A MIRACLE OF WOUND HEALING . . . Page 14

SCIENTIFIC AMERICAN

JANUARY · 1943

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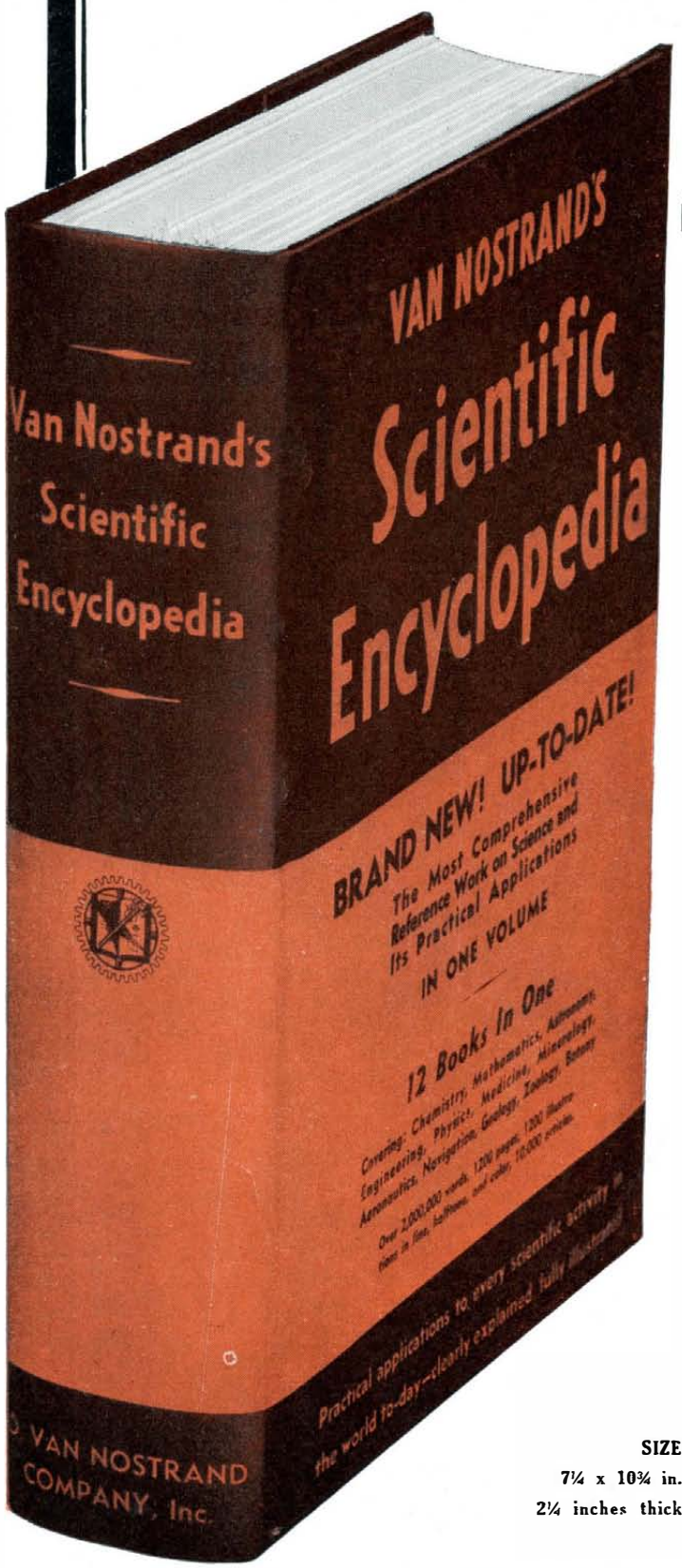

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THE linkage between industrial and military activities on far-flung fronts is photographically dramatized by Robert Yarnall Richie in our front cover illustration. Here is shown a centerless grinder in one of the shops of the Minneapolis-Moline Power Implement Company, grinding the bourrelet on 155mm shells.

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SCIENTIFIC AMERICAN

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NINETY-NINTH YEAR — **ORSON D. MUNN, Editor**

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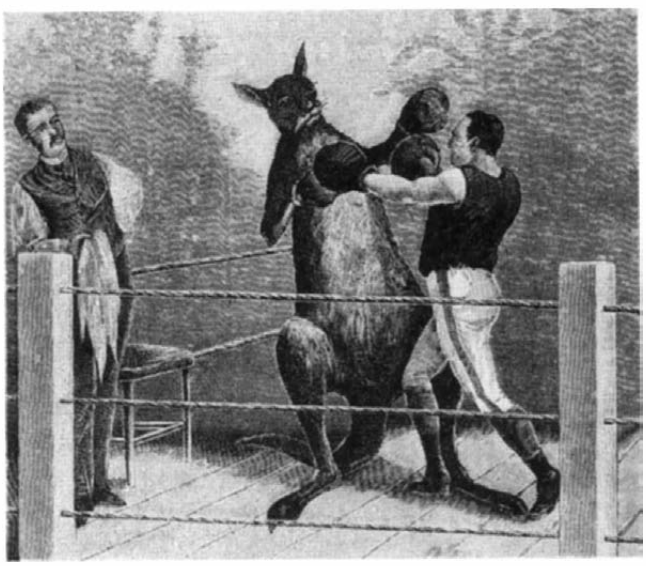
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1893)

PHOTOGRAPHY—"A proposal to erect a new monument to Daguerre in his native village of Briesur-Marne has moved M. Leon Vidal, the editor of *Le Moniteur,* to remark that but for Niepce, there would have been no Daguerre—photographically speaking, of course. . . . Niepce was really the inventor of photography. Daguerre contributed his brick to the edifice, no doubt; but it is often forgotten that, without Niepce, photography would not have been known.

KANGAROOS—"Among the recent developments in the world of sports, in Australia, is the training of the kangaroo to stand up and spar or box with a human antagonist. . . . The way in which the natural kangaroo spars in the bush, his birthplace, is peculiar. He places his front paws gently—almost lovingly—upon the shoulders of his antagonist, and then proceeds to disembowel him with a sudden and energetic movement of one of his hind feet. From this ingenious method of practicing the noble art of



self-defense the kangaroo at the Royal Aquarium has been weaned. . . . The flesh of the kangaroo is highly esteemed as a food, and from the hides a valuable leather is made. These are legitimate uses of the animal. But it is shocking to think of degrading so useful a creature down to the level and equal of a brutal human prize fighter."

HAIL—"A great rain and hail storm took place at Gray Hill, Texas, on December 6. This remarkable hail fell in large lumps, ranging from three to six inches in diameter. . . . The average was about one hailstone to every three feet square."

MECHANIZATION—"The government of India is offering a number of prizes for the best designs or models of a cart suitable for military requirements, to wit, a mule cart for the transport use of the British army in India."

FROM AN AD—"Astronomical telescopes of superior defining power. Eyepieces, etc. Manufactured by W. & D. Mogey, New York." [Late in November, 1942, the editor attended a ceremony dedicating a new optical shop just completed by the company which has directly inherited the Mogey name and reputation. Situated in the Watchung Mountains of New Jersey, this new shop of William Mogey and Sons, Inc., is now actively engaged in producing precision optical goods for the armed forces.]

ARMOUR INSTITUTE—"Absolutely unknown to the public, work has been going on for a year past toward the erection of a magnificent five-story building on Armour Avenue, and it is now all but ready for occupancy. This building will be known as the Armour Institute, and will be to Chicago all that the Drexel Institute is to Philadelphia and the Pratt Institute to Brooklyn. This building is but a small part of the gift. In addition to it, and for its support, Mr. Armour gives $1,400,000. All that money and brains and labor can do will be done toward making it the greatest institute for manual training, science, and art in this country."

NOT YET—"There is hardly a doubt that the natural gas supply, even in the most favored districts where this agent has been discovered, is generally approaching extinction, and it will soon cease to be an important factor among the fuels of the country, particularly as far as its use in manufacturing industries is concerned."

METEORS—"The meteors of Nov. 23, 1892, as seen by W. J. Hussey, at Palo Alto, Cal., did not come at a strictly constant rate, though nearly so. On the average, a single observer could see from 50 to 60 fairly bright ones every five minutes."

AIR BRAKES—"Repeated experiments on the Western Railway of France, especially between Paris and Mantes, have shown that with the Westinghouse brake a train of average load running at 53 miles per hour is pulled up without disagreeable consequences in a distance of less than 168 yards."

ICE—"The Hudson River ice harvest is now in progress. It begins sixty miles north of New York City. The ice is ten inches thick, and is pure water ice, so clear that one can read a newspaper through the blocks. The indications are that the ice crop this year will be the largest and finest ever gathered on the river, and will reach nearly 4,000,000 tons."

YERKES—"The large disks of optical glass made by Mantois for the University of Southern California have been purchased by the University of Chicago. They are nearly 42 inches in diameter, and will allow of a clear aperture of 40 inches. The glass is said by Mr. Alvan Clark to be exceptionally good. Mr. Clark will shortly undertake the work of grinding the objectives, which he has contracted to complete within eighteen months. . . . The contract for mounting the great telescope has been awarded to Warner & Swasey, of Cleveland, Ohio."

TORPEDO BOATS—"The famous torpedo boat builder at Elbing, Schichau, has just attained an unprecedented speed even for this class of vessel, torpedo boats built by him for the Russian and Italian governments having reached 27½ knots on an hour's run at sea. The new British boats are to be 200 tons displacement, while the Russian boats are 130 tons, so that the former may do better by reason of greater power and greater size."

99TH YEAR SCIENTIFIC AMERICAN JANUARY 1943

DOWN TO THE SEA FOR SUBS

'Chasers' of World War One Come Back as YP Boats

A. D. RATHBONE, IV

● So effective has been the work of the YP boats in stemming the depredations of Axis submarines on the Atlantic and Gulf Coasts that one of the editors of Scientific American delved deeply into the how and why of the Inshore Patrol. In the accompanying article he takes the reader mentally on a patrol trip, shows him the inner workings of this effective branch of our Navy. Photographs not otherwise credited are exclusive to Scientific American, and have been approved by the Navy Department.—*The Editor* ●

NAVIGATING a busy harbor at 0415—quarter past four in the morning in civilian life—in the necessary dimout of wartime is one of those situations where you do your best—and keep your fingers crossed all the time. Keen eyes peer anxiously from bow and flying bridge through the murky pre-dawn haze; the skipper stands tensely beside the helmsman in the darkened wheel-house, and though we're full of questions up to the ears, we hold our tongue, for even a landlubber can sense the strain of the moment as our ship, the *YP 191*, slides gingerly through the narrows on a trip with the Inshore Patrol.

Another craft, long, sleek, racy, comes slowly toward us from starboard. Our engine-room bell clangs, weirdly in this half-light. The Coast Guard cutter and our ship slowly nose toward each other, and we receive our sailing orders.

There is a devastating roar overhead and a couple of Navy patrol planes flash past and on out to sea. They're looking for submarines. So is the Navy blimp, stodgy by comparison, that abruptly shears the clouds of morning mist to hover protectingly over the squat hulks of freighters which have mysteriously emerged from the fogs of dawn. As more snarling planes appear and almost immediately vanish in the still gray sky, our convoy takes shape and moves pokily off down the coast. The laden steamers line up one-by-one, with Coast Guard cutters and our ships flanking, a British trawler and a corvette respectively closing the guardian floating box fore and aft, and we're off.

Soon after the Japs landed their sneak-punch in our Hawaiian solar plexus, the Nazis started hitting our merchant marine below the water line in coastal lanes as well as on the high seas—and momentarily there was little we could do about it. We had neither ships nor men to man them. All of our destroyers, generally conceded to be the submarine's deadliest enemies, were needed everywhere at once. All hell was loose in the Pacific, and as attacks on Atlantic and Gulf coasts by a Nazi battle fleet weren't considered likely or even possible, battleships, cruisers, destroyers, and other major warships were elsewhere.

THE NAZI submersibles promptly took advantage of the situation and began sinking freighters right and left, many within sight of the coastline. To establish an Inshore Patrol which would put the quietus on this audacious practice would require boats, more boats, and still more boats—and thousands of trained men to man them. True, the Coast Guard and such naval units as were available were instantly on the job, but despite heroic efforts through last year's freezing, blustery, wintry weather and notwithstanding long hours on watch day and night, there simply were not enough ships adequately to patrol the 1888 miles of Atlantic coast, the 1686 miles of the Gulf coast, to say nothing of the sea frontiers of California, Oregon, Washington.

The man-power problem showed immediate signs of self-solution. Potential sailors and officers poured into recruiting stations faster than they could be cared for. Long-range plans had foreseen such an emergency and the prepared programs for training seamen and junior officers went into effect with few hitches and little static. Specialty courses for signalmen, motor machinists, firemen, and men to master the intricacies of sound-detecting devices sprang up all over the nation. The man-power problem was on its way to be licked, but the ships for this new Navy—where were they?

As early as a year ago miracles were being wrought in American shipbuilding yards, but not even miracles could produce with sufficient rapidity enough small, speedy craft capable of guarding all our coastal shipping lanes. The need for ships was imperative—now—had been so for weeks—and tomorrow or next month just would not do. Although the War Shipping Administration had had under way for some time plans to build a fleet of 110- and 173-footers, the lack of steel, Diesel engines, fittings, gear, and armament had retarded production. As in 1917, when faced with a similar problem on a smaller scale, Navy scouts who knew good ships when they saw them explored coastal harbors, peered into yacht basins, and poked their noses around every mooring where it was conceivable that usable, sea-worthy boats might be found.

FROM this naval dragnet came as conglomerate a collection of craft as those that braved Dunkerque's dangers—and with them, whether or not the Navy liked it, as dare-devil a crew of amateur skippers as ever tasted brine who insisted on accompanying their ships into naval service. In some quarters criticism and contention followed the Navy's "Awfully sorry, but we just can't use your ship." Disgruntled owners, however, failed to realize that when a boat is too small to satisfac-

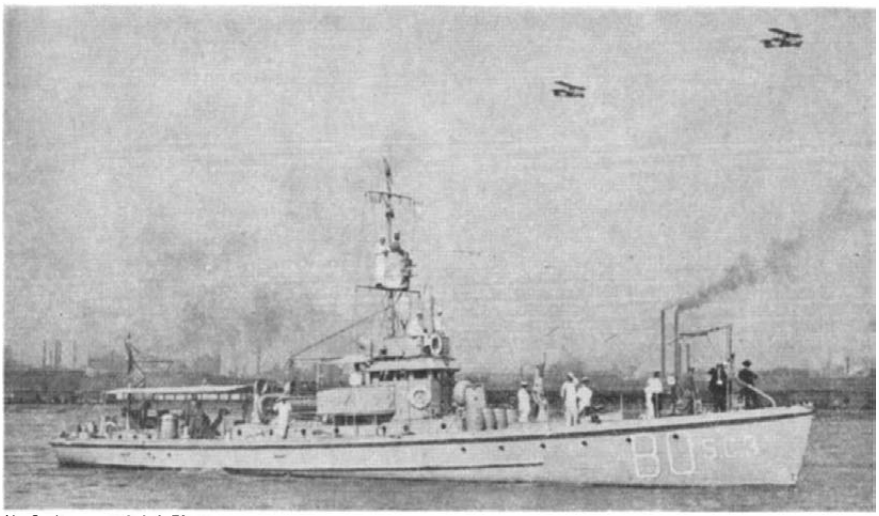
torily mount even a 50-caliber machine gun, when she hasn't the speed to escape from an exploding "ash-can" dumped from her own stern, when she isn't built to survive the riotous Atlantic storms, when there aren't enough two-way, or even one-way radios to go around, it is the utmost folly to enlist her services.

Our own ship in this convoy is one type of craft which the eagle-eyed naval scouts did locate and one they had hoped with a faint hope, indeed, to find—the wooden-bottomed submarine chaser constructed for service in World War 1. Nearly all of these had been sold into private service after the Armistice. Formerly known as S. C. Boats, their full load displacement was 76 tons, they were 110 feet in over-all length, 15 feet, 4¾ inches extreme beam over guards, and had a draught of five feet, 11 inches. Their planking was of 1¾-inch yellow pine, with white oak steambent frames 2½ by 3 inches, spaced at 12-inch centers. Deck planking was Oregon pine, and they were originally equipped with six watertight bulkheads.

WHEN built 25 years ago, the S. C.'s were powered with three main six-cylinder, four-cycle gasoline engines rated at 220 horsepower, at 400 revolutions per minute. Generally, the wing motors were utilized in cruising, the center motor being disconnected from the propeller shaft through a heavy clutch. Speed of these diminutive World War ships varied according to conditions, and although some of them were reported to have attained speeds of 17 to 19 knots, the experience of the fleet as a whole showed an average top speed of 14 knots.

These were the ships of "The Splinter Fleet," that brave little American Armada which, with only a 2400-gallon gasoline storage capacity per ship and a daily consumption of 600 gallons, with an armament as pitiful as toy pistols compared to that of the enemy, were expected to—and did—convoy ships across the Atlantic. Furthermore, they were expected to—and did—chase and sink submarines. Eleven of those midgets engaged in maintaining what was known as the Otranto Barrage—a bottling-up of enemy ships in the Adriatic Sea—and in the bombardment of Durazzo, Albania, in October, 1918.

After-deck of YP 191, with machine gun and "ash-cans" poised at stern



U. S. Navy Official Photo

Today's veteran "Splinter Ships," save for lack of portholes and crow's nest, resemble this sub-chaser of last war in nearly every respect. Note old style flying boats

So far as being in trim as fighting ships, the condition of the few old S. C.'s which were re-discovered was pitiful, but far from hopeless. After major Navy Yard operations which provided new decking, replaced worn struts and braces, slapped on coats of war paint, and made a hasty overhaul job on the Diesel engines—which weren't new, but which had replaced most of the original gasoline-powered motors—the 25-year old sub-chasers were once more rarin' to go after their old enemies. And that same scrappy spirit that must have originally been innoculated into the very timbers of the veteran S. C.'s seemed to imbue the young freshly-trained sailors of our new Navy, for early in 1942 those rejuvenated ships and their crews put to sea with no more armament than a box of 25-pound chunks of dynamite equipped with 11-second fuses. These crude but lethal weapons, which were temporary substitutes for depth bombs, plus a Tommy-gun for good measure, were the sum total of the old Splinter Boats' fire power when they first went out to help the Coast Guard and the few available Navy ships beat off the Axis submarine menace to coastal shipping. Today they're known as "YP" Boats—ours is *YP 191*—and they keep constant and co-operative company with the Coast Guard cutters, the mine sweepers, the converted private yachts, and the score or more of British armed trawlers and corvettes that have come over to help patrol our Atlantic and other coastal shipping lanes.

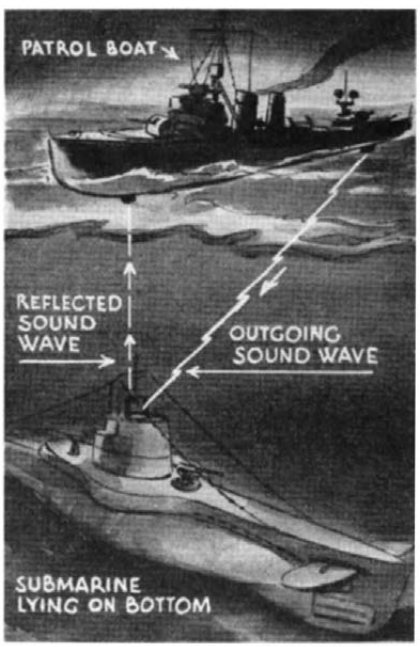
ENSIGN McCALLUM, skipper of the *YP 191,* introduces his two fellow officers, likewise Ensigns who have come into their epaulets since Pearl Harbor. Then we meet the crew, as true a cross-section of America as ever manned a Splinter Boat—or any other ship. There's a Mulligan, a Burke, and a Degnan; a Luzietti, a Kabat, a Morris; a Hanson, a Crosby, a Bartlet, and others, 17 sailors in all, to make up the crew of this Lilliputian sea fighter. While the officers wear their regular uniforms and maintain a certain amount of dignity, the deck crew, the black gang from the engine room, and "Cookie" all wear dungarees, and when weather permits, most of them are naked from the waist up. In the days to come we'll find that while discipline is ever-present, it is of a distinctly informal brand which perfectly fits the cramped conditions on a small ship, obtains the maximum amount of co-operation from the men, and produces a loyalty and admiration on the part of the crew for the officers that would exceed the demands of the strictest four-striper.

Sitting on the steps of the wheel house, enjoying the sun's warmth after the early morning chill, our ears are suddenly stricken with an outlandish garble of words: "Negat . . . Afirm . . . George . . . Fox . . . Negat . . . Afirm . . . George . . . Fox — Come in, Negat

. . . Afirm . . . George . . . Fox." And before we have time to realize that this is the voice of the two-way radio functioning, we hear the reply from "Negat . Afirm . . . George . . . Fox . . ." answering and standing by.

At frequent intervals throughout the rest of the day and through the night the radio, constantly in tune with shore headquarters for this area, gabbles away in this seemingly garbled language. Thus does the shore control constantly keep in contact with every ship, plane, and blimp engaged in the duty of Inshore Patrol.

Another device whose acquaintance we soon make is the listening apparatus tucked away below decks in a tiny cubicle called the "sound room." Back in that other war this boat, her sister ships, and many other craft were equipped with hydrophones which, when the ship was stopped dead still, enabled listeners to hear the sound of submerged U-boats' propellers. The hydrophone consisted of two rubber "ears" mounted on the ends of an inverted T pipe which could be lowered into the water under a chaser's hull. The "ears" were hollow rubber balls, with a copper tube inserted in each. These tubes, protected by a bronze pipe, extended up inside the ship, terminating at the listening post, and were connected to the ear pieces of an physician's stethoscope. The vibration from any sound made by a submarine or other ship could be heard through the stethoscope, and by turning the submerged T-shaped arm until the sound was equalized in the ears of the listener, the direction was determined. Applying the triangulation method of civil engineers to their hydrophones in order to spot a hostile object, a unit of three splinter ships could arrive at a close approximation of the location of the U-boat—and then proceed to drop depth bombs in the suspected area.



An echo-sounding method

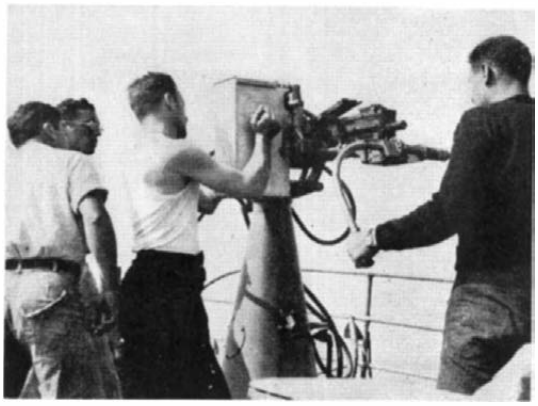
The basic principle of locating submarines has not materially changed since the last war, but science and inventive ingenuity have streamlined the process and refined the apparatus. Formerly, if an enemy submarine lay quietly on the bottom of the sea to avoid detection, and if its commander was sufficiently unobliging to refuse to revolve the ship's propeller now and then, the business of "putting the finger" on a sub became more difficult and less accurate in its results. In the present conflict, the principle of sound reflection under water, long applied to larger merchant and war ships to maintain a continuous graphical record of the ocean's floor beneath the cruising ship, is being adapted to search out silent submersibles that endeavor to "play possum" far beneath the waves.

The exact extent to which echo-sounding devices are utilized and their scientific and mechanical constituency are among those things which cannot now be told.

A "dungaree sailor" cleans a gun

In addition to ears, the convoy guardians have eyes. Ever overhead, the blimp hovers and circles; planes, Army, Navy, and Civil Air Patrol, come and go in an unceasing search for Axis subs which may be lying in wait for hapless victims.

Interrupting the more scientific side of our investigation comes a lusty call from the galley: "Chow down!" and we hasten up the companionway ladder and aft toward the tempting smells eminating from a full course chicken dinner. Yes, the Navy eats sumptuously and well, with plenty of wholesome, nourishing food expertly prepared. We marvel at "cookie's" dexterity in his tiny galley, which, from the rolling and heaving of the ship and the healthy appetites of an ever-hungry crew, never knows a still moment at sea. Eventually we acquire the knack of keeping bowls of soup, mugs of coffee, and platters of food from dive-bombing into our lap. "Cookie" tells us that, "When I open the ice-chest doors on a rough day, it's as though 30 people were standing over there throwing things at me!"



Machine-gun drill aboard YP 191

After chow the "Dungaree Navy," those youngsters from Texas and Iowa, from Massachusetts and Michigan, from all walks of life, go about their duties and we are again and again amazed at their knowledge of seafaring ways and the efficiency they have acquired in so short a time. We can't help but wonder what the Japs were thinking of when they picked on us.

