'SMOKE-EATERS' OF THE NAVY . . . Page 150

SCIENTIFIC AMERICAN

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The "Lexington's" Fire Gets Beyond Control

All the Sciences

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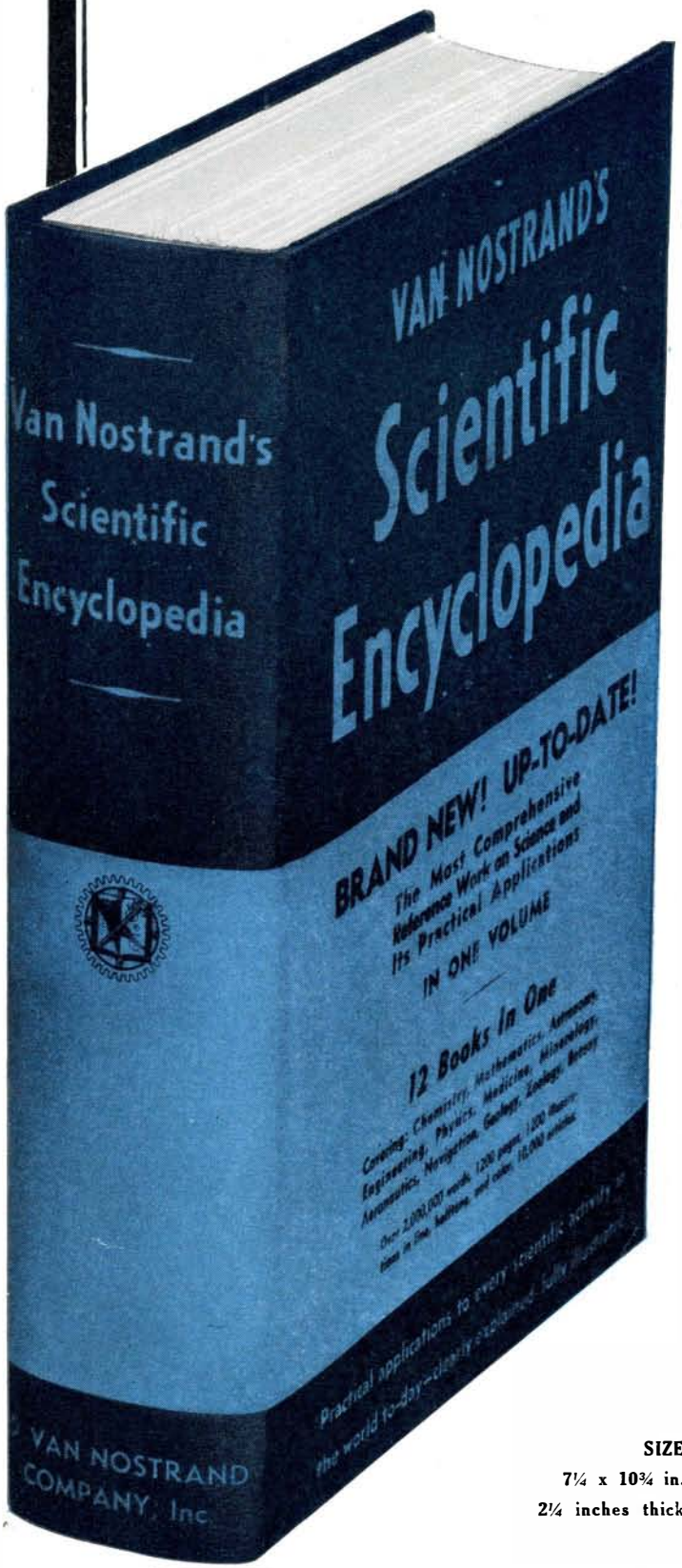

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THE official U. S. Navy photograph reproduced on our front cover shows the *Lexington* at the moment of the tremendous explosion which sealed her doom. Prevention of such disasters is the avowed aim of the Navy's "smoke-eaters," whose training is described on page 150 of this issue.

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SCIENTIFIC AMERICAN

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OUR *Point* OF VIEW

THE FUTURE MUST BE ASSURED

"I BELIEVE that the future security of our nation is dependent upon an adequate air force. This is true at the present time and will become increasingly important as the science of aviation advances and the airplane lends itself more and more to the art of warfare." Thus, in his minority report of *one* vote, spoke a member of the so-called Baker Board, set up in 1934 as a special War Department body to investigate the status of United States Army aviation. The head of the Board was the late Newton D. Baker, Secretary of War under President Wilson. Eight years later the author of the above words led an attack of United States war planes in the bombing of Tokyo. He was James Harold Doolittle, today Major General in the United States Army Air Corps.

Despite Doolittle's brave words, however, the report of the Baker Board included the following: "The limitations of the airplane show that the ideas that aviation, acting alone, can control the sea lanes, or defend the coast, or produce decisive results . . . are all visionary, as is the idea that a very large and independent air force is necessary to defend our country against air attack."

The Board likewise said: "Aviation is so expensive a weapon that no nation can afford to base its organization and supply thereof on visionary approaches, but rather on proven facts. The [phrases] 'Air Invasion of the United States' and the 'Air Defense of the United States' are conceptions of those who fail to realize the inherent limitations of aviation and to consider ocean barriers."

We have come a long way since those words were recorded. And it is with no thanks to the men, Army and Navy officials included—with the exception of the minority reporter—who comprised the Baker Board and compiled its report. Rather is it due to the Doolittles, the Generals Andrews, Arnold, Emmons, McNarney, Spatz, and other far-seeing officers who subscribed to the doctrine that aviation in war could serve in a far greater capacity than merely as "the eyes of the fleet," or of the Army. In this category, too, come the Glenn Martins, the de Severskys, Boeing's Johnson, Pan-American's Juan Trippe, and similar future-minded civilians who sensed the full measure of aviation in both war and peace, for it is the sensational developments in both of those phases of flying that stand us in such good stead today.

The headaches and the heart-aches of those who fought so hard and so long for progress in civil and military aviation are today at least partially assuaged by the secure knowledge that this country has a destiny in world flying that will not be denied. The United States stands on the threshold of unlimited commercial air transport. The air lanes are far, wide, and open, awaiting only the consummation of the present Herculean task of cleaning the Axis mess from the Aegean stables of the air, as well as of the land and the sea. When that is done, American commercial aviation will be in an enviable position, for countless wartime aeronautical developments engendering greater safety, power, speed, and carrying ability will be made available to the great flying ships of commerce that are sure to come, and which will be needed to speed the task of world rehabilitation.

Yes, it is a far cry from the spring of 1940, when the Army Air Corps program calling for 6000 new fighting planes was cut by governmental authority to a paltry 57—and that was less than a year after Poland's aerial pulverization, and it was the month of Dunkerque. But things are different now. The role of American aviation throughout the balance of the war is to be the toughest, the fastest, the wickedest, and the largest wartime aerial combat force ever known.

After the war? Who knows, fully? Certainly, we shall not retrogress. In the metamorphosis from bomb carriers to freight carriers, from troop transports to civilian transportation, we will not be hampered by the narrowing conclusions of another Baker Board. Far too many citizens of our next governing generation will have an intimate knowledge of flying and its infinite potentialities. There cannot be—there *must* not be—arbitrary and senseless limitations placed upon the assured expansion of our air power of peace. There can be no doubt about it, American aviation will go far—if we will only permit it to do so.—*A.D.R., IV.*

PSYCHIC INVESTIGATION CLOSED

IN OUR April 1941 issue we announced the inauguration of our investigation of the reality of psychic phenomena. As an incentive for anticipated co-operation from mediums and others claiming psychic powers, we added the sum of $5000 to the standing award of $10,000 which was instituted some years ago by the Universal Council for Psychic Research, and arranged for the chairman of that organization, Joseph Dunninger, to head our own investigating committee. It was stipulated that the combined award would be available for two years from March 15, 1941, to any medium or other person who could produce any effect in spiritism or any supernatural manifestation which Dunninger could not duplicate or explain through natural or scientific means.

Due to the lack of the co-operation necessary from followers of psychic enterprises, we have been unable to establish any clear-cut, solid, basic authority for the supposed existence of what are commonly known as psychic phenomena. We regret that it has, therefore, been impossible to contribute greater fundamental knowledge on this subject.

Although the Scientific American award of $5000 has been withdrawn as of March 15, 1943, we sincerely desire that one and all shall realize that our interest in psychic phenomena continues. Our Committee, or another responsible group selected by the management of this magazine, will be available for the investigation of any psychic demonstrations which fall within the category of the rules and regulations set forth in our April, 1941, issue and which may be deemed worthy of investigatory action. Meanwhile, we have been informed that the $10,000 offer of the Universal Council for Psychic Research still stands.

We wish to take this opportunity to express our sincere appreciation to the many people who have endeavored to work with us in our investigation of psychic matters. Scores and scores of readers have expressed their interest in this subject and many have contributed valuable suggestions. The members of our committee, busy executives during normal times, found themselves even more heavily involved since our entry into the war, and yet have managed to devote more than satisfactory energies to the affairs of the Scientific American Committee for the Investigation of Psychic Phenomena.

The efforts of our chairman have been indefatigable and his knowledge, based on his own experiences, has been extremely valuable. To those mediums and other persons who volunteered to appear before our Committee and selected witnesses, including representatives of the press, we extend our thanks. It is to be hoped that the scientific investigation of psychic affairs will be carried forward in the interests both of humanity in general and those who have evinced an interest in particular.—*The Editors.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1893)

INVENTORS—"Of all the countries in the world, none is so prolific in inventions as America. There are several reasons for this. The ease of obtaining patents, and their cheapness, holds out to every man the chance of creating for himself a piece of property by the exercise of his brains. . . . The independence of thought and feeling which pervades all classes leads to original views and to bold attacks on difficult subjects. . . . The inventor is the greatest benefactor of the human race, and especially of that part of it which is indigent; he is the real friend of the poor man, and indeed almost his only friend."

RAIN-MAKING—"Incidentally connected with the great naval review which takes place before the city of New York on the 27th, it will be interesting to notice what, if any, meteorological effects are produced by the great cannonading which is to take place. Some forty ships, nearly all carrying great guns, are to deliver double salutes almost simultaneously . . . Should it be a clear day, with no signs of rain until the opening of the cannonade, and rain should then fall, it would be a decisive point in favor of the rain makers."

GUN—"The first public test of the Brown segmental wire-wound gun . . . was attended with much success. . . . It is built on a new system, which is the winding of a steel wire around a segmental core of steel. The core is made of twelve pieces of steel 19 feet long, and with a cross section like the key of an arch. The core is 3 inches in thickness at the breech, and three-quarters of an inch at the muzzle."

LOCOMOTIVE—"For the past two months a portion of the traffic on the London and Greenwich tramway system has been regularly worked by a small locomotive driven by oil vapor. This is the Connelly motor, which has had successful use on tramways in the United States for some time. . . . The engine is fixed in a small car, and is capable of developing 12 horse power on the brake."

PURIFIER—"Rhubarb is the only fruit which contains binoxalate of potash in conjunction with an acid. It is this ingredient which renders this fruit so wholesome at the early commencement of the summer, and this is one of the wise provisions of nature for supplying a blood purifier at a time when it is likely to be most needed."

HOLE—"A dispatch from Augusta, Ill., says that four miles northwest of that place . . . William Allen bored a well on his farm, going to a depth of 77 feet. At that depth suddenly the entire bottom fell out, carrying all but about 5 feet of the walls with it. At the bottom of the deep hole thus formed could be seen a swift rushing stream. All efforts to fill up this hole have proved futile, the rushing current carrying away everything thrown into it."

'TIS TRUE—"Although the transmission of power by electricity is considered by many engineers to be principally applicable to cases in which energy is to be carried for long distances, yet . . . the day is not far distant in which electricity will become a powerful rival to the systems of belt, wire-rope, and cotton-rope transmission."

WAVES—"By using large metallic surfaces 16 m. in diameter as reflectors, and by allowing the discharge of the primary spark to take place under oil instead of in the air, it is found possible to obtain stationary electric waves in a long gallery and to determine their nodal points."

CABLE RAILWAY—"The change of the power of the Broadway street railroad, New York, from horse power to cable driving, which has been going on for over a year past, is now completed. . . . The cables . . . embrace four principal divisions . . . covering a total cable length of over 60,000 feet—more than eleven miles of running cable. . . . After the roadbed was completed, it became necessary to run the cable into the interior of the slotted tube. This was done by . . . thirty-six splendid horses, and in the course of two hours a section of the cable was unreeled and run into the tube. Each cable section was run in the same way."

SKUNKS—"Within the past few years skunk skins have made a wonderful increase in value. Formerly the hides went slowly at ten cents apiece; but the demand has grown for them, and a stripe and half stripe pelt now brings the trapper from eighty cents to one dollar and a black skin goes at one dollar and a half."

ALUMINUM—"Aluminum is found combined with 195 other minerals, and, therefore, constitutes a large part of the crust of the earth, but until recently has been very expensive because of the difficulty of separating."

BRIQUETTES—"Southern Pacific locomotives will soon use for fuel bricks made of coal dust and asphaltum."

ARMOR—A test of a new nickel-steel armor plate treated by the Harvey process . . . had as its object . . . to determine the tests to be established for 7000 tons of armor for which contracts are soon to be let . . . The plate in this trial was 9 by 7 feet in size and 14 inches thick . . . The first shot was fired with a charge which gave a velocity at the point of impact of 1,472 feet per second. The projectile entered the plate 5 inches and broke in fragments; no crack could be found in the plate. The second shot, with a velocity at the point of impact of 1,860 feet, entered the plate about 6½ inches and cracked it for part of its length . . . The fourth projectile, with the high velocity of 2,060 feet, entered the plate about 10 inches, cracking it in several directions, and breaking the backing.

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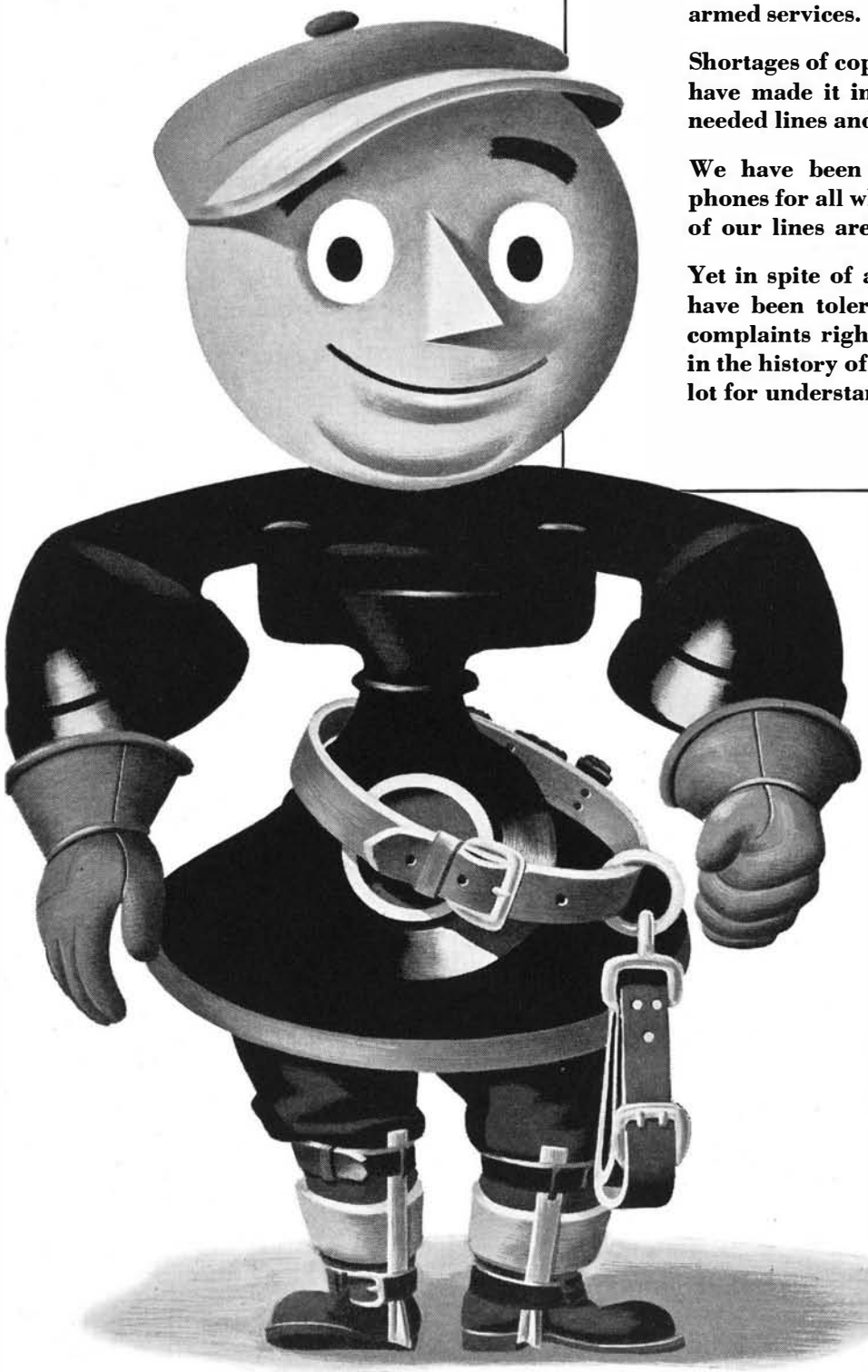


BELL TELEPHONE SYSTEM

WAR CALLS COME FIRST

'SMOKE EATERS' OF THE NAVY

How Selected Crews Are Trained to Fight Fires at Sea

A. D. RATHBONE, IV

THE CRY of "FIRE!"—most dreaded of all alarms at sea—rang out hysterically above the throb of the engines. Other throats picked it up. It echoed and re-echoed along the decks, through the cabins, up on the bridge. Flames rose swiftly and horribly; pandemonium reigned; and when the ship's list was checked, it was found that 140 persons had lost their lives in the burning of the *Lexington*. That was in January, 1840, off Eaton's Neck, Long Island. Just 102 years later and away over on the other side of the world, in the Coral Sea, another *Lexington* burned as fiercely and as stubbornly as had her wooden-bottomed, somewhat stodgy ancestor of an earlier century.

From the days of the Roman fighting galleys to the holocausts of the present war, the fire demon has plagued maritime history. Once that demon rode on silent, fire-tipped arrows; today its vehicle may be bombs, screaming downward in destruction. All through the long transitionary centuries from ancient trireme to modern battleship, in peace as well as in war, man has been unable wholly to localize fires at sea and prevent them from becoming disastrous.

In this war, particularly, it has not been the direct torpedo or bomb damage to naval units that has put many ships out of action, but fire—the fierce, uncontrollable burning of large supplies of fuel oil or other highly volatile inflammables. Especially has this been true of our lost airplane carriers which must maintain excessive supplies of high-octane gasoline for their complements of planes, to say nothing of the huge quantities of fuel oil needed for their own engines on long cruises, and the stocks of ammunition and bombs for the planes, as well as quantities of anti-aircraft ammunition for the warship's defensive armament. Time being of far more than the mere essence in re-fueling squadrons of planes aboard a carrier, supply lines of gasoline must be carried through the structure of the ship from the storage tanks up to the flight and hangar decks, so winged fighters can receive their gasoline supplies in the fewest possible number of minutes. Thus, the aircraft carrier, although capable of taking unbelievable punishment from enemy shells, bombs, and torpedoes and yet remain functioning, becomes a floating fire hazard that to date has defied the most heroic of fire-fighting efforts.

