose. Such a product is higher in protein than most protein concentrates, being exceeded only by those of animal origin. It is also higher than many animal feeds in carotene, a considerable part of the pigment in the grass having been absorbed by the protein precipitate," according to the article.

"A ton of dried forage of mixed type grass taken from plots early in May should yield about 285 pounds of dried product. Further purification of the crude product, as far as protein concentration is concerned, may be obtained by extraction with alcohol. By this process the green coloring matter is removed and the resulting product is tasteless, though nearly black in color. It contains over 72 percent protein on the dry basis.

"The residual grass material may have some food value. It yielded in laboratory tests about 875 pounds a ton. It is green in color and has the appearance of a palatable stock feed The alkaline treatment alone should not have affected it adversely since such treatment has been shown to increase the digestibility of straw," the magazine states.

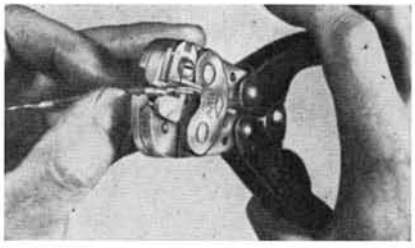
"Enormous quantities of protein-containing forage are unused annually by over-production during lush periods of growth, in discarded lawn clippings, and on ungrazed roadsides. Surpluses may be restored to the soil for their fertility value as well as preserved in silage or hay, and there is also this possibility of converting the protein, which is the most expensive of the three major food constituents, into a less bulky and nonperishable form to supplement the diet of many animals."

New Products

SOLDERLESS CONNECTORS

A TERMINAL connector for electrical wiring which has its insulation bonded to the terminal so that no insulation sleeving is required eliminates several tedious steps in making insulated electrical terminal connections. Developed by Aircraft-Marine Products, Inc., the connector eliminates the work of fitting and adjusting separate pieces of insulation sleeving over terminal connections.

The insulated terminal incorporates another important advantage in that it also supplants conventional soldering methods. Press dies, or a simple hand tool resembling a pair of pliers, crimp the terminal connector and the wire it holds into a homogeneous mass, making a perfect electrical and mechanical connection.



A simple crimping tool replaces the soldering iron on solderless lugs

These solderless connectors are also available in uninsulated form. Where conditions require, they may be obtained in styles fabricated from corrosion-resisting metal.

VACUUM-TUBE VOLT-METER

SPECIAL features of a new vacuum-tube volt-meter, made by Televiso Products, Inc., include high sensitivity, stabilized zero, and a built-in standard cell for calibration checks. Voltage ranges are .5-5-50-200 A.C., full scale. It is accurate to 2 percent of full scale on voltage, 2 percent on frequency to 150 megacycles.

This new volt-meter has automatic zero adjustment on all ranges. Readings vary 1 percent with 10 percent line voltage fluctuation. It is used for RF-AF production and laboratory measurements by communications and electronic equipment manufacturers.

HEATER REPAIR

BROKEN and burned out electrical electrical heating elements can be quickly and effectively repaired through the use of a new flux developed by the Chanite Sales Company. This flux, which incorporates a number of different natural materials, is applied to the broken element without special tools.

When a heating element has been burned out, it is necessary only to stretch the wire a bit so that the broken ends can be lightly joined, or to bridge the gap with another piece of wire, following which the wires are moistened with water applied with a piece of wood or a match stick. The moistened stick is then used to apply a small amount of the flux to the joint and the current is turned on. The flux instantly melts and forms a perfect bond between the ends of the wire.

It is claimed that joints thus made are as strong as the original wire and that any number of joints can be made in a heating element without affecting its utility. The flux is inexpensive and is used in extremely small quantities per joint.

COLD PADDING GLUE

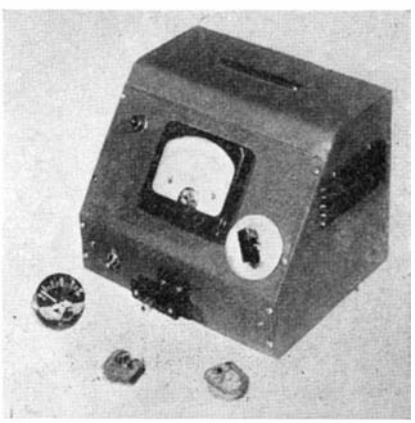
A SYNTHETIC resin-type cold padding glue, which is reported to successfully replace pre-war rubber latex compounds, is called Pliatab. Available in red or white (natural) color, and in containers ranging from one quart to 55 gallons, it comes ready to use with a moistened brush or, diluted with water, in a spray gun. This product, recently perfected by Paisley Products, Inc., serves equally well with all grades of papers, backing boards, and for many special gluing operations on cloth and leather bindings.

FLUXMETER

AS AN AID in production of radio and radar instruments, a new type electronic fluxmeter has been developed by J. Thos. Rhamstine. The unit also may be used for checking and comparing the magnetic flux of any shape or type of permenent magnet.

Designed primarily for checking the saturation of special Alnico meter magnets, this new device can be used for comparing various types of magnet steel. Different sizes and shapes of search coils may be used and may be small enough to insert in the air gap of assembled meters.

A direct reading indicating meter



Magnetic flux is read direct

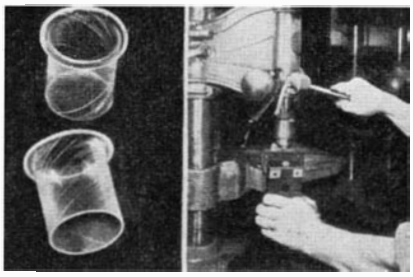
shows the flux as long as the search coil is in the magnetic field. This new permeability comparator has no moving parts except for the indicating meter, and employs a special vacuum tube circut operating from the A.C. mains.

ACETATE GROMMETS

SPUN acetate grommets, produced by Precision Paper Tube Company, are revealing marked superiorities in aircraft, hydraulic controls, small motors, lamps—in fact, in the many purposes for which small grommets are used.

Manufactured of acetate film, spirally wound and laminated for greatest strength, these grommets provide high insulating properties combined with the non-shatterable toughness of the material. Light weight, resistance to oil, moisture, and all climatic conditions are also advantages.