Only 12 months past it was touch-and-go in the Atlantic coastal battle with the submarines, as well as elsewhere on the Seven Seas. But today, under the guidance of Vice-Admiral Adolphus Andrews, United States Navy, Commander of the Eastern Sea Frontier, the safe convoying of ships up and down our coast from Florida to Nova Scotia is an accomplished fact. With ships and men ever more available, the little ships of this war are now expanding their protective services to include the Carribbean Sea, the Gulf of Mexico, and our Pacific frontier to an even greater extent than has heretofore been possible. To man this new Navy comes a never-ending stream of a new generation of "iron men in wooden ships," true American sons of the men who commanded the *Bon Homme Richard* and the *Constitution*.

Spreading The Tin Thin

Rapid Recent Development of Tin-Plating Processes and Reflowing Methods Is Resulting In Better Tinplate

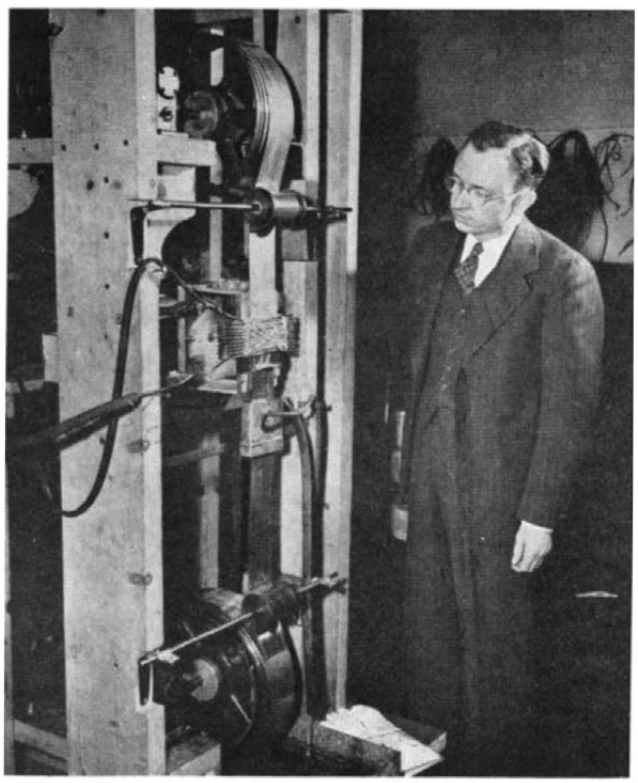
A. P. PECK

WHEN supplies of tin from the Far East were pouring freely into the United States, there was no trouble at all in obtaining the 70-odd thousand long tons of the shiny metal that were consumed annually in this country. A large part of this tonnage went into the production of tin plate for fabrication into containers of all sorts, the remainder into various other articles of commerce. But when the Japs moved into the Malay Peninsula, the Dutch East Indies, Thailand, Indo-China, and Burma, they cut off two-thirds of the world's supply of tin, and set up a production problem for research engineers of the United Nations that is already being solved on a large scale.

The time-honored method of applying tin to a sheet-iron surface in the manufacture of tinplate is, briefly, to dip the cleaned and prepared iron sheets into molten tin. A relatively thin film of the soft metal (some 90 millionths of an inch thick) adheres to the iron surface and protects it against corrosion, attacks by certain acids and some other active chemicals, and makes an ideal combination for the well-known uses to which tinplate is put.

In this hot-dip process, 1½ pounds of tin are normally applied to the surfaces of 100 pounds of sheet iron. This figure, incidentally, has been reduced to 1¼ pounds by government decree, as part of the whole program of tin conservation.

Several years ago, long before it became obvious that much of the world's tin was going to fall into the hands of international bandits, metallurgists and others were experimenting with a variety of methods of applying a tin coating to sheet iron. It is unnecessary, these research men reasoned, to produce, for some purposes, such a heavy tin coat as is provided by the hot-dip method. Thus there was developed an electroplating process of depositing tin on iron, making it possible to produce tinplate that required only about one third of the amount of tin consumed in the more conventional hot-dip process.



Tin reflowing by means of induction heating was demonstated and explained by Mr. Baker, shown here with laboratory set-up

True, this plating method, generally referred to as the electrolytic process, used less tin because it produced a thinner coating. This plate, however, was considered satisfactory for many purposes, although it was early found to have some drawbacks.

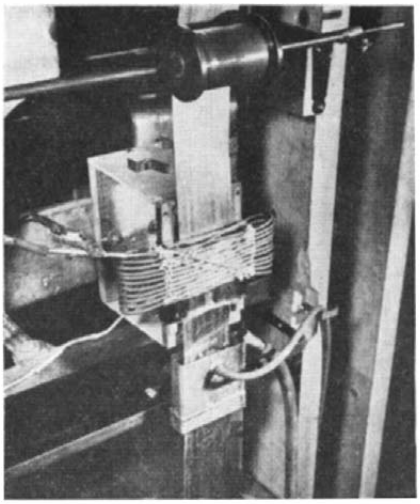
In the first place, electrolytic plate emerged from the tanks with a gray, unpolished appearance that was by no means as pleasing to the eye as is the mirror-like surface of hot-dip plate. Further investigation revealed that this dull appearance was due to irregularities in the thickness of the plating. Since the electrolytically deposited tin coating has an average thickness of only 30 millionths of an inch, these irregularities resulted in unsatisfactory protection of the base metal. Furthermore, these same "hills and dales" in the tin surface interfered with later fabricating processes, causing stacked sheets to stick together and preventing consistent operation of suction-cup lifting and handling mechanisms.

The solution to the problems thus posed seems simple at first glance, yet becomes complicated when production factors are considered. All that has to be done is to heat the tin coating to its melting point—some 450 degrees, Fahrenheit — whereupon the molten tin will spread over the base metal in a uniform coating that will solidify to a smooth, shiny surface when cooled. That's all there is to it, but how can the tin be melted—reflowed is the term generally applied to the process—and then cooled at the speeds required for today's electrolytic tinplate production?

Several methods have been developed for this reflowing operation. The most important involve the use of hot oil baths, passing the tin strip through a radiant tube or other type of furnace, using the electrical resistance of the strip itself to heat it when a current is conducted through the strip, or passing the strip through a high-frequency induction heating coil. In some cases, a combination of two of these methods may be found desirable.

The hot-oil bath for reflowing tinplate can be used successfully only on low-speed production lines. Because the differential between the melting point of tin and the temperature to which the oil can safely be heated is very low, the speed is limited. Also, since the oil heat reservoir can be maintained only at a relatively low rate of restoration, and the temperature cannot be quickly altered, the strip must be passed through the bath at a constant speed, a factor which is undesirable when the operation of tinplate production lines is considered.

The furnace method, regardless of the type of energy used, also is satisfactory for low-speed, constant-speed work, but becomes quite bulky as the speed of the strip is increased. The furnace must be from about one third to one half foot long for each foot per



Close-up of the induction heating coil and water quenching tank in the tin reflowing unit shown on page 7

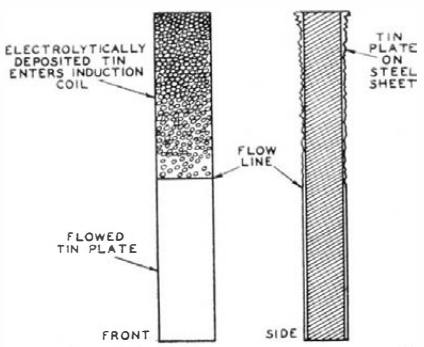
minute that the strip travels, thus setting a reflowing speed limit of 200 to 300 feet per minute for the radiant furnace. Here, again, since the heat can neither be generated nor dissipated at a high rate, the use of this method is restricted to constant-speed operation.

BECAUSE of the limitations of hot-oil and furnace methods of tin reflowing, they cannot readily be incorporated in the electrolytic-tinning line itself. They must be used as a separate set-up, making necessary an additional operation and extra handling of the strip during processing.

Melting the tin by the heating effect of current flowing through the tinplate itself does not have the speed limitations of hot-oil or furnace methods. Also, since the current can be readily controlled, this method is adaptable to production lines in which the speed is not always constant. The amount of heat generated can be readily adapted to the speed of the line.

With the conduction heating method, however, there is the problem of getting the electrical power into the strip at high speeds without arcing and burning at the contact rolls. Because the molten coating is in actual contact with the current-collecting rolls, there is a possibility of marring the tin surface. Thus, it becomes necessary to heat a section of the strip while at the same time attempting to quench it.

By the induction heating method it is possible to reflow tinplate strip at high speeds and under conditions of continuous operation. In this process the tinned surface is brought to the melting point by the same methods now extensively employed by industry in other types of electromagnetic heating, except that the frequency is much higher and the power involved is much greater. In the induction heating system there is no physical contact between the strip and any stationary or rotating part. Therefore, there can be no marking of the strip either by electrical or mechanical action. The heating is done in a very short space even at high speeds, the space required on the processing line being on the order of 10 to 12 feet for a strip speed of 1000 feet per minute.



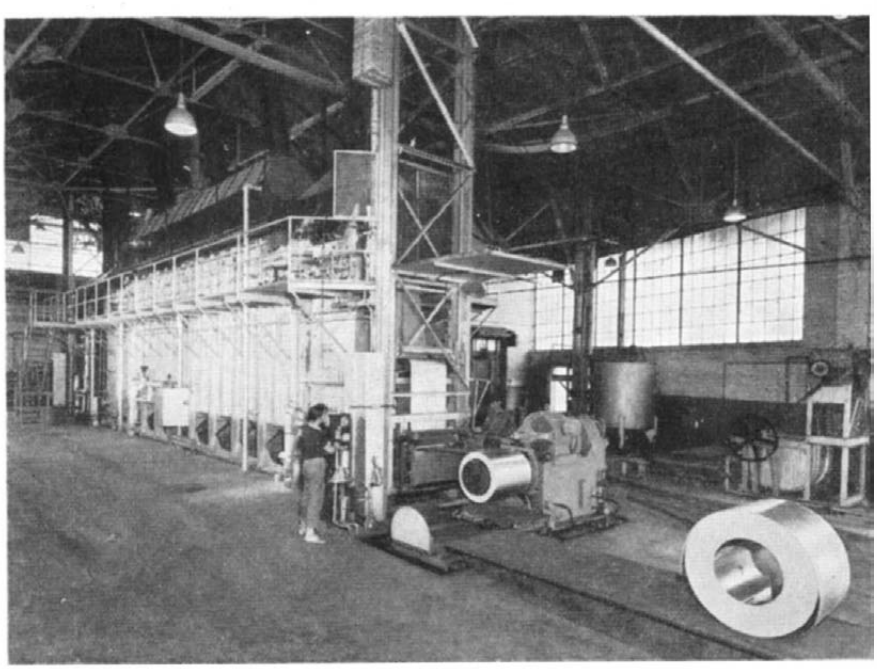
Matte surfaced tinplate strip becomes shiny and smooth when reflowed. Flow line indicates point where induction heat makes the transformation

Since the reflowing process as applied to tinplate is a relatively new operation, practical experience may indicate the desirability of using some combination of the methods just briefly described. In such a combination the tinplate might be preheated by, for example, the conduction method, while the final heating to the reflowing temperature would be accomplished by the induction process.

Most significant feature of the induction heating method of tin reflowing, which was recently brought out of the laboratory and into industry by engineers of the Westinghouse Electric and Manufacturing Company, is its adaptability to the electrolytic tinplate production process. Not only can it reflow tin at speeds as high as the fastest electrolytic line can produce the plate, but it can be designed as an integral part of the line itself. Thus it becomes possible to maintain continous production of electrolytic tinplate, in rolls or sheets, with a surface that is entirely satisfactory for many everyday purposes. Then, too, automatic control of the operation becomes possible, since the heat produced can be instantly and automatically adjusted to correspond to any change in speed of the strip merely by controlling the power input to the inductor coil. By such adjustments the correct temperature to melt the tin is maintained and oxidizing of the strip is eliminated.

Two of the accompanying photographs show details of an experimental model of a tin reflowing induction heater. The simplicity of the system—aside from the relatively high power required—is readily apparent. A strip of electrolytic tinplate passes through a flat coil of heavy wire, the ends of which are connected to an oscillator of suitable power. Just below this coil is a water tank through which the metal strip passes for quenching.

In demonstrating the induction heating method, Mr. R. W. Baker, Westinghouse research engineer, used this experimental model in which the tin strip to be reflowed is wound on a reel at the top of the framework. When



Electrolytic tinning line of the Crown Cork and Seal Company

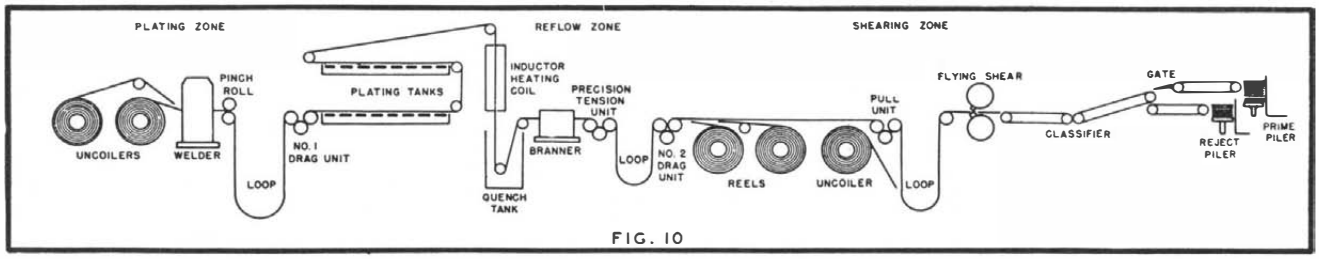


FIG. 10

Simplified drawing of a horizontal-tank tinning line, with reflowing unit in its proper place

the machine is in operation, the strip, dull and with a matte surface, passes through the coil, through the water tank with an accompanying hiss of steam, and emerges from the tank displaying a bright, shiny surface.

Here is how Mr. Baker explains what happened in the inductor coil:

"As the dull strip moved through the coil, radio waves whipped round and round the metal, setting up counter currents near the surface and melting the minute peaks down into the tiny valleys.

"Shooting into the tin, the waves ripped electrons — so tiny you could put ten million, million on an inch-long line—from the atoms of tin. These electrons, driven along by the current, smashed into one atom after another, creating heat at each collision. Multiply that process millions of times and the coating of tin flows smoothly. The melting action stops when the strip moves out of the coil and the water tank cools the metal."

THE CURRENT energizing the coil of the induction heater in the experimental model is at a frequency of 200 kilocycles, supplied by equipment roughly equivalent to that of a broadcasting station, less the many refinements needed for communication purposes. This frequency is not highly critical, and depends upon the thickness of the sheet. For the usual run of tinplate, of the order of .008 to .011 of an inch thick, 200 kilocycles has been found most practical, and is capable of handling, without change, the thickness variations found in commercial strip. The power required depends, of course, on several factors, including width of strip to be reflowed and the speed at which the strip must pass through the heating coil. On some of the large projected lines 1200 kilowatts will be needed, based on a strip speed of 1000 feet per minute.

To complete the picture of this newest development in a vital industry it is needful to glance briefly at the electrolytic tinplate process itself, and to see just how the tin reflowing system fits into it. Another of our photographs shows a modern electrolytic tinplate production line; one of the drawings shows in highly simplified form a similar line with the tin reflowing equipment as a built-in part of the whole.

THERE are several types of tinning lines so far developed, having two basic differences. One is whether the speed through the plating bath is held constant or allowed to decrease when a fresh coil of steel strip is to be entered into the line. The other principal difference is whether the plating tanks are vertical or horizontal. In one type of mill the strip moves through the plating tanks at constant speed, and means are provided for accumulating enough slack at the entry end to allow a new strip to be welded on. In the other scheme, which in general allows an overall faster strip speed, the entire line is slowed down when it is necessary to start a new roll. In the system which employs horizontal plating tanks, the two sides of the sheet are tinned separately, allowing variation in thickness between the sides and even in the kind of metal deposited. In the vertical tank method the sheet is tinned on both sides as one operation and hence both sides are exactly alike.

The type of line shown in the accompanying drawing is a high-speed set-up with horizontal plating tanks, designed for operation at 650 feet per minute, but with a possible top speed as high as 1300 feet per minute. However, it is impractical to shear tinplate strip into sheets at speeds faster than about 700 feet per minute, since there will be excessive buckling of the sheets above this speed, and provision has been made in the line for coiling the finished strip and then shearing it into sheets as a separate operation when the line is run at high speeds.

From the plating tank the strip passes through the reflowing unit and into the quenching tank. Then oil is applied to the surface and the excess oil is removed in the branning machine. From this point on the strip passes through the necessary drag and pull units into the shearing machine, or onto a reel.

Although some provision is made for accumulating slack in the strip, to be used up while a new reel is being welded in place at the entry end, it is possible to accumulate only enough slack for about four or five seconds of operation. Because the welding operation requires about 30 seconds, the line must be slowed down in order to weld new coil. For this slowing down process it is entirely possible to regulate the functions of all parts of the line, including the plating action and the induction heater, so that the finished tinplate remains uniform, regardless of variations in line speed.

WHILE the equipment needed for the induction heating method of tin reflowing is somewhat more expensive than ovens or hot-oil baths, the speed and flexibility of the process are sufficiently desirable ends to warrant the increased cost. Then, too, the development and application of this process may prove to be the opening wedge which will stimulate research along similar electronic lines in the steel industry. Once the ball of research starts rolling along a newly opened alley, there is no telling in advance how many pins will be knocked down.

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VINYL ACETAL

Being Used To Replace Rubber in Fabrics

THE thin layer of tough, resilient plastic which ordinarily would have gone into the safety glass windows and windshields of the new car you might have bought this year will be used instead to replace rubber in Army raincoats, and in a score of other vital war items now made from rubberized fabric. The plastic is Monsanto Chemical Company's Saflex, one of the group of synthetic resins known technically as vinyl acetals.

The process for compounding Saflex so that it can equal and even surpass the performance of natural rubber in water-proof fabrics was developed by Joseph L. Haas, technical director and fabric superintendent of the Hodgman Rubber Company, oldest rubber firm in the country.

Saflex-coated fabric, which the Hodgman company has christened

Horco-X, has already been used for Army raincoats, hospital sheeting, gas protective fabric, life-preserver jackets, and water bags, while many other military items are awaiting final action or still are in the experimental manufacturing stage.

In Army raincoats, the process for using Saflex will save more than 1¾ pounds of crude rubber per coat while proportionately greater savings will result from its use in heavier fabrics such as the hospital sheeting and gas protective cloth. With a 10,000,000 man Army, the saving in raincoats alone would amount to as much as 17,500,000 pounds of rubber. At the same time, since it is possible to use a lighter base fabric with Saflex, the new Army raincoats will weigh two pounds less than the present rubberized coats, making Johnny Doughboy's pack that much easier to carry.

Another advantage of the plastic after it has been compounded according to the Hodgman formula is that it can be applied to fabric with the same equipment and processes as rubber.

HARDENING

By Induction Process

Speeds Production

THE process of induction heating, cutting down production time in many war industries, has, as an outstanding example of its usefulness, doubled the speed in which 28-inch sprockets of heavy-duty tractors may be hardened.

A Tocco machine for hardening the heavy sprockets is being used by the Cleveland Tractor Company and was designed and installed by the Ohio Crankshaft Company, where the process was developed. The sprockets are used to drive the tracks of high-speed tractors which have gone into heavy military duty at airports.

Previously only six to eight sprockets could be hardened in an hour, but now approximately 15 of these tractor parts may be hardened in the same length of time by the specialized process, which is not only a more rapid method of heat treating than any previously used, but more precise, according to W. A. Silliman, chief metallurgist of the Cleveland Tractor Company.

The tractor company's problem was to harden the engaging surfaces of the teeth to withstand the wear imposed by the contact with the driving lugs on the tracks. While the surfaces of the teeth are hardened, the rest of the sprocket must be kept ductile.

Mr. Silliman pointed out that one important advantage of the Tocco process is the accuracy of control over the depth of the heat treatment and over the area of the hardened zone. The accuracy is made possible by the very nature of induction heating.

The operator places three sprockets into the hardening machine at one

Quenching the induction-heated teeth on three high-speed tractor sprockets

time. The induction block of the machine contains three inductors, each surrounding a sprocket area under treatment. High-frequency current flowing through the inductors sets up a current in the sprockets, heating the metal to 1500 degrees, Fahrenheit.

The heat is maintained for 10 seconds, and the current automatically shut off. A stream of water then is turned onto the metal, which is quenched for 10 seconds. As one cycle of heating and quenching is completed, the operator pulls the sprockets from the inductor block, sets the index on the fixture and moves them forward to begin another cycle.

STEELS FOR STEAM

Boiler Plants Use Chromium

Steel Tubing and Castings

WROUGHT and cast steel parts used in boilers differ in alloy composition in accordance with the requirements of the service for which they are intended. In general, the chromium content of the steels is determined by operating temperatures, although the strength requirements of the installation must also be taken into account.

In many industrial steam-generating units, for example, the tubing used for convection-type superheating elements operating in lower temperature ranges is made of molybdenum-bearing steel, containing 1.5 to 2 percent of chromium. Here good strength is desirable, but scaling and corrosion are not severe enough to necessitate the use of steel of higher chromium content. However, when higher steam temperatures are required, which may be obtained by the use of radiant-type superheaters—the coils of which are exposed directly to furnace heat—steels with good resistance to scaling and corrosion and also good creep strength must be employed. Either 4 to 6 percent chromium steels containing molybdenum and columbium or titanium, or an 18-8 type of chromium-nickel stainless steel have been found satisfactory. This latter type of stainless steel is also used for furnace damper blades, and support beams for boiler economizers.—*Electromet Review.*

CONSERVATION

Of Scarce Materials in Design of Ordnance Equipment

THE greatest program of design and redesign in history, concentrated on the firing weapons and equipment used by our soldiers, is now in full progress, according to an article in *Product Engineering.* The article, by Lt. Col. J. H. Frye, of the Ordnance Department, United States Army, states that the program is aimed at the conservation of every ounce of strategic material possible.

Already, it is pointed out, the substitutions and other engineering changes made by the Army Ordnance Department will result in the following known savings in major strategic materials through 1943:

Primary aluminum ..	170,000,000 lb.
Nickel	49,000,000 lb.
Chromium	9,700,000 lb.
Vanadium	1,250,000 lb.
Tungsten	17,500,000 lb.
Copper	671,000,000 lb.
Tin	12,000,000 lb.
Rubber (crude)	60,000,000 lb.

Furthermore, says Col. Frye, the design changes and materials substitutions have been made without affecting safety or military efficiency of the war material. Under no circumstances are chances taken with safety or quality. "Ordnance engineers," he points out, "are often criticized for their conservatism, for insisting upon thorough testing and proving, but the men on the firing line are glad that this is so."

Important examples of materials conservation, given by Col. Frye, include substitution of steel for brass in cartridge cases, steel for aluminum on 90mm anti-aircraft gun platforms, and the redesign of tank tracks to eliminate the use of rubber by employing other materials.

One of the most interesting substitutions effected—that of steel for brass in cartridge cases—was the result of a

co-operative effort in which American industry and Army Ordnance participated. It involved an intensive research program in which design played a most important part. "The successful termination of this research project," says Col. Frye, "is a signal tribute to American engineers, both Army and civilian, for many other countries had been trying unsuccessfully to make artillery cartridge cases of steel for years.

"True, the Germans and others had them in World War I and are using them today, but the latest advices are that ramming may have to be resorted to in order to extract the empty case from the gun after it has been fired," he declares. "This cuts materially the rate of fire, and artillery using European steel cartridge cases cannot be employed in barrage or other rapid fire.

"The steel cartridge cases developed in the United States are quite as satisfactory as the brass ones, and production orders have already been placed with more than 45 manufacturers."

How the various problems of design, metallurgy, and processing were solved is a military secret but it is sufficient to point out that practically all sizes of artillery cases now are being made from steel, and it is estimated that the saving in copper in 1942 will be 100,000,000 pounds, and in 1943, 591,000,000 pounds.

Another interesting design problem was that of the 90mm anti-aircraft gun platform. The original design, it is stated, specified aluminum floor plates because the added weight of steel plates of conventional design required five minutes longer for the gun to go into action. In the event of an air attack, a difference of five minutes would likely mean the difference of having or not having the battery and its crew after the attack. Some difficulty was experienced in tool and design, but as a result of co-operative efforts between industrial and Ordnance Engineers, a highly satisfactory steel platform is now being produced. It even saves a few seconds from the best previous time required for a gun to go from battery into action.

The redesign of tank tracks to eliminate the use of rubber has presented some difficulties, particularly because the urgency required fast action. The old design would have used many thousands of tons of rubber for this purpose alone, and represented one of the major Ordnance rubber requirements. These tracks are an ideal steel casting or forging job, and the problem would be simple except for the limited available capacities of these industries and of machine tools for finishing. As a result of these conditions, it has been necessary to design for several different methods of manufacture.