• Through the courtesy of the Navy Department, a member of our staff visited one of the several schools for the training of naval fire fighters. How our sailors, aided by latest scientific developments, combat conflagrations aboard ship is told in this article. All illustrations are U. S. Navy Official Photos.—*The Editor.* •

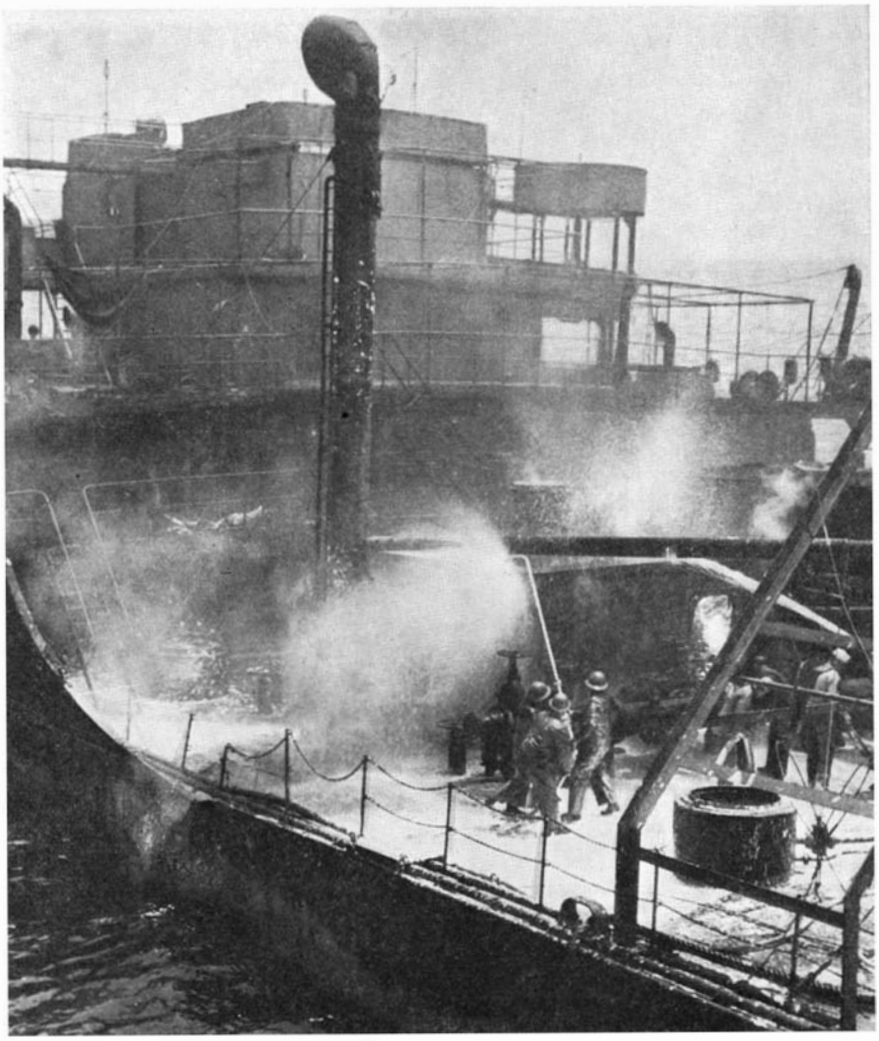
Down in Norfolk, Virginia, the Navy is seeking the answer to the apparent paradox of "water, water, everywhere"—and still the ships will burn. Five Fire Fighter Schools are now in operation, with the parent school at Norfolk, where the 30 officers and men comprising each of the faculties of the other institutions received training before taking over operation of the units at Boston, Mare Island, Bremerton Navy Yard, and Pearl Harbor. Classes for the short but intensive courses are recruited from the Damage Control Crews now existent aboard the Navy's ships, and when a vessel is in or near a port where a fire fighters' school exists, the men attend for as long as possible. It will be the one-day lecture and demonstration course, if time is short, or perhaps the one-week curriculum, if men can be spared that long. The student body is made up not only of enlisted men, but of officers as well—ensigns, lieutenants, and even three-stripers listening attentively, or keenly watching the practical demonstrations. Graduated groups, each known aboard its ship as the Damage Control Party, are not coached merely to stand by and await a fire, but to take on the extra job of specialized smoke-eaters, trained in the practical technique of extinguishing marine conflagrations and of saving lives of shipmates trapped by smoke or flame.

AND "practical" is certainly the word for the demonstrations, for they include setting fire to a tank of 200 gallons of oil, rendered additionally volatile by 10 gallons of gasoline, and, after permitting the fire to gain maximum headway, extinguishing it in a matter of five to seven seconds. At the Norfolk school, for example, are three peculiar looking structures of concrete and steel, squatting side by side in an open area. Each of these is a replica of a section of a destroyer, looking as though a gigantic knife had sliced down through the top deck to just below the water line. One of the structures represents the fo'c'sle, one the engine room, and the last, the boiler room. The decks, or "top-sides," are equipped with hatches, ventilators, fire-hose connections, scuppers, and many other appurtenances found aboard destroyers. Portholes have been provided in these slices of simulated destroyers as have likewise the ladders leading below, the companionways, and, in the instance of the fo'c'sle, old mattresses and other inflammables have been piled in what would be the berthing spaces to represent comparable combustibles aboard ship. While there are no actual engines or boilers in the respective sections that would normally contain them, the engine room and boiler room are exact duplications as to size, arrangement of hatches and ladders, and the bases for a destroyer's power plant. In other words, when a fire occurs below decks in these make-believe warships, and it is necessary as part of the training routine for fire fighters to go below, the physical conditions found in practice will approximate as nearly as possible those aboard ship.

LET'S GO "top-side" of the engine room section and join a group of future fire-fighting specialists of Uncle Sam's Navy. It's a good 40 feet straight up the rungs of that iron ladder to the railing around the deck, so take a good breath and hang on tightly. Once up there, we take a position to windward, for otherwise the brisk breeze would blow the smoke and water in our direction, and we're not garbed in dungarees, as are the students. Lieutenant Lloyd M. Johnson, USNR, officer in charge of the Norfolk school, takes over and explains the methods of fire extinction and the paraphernalia with which they are applied. The Lieutenant has seen plenty of marine fires in his day, for he spent 16 active years as a member of the Marine Division of the Boston Fire Department, while his assistants, Lieutenant

Edward Gaughan and Lieutenant (jg) Joseph F. Kilduff, both USNR, are Boston "smoke-eaters" in their own right.

Lieutenant Johnson explains that nowadays oil fires are fought with water—a practice once considered to be extremely dangerous—as well as with carbon dioxide gas and dry and liquid foam. True, the water cure for gasoline or oil fire does not consist of a solid stream of water, such as might be poured into a blazing building on land. For such conflagrations the H_2O is translated into either steam or "waterfog," both of which have the effect of smothering a blaze of volatile liquids. The CO_2 and the foam are extremely efficacious so far as fires aboard our fighting ships are concerned, but both substances needed for this type of fire fighting come in containers and it is possible that the supply would run out in the case of a serious blaze but, as Lieutenant Johnson phrases it: "There's always water near a ship." For that reason, as well as for the acknowledged efficiency of the methods, both steam and "waterfog" are used extensively and the methods of application form a major portion of the fire fighters' curriculum. Steam, however, does have certain limitations, for its small penetrating power and excessive heat makes it not so acceptable as an extinguishant in certain types of cargo fires, such as cotton and other similar bulky materials.



No practice fire, but a real one on which student firemen showed their mettle

FIGHTING fires with "waterfog" is not new, but the present-day nozzles with which it is applied are and what they do to water is something we'd all like to do to the Jap Empire. One of these nozzles smashes a gallon of water into millions of particles of fog, making it, for extinguishing value, equivalent to 30 gallons of water. When you consider that 54 gallons of water passes through the high-velocity nozzle tip in a minute, you can readily estimate the amount of "fog" that can be forced over the flaming floor of an oil-soaked engine room.

It's all very simple. When a solid stream of water is directed on a gasoline or oil fire, it has little extinguishing effect, and may serve to scatter the flames. When, however, the nozzle divides the supply of water in the hose into two streams and forces them to impinge one upon the other as they emerge from the same tip, an exceedingly fine spray, or fog, is formed. The fog offers a far greater heat-absorbing area than does the solid stream, and steam results almost instantaneously. The speedy absorption of heat in this manufacture of steam causes the vapors to increase in density. Oxygen, on which the fire feeds, is displaced by the downward motion of the waterfog, the mixture of air and burning vapor becomes too lean for combustion, and the fire goes where all bad fires should go—out.

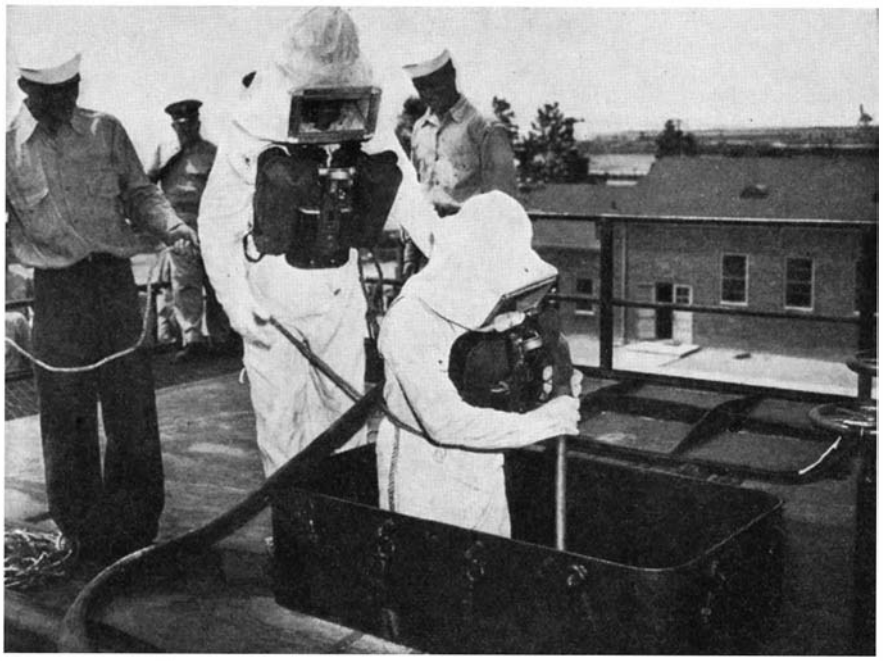
Student "smoke-eaters" force waterfog through escape hatch to "engine room" fire below

After this principle has been explained to the assembled sailors, Lieutenant Johnson and his assistants select two crews from the members of the class and demonstrate the workings of the nozzle, the hose, and the valves that control the water supply. When a ship goes into battle, the fire hoses are not spread out on the decks in anticipation of a possible fire. That was tried. Machine gun bullets, bomb and shell fragments succeeded in making Swiss cheese out of so much of the hose that it was thereafter left coiled in the most strategic places, but on going into action it is the business of the Damage Control Party to see that all is in working order and to be ready to act fast. Therefore, the practice crews atop the pseudo engine room section start from scratch and are timed to the second by a stopwatch.

Down below us, in the make-believe engine room, bilges contain 200 gallons

of oil, into which has been poured kerosene and gasoline, just to make it tougher. All hatches are closed, and at a signal from the lieutenant that exaggerated Molotov cocktail is ignited. Instantly there is a terrific roar of flames from below decks, black smoke pours from every crack and crevice, the lieutenant's whistle blows, and the neophyte fire fighter crews leap to their stations. The hoses roll out across the deck, the nozzle men are ready to couple on the proper tip—for there are both four- and ten-foot applicators, depending on the location and type of fire—the valve men are alert for the ready signal and, almost before we could cry "Fire!", millions upon millions of infinitesimal fog particles are on the way down through escape hatches to play their part of Nemesis on the flaming hell below.

For the first second or so the bellow of the flames seems even louder and angrier, the billowing smoke appears thicker, the huge hatch-covers bounce up and down with a noisy metallic clangor as the heat waves become ever more terrific. Then, almost as suddenly as it began, the fire begins to die down, the smoke is thinned and mixed with brief clouds of steam, and—the fire is out, out in a matter of seconds. It seems miraculous and, of course, not all fires give up so easily. Sometimes they're extremely stubborn, like the one that broke out on a damaged tanker, laid up for salvage operations near Norfolk. With an opportunity to put into reality what they had been learning, members of the school attacked the fire and fought it with foam as well as with fog for an hour and a half before bringing it under control. Sometimes, as a last resort, when a fire breaks out below in an extremely difficult place to get at, three-inch holes are cut in the deck in a pattern which will permit insertion of many nozzles, thereby forming a "water curtain" and isolating the fire from the rest of the ship.



Asbestos- and respirator-equipped rescuers go below on errand of mercy

Rescue work, use of inhalators, and proper application of asbestos suits are also a part of the training of a fire fighter. Contrary to popular opinion, the asbestos suit is not a panacea providing safety from fire. It is for emergency use, for getting in and out of a burning section as quickly as possible with the purpose of saving trapped men or of manipulating vital valves. Men clad in asbestos suits become heated very rapidly, and if water is then played on the suits, steam is created and the suit's incumbent is in a fair way to be parboiled. However, equipped with oxygen masks and protected by the asbestos, rescue parties descend after the fire is under control; part of their job often is to make certain the flames will not break out again.

Practice in fighting fires is not limited to those staged in the imitation sections of ships. On the grounds at Norfolk is a 15-foot tank which periodically spews forth enormous clouds of acrid black smoke and raging flames from a seemingly terrifying oil fire. But it doesn't terrify the Navy's smoke-eaters. Armed with the 10-foot applicator on the business end of a fire hose, they approach as closely as possible to the blazing tank, slither the applicator over the rim, and let waterfog or chemical foam perform its flame-devastating work. Then there's a sheet-metal house, some 10 feet square, which has probably taken more punishment from fire than any other structure in that area. Gasoline and oil are sprayed all over its charred insides, piles of oil-soaked rags and refuse are added to enhance the blaze, the flimsy door is shut, and the torch applied. Instantly the hut is an inferno, out-Dante-ing even that great artist's descriptions of hell. But it's all in the day's work for the foam- and fog-boys, who have the situation under control in jig time.

Navy "Brass Hats" join with enlisted men in learning modern fire-fighting ways

Back of all this present-day efficiency in fire fighting at sea, however, is a long, long trail, not particularly pretty in retrospect. Strangely, although man's ingenuity developed his sea-going craft from the crude, wooden, oar- and sail-propelled triremes of the Middle Ages to the steel-clad, Diesel, steam, and electrically powered monsters of today, he failed utterly to safeguard the children of his genius from the hazard of fire. Lengthy and woeful is the list of marine disasters both before and after the loss of that first *Lexington,* over 100 years ago. It took the destruction of the steamer *General Slocum,* which burned while going through Hell Gate, East River, New York, in 1904, with the loss of 1021 lives, to sharpen man's perspective to the point where he determined that such things shouldn't happen.

Prior to that Hell Gate holocaust there were quasi housekeeping rules and regu-

The *Yorktown* Damage Control Party does its best during the height of the fire

lations for passenger and cargo ships, with the loosely held theory that "everything should be all right," and that if they were, preferential marine insurance rates would be granted. The *Slocum's* casualty list served to tighten up inspections, and the National Fire Protection Association, then but a 10-year old infant organization "to promote the science and improve the methods of fire protection and prevention . . .", went to work with a vengeance. One immediate result was that the now extinct Steamboat Inspection Service laid down far more stringent regulations governing marine fire hazards, and did its best to see they were lived up to.

Slow and laborious progress in fire protection and prevention was made in the fields of steam-powered vessels—and then came the shipping of fuel oil, which produced new and vexing problems. Promiscuous cargo ships, never constructed for carrying liquids, transported inflammables in any old tank or tub available with exactly the result that might be expected—a series of bad fires and an upward curve on the marine insurance loss chart. Once again the N.F.P.A. girded its loins, this time aided by the American Petroleum Institute, and governmental assistance was eventually obtained to set up the Bureau of Marine Inspection and Navigation to replace the outmoded and not too efficient Steamboat Inspection Service. Results were soon obvious, but much was still to be desired when the meritorious effects of carbon dioxide gas on fires were given attention by marine fire engineers and underwriters in about 1929. Potentialities of this flame exterminator had hardly been thoroughly explored, however, when the passenger steamer *Morro Castle* burned off the New Jersey coast in 1934.

Said Commander H. L. Vickery, U.S.N., to the National Fire Prevention Association in 1937, relative to fire-resistive ship construction and the lengthy experiments which had by then been conducted aboard the vessel, *Nantasket*: ". . . the *Morro Castle* fire focused a great amount of attention on the proper fire-proofing of ships. As always happens following a spectacular disaster, the public was greatly aroused and many panaceas were proposed to prevent another such disaster . . . and a Senate investigation was started. . . ."

Said Scientific American in its April, 1939, issue: "New safety features being incorporated in the S. S. *Ancon,* recently launched, will make her and her sister ships, the *Panama* and *Cristobal,* the safest ships in the world . . . the experts conducted a long series of tests on an obsolete vessel, the S. S. *Nantasket*. . . . So complete is the attention of experts to safety aboard these ships that, in the words of the committee of experts: 'the hazard of fire need no longer be a serious menace to the safety of life at sea.'"

Unfortunately, those remarks and conclusions had to do primarily with peacetime fire hazards, and did not take into account the bludgeoning of Jap and Nazi bombs and the resultant conflagrations. Truly, the passenger and cargo vessels of the future will be paragons of preventive fire protection, and life at sea will indeed be safer. Meanwhile, the Navy is literally performing miracles in fire suppression, and doubtless out of it all will come better and more effective measures of combating that age-old menace to maritime travel—fire at sea.

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WAR VEHICLES
Include More than Tanks and Transport Trucks

THE MAJOR importance of motorized and mechanized units to modern warfare is well known, but interesting sidelights of army motorization are the many specially equipped vehicles which play minor but significant roles in military movement.

There are, for example, the "mobile classrooms" used for training army officers in truck mechanics at various camps across the nation. These big trucks, fully equipped as traveling mechanical schools and staffed by a driver and two instructors, have visited camps from Massachusetts to California. Officers trained in this way in turn become instructors in truck mechanics. Each truck contains various types of engines, transmissions, axle assemblies, and other vital parts of trucks.

Another valuable development is the complete lubrication system on wheels for servicing army motor vehicles. Built to travel up to 50 miles an hour over hard-surfaced roads, it can perform in the field any lubricating job that can be done in the shop.

First office trailer to be used in the army was created recently. It boasts a built-in desk, work table, map board, and typewriter stand. Electric lights and telephone facilities can be had by plugging in on the service lines covering the maneuver area. At night, panels slide into place over the windows, permitting lights without danger of detection from the air.

A special service truck has been built to carry bombs from arsenal to plane. Rigged with derrick and windlass, it hauls a trailer loaded with bombs which weigh as much as 1200 pounds.

A portable laundry unit able to take care of the weekly laundry of about 1500 soldiers has been developed by the Quartermaster Corps. Mounted on a four-wheel semitrailer, it contains the machinery required to do field laundering. Included are a washing machine, an extractor to remove surplus water from the washed materials and two steam-heated tumblers for use in drying them. Laundry companies to operate these units consist of 153 enlisted men and five officers and each company has 10 units to operate. Each unit is expected to take care of about 1000 pounds of laundry in an eight-hour day.

Also accompanying troops into the field is a new mobile sales commissary to sell cigarettes, candy, razor blades, and about 60 other articles. Mounted on a 2½-ton truck, the unit carries a driver, four clerks, and a stock of goods sufficient to supply about 8000 men.

The army's recruiting service has also taken to wheels. Trucks and trailers—18 in number—were put in operation to reach localities where there are no established recruiting stations. They provide sleeping quarters for five men, as well as full office facilities. Completely equipped as a streamlined office, the trailer also provides living quarters, cooking stoves, sinks, and clothes closets. From its complete equipment and information service, it can give the prospective recruit all he needs to know of the army he is about to join, its opportunities and classifications. If necessary, the movable station can remain on the road an indefinite time, yet it can always pause for several days at well-attended events, such as fairs and similar gatherings.

These random examples of the numerous specialized functions which trucks and trailers perform in World War II effectively demonstrate the growing importance of motor vehicles in the army.

Anti-Sabotage Lighting

Guards for Industrial Plants, Power Stations, Dams, and so on, Need the Help of Planned Lighting

J. A. SUMMERS

MOST important function of protective industrial lighting is to enable guards to see any menaces which might affect the safety of the property, interfere with production, or interrupt the rapid transportation of war material. Since low levels of illumination usually prevail around factory and plant buildings, it is essential that the lighting be designed specifically to accomplish this purpose. As no two properties are the same, it is necessary to make a careful study of possible places of concealment from which an attack can be launched, places where entrance may be gained, places where fire could be started, and, in general, study the area to find the most vulnerable points of attack, and light these areas so that the guard can effectively perform his duties.

The eye is relatively inefficient in semi-darkness and does not immediately adapt itself to a sudden change in brightness. This is important to keep in mind when designing the lighting because, if the guard is in a brightly-lighted area, he may not be able to see an intruder at a distant point, if the illumination at that point is of the order of a tenth of a foot-candle or less. It is not safe to assume that a guard can see an intruder at a distance merely because the illumination at the location of the intruder appears adequate. If the contrast between the intruder and his background is low, he may be invisible even though there appears to be adequate illumination at that point. Here paint can be a helpful ally, to get contrast wherever possible.

The ability to see a source of danger at night depends on the state of dark adaptation of the eye at the moment of observation, on whether it is fixated at the point of danger or roving over the area, and on the alertness of the guard. A roving eye would probably miss a poorly-illuminated point of danger that could be seen distinctly if the eye were focused at the point. A tired or sleepy guard would not notice the faint wisp of smoke or the skulking figure that an alert, wide-awake guard would readily detect. Since safety of the plant is a prime requisite, all of these factors must be given careful thought so that the illumination will provide the seeing conditions necessary for the guard to function efficiently and effectively for plant protection.

While there has as yet been no extensive damage done by enemy-controlled saboteurs, there is ample evidence that plans have been made for the destruction of our factories and transportation systems. There is no doubt that greater vigilance will be required as the war progresses and every vulnerable point of attack must be carefully lighted so that the attack may be discovered in time to prevent the damage. Boundary fences, yards, alleys between buildings, areas along railways and highways, entrances to yards, roofs accessible from adjoining property, areas around parked freight cars, areas around woods and shrubbery, and any place of concealment near the property are some of the most frequently chosen points which, the experience of law enforcement officers indicates, are selected for attack.

A strong fence is an essential barrier around any war plant but a fence is not impregnable, and it must be well guarded. Good lighting of the fence line is essential, regardless of what other types of lighting are provided, because it is necessary that the guard be able to see a would-be intruder before the damage is done. The lighting must be sufficient so that the guard can see under the worst conditions, because in bad weather the danger is greatest. It is during rain, snow, or heavy fog, when seeing conditions are poorest, and when guards would like to seek shelter, that the professional saboteur is most likely to be at work. Plant management should help the guards to do effective work under these trying conditions by giving them lighting that makes the danger visible.