The main feature is the ease of assembly made possible by the method of manufacture. Grommets are supplied with one end spun, inserted in place, and subsequently spun over on stand-



Left: Acetate grommets ready for assembly and, right, rolling the grommets on a small standard drill press

ard drill press equipment with special tools supplied by Precision.

The heat of the spinning operation actually shrinks the thermo-plastic material, so that a tight fitting, tough, permanent insulation results.

PRECISION COUNTERSINK

TO FILL the need of precision countersinking of large rivets, bolts, and screws, the Aero Tool Company has developed a large-sized micrometer stop countersink. This new tool, which countersinks up to 1¼ inches, is capable of countersinking ½-inch rivets, and can be instantly and positively locked at each micrometer setting in increments of .001 inch. Adjustments are made manually and can be made while the tool is in operation.

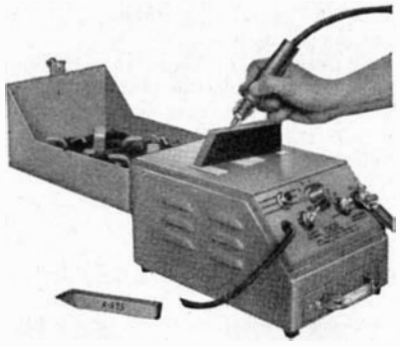
ETCHER AND DEMAGNETIZER

A NEW tool that is ready for instant use as either an etcher or demagnetizer, is enclosed in an attractive case with a removable, hinged cover.

To etch small tools and parts, they are placed on the work-plate, a switch is turned "On" to proper heat, the etching is started. A ground clamp is provided for etching parts too large for the work-plate.

A wide range of heats is provided for marking all iron, steel, and their alloys from small delicate parts up to large, smooth castings. An indicating lamp glows brighter as each higher heat is used.

To demagnetize, it is necessary only to turn the switch "On" to either Num-



For etching or demagnetizing

ber 1 or Number 2 position and proceed as with an ordinary demagnetizer. Maximum rating is 5.5 amperes. Overall pole area, 13½ square inches.

BRONZE-ON-STEEL

BRONZE faced pistons, which may well cause a small revolution in the manufacture of such parts, are made by a method which involves flame spraying of bronze on steel. The successful application of that method by the Neo Mold company's process (now proved under the most gruelling practical use) is the first of its kind, although attempts have been made in the past to achieve this particular result by other bronze-on-steel methods. Comparatively light steel blanks are sprayed with a special bronze alloy to a thickness of approximately .045 inch on the bearing surface. This is rough machined in the initial production, then given the required high finish, with oil grooves.

Pistons for aircraft landing struts were formerly machined from bronze castings. Each required about seven pounds of bronze. Now made by the new process, some three and a half pounds of bronze are saved on each piston, and the finished product is lighter than the old pistons. Chief advantage is that the strength of steel is combined with the bearing qualities of bronze. Neo Mold metallurgists claim that the end-product is a bronze facing which for this application is superior to that of a machined bronze casting, one important factor being its oil bearing quality. Having a extremely fine porosity, the sprayed bronze absorbs and retains oil, becomes self-oiling.

This process is now being applied to all types of pistons for compressors and pumps, where a combination of strength, lightness, and wearing quality is essential.

AIR STERILIZER

INDUSTRY can now safely apply a principle widely used in the hospital field—the germicidal effects of ultra-violet rays to the disinfection of the air—in plants and offices through the use of a new device known as Hygeaire System. This system is a combination of the well-known G.E Germicidal Tube and a patented reflector in

the fixture designed to project a zone of protection across an area above eye-level. Air-borne bacteria and viruses are carried into the zone of ultra-violet rays, and to their deaths, by convected air currents, giving to the protected space the germicidal effect of 100 air changes per hour.

Industry will find in Hygeaire System, made by the American Sterilizer Company, a new tool with which to help combat absenteeism, disrupted production schedules, and unavailability of key personnel.

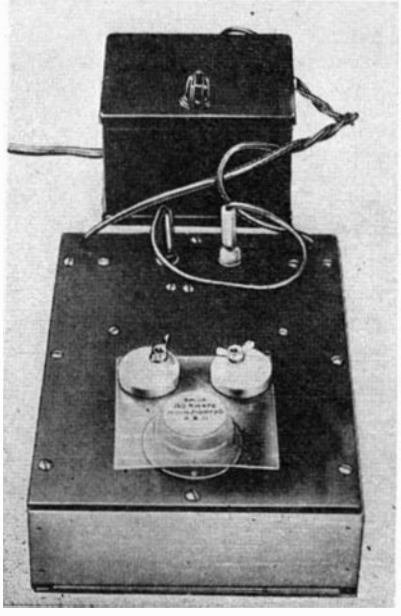
DIAMOND HAND HONE

Designed with the diamonds set in a hard metal bond, a new hand hone provides an improved method for keeping cutting edges keen. Just a few strokes will quickly sharpen high-speed steel as well as the hardest grades of cemented carbide-tipped tools. It is claimed this hone holds its flat surface longer and will not score, groove, or chip.

METAL MARKING

Yielding 1200 to 1500 impressions per hour, a new electrolytic method of marking metal is announced by the Acme Metal Marking Equipment Company. By means of Met-L-Etch, as the system is called, names, numbers, trade marks, inspection symbols, and other data are quickly and permanently etched on smooth metal surfaces without the use of acid. The part to be marked does not need any special preparation, nor does it require cleaning or neutralizing after being marked.

The operating procedure is simple. A drop of conductive solution, good for 500 impressions, is applied to a silver pad on which rests a celluloid stencil engraved with the mark to be etched. The part to be marked is placed on the stencil in contact with adjustable guide posts. The current is turned on by a slight pressure, one second being sufficient to produce a permanent mark that cannot be eradicated without removing the surface of the part itself.

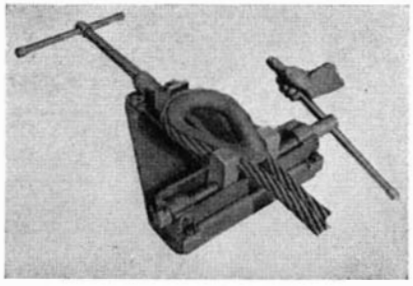


Electrolytic metal marking unit

Two models of Met-L-Etch are offered, one for marking flat surfaces, the other for marking the periphery of round parts.