In addition to the use of castings,

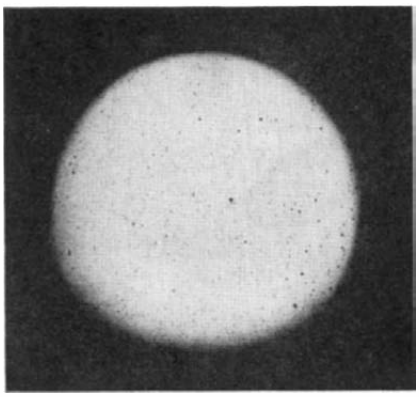
shoes have been developed by utilizing combinations of castings, stampings, and rolled steel sections. Here again, military regulations do not permit a description of these constructions, but the important point is that satisfactory tank tracks are being produced which eliminate more than 85 percent of the former rubber requirements.

SPRAY ANALYZER

May Help to Cut Gasoline Bills

A NEW electric-spark photographic device for snapping split-second portraits of liquid spray droplets is a possible research aid in squeezing more automobile miles out of each gallon of gasoline. The spray analyzer was developed by Samuel Gilman, research engineer at the Westinghouse Research Laboratories, who uses it to photograph water droplets one-thirtieth the size of the head of a pin. It may be used by other engineers to study liquid sprays inside carburetors, Diesel engine fuel injector systems, milk evaporators, and similar machinery, he said.

"New automobile carburetors giving more miles per gallon may result from studies made with this apparatus," Mr. Gilman explained. "By using it, automotive engineers will be able to determine the exact size of gasoline droplets in the carburetor—and the fineness of the droplets influences the rate at which the fuel vaporizes. They will also be able to find out whether the spray is uniformly distributed throughout the carburetor."



Right: **Camera set-up for analyzing liquid sprays. *Above:* "Portraits" of flying water droplets, "stopped" by a ten millionths of a second spark flash**

Water droplets studied by Mr. Gilman are so tiny that they would evade the camera if ordinary exposures were used, so he takes the pictures in ten millionths of a second by means of a high intensity flash from a 5500-volt spark gap. The camera points directly at the flash and the spray passes between them.

"What we actually photograph is the shadow of the droplets," he explained. "The tiny particles cut off the light passing from the electrical spark to the camera and are recorded on the photographic plate as white dots. These 'portraits' are enlarged 65 times by throwing their images upon a ruled screen where they can be measured easily.

"But before we got clear pictures of the particles we had to counteract the lens action of the droplets themselves. We found that many droplets acted as little lenses, spreading the light from the spark gap and showing up on the pictures as tiny blurred lights whose actual size could not be measured.

"This 'wild light' was tamed by putting a condensing lens between the spray and the spark gap. The condensing lens concentrated the light on the lens of the camera and kept the light away from all the droplets except those directly in the concentrated beam."

The droplets having their picture taken still act as lenses but the light they transmit is so feeble in comparison to the condensed beam from the spark gap that they appear black against it.

AIR DUCTS

Now Being Fabricated From Non-Critical Materials

SHORTAGE of sheet metal for the fabrication of ducts and casings used by the air conditioning industry has accelerated the development of substitute

Air ducts of composition board, with replaced metal duct in the foreground

materials for the conservation of priority products. One such substitute is found in the use which Carrier Corporation is making of composition boards. As a result of this development it is now possible to fabricate a duct system which formerly required 300,000 pounds of sheet metal with only 66,000 pounds of sheet metal, the remainder being composed of non-critical composition board.

PARTS PROTECTION

Afforded by New Cellulose Wrapping

RUST, dust, and corrosion are silent but powerful enemies of a smoothly running war machine. They are particularly damaging if they can attack before the parts are finally assembled and the weapon, instrument, or vehicle put to use. Delicate shafts and gears made to fit to the ten-thousandth of an inch would be ruined by the thinnest layer of rust.

Consequently these enemies must be continually guarded against during the fabrication and shipping of ammunition, guns, range-finders, tanks, planes, and spare parts. Traditional protector against rust-inducing moisture has been a layer of thick grease, but it takes far too much time and labor to remove the grease, as any World War One soldier who was presented with a grease-coated rifle well remembers.

In order to save valuable man-hours otherwise spent in such cleaning operations, a number of plants engaged on war equipment work are now using a new tough, moisture-proof wrapping material. It is made of Du Pont cellophane film laminated to a light cotton fabric known as "scrim" and then impregnated with other moisture-proof materials. It can be sealed by twisting the ends of the package by hand or by using a heat-sealing device.

In view of the climatic conditions encountered in today's far-flung battle zones—the abrasive sands of Egypt, the high humidity of the tropics, the mists and rains of the Aleutians—protection of spare parts for airplanes and guns is of particular importance.

The finished part or article may now be thoroughly cleaned of dirt and machining oils at the point of production. It may then be wrapped in the cellulose material without any other protection against rusting, except a light coating of oil which in many cases need not be removed, or a lump of moisture-absorbing silica gel placed inside the wrapping.

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FUEL—Quantities of fuel oil and Diesel oil purchased by Class I railroads in the first six months of 1942 increased 28 percent, respectively, compared with the same period of 1941, reports of the Interstate Commerce Commission disclose.

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EAR PLUGS

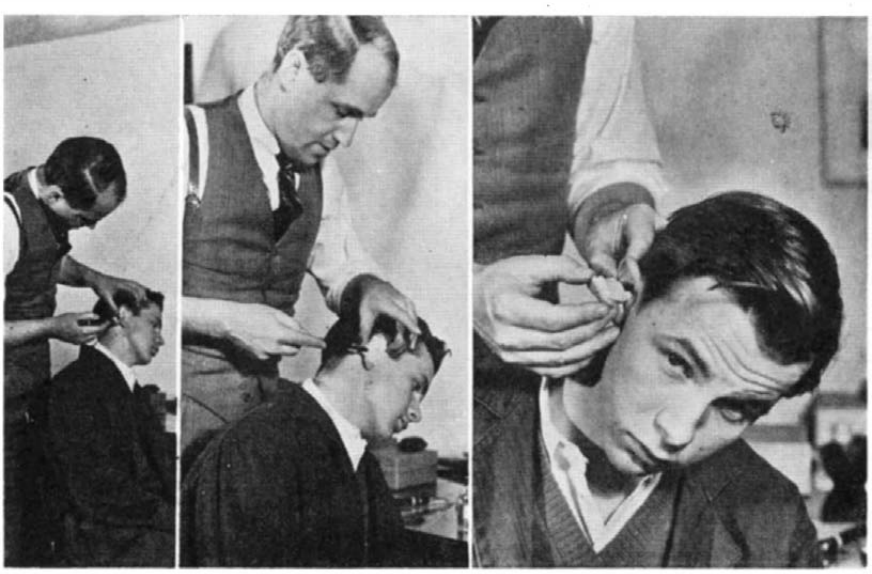
Molded "To Measure" From Plastic

TO PROVIDE relief from nerve-wracking noise in factories, defense plants, ship yards, foundries, and so on, an individually molded ear-stopper of smooth, translucent plastic or plaster of paris has been devised. Reproduced from a special impression taken of each ear, the new ear plug fits the auditory canal comfortably and will not fall out under ordinary conditions.

The impact of loud sounds and noise is reduced with the new device by as much as 40 decibels—or a diminution in sound power of 10,000 times—according to the makers, Maico Company, Inc. Interest in the new product has been accelerated by the increased tempo of production in war plants and the resulting boost in noise-level intensity. In addition, the expansion of precision operations and increase in over-time work has made the adverse effects of incessant clamor much more noticeable. Use of sound-muffling ear-stoppers is claimed to reduce the excessive fatigue and nervousness common to noise-harassed war plant workers.

In use, a factory employee selects his "left" and "right" ear-stopper, inserts each with a simple rotary movement. Thus in position, each plug extends a short distance down the auditory canal, while the exterior portion nestles in the concha of the outer ear. A small, curved segment of the ear-stopper lies just behind the frontal fold (helix) of the ear in such a manner that the entire device is held securely, yet comfortably, with sufficient space for equalization of air pressures. The ear insert can be quickly removed when desired, and is easy to clean by washing in soap and water or mild antiseptic.

Impressions of the ear canals may be taken by physicians, dentists, or qualified technicians, using a special plastic material available from the Maico Company. The molded impressions are boxed and shipped to the Maico laboratory where they are reproduced—dental inlay fashion—in plastic. Each ear stopper is then highly polished to a glassy smoothness and delivered to the user.



Steps in producing made-to-measure ear plugs. *Left to right:* Outer ear and canal coated with oil, cotton plugging canal; placing the plastic with spatula; removing plug

INDUSTRIAL TRENDS

WAR-TIME PRODUCTION LINES

Now THAT pleasure-car production lines — symbols of American industrial ingenuity—have disappeared from the face of the earth, and automotive plants have been all-out for war for some time, it is interesting to take stock of this one corner of our industrial picture.

Probably no one private citizen is more qualified to speak on this broad subject than Alfred P. Sloan, Jr., Chairman of General Motors Corporation. Hence we will turn most of this page over to Mr. Sloan and, by direct quotes and paraphrase, present his keenly analytical views.

Citing the contribution which engineers and production men have been able to make in developing a wartime technology, and relating the part played by production management in promoting both quantity and quality in war material, Mr. Sloan says that General Motors production rates have been accelerated, engines have been increased in horsepower, guns have been simplified and given longer life, and improvements have been made in tank construction, in airplane propeller design, and in the manufacture of shells. New devices have been developed, new characteristics built into old devices. Meanwhile, a sound basis has been established for continued advance in war production techniques.

"In past years the energies of American industry were focused on the development of a peacetime technology for the production of civilian goods; there was very little demand for war materials," Mr. Sloan states. "Consequently, there had not been developed techniques for the intensive mass production of war materials that is now required. What is taking place is the application of management skill and experience, gained from peacetime production for consumers, to the problems of turning out vitally needed implements of war. This, together with the application of newly developed methods, is creating a new technology of war production."

Acknowledging "the generous co-operation of other manufacturers and of Army and Navy technicians, without which much of this progress (in General Motors) would not have been possible," Mr. Sloan groups into four categories the results made possible through the application of industrial mass production techniques to the production of war materials: (1) savings in critical materials, (2) savings in production time, (3) savings in cost, with consequent reduction in the nation's expenditure for war material, and (4) improvement of product as based in part upon reports of actual experience with the product in the combat areas.

Citing results obtained in the manufacture of one type of machine gun as illustrative of the same manufacturing approach applied throughout General Motors war production activities, Mr. Sloan explains some typical accomplishments in achieving the objective of not only more and more weapons, but better and better weapons in the technical sense:

"Mass production begins with planning, involves the attainment of complete interchangeability of parts and finally requires the introduction of progressive processing and assembling. In the case of the machine gun example, it became possible through changes in manufacturing methods to double production in the same man hours, to cut costs to half the original amount, and to build additional quality into the gun. Through new processes, more plentiful materials were substituted for critical materials; the number of special types of steels required was reduced by two-thirds.

"Co-operation with machine tool manufacturers resulted in the development of new machines which greatly shorten manufacturing time, releasing operators and tools for other assignments. For example, side plates originally milled individually were pressed nine at a time. This process was later improved by stamping the plates on a punch press, using five men for the operation instead of 40, thus enabling one division to transfer 35 men to other vital operations. Vertical reamers and drilling machines now handle up to 12 gun barrels at one time. Electric riveting, replacing the conventional cold hammer method, halves the production time on the riveting operation while doing a much more satisfactory job."

Discussing the problem of maximum effectiveness of military machinery, Mr. Sloan says:

"Modern implements of war must be specialized in order to meet specific needs. Mechanical equipment intended to perform a particular duty must be of highly intensified design in order to give maximum performance in that one special service. This means that for duties other than those for which it was designed, an item of equipment may render, in comparison, mediocre or even inferior performance. In other words, a piece of equipment designed to operate at maximum effectiveness under certain conditions will not operate at the maximum under all conditions.

"This principle is illustrated in the utilization of the Allison liquid-cooled airplane engine, which, in certain designs of planes, is higly effective in medium altitude fighting, while the same engine with adequate supercharging capacity added, and in other designs of planes, is rendering equally effective service at very high altitudes. Yet the former combination would not perform effectively under the latter conditions, as any explosive type of engine loses power rapidly in the higher altitudes, which characteristic must be corrected for by some type of super-charger.

"In general, it may be said that in the engineering of military products, as in the engineering of automobiles and other peacetime products, the development, in a single unit of superlative performance on all counts and under all conditions is impossible. Extreme qualities in some performance factors necessitate compromises and lesser qualities in others. Viewed from another angle, this principle of selection is, of course, the very thing that makes possible the engineering of superlative performance in the specific area desired."

CORK AND KAPOK

Widely used in life-jackets and belts, cork and kapok are two imported products that have been hard hit by war. Work on replacing them with domestic materials is proceeding apace. How cork is being grown in the United States has been discussed previously in these columns; now come reports of a kapok substitute that, present indications are, will not only replace this import from Japan but will, in many uses, be found superior. This substitute is the floss of the common milkweed. As a lining for life-jackets and for flying suits it is warmer than wool, more buoyant than kapok. Other uses for this weed are in the offing, uses which promise to be of outstanding importance in wartime as well as peacetime applications.

—The Editors

Biodynes

A Miracle of Wound Healing and Tissue Repair—The Life Cell's Secret

LOIS MATTOX MILLER

THE bio-physicist, Dr. George Sperti, of Cincinnati, was urged by a professional colleague to attend a medical meeting in Chicago, and since he had other business in the city, finally agreed. He arrived at the meeting late and slipped into a seat in the rear of a lecture hall, which was packed with doctors.

Dr. Thomas F. P. Walsh, a surgeon of Mercy Hospital, Chicago, was lecturing, and illustrating his talk with lantern-slide displays of a woman patient burned when a gasoline stove exploded. Even that audience of case-hardened doctors shuddered; the burns were almost certainly fatal. But no—the slides unfolded the progress of the case, day by day, while under treatment with a new burn ointment therapy. The surgeon commented on the amazing absence of pain. To the spectators' astonishment, the slides showed small islands of new tissue beginning to form in the burned areas within three to four days. The patient went straight on to a rapid and complete healing and was hardly scarred at all.

"If I hadn't seen these pictures," said one doctor, "I would have sworn that this was an incredibly fine job of skin grafting."

Dr. Walsh ended his talk on a dramatic note:

"I feel impelled to tell you, gentlemen," he said, "that this emergency was even more extreme to me than these pictures may indicate, for this case was in my own family."

Dr. Sperti was the discoverer of the ointment used. This was its first piece of professional recognition. The lecture was as startling to the discoverer as to any other spectator, for the ointment had been tested only once before, and less rigorously. A nun working in Dr. Sperti's laboratory in Cincinnati was burned severely as a result of an explosion during an ether-extracting operation. As an emergency measure, fellow workers smeared on large quantities of an ointment with which they were experimenting in the course of cancer research, which is their real business. For some reason which no one could then—or can yet—explain, pain ceased immediately and the burns healed without scars.

Some of the most interesting cases treated have been reported in the scientific journals and supplies of the ointment were offered to doctors who might be interested in making further clinical trials and reporting their results. Several hospitals took advantage of the offer. The Chicago report on results was merely the first of many just as remarkable which have followed in a steady stream since. Dr. Walsh alone has used the ointment in 100 serious burn cases; the story of each is gratifyingly monotonous.

THE magical ointment is full of biodynes (from *bios,* life; *dyne,* force) and you are going to hear a great deal about it from now on.

The use of the salve in treating burns is a minor aspect; the biodynes are much more important than that. They are "intercellular wound-hormones," whose existence scientists long have suspected but never before proved. These hormones are discharged by injured cells to stimulate the growth, breathing, and reproduction of other cells. Thus, at last, science begins to understand the miracle of wound healing and tissue repair. More important still, the biodynes may explain the mysterious process of cancer growth.

Cells are the microscopic building blocks that make up all living tissue—plant, animal, human. Each individual cell behaves very much like the whole organism of which it is a part; it breathes, uses energy, grows, reproduces itself, and normally lives in complete harmony with its neighbors.

But sometimes certain cells, for no apparent reason, go haywire, get "all out of breath," burn up sugar energy, grow abnormally, and communicate this mad behavior progressively to adjacent cells. Generally, such chaos in the cell community describes the condition called cancer. Since the hormones which control cell growth have now been isolated, perhaps science may be able to use them to prevent, control, or cure cancer! This possibility is as yet remote.

The story behind biodynes is this: In 1935, the Archbishop of Cincinnati established a graduate institute for scientific research (the Institutum Divi Thomae), choosing as its scientific director Dr. George Speri Sperti, co-founder and director of the University of Cincinnati's Basic Research Laboratory. Sperti was then only 35 years old; but already he had acquired a reputation as a brilliant scientific investigator. The new institute gave him the scope and opportunities he was looking for: the modern laboratory in Cincinnati and another for the study of marine cell life on the ocean-front at Palm Beach; a small but carefully picked staff of chemists, physicists, plant physiologists, biochemists; affiliations with a number of big hospitals for clinical research; and a major project—cancer research.

Tackling first things first, Dr. Sperti reminded his colleagues of a queer, half-understood factor in cell behavior. When a living tissue is wounded, the adjacent cell communities snap out of their peaceful, leisurely routine and begin reproducing themselves at a furious pace. Only after the destroyed cell-tissue has been replaced and the wound healed, do things return to normal. Obviously, some substance must control, and at times stimulate, cell metabolism. What was it? Where did it come from? How did it work? Find that substance, Dr. Sperti reasoned, and you may have the key to the innermost secret of cell behavior, and a clue to cancer growth.

FOR more than a half-century scientists from Virchow to Carrel had speculated on the nature of these wound-healing agents, and in recent years had agreed that they were some kind of "wound hormones." The institute researchers resolved to try to isolate them so that they could be studied.

The first step was to injure living cells and watch what happened. But how can you injure such microscopic units without killing or destroying them? Dr. Sperti proposed to use ultra-violet rays. Everyone knows that, in controlled doses, such irradiation is stimulating and healthful; that in large doses it can be harmful, even fatal. More than the healthful dose, and less than the lethal overdose, he reasoned, ought to produce just the right amount of injury.

For the next few years the scientists labored over the lights and the test tubes. Suspensions of yeast cells, cell-

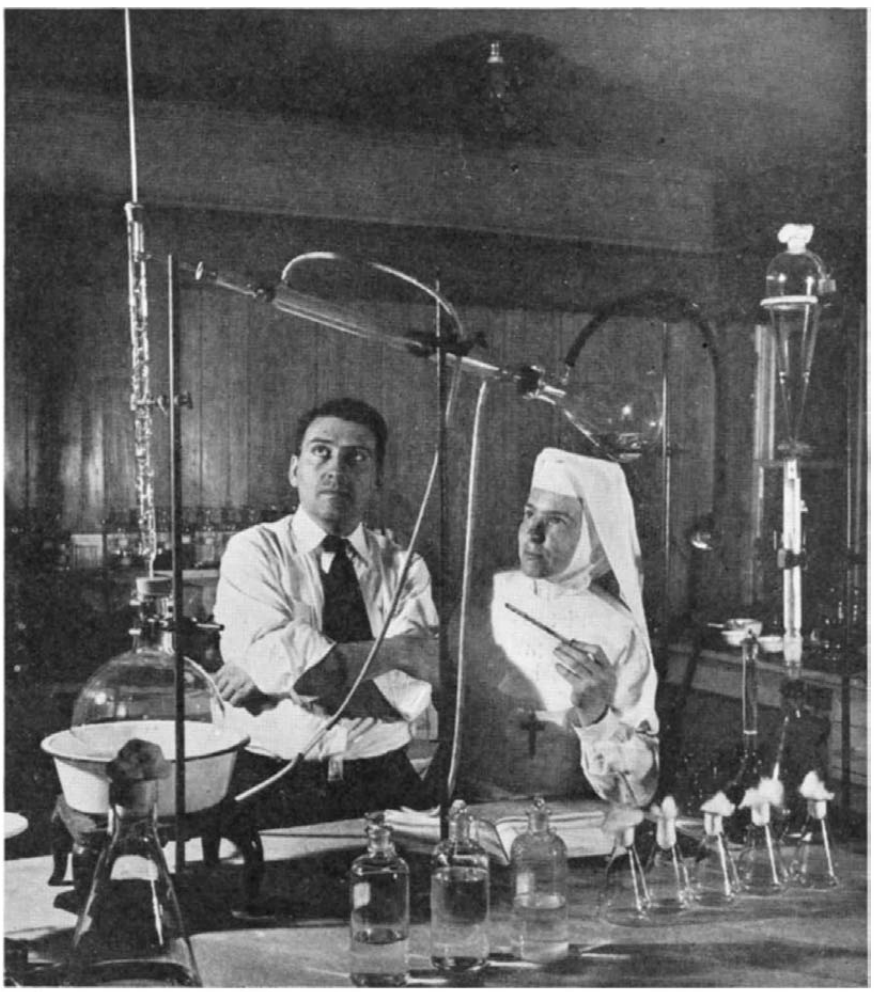
tissues of chick embryos, lizards, fish, and animal livers, were exposed to the ultra-violet rays. After a predetermined degree of injury had been done, the wounded tissues were carefully washed in solutions. Then the cells themselves were filtered out of the solution. Now, if some chemical had been released by injury, it had to be there in that sterile cell-free solution. And it was! When other bits of living cell-tissue from a chick embryo were immersed in the solution, the furious speed-up of cell growth and reproduction was plainly visible under the microscope. The life-cell, at last, had given up one of its most important secrets.

Now the laboratory workers assailed living tissues with chemicals which have long been suspected as cancer-causing agents. They also attached test tubes containing cells to the diaphragm of a loudspeaker; its vibrations caused mechanical injury the extent of which could be controlled. When injury was not too great, the biodynes were always there. But when cells were too violently assailed by vibration, too much ultra-violet or whatever, there were no biodynes. Why? Because biodynes are secreted by injured *living* cells, and not by cells that have been killed.

The investigators now wanted to know more about the biodynes themselves. One of the first things they learned was that there are different kinds of biodynes, serving different purposes. Some induce the growth and reproduction of cells, and thus play a major part in wound healing. These they named the proliferation-promoting factor. Another type stimulates the cell's breathing, now called the respiration-stimulating factor. Still others are called the glycolytic biodynes, and cause the cell to speed up its consumption of sugar for energy. It is not improbable that the number of known biodynes will increase with further research, as was true of vitamins.

But what part do the biodynes play in cancer? In cancer the cells grow abnormally; cell respiration is depressed; and sugar is burned up by the process called glycolysis. Each of these things might indicate the abnormal presence or absence of particular biodynes: too much of the growth factor, too little of the breathing stimulant, too much of the glycolytic biodyne.

Here is the way Dr. Sperti presented the theory to doctors at the Third International Cancer Congress: "It seems clear from our researches that carcinogenic (cancer-causing agents have the power to injure large numbers of cells, *and to keep them injured over a prolonged period of time,* resulting in the secretion of a large and continuous quantity of growth-factor and an unbalance in metabolism. This, we feel, may be the cause of cancer."



Sister Mary Redempta, S.S.J., of the Institutum Divi Thomae, describing to Dr. George Sperti her results in the fractionation processes in preparing biodynes

Whether this theory will hold water, and—if it does—how the biodynes may be used to normalize the cells, are now the subjects of intensive investigations, both at the institute and in the medical clinics affiliated with it.

Meanwhile, the biodynes are being put to work on other fronts. Dr. Sperti is impatient with investigators who allow newly-discovered knowledge to lie idle merely because time isn't ripe for its application to the big job. "Look at the implications of your facts," he urges; "think how they may be applied along the lines."

That is how the biodyne ointment for burns was created. Obviously, the proliferation-promoting factor was important to wound healing, and particularly in burns where large areas of new tissue must be grown. But more than that was needed. Experiments have shown that burned tissue suffers from subnormal respiration. The respiratory-stimulating biodyne was needed also!

With growth biodynes obtained from injured animal and fish livers, and respiratory biodynes from yeast cells, the institute workers compounded the ointment for burns which has performed so nobly. Incidentally, it contains virtually nothing else but biodynes and a greasy base. Just why it relieves pain, since it contains no local anaesthetic, is still unknown.

One group of institute workers discovered another interesting application. Healthy skin is characterized by ample cell respiration; it loses its fresh and vital appearance as age, dirt, lack of sunshine, and so on, lower skin breathing. Moreover, the cosmetics which women use, according to laboratory tests, merely depress skin breathing further.

Does this mean that the ladies, for health's sake, should junk their creams and lotions? Not at all. Simply by incorporating the respiration-stimulating biodyne, the depressing effect of cosmetics on the skin can be offset.