THE ILLUMINATION along the fence line should be reasonably uniform, and the spacing of the units should be such that in case of an outage of one lamp, there is sufficient light from adjacent units to prevent an intruder from slipping through the darkened area without being seen. One or more searchlights under control of the guard should be available at strategic locations for emergency use. The area outside the fence to be lighted depends on the terrain, methods of guarding, and places of concealment, such as shrubbery, long grass, piles of material, and so on. If in open country with places of concealment readily available, a strip 100 to 150 feet wide should be lighted. If the ground is relatively clear and level, half this distance is sufficient.

The area to be lighted can easily be controlled by tipping the units up 15 to 40 degrees, or using a unit with the desired distribution. Street lighting luminaires equipped with refractors are the type most commonly used. Any of the well-known refractor types for distribution of light will be found useful under various conditions, depending on location of the patrol road, whether the guards are in cars or on foot, or whether located at fixed stations in towers. Personal preference based on the illumination desired inside the fence frequently dictates the type of lighting used. If no light whatever is desired inside the fence line, the Fresnel type of unit is favored. This unit gives a wide fan of light through 180 degrees in the horizontal and a very narrow beam in the vertical plane. Equipped with a 300- or 500-watt lamp and mounted 12 to 16 feet high and 125 feet apart, the Fresnel lenses will give a good illumination for a distance of 150 feet or more, in level country. In hilly country, or where there is heavy undergrowth, the results are less satisfactory. One of the advantages claimed for the Fresnel lens is that it is so glaring to the intruder that he cannot see anything beyond the lamps. It is not safe to rely too much on glare, for the experienced saboteur knows the methods of shielding his eyes by looking through long tubes and is able to see beyond the glare zone.

The conventional method of lighting a fence line is to use a refractor unit with a two-way distribution which directs two narrow beams of light 180 degrees apart, giving a band of light along the fence. Five-hundred watt multiple or 10,000-lumen series lamps are mounted in these units 25 feet high on poles 150 feet apart. The poles are placed 5 feet to 15 feet inside the fence in order to prevent them, as well as the luminaires and wiring, from being molested. If the fence is solid instead of a wire fence, it is necessary to mount the units approximately over the fence so as to prevent a dark shadow outside the fence. This type of unit is satisfactory to use along highways, railways, and navigable waters, because there is no objectionable glare which would interfere with traffic.

ANOTHER method of fence lighting is to place 1000-watt floodlighting projectors at the corners of the property and every 300 feet between corners. This system has been widely used in the past and still finds favor in outlying places where there are no neighbors to be annoyed by the glare. If there are patrolling guards, the projectors should be directed outward with the inner edge of the beam along the fence, so that if the guard looks back he will not be blinded by the glare. If the patrol road is near the fence, the projectors should be aimed in the direction which the guard is patrolling. If the guard is at a fixed station, the projectors should be directed away from his station. Floodlights should not be used along highways, railways, or navigable waters unless the beams of light are directed approximately at right angles to traffic so as not to cause a traffic hazard.

While it is of the utmost importance to light the boundary fence it is not sufficient protection for a property with groups of buildings, storage yards, and railway sidings because of the many places of concealment for an intruder who succeeds

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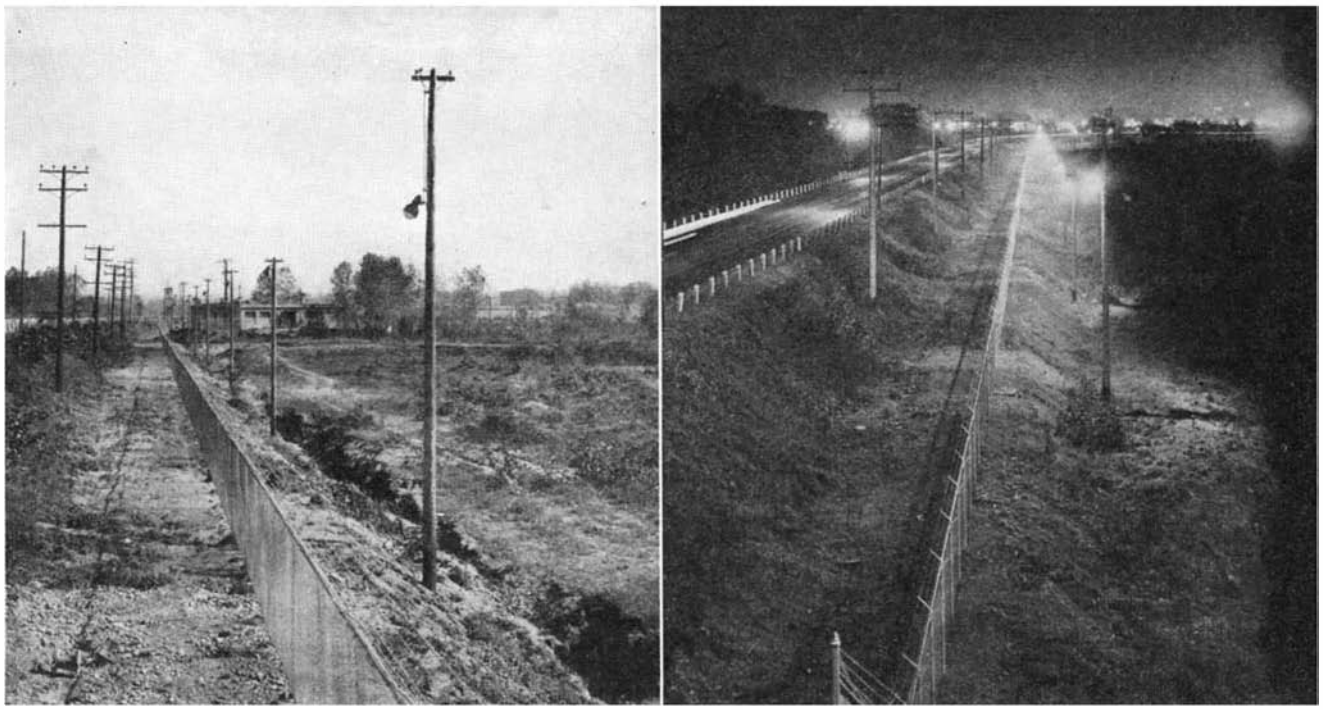
Courtesy *Illuminating Engineering*. Originally presented at a Wartime Lighting Conference of the Illuminating Engineering Society. **The author is a member of the Nela Park Engineering Department, General Electric Company, Cleveland, Ohio.**



Day and night views of typical installations of refractor luminaires along boundary fences

in penetrating the fence line or getting into the yard during the day and concealing himself until after dark. A fence is not impregnable, and a quick dash at an opportune time to a convenient hiding place in the dark is quite feasible to a carefully trained saboteur. It must be remembered that enemy-controlled saboteurs are thoroughly trained in a special school, and they include some of our own naturalized citizens who are thoroughly familiar with the customs of our war industries. No chances can be taken, therefore, in providing convenient dark hiding places where they can wait for the right time to commit their depredations. Incidents have been reported where ambushed saboteurs have attacked guards in the darkness before they could give the alarm. It would be desirable, therefore, in yards that are not well lighted, to have the guards accompanied by trained dogs which would give warning of danger.

Yard lighting may be used in place of, or in combination with, fence lighting, but in all cases it is necessary that the lighting extend at least to the fence, and preferably 50 feet or more beyond. Areas around important buildings should be well lighted and visibility would be greatly improved if a five-foot band of light paint or white-wash were placed around the bottom of all buildings so as to form a light background against which an intruder could be seen at a distance.

THERE is no standard method of lighting a yard, because of the wide variation in the size and distribution of the buildings and various materials around the yard and the vulnerability to attack from adjoining areas. The system best adapted for the purpose will be determined by the area between buildings, height of buildings, location and height of stored material, location and number of freight cars, adjacent hazards, and the system of guarding. Floodlighting projectors, refractor units, projector spot and flood lamps, and outdoor reflectors will be found useful and all types may be desirable in the same yard. Floodlighting, because of the wide variety of size and beam spread, is probably the most widely used, but caution should be exercised in placing the projectors so that glare does not become a hazard to street or railway traffic, to navigation, or to the guards. Roofs of buildings are convenient locations for projectors, but only in exceptional cases should they be used on buildings less than two stories high. In the open country, where neighbors will not be annoyed by the glare, they may be placed on low buildings near the fence and directed outward. In such cases the glare is a deterrent to the intruder and does not interfere with the guard.

The same method applies to buildings near a river, if the projectors are pointed approximately at right angles to the line of navigation. They should not be used along a railway or street, unless the building is at least 40 feet high and the light controlled so as not to obscure traffic signals or interfere with traffic. In some cases a group of projectors on a pole at least 40 feet high located near the center of a relatively large section of the yard may eliminate shadows and reduce wiring. The amount of light required varies from ¼ to 1 footcandle depending on the vulnerability and importance of the location. The number of projectors required may easily be calculated by multiplying the area by the footcandles required, and dividing by the lumens in the beam of the projector used. This may be expressed as a formula as follows:

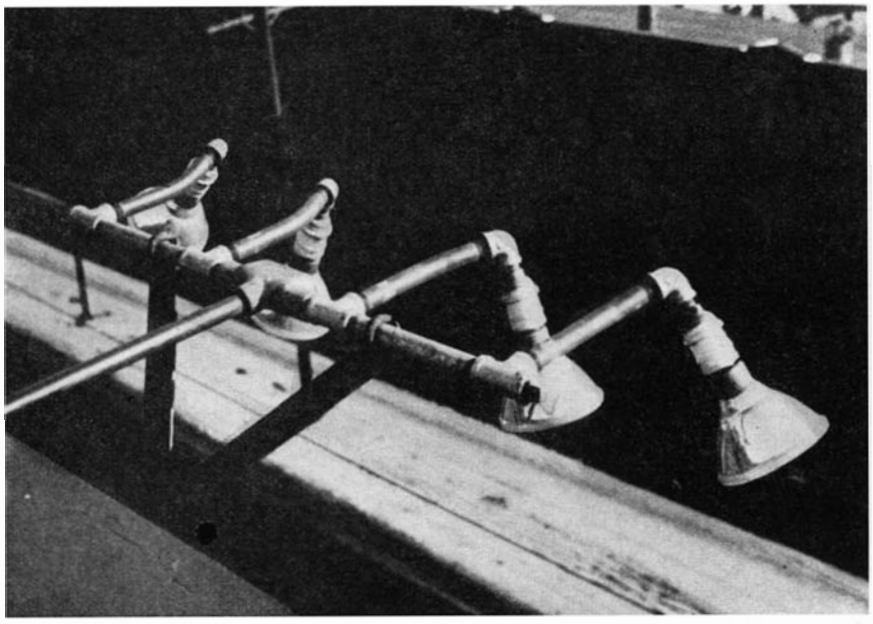
$$\text{Number} = \frac{\text{Area} \times \text{Footcandles}}{\text{Beam Lumens}}$$

The calculations for a large yard are simplified if it is divided into sections which can be served by projectors from a chosen location. This gives a number of small, simple problems rather than one large, complicated project. If possible, it is desirable to choose more than one location for projectors for a given area so as to reduce shadows from any material stored, or likely to be stored, in the area.

If there are freight cars parked at a loading platform, it is important to have light on both sides of the cars because a group can make this a meeting point in which they can hide between, under, on top, or inside of the cars, where they cannot readily be seen. If the platform has working lights, part or all of these may be utilized for one side of the cars and the other side floodlighted from other buildings.

WHERE buildings are only 25 feet to 50 feet apart, refractor units or porcelain-enameled reflectors may be found more practical and economical than floodlights as they can frequently be served from nearby wiring. With copper a critical material, the resultant saving in wire may be important. The 150-watt PAR-38 projector flood or spot lamps have been used for this purpose. Distributed at upper windows where they are easy to maintain, or mounted in groups on roofs, they have proved very satisfactory for distances up to 200 feet. These lamps have also solved an embarrassing problem encountered by small factories in congested districts that are confronted with complaints from neighboring residents because the protective lighting shines in bedroom windows. A simple solution is to mount the projector flood lamps with standard glare shields on about 20-foot centers, at the upper windows or roof. This provides a bright band of light around the factory without any annoying spill of light.

All entrances to the property that are used at night should be well lighted for a distance of 50 to 200 feet from the gate.



Typical method of mounting projector lamps on conduit

These are the inspection places for all who enter, and it is necessary for the guard to examine credentials and suspicious packages. If trucks use the entrance, it is necessary to examine them for unauthorized passengers or materials. The guard should be able to scrutinize approaching persons so as to detect anything suspicious. Thus he will be in readiness against a surprise attack. Light should be provided on both sides of the entrance using street lighting units or industrial reflectors. Floodlighting projectors should not be used unless they can be mounted at least 40 feet high on buildings close enough to the gate to be able to direct the light sharply downward to prevent glare. The same conditions apply to entrances at railway sidings which are even more important than other entrances because of the ease of concealment on freight cars. A minimum average of one footcandle should be provided.

The area around power generating stations and substations requires lighting similar to industrial plants, but in addition they have such hazardous locations as the coal pile, coal-handling machinery, water intake, cooling tower or pond, and transformers. All approaches to these critical areas should be carefully lighted because power to vital war industries could easily be interrupted from any of these points. Small bombs which look like coal can easily be thrown in the coal pile, or bombs can be floated in the water. High-tension lines can be repaired quickly, but a damaged transformer may interrupt power supply for a long time. Convenient locations for floodlights can usually be found so that these critical areas can be lighted from more than one direction to reduce shadows.

Both vehicular and railroad bridges are particularly susceptible to attack during wartime, because their destruction may seriously interfere with the rapid transportation of vital supplies for our armed forces. Railroad bridges are usually more vulnerable than vehicular bridges because it is not as easy to detour a railroad bridge and because there are fewer people around who would detect any suspicious movements. No amount of light will prevent a saboteur from attacking a bridge if it is not well guarded, for he would know whether or not alert guards were present and know their habits, but guards without lights are seriously handicapped and cannot do an effective job.

The important places requiring illumination are the approaches, anchoring piers, supporting piers, and the water for at least 300 feet from the bridge, both up-stream and down-stream, so that a boat or floating matter can be detected in time to prevent damage.

Underbrush should be cleared away from the immediate neighborhood of the approaches so as to remove places of concealment. Both banks should be closely scrutinized for a considerable distance from the bridge for probable rallying points from which to launch an attack and these points be kept under surveillance by periodically directing a searchlight beam to the point.

Another way of using projector lamps, employing adjustable sockets

IN GENERAL, floodlighting is the easiest way to light the bridge. Groups of projectors are located on both banks of the stream on both the up-stream and down-stream sides of the bridge and directed on the piers and surrounding water. A searchlight under control of the guard should be provided to pick up any suspicious object or movement. Where the bridge is in a populous neighborhood, it may be necessary to confine the light closely to the bridge to prevent annoying glare to residents, and then depend on searchlights to sweep the water periodically to detect approaching danger. Vehicular bridges supplied with street lighting can frequently be lighted more conveniently by tapping current from the existing lines to units placed on both sides of each pier.

In general, the same conditions that govern bridges also cover dams. The main difference is that it is more difficult to approach a dam from the down-stream side and it is easier to quickly float destructive explosives from the up-stream side because the current is more rapid. If the dam is supplying a vital utility, exceptional vigilance is necessary at the anchorages, and on the up-stream side of the dam. Sufficient explosive to wreck the dam can be floated almost submerged and is difficult to detect. An uncontrolled float might miss a bridge but it would not miss the dam. It is important therefore to have a searchlight to pick up distant objects and detect suspicious movements a long distance away.

The lighting around piers and docks must be carefully planned so that the direct glare from the light source or the reflected glare from the water does not interfere with navigation. For this reason local lighting units are preferred to floodlighting unless the floodlights can be placed high enough or at a suitable location so that the glare will not interfere with navigation. If the piers are covered, industrial reflectors may be placed along

the sides or roof of the structure, being careful that they do not extend beyond the pier where they might catch in a ship's rigging. In some sections of the country the authorities require lighting under the pier to prevent small boats from harboring there in the darkness. Small piers can be so lighted with vapor-proof units under the floor; larger piers may use the projector flood lamps. They are usually mounted at the water end of the pier and directed toward the land end so that inspection can readily be made by patrol boats. If the guards are on shore the projectors should be mounted at the shore end, pointing out. In critical areas a searchlight to sweep the waters periodically helps to detect suspicious craft and avoid the danger of attack. Marine regulations must be followed in all cases where light or sky glow, as discussed in a latter paragraph, are visible from navigable waters.

Since safety is of fundamental importance in protective lighting, it is obvious that every precaution must be taken to prevent any tampering which would endanger the lighting. If the wiring is easy to cut, this would be the first point of attack. If possible, the wiring should be put underground or in conduit. A closed loop circuit offers some protection to exposed wiring as it would have to be cut at a number of places before much lighting would be affected. Feeding each group of projectors from a different circuit helps prevent simultaneous outages over large areas. There is no quicker way of destroying the protective lighting than by cutting the circuits. The more difficult it is to do this, the less is the danger of sudden darkness at a critical time.

Along the coastal areas it appears necesary to minimize upward light which might contribute to the sky glow against which enemy raiders can see a ship in silhouette. How much screening of upward light is necessary depends on the amount of protective lighting and how close it is to other larger areas of artificial illumination. Tests are at present being conducted to determine how much and how far inland such screening must be done. Until such standards have been established, it is necessary to be governed by local regulations, if any. Light sources which can be seen from the ocean must be completely screened, for these are a definite hazard. Floodlighting projectors should not be pointed toward the ocean as it is very difficult to screen them unless they are behind a building. By careful planning and screening, satisfactory lighting can be applied to plants in the coastal areas.

Since enemy-controlled saboteurs are thoroughly trained, resourceful men, skilled in the diabolical art of wreckage, every assistance must be provided to the guards which will enable them to prevent these foreign agents from interrupting our war production. Proper lighting will enable the guards to see any intruder or any danger before the damage is done. Every project must be carefully studied so as to be sure that any probable point of attack is lighted in such a manner that the guards can work with maximum efficiency.

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QUENCHING OIL

Developed on Art of Ancient Damascus

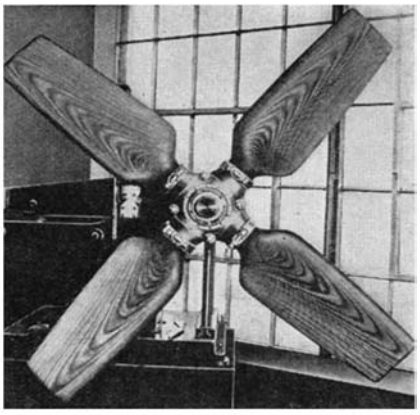
A MODERN version of the discovery of the famous Damascus armorers of how to make sword steel that would bend and not break—without entailing the human suffering involved in the olden method—has been developed by 20th Century research. In the ancient method, human blood was the original "quenching oil." Steel makers in modern times, however, have had petroleum oils for tempering purposes, oils not available to the Damascus sword makers. The modern process of closely controlling the rate of cooling of red-hot metal in order to bring about the desired changes in the structure of the metal is called "quenching," and the steel has to be cooled rapidly to be hardened and strengthened but distortion and cracking have to be avoided.

To develop a product that would increase the depth of hardening and still not crack or damage the steel, the technologists of the Gulf Research & Development Company's Hammarville laboratories near Pittsburgh went back to the story of Damascus steel. They were inclined to believe that blood and salt water had almost the same properties for tempering steel. They concluded that in the barbaric method of ancient Damascus the tissues of the body—the more solid matter of flesh and muscle—probably had more to do with the tempering than the blood itself. They were cognizant, however, of the fact that organic matter in the blood was made up generally of large molecules, and this knowledge was employed effectively by the technologists in the experiments which led to the development of Super-Quench, an oil which has shown an ability to bridge the gap between speed of cooling in water and in other quenching fluids. It is said to have a faster cooling rate than any known quenching oil—a cooling rate intermediate between other oils and water through the hardening temperature range and yet retaining the slow speed of other oils below the hardening temperature range. Thus it imparts the maximum hardness and greatest depth of hardness and at the same time retains the minimum tendency toward distortion and cracking that is characteristic of all quenching oils.

BONDED

Plywood, Compressed, Makes Propellers, Has Other Uses

"WILL plastics replace metal?" That is a question which has been frequently asked and while the answer is still the same—"No," for many products, and "Yes," for some—the closest approach from the standpoint of strength-weight is the new type of plastic-glued plywoods. The newest of these is Compregwood.



A propeller test club made of the new compressed plywood described here

The word "Compreg" is a coined word, a combination of "compressed" and "impregnated." The substance which it designates is an outgrowth of the two other types of plywood. The original type of Durex resin-bonded plywood, which is waterproof, weatherproof, fungus- and vermin-resistant, is made simply by using Durex resin as the bonding agent between the plies or veneers. These are given a light coating of resin and pressed together under moderate heat and moderate pressure. The second type is made by impregnating the wood veneers or plies with the resin and bonding them together. Again moderate heat and pressure are used. The actual physical structure of the wood has not been changed except insofar as the absorption of the resin has changed it. However, Compreg is made by impregnating the veneers with resin, then subjecting them to heat and very high pressure—so much pressure that the wood is actually squeezed together—compressed. Just how much the veneers may be compressed depends upon two factors: The density of wood veneer itself and the amount of pressure. Compreg has a very high tensile strength and high compressive strength as well as impact strength. By comparison, its flexural strength is low.