RIGGERS' FORMING VISE

For splicing and clamping wire rope and cable for forming around the thimble, or in forming slings, a new



Wire rope is held securely

rigger's vise has been announced by Patrick - McDermott and Company. Known as the P-M Portable Riggers' Forming Vise, the unit is designed and built in such a manner that the shaft levers give complete and easy control of both front and back jaws. Wire rope or cable is securely held and formed in the vise, with guards to protect the threads from damage by and friction of the wire rope. Rigid construction assures great strength and durability.

ELECTROPLATING COMPUTER

An aid to the electroplater and plating chemist, made available by the Hanson-Van Winkle-Munning Company, is called the Jernstedt Electroplating Computer. It does for the plater what the slide rule accomplishes for the engineer—makes use of logarithmic scales to eliminate lengthy calculations. Accuracy of control and a minimum loss of time are the results, after the plater becomes familiar with its operation.

Among other things, the instrument accomplishes the following: Computes chemical additions required in a plating bath of any gallonage. Indicates weight of metal deposited on unit area, given the thickness. Gives plating time required to deposit a given thickness of any metal. Computes current density required to produce a deposit of given thickness. Indicates thickness of deposit resulting from an established plating time at a known current.

PLASTICIZER SUBSTITUTE

Shortage of the critical materials forming the usual plasticizers for cellulose acetate is being effectively relieved by PHO, a development of The Neville Company, according to a report from the company's research laboratory.

PHO can replace up to 50 percent of the usual expensive plasticizers for cellulose acetate. It is a viscous, resinous liquid, so that the total plasticizing oil content of PHO-made compositions is somewhat higher than when the ordinary plasticizers are used alone.

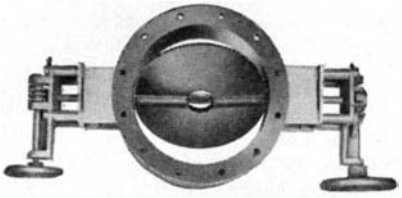
These plasticized compositions are

being used as injection molding compounds for small industrial molded pieces, insulation parts, and for consumer articles such as pens, pencils, combs, and the like; and lacquers when dissolved in solvents.

TWO-IN-ONE VALVE

DESIGNED for either a high pressure drop and small volume or a low pressure drop and large volume, a dual-purpose butterfly valve operates beyond the limitations of a single valve. Close control and shut-off of volume and pressure can be obtained and the valve is easily adapted to power operation.

The larger beveled vane seats against the body of the valve, while the smaller vane is free revolving. Four to six revolutions of the hand wheel completely open or close either valve vane.



Dual-purpose butterfly valve

This type of valve, developed by R-S Products Corporation, is available in various combinations of sizes and for operating pressures of 15 to 900 pounds per square inch.

PROTECTIVE FILM

ANTI-CORROSION films for steel can be obtained by the use of Sublan, a product of the Glyco Products Company, Inc. Polished panels protected with a Sublan-mineral-oil mixture have been stored for 10 months and showed no rusting. Furthermore, the film supresses latent finger prints on polished steel surfaces. The film is readily removed by a cold solvent wash or dip.

FREQUENCY METER

FEATURES of a new direct-reading Norelco frequency meter include eight ranges covering 0-50,000 cycles and sufficient power to operate a strip-chart recorder without an auxiliary amplifier. The instrument is of considerable value in research and development and for production, inspection, and maintenance applications.

SAW-TOOTH GAGE

A CONVENIENT little gadget for lumber workers is a polished steel inserted-tooth saw gage, about 6½ inches long, by which the saw mill operator can check his filing job in order to obtain the best possible lumber.

The gage, distributed by The American Saw Mill Machinery Company, is notched and marked so that one can instantly square the saw bits with the saw and see that each bit projects the same distance on each side of the saw, in order that each bit will do the same amount of work. It is important that each bit be checked on *both* sides of the saw, for only a little oversize by any bit on either side will mark the lumber and produce an inferior sawing job. The gage will be sent gratis to any saw mill operator requesting it.

FIRE FIGHTER

DESIGNED especially for fighting both flammable liquid fires and those of electrical origin, a new fire extinguisher ejects a stream of "All-Out" dry chemical which, when activated by heat, forms a dense, fire-smothering cloud over a flaming area up to 18 feet distant. The insulating qualities of the cloud help guard against re-flash and create a heat-deflecting screen between the operator and flame, permitting close-range attack with greater safety and less heat discomfort. The chemical, a non-conductor of electricity, is harmless to humans and to delicate, mechanized parts of motors or machinery.

Weighing only 37 pounds fully charged, the "All-Out" extinguisher is easily maneuvered and can be quickly recharged at the scene of the fire.

ALL-PLASTIC GOGGLE

JUST announced by Willson Products, Inc., is the new MonoGoggle designed to provide high impact strength, unobstructed vision, and the highest degree of comfort. Weighing only 1¼ ounces, this new streamlined goggle has a replaceable, nonshatterable crystal-clear plastic lens and can be worn comfortably over any prescription glasses.

Safety, comfort, unobstructed vision

Metals in Industry

(*Continued from page* 21)

Corps Specification An-A-17 with tensile strength of 32,000 pounds per square inch minimum, yield strength of 20,000 pounds per square inch minimum and a minimum elongation of 3 percent in 2 inches. The properties of the cast alloy reach the foregoing specifications within three weeks at room temperature.

Besides eliminating difficulties often associated with heat treating, development of the alloy has permitted the casting of large pieces that would otherwise require expensive heat treating equipment and the casting of high-strength aluminum in foundries that lack heat-treating facilities entirely.

METAL TONNAGES
Compared for World War I and World War II

A STUDY by WPB of the comparative annual rates of consumption of some 30 leading metals and minerals in this war, as compared with World War I, shows that magnesium stands at the top of the list with respect to percentage increase.

Magnesium is used in this war at a rate 1400 times that of World War I. Aluminum is next with a current consumption rate 20 times as great. Copper is being used at five times the rate and steel at about twice the rate of their consumption in the other war.