The manufacture and sale of such

products, of course, will bring to the institute royalties which will be quite welcome for the maintenance of more important research. Does that seem strange? Not to Dr. Sperti's eminently practical way of thinking. While he was still an undergraduate at the University of Cincinnati, he invented (more or less because engineers said it couldn't be done) a K-va electric meter which measures accurately the huge power loads consumed by industrial plants, and a large manufacturer contracted to pay $50,000 for the invention. A few years later, when he was a full professor, he decided that the University's Basic Science Research Laboratory needed modern quarters and better equipment. At the time he was studying the application of physical laws to biological materials, and he was aware that existing processes for irradiating foodstuffs were unsatisfactory. They would put vitamin D in milk, for instance, but leave the milk tasting like burned meat. Dr. Sperti produced the solution: "selective radiation" which employs only the narrow band of vitamin-producing rays and filters out all others. In return for Dr. Sperti's patent, General Foods gave the University of Cincinnati $300,000 with which to start its basic research laboratory.

From these early experiences he evolved the theory that in scientific research, brains, imagination, enterprise are more essential than money: if your scientists have those basic qualities, and run short of funds, they can always turn their hands to making research pay at least a part of its own freight. He has operated on that theory consistently. The institute draws royalties from his patents on fluorescent lighting, vitamin preparations, food preservation, meat tenderizing, and irradiation processes. The Sperti sunlamp, which imparts vitamin D and tans the skin with almost no risk of burning, brings in $50,000 a year in royalties.

Today, the scientists on the staff, inspired by Dr. Sperti's example, often turn their minds to such practical problems after a day's work is done, and solve them as you would a crossword puzzle or brain-twister. It's their form of relaxation—but it pays dividends.

Thus, in their spare time, they have discovered sources of natural rubber in Florida, and have produced from Florida seaweeds better agar than used to come from Japan. They have developed also a process for impregnating toilet soap with vitamin D which can be absorbed by the skin; and another that converts waste brewer's yeast into a cheaper, more nutritious chicken food. Recently, they have developed a method for sealing the flavor in coffee beans before roasting, which produces a more delicious coffee from 25 percent less grounds.

The Institutum Divi Thomae is supported by the Archdiocese of Cincinnati and private contributors, but income from inventions now covers approximately half of the expenses of its main laboratories at Cincinnati and Palm Beach, and its ten affiliated laboratories, whose staffs number more than 100 scientists, including students. Cancer research takes lots of money, and these Institutum scientists are proud to make extra-curricular contributions to its upkeep. Perhaps that is why one distinguished cancer specialist, inspecting the Palm Beach labortories last winter, made this remark: "Dr. Sperti never reported his discovery of that other biodyne—the one that stimulates such loyalty and devotion in the human heart."

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VITAGRASS

Yes, There Are Vitamins in Grass—But . . .

A NEWSPAPER item stating that common grass contains vitamins was printed and reprinted the nation over, a number of months ago, and still brings this magazine inquiries about the method of use. This whole question has been neatly summarized in *Nutritional Observatory,* publication of the Heinz Nutritional Research Division of the Mellon Institute, Pittsburgh, Pennsylvania, according to the following quotation:

"The flavor, fiber content, and high water content of fresh grass are three reasons against its use, together with the possibility for eating noxious weeds that may grow with grass and escape removal in its preparation for use. It is necessary to limit the intake of fiber for convenience as well as for comfort, and also to avoid serious wastage of other parts of the diet through increased rate of peristalsis, mucous secretion, and bacterial activity.

"Man, unlike such ruminants as the cow, for instance, is not equipped with intestinal bacteria to handle large amounts of such bulky fare as fresh grass.

"Grass has now been suitably dried without destroying its nutritive property. One such preparation, a dehydrated cereal grass, made largely from young wheat, is getting increased notice. A bread in which dried cereal grass has been incorporated has gained some popular acceptance.

"Grass either fresh or dried is decidedly laxative for most human beings and care must be exercised in its use, especially if eaten in large amounts. Probably the digestive system should be prepared gradually for consumption of grass. Not all individuals would be adapted to this kind of regimen, particularly the young, sick, and aged with delicate digestive mechanisms.

"The requirements for carotene (provitamin A), ascorbic acid (vitamin C), and iron can readily be met by eating moderate quantities of dried grass. In the case of calcium and the vitamin B complex factors, as thiamine, riboflavin, and niacin, between four and six ounces need be eaten, amounts so large as to be undertaken only by an enthusiast.

"Undoubtedly the wisest and safest recommendation is to use dried grass, if at all, in small amounts and finely ground, either as an added ingredient in common foods such as bread, or as a supplement to the diet in the form of tablets, which should be prescribed only on advice of a physician."

NO MORE MESS

New Superior Base for Ointments is Developed

OINTMENT bases that can be whisked from clothes or skin with plain water have recently been developed by pharmacists; greasy, messy ointments and salves may soon be out of your medicine cabinet. Many formulas for the new type of ointment have been proposed; a few have been successful. The most promising to date is announced in the practical edition of the *Journal of the American Pharmaceutical Association.*

The new ointment base was developed by Dr. Emerson C. Beeler at the Washington, D. C. laboratories of the American Pharmaceutical Association. Smooth and "washable," the base consists of cetyl alcohol, white wax, propylene glycol, sodium lauryl sulfate, and water.

The alcohol used is a giant molecule, compared to your rubbing alcohol. This makes it a white, wax-like solid. In combination with the "wetting" agent, sodium lauryl sulfate, it causes medicinal agents to penetrate the skin better. It is also greaseless and is said to make the skin velvety. It permits the heat of an inflamed area to escape more readily; discharged fluids are not sealed in as is often the case with greasy salves. —*Science Service.*

OUR *Point* OF VIEW

A LETTER—AND A REPLY

Midwestern State College

Dear Dad:

Yesterday being Women's Day on the Campus, Dean Rush, of University of Pittsburgh, gave a marvelous talk on the war and a girl's part in it. At dinner we all discussed the talk, what we haven't done, what we could do in the future, and agreed we haven't accomplished or sacrificed a single thing. The result is I am in a terrible state of confusion and I know you are the only one who can straighten me out. The other girls in the house are bothered by the same feeling of helplessness. Right now I should be studying for a geography location test, but all the time it seems as if something was hanging around my neck, and I can't shake it off or settle down to anything.

I have the feeling that all this studying is very unnecessary, that it isn't vital to the war effort in any way, that one can hardly plan on anything, even from day to day. Oh, yes, we are told they want the women to remain in college and prepare for the future, but it all seems so useless when the only future we can see looks dismal and unpromising. I know if I weren't in college I would be doing little more, if anything, to help, but when my own brother writes he is dropping out of school, as you know, to join the Marines, when other boys to the right and left of me are leaving for the armed services, I feel so infinitesimal. And helpless.

As for the future, what can we look forward to but depression and a state of readjustment which will change our mode of living more than we can imagine? The boys I know have two attitudes, neither of which help much. With them it seems to be a case of "eat, drink, and be merry, for tomorrow you may die," or, get all you can out of college, for the training and good marks will help to get ahead both in the Army and in the future. Actually, Dad, how many of the 18- and 19-year olds are going to buckle down and study hard when they know they will be called soon?

I know there is no answer to this, but I only wish I could feel more secure and settle down to work, and when I am all mixed up, how can I be expected to concentrate on such seemingly trivial things as the location of Azizia?

Love, Patricia.

P.S. Where *is* Azizia?

New York.

Dear Pat:

To answer the easiest of your questions, Azizia is some 20 miles south of Tripoli, near the northern coast of Africa. If I could truthfully and fully answer the rest of them, I not only could put all astrologers out of business, but also I could name my own price for the information.

However, perhaps I can offer a sort of mental sedative, or injection, consisting of one part hope, one part mental balance, and plenty of parts each of intestinal fortitude and faith in the American Way.

To try to be practical about it all, let's first admit that our world is very, very sick, and that it is going to take several transfusions, maybe a major operation or two, and a lot of careful nursing through the recuperative period before the world's pulse, blood pressure, and heart are once again somewhere near normal. To accomplish this will require the efforts of at least three, possibly four, generations of the earth's peoples, among whom Americans are destined to play major roles. The transfusions and major operations must be accomplished by my own generation, part of the ones just ahead of and behind me, and a portion of yours. When the surgical work has been completed, it will be far more the job for you, your brother, and all other members of your generation than it will be for people my age or those older than I to recuperate the world—to prevent it from sloughing into the "dismal and unpromising" future you mentioned.

Your job will be the toughest. After all, transfusions and operations are primarily mechanical in nature. They require health, skill, and money. Youngsters of your age have an abundance of health. My generation can contribute a reasonable amount, plus skill and money. The men and women older than I can donate the skill derived from years of knowledge and experience, as well as money obtained from various sources.

But to guide a very ill world patient through convalescence calls for extreme patience, diplomacy, and a knowledge of many things, such as architecture, engineering, medicine, law, chemistry, physics, languages, economics, history, and, yes even the location of Azizias.

That's your job. Yours and all members of your generation who may be blessed with the opportunity of receiving knowledge from our "intelligence factories"—our colleges and universities—both now and after the war is over. It is to be hoped that your brother and as many members of his class as possible will be spared to return to college for the "know how" they will need to guide the destinies of America and the world. After the last war, I, like many others, didn't go back to school—and I've lived to regret it.

It is only by acquiring that "know how" that you and your classmates may be fitted for the job of bringing a recuperating world back to a state of health which will mean happiness to all. That "know how," as always, comes from our "intelligence factories."

Above all, it is not a question of looking forward to "depression and a state of readjustment." It is a challenge to the young men and women of your age to prepare themselves to, if possible, prevent depression, or, if that materializes, to conquer it. As for readjustment, we are all going through that now, every day—and will continue to do so—to such an extent that it is problematical if we can be called on for any performance we cannot render. Doubtless many Dads have to answer letters like yours, and I say for all of them to all of you—stick to your job of learning as long as you can. If you must give it up to protect your country, by all means go back to it as soon as you can. We shall need you and your knowledge.

Dad *(A.D.R., IV.)*

(The two letters printed above are copies of actual correspondence, with only minor changes, between an Associate Editor of this magazine and his daughter.—O.D.M.)

Star of A. D. 1054

An Unprecedented Physical Process in a Unique and Extraordinary Object

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

Two recent papers from Mount Wilson, dealing with the Crab Nebula, permit additions to the account which we gave last August.

It was already known that the Crab Nebula shows a strong continuous spectrum in addition to the familiar bright lines. Baade, photographing with color screens—one transmitting the red hydrogen line and the strong forbidden nitrogen lines close by, and the other including a region further in the deep red in which the spectrum shows no bright lines—finds images so different that they would hardly be taken for the same object. The first reproduction shows an intricate network of bright filaments on the original, remarkably rich in fine detail, superposed on a feeble continuous background. On the second the filaments are entirely absent, and there is only a diffuse image quite devoid of sharp detail and considerably smaller than the first. The star-images outside are about equally bright, so that this cannot result from under-exposure.

These remarkable photographs show that the nebulosity consists of two distinct parts, "an outer system of filaments, and an inner mass of amorphous structure." The line spectrum is evidently concentrated in the filaments and the continuous spectrum in the amorphous mass.

The filaments are conspicuous in the first photograph because the color-screen was deliberately chosen so as to transmit the light of the bright red lines, and cut off the continuous spectrum as closely as possible on each side, so that its light might not drown out the details. Baade estimates that, when the whole range of spectrum is considered, the continuous spectrum accounts for more than 80 percent of the light of the nebula.

This fine piece of observation opens the way to a fuller understanding of this remarkable object. Photographs with the first filter show the filaments much more sharply than the older ones in which they were half drowned by the continuum. Ten years hence, when new plates taken in the same way can be compared with them, we should have much more accurate determinations of the outward motions of the filaments than we have now.

AT THE same time, and at the same observatory, the spectrum of this nebula has been studied by Minkowski, both by observation and theory. The observations put it beyond any doubt that the bright-line spectrum comes from the filaments; for whenever a filament, as shown on the direct photographs, crosses the known position of the slit of the spectroscope, the bright lines appear. This bright-line spectrum is of the ordinary nebular type, with "permitted" lines of hydrogen and helium, and forbidden lines of oxygen, nitrogen, neon, and sulfur. The hydrogen lines are fainter than usual, and the nitrogen lines stronger; but it is evident that we have to deal with the now familiar situation in which masses of gas are illuminated with short-wave ultra-violet light coming from a very hot star, and thus excited to shine by processes which are well known.

This hot star must be the remnant of the old super-nova. It is probably the "south-preceding" component of the faint double star near the center of the nebula. (The other component has a spectrum of the solar type, and is not hot enough.) Baade concludes, however, that the question cannot be settled decisively until the proper motions of the nebular filaments are better known. From these the motion of the point from which they were ejected in 1054 can be found. This should agree with the motion of the star, which is already pretty well determined; but, as Baade remarks, the mass of the nebula may be as great as, or greater than, that of the remnant of the star from which it was ejected, and therefore the motions of the two need not be exactly the same.

The star in question has the photographic magnitude of 15.9. Allowing for the distance of the nebula, and an estimated absorption of 1.2 magnitudes by obscuring interstellar matter, the absolute photographic magnitude comes out 4.8, or about twice as bright as the Sun.

The brightness of the nebula is greater by about seven magnitudes —that is, it is 600 times brighter than the star which illuminates it, and 1000 times brighter than the Sun, visually as well as photographically, since the color is about the same.

It might seem at first sight absurd that the nebula should be so much brighter than the star which sets it shining; but this is what might be expected if the latter is exceedingly hot. All but a very small fraction of its radiation would then be in the remote ultra-violet, to which our atmosphere is opaque. The nebula acts as a transformer, absorbing much of this energy, and converting part of this into light of longer wavelength, which gets through the air to us.

IT HAS been well understood for years just how isolated atoms can be stirred up to emit their characteristic bright spectral lines in this way; but the continuous spectrum is something new. It is certainly not due to reflected light from the central star—it is hundreds of times too bright. We cannot get away from this conclusion by assuming that this nebula itself is almost opaque, and obscures more than 99 percent of the light of the central star, for the bright lines shifted toward the red, which must come from the receding gaseous filaments on the far side, are substantially as bright as those shifted to the violet, from the near side. The nebula is undoubtedly almost transparent, and its continuous as well as its line-spectrum must be formed within it by some process of transformation of the short-wave radiation of the central star.

Minkowski has proposed a very interesting explanation for this. Briefly, he suggests that the process which causes this faint nebula to shine is essentially the same as that which makes the gases of the Sun's surface appear as a luminous photosphere, and keeps the vast stores of heat inside the Sun from escaping faster than they do.

In the solar gases, even at the surface, there are a great many free electrons, removed from the various atoms. When such a free electron passes near a charged atom it may get by unscathed and recede at the

same speed; or it may suffer a transition to another orbit, and escape with diminished velocity; or it may be captured by the atom and remain bound to it. In the last two cases, energy has to be got rid of, and it escapes as radiation—not with a precisely fixed wavelength, as in the case of a transition between different states of the same atom, but with all sorts of wavelengths, depending on the circumstances of the transition. The light resulting from a multitude of transitions of this sort, analyzed by the spectroscope, gives a continuous spectrum.

It is now generally accepted that the continuous background of the spectrum of the Sun, and of the stars in general, is produced by transitions of this kind in the solar or stellar atmospheres, and the regions underlying them. In a star, the total thickness and quantity of gas is great, and the net effect, seen from a distance, closely resembles the surface of an incandescent solid.

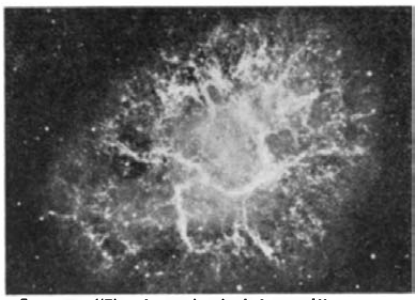
MINKOWSKI'S bold suggestion is that the excessively tenuous gases in the Crab Nebula shine by the same process. There is no doubt that the atoms in these gases would be highly ionized by the influence of the radiation of the central star; and that the electrons thus liberated would undergo transitions such as have just been described when they come near the charged atoms. The only question is whether enough light could be produced in this way to account for the actual brightness of the nebula.

After a thorough analysis by methods too technical to summarize here, Minkowski concludes that this is possible and arrives at numerical results which, though approximate, should give a good idea of the general situation.

He finds that the nebula is 15 times as massive as the Sun. This seems large; but its average diameter is four light-years, so that its mean density comes out 3×10^{-21} g/cm^3—or one pound in a sphere 4000 miles in diameter. This corresponds to 500 atoms per cubic centimeter, which is a thousand times or so greater than the density of the interstellar gas which pervades our part of the Galaxy. Hence the existence of the nebula as a luminous body is intelligible.

The amount of gas in a column a centimeter square, extending right through the center of the nebula from edge to edge, comes out 12 milligrams —or equal to that of a column of ordinary air of the same cross-section and four inches long. After full allowance for the higher opacity produced by the electron haze in the gas, it is evident that the nebula must be almost perfectly transparent to the light of the stars behind it.

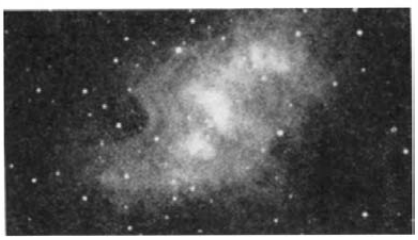
The central star which provides the power to run this extraordinary transformer of energy must be exceedingly hot. Only rough numerical estimates can be made, but Minkowski finds that all the known data can be reconciled



Courtesy "The Astrophysical Journal"

Above: Crab Nebula, λ6300—6700 (in the red of the spectrum)

Below: The same at λ7200—8400 (in deeper red and infra-red)



with a surface temparture of 500,000 degrees, a radius of 1/50 of the Sun's, and a total radiation 30,000 times the Sun's. Practically all this is in the extreme ultra-violet, and the transformation of a few percent into visible light accounts for the observable nebula. In the outer parts of the nebula, where the atoms get down to more ordinary states of ionization, the bright lines would be emitted by the standard process.

This interpretation describes an unprecedented physical process; but it applies to a unique and extraordinary object, and is derived from our best present knowledge of the properties of matter. Its author does not present it as *proved,* but as a hypothesis consistent with the known facts.

The most remarkable part of the picture is the central star, which is almost as small as a white dwarf, but excessively luminous and hot. The existence of such stars is not merely explainable theoretically, but was predicted years ago. If a star contracts more and more, its central density must at last become so great that the matter approaches the degenerate state where further contraction will occur only under enormous pressure. The white dwarf stars are generally recognized as being degenerate throughout, except for a thin surface layer. There must be an intermediate stage where the core of the star is degenerate, but the outer half is still composed of normal gas. Such a star, though only two or three times as large as in its final state, would still be very hot on the surface. Eddington—in discussion at a conference in Paris in 1939—stated that a star's surface would at this time be the hottest in its whole career and coined the name "blue dwarf" to describe it.

HERE we have a star that appears to be actually in this state. The only trouble observationally is that it is not blue, but yellowish-white. However, when only a ten-thousandth part of the whole radiation of a star is found in the visual and photographic region, it is quite possible that some secondary effect may disturb the distribution of this minute fraction of the radiation, and modify the color.

The mass of this blue dwarf, if it is degenerate at the center, must be not much greater than the Sun's. Here we meet our final difficulty; we must assume that in the super-nova catastrophe most of the mass of the original star was blown off into space, leaving only about a tenth—more or less—to settle down into a blue dwarf. But even this has been predicted on general principles.

In a degenerate mass of gas, when the velocities of the moving electrons begin to become comparable with that of light, the law connecting pressure and density changes. Chandrasekhar has shown that, when this is taken into account, a star of small mass (less than twice the Sun's) will settle down into a permanent state with a degenerate core, as a white dwarf, and finally as a "black dwarf," cold on the surface; but a large mass (ten times the Sun's or more) can never become quite degenerate, but should continue to contract without limit.

It is natural to suppose that something would ultimately happen to end this process, and it may well be that the contracting star blows up, ejects enough matter to leave a residue small enough to form a degenerate core, and then develops successively into a blue, a white, and a black dwarf. At the Paris Conference of 1939, Chandrasekhar suggested that some catastrophic change of this sort might be responsible for a super-nova.

This suggestion—at that time pure theoretical speculation—fits in remarkably well with these later data. — *Princeton University Observatory, October 30, 1942.*

Soil Saboteur

Selenium, When Present in Soil, May Kill Livestock, Poison Foods Raised for Human Consumption

J. V. SHEPARD

A FARMER living in one of the Great Plains states walked into a doctor's office the other day complaining of vague gastro-intestinal symptoms and a persistent skin rash. Instead of proceeding with a physical examination of the patient, the doctor inquired whether his chickens were doing well and whether all his eggs had hatched this spring. In due time, the physician explained that there is a very real connection between sick poultry and sick farmers. Chickens, livestock, and human populations living in certain areas of the Northwest eat grains and other foodstuffs raised on soil containing selenium, an element as poisonous as arsenic.

Selenium poisoning first became a problem in the Northwest when that territory was opened up to homesteaders. These early settlers were baffled and dismayed by a strange affliction which deformed or killed off great numbers of their livestock. Many cattlemen thought the malady was caused by alkali waters, so it became widely known as "alkali disease." Finding themselves unable to cope with the problem, cattlemen and farmers turned to their agricultural experiment stations for government help; but it was not until 1929, after many fruitless and disappointing experiments, that scientific investigators got on the right track and started hunting down the selenium saboteur.

One of the first to prove that grains and plants in certain areas were toxic to animals was K. W. Franke, of the South Dakota Experiment Station, but he could not determine the exact nature of the poison. Finally, in 1931, the problem became serious enough to warrant federal aid. Dr. H. G. Knight, a government chemist, suggested that selenium might be the toxic principle in the grain. It was an inspiration straight from heaven, but it took Dr. W. O. Robinson, another government research man, to anchor that inspiration with some solid facts. In 1933 he successfully proved that selenium in the soil=selenium in plants=selenium in livestock=dead, poisoned livestock.

Selenium poisoning may be of a chronic or acute type, but in either event the effects are not pleasant to behold. Cows, horses, and pigs which have eaten toxic grains suffer from loss of weight, lameness, damage to heart and liver, and, most pitiful of all, a marked deformity of the hoofs which may eventually slough off. These animals are frequently in such pain that they will remain in one spot and starve rather than attempt to graze on their sore feet. Cows with deformed hoofs have even been observed grazing on their knees in order to rest their deformed feet. In the acute form of poisoning, known as "blind staggers," the animals suffer from impaired vision and seem to lose all sense of direction. They wander about in circles, and when confronted with an obstacle, they will push up against it rather than attempt to detour. They frequently acquire a depraved appetite for such items as wood and metal. While the hoofs are not affected in this form of poisoning, the animals suffer from increasing paralysis and usually die within a short time.

Deformed hoofs of a cow seriously afflicted with poisoning by selenium.

DUCKS and chickens also have their troubles with selenium. The effects of the poisoning on adult birds are not very spectacular, but the effect on a chick embryo developing within a selenized egg is something really fantastic. The embryos are frequently deformed into such weird shapes that one might suppose Dame Nature had suddenly got all her patterns confused, cutting out peculiar birds with one eye, no wings, short legs that end in a single toe, and beaks much too short to pip the shell. Even when the chicks are not too deformed to hatch, they are born weak and decked out in a most unbecoming wiry down.

One of the most devilish things about selenium poisoning is its effect on animal fertility and the fact that it can carry over to the next generation. Experiments on laboratory animals have confirmed field observations that matings between selenized parents are frequently sterile and, even when conception does take place, there is constant danger of miscarriage or birth of deformed offspring.

WHILE the selenium problem has been most serious and persistent in South Dakota, Wyoming, and Nebraska, there are perhaps a dozen more states in the Great Plains area and the Rocky Mountain belt which have reason to be concerned with the problem. Actually there is not a continent in the world which is entirely free of the menace, for selenium has been found in wheat grown in Canada, Mexico, Spain, Argentina, Australia, New Zealand, Algeria, and South Africa.

In those states where selenium deposits are found in the soil, they are by no means evenly distributed over the entire area but are found associated only with certain geological formations. The foundations for our present-day selenium problem were laid as far back as 60 to 90 million years ago. During the Cretaceous per-

Laboratory result of injecting a healthy egg with selenium: deformity.

iod selenium-rich shales were deposited over wide areas of the earth's surface. At that time there were no such things as cows and farmers and western wheat: only a few giant reptiles were on hand to witness the dark deed. Nor was there any hint of a 20th Century drought in that area now known as the Great Plains, for it was submerged beneath a shallow sea. To the west of this sea was a range of mountains which preceded our present Rockies. Geologists believe that active volcanoes in these mountains spewed out gaseous selenium and seleniferous ash which were blown out over the sea and combined with soluble iron compounds in the water. These compounds remained in the earth when the sea finally drained away.