Actually, this new plywood might be termed a wood alloy in the sense that the physical characteristics of the resin combine with those of the wood and produce a stronger, more stable material. The degree of such change again depends upon the type of wood, the type of resin, and the amount of heat and pressure.

One specific use of Compreg—for the manufacture of propeller blades and test clubs, as made by Camfield Manufacturing Company—will help to indicate the position of this new material in the industrial field.

Carefully selected veneers are impregnated with resin in a retort, under pressure. The veneers are then air- and kiln-dried. When dried to the proper degree, they are given a surface coating of a bonding resin and the veneers are built up into what are called step blanks. The

required number of step blanks to make a finished blade are clamped together and placed in a kiln until the resin has partially set or is partially cured—just long enough that the blade may be handled and withstand carving. It is now carved to the proper plan form but is considerably oversize in thickness. This is to allow for final compression. After the carving or shaping operation, the blade is sanded and fitted to templates. It is then balanced to a master blade and ready for the press. Prior to pressing, the blade must be heated to start the final cure of polymerization of the resin. This is accomplished at the Camfield Manufacturing Company by means of a specially built machine which heats the blade by high-frequency current. The blade is then placed in a steam-heated die or mold and subjected to great pressure to compress the blade to the desired finished thickness.

When removed from the mold, the blade is finished, ready for use. It is checked with the master blade and if additional balancing should be required, it is quite easily done at the shank. The surface is smooth and glossy, actually seems to have a definite "feel" appeal. The blade is strong enough for its grueling job, will not warp or change in any way, is not subject to oil, grease, gasoline, moisture or corrosion, will not mar easily, and, in fact, is almost a thing of beauty.

While this processing sounds simple, there are naturally many factors which enter into it that were not included in the discussion. Among them are selection of the veneers, time, tools, and experience. Nor should it be construed as an inexpensive processing, although continuous research on the part of all the materials and machine manufacturers involved may eventually change this factor.

Flat panels of "Compregwood," as it is called, are also being used in aircraft construction for such parts as backing plates and reinforcing plates. Compreg is stronger than metal, pound for pound. Where weight is such a tremedous factor as it is in aircraft, there is excellent reason for prophesying that this new material will make an enormous contribution to our war effort in the next many months.

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HYDROELECTRIC—The first hydroelectric plant in the world to operate unattended with automatic control recently completed 25 years of service, during which no changes were required or made in the system.

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PEACETIME LAMPS

Find Many Uses in Military Service

AUTOMOBILE headlights, small household bulbs, and some 200 other "peacetime lamps" have been drafted by Uncle Sam for important jobs on the war fronts, according to engineers at the Westinghouse Lamp Division.

"The sealed-beam auto headlamp, which first was developed several years ago, now is being used for more than 30 different military applications," declares R. R. Brady, commercial engineering manager. "Your 1943 auto's headlight now can be found serving as an airplane landing light or showing the way for an Army tank.

"Small household lamps built into special reflectors and wired in long strings—Christmas tree fashion—can be laid out in a few minutes to mark an emergency landing field. Machinery that formerly turned out tiny Christmas tree bulbs now is producing gunsight lamps that show American gunners their targets with clarity," Mr. Brady says. "More than 20 types of these lamps are produced for various gunsights."

The sealed beam headlight, now used as a retractable airplane landing light,

War-born successor to the sealed-beam automobile headlight, rated at 600 watts, is here being tested to determine its ability to light up runways

has been made 10 times as bright as was its auto contemporary, Mr. Brady explains. Made entirely of glass, this 600-watt lamp consists of a reflecting surface, filament and lens sealed into one permanent unit.

"The inner surface of this glass reflector is given a fine coating of aluminum one-thousandth the thickness of a human hair," he continued. "This means a big saving in aluminum over the automobile headlamps with the all-metal reflectors which were used several years ago.

"The wire filament of a sealed beam lamp instead of being enclosed in a small bulb, is contained in the larger space between the lamp's reflecting surface and the lens. "This gives perhaps 50 times as much area on which the evaporating tungsten can condense. It is tungsten evaporating that blackens the ordinary lamp. Greater surface area thus assures the sealed beam lamp of retaining full efficiency throughout its life."

Among its other military uses, the sealed beam lamp is put on tanks where resistance to shock is of great importance. It is used also for spotlight and signalling duty.

"Whereas more than 3200 types of lamps once were manufactured by the Westinghouse Lamp Division, the number has been reduced to 1700 today," Mr. Brady states. "This reduced number enables us to concentrate on lamps needed in various phases of the war effort. The peacetime lamp has gone to war."

STEEL PEP

Stepped-Up by New Blended Hardeners

DETAILS of five new "blended hardeners" for steel, alloy addition agents containing a minimum of critical materials and destined to play a dual role in the conservation of the nation's stocks of critical alloy metals, were released in a report issued recently by Technical Committees of the American Iron and Steel Institute.

The five "hardener" agents may be used interchangeably, in accordance with manufacturer's directions, to benefit all lean alloy steels and medium and high carbon steels. Each appears to improve hardenability and strength without undue sacrifice in ductility in very much the same manner as do the conventional alloying elements such as chromium, molybdenum, and so forth.

Except for small percentages of aluminum, the new agents contain no critical materials. Boron is present in each, and four of the five utilize, in addition to boron, one or more of the following chemical elements: Calcium, manganese, silicon, titanium, or zirconium.

The most spectacular result of the Committee's investigation, which was undertaken at the request of the War Production Board, was the discovery that these new agents have an ability, as yet unexplained, to intensify or "pep up" performance of certain of the lean alloy steels to the point where they are equal to other steels of much higher alloy content.

PLASTICS TESTS

Are Revealing New Knowledge of these Materials

PLASTICS are being put through a "daily dozen" at the University of Illinois by research engineers who, looking ahead to the almost certain limitless possibilities, want to learn all about the mechanical properties of these new materials. Some of the tests employed last as long as a year.

Plastics have been developed and put to use so rapidly that there has been little time to learn fundamental facts about their mechanical properties, according to William N. Findley, in charge of this testing project. Therefore, some two and a half years ago he set out to fill in the data which will enable designing engineers to use plastics for more things and with more efficiency. The results are being used by the American Society for Testing Materials to designate standard methods of testing plastics.

In carrying out this work, he has been advised by other members of the University of Illinois Engineering Experiment Station staff, who for more than a quarter of a century have put metals

through similar "exercises" to learn fundamental facts about them.

Among the results of these tests of metals has been a completely new understanding of how metals break in service, and data which enables designers to make stronger crankshafts and gears, bridges that withstand vibration, safer railroad rails, wheels, and axles, and better battleships, guns, and airplanes.

Results from the tests of plastics are equally fundamental. Some of these findings already have been applied to aircraft design. They also are important in the design of electrical and other parts for battleships, tanks, and guns.

In the University's Arthur Newell Talbot laboratory, specimens of plastics are tested in an air-conditioned room where the temperature never varies from 77 degrees, or the humidity from 50 percent. Specimens of the plastics are tested by stretching or by bending. In one test, the specimen is pulled until it breaks in a machine which records the force needed and the amount of stretch before the failure.

Other machines bend the plastic specimens at speeds ranging from a slow wiggle to a singing whine. The speed of bending has been found to be an important test factor. The machines accurately record the number of bends before the specimen breaks, and stop themselves when that happens.

For still another type of test the specimens hang along the back of the laboratory like a row of hams in a slaughter house, with heavy weights suspended from each specimen. Using instruments so delicate that a microscope is needed to read them, the engineers record the amount of stretch in a day, week, month, or year.

CORRUGATED

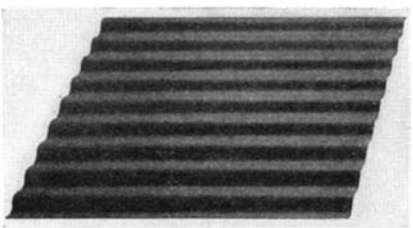
Rags and Resin Replace Steel in New Sheets

RAGS and resin have been combined into a war emergency building material substitute for corrugated steel sheets. Called corrugated asphalt siding, the new product was recently placed on the market by The Celotex Corporation, and is being used for both government and private construction.

The new product is designed for wartime application on industrial, commercial, and farm buildings. It can replace corrugated steel sheets used for covering outside walls of temporary structures of all kinds, including factory buildings, warehouses, storage and machine sheds, dairy barns, and drying sheds.

Corrugated asphalt siding consists of two sheets of heavy felt saturated with a recently developed resino-bituminous compound. The sheets are bound together with a high melting-point asphalt adhesive and corrugated under high pressure.

The finished sheets are hard, rigid, light in weight, and moisture-proof. They retain their stiffness and corrugations in summer weather because of the high melting-point, wear-resistant resins used in the saturating process. No critical raw materials are required, according to the manufacturers, who also state that the life of corrugated asphalt siding can be prolonged indefinitely by coating or painting immediately after application and every few years thereafter.



Replacement for corrugated steel

BATTERY CASES

Now Made of Ceramic to Conserve Rubber

SAVINGS of many tons of precious rubber for the war program have been effected by the Storage Battery Division of Philco Corporation, through the development of Vitrabloc storage batteries using vitrified ceramic cases composed of non-critical materials to replace rubber jars. The new batteries will be used in telephone, public utility, and industrial installations.

Faced with serious shortages of rubber, the Philco Storage Battery Division long ago began research work to find suitable substitutes. Because of its location in the center of the ceramics industry, Philco engineers turned to these materials as alternates for rubber, and finally developed the new batteries, a special blend of four clays being produced to obtain the desired density, color, strength, and resistance to shrinkage.

Like glass, Vitrabloc does not absorb moisture, and acid does not penetrate or affect it. Even when heated to 212 degrees and then plunged into ice water, there is no contraction of the jar. Pure white in color, Vitrabloc jars provide one feature that has been desired for years in storage batteries—high light reflection to brighten dark battery rooms.

• • •

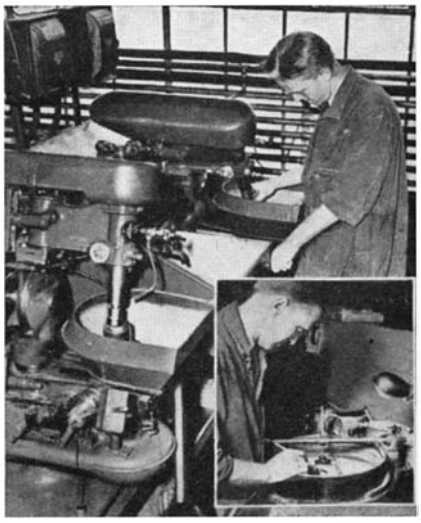
FATS—One hundred pounds of scrap fats and oils can be converted into more than six pounds of glycerin, then to nearly 15 pounds of nitroglycerin.

• • •

GLASSPEED

Diamond-Charged Lens Grinding Tools for Precision Optics

A SPEEDY machine method of grinding precision lenses has recently been turned over to the Government by the American Optical Company which has also contracted to build the necessary grinding machines. The machines eliminate the previous slow grinding of lenses by hand, and are now being allocated by the War Department to plants engaged in manufacturing precision optics and prisms for military optical instruments.



Two of the new automatic lens grinding machines and (inset) the old and slower method of grinding by hand

Designed by American Optical engineers, the curve-generating machine can be so adjusted by an operator that its diamond-impregnated grinding tool automatically grinds curves or planes on glass with high accuracy. As differently curved tools can be used in the machine, a wide range of curves can be ground. From one to 50 lenses can be ground at a single operation, the number depending on the size of the lenses. These sizes range from a fraction of an inch to six inches in diameter.

Heretofore, these lenses were ground by hand and with the use of loose abrasives, a critical material. This hand grinding required considerable time and extraordinary care to insure accuracy. The new grinding machine speeds up the operation considerably—on an average it is eight to ten times faster—and no abrasives are needed, as the diamonds in the grinding tool do the actual grinding. Many thousands of lenses can be ground before the tool loses its accuracy.

When sufficient glass has been removed, an adjustable circuit breaker in the machine automatically stops the grinding operation. On a large lens, it is possible to grind off a millimeter of glass in 45 seconds. A skilled lens grinder, using the old hand-grinding method, required six or seven minutes to accomplish the same result.

Three essential parts enter into the grinding operation: curved metal blocks on which the lenses are cemented or imbedded in pitch; diamond charged grinding tools; and the head of the machine. This head, which holds the tool, can be rotated in an arc of 110 degrees.

A protractor on the machine, divided into degrees and minutes, guides the operator in tilting the head until the tool is set at the proper angle to grind the desired curve or plane. If the head is swung to the right, a concave surface is ground—to the left, a convex surface. If a flat surface is desired, the head is shifted to a perpendicular position. The grinding end of the tool is curved or flat, depending on the surface to be ground.

INDUSTRIAL TRENDS

. . . AND PASS THE AMMUNITION

GREATEST expansion of the chemical industry during the past score of months has, of course, been in the production of explosives. Yet, equally of course, it is not in this specific field that the fore-shadow of the general trend of the industry in peacetime is to be traced. On the other hand, developments brought about in the effort to increase volume production of explosives are already making themselves felt in many places; they will become doubly important in days of peace. Some of these, for example, revolve around nitrogen and nitric acid, toluene, sulfuric acid, and glycerine. These developments have been brought about through applications of research; the ways in which they will affect the future are equally dependent on the same process.

Fortunately for the chemical industry as a whole, it has always been keenly aware of the value of research. This awareness has, largely, been responsible for the way in which the industry has met the demands of war. It will be just as responsible for the future of all branches of the industry and will be the factor that will, more than anything else, prevent the present expansion from becoming a white elephant when the clouds of war are blown away.

Two important angles of the chemical industry must not be overlooked when considering probable trends. These involve expanding post-war markets that will surely be available, especially in consumer-goods fields, and the fact that the industry itself has always displayed great skill in adapting its products to new uses.

Great as has been the expansion of chemical plants since the start of the war, it is safe to say that it would have been equally as great without such impetus, although the expansion period would have been longer; the industry was already on the road to new horizons when the war intervened to make the goals a bit greater and more important, but little different in aspect except for the ultimate uses of the materials produced. Add to this the perfection of new techniques that have been rushed into production by war-time demands, and the over-all picture of the industry for the future begins to assume form. All in all, it appears that the production of various chemical materials has been advanced some five years or more over that point which it would have reached in more normal times. That this time-lead will increase as the war continues is a foregone conclusion.

The expansion that has taken place in this compacted time will undoubtedly react to the benefit of the industry as a whole in post-war days. There is little to fear that the expansion is unhealthy, that it will result in useless plant capacity once the pressure of war production is removed. The consumer markets that are stilled for the duration were just beginning to awaken to the benefits of chemistry when the war changed the whole aspect of things. When the change-back takes place, these markets will be eager for the output of practically all chemical plants for a long time to come.

Then there is the adaptability of the industry to consider. New materials in a wide range of fields have been perfected and undoubtedly there are many more that today are labeled as finished products but which cannot be revealed because of military secrecy. Plastics and synthetic rubber are, of course, the two outstanding accomplishments of chemistry and it is these two that, in great measure, are making the industry largely a supplier of raw materials to other industries. In this role of supplier, alone, are to be found many of the possibilities of the future.

All of these generalities lead to the logical assumption that the greatest frontiers of chemistry are still ahead, that the most valuable possibilities of the industry are still to be explored. But such generalities are of little value unless backed by specific cases of the present that can be projected into the future.

Thus there are, first, the plastics already mentioned. Of these there are a great variety, each of which fills a definite need. There are the phenolics, the cellulose plastics, the melamines, the ureas, and others, many of which offer possibilities of competition with metals and other materials of common use. These plastics have, in the past, found places in many industries, but, for the most part, in minor applications. Now, however, they are branching out and their ultimate saturation point is far beyond the horizon. Among the leading uses of these materials at the moment is the manufacture of plywood, in which the plastic acts as the glue to bind together the layers of thin wood. These plywoods, already applied to the fabrication of buildings and airplanes, ship sections and trailers, have an assured future that is bound inextricably with the chemical industry through the web of plastics necessary to their manufacture.

But to return to the field of explosives and its influence on the chemical industry, it is found, for example, that the former is closely linked with this part of the picture. Many explosives require nitrogen; so do the fertilizers that make possible profitable crops. Great expansion of facilities for nitrogen manufacture from the air and from petroleum presage a vast supply of nitrates for the farm, a supply that will undoubtedly be completely consumed in the United States during the post-war period when this nation will have to take over the tremendous job of feeding a large part of the population of the world.

In other chemical fields there is the manufacture of toluene, the facilities for which can readily be converted to other types of more peaceful production; the processing of natural oils and vegetable matter to furnish new and important raw materials for industry, processes which will draw the farmer more and more into the industrial picture; the production of synthetic rubber from a variety of sources which are too well known to bear repetition here; and a host of other seemingly miraculous goings-on that in the time of day after tomorrow will be the common places of the common man.

FOR CREATURE COMFORT

THAT COMFORTABLE chair which cradles your weary bones after a hard day's labor contains materials that, today, have been diverted completely to the war effort; when that chair has to be replaced or a new one is required for some other weary bones, it will be an entirely different piece of furniture in some respects. This is not to say, however, that new "war-time" chairs will be one iota inferior to those made before the war; in fact, such is the versatility of research that the newer furniture may, in many ways, be superior to those made when construction materials of all kinds were easy to obtain.

Many a utilitarian mind will be eased, when contemplating the future of furniture, to know that most purely ornamental items are out for the duration; these same minds will probably hope that this disappearance from the home scene will be permanent, that furniture builders of the future will design for comfort and utility rather than under the rococo influence of a dead past.

Although there is a definite shortage in some fields of certain types of woods, furniture manufacturers have shown themselves to be adept at changing their procedures so as to make the most of available supplies. Thus there is no anticipated shortage of wood furniture for some time to come. But it is not wood that concerns furniture manufacturers so much at the present time; steel is the crux of the situation at the moment. Chairs, chaise lounges, sofas, day beds, use sizable quantities of steel for the springs which make for comfort and long life. Hence it is comforting, in more ways than one, to know that ingenuity of manufacturers has made possible the design and manufacture of these articles without recourse to the forbidden metal.

Thus we find new furniture constructed with "springs" made of bent and twisted plywood, flexible slats, and many other variations of lever and spring principles worked out in available materials. Even hinges for folding couches are being made entirely of wood. With such an auspicious start, it is evident that the furniture industry will, at least for the time being, continue to supply aids to creature comfort that are sorely needed at all times, and particularly needed in times of stress.

—*The Editors*

Buried Telephone Talk

Plowing the New Transcontinental Telephone Cable into the Ground with a Hundred-Ton Tractor-Train and Mole

TEMPLE C. SMITH
Engineer, Motor Vehicles and Construction Apparatus, American Telephone and Telegraph Company

● THE accompanying article describes the engineering technique of laying simultaneously underground a pair of telephone cables from Omaha to Sacramento, and on similar projects. This completes the first all-cable telephone route across the continent, 70 percent of which is underground out of reach of wind, sleet, and ice. Each cable contains 54 pairs of wires, and each pair of wires can handle six simultaneous conversations, a total of 648 for the two cables, although the ultimate practical capacity of the two is upward of 500 conversations. The new underground cables were decided on three years ago when the possibility of war with Japan was foreseen.—*The Editor.* ●

HUGE plow trains like the one shown in Figure 1 have just finished doggedly working their way across the Great Plains, laying the first transcontinental telephone cable.

Similar trains have been burying telephone cable in other parts of the country. In fact, to meet the demands for additional toll facilities arising from the nation's emergency program, the Bell System found it necessary to secure equipment for and to train crews to handle ten complete plow trains.

Only recently has an entirely power-controlled plow been developed which is capable of cutting a slot as much as 50 inches deep, where such depth is needed, and of burying either a single cable or a pair of cables, together with as many as three properly spaced lightning protection wires where conditions indicate that they are necessary.

In Figure 1, two identical plows are included in the line in which all plows, tractors, and trailers are connected from one end of the train to the other, either by one-inch steel cables or by direct-acting towing hooks and eyes. The front plow roots through the earth with a 3¾-inch share, loosening and breaking up the ground to a depth of from 30 to 50 inches, thus insuring uninterrupted passage of the following plow, which deposits two cables and the lightning shield wires, all properly spaced, in the ground. This 100-ton train, with its more than 400-horsepower pulling force, moves forward at the rate of a brisk walk, laying the cables and lightning protection wires as it goes. Pauses are necessary only to change cable and wire reels on the trailers and to remove any major obstructions encountered in the ground.

Where the ground is not hard and is free of rocks, and thus there is no danger of interruption to the plow from buried obstructions, the train make-up may omit the rooter plow. On the other hand, it frequently happens that more difficult conditions exist, or underground obstructions are known to be present or are suspected—as, for example, when nests of heavy boulders extend down to the bottom of the trench (Figure 2). Here two or three tractors and one plow will first go over the line to root a trench. They are followed, as an entirely separate operation, by another plow train consisting of one or two tractors, a plow, and one or two cable reel trailers, depending upon the number of cables to be placed in the trench.