In considering the figures for the light metals, impressive though they be, it should be noted that the *tonnage* increase for steel is far and away the largest. The country's steel production in 1918 was about 50 million tons, and in 1943 is was about 90 million tons—an increase of 40 million tons. Aluminum has gone from 50,000 tons to one million tons, and magnesium from about 200 tons to 300,000 tons.

Just the tonnage *increase* for steel actually dwarfs the present *total production* of all the other metals combined.

SHELL FORGING
Now Accomplished by Metal-Saving Process

IMPORTANT production advantages have resulted from the adaptation by Porter-Blairsville Company, a division of H. K. Porter Company, Inc., of a new method of forging large caliber projectiles for the United States Navy.

Previously straight cavity forgings were used as raw material, the operations comprising upsetting and piercing, using a straight punch, in one pass in the press; drawing in a draw bench, using five rings; and machining to give the proper contour for nosing. Considerable metal was removed in machining the outside of the forging.

With the "contoured cavity" method now in use there is little waste of metal. A shaped punch is employed to make the contoured cavity, which flares out in size from the closed to the open end of the forging. Since the required taper is produced by forging rather than by machining, the metal required per unit has been reduced approximately 13 percent.

There are other advantages, the Porter-Blairsville Company reports. Since the contoured cavity is of larger diameter, larger punches and mandrels are used, and these provide better rigidity and less wear in operation. More concentric forgings and improved tool life result. There is also less tendency for the base to punch through in drawing.

CARBIDE TIPS
Now Applied to Unused Tools

IT has become common to salvage used cutting tools by brazing tungsten carbide tips to the used steel surface, but it is something new to reclaim unused tools as the Yale and Towne plant is now doing.

In the early days of tipping, carbide tools proved so satisfactory that workmen were reluctant to use up the high-speed steel and carbon steel tools still in stock. To cut down this dead inventory and to achieve some kind of early return from the investment in these tools it was decided to carbide tip all unused tools. Now all unused tools are considered merely as blanks made for the individual jobs, that are placed in final working condition by tipping.

NE STEELS
What is their Future in the Metals Field?

FEW technical questions about the future loom as large in the minds of materials engineers and metallurgists as the probable position in the post-war era of the NE steels—the American wartime emergency steels, made in the open hearth, that have properties comparable to much higher alloy steels formerly used.

Edwin F. Cone has made a survey of leading engineering opinion on this subject for *Metals and Alloys* and offers the following conclusions as a preview of the future of the NE steels:

As a class the NE steels are here to stay, although the extent of their use will be lower than at present. Price factors as much as anything else will set the level of their ultimate use.

The reasons for a lessened relative post-war demand will be (a) the fussier heat-treating behavior of the NE steels, (b) the psychology of favoring the familiar over the new or strange, (c) NE steel overpricing, so that either the lower prices of the "needled" carbon steels or the better properties of the higher alloy steels become more attractive, and (d) sales pressure from the alloy producers.

The older, high-alloy engineering steels will regain some (perhaps much) of the ground they lost during the war, but will probably not resume their former relative position.

Aviation

(*Continued from page* 9)

expansion by continuing construction of airports and airways on a large scale, by installation of blind landing facilities, and by general technical development.

Among other plans, the C.A.A. is announcing the installation of automatic air traffic control systems in the Washington and New York areas. These are to be ready for use in 1945. They are to be followed by similar installations in Los Angeles, Cincinnati, Cleveland, Chicago, and Oakland, California. The position of aircraft will be reported and recorded automatically, and other devices will help in the work of traffic control.

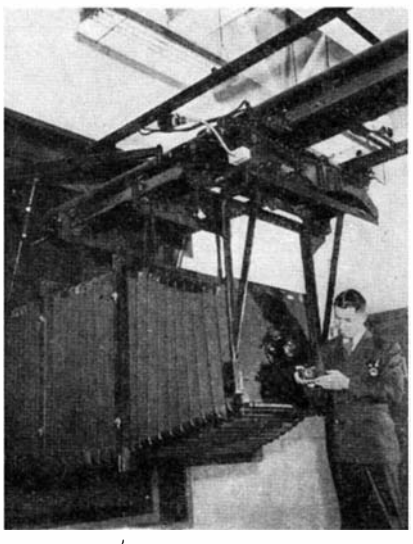
So congested may our airways become that it will be necessary to route traffic around major points in the manner used for controlling highway and railroad traffic.

PHOTO TEMPLATE

Process Speeded by New Change-Making Technique

LIKE DRESSMAKING, the building of an airplane requires a full-sized pattern —called a template—for each individual part, and in the Boeing Fortress, for example, there are 30,000 of these parts. In former days, these templates were built laboriously by hand from conventional blueprints. Some were made of wood and some of steel, but in either case the work was slow, and many templates required as much as 200 hours of layout time. But with the photographic method of making templates. the process has speeded up immeasurably.

The great saving in photo templates lies in the fact that hundreds of copies of a template can be made from one photographic negative. The original engineer's drawing or master layout is made to exact size in the engineering department on a sheet of thin steel. This master layout is then taken to the photo template darkroom for reproduction and is placed on a huge easel, to which the sheet is held tightly by vacuum. The camera which does the job of photographing this master drawing is shown in one of our illustrations. It weighs some six tons and is valued at approximately $20,000. The bellows and lens of the camera are in the same room with the easel, but the holder for the glass negative is in an adjoining room.



Steel girders support the photo-template camera and connect it to easel, insuring complete rigidity

The master drawing is photographed on a glass negative about one fifth the size of the original drawing. The camera which made the original negative is then used as an enlarger and the negative image is projected onto a sensitized steel sheet to the exact size of the piece to be reproduced.

One of the original problems in speeding up work was developing a technique for changing some small detail without making an entirely new master template. These changes are now printed on a translucent, dimensionally stable cloth substance, which is sensitized on one side. The cloth print is then glued on the original template at the point where the change is to be made.