WHILE the question as to the primary source of selenium is chiefly of academic interest, the fact that selenium is invariably found in certain geological formations is of great practical importance here and now. Whereever the geologist spots an outcrop of certain shales and limestones of the Cretaceous period, he can be pretty sure of finding seleniferous soil and can mark this area as a danger zone. In fact, from a geological map of the world, it is quite possible to predict just where seleniferous areas will occur.

Even after it has been definitely proved that the soil of a particular region contains selenium, it does not follow that the plants growing in that soil will contain a toxic amount of the element, for plants vary widely in their ability to absorb selenium. Furthermore, selenium occurs in three chemical forms: chiefly as basic iron selenite, an insoluble form available to only a limited variety of plants; less frequently as calcium selenate and organic selenium, which are available to all plants. The most notorious selenium gluttons are flowers like the vetches, woody aster, and prince's plume, which grow in colorful profusion throughout the cattle- and sheep-raising sections of the Northwest. These plants look deceptively beautiful and harmless, but let the bovine diner beware! Such floral fare is responsible for livestock losses estimated at millions of dollars annually.

Selenium-accumulator plants are doubly dangerous in that they are able to convert insoluble selenium into water-soluble compounds of the element and return it to the soil in a form readily absorbed by farm crops.

But the career of a selenium-accumulator plant is not all evil. Because they grow only on toxic soil, they help investigators spot selenium outcrops and map off the areas dangerous for farming and ranging.

If livestock alone were the victims of selenium poisoning, our story would be tragic enough, but there is reason to believe that human populations in certain rural areas are consuming toxic amounts of selenium in drinking water, cereals, vegetables, meat, eggs, and

Chick embryo found in egg laid by a hen poisoned with selenium

milk. Foods produced in seleniferous areas should be carefully analyzed and the final market products checked for total selenium content. Brief public health surveys have been conducted in the most seriously affected areas, but much work remains to be done. Local physicians in these areas are learning to recognize symptoms of selenium poisoning and should be requested to report all cases to state or federal authorities.

The selenium problem, for all its discouraging aspects, still has its bright side, for there are several methods of control which reduce the danger to a minimum. Highly toxic areas may either be fenced off or planted with non-food crops which are to be used in industrial products. In one section of South Dakota the government has already withdrawn 100,000 acres from cultivation. In other places it may be sufficient to destroy selenium-accumulator plants and to raise alfalfa or other forage grasses which do not absorb toxic amounts of selenium. Whereever proper irrigation and adequate under-drainage are available, much of the selenium can be washed out of the soil and drained away.

Research workers have long been trying to discover a possible counteractant for selenium poisoning. Dr. A. L. Moxon, of the South Dakota Experiment Station, has found that arsenic compounds are effective in protecting laboratory animals against selenium, but the dosage has not yet been standardized for practical use on the farm. Tolerance levels of selenium for livestock feed have also been determined so that farmers in the toxic areas can have their grain analyzed at the state laboratories to see whether it contains a dangerous percentage of selenium.

Having taken adequate precautions to protect hen and horse from selenium poisoning, it would seem only reasonable to establish tolerance levels for the human animal and to enforce these standards by government inspections. The agricultural experiment stations have done a splendid bit of work in routing out the cause of soil sickness and in pointing the way to eliminate the danger.

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AGAR

Source Found in Puerto Rico

DISCOVERY of a bountiful source of algous materials suitable for preparing agar, the indispensable fungic and bacterial culture medium used in every hospital and biological experimental laboratory, for years a Japanese monopoly product, may prove to be a significant result of ten months spent in Puerto Rico by Dr. Hugo L. Blomquist, chairman of the Duke University botany department.

Already agar is becoming more difficult to procure and, with the Japanese and other oriental sources closed, laboratories will have to look elsewhere for supply. Professor Blomquist reports that he has located several types of seaweed from which satisfactory agar-producing materials might be obtained.

Agar is unique in that while bacteria and fungi flourish in its gelatinous mass it is not consumed or destroyed by it. Dr. Blomquist, an authority on grasses, algae, ferns, and mosses, became interested in the probable origin of several unusual specimens of tropical seaweed while at work during recent summers at the Duke Marine Laboratory at Beaufort, North Carolina. Following severe storms and several hurricanes, the shore became littered with the strange specimens, now taking on an important aspect.

Going to the University of Puerto Rico in August, 1941, as exchange professor, Professor Blomquist began to look for the tropical seaweed, but it was only after Pearl Harbor that the search and final discovery of abundant areas of growth gave the routine scientific investigation practical importance.

Glass, Present and Future

Applications of Glass to Unusual Purposes Reveal Interesting Possibilities for Further Development

R. A. MILLER
Pittsburgh Plate Glass Company

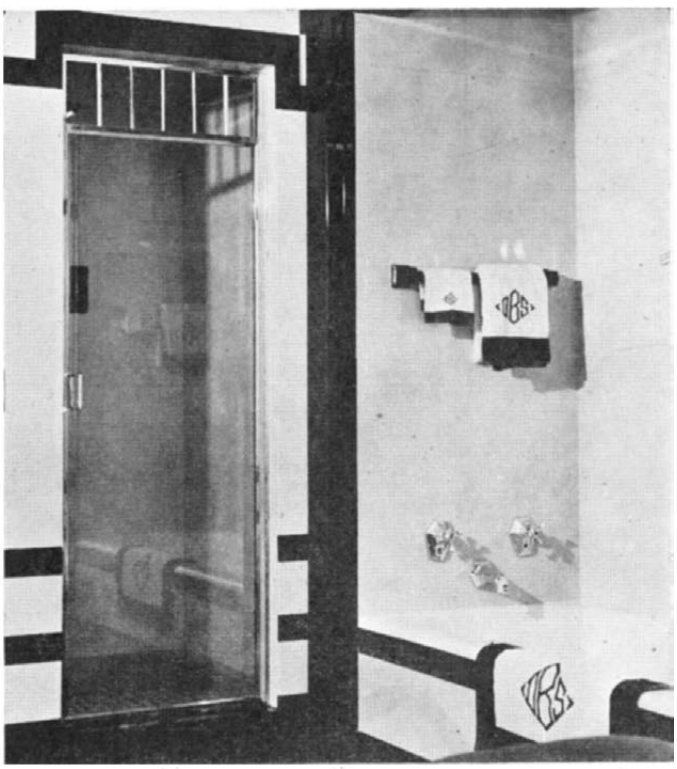
THE glass industry offers a diversity of opportunity for the adaptation of its product to human needs, needs emphasized as well as created by the war. Developments over the last ten-year period have altered general conceptions as to the fragility of glass. Now glass is utilized in many places where previously its tendency to break had precluded the possibility of such use.

Obviously, in this time of stress, military objectives are the chief concern. Factories are being converted in every way possible to the production of military materials, and many civilian needs must remain unsatisfied. As a result, careful consideration of consumer requests and desires may, and probably will, develop many new fields in which glass products can be used to the satisfaction of all concerned.

Automobile tires cannot be made from glass, but tight catch basins for shower bath installations are possible. There is no satisfactory glass hand grenade, but satisfactory orifice plates of glass for use in the metering of gas and other fluids have been made. Perhaps there will be no request in the near future for glass dance floors, but the fact that they can and have been built, indicates an increasing sense of the utility of glass as an engineering material.

In the war effort, glasses have been developed which will stop .50-caliber bullets effectively. Such impacts will tear off a man's leg or arm. Today, bent laminated glass housings for pilots and bombardiers on bombing planes are being fabricated. A year ago they were believed to be impossible to make, but are now wholly acceptable to the armed forces. Special bombardier windows are now made for aircraft in bent laminated safety glass. A year ago, it was believed impossible to supply such windows in normal plate glass.

The widespread casualties resulting from glass blown from its frame by bomb explosions have emphasized the necessity for providing adequate protection against that hazard. Under most conditions, tempered plate glass and laminated safety plate glass afford the maximum protection obtainable. Wire glass gives reasonably good protection, but involves a hazard of serious injury from flying chips and particles when the debris is being cleaned up. There are different materials on the market which will afford a degree of protection from flying glass, dependent upon the thickness of the film applied to the glass, its adhesion to the glass, and the tenacity of the film itself. It is impossible to evaluate any of these materials, and any such evaluation probably will not be accomplished. Suffice it to say that ordinarily the thickness of films should be materially greater than a single coat, and should approach very close to .030 inches.



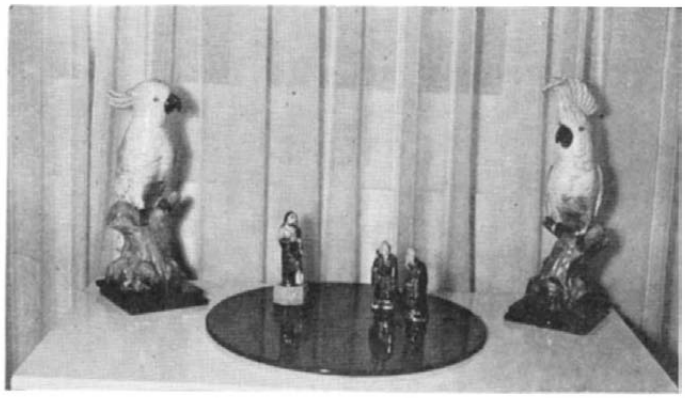
The walls of this modern bathroom are of Carrara glass, the door of the shower stall of Herculite tempered plate glass

New and suitable applications for glass products are being sought, and some more recently uncovered are quite unusual. A notable application is a glass vault; an attempt is also being made to construct caskets entirely of glass. Several glass or glass-lined bathtubs have been built in various parts of the country. Principally these have been made of tempered plate glass, and it is proposed that the burial vaults be of the same material. Self-supporting glass shelves, requiring only a few screws to hold them in place, are an immediate possibility. Tempered plate glass mirrors are available in essentially the same forms as normal glass mirrors, and with the further advantage that there will be no hazard of flying glass resulting from bomb explosions. Recently, the adaptation of mirrors to the exterior of strategic buildings, as an effective means of camouflage, has been suggested, but whether or not its value is sufficient has not been determined. Invisible or non-reflecting glass in large areas is still a dream of the future, but treated glasses affording these characteristics, on small areas, especially in optical instruments, are gradually becoming available.

Tempered plate glass kick-plates on doors have been found to be satisfactory. They are obtainable either as enamelled tempered glass or as the clear or sand-blasted product.

Numerous everyday uses of glass offer themselves for consideration. In many instances only the fringes of the realm of possibility have been explored. Wider use of Nucite chalkboard in school rooms in increasing volume is possible, while applications of mirrors in homes has by no means approached a saturation point. Many people will recall having seen a considerable display of corrugated glass washboards. It seems entirely likely that the field for this item can again be exploited to a large degree.

One interesting application of tem-



Carrara glass plaques make attractive centerpieces or appropriate bases for small objects

pered glass louvres may be found in the cooling towers of ice factories, breweries, and many other industrial works where water must be cooled by atmospheric evaporation. At least one such tower has been erected in western New York and serves as an outstanding landmark and advertising means for a prominent ice company in that territory.

The tanning industry is another field that offers wide possibilities for the use of polished plate glass, in the form of slabs for "tacking" hides, a process used in virtually every tannery throughout the country. Glass has only just begun to invade this industry, and the potentialities appear enormous.

EVEN though there has been a very definite curtailment of private building construction, still there should be available many opportunities for the distribution of glass plates as the lintels of windows, especially in kitchens and other places where various utensils are habitually placed on the window sill. The potentially large volume of business in the use of tempered plate-glass dresser tops for kitchen cabinets and other household equipment of a similar character should not be overlooked. Desks in children's nurseries may be protected against damage to the writing surface by a tempered glass cover. A piece of tempered flesh-tinted glass brings out beautifully the grain of a mahogany or oak desk.

In this enlightened age there are many homes heated with more or less unsightly steam or hot water radiators. The tops of these radiators offer an outlet for structural glass shelves. Inking plates on printing presses; glass covers on end tables to prevent unsightly rings caused by the overflowing cup; window ventilators; wind screens on porches; and cigarette or cocktail trays, all offer potential or present markets. Tracing tables in drafting rooms, mantel mirrors in the living room, direction signs, air-raid protective glazing, and crane cab windows, are a few suggestions for expanded use of glass, already tried and found satisfactory.

In this day of rationing, kitchen reminders comprising a mirror and a sandblasted section upon which the desired items may be noted, appeal to the housewife. Blocks of Nucite are suitable materials as knife sharpeners. Glass fire screens serve all the purposes of the now unobtainable wire or bronze screens, and the support may be made of hard wood blocks. Of course, these screens should be tempered plate glass.

Glass blocks merit careful consideration as a means for expanding sales. The utility of the small glass block banks as repositories for accumulating funds for the purchase of war bonds and war savings stamps should not be overlooked. Glass blocks definitely offer a means for satisfactory glazing without having recourse to any of the types of sash commonly used in the past, and no strategic materials need be consumed. Glass surface plates for use in machine shops and tool rooms will afford surfaces more than comparable in accuracy with the metal plates previously used.

Recently a man suggested an aerial glass fort, consisting of a huge star-shaped glass parachute with smaller star-shaped glass parachutes suspended from each corner of the larger one, and again still smaller glass forts suspended from each corner of the smaller parachutes. He proposed to tow this thing up into the air with airplanes or other similar tractor means, and then depend upon the wide expanse of the glass parachute to offset the effect of gravity and maintain the fort suspended in the air. Another chap has suggested the coating of the exterior of submarines with mirrors so that when they came to the surface, one would see the reflection of the waves rather than the contour of the submarine proper. It might work, you know, but is highly problematical! The suggestion of camouflaging buildings with mirrors probably falls into the same general category as this last proposal.

THERE seems to be a definite possibility that large glass plates may be used as wholly satisfactory reinforcing means in concrete structures in lieu of the previously employed steel rod, which is now unavailable. One advantage of this material would be the reduction in the total weight of a given beam to carry a given load, since the density of the glass and that of the concrete which it displaces are about the same. Some reduction in thermal stresses should also result, since the coefficients of expansion of the two materials are very nearly alike. It is an idea which will bear considerable inspection and development work.

Another outlet of potentially great volume would be the lining of various types of chutes with glass plates, either

One of the first glass altars ever installed

shaped or in the flat form. Heretofore the cost of glass in comparison with other materials has precluded its use, but in view of the fact that problems of rusting, and the consequent speeding up of abrasion, will be eliminated, it is probable that glass will show a life comparable to steel and other materials which will more than justify the extra cost. The use of glass for the surrounding casing on various types of household furnaces, is another idea being studied.

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GLASS WALLS

Now Available in Portable Form

A WAR-INSPIRED improvement in partition construction, which uses only wood and glass, is facilitating the quick subdivision of existing homes and offices to permit their additional occupancy and more efficient use. The

Frame, A; moldings, B and C; wedges D

improvement, announced by the Owens-Illinois Glass Company, is a packaged glass-block interior wall, consisting of prefabricated wood strips and Insulux glass blocks. Demountable at will, all materials in the wall are salvageable for use in remounting the wall elsewhere, or in different dimensions. The blocks are eight and twelve inches square and four inches thick, set in the wall on edge. The wood strips are ridged on their sides so as to groove into the corrugated edges of the glass blocks. The strips are profiled so as to interlock with each other.

The whole wall, once put up, then is locked up with coupled wood wedges around the sides and top.

With this development, houses need no longer be constructed with permanent interior walls. A house with only its outer walls can be considered ready

Setting up a portable glass wall

for occupancy. Its occupants can move in with their portable walls as a part of their belongings. The layout of the rooms then becomes a part of the decorative design of the new occupants. Each year—or at will—the room arrangement can be changed.

In the case of a war factory needing additional administration offices, walls so readily constructed or moved, and furnishing all the inherent light-transmitting properties of glass, plus privacy, to the otherwise darkened interior of the plant, are indispensable. where additional employees are crowded into an established office, rooms can be subdivided in much the same way that rooms in homes are added to accommodate war workers.

GRAIN PESTS

Insects Require Intensive Control Measures

THE shortage of storage space for a large part of the tremendous grain crop is resulting in use of many makeshift temporary structures, which accentuates the problem of insect control, cereal pests in flour mills, warehouses, and other storage places normally costing the nation nearly a third of a billion dollars annually.

Examinations in Oklahoma, for instance, made over 23 widely scattered counties, show that an average of 42 percent of all stored wheat in past years was infested with some form of harmful insect.

In most grain storage structures, contact sprays, when properly applied, reduce the number of necessary fumigations. Contact spraying is helpful in freeing both regular and makeshift structures from insects before the grain is put in for storage.

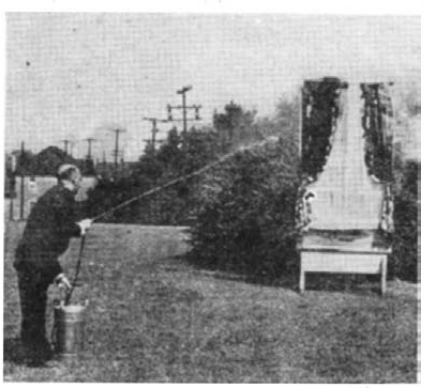
These contact sprays usually consist of a specially refined odorless petroleum oil, which acts as a carrier and solvent for toxic materials that are deadly to insects. While pyrethrum is the toxic ingredient in many sprays, it is now being supplemented by a synthetic compound derived from castor oil and known as isobutyl undecylenamide or by the more pronounceable name of IN-930. Du Pont chemists, who developed this compound, say it is replacing a substantial portion of pyrethrins previously required for an active base, and is not only more efficient but is more stable and easier to standardize.

OCD EXTINGUISHERS

Now Being Turned Out By Thousands From Many Factories

THOUSANDS of new fire extinguishers to be used by OCD workers in fighting incendiary bombs and fires started by bombings are now coming from factories in the east, the middle-west, and the west. It was recently announced by Underwriters' Laboratories, Inc., after completing an inspection of the production at many of the twenty-odd factories where the extinguishers are being made, that test equipment and inspection programs have been set up at most of the plants. The Laboratories will test the extinguishers and label those that meet the specifications.

The extinguisher type decided upon, and now in production, uses water—the best all 'round and most plentiful fire extinguishing medium. The device consists of an iron tank which is galvanized to prevent it from rusting.



The new OCD fire extinguisher being tested on a simulated building fire

The tank holds four gallons of water. In the tank is installed a hand pump to which is connected a ten-foot length of hose with a nozzle on the end equipped with a deflector so that a solid stream or a spray may be had.

The essential difference between the new OCD type of water extinguisher and the type which has been used by fire departments for many years is that

Next to the Stars and Stripes . . .

AS PROUD A FLAG AS INDUSTRY CAN FLY

Signifying 90 Percent or More Employee Participation in the Pay-Roll Savings Plan

IT doesn't go into the smoke of battle, but wherever you see this flag you know that it spells Victory for our boys on the fighting fronts. To everyone, it means that the firm which flies it has attained 90 percent or more employee participation in the Pay-Roll Savings Plan . . . that their employees are turning a part of their earnings into tanks and planes and guns *regularly,* every pay day, through the systematic purchase of U. S. War Bonds.

You don't need to be engaged in war production activity to fly this flag. Any patriotic firm can qualify and make a vital contribution to Victory by making the Pay-Roll Savings Plan available to its employees, and by securing 90 percent or more employee participation. Then notify your State Defense Savings Staff Administrator that you have reached the goal. He will tell you how you may obtain your flag.

If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

Make Every Pay Day "Bond Day"

U. S. WAR Bonds ★ Stamps

This Space is a Contribution to Victory by SCIENTIFIC AMERICAN

the former is made almost entirely of non-strategic materials.

The pump of the OCD extinguisher, instead of being made of brass, is made of steel tubes coated inside and out with porcelain—a radical departure from previous construction. The piston, piston rings, stuffing box, and valves of the pump are made of plastics. Glass marbles serve as valve balls. Such parts were formerly made of brass.

The ten-foot length of hose attached to the pump is made entirely of reclaimed rubber, no crude rubber at all being used for this part. The nozzle on the end of the hose is of plastic which will withstand hard abuse without breaking.

The extinguishers have been designed with a tapered tank so that they may be "nested" to conserve space in being shipped to the various parts of the country where they will be used. They will be shipped disassembled, to be assembled at their destinations by the OCD personnel to whom they are assigned.

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LINGUISTICS—There are more than a thousand distinct languages now spoken on earth, without considering fairly diverse dialects.

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LOW-GRADE ORE

Being Utilized by Means of Chemical Balloons

CHEMICAL "balloons" are now lifting, from low-grade minerals which were once disregarded, quantities of vital copper, zinc, lead, nickel, tungsten, chromium, and other strategic metals for military production, according to E. I. du Pont de Nemours & Company.

Working of low-grade deposits formerly thought of little value is made possible by so-called froth flotation. Chemicals with an affinity for the grains of ore lift them in a bath from the worthless "gangue" or residues with which ores are associated in the earth.

Copper and zinc for shells; lead for bullets; copper for wire in motors, communication, and power lines; vanadium; nickel; tungsten and molybdenum for special steels; manganese; chromium; and a host of other vital metals are now obtained by froth flotation.

Flotation agents have been used for many years, but new chemicals developed in recent years have improved the practical and economical recovery of ores from low-grade mineral deposits. In mining camps of the United Nations enormous loads of low-grade ore ground in water flow daily into boxes, called cells. Minute amounts of chemicals are mixed with the ore.

The chemicals attach themselves selectively to the grains of the valuable minerals, and air bubbles lift them to the surface. Then the precious minerals are scraped or skimmed off the surface. Subsequent smelting and refining give important metals that go into implements of war.

SCABBARD

For Bayonets, Is Made of Plastic

A NEW bayonet scabbard made of Tenite, a tough plastic material produced from cellulose acetate butyrate,

Light-weight scabbard of plastic

is now being issued to United States troops throughout the world. This scabbard is exceptionally light in weight, as compared with the ordinary type constructed principally of wood and leather, yet is strong and durable. It is particularly satisfactory for hard service in all climates.

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RUBBER—If automobile and truck owners of the United States were to turn in an average of one worn-out, discarded tire each, a 435,000-ton supply of rubber scrap would be provided.

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ANTI-FREEZE

Boils at High Temperature, Prevents Rust

AFTER having been proved in use over a test period, a new radiator anti-freeze, known as No-Freeze, has been placed on the market. It protects cooling systems against freezing down to 35 degrees below zero and has a boiling point of 324 degrees, Fahrenheit. Made of non-critical materials, it is stated that No-Freeze does not contain inorganic salts and will prevent rust in an engine cooling system.

ELECTRON MICROSCOPE

Progress Report Reveals New Horizons

THAT the electron microscope is playing an ever-increasing role in the war effort, is found in a recent announcement that 43 of the RCA instruments are now in use where they will be of greatest service in bacteriology, chemistry, and metallurgy. Seven of these instruments are installed in England. Scientists of RCA Laboratories, in reporting on their electron microscopes' performance to date, list the following 12 outstanding discoveries and accomplishments:

Photographing of influenza virus.

A considerable amount of secret work is being done on the development of polymers as applied to plastics and especially to artificial rubber.

New light has been thrown on the texture of textile fibers which may lead to better and longer-life tires, also longer-wearing, warmer clothes.

Study of bacteriophage virus and its destructive effect on bacteria.

Finding of unusual and unclassified crystal growths which the light microscope has been unable to resolve. Since the microscope is able to focus to a great depth even at low magnification, it is possible to study crystal structures which could not be resolved heretofore.

The study of surface structure of metals by the replica method, resolving detail unexplored by the light microscope.

Stereoscopic micrographs are made possible by the extremely high resolution and depth of focus of the electron microscopes, producing images with third dimensions.

Through the high resolving power and large depth of focus of the instrument, accurate calibration of magnification is possible, so that particle size and distribution can be determined.

Photographing of plant virus, such as the tobacco mosaic virus, and the study of anti-serum in the control of these viruses.

Discovery of the fact that virus particles have internal structures as found in the vaccinia virus.

Recording of the action of germicidal agents on individual bacteria.

Adaptation of the electron microscope to production control is becoming increasingly important. For example, control of production of paint

pigments by the use of the electron microscope has resulted in a great improvement in pigments of all types from paints to inks.

CERAMICS

Take on Added Duties in War-Time

A SCIENTIFIC industry as ancient as man yet as modern as today is coming into its own—and may yet prove to be one of the saviors of the American standard of living in this day when nothing short of an A-1 priority can buy even a tin can—according to one of its foremost Chicago exponents, Dr. H. G. Fisk, mineral technologist at the Armour Research Foundation. The industry is that of ceramics, which began as an art rather than a science centuries ago when primitive man first formed crude utensils from the clay found near his aboriginal home. Dr. Fisk states:

The ceramics of today is a far cry from those early clay dishes. Even before war took metals out of circulation, ceramic raw materials were involved in 70 percent of all industrial chemistry operations; they were fundamentally basic in the processing of most metals and an integral part of such sciences as radio and electrical engineering.

Since Pearl Harbor imposed rationing upon the American scene, however, ceramics is daily becoming more important than ever and is well on its way toward a degree of importance it has not known since the advent of the metal age.