IN ROOTING or plowing, occasionally the train may become stalled in pulling across a ravine or up a hill. The front tractor, with its powerful single drum winch runs ahead to firm ground and prepares to "winch out" the train by making a two-to-one pull on the rear tractor, which remains coupled to the plow (Figure 3). When this operation is necessary, the driver of the front tractor first puts a tension in the steel winch line and sets the winch brake. Then he grinds the Caterpiller tracks into the firm ground, pulling against the taut winch rope, until the tracks are sufficiently dug in to give the tractor a firm setting for a pull. Now, with the track brakes set on the front tractor and the winch pulling, and the rear tractor exerting whatever forward traction with its tracks the condition of the ground permits, the train moves ahead.

One Caterpillar tractor's maximum drawbar pull is about 30,000 pounds on the level; but in moving up hill the pull is decreased in proportion to the steepness of the grade, since it is necessary, of course, to raise the tractor weight of some 41,000 pounds. With the aid of a double line pull from the heavy-duty winch of the forward tractor, the effort exerted may reach as much as 150,000 pounds. On a well chosen route there are few situations for which this set-up is not adequate.

Figure 2: **Rocks uprooted by plow**

By careful handling of the equipment, cable can be plowed in hillsides even where the grades are as much as 60 percent. It will be evident that in such territory spe-

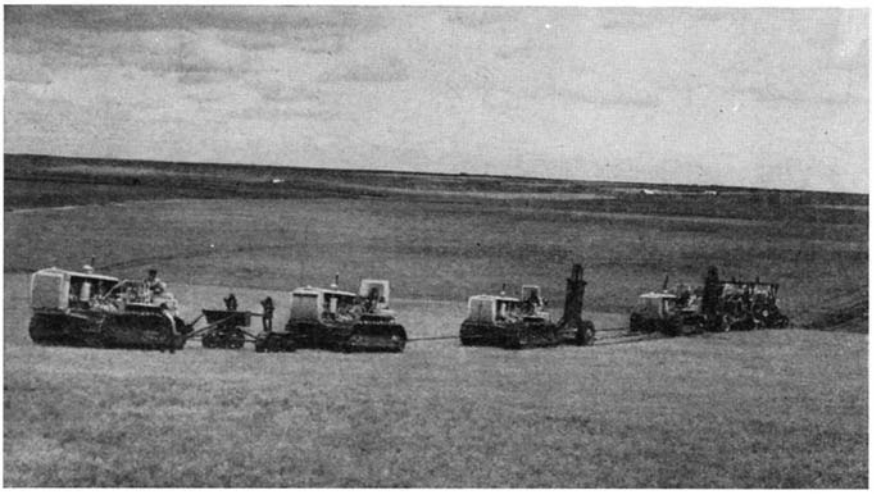


Figure 1: **Cable-laying train plowing across the Great Plains. In it are: tractor; empty cable reel trailer; tractor; tractor; rooter plow; tractor; cable-laying plow; trailers loaded with two reels of cable. The plow is shaped like a tall, vertical leg, its share the toe. Into this leg the cable is fed from behind, curves forward and downward in a semicircle, and emerges at the rear of the heel, while the toe part proceeds ahead and prepares the cable space. There are no sheaves in the plow; the cable is oiled**

Courtesy *Bell Telephone Magazine*

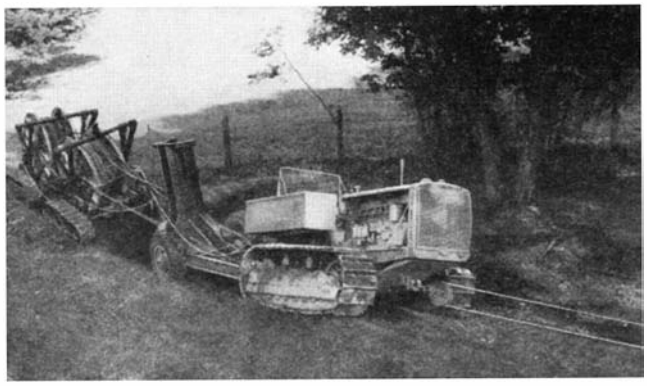


Figure 3: **Winching out of a soft spot**

Figure 4: **A creek? Plow right across it**

cial attention must be given to selecting locations where cable reels can be changed on the trailers. Distances between locations thus determine the cable lengths per reel.

The preferred method of operations in these mountainside conditions is to root down the grade, leaving a tractor dug in on the top, with its winch rope attached as a safety line to the back of the rooter plow as it is slowly pulled down the slope by other tractors. The cable-laying train can be let down grade in the same manner. To obviate the possibility of buried stones wedging at the side of the plow share when placing the cable, the last pass of the plow doing the rooting work is in the same direction as the cable-laying plow will take. Since the cable must be laid in continuous lengths which usually are about 1500 to 3000 feet each, there may be one or more up and down grades in one cable length, thus making necessary the pulling of the cable plow train up grade as well as down. Here again the trusty winch is brought into action after the tractor has been placed in a strategic position at the top of the hill.

WHEN it has been determined that a buried cable will be required between two points, possible routes are explored to establish the best location, keeping in mind such factors as accessibility, estimated cost of the construction, nature of the terrain, plant of other utilities, cost of right-of-way, and future developments. In rugged country this initial survey of the route may be made with the assistance of aerial photography. The airplane survey pictures are carefully studied through special lenses which give a three-dimensional effect, and remarkable detail is afforded by the present-day photographic and viewing equipment. The relative heights of trees and buildings stand out with all the clarity of the old-time stereoscope. Since private right-of-way is generally followed, often over very rough terrain, the use of this ideal method of selection is often found to be worth while.

The tentative route laid out on the aerial survey picture is now explored on the ground by engineers. Ordinarily the route goes across fields, woodlands, mountains, and streams, but always consideration is given to accessibility from the highways, and to the other factors which have been mentioned. This is important for both ease of installing the cable and maintaining it in the foreseeable future.

Information regarding soil conditions and underground obstructions is very valuable in planning the route. Sometimes oil and gas pipe lines are encountered. Experience indicates that there are many pipes in ground regarding which there are no accurate records—and in many cases no records at all. These underground pipes have to be located both as to where the proposed route crosses them and to their depth, because the plow is sufficiently rugged and the tractors have ample power to snap a good sized underground pipe in two.

By the use of suitable apparatus, underground pipes and cables can be readily located without excavating. There are commercially available vacuum-tube type locators which indicate the vicinity of buried cable or pipe. To determine their exact location, a triple coil electrical detector developed by the Bell Telephone Laboratories may be used. This device, which is primarily for locating cables, can be used also in exploring for buried pipes. It is so accurate than an underground cable can be located within less than inch both laterally and in depth below the surface.

Through use of the information accumulated by the methods discussed, the line of the proposed buried cable can now be staked out in readiness for the work crews.

One of the first jobs to be done in opening up the cross-country roadway is to build gates in all the fences encountered. These are necessary for future maintenance as well as for the passage of the cable-laying train.

At sharp ravines, road ditches, and stream banks, a roadway is made by a Caterpillar tractor operating with a bulldozer. A creek crossing, as in Figure 4, becomes quite simple, and no delay is involved if the bulldozer has first cut a road through the banks. At such locations, if there is any danger of the cable being disturbed later by road construction work or earth washing, the cable is plowed in at full 50-inch depth and, to afford maximum protection, a covering of steel or creosoted wood is sometimes placed over the cable. The plow operates satisfactorily across gravel and macadam roads as well as those which are not surfaced. After passage of the plow, the disturbed ground in the roads and the ditch banks is carefully restored to its former condition, thus preventing erosion.

THE Caterpillar-tractor-operated bulldozer, or its close relative, the trailblazer, is useful in preparing a roadway where it is desired to plow in the cable along a hillside instead of up or down the hill. It is not safe to operate the train on more than about a 10 percent side grade, due to the tendency of the pulling tractors as well as the plow and trailers to slide down hill. On such side-hill grades the winch is again useful in minimizing the tendency of the train to slide to the

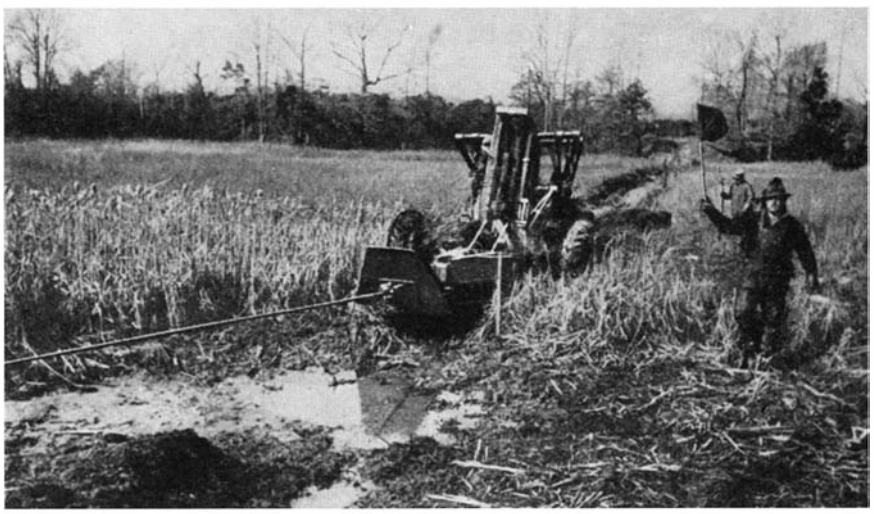


Figure 5: A skid under the plow helps when crossing marshes

down-hill side and possibly make trouble.

Of course, in wooded country a roadway must be prepared for moving the cable reels and equipment along the right-of-way as well as to clear a place to plow. On private right-of-way an easement on a strip of ground about one rod wide is ordinarily secured, anticipating the possible future need of a second buried cable. A passageway at least ten feet wide is cleared, and at reel-change points additional width is required to maneuver the equipment. The ten-foot width will permit passage of the train in rooting and plowing.

Where practicable, the trees within the proposed plow-trench area are pulled out by the roots in order to eliminate the interference with plowing which the roots would cause, and also in order that the roots may not conduct lightning to the cable.

It has been necessary in a few cases to bury cable across marshy grounds or swamps (Figure 5). This has presented a difficult problem. However, because of the use of specially designed equipment and appropriate methods, there have been no cases where the heavy cable-plowing equipment has been lost in marshes, never to be seen again. It is gratifying to relate that all swamp jobs yet attempted, even those in the very soft and seemingly bottomless Dismal Swamp at the southeastern tip of Virginia have been successfully completed.

Attaching "swamp grousers" made of overhanging, bolted-on oak cleats, to the Caterpillar tracks has helped materially, although if these alone were relied upon and an attempt were made to pull the train with the tractor tracks, a grave would be quickly dug for the machine. However, the tracks so equipped do permit maneuvering the tractor across a marsh, thus obviating traveling long distances to find firm ground or roads. In this manner the tractor can be quickly run ahead and located for a winch pull from firm ground or, if this it not available, with the front end anchored to some stable object.

For swamp work the plow tongue is supported by a special steel skid. In Figure 5 the skid seems small because of the large equipment with which it is associated. Actually it is 3½ feet wide and 11 feet long.

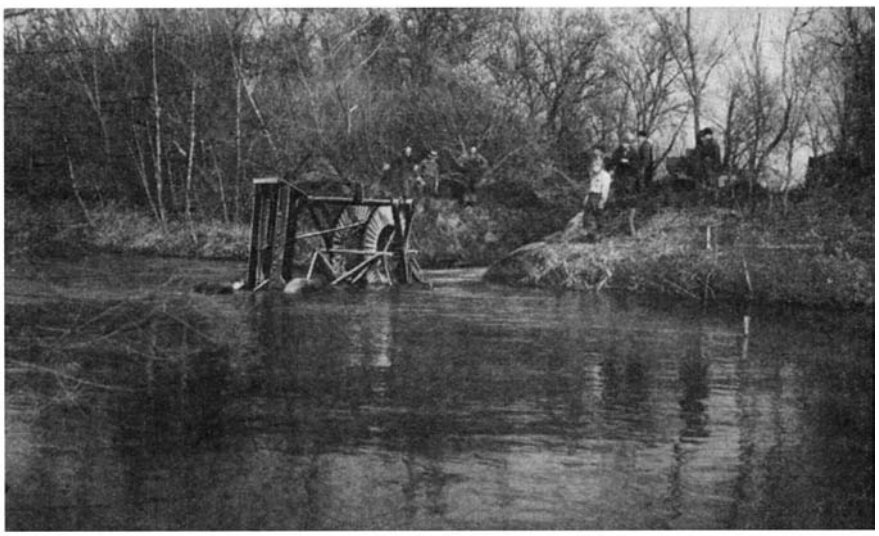


Figure 6: **If a river is not too deep the plow proceeds in normal manner**

The buried cables ordinarily used range in sizes from 1 to 2½ inches in outside diameter. However, cables as large as 3.2 inches in diameter may be used by employing a wider share, which the plow is designed to accommodate. Usually the cables are covered with a jute wrapping, under which, in gopher infested territories, steel tape surrounds the conventional lead sheath. In some cases a thermoplastic rubber covering with a burlap wrapping replaces the jute.

BUT ASPHALT-IMPREGNATED jute covering and impregnated burlap develop comparatively high coefficients of friction against the steel walls of the rectangular tube through which they pass while in the plow share. When two cables are buried, the top one in the ground may show a tension as high as 5000 pounds as it is being pulled through the share. This tension is objectionable for electrical as well as mechanical reasons. In order to obviate this difficulty, an oil spray apparatus is used, from which a constant spray of oil impinges upon the lower side of the bottom cable as it enters the plow, thus reducing the tension in the cable to a safe maximum of less than 1000 pounds.

With two or three powerful tractors pulling in series formation, what happens if the extremely rugged rooting plow hits, let us say, a buried ledge of solid rock? The plow is an integral part of the very heavy, briskly moving rooter train with its combined tractor pull of 200 or 300 horsepower. Recollections of the schoolboy poser about the irresistible force and the immovable body come to mind. A large safety shear pin, which releases at 72,000-pound pull, is located in the front of the plow tongue. The shear pin, like a fuse in an electrical circuit, saves the equipment from damage.

The clatter of the several Diesel engines makes good vocal signals impossible. This condition is met by the tractor exhaust whistle, which can be blown by cords hanging at either side of the plow. Particularly when a quick stop is required, a loud signal must be used to reach the drivers of the noisy Caterpillars which are ahead, as well as the near one.

Under ordinary conditions it is possible to place about 17 trench miles of cable per five-day week with this equipment. In extremely rough mountain territory some right-of-way may be too steep or rocky or inaccessible for the plow train, but it is surprising how relatively small is the footage even here which cannot be economically plowed.

In an article such as this, only the major operations and the principal items of equipment can be mentioned. Many others have had to be developed in order to make the use of buried cable broadly applicable. There are the jobs of passing under concrete arterial highways where the pavement cannot be disturbed and the soil may be either earth or rock. There is the matter of finding a way to cross under rivers too swift and full of boulders for submarine cable and having granite beds which cannot, of course, be plowed. There is the matter of avoiding buried pipes and other obstructions. These have been interesting problems in themselves—of whose solutions there is not space to write here.

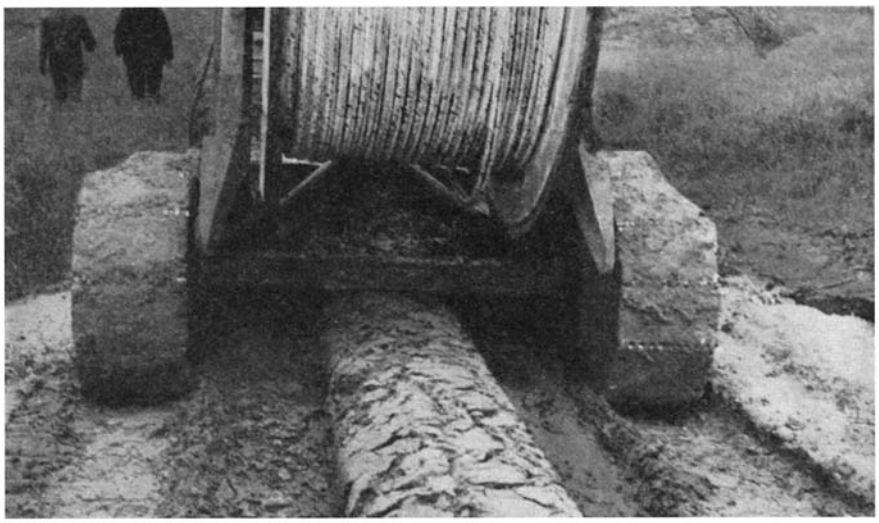


Figure 7: **A device under the rear trailer covers the trench**

In Flight, Troubles Begin

Innovations for the Aerial Navigator Must Be Practicable Under Actual Conditions in an Airplane

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

A GREAT deal has been written of late about navigation, and its general principles should be familiar to most readers; but there are many points which, though easy enough to explain and understand, are not widely known. The writer —who has spent a good part of his time for the past year in teaching navigation— is therefore moved to put some of them down here.

All accurate determinations of anything must depend on measurement; and the navigator at sea or in the air, out of sight of land, has but one kind of measurement he can make—namely, of the angular distance, or altitude, of some heavenly body above the horizon. The significance of such an observation was clearly described in the February, 1943, issue of Scientific American by Mr. E. B. Collins. At the instant of observation the body—which we may suppose to have been a star—was directly above some definite point of the earth's surface, the sub-stellar point. If the observed altitude of the star was H, the observer must be situated on a circle of radius 90°—H, with the sub-stellar point as center, but may be anywhere on it. Simultaneous observations of two stars give two circles, which intersect and give a "fix" defining the observer's position (Figure 1, taken from the previous article.—*Ed.*).

Practically, the problem splits up at this point into three clearly separate parts. How may the navigator find the position on earth of the sub-stellar point? How may he find his distance from it? How may he carry out the calculations required to get his "fix"?

The first problem is really far the hardest. Its answer demands a full knowledge of the motions of the Earth, Sun, Moon, planets, and stars, and accurate predictions years in advance, based on this knowledge. Fortunately for the navigator, astronomers have been deeply interested in these questions on their own account, and the results of centuries of observation and of an enormous mass of mathematical analysis and numerical calculations are boiled down into the Nautical Almanacs—from which, for any Greenwich time, the desired quantities can be derived. To find the Greenwich time accurately used to be be very difficult, for the best chronometers ran off gradually on long voyages; but since the advent of radio signals, this trouble has vanished.

The measurement of the altitude of star or Sun must be done by the navigator himself; yet, again, this task is vastly simplified by the capitalization of experience. The sextant, with which he observes, is a masterpiece. Its very simple principle—discovered originally by Newton—has never been bettered; but it is far from easy to construct a portable instrument, light enough to be held in one hand without fatigue, which reads angles to a fraction of a minute of arc. On the graduated arc of an ordinary marine sextant, 1′ corresponds to rather less than a thousandth part of an inch. To graduate the scale so that all the divisions are at least as good as this, and that the center pivot of the moving arm is set in place with comparable accuracy—and, what is more, so that the whole affair remains accurate after years of use—demands a very high level of workmanship.

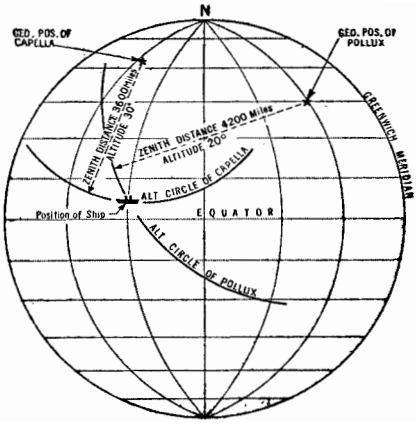


***Figure 1*: The two-circle fix**

ONCE more, the navigator who will pay a fair price has his problem solved for him—his tested and certificated sextant is amazingly accurate and trustworthy. With such an instrument, equipped with a telescope magnifying five or six times, altitudes could be measured to a small fraction of a minute of arc, and the ship's position located to a correspondingly small fraction of a mile, were it not for one thing. The rays of light which reach the observer from a star are deflected by refraction in passing through the atmosphere; but allowance can be made for this with all necessary accuracy. The rays which come from the sea-horizon are also refracted; and, unfortunately, the amount of this refraction varies considerably according as the air is warmer or cooler a few feet above the surface than at the water level. The average effect can be, and is allowed for, but the daily and hourly deviations from average conditions are unpredictable. They very rarely exceed two or three minutes of arc; but on the average they probably vitiate the result by about 1′. For this reason alone positions obtained with the sextant at sea are likely to be a mile or so wrong.

The aerial navigator is quite differently situated. He can rarely see the sea-horizon clearly, and his sextant must have a level-bubble built into it in some way, so that, when the image of the Sun or a star appears to be in the center of the bubble, it is really on the true horizon. Even the best observer cannot hold the bubble perfectly steady—nor is it possible to center the Sun's image in that of the bubble with the same delicacy of adjustment involved in making it touch the image of the sea-horizon. Nevertheless, a good observer with a bubble sextant can get results with an average error of less than 2′ for a single "shot."