AREA AIRLINES

Designed to Supplement Major Routes

AN AMBITIOUS yet sensible plan whereby the benefits of scheduled air service can be extended to more local areas has been put forth by Southwest Airways. Called "Area (Feeder) Airlines," the system is described in the following words:

"They are lines that would serve within untapped, potentially rich trade areas; feeder systems that would supplement trunk (major) airlines, carrying passengers, mail, and express over small city and rural routes radiating outward from central air terminals. Operating smaller airliners, they would bring speedy, reliable, and frequent schedules to thousands of communities now untouched by air service—and where there are no landing facilities they would still pick up and deliver airmail and cargo through the use of a special mechanical device, so that rural districts as well as metropolitan centers would have direct air service."

The equipment which would be employed on area airlines includes twin-engine transports designed to accommodate 10 to 12 passengers and to carry 800 to 1000 pounds of mail and express. Cruising speed would be approximately 180 miles an hour to assure a scheduled speed of 120 miles an hour with full allowance for time spent in climbing into the air, maneuvering, and descent. Stations would be only 15 to 20 miles apart, which would constitute a decided element of safety. Helicopters might be used in certain areas. The operators would be new companies—not those already interested in the great transcontinental airways, but relatively small though stable concerns which understand the needs of certain regions and are willing to devote themselves wholeheartedly to the service of those regions.

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.)

A TABLE OF COMMON HAZARDOUS CHEMICALS is a 32-page compilation giving information designed to promote and improve methods of fire protection and prevention in plants where hazardous chemicals must be employed. *National Fire Protection Association, 60 Batterymarch Street, Boston 10, Massachusetts.—30 cents.*

THE USE OF SULPHUR IN THE CONTROL OF TRUCK CROP AND CANE FRUIT INSECTS AND DISEASES is an 86-page booklet describing the insects and their effect on a list of over 50 crops and fruits, and outlining the proper control uses of sulphur in each case. *Texas Gulf Sulphur Company, Second National Bank Building, Houston 2, Texas.—Gratis.*

A PROPOSED WORLD GOVERNMENT, by George A. Birdsall, is a 110-page booklet briefly outlining the author's plan, its possible effect on the nations, and the philosophy of world government. A Constitution to provide World Government is set forth, containing 10 Articles. *George A. Birdsall, 301 South Highland Street, Arlington, Virginia.—$1.50.*

LARCO DIAMOND TOOLS is a 32-page booklet covering the most pertinent facts about grinding wheels in question and answer form. Also given are cross-sectional views, sizes, and prices of various models. *Plant Service Department, Larco Tools, 551 Fifth Avenue, New York 17, New York.—Gratis. Request this on your business letterhead.*

ALUMINUM IMAGINEERING NOTEBOOK is a survey of 12 important economic advantages of aluminum plus some examples of things that have become realities. *Aluminum News-Letter, 2195 Gulf Building, Pittsburgh 19, Pennsylvania.—Gratis.*

GEON RESINS AND PLASTICS is a four-page folder which outlines the characteristics and specific properties of four Geon resins and also the characteristics of Geon plastics. A partial list of their applications is also presented. *Chemical Division, B. F. Goodrich Company, Akron, Ohio.—Gratis.*

AN IMPORTANT MESSAGE FOR ALL USERS OF INDUSTRIAL TAPES is a six-page manual giving suggestions for the proper selection, handling, use, and storage of industrial adhesive tapes. Individual sheets are devoted to information for department heads, employees using tapes, and storeroom personnel. These sheets are detachable for posting on bulletin boards. *Bauer and Black, Industrial Tape Division, 2500 South Dearborn Street, Chicago 16, Illinois.—Gratis. Request this manual on your business letterhead.*

FACTS ABOUT COLOVOLT—THE NEW COLD CATHODE LOW VOLTAGE LAMP is an eight-page booklet containing complete data and a listing of 40 features of this fluorescent lamp, including instantaneous starting, wide voltage range, reduced fire hazard, and a one-year operating guarantee. *Mr. R. L. Sullivan, General Luminescent Corporation, 638 South Federal Street, Chicago 5, Illinois.—Gratis. Request this booklet on your business letterhead.*

JEWELS OF INDUSTRY is an illustrated folder outlining the significance of Eli Whitney's idea of interchangeability which resulted in mass producton based on precision measurement. Also presented is the importance of quality control of production. *Continental Machines, Inc., 1301 Washington Avenue, South, Minneapolis 4, Minnesota.—Gratis.*

LIQUID VIBRATING SCREENS is an eight-page illustrated booklet covering the installation, construction details, dimensions, and weights of screens for recovering many types of waste products and reducing pollution. *Link-Belt Company, 307 North Michigan Avenue, Chicago, Illinois.—Gratis.*

CANNON PLUGS FOR AIRCRAFT BATTERIES, ENGINES AND GENERAL APPLICATIONS is a 24-page bulletin with illustrations, sectional views, and data sheets on a variety of battery connectors. Also presented is a summary of the uses, styles, and features of all the types of connectors. *Catalog Department, Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.—Gratis.*

ECONOMY BOILER BAFFLES is an illustrated bulletin showing how fuel economy and greater steam generating capacity can be achieved by the modernization and proper location of baffles. *The Ramtite Company, Division of The S. Obermayer Company, 2563 West 18th Street, Chicago 8, Illinois.—Gratis.*

CHERRY BLIND RIVETS is a 36-page manual describing and illustrating drilling the hole, selection of the rivet, operation, installation procedure, tools, and inspection technique. Request Manual B-44. *Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California.—Gratis.*

SIMMONDS PRODUCTS FLY WITH FAMOUS PLANES is an eight-page illustrated booklet describing a group of advanced aircraft and industrial products—an automatic engine control, precision push-pull control, hydraulic fuse, and chronometric radiosonde. Post-war plans of the company are outlined. *Simmonds Aerocessories, Inc., 30 Rockefeller Plaza, New York 20, New York.—Gratis.*

Our Book Corner

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

TO MAKE CERTAIN that books ordered by or for men in the Army, located in the United States, or men in the Navy, Marines, or Coast Guard, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 10¢ additional; from $5 to $25, 20¢; from $25 to $50, 30¢.