Modern ceramics, too, is a far wider science than mere clay modeling. In its broadest sense, it involves practically all non-metallic minerals.

And that is the basis for its special importance in war-time, for non-metallic minerals along with plastics are the only answer to the plaguing question of replacing metals needed in war production.

Silicate products—principally glass—are the basis for a large portion of ceramic articles—glass for window panes as well as the precision mirrors and lenses of modern optical instruments, glass made into dishes said to rival fine eastern china in beauty. And now, glass is being put into use once again for food containers, for shipping oil and other fuels. And modern improvements in annealing are making it practical.

Glass insulation was successful even before the war—but war's stimulus makes it almost a "must." Glass wool, for example, used in insulating a battleship, cuts down the weight by some 50 tons, and it is fireproof and vermin-proof.

Another new use for glass is in marking airports and military highways. Tiny glass beads imbedded in the surface of markers reflect even a weak light into a guide for fliers or caravans.

A second common and fundamental ceramic product is enamel, which today is experiencing a come-back as a replacement for aluminum. Aluminum once replaced enamel in the manufacture of kitchen utensils, hospital instruments, and other common containers, and gained immediate popularity because of its greater lightness. Today's superior enamels, however, placed over a stronger and thinner base metal, rival even aluminum.

Enamel has also been introduced as a lining for water and steam pipes and hot-water heaters since copper has joined the list of vital metals. And enamels are even used on bricks and other construction materials to aid in withstanding the elements.

Another fundamental use of ceramic products is for abrasives. The present day machine gun, for example, requires 32 different grinding operations before it acquires the precision for fir-

ing against the enemy. And the abrasive wheels used in those grindings are the modern descendants of the old grindstone—made to run at speeds at which the latter instrument would have flown into a thousand pieces.

Made from fused alumina, formed from bauxite deposits too poor in quality for extraction of pure aluminum, the modern abrasives are hard enough to grind the finest steels to precise measurements. Other abrasives still harder are made of tungsten carbide and boron carbide.

Corundum—either synthetic or natural—is also used for sapphire jewels in precision bearings for time bombs and split-second airplane instruments.

Other ceramic products vital in today's industry are magnesium oxide and similar products used for refractories in steel and oil industries; graphite used for molds in metal castings; asbestos for insulation, shingles, and heat-proof suits and gloves; quartz in radio manufacture; kyanite for refractories and, recently, low-grade topaz found in the United States, now used as a substitute for kyanite, formerly imported from India; pigments for paints; quartz sand used in sandblasting; and various and sundry types of bricks used for construction to replace lumber.

Many of these products were vital long before war created unusual circumstances. But all of them have taken on unusual significance during recent months and will become more important as long as the war lasts, in the opinion of Dr. Fisk.

PENCIL DRAWINGS

Made on New Board

Can be Blueprinted

COMPLETELY satisfactory blue prints can be made from pencil drawings provided the drawings are made on a surface which permits the drawing of hard, clean lines. Such a surface, applicable to any drawing board, has recently been developed by the W. H. Long Company. The surface, called the No-Ink Top, is a specially processed white composition ⅛ of an inch thick, which is to be permanently glued to the drawing board. Drafting tape is used in place of thumb tacks to hold the drawing in position and a 3H or harder pencil is used.

The resiliency of the surface allows the drawing paper to be indented under pressure of the pencil. All lines are drawn with a double stroke, the result being that the shallow indentation made by the first stroke is filled solidly with lead on the back stroke. Thus is produced an opaque, evenly-edged line which is virtually as clean cut as an inked line.

Although the surface of this new drawing board top yields to pressure of the pencil, all indentations disappear immediately; even needle holes made by the compass close up and disappear.

SHOP GLAMOR

Preserved by Design

of Welding Clothes

THE PROBLEM of how a woman can carry on a welding job safely and still look feminine has been solved by new-

For the form divine

ly designed tailored leather garments, of the type shown in one of our illustrations. Said to be the first clothing of its kind to be shaped to women's curves, this new safety clothing was designed by American Optical Company engineers to protect against dangerous flying sparks generated during the welding operation. The tailored leather garments, plus leather gauntlets and cap, welding helmet and safety goggles—not to mention lipstick—complete the protective ensemble.

FIREPROOFING

New Plaster Will

Withstand Bomb Fire

TYPICAL uses of a new fireproofing plaster are protection against incendiary bombs, prevention of the upward spread of fire in a basement, fireproofing rooms, and so on. This plaster, made by the Paprex Company, is applied directly to wood, concrete, metal, glass, and standard plaster surfaces to a thickness of ⅜ inch. It dries in about four days, after which time it will withstand direct exposure to a blow-torch flame at 2200 degrees, Fahrenheit, for 20 minutes.

Having a consistency of tacky dough when dissolved in water, this new plaster is made from non-critical domestic materials.

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STREETS—Street costs in American cities have been going down since 1930, analysis of reports of cities with 100,000 or more population discloses. In 1930 a total of $139,323,000 was spent on streets by the cities in the 100,000 group, which amounted to 8 percent of total expenditures. In 1939 street expenditures by the cities had dropped to $116,444,000, a decline of 16 percent.

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PRIMITIVE NAVIGATION

Methods Relied Upon

by Solomon Islanders

NATIVES of the Solomon Islands use "spiritual aids to navigation," according to an exhibition in the department of anthropology at Field Museum of Natural History, Chicago.

Radio direction finders, periscopes, and other modern aids to aviation and navigation are commonplace in the Solomon area since the navies and air forces of the United States and Japan have come into conflict with each other there. However, the primitive natives of the region, who make long voyages in their large war and trading canoes, place their faith in grotesquely carved wooden figures in semi-human form. These are placed on the bow of a canoe, just above the water line, in a position in which they seem to peer down into and through the water with vigilant eyes that never blink from fatigue. The Solomon Islanders regard these images as representatives of a protecting deity, a spirit which is supposed to watch for reefs, rocks, and all other hidden dangers of the sea, and to guide the vessel away from such perils.

The natives place the same confidence in these inanimate lookouts that we place in living seamen, especially trained to watch and listen from forepeaks and crow's-nests, aided by the most up-to-date mechanical devices to locate the approach of danger.

INVISIBLE RAYS

Make War Maps, Charts,

Instruments Visible

COMPLEX maps and ocean navigation charts which can be read in total darkness and military control panels

lighted by invisible rays are now practical for war use through the development of a new group of ultra-violet (black light) sources, according to E. W. Beggs, Westinghouse lighting engineer.

All of the new fluorescent type of black-light devices, ranging from a walnut-sized bulb to a four-foot glass tube, use a newly discovered chemical coating which transforms short wave ultra-violet into near ultra-violet or black light. "Black light is fast becoming an effective war weapon for the nation's fighting forces," Mr. Beggs says. "Already it is making it possible for American pilots to illuminate fluorescent glowing instrument dials in the darkness without glare which would impair the pilot's ability to see out into night. Even the feeble glow of the instrument panel can be dimmed or instantly extinguished at the turn of a switch."

Trail-blazing with fluorescent powders or paints is another one of the important new possible uses for black light, the engineer said. By this method, markings left on trees, stones, and bushes remain invisible until picked out in the darkness by ultra-violet spotlights.

Maps which must be read under blackout conditions either on land or sea can actually be made to light up in the dark in several different colors for different types of information, Mr. Beggs explained, in describing the most effective light sources required to activate fluorescent and phosphorescent materials. Charts coated with phosphorescent chemicals act like storage batteries of light, absorbing a quantity of illumination in less than a minute and then releasing it in the dark over a period of several hours.

"Both fluorescent materials, which light up only while irradiated by invisible ultra-violet, and phosphorescent coatings will have unlimited applications in civilian as well as military activities. New and efficient black-light lamps ranging up to four feet in length and resembling fluorescent lamps in appearance have been developed for practical use by applying a chemical coating to the glass walls of the tube," the Westinghouse engineer pointed out.

"Such units are now ready for the production aisles of war plants, the control rooms of power stations and ships and other places where complete blackout might cause dangerous confusion. The black-light lamps would light up fluorescent paint or machinery, power switches, doors and stairways and even create paths of soft illumination across the floor. The same effect can be attained without ultra-violet by using regular lighting and phosphorescent material, although this illumination is not controllable and is limited to a definite period of time," Mr. Beggs explained.

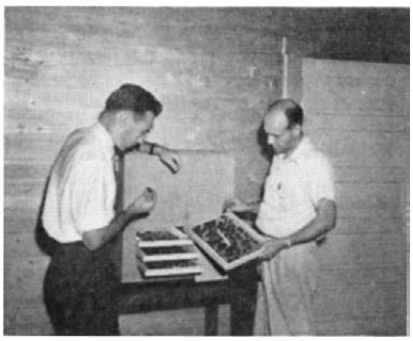
The most effective light sources for charging up phosphor chemicals as well as fluorescent coatings are mercury vapor and fluorescent lamps, Mr. Beggs' research has revealed, although ordinary incandescent lamps and argon glow bulbs are also used. Black-light is obtained from these sources by using either a purple filter or chemical coating to sift out visible light. Phosphorescent paints charged up with mercury vapor or fluorescent lamps have high initial brightness.

HOME DEHYDRATION

Offers New Possibilities For Food Preservation

INTEREST in the dehydration method of preserving fruits and vegetables in the home has been greatly stimulated by the prospect of a long war. When fruits and vegetables are dehydrated, their bulk is greatly reduced

and a far larger quantity may be preserved per jar. Then, too, dehydrated products can be preserved quite satisfactorily in other types of containers than the conventional "fruit jars." Cel-



The dehydrating trays

lophane-lined paper bags or old tin coffee cans which may be available offer adequate protection.

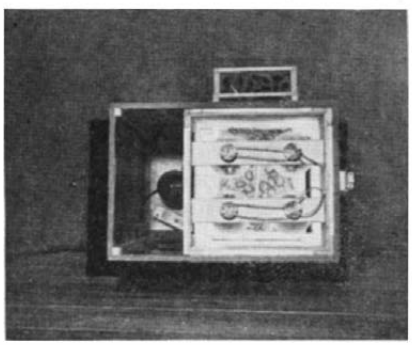
Working with General Electric engineer Howard Haynes, Drs. Donald Comin and Alvin C. Wolfe, of the Ohio Agricultural Experimental Station, have developed a new infra-red dryer that cuts drying time almost in half and in so doing produces a much more acceptable product. When drying time is shortened, these workers state, the taste quality of the dehydrated product more closely approximates that of the fresh fruit or vegetable and its nutritive value is quite likely to be higher. However, there is a limit to the rate at which moisture can be effectively removed in the drying process. If it's done too rapidly, the outside of the product dries faster than the center, hardens, and thus materially retards dehydration.

In the cabinet of the new dryer are four drying trays placed one below the other. Above the top tray there are four 240-watt reflector drying lamps. The top tray is heated by the radiant energy from the lamps, the lower three trays by warm air circulation. To maintain uniformity of product, tray positions are changed every 15 or 20 minutes, the top tray going to the bottom, the others moving up one notch. A small household-type electric fan is used to further induce rapid drying; an opening at the top of the cabinet permits the moist air to escape. The relative humidity inside is kept below 65 and temperatures of 140 to 150 degrees are maintained.

Such a dryer is simple and inexpensive to construct. The cabinet may be built from any good insulating material such as half-inch Celotex. It can be conveniently placed on a kitchen table and plugged in to the nearest electrical outlet.

Another home-type dehydrator has been constructed by Orrin Hale of Seattle, publisher of *Northwest Gardens and Homes* magazine. Hale's dehydrator is built of four plywood panels forming the walls and door. These were reinforced at the edges by pine boards. Before staining, the designer gave the entire exterior of the cabinet two coats of Rez, synthetic resin sealer, which penetrated the pores of the plywood to prevent warping, the bugbear of such wooden cabinets, because they contain ideal ingredients for such a condition—large amounts of moisture and heat.

Heat is furnished by a large-size electric element in the bottom of the cabinet, controlled by a thermostat.



Looking down on home dehydrator

An electric fan blows hot air over the contents of the dehydrator and keeps the air circulating. To allow passage of air, the trays are three inches shorter than the cabinet, and are placed alternately to the front and back for better ventilation. Trays are four inches apart, are made of pine wood frames with galvanized screen on which fruit and vegetables are laid.

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MILEAGE—The 32,065 members of the National Rural Letter Carriers Association consume approximately 140,000 gallons of gasoline every day in covering 1,400,000 miles. Frequent stopping and starting accounts for the low gas mileage.

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FULGURITES

Fallen Wire Produces Petrified Replica of Arc

LIGHTNING recently struck a power line near Wooster, Ohio, and the broken wire carrying 22,000 volts fell to the ground. Along 45 feet of the wire as it lay on the ground the brilliant bluish white flames of the electric arc played continually, flaring up more brightly with every lightning flash which produced powerful electric surges in the wire in addition to its own current.

After the storm, long masses of glassy solidified molten sand and rock were found along the ground where the wire had lain. They were shaped like a tree trunk with short side branches. Where the arc was fiercest the trunk was four inches in diameter and the branches more than an inch in diameter.

This unusual phenomenon was reported by Karl Ver Steeg, of the College of Wooster, in *Science*.

Lightning, when it strikes in dessert sand or on a beach, often leaves a fused and petrified replica of itself. These fulgurites are sometimes several feet in length, but seldom more than two inches in diameter. The one produced by the broken wire and the storm is therefore a record breaker, doubtless due to the fact that the arcing continued for nearly three hours, while a stroke of lightning lasts but a small fraction of a second.

Fulgurites, a few inches long, have also been produced in the laboratory by causing artificial lightning to strike into a bucket of sand, as has been described in these pages in the past.

SEALING LIQUID

Protects Concrete, Wood, Against Oil Infiltration

WHEN several coats of a new liquid material have been applied on a wood or concrete surface, that surface is protected against attack by oil or grease. This new sealing liquid, known as Carbo-Non-Solv, dries in two or three hours and is available in several colors. It is claimed to be inert to attack by petroleum products, manufactured solvents, organic and inorganic oils, and fatty acids.

RUST

Films Being Studied by Special Balance

ARMED with a new laboratory weapon, scientists are on the trail of an invisible saboteur that attacks machines and practically all metals, in peacetime as well as in war. This enemy is air, whose atoms of oxygen are constantly eating away metal surfaces. Each year these atoms cause more than $200,000,000 damage to bridges, steel buildings, and machine parts—the result of tarnish, rust, and corrosion.

To find out how oxygen combines with metals, and how fast, Dr. Earl A. Gulbransen, of the Westinghouse Research Laboratories, is actually weighing oxide films, or rust, with a tiny weighing machine so sensitive it measures billionths of an ounce.

"One thing we want to know in particular," the research chemist explains, "is just exactly what makes stainless

steel stainless. If we can uncover this secret, we may be able to find some simple way to give ordinary steel and other metals the same protection against oxygen in the air."

Dr. Gulbransen devised the special balance, and sealed it in a glass tube to take measurements on pieces of metals half the size of razor blades. Movements of the balance's pointer, so minute they can be observed only through a microscope, reveal the weight added to a tiny sample of steel by a single layer of invading oxygen atoms. One layer of atoms is about 10 billionths of an inch thick. It tips the scales at 15 billionths of an ounce.

"Our job of fighting rust is difficult," Dr. Gulbransen continues, "because we are combatting a process of nature. In extracting metals from their ores, we drive out the oxygen and other undesirable substances. Once they are purified, we try to keep oxygen from recombining with them. Tarnish, corrosion, and rust are evidence that metals don't like to be alone—would rather reunite with their former allies and slip back into the crude ores, or oxides, which are the most stable forms for them to exist in."

After the metal sample is placed on the balance, neither it nor the balance can be touched by the chemist during the experiment. The tube in which the balance is mounted is sealed and the air is removed by two vacuum pumps.

"Then the sample of steel must be cleaned," says Dr. Gulbransen, "although it was polished and washed three times in alcohol before it was placed in the tube. But even the brief contact with air while putting it in the tube was enough for the formation of several layers of oxide which must be removed.

"This final cleaning is done with hydrogen. A small amount of the gas is piped into the tube from a pressure tank. The hydrogen combines with the oxygen on the surface of the sample to form free water vapor, which can then be pumped out of the tube.

"The apparatus is then ready for the start of an experiment. A small amount of oxygen is admitted to the tube from another tank. The sample gets heavier, as the oxygen combines with the surface layers of the steel, swiftly at first and then slowly. Movement of the balance beam is watched through the microscope, and the changes in weight are recorded every few minutes."

The chemist can make his experiments at any temperature from 332 degrees above zero down to 292 degrees below. "Experiments at many temperatures are important," Dr. Gulbransen points out, "because air affects metals differently at different temperatures. Stainless steel, for example, does not remain stainless above 1000 degrees, Fahrenheit"

TUBE PACKING

Redesigned to Save Materials and Space

A NEW principle of packing radio tubes which, if utilized by the tube industry, will result in shipping space, material, handling and warehousing savings, has been developed by the manufacturers of RCA radio tubes. By adopting the new method, RCA alone is saving some 120 tons of packing material a year, and is able to ship approximately twice as many tubes in a boxcar or truck. To extend the value of the new packing principle more quickly, RCA has granted patent rights to the new type cartons to other tube manufacturers. In addition, other tube manufacturers have been shown factory routines that have been developed to make best use of the new process.

The new packing ideas were developed by Charles I. Elliott, a 27-year-old packing engineer who attacked the problem by consigning all existing packing containers to the scrapheap. Then he set about designing new type containers which would use the least possible amount of cardboard, now needed in the war effort and therefore strategically important, and that would make possible more efficient factory handling.

Mr. Elliott found that existing packing methods required the use of 210 separate pieces of packing material per 1000 tubes. Improvised handling methods were used in the factory where tubes travel from one assembly opera-

tion to another. A packing box of 22 parts, some of them no longer obtainable, was used to store and ship glass tubes.

When he had finished re-designing packing cases, Mr. Elliott found that he had reduced the 210 pieces of packing per 1000 tubes to 24 pieces. He discovered that a single one-piece, tray-like container, planned to hold the tubes safe within shipping cases, could also be used to save time in the various steps of the actual manufacturing processes themselves.

Standardization of tube packages is vitally important in wartime for many reasons. Spare radio tubes can be made to fit into spaces designed for them by the builders of planes, tanks, mobile units, ships and other fighting equipment, and the tube packages will fit the spaces, no matter from which factory they originated. This is a vital consideration with United States fighting equipment in action in many parts of the world.

In handling receiving tubes alone, savings of 30 percent in material were found to have been achieved by the new methods. Factory handling efficiency has been stepped up 20 percent, loss by breakage has been materially reduced, as has the need for storage space. It is now possible to pack 647,500 tubes of a given type into a single boxcar, an increase of nearly 100 percent in capacity.

BETTER CONCRETE

Made Possible By New Form Lining

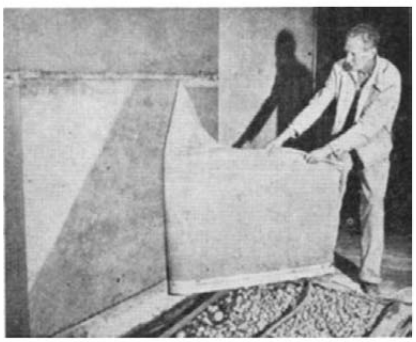
A NEW product which makes concrete several times more resistant to weather and abrasion in dams, fortifications, and construction projects of all types was announced recently by Dr. W. A. Gibbons, Director of Development, United States Rubber Company. The product is an absorptive lining for forms in which concrete is poured and is known as Hydron. By removing water and air bubbles from the surface of concrete, Hydron produces a concrete that will last longer and will have a smoother and more pleasing finish without brushing or scraping.

In one test, samples of concrete were held within two inches of an air blast delivering sharp steel grit at twenty pounds air pressure, Dr. Gibbons stated. With concrete cast against ordinary wood forms the blast dug a hole one quarter inch deep in one minute. With concrete cast against Hydron the particles bounced off the case-hardened surface leaving a barely perceptible mark.

In weathering tests where samples

were repeatedly frozen and thawed, samples of concrete cast against Hydron withstood four times as many cycles as samples cast against wood.

Hydron form linings consist of an absorptive material faced with a fabric and are easily applied to the concrete forms by stapling. After the concrete



Absorptive lining improves concrete

has been cast the forms are removed and the fabric is easily peeled from the concrete, leaving a smooth surface that needs no brushing, scraping, or other refinishing operation.

OIL EXPLORATION

Methods Adopted for War Purposes

SOUND ranging to locate enemy artillery, listening devices to warn of the approach of aircraft and submarines, depth-sounding to determine the position of underwater objects, demolitions of land and sea mines by radio or acoustical impulses, position finding and navigating, terrain clearance determination for planes—these are only a few of the war-time applications of the science which has been so successful in finding oil fields.

Oil men, accustomed to think of geophysics as a specialized branch of oil exploration only, may be astonished to learn that this many-faceted science has dozens of uses in war.

Geophysics to the oil man is the science of mapping the dips and curves of geological formations many thousands of feet underground by the reflection or refraction of echoes from man-made earthquakes, by magnetic readings, electrical well logging, and many other means. Actually, the science of geophysics is one of the broadest, and concerns all of the physical phenomena in, and the transmission of energy through, the earth, the water and the air.

Meteorology is a branch of geophysics. So is radio. Both have their manifold added values in war time. But even the special tools of the exploration geophysicist, who in peace time searches out oil fields, assume extra importance in war.

MISCELLANY

Seismic (earthquake) phenomena are used to make foundation tests and locate construction materials for land fortifications, shelters, gun emplacements, harbor installations, and air bases, highways, railroads, bridges, canals, and tunnels. Instruments measuring magnetic phenomena regularly are sent out over artillery practice ranges to determine the location of buried shells and munition dumps.

Oil and other mineral resources also take on augmented value in a national emergency, and accelerate the long-time application of geophysical exploration methods in the search for them. Even water supply and control can be aided by electrical, seismic, and well-logging methods to find water-bearing strata, make contamination surveys, test water wells, and make surveys for irrigation, drainage, flood control, and power projects.

Strategic and critical minerals such as aluminum, antimony, chrome, manganese, mercury, nickel, tin, and tungsten also can be sometimes located by geophysical methods, but exploration is much more difficult as a rule than in searching for potential oil-bearing structures.

CONDUIT

Has Plastic Covering to Replace Rubber

FOR use in planes, tanks, and boats to protect electric wiring from gasoline and oil, there has been developed a plastic-covered metal conduit which not only is replacing rubber for such service but is adding an advantage of weight reduction.

The plastic skin over the flexible metal conduit in Amerflex, as the new product is called, protects not only the conduit itself, but also the wires inside against wear, abrasion, heat, and most solvents.

This new plastic-covered conduit is available in types which do not become brittle at sub-zero temperatures and which have high dielectric and high tensile strengths.

TRANSPARENT CLOCK

Has Glass Dial, Hands Appear to Float

THE HANDS of the clock shown in one of our illustrations seem to float mysteriously in mid-air; their means of support is not apparent. The hands are mounted on two separate glass disks framed in metal rings, on the outer edges of which are teeth that engage with rotating gears hidden within the base of the clock. In front

of and behind the rotating glass disks are two other glass circles, the front one of which carries the hour graduations.

Clocks of this sort, made by Etalage Reclame Corporation, can be used as date reminders, by placing a suitably marked white card against the back,

As through a clock, clearly

or as timing devices in conjunction with photoelectric cells. For the latter purpose, parts of the rotating glass disks can be blacked out as necessary to achieve the timing effect desired.

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WOODPECKERS—Fence posts treated with zinc chloride not only outlast untreated posts from three to ten times, protecting them from premature decay and termite attack, but seem to discourage woodpeckers as well. In recent experiments at Clemson College, South Carolina, several untreated posts showed considerable damage by woodpackers, while treated posts did not.

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BLACK COSMETIC

With Good Adhesion, For Commandos

ACTIVITIES of Commando troops during night raids have prompted a British trade journal to suggest that the cosmetic industry might find a new outlet for its products through the development of a black face cream for use by these troops.

Such a cream, it is pointed out, should be easily applied and non-irritating. It must be capable of application to the eyelids without harmful effects, and must stay on the skin in the presence of excessive perspiration.

INSECT PESTS

Do Damage Running into Billions

MAN-MADE barriers are no barriers to insects and political boundary lines are easily crossed by crop pests, Dr. P. N. Annand, Chief of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, said in an address prepared for the Second Inter-American Conference of Agriculture recently held in Mexico City. Because of this fact, he said, pests native to one country have often become serious problems in widely separated nations.

Dr. Annand cited the series of insects introduced from abroad to the countries of the Western Hemisphere. A coordinated effort can do much to control these pests, he said, mentioning the cotton leaf worm which lives continuously in the American tropics and annually moves northward and southward into the temperate zones to seriously damage cotton.