BUT, in flight, troubles begin. The least deviation of the motion of the "ship" from perfect uniformity, whether in speed or direction, introduces accelerations which deflect the apparent direction of gravity for an observer sitting in it. At times these deflections are emphatically large; they may amount to 60 degrees or more in a sharply banked turn, and, in a loop, they reverse the direction of gravity.

A relatively simple calculation shows that, in an airplane flying at 200 miles an hour and changing its course at the rate of only one degree per minute, the centrifugal force would throw the level bubble off by 9′. Extremely good piloting is necessary if good sextant observations are to be made in the air, and, even so, the average error of a single shot will be several minutes. The average of a set of rapid observations is, of course, better.

It is an old standard principle of computation that the tables used in working out observations should preserve *one* "guard-figure," running beyond the accuracy of the measures. To use two such figures would be a waste of time; to use none would throw away part of the painfully acquired precision of the instruments.

In marine navigation, where the sextant readings are to be trusted to about 1′, tables which go to tenths of a minute are abundantly accurate. To stop at 1′ would not quite do; for, if two or three quantities taken from tables have to be combined, the neglected decimals may, by bad luck, all work in the same direction. By the laws of chance this happens rarely and there would be little real loss, on the average, if the marine navigator rounded off his calculations to even minutes. For the airman, the gain in calculating to tenths of a minute would be wholly illusory.

Three different kinds of "almanac" are therefore published at present by the Nautical Almanac Office. The *American Ephemeris,* for the use of astronomers, contains phedicted positions of the highest

attainable accuracy (to 0."1). The *Nautical Almanac* gives data to 0.'1; and the *Air Almanac* only to 1'. The *Ephemeris* is of course much the bulkiest, and is the slowest to use; the calculations necessary for precise interpolation between tabular data, given usually at intervals of a day, are somewhat laborious. In the *Nautical Almanac,* the data useful only to the astronomer (such as that regarding Uranus and Neptune) are left out, and those which the navigator needs are given in detail. These are the declination and Greenwich hour angle of the body, which equal exactly in latitude and longitude of its sub-stellar point, (see Mr. Collins' article). For the Sun, these are given for every two hours of Greenwich time; for the Moon, which moves faster, for every hour; for stars and planets, for every day.

THE *Air Almanac* helps the navigator still more, giving the all-important "G.H.A." for every ten minutes. Allowance for the odd minutes and seconds can then be made by adding a small correction from a table printed on a cover-flap so that it can be folded down where it is needed. It is remarkable how much time is saved, and danger of mistake escaped, by simple things like this.

For the practical use of the navigator, it is hard to see how anything could be quicker and more convenient to use, or more nearly fool-proof, than the *Air Almanac.* In using the last adjective the writer is very far from intending to cast any aspersions upon the capacity of the officers of the Air Force of our own or any other country. It is one thing to make calculations in a well warmed and lighted room, with no distractions and no hurry, and a very different one to work in more or less cramped quarters under black-out conditions, with the thermometer far below zero, and the barometer so low that one cannot keep alive without oxygen—to say nothing of urgent need of instant use of the results, and the knowledge that the enemy is not far away. Everything that can be done in advance to simplify the work and avoid mistakes is of tremendous value.

The same principles apply to the third of the navigator's problems—his calculations. Theoretically, they are much simpler than the others. A great number of methods of solution are available, all sound in principle, and some of them mathematically elegant. But, in practice, considerations of accuracy, feasibility, and speed are vital.

The most obvious of all suggestions is to plot the true sub-stellar points on a globe, draw the "Sumner lines," and note their intersection. This must have occurred to everyone who thought about the problem, since Captain Thomas H. Sumner discovered, in 1837, that each observation determined that the ship was on a given circle, but not at what point on this circle.

But the practical difficulties are extreme. It is by no means easy to draw circles, even on flat paper on a well-lighted drawing-table, so that their points of intersection are accurate within 1/1000 of an inch, and it will certainly be no easier to do so on a globe. If this error is to correspond to one nautical mile, the globe must be on a scale of 100 nautical miles to one inch, or 68 inches in diameter—not a handy affair to work with, even in the chart-room of a large ship in smooth weather. A scale of 500 miles to the inch, giving a 14-inch globe, would be about as large as was practicable —but on such a scale the best pencil lines which could be drawn to represent the Sumner circles would be miles in width. The centers of these circles would have to be plotted with an accuracy of 1/500 of an inch, and their radii measured on the average to 1/3000 part of their own amounts. Work of this accuracy, under good drafting-room conditions, is possible, though slow; but to attempt it under

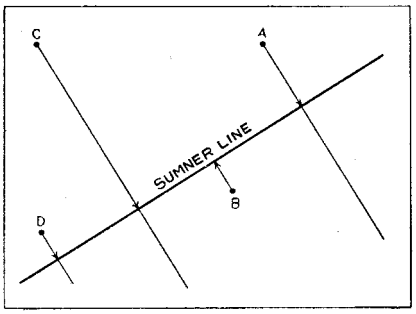


Figure 2: **Finding Sumner line**

the circumstances of a bombing flight would be absurd.

This difficulty is completely removed by the method devised in 1875 by Rear Admiral Marcq S. Hilaire. The navigator always knows where he is, within a hundred miles or so, and usually much better—barring major catastrophes like that of a ship driven before a gale with her bridge carried away.

THEN (as Mr. Collins has explained) he has only to calculate what the altitude of the star, and its true bearing (azimuth), would have been, if observed from the assumed position at the actual time; plot this assumed position upon a large-scale chart (say 20 to 50 miles to an inch); draw a line toward the calculated bearing; lay off on this the difference between the calculated altitude and the one actually observed (toward the bearing, if the observed altitude is greater, otherwise away from it); and draw a line through the resulting point at right angles to the bearing line. This is the desired Sumner line: it takes hardly more time to draw it than to read how it is done. It can easily be shown that it does not matter where we choose our assumed position—within reasonable limits. This is illustrated in Figure 2, which shows bearing lines drawn from various points, *A, B, C, D,* with the proper "intercept" cut off on each. So long as these points are not more than 50 miles or so apart, the bearing lines, which all run to the sub-stellar point, are very nearly parallel, and the line drawn perpendicular to each one, at the indicated point, will be the same in every case. No matter where we start, we finish with the same line to locate our ship.

The problem then reduces to the calculation of the star's altitude and azimuth at a previously assumed place and time.

There is nothing so terrible about the old direct methods. They can be worked in practice by any one who has sense enough to follow certain simple rules, but on the principles already stated, anything that shortens the actual work and leaves fewer places to make mistakes, is a real advance.

A VERY simple solution is found in the great Hydrographic Office Table (No. 214) in which the solutions of the problem are actually worked out, in advance.

The desired quantities depend on three given data: the latitude of the assumed point, the latitude of the sub-stellar point (otherwise, the declination of the star), and the difference between the longitudes of the two (otherwise the local hour angle of the star). Now we cannot change the sub-stellar point; its position is fixed: but we can shift the assumed position as we please, and still get just the same Sumner line.

We may then choose our assumed point so that its latitude is an exact number of degrees, and its longtitude differs from that of the sub-stellar point by an exact number of degrees. If, now, tables are constructed giving the desired values of altitude and azimuth for each degree of these quantities, and each degree (or, better, each half degree) of the latitude of the sub-stellar point, we can get the exact answer we want by interpolating between two adjacent tabular values, and so allowing for the odd minutes of arc in the last quantity.

The "intercept" can then be found, and the Sumner line drawn, as in Figure 2. The navigator will in any case want to have this line on a *chart,* not on a globe: if he is a mariner, on a chart which shows the coast-lines, reefs, and possible dangers; if an aviator, on one which shows his objective, peaceful or warlike, and its vicinity.

In the writer's opinion, far too much concern has been expressed in various popular discussions about the rare case in which the dead-reckoning estimate of the navigator's position is seriously in error. Should this actually happen, and observations be available to correct it, Sumner lines worked out with the assumed position, even if very far wrong, would give a fix fairly near the truth. Starting from an assumed position near this a good fix would follow.

It should be emphasized that the time involved in using these modern tables is only a small part of the whole time of working out an observation. Correcting the sextant reading (simple, but always necessary), taking the position of the subsolar point from the almanac, and plotting the final line of position on the chart—though none of them very laborious—take up together a good deal more time than the reference to "H.O. 214".

It would not be reasonable to argue that this method is the best and quickest possible; but discussion of this subject should obviously be postponed till "after the duration," most of all by the inventors of better things.—*Princeton University Observatory, January 20, 1943.*

Fossil Magnetism

Experimental Evidence Denies that the Earth's Magnetic Field Has Been Completely Reversed

A. G. McNISH
Magnetician, Department of Terrestrial Magnetism, Carnegie Institution of Washington

THE MAGNETIC compass, which has guided the travels of man for many centuries on land and on sea, and now even in the air, remains today one of the most important of navigational instruments in spite of the strong competition being offered it by the far more elaborate and expensive gyrocompass. That the magnetic compass has faults one must admit, but these faults are far more frequently due to careless construction and installation than to defects inherent in its basic principle. The mariner's compass is a precise instrument for navigation; usually it receives less care and attention than a cheap alarm clock, and yet it performs its function faithfully.

In order that the magnetic compass may attain its maximum utility, a knowledge of the direction of the magnetic force at all places on the earth's surface is necessary, and, since this force is slowly but constantly changing in direction and intensity (Figure 1), continual observations of it must be maintained. Although observations extend over four centuries, no definite law of these changes has been discovered—the changes are too complicated and perspective too limited to admit even today of much more than a descriptive model of the phenomena.

The geomagnetician has taken a hint from the biologist who, being unable to observe directly the evolution of the various forms of life, seeks the necessary evidence in the fossil remains of past ages. Just as rocks preserve a record of the evolution of various forms of life, so also they seem to have preserved a record of the evolution of the earth's magnetic field.

Half a century ago studies were made on ancient bricks and potteries and on the magnetization of volcanic rocks. The results of the studies on volcanic rocks led to weird conclusions, the weirdest of which was that in a not too distant past the direction of the earth's field was completely reversed. It is assumed that volcanic rocks, on cooling, become magnetized in a direction which coincides with the direction of the earth's magnetism at that place when the rocks cooled. But in many cases the rocks may have become magnetic before they found their final resting places, thus leading to ambiguous results.

No suggestion that the direction of the earth's field was completely reversed is to be found in historic records of geomagnetic observations. Reliable observations at a number of places extend back over four centuries. They show that large changes —as great as 35 degrees in the direction of the horizontal component in 200 years —have occurred, but there is no suggestion of a complete reversal in direction. A systematic study of the direction of the earth's magnetism in past geologic ages based on the residual magnetism of rocks would clear up this important point and establish the necessary conditions which any theory of the geomagnetic field and its secular, or long time, variation must fulfill.

Fortunately, suitable rocks are readily available for the prosecution of this investigation—the varved Pleistocene clays (Figure 2) left at the retreat of the last glaciation. These clays are adaptable to this study for a number of reasons: They have retained essentially the same directions in geographic space ever since their deposition; they exhibit distinct layering, each layer (varve) corresponding to a year, so that the relative date of each layer may be determined; their chronology for 7000 years has been reliably established by Antevs. The magnetic properties of these clays are due to the presence of finely divided particles of ferromagnetic materials, presumably magnetite, which abound in the hills over which the ice-sheets passed. During the summer thaws these particles were washed into the calm waters of the terminal lakes where they settled to the bottom. Large particles being deposited at first and finer particles during the ensuing winter, gave rise to the distinct varving. The magnetic particles, as they settled to the bottom, aligned themselves with the earth's field at that time, behaving like minute compasses. Subsequent depositions locked these particles in place, thus preserving a record of the direction of the magnetic field at the time.

These clays, like most sedimentary rocks, are only slightly magnetic as compared with volcanic rocks. However, their magnetization may be readily measured by a newly developed technique which is due in the larger part to my colleague, E. A. Johnson, who has been working with me on investigating the magnetization of these clays.

After these clays have been collected—care being taken to avoid all proximity to magnetic materials throughout the process—they are cut into cubes, the faces of which are alined in a known geographic direction in place. The cubes are then rotated in a coil to determine their magnetization without exposing them to any artificial magnetic field—a fault inherent in the method of measurement of most previous investigators.

RESULTS of these measurements have been highly consistent. Directions of magnetization in adjacent annual layers agree with each other to within the limits of observational accuracy, considering the difficulties involved in squaring off and properly alining the faces of the cubes. The directions of magnetization in widely separated layers, corresponding to different years, may differ considerably. Agreement between separate specimens from the same layers has been very good, even though the sites from which the specimens were obtained were several miles apart. Measurements, which reveal similar results, have been made on core-samples obtained from the ocean-bottom. However, with these core-samples it has not been possible as yet to refer the observed direction of magnetization to a fixed geographic direction nor to establish either a relative or absolute time-scale.

Interpreting these measurements as observations on the direction of the earth's magnetism in past geologic ages, we may

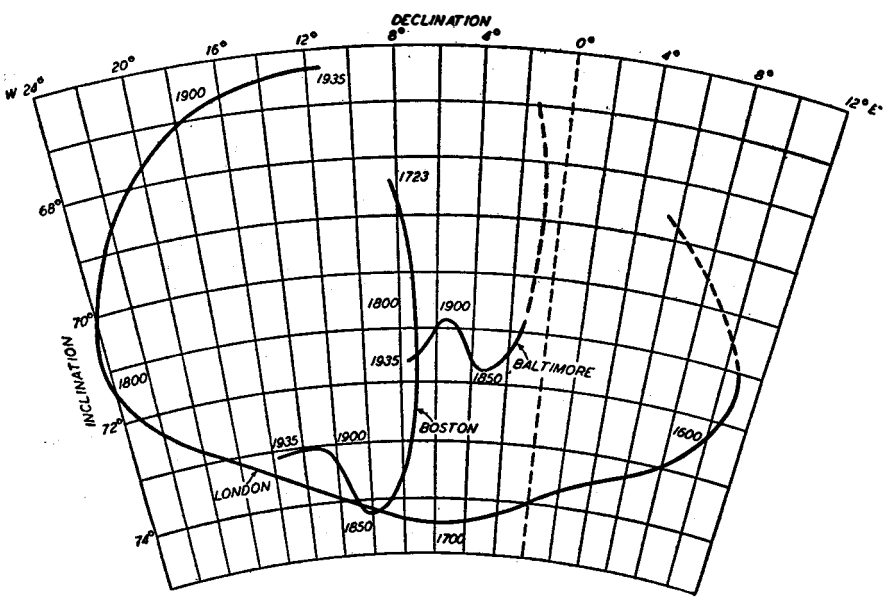


Figure 1: **Time variations in direction of magnetic force**

Modified from the *Proceedings* of the American Philosophical Society.

conclude that, during the period investigated, the direction of the field was not remarkably different from what it is today, and that changes were taking place similar in magnitude and rate to those which have been observed during historic times (Figure 3).

One may appropriately raise a question as to whether or not the magnetization of these varves as measured today closely corresponds to the magnetization they acquired at formation. In support of the belief that they do is the fact that the coercive force of the clays is very high, so that an extremely strong magnetic field is required to alter their magnetization. The observations themselves supply the evidence that the clays are not randomly magnetized. If the earth's magnetism had slowly altered their original magnetization during the thousands of years that they have lain in their present beds, tending to make the direction of their magnetization regress toward the present direction of the earth's field, large differences in the direction of magnetization for layers differing in ages by one or two hundred years in ten thousand would

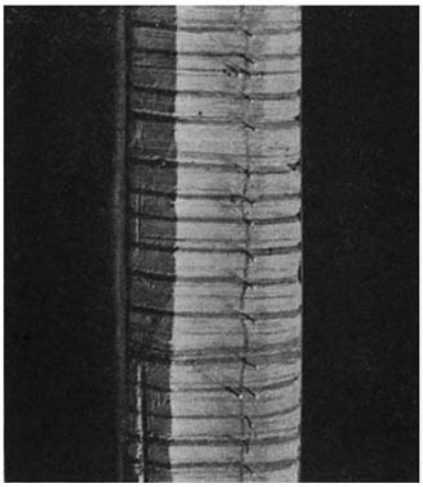


Figure 2: **A section of varved sediments. Each pin represents one year (one varve). Each varve contains a dark lamina deposited in winter and a light lamina deposited in summer. Outstanding in research on the duration of post-glacial time is Ernst Antevs, mentioned in the text. An American geologist of Swedish descent, he has substituted for mere estimates and "guesstimates" actual counts based on varves found in sediments deposited in lakes bordering ancient glaciers as they melted back, vanished, released the waters, left the sediments where they rest today.**

not be expected. In short, by a process of exhaustion of possible causes, one is compelled to the belief that only the earth's magnetic field at the time of their formation could be responsible for the directions of magnetization observed in the clays today, and hence that they portray to a high degree of fidelity the changes in the Earth's magnetism during past geologic ages.

Information derived from the study of fossil magnetism permits a more complete description of the earth's field and its changes than has been possible before—a description which is essential to the formulation of a theory regarding its cause and origin. If, as was suggested by observations on the magnetization of volcanic rocks, the earth's field has been completely reversed in past geologic times, one type of theory must be proposed. But if, as is supported by the evidence from the varved clays, the earth's field has remained relatively constant throughout time, changing only in minor particulars, then a different type of theory is required. The evidence furnished by the varved clays fits well into a general concept derived from our present knowledge regarding the spacial distribution of the field and of its secular or long-time change.

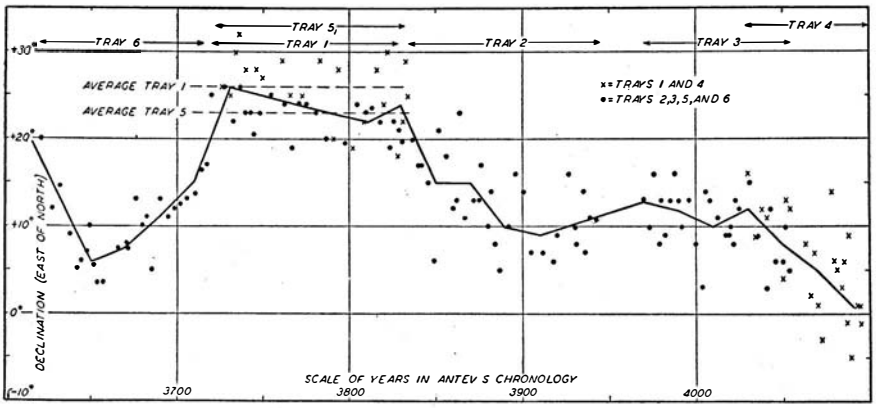


Figure 3: **How long-time trends are worked out from trays of varves**

Extensive data on secular change have been compiled by Fisk. He demonstrated that secular change is essentially a regional phenomenon. There are large areas, continental in extent, where the magnetic force is increasing and corresponding areas where it is decreasing. The most satisfactory representation of these changes on a world-wide scale is obtained by an isoporic chart for vertical intensity, that is, a chart on which appear contour lines of equal annual change in that element. Examination of such a chart reveals several centers where the rate of change is a maximum.

RESEARCH has shown that the earth's field and its secular variation at the present epoch may be represented by a small but powerful magnet near the center of the earth to produce the uniform field, by a set of 14 considerably weaker magnets appropriately located midway between the center and the surface (that is, at the discontinuity between the earth's presumably fluid core and the mantle), with their north poles directed toward or away from the center, to produce the residual field, and by the yearly addition of a set of 13 magnets all of the same strength and about one-hundredth as strong as the magnets of the residual field and in general midway between them to produce the secular variation.

Clearly, the continual addition of the secular-change magnets for a long time would build up a new residual field after about a century which would differ markedly from the one existing at the present time. Therefore, continuation of secular change for more than a century or two in the same sense, that is, either plus or minus, seems unlikely—changes in secular change must occur. Historic records favor this view, since at no point do we have evidence that large secular changes have continued in the same sense for longer periods. Although the compass-direction at London changed from 35 degrees—from 11 degrees east to 24 degrees west—between the years 1600 and 1800, both before and after those years the change was in the opposite direction. Such is also the evidence supplied by the varved clays that, although large changes have occured with relative rapidity, these changes have not continued in the same sense for a long enough time to alter the main aspects of the earth's field.

This concept which has been presented is only a model. The earth's magnetism cannot be due to concentrations of magnetic matter at individual points, but such concentration of matter at points constitutes a limiting case. Thus the residual-field magnets at the surface of the earth's core are symbolic representations of extensive regions of magnetization existing at lesser depths, and the secular-variation magnets correspond to the growth or decay of magnetization on the edges of these systems. According to this concept, secular variation consists of a migration of the regions of magnetization which give rise to the residual field. Representation of these regions by magnets at the surface of the earth's core establishes their limiting lower depth—the regions themselves must be nearer the surface; namely, in the rocky mantle of the earth. An excellent picture of the migration of those regions is revealed by magnetic charts of the residual field for various epochs. Distinct, progressive changes in location and extent of these regions are evident.

Thus, from the accumulated evidence of lengthy series of painstaking observations extending over several hundred years in time and over millions of square miles of the earth's surface, a more coherent picture of the earth's magnetic field and its secular variation is presented than was obtainable before. The general features of this picture are supported by the evidence derived from the study of magnetization in varved clays which permits extension of the picture backward into past geologic ages. Further, and perhaps new and vital, evidence will develop with the continuance of the investigation of fossil magnetism.