OIL IN THE EARTH

By Wallace E. Pratt

FOUR lectures delivered before the students of the Department of Geology, Universtiy of Kansas, form the basis for this elementary discussion of a highly important natural resource. The text deals briefly with the nature of oil, its origin, and the formations in which it is found. It then surveys the oil geology of the United States with side-glances at foreign sources. How oil is found and whom it belongs to—internationally speaking — completes the text of this compact little book, which ends on the note that a way must be found to free ouselves of our present dependence on oil in the earth. (110 pages, 5½ by 8½ inches, unillustrated.) —$1.35 postpaid.—*A.P.P.*

GENERAL CHEMISTRY

By H. G. Deming

FOR THOSE who seek to start from scratch and learn chemistry at home, few or no college textbooks, or even high school textbooks, are suitable. Two vital factors are lacking—a teacher to consult and experiments to perform in a well-equipped, going laboratory. For those who have already studied college chemistry this book would give an excellent review and if the study was pursued a generation ago it would also provide the larger, deeper content required of the student today. It is so up-to-date that some wartime industrial slants have been embodied in it. (711 pages, 5½ by 8¼ inches, 167 illustrations.)—$3.85 postpaid.—*A.G.I.*

GEOLOGY FOR EVERYMAN

By Sir Albert Seward

FASCINATING chapters on geology as an amateur's hobby but based almost entirely on the geology of Great Britain. (312 pages, 5 by 7½ inches, 19 illustrations.)—$3.35 postpaid.—*A.G.I.*

PRACTICAL ANALYTIC GEOMETRY WITH APPLICATIONS TO AIRCRAFT

By Roy A. Liming

SPECIAL book by the head of Engineering Loft Mathematics, North American Aviation, Inc.; being a comprehensive study of the application of analytic geometry to the practical mathematical definition of airplane contours and structures. Pre-requsites: algebra, solid geometry, trig. (272 pages, 5¾ by 8¼ inches, plus tables, illustrated.) — $4.60 postpaid. — *A.G.I.*

PRODUCTION CONTROL

By Asa S. Knowles and Robert D. Thomson

SIMPLIFICATION and standardization of production control methods in industrial plants are highly important in efforts to achieve maximum shop efficiency with a minimum of overhead expense. Hence this manual for production men stresses those points of control which are most important in the correlation of procedures. The text covers storekeeping control, planning procedures, four types of industrial control systems, distribution of overhead expense, control of variable costs, and so on. (272 pages, 6 by 8½ inches, a number of photographs and drawings.) —$2.60 postpaid.—*A.P.P.*

THE READER OVER YOUR SHOULDER

By Robert Graves and Alan Hodge

THERE have been scores of writers' desk books; this one is altogether different and, in fact, unique. It deals almost wholly with the kind of final polishing-off of written manuscripts which all but a few writers omit and over which editors have to perspire. In fact, it takes examples of 54 established authors' writing and subjects them to minutely detailed point-by-point criticism; revealing thereby that even eminent authors, British and American, often write with great carelessness. It states advanced principles of clear writing that are less well covered in the schoolbooks and handbooks. (466 pages, 5½ by 8¼ inches, unillustrated.)—$3.10 postpaid.—*A.G.I.*

EXPERIMENT AND THEORY IN PHYSICS

By Max Born

THOSE who are interested in the underlying philosophies of physics will find in this little book by a noted physicist a discussion of some of its current major trends of thought, center-

The Editors Recommend

Best Sellers in Science

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

FORWARD WITH SCIENCE — ***By Rogers D. Rusk.*** Philosophical discussions of developments centering around modern physics: Newly discovered particles, electron microscope, atomic energy, man-made radio-activity, cosmic rays, and so on. **$3.60**

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

FUNDAMENTALS OF PERSPECTIVE — ***By Theodore DePostels, A.I.A.*** A method of showing the order, or sequence, in which lines of a perspective are drawn. Use of colors, numbers, and arrows eliminates much text found in other books on this subject. 20 loose sheets in binder. **$2.60**

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ELECTRONIC PHYSICS — ***By Hector, Lein, and Sconton.*** A simplified text for those who desire to acquire a sound basis for following the advance of applied electronics. **$3.85**

A LABORATORY MANUAL OF PLASTICS AND SYNTHETIC RESINS — ***By G. F. D'Alelio.*** How to prepare many of the well-known resins and plastics in the laboratory. Understanding of the text requires a knowledge of organic chemistry. **$2.10**

MACHINERY'S HANDBOOK — ***12th Edition.*** "Bible of the mechanical industry," 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

FUNDAMENTALS OF OPTICAL ENGINEERING — ***By Donald H. Jacobs.*** This new work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.10**

PROCEDURES IN EXPERIMENTAL PHYSICS — ***By John Strong, Ph.D.*** A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS
Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

PROPOSALS for several interesting varieties of modified Gregorian telescopes, offered to other advanced members of the amateur telescope making fraternity by Lyle T. Johnson, Box 236, La Plata, Md., are contained in the following extracts and abstracts from several of his letters.

"As I was reading Pickering's chapter, 'Reflectors versus Refractors,' in 'A.T.M.A.,' his statement, page 607, about the extensive diffraction effects due to the large size of the secondary mirrors in Cassegrain and Gregorian telescopes, led me to wonder whether some way couldn't be found to reduce these effects. I have figured out two ways of doing this for the Gregorian telescope. In the best of these (Figure 1) the small mirror is placed at the focal point of the primary, and its diameter is equal to that of the field desired at the eyepiece divided by the amplifying power of the secondary.

"In the layout shown the elliptical flat (½" minor axis) will give a field of 2" diameter at the eyepiece. The cone of light (from a single star), reflected from the secondary to the eyepiece, has a diameter at the flat of 3", or six times the diameter of the flat. This means that the small flat will give the same diffraction effects and light obstruction as a 2" mirror in front of the 12" primary. I will call the diameter of this imaginary 2" mirror the 'equivalent diameter' of the flat. As the secondary mirror of the conventional 12" Gregorian would be 3½" or 4" in diameter, the modified Gregorian should give considerably better definition.

"As the secondary of the modified Gregorian is not in front of the primary mirror, it may be made as large as desired. That is, since there is no necessity of cutting the mirror to exact size, Pyrex blanks can be used just as they come. Also, turned edge would do no harm, whereas a slight turned edge on a conventional Cass or Greg is disastrous to definition.

"No perforation of the primary is necessary. Because the light beam doesn't have to pass through the hole, correct design would make a larger field available for photography.