He also commented on the rapid developments in the co-operation between the Americas and commended the co-operation between the United States and Mexico as exemplified by the establishment of a laboratory in Mexico City to study fruitflies. Government co-operation between Mexico and this country on the control of Pink Boll-worm started in 1927 and has continued and grown to the present date.

Dr. Annand pointed out that there are probably more than six million kinds of insects in the world, and 13 of these in five or more American Republics annually cost the people over $6,000,000. This is but a fraction of the total cost of insects, as in the United States alone insect damage and control costs over $2,000,000,000 annually. International surveys in locating important pests would be of great value, he said.

Dr. Annand expressed the hope that the Conference in Mexico City might be the forerunner of a series of Pan-American conferences that would do much to solve the common problems of all American entomologists.

HIGHWAY RULES

Safety Depends on Proper Use of the Eyes

BECAUSE more than 90 percent of the judgments and actions of automobile drivers are guided by their eyes, the Better Vision Institute sets down the following 10 rules for highway safety:

1. Keep the windshield clean. A dirty windshield will cut down vision 50 per cent, or more.

2. Keep your eyes on the road. A car traveling 40 miles an hour goes nearly 60 feet in a second.

3. Wear glasses if necessary. If your eyes were good 20 years ago when you first took out a driver's license, don't take it for granted that

they are as sharp as ever. You wouldn't run a car for years without a tune-up, or checking up on the brakes.

4. If you have driven a long distance and are tired, don't take a drink of alcoholic liquor to "brace you up" to finish the trip. When you are tired, liquor may quickly make you wobbly-eyed and blunt your sight.

5. Don't drive fast at night after leaving a brightly lighted room. It takes the eyes 10 or 15 minutes to become accustomed to night driving.

6. Dim your headlights at night when passing another car, and drive slowly after passing, for your car travels a considerable distance while your eyes are recovering from the glare of headlights.

7. If you have eyes that see well only at 30 miles an hour, don't drive faster. Know your visual capacities.

8. There are more accidents during twilight than other periods of the day. For most eyes seeing conditions are difficult during twilight and extra caution should be exercised.

9. Know your own eyesight limitations. If you have a dominant right eye that does most of your seeing, the left mudguard may easily be sideswiped. If you have poor side vision, which is not uncommon, you may not see a car approaching an intersection before it is upon you.

10. If you are blinded by headlights in night driving, don't wear sunglasses to cut down the glare, for they also reduce your vision and may make you almost as "blind at a bat."

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COLORS—Military flares, rockets, tracer bullets, and so on, owe their bright crimson color to strontium which comes from celestite, mined in the United States and to some extent in Mexico.

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TEXTILE OUTPUT

Sets New Record, Will Continue to Increase

THE cotton textile industry of this country produced in 1941 more than 10½ billion linear yards of cotton fabrics, surpassing all previous records, according to a survey made by WPB and OPA to obtain data for planning the Government's war textile program.

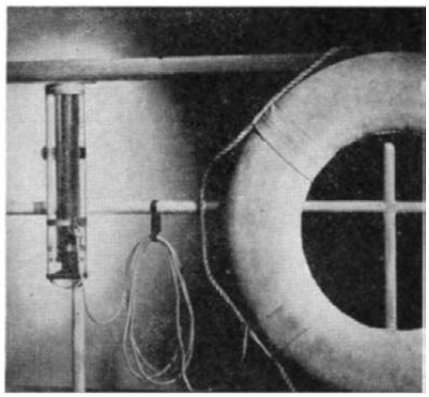
Even though the 1941 production represented a 25 percent increase over 1939 production, 1942 production will be even larger than that of 1941. WPB found it necessary, in view of steadily increasing military and civilian requirements, to plan for an estimated 12 billion linear yard output in 1942.

The reason for increasing military requirements is, of course, the steadily increasing size of our armed forces. The reason for increasing civilian requirements is the fact that cotton textiles are being called on to replace in civilian products the silk, nylon, and wool fabrics now being diverted to the armed services, and the further fact that a substantial part of textile production is being diverted to the manufacture of bagging and twine which were formerly supplied by burlap and imported cordage fibers.

WATER LIGHT

Of New Type, Contributes to Life-Saving at Sea

ADDED protection for crews of coast guard and merchant marine vessels involved in submarine attacks is afforded by a new plastic-housed electric



It lights when cast adrift

water light attached to life preservers and life rafts. Upon hitting the water, a weighted base turns the light upright, automatically illuminating it. The light will burn continually for 10 hours or longer, indicating to rescue craft the position of drifting seamen.

Use of "Lucite" methyl methacrylate plastic has reduced the weight to one-fifth that of the usual water light. The housing weighs about 19 ounces, the entire light just over three pounds.

The tough plastic is water resistant, protecting the lamp and battery.

SPATTER PROOFING

Used in Arc Welding to Speed Up Work

WELDING spatter is prevented from adhering to metal surfaces if those surfaces are coated with a new material developed by Acme White Lead and Color Company. This material, which can be applied by brush, spray, or by wiping, conducts electricity, and, it is claimed, helps to prevent the arc from breaking. After welding is finished, the surface coating is removed by wiping, leaving the welded part ready for paint or other processes.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SURFACE FLAWS

Disclosed by New Liquid and Ultra-Violet Light

FOR the detection of surface defects in non-magnetic materials, a new fluorescent liquid has been developed. This liquid, which is used to cover the surface to be examined, glows under the influence of ultra-violet light to indicate the position and character of defects extending inward from the surface. The liquid, developed by Magnaflux Corporation, discloses flaws that are relatively deep compared with their width, and the indication can be interpreted as to type and extent. Scratches and minor surface irregularities are not shown.

PROTECTION

For Polished Surfaces Afforded by Removable Film

APPLIED by spray, brush, dip, or roller, a new material is available for protecting polished metal surfaces and ceramic parts. The material, produced by Ault and Wiborg Corporation, dries to a flexible, transparent film in from six to eight minutes at 200 degrees, Fahrenheit. Thus, coated parts can be inspected yet the film can easily be removed when necessary by peeling or blowing off with an air valve after one corner has been loosened. The removed material can be reused after it is again reduced to liquid form.

HEAT TREATING

Copper Plating is Restricted, is Easily Removed

IN the heat treating of steel parts it is often desired to harden local areas while other areas remain soft. This selective hardening is accurately controlled by copper plating and thus protecting those parts which are to remain soft.

To expedite such work the Michigan Chrome & Chemical Company has recently announced a lacquer which is to be applied to those parts of a steel piece that are to be hardened. Following the plating operation, during which no copper is deposited on the lacquered areas, the lacquer is removed and the heat treatment carried through. Thus it becomes unnecessary, as is done when the lacquer is not used, to grind the copper plate from areas that are to be hardened.

Another material, developed by Sulphur Products Company, is used in the same type of work. This chemical is designed for rapid removal of copper plating from the masked parts after the hardening operation has been completed. The plated part is merely immersed in a water solution of the chemical and then dipped into a solution of sodium cyanide. The copper plating, it is stated, is thus removed without injury to the plate.

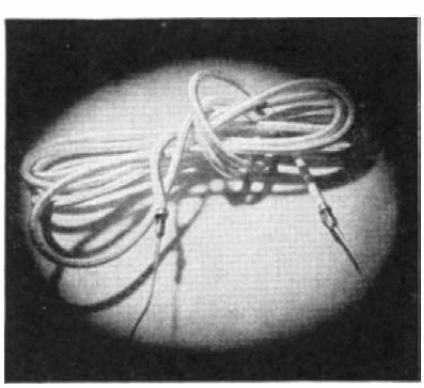
FLEXIBLE HEAT

Provided by Glass-Insulated Units

AVAILABLE in any length, by the inch, foot, or yard, a low-power flexible heating element now finds many uses particularly in limited space. Known as the Glasohm, and also used as a flexible power resistor, this is a product of Clarostat Mfg. Co., Inc.

In the Glasohm construction the resistance wire is wound on a fiber-glass core and is protected by a fiber-glass braided covering. The unit can be readily bent and compacted to fit snugly about parts to be heated, or jammed into tight spots, in either case providing an efficient heating means. Wattage ratings are from 1 to 4 watts per body inch depending on the application, and operating temperatures are up to 750° Fahrenheit.

Glasohm heating elements are now



Heat by the inch, foot, or yard

found in electric soldering irons, electric pencils, curling irons, water immersion heaters, and other low-power appliances. Also in temperature-control ovens for oscillating radio crystals, the heating of aviation and marine instruments, localized heat for chemical apparatus and laboratory equipment, and similar applications.

METAL ETCHER

Has Wide Heat Range

For Various Uses

FOR permanently marking tools, parts, and so on, made of iron, steel, or their alloys, the new electric etcher shown

Permanent marking, by etching

in one of our illustrations has been developed by the Ideal Commutator Dresser Company.

This etcher, provided with 14 etching heats, is equipped with a work plate and a ground clamp. Small tools and parts are etched by placing them on the work plate; the ground clamp is used for making connection to large heavy parts and castings.

GANTRY CRANE

Is Equipped With

Swivel Casters

A CRANE that can be used on any firm, level floor, which is not restricted by tracks or overhead runways, and which can be moved from one location to another, has recently been made available by the Service Caster & Truck Company. This crane, shown in one of our illustrations, is available in sizes from 500 pounds to 20,000 pounds, each of which is equipped with eight casters furnished with floor locks. Such a crane can be built in any reasonable height and may be used as a truck after lifting the load off the floor. The flexibility of operation provided by the casters makes the cranes adaptable to many shop and industrial purposes.

BABBITT

Bearings Have New

Low Tin Content

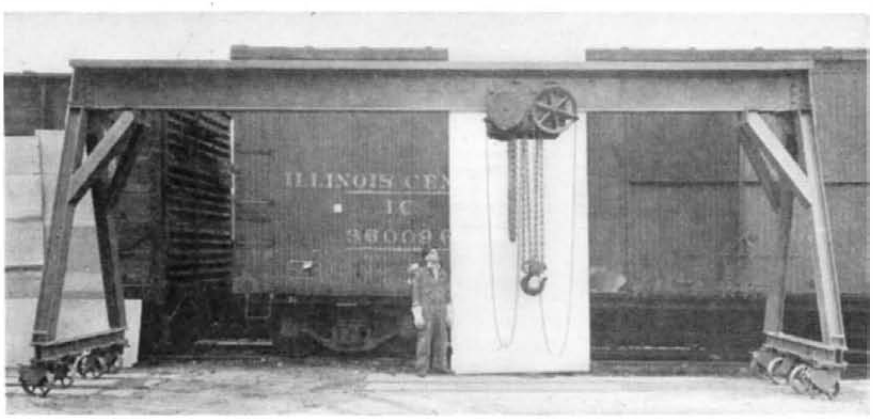
A NEW low-tin babbitt has been developed for general application under many normal operating conditions and in cases where fitting and lubrication will be carefully watched. This bearing material, known as Rex, and manufactured by the National Bearing Metals Corporation, has a compressive strength of 17,500 pounds per square inch and pours at 625 to 675 degrees, Fahrenheit.

FLOOR PROBLEMS

Solved by Use of Oil-

Absorbing Material

OILY surfaces, always a hazard in shops, can be completely eliminated by the use of a newly developed material which replaces the more conventional sawdust and sand. This new material, known as "Quick-Sil," is absolutely fire-proof and will not ignite or sustain combustion. "Quik-Sil" is used by spreading it on wet and oily surfaces, where it absorbs the oil and completely dries up the floor. If the oily surface has become caked, a solvent is first applied and then the "Quik-Sil" spread over to absorb the solvent and oil at the same time.



Flexible operation is the keynote of this new crane for industrial use

GLUE EXTENDER

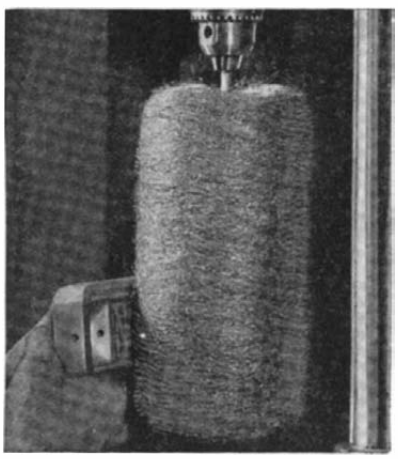
Mineral Gives Advantages To Adhesives

ADDED to glue in proportions up to as high as 25 percent, a new pulverized mineral material known as Micromite Glue Extender, increases the body of the adhesive and allows it to flow freely. It is supplied in 50 pound packages by the manufacturer, the Tamms Silica Company.

SPINDLE

Covered With Steel Wool, Removes Burrs

STEEL wool, an abrasive material ordinarily considered only for use in hand operations, can now be used on a spindle for high-speed production operations in the removal of burrs from non-



Powered burr remover

ferrous metals. Such work is made possible by the use of "ribbon" type steel wool which is wrapped around a small shaft and the completed spindle mounted in a chuck. These spindles, made by the American Steel Wool Manufacturing Company, Inc., make it possible, it is claimed, to clear burrs from three sides and two edges in one operation. Also, when the spindle is in use, it is said to make no permanent grooves.

RESISTANT PAINT

Used in Presence of Acids, Alkalies, Salts

DESIGNED to replace chlorinated rubber paints, now unavailable because of the rubber shortage, a new surface coating is obtainable which shows outstanding resistance toward acids, alkalies, oxidizing agents, and salts. This new paint, for use in chemical industries, pickling plants, textile mills, and so on, is composed of a combination of domestic waxes. Known as Rust-Eeter 66, this coating dries as rapidly as the rubber paint which it replaces —that is, in less than one hour.

The one point in which this new paint is inferior to rubber paints is in oil resistance; oils and greases will dissolve it rapidly.

PLASTIC MALLET

Does Not Throw Sparks, Resists Wear

THE HEAD of a new non-metallic mallet is made of a canvas-base laminated phenolic plastic material which is secured to a hickory handle by a laminated Bakelite wedge. Such a mallet head will not throw sparks under any conditions of use and hence can safely be employed in munition and shell-loading plants.

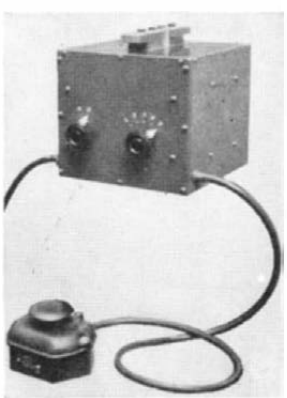
It is claimed that this mallet, made by the Penn Fibre & Specialty Company, resists wear and does not deteriorate with age. The face can easily be resurfaced on a grinding wheel.

SOLDERING

Special Transformer Equipment is Used With a Jig

ONE of the specific applications of the soldering equipment shown in an accompanying photograph is to a multiple-leaf condenser assembly which is set up in a specially designed jig. When the current is applied to the leaves through the jig, the complete soldering operation is finished in 1½ to 2 seconds, under control by a foot switch. By ordinary methods the leaves were soldered individually.

Similar complicated soldering jobs can be accomplished with this trans-



Complicated industrial soldering jobs can readily be accomplished with this new transformer

former setup, which is furnished with a ten-step heating adjustment, by correct design of the jig for the work to be handled. The American Car and Foundry Company, manufacturers of the equipment, also co-operate on problems concerning jigs to be used for various purposes.

The Thunderbolt in Action

Why This Fine Plane is Rightly Called the Fastest and Most Powerful High-Altitude Fighter of the Day

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

WE HAVE only the highest commendation for the report on our combat airplanes which was recently issued by the Office of War Information. Since the time when the subject of the quality of our fighting aircraft became controversial, a number of government announcements or reports have appeared, but none have been so objective, so accurate, and so dispassionate as the report of O.W.I. under the capable leadership of Elmer Davis.

The Republic P-47 Thunderbolt comes under the head of supporting evidence. Powered by a Pratt & Whitney 2000-horsepower engine, equipped with a multi-stage turbo-supercharger, heavily armed and armored, the Thunderbolt has a good claim to be called the fastest and most powerful high-altitude fighter of the day. It is being put into production not only at the plant of Republic but also at the plant of one of our other important airplane manufacturers.

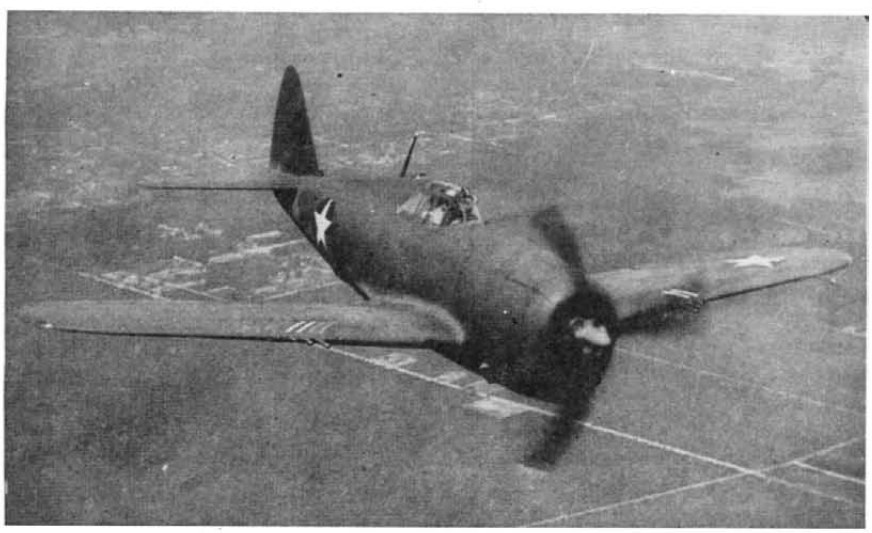
The photograph below shows the P-47 going through its paces for the benefit of a cameraman. We note the all-plastics sliding canopy which gives the pilot excellent vision; the neat engine cowl which gives the impression that engine, cowl, and fuselage blend inperceptibly into one another; the smooth, well filleted wing; the ominous number of machine gun bores protruding from the leading edge of the wing. The design is attributed to Alexander Kartveli, a noted Georgian engineer.

MATERIALS

Airplane Parts are Fertile Field for Substitutions

THE USE of plywood in airplane construction as a substitute for aluminum alloys has often been discussed, but this is not the only example of material substitution. L. D. Bonhain, of Lockheed Aircraft Corporation, in a paper before the Society of Automotive Engineers, describes wide and successful use of "non-critical" materials in airframe construction and some of these substitutions have proved so satisfactory that they are likely to remain after the end of the war.

Alloying elements such as nickel, chromium, molybdenum, vanadium, and manganese are scarce and difficult to obtain. Hence, in many sheet metal parts and in tubing, alloy sheets have been replaced by low carbon steel. Stainless, corrosion- or heat-resistant steel has been displaced even in such essential elements as firewalls, exhaust-shrouds, and ammunition boxes. Such substitutions may mean added



Supporting evidence of the accuracy of the recent O.W.I. report on the quality of our fighting airplanes: the Thunderbolt, in many ways the best of our military planes

weight but the added weight is fully justified except for important combat airplanes.

While alloy sheets are being replaced by low carbon steels, the conservation of aluminum is being accomplished by the use of plywood, plastics, wood, and magnesium. A great permanent use of these latter materials may be expected. This is particularly true of magnesium, for whose production facilities have been enormously increased. In finishing materials, naphtha and alcohols have displaced scarcer materials as thinners. Rubber has been eliminated by the use of synthetic rubber, felt, and bound hair. American industry, metallurgical and chemical, has risen to the occasion, and airplane designers have co-operated magnificently. We can do just as much as the Germans in the matter of "Ersatz," though we brag less about it.—*A. K.*

SOUND-PROOFING

Needed in Engine Testing Laboratories

With enormously powerful engines and their necessary propellers it is quite a problem to reduce the resulting noise. Engine laboratories must therefore be enclosed in massive buildings which, by their bulk, prevent noise transmission. Also, both inlets and outlets to the test cell must embody sound-absorbing devices.

In one engine testing laboratory the test cell is equipped with sound-absorbing baffles of Fiberglas pads installed in the inlet stack. Vertical stacks are about 40 feet high with a 20-foot square opening. Similar Fiberglas wool stacks are provided at the outlet.

Fiberglas thermal insulating wool is glass in soft, flexible, fiber form. It seems to meet all the practical requirements of this special use. Among these are: high noise reduction or sound absorption coefficients; ability to stand up under wind speeds of 100 miles per hour; resistance to gasoline and oil fumes; fire proof; particles of acoustical materials, which might injure motors or test devices, cannot get into the air stream; chemical inertness; rapid draining and drying properties. — *A. K.*

Quiet, please. Engines testing

FLIGHT RECORDER

Takes Over Some Flight Engineer's Duties

The heroism of the test pilot—how frequently he risks his life, how he suffers temporary blindness when coming out of a steep dive, and the like—has been well recorded by the press.

Test pilot's flight recorder

Flight test engineers undergo only some of these risks, but they have arduous duties which involve, among other things, taking by hand notes of engine and plane performance, and of speed, pressure, and temperature in many parts of the engine. In fact, with the complexity of the modern airplane, it has become almost impossible to take the necessary records frequently enough in a power dive or a steep climb.

To meet this situation, the Brown Instrument Company has developed a new electronic instrument, a portable "flight-recorder" which was specifically designed for the Douglas B19, the world's largest plane, and is an adaptation of a new type of self-balancing electronic potentiometer. When in service on the B19 it automatically prints on paper the temperatures of all 72 cylinders of the four motors, the temperature of the carburetor, exhaust, and oil lines, and also the pressure distribution on wing-struts, bulkheads, and tail surfaces. Douglas Aircraft engineers have increased the recorder's range by the use of a selector switch, which permits readings to be taken in six groups of 24 each.

In spite of its complex service, the recorder is compact enough for use on a single seater pursuit where it is physically impossible to carry a group of test pilots.—*A. K.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

A First Aid Index is an accordion-type folder, 6½ by 3 inches, which bears the approval of the Commander-in-Chief of the U. S. Volunteer Life Savings Corps. It covers, with illustrations, all the important points in elementary first aid. *Sylvania Electric Products Inc., 500 Fifth Avenue, New York, New York.—Five Cents.*

Keeping Livestock Healthy is the 1942 Yearbook of the United States Department of Agriculture and its 1276 pages are this year devoted entirely to the fundamentals of animal disease and insect control, also diseases and parasites of swine, goats, poultry, dogs, cats, and wild life. 98 chapters by various authorities. *Superintendent of Documents, Washington, D. C.—$1.75.*

Turret Lathes is an eight-page catalog describing and illustrating a line of lathes and their attachments and accessories. Important construction features are stressed. Request Catalog No. 67-W. *South Bend Lathe Works, South Bend, Indiana.—Gratis.*

What Keeps the Wheels Turning is a 20-page illustrated booklet which tells the story of electrical power in present-day industrial operations, and the specific part which glass insulation plays in keeping this power in operation. *Owens-Corning Fiberglas Corp., 100 Nicholas Bldg., Toledo, Ohio.—Gratis.*

Wire Data Card is a 5¼ by 3 inch celluloid card on which tabulations give the composition and physical properties of certain alloy wires, as well as wire gages and a feet-per-pound conversion method. *Callite Tungsten Corporation, 542-46 39th Street, Union City, New Jersey.—Gratis.*

Handbook of Welded Steel Tubing is a loose-leaf data book which gives a summary of the physical, chemical, and metallurgical properties of welded carbon and alloyed steel tubing, together with commercial tolerance limitations and extensive engineering data. *Formed Steel Tube Institute, 1621 Euclid Avenue, Cleveland, Ohio.—$1.*

Stamping, Marking, and Numbering is an 8-page brochure which illustrates and describes more than 65 modern marking tools and machines which are adaptable to a wide range of ordnance and industrial marking. *Acromark Corporation, 399 Morrell Street, Elizabeth, New Jersey.—Gratis.*

Specifications for Productive Lighting in War Plants is a 32-page illustrated manual designed to meet the needs for up-to-date data on the use of lighting as a production tool. The lavishly illustrated text deals with problems of production, rejects, employee fatigue, accidents, and so forth. Both fluorescent and incandescent lighting are covered, and complete solutions are given for 21 lighting problems of the kind most commonly encountered. *Benjamin Electric Mfg. Co., Des Plaines, Illinois.—Gratis.*

Heat Transfer Through Metallic Walls is a 20-page illustrated bulletin which describes in detail methods of calculating the rate of heat flow through metallic walls. It dicusses conductivity of various metals under different operating conditions, and other phases of the subject. A series of charts eliminates much tedious computation. *International Nickel Company, Inc., 67 Wall Street, New York, New York.—Gratis.*

Fatigue Versus Efficiency is a 10-page illustrated multigraphed folder which describes briefly, yet completely, the causes of fatigue in industry, in the home, and in schools, carrying along through the effects of such fatigue to suggested methods of relief. *American Bottlers of Carbonated Beverages, 1128 Sixteenth Street, N. W., Washington, D. C.—Gratis.*

The Wood Preserving Industry and The Conservation of Forests is a 34-page illustrated review of the lumber, cross-tie, and wood preserving industry in the United States. It presents charts on various activities, and specific information on preservative methods. *Grant B. Shipley, Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

Rabbit Raising (Conservation Bulletin 25 of the Fish and Wildlife Service, Department of the Interior) is a 64-page booklet dealing with feeds and feeding, breeding, management, equipment, and marketing, in connection with rabbit raising for food and fur. *Superintendent of Documents, Washington, D. C.—10 cents cash.*

Glues for War is an illustrated four-page broadside detailing the uses in which wood and glue are alternating for steel in production of vital war materials. Also shown are simplified methods of glue mixing and application. *I. F. Laucks, Inc., Maritime Building, Seattle, Washington. —Gratis.*

Felters is a 12-page catalog devoted to a description of felt as an engineering material and its applications in industry. Data presented cover grades, properties, and specifications, as well as applications to vibration isolation, sealing of lubricants, sound absorption, and so on. *The Felters Company, Inc., 210 South Street, S. W., Boston, Massachusetts.—Gratis.*

Partial List of Uses of Forest Products In Subtitutions for Steel and Tin is a mimeographed report giving lists of numerous manufactured items customarily made from metals which have been and can be made from wood or wood derivatives. Publication R1289. *U. S. Forest Products Laboratory, Madison, Wisconsin.—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.