Using All But The Smell

Off-Size Citrus Fruits and Cannery Wastes Are the Basis of a By-Product Industry of Huge Proportions

HAMILTON M. WRIGHT

IT IS ESTIMATED that from 2,500,000 gallons to 3,000,000 gallons of concentrated citrus fruit juice were produced in the United States during 1942 for shipment abroad under the lend-lease act and to American military bases on foreign shores. The Government buys the juice under specifications that the flavor must be good and that the vitamin-C content must be in the ratio of two milligrams for each gram of the concentrated juice.

Another citrus product that figures largely in export is citrus pectin, used in the production of jams, jellies, and marmalades. Large amounts will go to England, which at one time during the height of German bombings was reported to be entirely without marmalade.

While concentrated citrus juices and citrus pectin have become important exports, they are only a part of the imposing list of citrus by-products which science has developed for a wide range of uses. Among these are citric acid; oil of orange and other essential oils for flavoring candies, soft drinks, and lending the desired aroma to perfumes; and glucosides, including hesperidin, a flavone glucoside occurring in most varieties of citrus fruit. Then, too, there are orange peel; orange meal used for cattle fattener; orange butter; powdered juice; citrus wines, brandies, and cordials; flavoring extracts; soft drinks with orange flavor; tea-seed oil used in the fixation of dyes; commercial alcohol; and the pectin mentioned above, which is also used in the manufacture of emulsions and lotions where it acts as an emulsifying agent to hold oils in suspension. Pectate acid salts or pectate are beginning to be used in some of the technical industries.

To gain a first-hand impression of citrus by-product possibilities, consider an orange sliced in two. The yellow outside covering, skin, or peel, of the orange is called the "flavedo" and contains many small cells filled with oil which may be easily pressed out. This fragrant oil contributes importantly to the production of orange flavoring extracts, perfumes, and so on. Preserved orange and lemon peel are much esteemed products in which the flavor and essence of the oils are important. The manufacture of citrus oils —the first citrus by-products—had its birth in Italy at the time of the American Revolutionary War, but up to recent years Italy produced only citrate of lime, citrus oils, and some peel in brine from citrus fruits. Today, the picture is different.

The principal pigments in orange peel are chlorophyll and carotin. The latter is closely related to vitamin A, and is found in most yellow fruits and vegetables. It is not put to commercial use but gives the orange its yellow color.

Next after the orange peel or flavedo comes the "albedo." This is the source of citrus pectin and is valuable in other citrus by-products. The albedo is the thick, white, pulpy portion of the rind, and includes also the membranes between the segments of the fruit and the pith at the center.

Pectin is that material in fruit which, with the addition of sugar, not only causes fruit juice to jell, but has important medicinal uses and implications. Many of these medicinal uses are still in an experimental state, and it may be years before the medical profession will consider that time and research have combined to approve or disapprove some of them. However, literally hundreds of articles have been written on the medicinal uses of pectin in the last ten years. As one example, the Bulletin of the National Formulary Committee (American Pharmaceutical Association) says:

"ONE OF THE remarkable things about the animal mechanism is the fact that the blood courses continually through many arteries and veins without clotting, yet the delicate balance of blood constituents automatically shifts to allow coagulation on wounds. Hemostatic substances added to blood in the living animal must not cause clotting in the circulating blood but must hasten coagulation of drawn blood. In the case of many substances the action on drawn blood is entirely different from that on circulating blood in the body.

"Pectin, when introduced intramuscularly or intravenously, has been found to exert a distinct accelerating effect on coagulation of drawn blood, yet when added outside the body to previously drawn blood does not seem to have any particular effect. Likewise, it has no coagulating effect on circulating blood. Pectin, when orally administered, in addition to showing some accelerating effect on coagulation of drawn blood, exhibits a styptic action through the gastro-intestinal tract."

New methods of chemically altering pectin for use in jellies and so on are expected to reduce the sugar requirements for these purposes by 30 percent and may do away with it entirely. A $990,000 plant for the production of citrus pectin and concentrated orange juice, completed recently at Dunedin, Florida, will supply 800,000 pounds of citrus pectin and large amounts of concentrated citrus juice for lend-lease. The funds were provided by the Government and the plant has been leased to operators who, for the past six years, have been engaged in producing citrus juices and concentrates at a large plant nearby.

ANOTHER large processing plant has been completed at Lake Wales, Florida, at a cost of $250,000. It will consume 1½ million boxes of off-size citrus fruit per annum in the production of concentrated citrus fruit juice. The Dunedin plant will use from 1½ to 2 million boxes of off-size citrus fruit per annum, the two plants thus consuming some 3½ million boxes of such fruit each year.

The most important outlet for citrus fruit is the fresh fruit market, but the public exhibits a preference for fruit of

Scientifically compounded fertilizer helps produce mineral content in citrus fruits

attractive appearance and uniform size. Thus the search for means to utilize off-size fruit had an important part in the development of citrus by-products.

It was in California that attention was first given to the use of off-size fruit and, as the result of years of research started there, the canning of fruit juices and the production of valuable by-products has reached the status of big business.

One of the most important facts to be taken into consideration in the commercial handling of orange juice is that the oxygen of the air is a definite enemy of good flavor. Moreover, the oxidation of the juice tends to destroy the vitamin-C content; for this reason, the juice must be squeezed out of the orange so that a minimum amount of air comes into contact with it, and air must be excluded in the concentration and preserving processes.

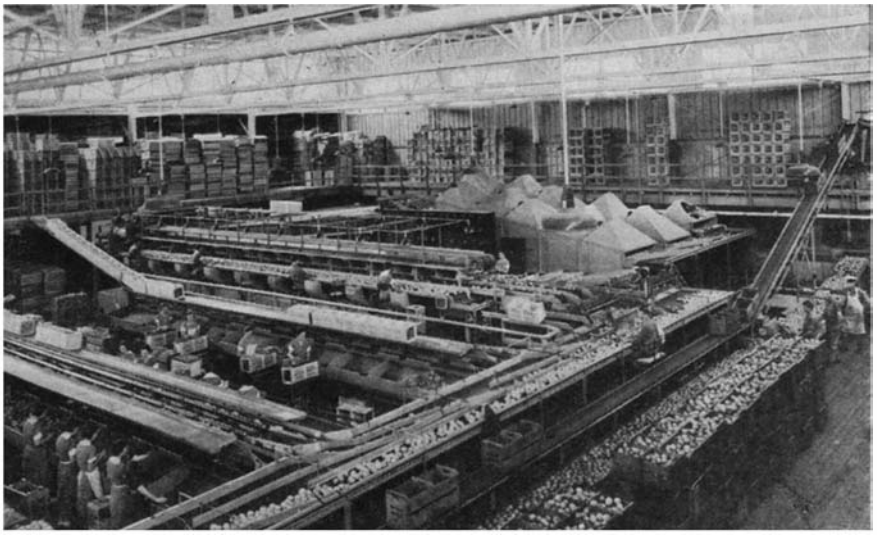
Most of the plants concentrate citrus juices with the use of the vacuum pan, constructed of stainless steel and ordinarily operated under approximately 26 inches of vacuum and at a temperature of 120 degrees. Orange juice is thus concentrated so that the resulting product contains about 65 percent solids. Most plants follow the process of flash Pasteurization of the juice prior to the time that it enters the concentrator. The final product is packed in one-gallon cans which are hermetically sealed. Most of the orange juice which is used domestically for the preparation of orange drinks and carbonated beverages is packed in barrels with sodium benzoate added as a preservative.

IN ANOTHER concentrating process, orange and other citrus juices are treated under high vacuum and low temperature. The juice is not pasteurized at any time and the concentrated product more nearly retains all the flavor of fresh orange juice.

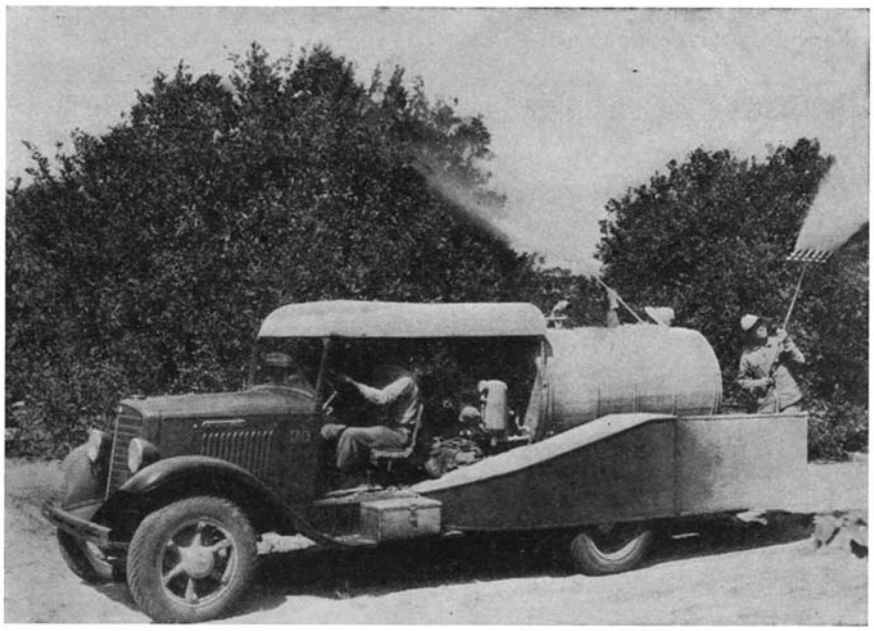
Most citrus-fruit processing firms have their own methods of concentrating, each slightly different from the other. The flavor of the concentrated juice varies with the different brands, according to the type of fruit used, and the process utilized. Generally speaking, the vitamin-C content of the finished product is not less than 85 percent of that contained in the original juice and, in many instances, more than 90 percent of the ascorbic acid is retained.

Concentrated orange juice is usually reduced to a volume of not more than one seventh of that of the original juice. A leading Florida producer concentrates to one tenth or even one eleventh of the original volume. Concentrated lemon juice is usually brought down to a volume of one sixth and grapefruit from one seventh to one twelfth of the original.

It is difficult to make all-inclusive statements about the keeping qualities of citrus juice concentrates, for the reason that they are packed in different types of containers and with and without preservatives. In general, properly manufactured concentrates of orange, grapefruit, and lime juice, sealed in gas-tight containers, in the absence of oxygen, may be preserved for from 12 to 36 months at 30 degrees, Fahrenheit, without objectionable deterioration. Sulfur-dioxide added to those concentrates packed in waxed fir barrels will retard darkening and loss of vitamin C, particularly at higher temperatures. In general, the rate of deterioration is proportionate to the rate of oxidation and as low temperature storage and protection from air retard oxidation, cold storage and tight containers are the most effective means of prolonging the storage life of citrus concentrates. Orange concentrate in gallon cans for consumption in two to four months has been shipped to England without special storage provision, although cold storage of citrus concentrates is desirable for protecting the color, flavor, and food value. The Government is now at work on methods for improvement of keeping qualities of these products without special and expensive cold storage.



Fresh fruit packing is still the most important outlet for the citrus industry, but by-products are catching up. Before packing, fruit is sorted, washed, polished, and dried



To protect fruit against insect pests, citrus groves are thoroughly, regularly sprayed

ABOUT two thirds of the bulk of the fruit processed for juice is rejected by the canneries. This rejected part consists of rind, pulp, and residual fruit juices, oil, and water. This waste formerly constituted a disposal problem which frequently cost canneries from $25 to $50 per day during the operating season, for even an unsatisfactory solution.

Attempts to convert this waste into cattle feed were made over a period of almost five years. The product was bitter. It imparted a bitter taste to the milk of cows. At last, an inexpensive means of complete dehydration was discovered. The discarded pulp and rind were mixed with lime which formed a calcium pectate. The water could then be readily pressed out of the waste. When the product of this process was dried by direct-fire dryers, a valuable cattle feed was obtained, entirely free from any bitter taste and incapable of producing bitterness in milk. This feed is rich in carbohydrates and protein and compares favorably with dried

beet pulp for cattle. It is largely bought by dairies and has been found to increase the butter-fat content of milk. In 1940, 18,000 tons of dried citrus pulp cattle feed were produced in Florida; in 1941, the production reached 35,000 tons valued at $1,450,000; still production has not reached within 25 percent of the present possible maximum.

But even this cattle-feed production was only a partial answer to the waste problem. The juice or "press water" which was pressed out of the citrus pulp and rinds in the manufacture of the cattle feed from cannery wastes amounted to millions of gallons each season, and constituted a pollution nuisance. The Government Citrus Products Laboratory at Winter Haven, Florida, has announced that it has perfected an inexpensive process to convert this press water into alcohol.

As the press water contains a low sugar content it is first concentrated under vacuum until the sugar content amounts to from 10 to 12 percent. The press juice is screened but not filtered, and then inoculated with 4 percent by volume of starter yeast. During fermentation the temperature is maintained at between 75 and 85 degrees, Fahrenheit, and the run is completed in 72 hours in accordance with the internal revenue law.

It requires about 25 gallons of press juice to yield one gallon of 190 proof alcohol. Thus, hundreds of thousands of gallons of commercial alcohol can now be produced from the press water from cattle-feed plants. As an additional by-product, about 12½ ounces of dry yeast, which can be used in stock or poultry feed, can be obtained per gallon of alcohol produced.

The amount of citrus fruit shipped from Florida today is almost double that of six or seven years ago. The fruit now provides a reasonable profit to the grower, whereas a few years ago in many cases the fruit was being sold at less than production cost. This condition has been largely brought about by observance of higher maturity standards which assure better fruit reaching the market, and through advertising, sales promotion, and research. The fresh fruit market only runs about eight months of the year. Citrus fruit canning in Florida has sprung up in the past 15 years. The grapefruit canning industry received its impetus in the last ten years, climaxing its growth in the 1940-41 season when over half of the grapefruit production was put into cans, approximately 14,000,000 boxes being canned. The orange canning industry is now in its infancy, but it is growing by leaps and bounds.

• • •

Save Your Tires

Sealing Puncture Holes Protects the All-Important Fabric and Greatly Prolongs the Life of Tires

A. L. MURRAY
President, Auburn Rubber Company

THE MORE the matter of tire conservation is studied—both by inspections made of discarded tires and by taking up these matters with the heads of various tire companies or with men in charge of tire repair work—the plainer it becomes that repairmen and owners alike have been badly overlooking one of the greatest of all causes of tire destruction.

Nobody, least of all the owner, could be particularly blamed for it, because the average driver sees only the outside of his tire and doesn't realize that the tread of a tire is only its wearing surface. So the owner, who probably never sees the inside of a tire carcass, has had practically no realization that the most important part of a tire is really the inside fabric, which constitutes its one source of sufficient strength to continue to out-wear the tread.

A checkup of tires which recap men have had to turn down because it wouldn't pay to retread them shows a small percentage with sidewall cracks caused by under-inflation, and another small percentage of breaks caused by some such accident as running against the curb; but the great majority had to be turned down because of fabric damage caused by neglected puncture holes as described by the accompanying drawings.

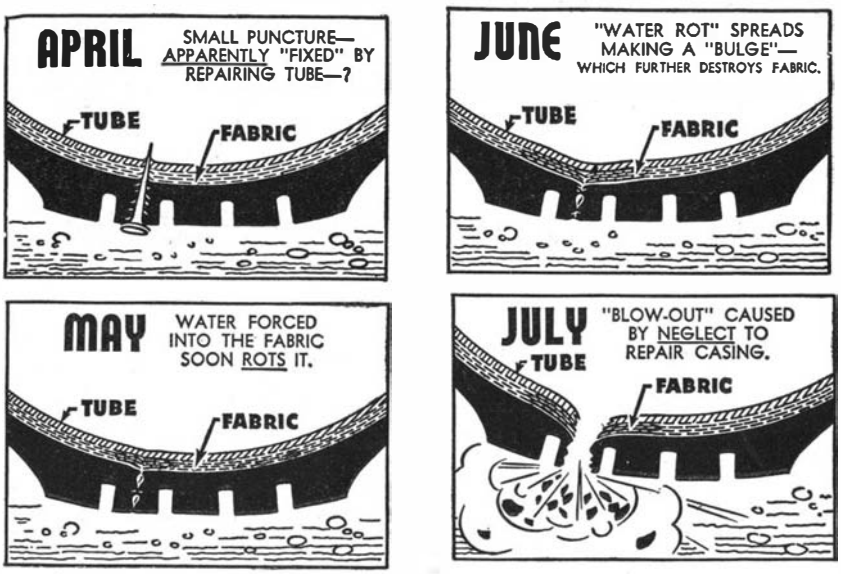
Since the average automobile owner, when his tire shows a leak or a puncture, simply drives to a repair shop to have that "flat fixed" at a charge usually of about 50 cents and doesn't want to pay any more, the dealers cannot be blamed very much if they finally gave up trying to get the owners to do any more than take care of the puncture by means of a pasted-on rubber patch on the tube and possibly a similar one pasted on the inside of the casing, neglecting entirely to do anything about the puncture where the tread of the tire and its fabric had been cut.

Every tire repairman has his way of sealing such a break in the casing so that water will be prevented from working into and rotting the fabric. If this is not done, a blowout will eventually result.

The big thing is that punctures are much more common that most people realize. Ordinarily, it is quickly fixed and the owner soon forgets about it. More than one man will tell you that "I have never had a puncture," although his tires are nearly two years old. That is simply because he has forgotten about it or some one else was using the car at the time. The chances are that inside inspection will show that anywhere from three to eight punctures have been received by his set of five tires.

Considering that present tires will have to last for a long, long time, it seems that the feeling of security alone of having all tires carefully inspected inside should be worth more than its cost. If fabric water rot from punctures is started, taking care of it without delay means a lot more mileage from that tire than it could possibly give otherwise. And this care can be given only by removing the tire and sealing the hole. Naturally, the tube would be inspected at the same time and quite often this will show the starting of a rim or a bead cut which—unless taken care of—will soon result in tearing the tube so badly as to practically destroy it.

While all of these things about taking care of tires cause a certain amount of present bother, there is at least the consolation that in the future both tires and cars are going to last all of us a whale of a lot longer.



Puncture hole in casing, unrepaired, may lead to disastrous blowout

Wanted: MORE EXECUTIVES!

To help win the war!...and the peace to follow!

Every great crisis produces new leaders. This war is no exception. It has created as great a crisis for business as for our nation, and new leaders are rising to the top every day.

Right now, companies are searching high and low for men of executive ability and training to manage the different departments in new and expanded plants. The war and its demands for production, and *more* production, has thinned the ranks of executives to the danger point. The country needs men of executive ability just as it needs production workers and men for the armed forces.

Where will it find them? Ordinarily there would be enough "officer material" right in the ranks . . . men who had been learning by experience, slowly but steadily advancing in the companies which employed them. That is one way of doing it—the hard way, the slow way. But now time is pressing. Such men are needed not two years from now, but *today* and *to-*

morrow! Where will they come from? Those men will have to be trained, *and the smart ones will train themselves—now!*

How can they do that? Through the Alexander Hamilton Institute's intensive Course of Executive Training.

This executive training, which is described in a book called "FORGING AHEAD IN BUSINESS," can help you to accomplish in months what would otherwise take years—if you could get it at all. It is valuable to men in different lines of business because it covers the fundamentals of *all* business—production, marketing, finance and accounting. It is equally effective for the college graduate or the business man who only finished grammar school.

More than 400,000 men have enrolled for this training and every day reports come in of their promotions, salary increases, new and better positions. Many of these men have become so famous that you will recog-

nize their names instantly when you see them in this booklet.

Send for "FORGING AHEAD IN BUSINESS"

The facts about this executive training are given in the book "FORGING AHEAD IN BUSINESS." This 64-page book has inspired thousands of men. Many say it started them on the road to real business success.

A word of warning. If you are *not* interested in executive training, don't send for this book. But if you *are* interested in this way to better your position and increase your earning power, then we want you to have a copy of "FORGING AHEAD IN BUSINESS" with our compliments. Simply fill in and mail the coupon, and the book will reach you by return mail.

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Please mail me without cost a copy of the 64-page book—"FORGING AHEAD IN BUSINESS."

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Tuning Forks Govern Time

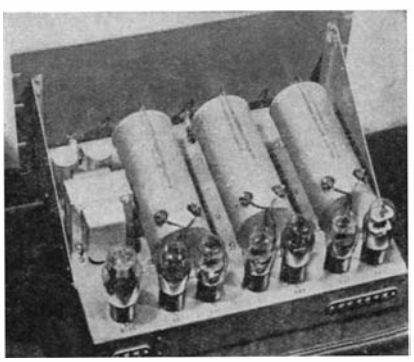
Radio Networks Provided With Split-Second Timing by Newly Developed System

A HIGHLY accurate time system is now in operation in vital NBC studios and control rooms at Radio City, New York. Electric clocks connected to this precision system will not vary more than one-third second a day. War conditions created the need for this time system. Most electrical power distributing systems throughout the country have been affected by the heavy power demands of war industries. As a result, many of the country's operating divisions, New York in particular, have encountered deviations in the frequency of alternating current supply lines to which electric clocks are ordinarily connected. As far as the public is concerned, these deviations are not important since they are extremely small in magnitude. In network operation, however, where seconds count, the lack of synchronization between NBC divisions and affiliated stations becomes a serious problem and may confuse switching operations of an entire coast-to-coast network.