"This telescope would have a rather unconventional tube—L- or T-shaped and wider than it is long. It probably would be possible, however, to design a mounting with the light passing from the secondary through a hollow declination axis to the eyepiece at an easily accessible point.

"In the conventional Gregorian the minimum value of amplification of the secondary is about 5, but in the modified type it could be made smaller if desired.

"Although the diagonal flat is extremely small, the more advanced amateurs probably wouldn't have too much difficulty with its construction.

"As the eyepiece is at one focus of the ellipsoidal secondary, and the small flat at the other focus, any dust on the surface of the flat would be sharply in focus at the eyepiece. This bad effect might be reduced or eliminated by moving the flat a little farther away from the primary. This would cut down the diameter of the field of view, unless the flat were made larger—which in turn would increase the diffraction effects and light loss. The flat probably could be shifted far enough from the primary focus to throw the specks of dust out of focus without reducing the field of view too much.

"As the two beams of light cross at the position of the flat, the construction of the diagonal supports is more complicated than in the Newtonian.

"An alternative method of reducing the diameter of the obstructing mirror, which was considered, required a larger flat placed between the primary and its focus. This would reflect the light from the primary to the secondary at the side of the tube, and then back through the hole in the primary to the eyepiece. It, however, was seen to give only a slight reduction in the diameter of the central obstruction, hence not much would be gained. It also has the disadvantage of four reflections instead of three, and the primary must be perforated.

"The modified Greg eliminates one of the disadvantages of many Gregorians—direct light from the sky striking the eyepiece.

"Design data:

"Primary, 12" $f/3$.

"Secondary, 5" or 6" diameter.

"Equivalent focal length, 144".

"Diameter, d, of secondary necessary for rays parallel to axis is given by $d/12 = 12/36$, therefore $d = 4$".

"Diameter, D, of cone of light reflected from 4" secondary is given by $D/36 = d/48$, or 3".

"If equivalent diameter of flat is E, and primary mirror diameter is M, then $E/M = ½/D$ and $E = M/2D$, or 2".

"Useful diameter of field at secondary focus = ½" times amplification, or 2".

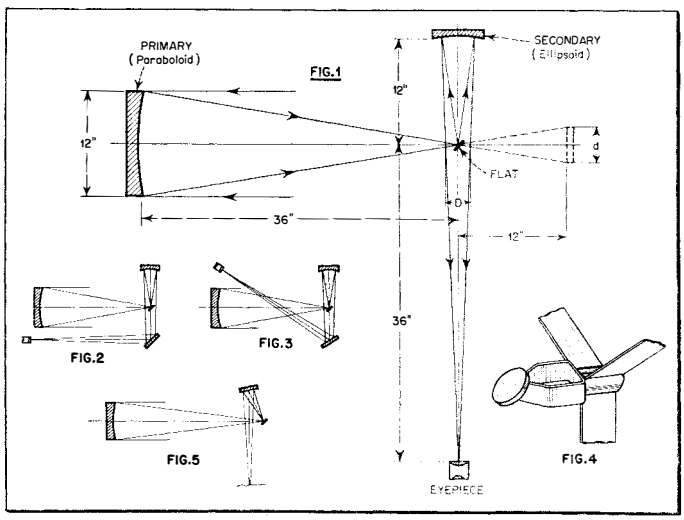
"This idea of mine may not be new.

"If the mounting for the modified Gregorian should prove too difficult it would be possible to make the tube more like that of the conventional telescope, at the expense of an extra reflection (Figures 2 and 3).

"Figure 4 shows the small diagonal support, which presents a minimum of obstruction to the light traveling from the concave secondary to the eyepiece. If the obstruction of light before it gets to the primary is greater than the diameter of the flat, this makes no difference as long as it is smaller than the 'equivalent diameter' of the flat. Thus, in Figure 1, the obstruction at the center of the spider could be up to 2" in diameter without obstructing more light than the flat does.

"Later, while 'pushing glass,' I thought of another modification (Figure 5) which further reduces the bad effects due to the diffraction around the secondary. Its secondary is an off-axis ellipsoid. The beam of light misses the diagonal entirely. Obstruction by the small diagonal occurs only before the light reaches the primary and, if the diagonal has a diameter of a half inch or so, the obstruction is insignificant. In fact, the diffraction due to the spider would be more serious than that due to the diagonal itself. This telescope should approach the performance of a refractor of equal aperture, more closely than any other type of reflector.

"Another advantage of this general type of Gregorian [shall it be called the crossed, or Johnson, type?—*Ed.*] is that there is a certain amount of interchangeability of the secondaries, so that one off-axis ellipsoid could be used as the secondary for almost any paraboloid of approximately a given diameter. On the contrary, the secondary of the conventional Cassegrain or



Gregorian must be made especially for that particular diameter and focal length of primary. This quality could be made use of by a person who desired to build a second Gregorian a few inches larger than the first.

"Figuring an 'off-axis' ellipsoid would be difficult—just how difficult I don't know. The fellows who have been designing [Schell.—*Ed.*] and making [Beede of Youngstown, Ohio.—*Ed.*] off-axis paraboloids could perhaps shed a little light on the subject. It perhaps would be best to figure the mirror spherical and then arrange the pinhole, mirror and knife-edge in the same positions as the primary focus which mirror and eyepiece would occupy in the telescope. Then one could see what the mirror looked like, and figure accordingly. If things permit, I may make one of these telescopes but, if you publish this, someone else may come up with some better ideas on the subject in the meantime."

Johnson's letters were shown to Porter, who commented: "That's the way —try it out and find the bugs in it. if any."

Johnson next performed an experiment to throw light on figuring the off-axis ellipsoid (Figure 5) with small polishers but the equations pertaining to it would be too detailed to publish here. Especially interested readers may borrow them, or should write to Johnson direct.

All of Johnson's data were next submitted to Norbert J. Schell, 1019 Third Avenue, Beaver Falls, Pennsylvania, one of the amateur group (Beaver County Amateur Astronomers Association) 25 miles north-west of Pittsburgh, near Ohio's border. Schell is the originator of the off-side, or unobstructed, reflector (this column, April, 1939), also of the off-axis reflector (May, 1940) and is a widely known advanced amateur designer. His invited opinions, comments:

"So far as I know, this is a new way of getting away from most of the obstruction in a compound reflector. The only other similar effort to reduce the effective size of the obstruction was that mentioned by Dall, ('A.T.M.A.,' page 584).