A LAYMAN'S GUIDE TO NAVAL STRATEGY

By Bernard Brodie

No stuffy, pedantic book is this—instead, most readable. The author writes in a smoothly-running style which can be followed without brow-knitting. While non-technical, it follows the same general ground as a technical treatise. While it was not written as a reply to the De Severskys and the Ziffs, it does, and without the least rancor, reply to these writers to the extent that their air-mindedness is extreme, arguing for sound balance between air and sea forces. (291 pages, 5½ by 8¼ inches, lightly illustrated.)—$2.60 postpaid.—*A.G.I.*

PHYSICAL CONDITIONING

By George T. Stafford and Roy O. Duncan

Two noted physical culturists present a conditioning program primarily for use of coach and athlete, but one which will immeasureably benefit all who religiously follow its tenets. (110 pages, 6 by 9 inches, many drawings, index.)—$1.10 postpaid.—*A.D.R., IV.*

THE AMERICAN ANNUAL OF PHOTOGRAPHY

Volume 57

Here it is again—the annual standby. Comprehensive articles on many phases of photography, plus an exhibit of the year's best photographs. (240 text pages, 36 advertising pages, 7¼ by 10 inches, paper covers, lavishly illustrated.) —$1.60 postpaid.—*A.P.P.*

STAR MAPS FOR BEGINNERS

By Levitt and Marshall

Set of 12 full-page, white-on-black, shamrock-shaped, month-by-month charts, with accompanying discussions, instructions for use, table of planetary locations till 1947. (33 pages, 8½ by 11 inches.)—$.50 postpaid.—*A.G.I.*

THE MAN BEHIND THE FLIGHT

By Assen Jordanoff

A complete course of instruction in the fundamentals of aeronautics for the men who are building our airplanes and keeping them in flight, packed down into solid straight-from-the-shoulder text. This book provides the facts that aviation students need to know about physics, mechanics, hydraulics, and electricity. Written for easy reading, yet not "written down." (276 text pages, 8 by 10 inches, lavishly illustrated with explanatory drawings, plus 90 photographs of plane types and aviation personalities.)—$3.60 postpaid.—*A.P.P.*

STOWAGE

By Captain Pierre Garoche

An American adaptation of the author's original work on handling and transport of cargoes. Author is well known in maritime circles as Chief Officer of French School Ship, as shipping supervisor of all supplies from here to France before his country's fall. Covers problems of operation, loading, stowage, transportation, damage, carriage of special cargoes. (437 pages, 5 by 7¼ inches, many diagrams, index of subjects and port facilities throughout the world.)—$3.60 postpaid.—*A.D.R., IV.*

SCIENCE AND MAN

Edited by Ruth Nanda Anshen

Essays by Hrdlicka (human evolution); Compton (purpose of science); Niebuhr (religion and action); Kaempffert (science and democracy); Koffka (the psychologist); Huxley (science, natural and social); Cannon (body scientific and politic); Mumford (looking forward); Jessup (international law and totalitarian war); Jung (human behavior); Conklin (science and ethics); and a dozen others. These vary considerably in interest but not in level—that of the more intelligent, thinking fraction of the population who seek mental stimulation rather than factual enlightenment. Critical essays. (494 pages, 5½ by 8½ inches, unillustrated.)—$4.10 postpaid.—*A. G. I.*

THE LONG SHIPS PASSING

By Walter Havighurst

Exhibiting a keen insight into the geographical and economic importance of the 300-year history of the Great Lakes, the author has presented a dramatic, entertaining, rapid-fire saga of the world's mightiest waterways. It is a vivid trail of progress from legendary seas, through the chants of voyageurs, the vanished fleets of sailing vessels, the immigrant boats, the post-Civil War

OUR BOOK CORNER

freighters, the building of the Soo Canal —where a laden ship passes every 20 minutes for eight unfrozen months of each year—down to the present vital parade of long ships passing from Superior to the steel mills, with their cargoes of war-winning iron ore. Excellent Americana. (291 pages, 5½ by 8¼ inches, index.)—$3.10 postpaid.—*A.D.R., IV.*

HOW TO REMODEL A HOUSE

By Dalzell and Townsend

Not alone how to do it, but how to plan it. Not for architects, but for actual owners. This book gets down to brass tacks on practical details and principles; it isn't merely vague and general and doesn't merely show a lot of before-and-after pictures. (528 pages, 5½ by 8¼ inches, 318 illustrations.)—$4.85 postpaid. —*A.G.I.*

FUTURE OF TELEVISION

By Orrin E. Dunlap, Jr.

Television at present represents a sleeping giant of science and commerce, which, when it finally awakens, holds promise of becoming a billion dollar industry, employing thousands of people in a multi-ringed circus that today still challenges the ingenuity of electronics research and radio engineering. In the smoothly written text of this book, Mr. Dunlap lifts the edge of the curtain and looks forward into the future. Only the next generation can prove the accuracy of his prophecies. (194 pages, 6 by 9 inches, a number of photographs.)—$2.60 postpaid.—*A.P.P.*

SEISMOLOGY

By Professor Perry Byerly

Compact volume, emphasis on succinctness. Easy chapters on elasticity and plasticity; earthquake vibrations; causes, effects and distribution of quakes. Hard chapters (calculus, physics) on seismograph; elastic waves; paths of waves and travel time curves; location of epicenters; seismograms Solid book. (256 pages, 6 by 9 inches, 58 illustrations.)—$4.75 postpaid.—*A.G.I.*

HANDS OFF!

By Major W. E. Fairbairn

By the author of "Get Tough!" this book is the woman's version of unarmed self-defense. Not a collection of parlor tricks, but sensible, sane, realistic, proved, self-protective methods with the hands as the only weapons. Excellent course for women and girls in war or peace. (41 pages, 5¼ by 8 inches. Profusely illustrated. Paper cover.)—85 cents, postpaid.

HANDWRITING ANALYSIS

By Stein and Zubin

As ordinarily practiced, graphology is a pseudo-science, frequently degenerating to the level of palmistry and astrology. But there is an empirical science of graphology made possible by the fact

that, like posture, gait, and mannerisms, handwriting is a form of behavior expressing intellectual and emotional habits. This primer of graphology isn't a bit like the familiar popular treatises, because it isn't so specific (the specificity is largely gratuitous). It is a dry, statistical, basic, hard study of underlying principles, not of intuitional thrills. Authors are connected with the New York State Psychiatric Institute, and book is published by a division of the Columbia University Press. (147 pages, 5½ by 8½ inches, illustrated.)—$2.10 postpaid. —*A.G.I.*

EXPERIMENTAL ELECTRONICS

By Ralph H. Muller, R. L. Garman, and M. E. Droz

SOLID is the word for this book, written to supply practical information on the characteristics and non-communication applications of electron tubes. The experiments on which the text is based are clearly described and the results of each are presented in tables or graphs of original data. Written for students, radio engineers, communications experts, and the general reader who wants to dig deeply into this most modern of all sciences. (330 pages, 6½ by 9 inches, a large number of drawings, completely indexed).—$4.75 postpaid.—*A.P.P.*

PARACHUTES

By Herbert S. Zim

THOROUGH study of the timely, exciting subject of parachutes, how they are made, how used in warfare and in civilian life. Development of the 'chute from early beginnings, with data on laws of gravity, other pertinent scientific principles, problems of jumps, training of fighting services, details on use in forest fire-fighting, in exploration, delivery of mail and supplies, meteorology. (252 pages, 5¼ by 8½ inches, profusely illustrated.)—$2.60 postpaid.—*A. D. R., IV.*

MAP READING AND AVIGATION

By Field and Stetson

BRIEF, elementary textbook for aviation students. Part I drills the reader on what he should know about contour, and other maps, and their close interpretation, also on aerophotographs. Part II teaches the rudiments of celestial navigation. Elementary algebra and plane geometry are prerequisites. Authors are professors respectively at Princeton and M.I.T. (129 pages, 8½ by 11 inches, 83 illustrations.) —$2.60 postpaid—*A.G.I.*

HOW TO TRAIN HUNTING DOGS

By William F. Brown

FUNDAMENTAL training of recognized breeds of hunting dogs, with history and standards of each, data on particular use, and proved system of education. Author is editor of *The American Field* and is recognized in many circles as *the* authority on field trials. (228 pages, 6 by 9 inches, 217 illustrations.)—$2.60 postpaid.—*A.D.R., IV.*

The Editors Recommend

Best Sellers in Science

PLASTICS — ***By J. H. Dubois.*** Meaty information on the whole general subject of plastics, presented in narrative form for easy reading. Tabulations of properties of plastics, plus basic design information, for laymen and technicians alike. **$3.10**

CHEMISTRY — ***By Gerald Wendt, Ph.D.*** Chemistry made easier by a presentation that is intermediate between popular works and classroom texts. This book contains the main substance of a first-year college chemistry course, giving the reader better than a sketchy background in this important science. **$2.35**

HOW TO READ ELECTRICAL BLUEPRINTS — ***By Gilbert M. Heine and Carl H. Dunlap.*** A chapter on how blueprints are made, plus nine other sections, each of which is devoted to a specialized part of the electrical field, from bell and signal wiring through motor control diagrams to power station blueprints. **$3.10**

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

PLANE TRIGONOMETRY MADE PLAIN — ***By Albert B. Carson.*** The emphasis in this book, by an author who has tried to make the subject as painless as possible, is on practical applications rather than on mental gymnastics. A good book for the home user who wants to brush-up on trig. **$2.85**

TECHNIQUE OF PLYWOOD — ***By Charles B. Norris.*** Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems. **$2.50**

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

THE TRISECTION PROBLEM — ***By Robert C. Yates.*** Embodies mathematician's answer to would-be trisector. Gives chief dependable data on this never-ending dispute. Compact, crisp, concise. **$1.10**

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

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

FIRE FROM THE AIR — ***By J. Enrique Zanetti.*** Pertinent facts regarding incendiary bombs. History, modern types, materials, and the strategy and tactics of their use in modern warfare. **$.60**

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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"

WHICH is the best type of tube for a reflecting telescope? Old argument, never settled, because it depends too much on personal factors. (Which is the best type—blonde, brunette or red-head?)

Alfred Bryant, 516 Egleston Avenue, Kalamazoo, Michigan, settled one of these questions, the one about the telescopes, for himself by making one telescope for each type of tube (Figure 1). From left to right these are:

Hexagonal tube (9¼" mirror, 78" f.l.).

Octagonal tube (12½" mirror, 81" f.l.).

Square tube (6" mirror, 70" f.l.—solar telescope).

Skeleton tube (7¼" mirror, 58 f.l.). But Bryant throws out the skeleton tube for city use — extraneous light makes too much trouble.

Round tube (7¼" mirror, 58" f.l.).

Round tube was all right, Bryant says, but "it is hard for the beginner to direct his tube to find objects."

Hex and octagonal are all right but hard to make.

He votes for the unromantic square type. Easy to make. Easy to direct. Doesn't need internal ribs. Easy to adjust optical parts. "I admit," he says, "the square type doesn't look so handsome, but looks do not a telescope make."

The R. A. circle on the 12½" consists of a 72" steel tape around a pulley, giving 3" spacing per hour, which is good for visibility.

Incidentally, Bryant must be industrious.

SCHMIDT camera and mounting, made by Philip Knowlton, 83 LaSalle Street, New York, New York, is shown in Figure 2. It has an 8" Pyrex mirror stopped to 7", a 3½" correcting lens and rates as *f*/1.9.

Correcting lens is a disk of Vitaglass 1/32" thick, figured flat on one side; on the other convexed, then concaved near the edge. It has an extra stop which works at *f*/4, also a 77mm haze filter. Tube is ½" five-ply plywood reinforced with 16-gage iron.

"Fussiest job," Knowlton writes, "was design of film holder." Figure 3 shows the one made. "By experience I found that the focus is so short that the back of my hand contacts the mirror while loading film.

"Plate glass would have been easier than Pyrex to grind so deep for the mirror if no machine had been available. A machine should be used—for if anyone thinks there's a lot of rub-rub-rub to a common 6" *f*/8 mirror, let him try a Schmidt by hand—mine took the spare time of 10 months. But it was not as difficult as at first it seemed—mainly tedious.

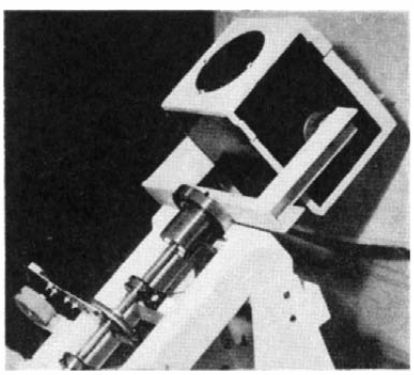
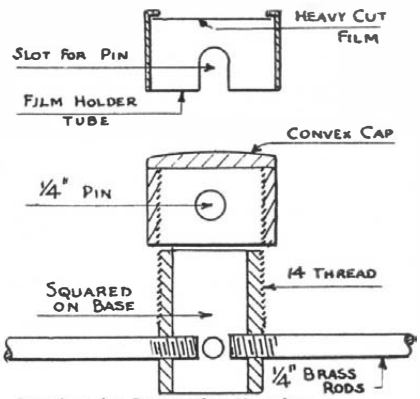


Figure 2: **Knowlton's Schmidt**

"The fork of the mounting is of 3" angle iron, welded and bolted to a heavy stub-shaft resting in a roller bearing. The fork is long enough to permit the camera to be pointed north. Main supports are of 2" x 4" material, each leg having an adjustment.

"The clock drive consists of a lever (Figure 4) on the polar axis shaft, its broad flat end faced with hard rubber. This bears against the knurled knob of the alarm clock. The clock may be shifted sidewise and the lever lengthened or shortened to obtain adjustment of drive speed."



Drawings by Porter after Knowlton

Figure 3: Film holder details

AS EACH new crop of amateur glass workers comes along, a few individuals discover coal tar pitch and are led to think it is something new. Following, from an old letter from J. W. Fecker, Pittsburgh professional, gives answer:

"Both Lassell and Herschel used coal tar pitch and describe the use of it in some of their earlier memoirs. We have used it here in the shop ever since the business started and it is used on all large jobs.

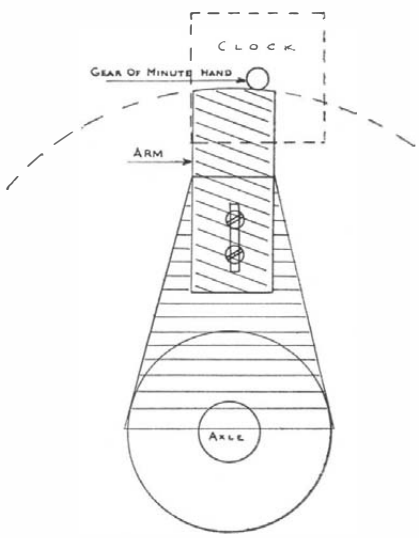


Figure 4: **Principle of drive**

"Coal tar pitch works very well, particularly on glass such as Pyrex and the ordinary crowns and flints. Some of the special glasses, like barium crown, fluor crown, and the extremely dense flints, do not polish so well on coal tar pitch, due to some of the oils in the tar causing

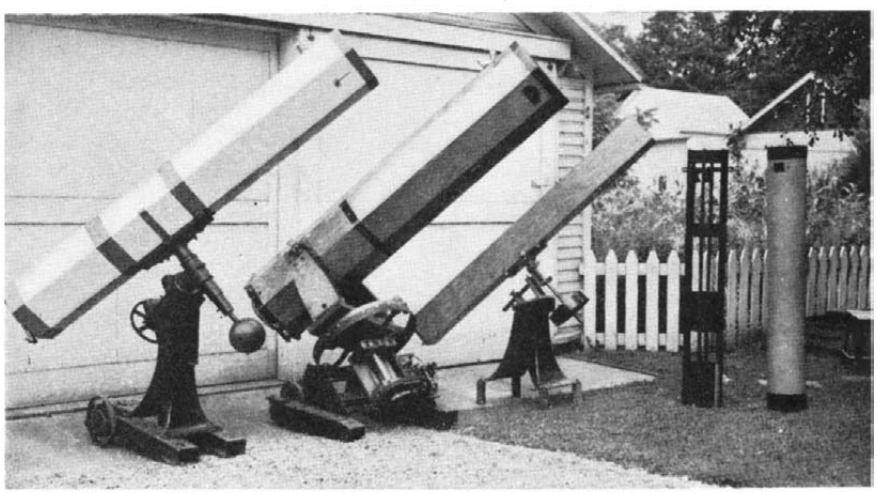


Figure 1: **The Bryant family of telescope tubes—all different**

a staining action on the glass. Particularly is this noticeable on the extremely dense flint.

"We generally mix the coal tar pitch with asphalt, resin, bee's wax, pine pitch, or whatever is necessary to give us the requisite body. For small lens work where the spindles run at high speed, we use quite a bit of pine tar pitch. We also temper it by boiling it for a long time to boil out the oils and make the tar harder.

"The hardness and consistency of the polisher depends to a large extent on the

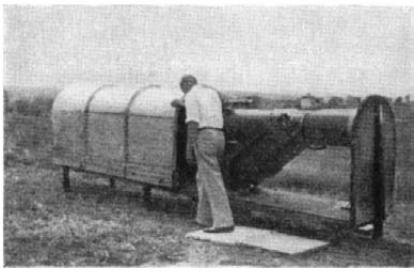


Figure 5: Tarbell and housing

type of work you are doing, and no one mixture is a universal polishing agent.

"For the amateur, I presume pine tar pitch is a little better, because coal tar pitch has a tendency to soften, and give edge error."

NEAT housing for a telescope is shown in Figure 5. E. D. Tarbell, Hunter Avenue and Leeds Road, Kansas City, Nebraska, is the designer and maker. He writes: "The housing itself is made of 20-gage galvanized iron braced by 1" angle iron ribs, though the one at the open end is 2". The whole housing slides on a two-by-four track set on posts. The sills of the cover are two-by-eights. The rollers are rear wheel car bearings from a junk yard. The rear pair are not placed near the end but about two thirds way back, enabling me to use a shorter track extension back of the telescope.

"The inside of the housing is painted black, and at the rear I have a tray in which I can change films for photographic work, even in full moon, without causing fogging."

ANOTHER amateur with a unique way of making a pitch lap is Robert E. Smith, D.D.S., Medico-Dental Bldg., Sacramento, California. He says he first obtains the "Pittsport Doormat," a rubber device prepared by the H. O. Canfield Co., Bridgeport, Connecticut, and used by numerous amateurs for casting tailor-made laps of pitch. One of these is shown in Figure 31, page 37, of "Amateur Telescope Making—Advanced." Usually when they come there is a web between the partitions and the user must chisel this out, but Dr. Smith leaves it in—he even asks the makers to select a mat having a good, flat web with no undulations or imperfections. He describes the job thus: "Cut the mat to fit the mirror, with its squares off-center, of course. Place mat on mirror. Wrap the customary collar around the edge; I use rubber for this. Paint the whole thing with glycerine. Pour melted pitch into all the squares,

TELESCOPTICS

making sure there is more than enough. Place the warmed tool on this and the lap is practically made. Its neat channels also run clear down to the glass as is desirable.

"Let it cool somewhat and then remove mat and collar, chamfer the lap and cold press, and there you have it. Such a lap is pretty to look at and easy to make."

Maybe just at present Japan may have something to say about making a lap that way—rubber. But that should not last forever.

PRISMS. Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, offers simple tests for telescope prisms for diagonals, which anyone can apply. He writes:

"There is no way of testing the flatness of prism faces except by observing the interference fringes when the prism is brought into contact with a standard flat. This note deals instead with methods of testing the correctness of the angles. The right angle between the square faces may be tested with great accuracy by the method described by Russell W. Porter on page 54, 'A.T.M.,' and improved by John M. Pierce. The prism is placed with the large face toward the observer. A white card having an accurately circular hole about ⅛" in diameter is held close to the eye. The hole appears as a black spot in the center of the prism, the spot being bisected by a line which is the edge formed by the two square faces. If these faces are at right angles, the spot will appear circular, as in A, Figure 6. If the angle is more than 90°, the spot will be drawn together as in *B;* if less than 90°, the spot will appear elongated as in *C*. The corresponding shapes of prism are shown in the lower part of the figure. This type of defect is called axial-angle error.

"Assuming that the square faces form a true right angle, there remain two ways in which the prism may be incorrect. In the first, the two acute angles, which should both be exactly 45°, may be unequal, as shown greatly exaggerated in *D*. Now, referring to *E*, imagine the prism cut by a plane surface exactly perpendicular to the face *x*, as shown by the dotted lines. In the second, the other two faces, *y* and *z*, should also be perpendicular to the same plane. If they are not, the prism is actually a section of a pyramid, as shown in *F*, and this is called pyramidal, or sometimes side-angle, error.

"The two errors last described may be tested very simply by use of the principle of triple reflection. The set-up is shown in *G*. The prism is placed on a table in a dark room, with one of its square faces toward the observer, who should be at a distance of about 10'. The card with the hole is held in front of the eye, the back of the card being illuminated by means of a small, shaded light. Two images of the hole are formed, one by direct reflection from *x;* the other by triple reflection from *z, y,* and again from *z*. If the two acute angles of the prism are equal and there is no lateral distortion, as in *F*, the singly and triply reflected rays will coincide and one image only will be seen.

"If, however, the acute angles are unequal, as in *D*, the triply reflected ray will follow the course shown by the dotted line in *H*. Two images will be seen, displaced vertically, as in *J*, or, if the error is slight, the spot will appear elongated.

"In the case of lateral distortion due to pyramidal error, as in *F*, the triply reflected ray will be displaced in a plane perpendicular to the paper, and the images will be displaced horizontally, as in *K*. If both errors are present, the images will

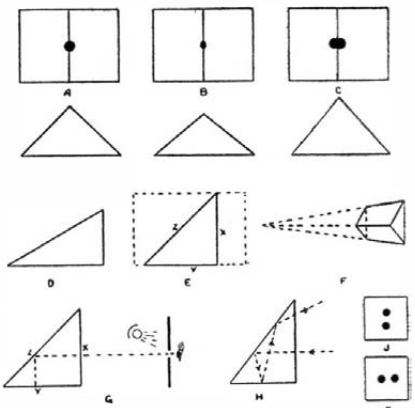


Figure 6: Wates' prismometry

be displaced or elongated more or less diagonally.

"It is important to note that the triple reflection test is not a proof that the acute angles are 45°; only that they are equal. An isosceles or equilateral prism will also give a single image; therefore the Porter-Pierce test must first be applied to determine the angle between the square faces. Note also that the condition shown in *F* is perfectly consistent with all three angles being correct.

"As to the sensitiveness of the test, it should be easy to observe an error of 5' of arc, which is the generally accepted standard for a satisfactory telescope prism. I have a 2" prism by a noted maker which shows no trace of elongation; I have another prism—a 1" "pick-up" job from a pair of field glasses, which shows two images separated by the whole width of the face, at a distance of 4'.

"It is not suggested that the above test should replace the still more precise standard shop methods used by prism makers, but for checking at home prisms of doubtful origin and quality its simplicity should recommend it to amateurs."

The still more precise method of testing prisms, alluded to by Wates, consists essentially of a refinement on the methods he describes. Light from an artificial source, a narrow slit mounted in the optical axis of a telescope, passes through its objective and into the prism, which is placed at a distance of a few inches. It is there reflected internally, and returned by way of the same objective to the eye. If, under magnification of about 25 diameters, the returned image of the slit coincides with the slit itself, the prism shows no error greater than approximately two seconds of arc. This is the test by autocollimation.

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