"Johnson's method is sufficiently different, using a Gregorian set-up and all reflecting surfaces, to give him credit for doping out something new.

"Of his designs I rather prefer the on-axis type as being somewhat more fool-proof, but the off-axis type would, or rather could, be made to get away from the somewhat awkward arrangement of the on-axis.

"The off-axis type, like all other off-axis arrangements, would result in a restricted field, as the field will be the same as the field resulting from the use of the larger imaginary surface, a side section of which is represented by the off-axis surface in use.

"The off-axis type could be designed with the secondary closer to the small flat than with the on-axis, and in this way would bring the secondary focal plane closer to the tube.

"It seems to me that, since the off-axis design leaves only the obstruction of the small flat, it might be better with it to make the primary an $f/5$ or even $f/6$, which would still leave a flat rather small—say an inch or so—and reduce the amplification factor of the secondary accordingly. This, with moving the secondary closer to the flat, would make it possible to bring the secondary focal plane about a foot or so outside the tube.

"There is another reason why I would suggest that the secondary be small. It would not be necessary to make and figure it as a section, but it could quite easily be made full size of the imaginary secondary, and thus figured symmetrically in the regular way. This large secondary would, in use, be placed so that the proper off-axis part of it came into action. I would recommend this method over either making the section only, or making several sections en-bloc. I have tried both and I am satisfied that by this method, surface accuracy is more readily obtained and this is well worth the use of the over-sized surface. I would not recommend this for very large surfaces, or for off-axis primaries as such, but for secondaries, by all means.

"As to the efficiency of Johnson's Gregorian, I think it should work out in the regular off-axis form at least as well as a first-class Newtonian with small flat, such as is used for higher powers; and in the off-axis form, I think it will surprise those who have had no previous experience with reflectors working with little or no central obstruction.

"There is another angle to the off-axis form, which may be found to be an improvement. To wit: Obstructions are usually out in front of the primary almost as far as the focus, and the resulting diffraction is without question worse than if there were a similar size of obstruction at the mirror surface (or at or near an object glass). In Dall's experiment to bring out effects of various sized obstructions, from which he came to the conclusion that a 1/5-sized obstruction is as large as could be used without causing too much trouble, I don't think he brought this double distance into effect. At least he did not displace the obstruction relative to the diaphragms used. In this on-axis Gregorian of Johnson's the effective obstruction is only ¾ the distance from the focal plane to the secondary—a much shorter path for diffraction to spread out. This might be found to produce only the diffraction effect of a considerably smaller obstruction at the usual location. This is one of the reasons I prefer the on-axis design in this case—the other being the matter of field, previously mentioned.

"The job of figuring an $f/3$ primary must also be given consideration.

"Some trouble must be expected from maintaining good smooth coatings on the small flat—and of course this must be a really good flat.

"I hope you will mention Dall in this, as his scheme, referred to above, always stuck in my mind as a starter toward the ideal way of reducing the obstruction of a symmetrical, or on-axis, mirror."

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KEEPING UP WITH *Electricity*

BACK ON THE JOB after a 25-year layoff are the original Westinghouse generators at Niagara Falls. These went into service in 1895 as part of the first great a-c polyphase power system. Replaced in 1917, they were kept as standby equipment until the beginning of the present war. Rewound and reconditioned, they are now back in full-time service, delivering *more* power than when new.

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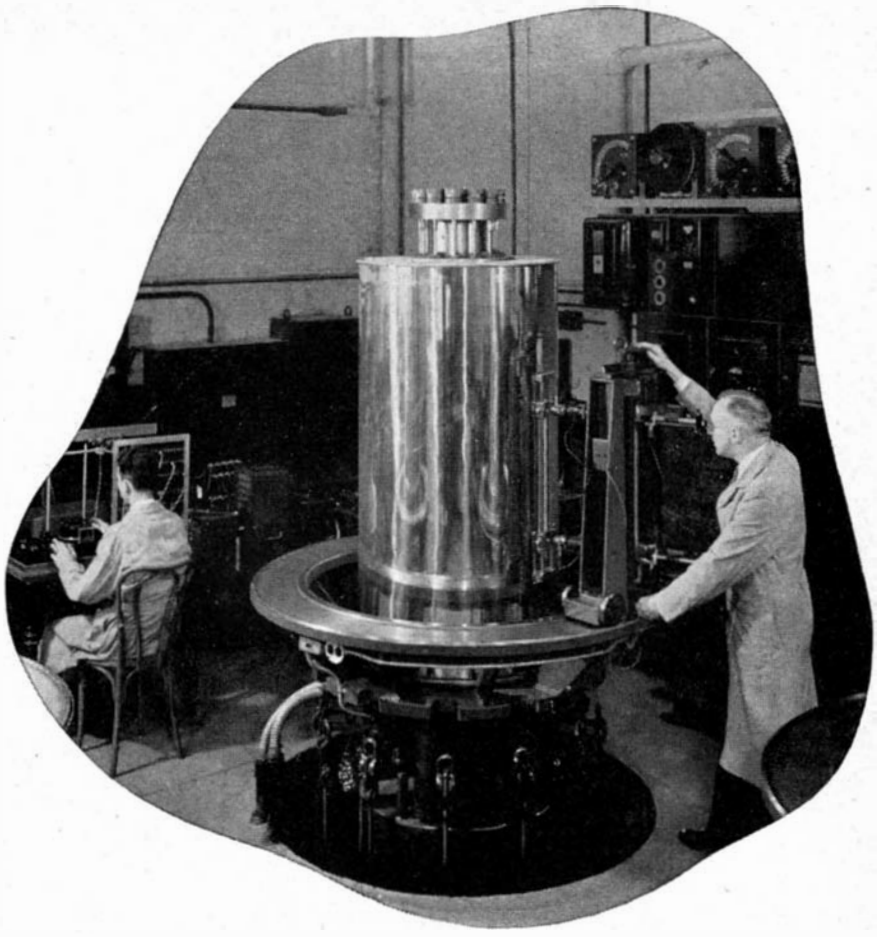

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