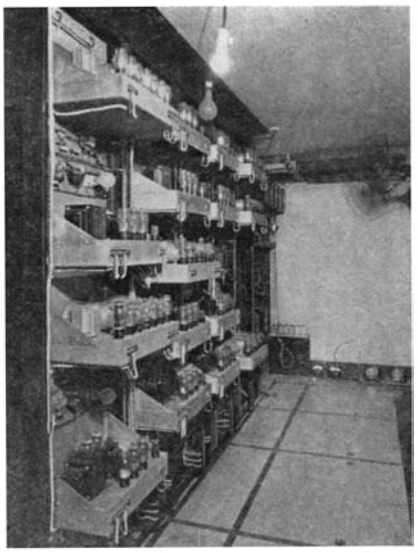
The new precision clock control system, as perfected under the direction of O. B. Hanson, NBC Vice President in charge of engineering, is based fundamentally on the use of a special tuning fork operating in a vacuum chamber. This fork, vibrating at a natural rate of 60 cycles per second, creates infinitesimal pulses which are then amplified millions of times by a series of vacuum tubes, until sufficient power is generated to operate the required number of clocks—200 in the case of Radio City.

As a check on the absolute accuracy of the system, the master clock in each NBC divisional headquarters will be compared daily with the extremely accurate time signals transmitted by radio from the United States Naval Observatory, at Washington, D. C.

Normally, the apparatus draws its basic power to drive the tuning forks and energize the amplifiers from the city power mains. But, if this source should fail for any reason whatsoever, automatic devices would connect the clock control equipment to a reserve power source derived from storage batteries. Change-over would take place so quickly that the operation of the clocks would not be affected.



The tuning forks that constitute the heart of the time-keeping system described are in the cylinders shown



Rear view of the time clock control equipment. All timing units and power supplies are provided in duplicate

When checking the master clock with Naval Observatory time signals, the engineer in charge may speed up or retard the entire time-clock system for correction purposes by bringing into play either one or two secondary tuning forks. One of these vibrates at 55 cycles; the other at 65 cycles per second. The actual correction is done automatically, the proper correction frequency being applied for the required period by an auxiliary clock arrangement.

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VACUUM SEAL

Paper and Adhesive Used in New Coffee Seal

A NEW CAP, made entirely of non-critical materials, designed for Duraglass coffee containers, is, for the most part, a paper product. It is made by a process developed by Owens-Illinois Glass Company and is the result of experiments which have been under way for many months.

This new closure provides a complete package which does not depend in any way on vital materials essential to the war effort, yet it gives the coffee industry an all important vacuum cap to replace metal closures. Not only does this cap preserve the goodness of the coffee in its shipment from the roaster to the eventual consumer, but it also provides an adequate reseal.

The three small parts shown between old and new jar closures in inset are only additions needed to adapt existing machinery to use of new closures

"The new cap is the salvation of the vacuum-packed coffee business," one large coffee roaster declares. "It has provided us with the one thing we needed to take the uncertainty out of our future use of glass containers which so many of us have learned to like so well."

No screw-threads are provided in the new cap, which is made of a combination of paper, adhesive, and special sealing materials. Its exterior surface is coffee brown in color. The interior surface, light in appearance, is tacky to the touch. This is the secret of its vacuumizing property and its practicability for resealing. It can be pressed down after each use, thus tightly closing the jar.

U. S. RUBBER

Guayule and Kok-Saghyz Sources Now Striding Ahead

PROGRESS in the expansion of the guayule rubber production program under the several co-operating agencies of the United States Department of Agriculture has exceeded early expectations, according to a recent report. The Forest Service, which is administering the production phases of this emergency program, has already started to mill the older shrubs planted by the Intercontinental Rubber Company and previously reserved for seed collection. During the winter of 1942-43, the Forest Service-operated factory at Salinas, California, will manufacture an estimated 600 tons—only a fraction of the nation's needs, but the first natural rubber produced in the United States since the beginning of the war. Plantations now being established are expected to yield about 21,000 tons from the harvest starting late in 1944. The planting and harvesting schedule is planned to produce about 80,000 tons annually thereafter. Even the maximum production mentioned, the Forest Service points out, is small in

comparison with the country's normal peacetime consumption of 700,000 tons of rubber a year.

The speed-up in actual rubber production over estimates made a year ago is partly the result of a change in field operations. Instead of harvesting the guayule shrub at the end of four years—which would have delayed the first substantial production until 1946—the Forest Service finds it can increase the number of shrubs per acre and harvest them at the end of the second growing season in the field, the anticipated rubber yield being about 800 pounds per acre.

Only a small quantity of guayule crude is required to "liven up" considerable amounts of reclaimed rubber, and for use in some important products. Moreover, guayule rubber can be handled with the same manufacturing facilities that have been used for plantation rubber from the East Indies and Malaya.

Thousands of local workers in the Salinas, California, area, especially women and girls, helped to weed the 1942 nursery beds and collect seed. The weeding job will not be so large in the future, as a new oil-spraying method kills most weeds in the beds without affecting the guayule plants.

A second source of natural rubber grown in the United States is the Russian dandelion, kok-saghyz, of which over 18,000 pounds of roots have been harvested from experimental plantings made in the summer of 1942 to determine the feasibility of producing rubber from this plant in North America. These roots are from only a small part of the test plantings of 1942. The balance have been left in the field to determine their ability to winter-over and produce seed the second year when seed production is greater.

Largest field plantings of last summer were made by the Forest Service, aggregating 130 acres at several National Forest nurseries in Minnesota, Michigan, Wisconsin, and Montana. On the basis of the year's plantings, the Department reports that kok-saghyz can be grown successfully in the northern tier of states from Vermont to Oregon. It requires fertile soils and is especially adapted to such organic soils as mucks and peats. Root production of 4000 pounds or more per acre was obtained at a number of localities throughout this belt.

The Department of Agriculture emphasizes that this work is experimental and offers no immediate relief from the rubber shortage. Nor, for the time being, will any kok-saghyz seed be available for farm planting.

Preliminary tests made at the Agricultural Research Administration's Eastern Regional Laboratory in Philadelphia showed an average yield of rubber from the raw roots of somewhat over 1 percent, or about 4½ percent of the roots, dry weight, as compared to a 6 to 8 percent average from fall-harvested mature roots in Russia. The kok-saghyz rubber obtained is of high quality, comparing favorably with Hevea rubber. Enough rubber will be extracted to permit further experiments to test its suitability for various specific uses and to determine suitable methods for extraction on a commercial scale.

CURRENT LIMITS

Much Higher in Wires Than Formerly Thought Possible

At a recent National Technical Meeting of the American Institute of Electrical Engineers, two Philadelphia engineers disclosed a new method of determining the maximum electrical capacity of overhead power lines—a method which may enable present lines to be loaded with 10 to 35 percent higher currents and make possible the use of smaller wires in new lines.

The investigation into how much electric current can be carried by copper wire in overhead lines was made by A. H. Kidder and C. B. Woodward of the Philadelphia Electric Company. Ordinarily, they pointed out, wires large enough to carry high currents without becoming hot were used because copper was plentiful. Under present conditions of scarcity, however, studies have been made to determine just how hot smaller copper conductors may become before the heat changes the physical characteristics of the copper, reducing its strength and causing the line to stretch and sag.

"It was concluded," the engineers de-

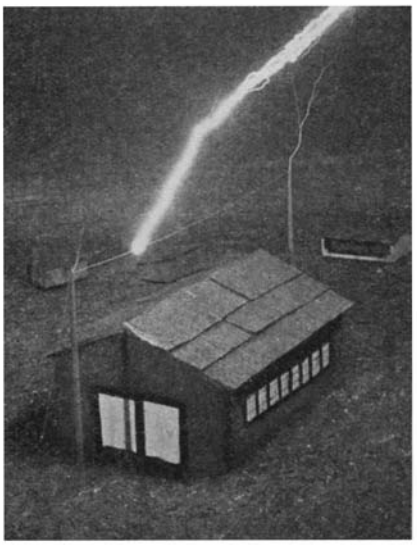
clared, "that copper temperature ceilings of about 237 degrees, Fahrenheit, for normal operation and 318 degrees, Fahrenheit, for emergency operation appear permissible if of short duration and infrequent.

"Our electric current limits," they continued, "are from 10 to 35 percent higher for bare conductors and from 10 to 20 percent higher for covered conductors than those previously used in the Philadelphia area." Operation at these limits will, during 99.93 percent of the hours in the average year, maintain copper temperatures far below ceiling temperatures in both normal and emergency operations.

LIGHTNING SHIELD

Replaces More Cumbersome, Costly Methods

DEVELOPMENT of a wire "umbrella" to shield vital explosives plants and oil storage centers from lightning was recently disclosed by Dr. Gilbert D. McCann, Westinghouse Electric & Manufacturing Company engineer. Fashioned with a



Model lightning shield stands test

minimum of strategic materials, the "umbrella" is being used by some war industries and is on guard at one huge ordnance plant.

Power line protection methods developed at Westinghouse 12 years ago by the late Dr. Charles L. G. Fortescue, noted lightning expert, guided Dr. McCann in his search for a more efficient way of shielding war plants. Dr. Fortescue improved the method of stringing a grounded wire above the lines to lead direct lightning strokes harmlessly into the earth. The "umbrella" works on the same principle. It consists simply of a steel wire strung above the building to be protected and anchored on tall wood poles at each end. The wire is then connected to steel rods buried in the ground.

"This method," Dr. McCann explained, "saves copper for other war uses. Previously explosives plants or oil depots were guarded by lightning rods which required about 250 pounds of copper attached to the building and buried in the surrounding ground. An umbrella for the same building can be erected with only 60 pounds of steel and two wood poles. And with the new design, danger of lightning leaping to metal sections of the building and causing sparks has been eliminated."

FIRE DETECTOR

Acts When Touched by Flame

A NEW method of detecting fires and setting off automatic extinguishing systems is known as the Kidde flame detector, a device which was especially designed for use

Pencil points to detector filaments

in Army tanks, where sudden over-heating of engines and varying climatic conditions from Alaska to Egypt made the use of fixed-temperature and rate-of-temperature-rise detectors impractical. As its name implies, the flame detector is actuated by the flames themselves rather than the heat of a fire. The basic element consists of two organic filaments holding an electrical circuit open. At the slightest contact with flame these filaments are destroyed and the circuit is closed. As an extra precaution, there is also a fixed-temperature thermostat in the flame detector, but this is set high enough to over-ride operating temperature conditions.

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RUBBER PLANTS—Nearly 2000 varieties of plants found in this hemisphere have been tested for rubber since March 1942, by investigators of the department of agriculture at Cornell University.

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OZONATOR

Provides Purified Water Under Field Conditions

A SELF-CONTAINED unit for purification of water without the use of chemicals, through the application of ozone, is sufficiently portable for use in any location where a current supply can be obtained; if desired, it can even be driven by an independent gasoline engine power plant.

Enclosed within the unit, shown in one of our illustrations, are all elements for generation and application of ozone to the water. Water to be purified is circulated through the Sterozone, as the unit is

Pure water at a far outpost

called, by a centrifugal pump, the ozone being automatically injected into the water during its passage through the water. Any ozone injected in excess of that required to oxidize completely all organic impurities in the water remains as a residual concentration, which acts as a safeguard against subsequent pollution.

In the unit illustrated, the water tank, made of heavy canvas, has a capacity of 250 gallons. This tank is supported by an exterior frame.

Readers interested in more details regarding ozone treatment of water for purification purposes are referred to the feature article appearing on page 136 of the March 1942 issue of Scientific American.

FIREPLACES

Can Solve Heating Problems if Properly Used

THE OLD family fireplace is going to play a return engagement this spring, and the cheerful fire on the hearth will be one lighted by necessity; it will not be the luxury item of other years. As a result of the oil shortage, many central heating plants will be shut down earlier than usual, and a fireplace will be ideal for those cool spring mornings and evenings.

Successful use of coal in a fireplace basket grate depends upon starting your fire well. Once started, an anthracite fire needs attention only once or twice a day. Here are tips that will help:

1. Make sure that your basket grate receives air mainly from the bottom through the front and not from the sides or back. Cut out these side and back drafts in the case of open basket grates by pushing the grate against the back wall. Then use fire bricks to build up a wall on each side of the grate. You don't have to cement them, merely pile the bricks up like a child does his playing blocks, nor do you have to take these precautions with grates having closed sides and backs.
2. Build a large fire of paper and kindling or charcoal over the entire bottom of your grate. When this is burning

briskly, add anthracite, filling the grate to the top. Do not make the mistake of building a small fire in the center of the grate and expect it to spread. It won't.

3. Don't poke the fire unduly. Generally this is needed only in the morning with hard coal, which burns down to a clinker-free fine ash. Use the poker every morning to work the ashes through the bottom of the grate, and then add more anthracite. Your hard coal fire will burn slowly all day long, and provide a constant flow of heat. You may find it necessary to add coal at night. If so, fill the grate to the top.

WINDOW SCREEN

Now Made of Translucent, Corrosion-Proof Plastic

TRANSLUCENT plastic filaments are now being used to produce a window-screen cloth of standard 16-mesh weave. This cloth, known as PlastiScreen, is resistant to corrosion, will not stain surrounding woodwork, and is said to be entirely unaffected by water. Continued exposure to sunlight darkens the color of the cloth slightly and the heat resistance limit is 175 degrees, Fahrenheit.

LEAD PIPING

An Old Question and the Present-Day Answer

READERS who request a categorical answer to the question whether ill health can result from lead piping for household water supply will find after closely studying the language of the following note, that no categorical answer is possible. It depends on local circumstances. The following is the reply given to a physician by *The Journal of the American Medical Association.*

"Lead pipe is used in the water supply of many cities and it causes no trouble, because the amount of lead which is absorbed by most waters is negligible. Lead piping is effective in forming an insoluble coating of salts which inhibits its solution. It is *only when the water supply* is acid, particularly because of organic acids, that it is a potential danger. It may also dissolve when different metals are used in the plumbing, when galvanization may play a part. The question of whether serious amounts of lead are liberated may be solved by analyzing the water for its lead content. It is considered that 0.10 part per million is perfectly safe.

"The practice of using lead pipe to connect water mains to the water lines within residences in the distribution of community water supplies is common and perhaps even general throughout the United States. It involves no significant risk to the users, since the volume of water in transit through a short section requirements of a household. The quantity of lead that is likely to be picked up by water in transit through a short section of lead pipe is small, and it tends to decrease with time because of the gradual deposition of relatively insoluble material on the inside surface of the pipe. Water with highly solvent properties will dissolve some lead from such a pipe on standing. The length of standing and the temperature of the water will influence the final concentration, but the actual quantities of lead will be small.

"It is partly because of the hot water lines in the house, partly because of the greater surface of exposure, and partly because of the longer period of stagnation of the water in certain parts of the system that the use of lead piping in the house is more dangerous than in the connecting line. Initially satisfactory water drawn from taps in established homes in American cities that employ lead connections between the mains and household lines rarely contains more than 0.02 mg. per liter. The lead concentration in new homes or in homes with renewed plumbing is likely to be higher because of the plumbers' practice (not universal) of luting the joints with lead-containing paste. If it can be shown that the lead content of the water in any specific community is unduly high because of the solvent effects of the water on these connecting lengths of lead pipe, there is no doubt that other methods should be employed."

THE FUTURE

As Seen by an Engineer Looking Ahead

THE PREDICTION that we will probably all be riding on soybean rubber recaps before the war is over is made in *Chemical and Metallurgical Engineering,* by Procter Thomson, associate director of the Chemical Division, Procter and Gamble. Writing in an issue of that publication which is devoted to resources of the Middle West, Mr. Thomson takes as his subject the state of Ohio which is not only in third place among the states of the country in war production but will fill an important role in post-war development.

"In synthetic rubber," Mr. Thomson states, "Ohio is out in front. Assuming

that natural rubber may come back in the picture, synthetic rubber will still have a place in many types of special service. Where oil and gas-proofness are required, or odorless gaskets for food containers, or non-inflammable insulation for wires—to mention just a few cases—the synthetic rubbers will have an advantage."

Other predictions he makes for the post-war world take in the field of plastics, glass, powder metallurgy, aeronautics, synthetic resins, and many other technical developments coming out of the war.

"From plastics," he says, "there will probably not be auto bodies—steel or aluminum are too handy for that—but windows made entirely of plastic for cars are clearly indicated. For homes, inside storm sashes of light weight plastics will fill a long-felt want. There will also be plastic pipes for chemical solutions, leather-like 'fabrics' for furniture, containers for food, and lamp standards and reflectors, particularly for homes.

"From glass we will have insulation against heat and cold, handier and quicker to install than present types; we will have double-glazed windows at prices no greater than the present single windows, and glass blocks superior to any now on the market.

"Powder metallurgy will extend along lines now in production to give us special self-oiling bearings, cutting tools containing tungsten and similar carbides, and gears made directly from metal powder and requiring little finishing.

"In the field of aeronautics, helicopters and autogyros will supplement private airplanes of conventional type to make the personal air car as common as the personal road car was in, say, 1915.

"Automobiles, lighter in weight, and powered with motors designed to run on 100-octane gas, will not only be feasible but probable. If tools and dies for present day cars are scrapped in the salvage drive, new car design will start without any inhibitions at all.

"Furniture will, no doubt, be virtually revolutionized. Aluminum and magnesium will furnish material that will be as light as wood without the glue-joint problem in winter. Magnesium has already been developed in alloys of non-inflammable character so we need not worry about sitting on the 'hot seat' of an incendiary chair.

"Synthetic resins will permit manufacture of 'bent wood' furniture similar to that shown in the Swedish Pavilion at the World's Fair in New York. Urea-impregnated plywood may also invade this field.

"Synthetic detergents, now playing an important part, will expand but in this writer's opinion will probably be limited to special fields.

"In foodstuffs, wheat flours fortified with soybean and peanut proteins will be the standard. No longer will good edible proteins be fed to animals to reconvert inefficiently. Solvent extraction may do the same with vegetable fats. There is no reason to feed fat to an animal just so it can manufacture fat."

Mr. Thomson declares, however, that these technical developments will not be enough. "The engineer," he states, "will have to become as important in state building as the lawyer is now. Somehow he will have to become the man who is looked to for the answer to the question 'What will we do next?' in hard times as in good . . . It is definitely up to the engineering profession to put across to the people and the politicians that there is real work to be done, work that must be done in our generation, come post-war boom or depression."

SOIL ANALYSIS
Essential to Efficient Use of Fertilizer

PLANTS, like animals, require food to live, grow, and reproduce, according to a bulletin recently issued by Massachusetts Agricultural College. "Plant food," the bulletin continues, "consists of chemical compounds of ten elements, viz: Carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulfur, calcium, iron, and magnesium. Plants receive the first three from the air and water. The supply, practically speaking, is unlimited. They receive the remainder from the soil. But the supply of soil elements is not by any means unlimited, as the great bulk of the soil consists of useless material, and the amount of plant food elements in it are relatively small.

"This is particularly true of nitrogen, phosphorus, and potash. The supply of those elements in the soil is so small that the repeated yearly removal of small portions in the crops soon depletes the supply to a point below the requirements of maximum crop growth. When that point is reached it becomes necessary to replenish the supply. Replenishment can be accomplished by adding the necessary chemicals to the soil. That is what fertilizers are: Crude chemicals to be applied to the soil for the purpose of replenishing the supply of one or more of the plant foods in that soil.

"It follows that the value of fertilizer is in proportion to the amount of plant food which it contains. It is evident also that in order to produce the desired results on any given piece of soil a fertilizer must carry the elements of plant food which is not being furnished to the crop in adequate amounts.

"If, for example, a soil is failing to supply as much nitrogen as the crop needs it should be treated with a nitrogeous fertilizer. In such a case a phosphoric or potassic fertilizer might be entirely useless."

TEMPLATES
Rapidly Produced With New Transfer Film

FAMILIAR in peacetime as wrapping for fruit and other perishables, thin sheets of glossy, waterproof Pliofilm are now speeding the flow of airplanes and other military equipment to the United States Army and Navy. Thus, Goodyear chemists, in co-operation with engineers of the Peerless Photo Products Company, have developed an emulsified Pliofilm which has the property of maintaining its exact size under all conditions of wetting and handling. This new product, known as Transphoto film, is being used throughout the airplane and similar industries to hurry the fabrication of templates for war-expanding factories everywhere in the United States.

Pliofilm's use for this purpose is saving thousands of precious man-hours previously needed to make the templates. It is said to be highly superior in accuracy to any process used before. A pattern for a template, known as a master layout, is outlined on a smooth, thin sheet of metal previously coated with a priming paint. Then the emulsified sheet of Pliofilm is wet in a special solution, after which it is spread over the master layout. A brush or window-type of rubber squeegee is used next to bring the two into as close contact as possible.

After about five minutes in this position, the emulsified Pliofilm is lifted off and processed through hypo solution, familiar to photographers, then rinse water, then a bleach, and finally through a transfer solution. It is much the same process as used with photographic film except that no darkroom is required.

Next the "developed" sheet of Pliofilm is pressed against a sheet of virgin metal

and allowed to remain in this position for several minutes. When it is removed, a bright positive image of the original layout remains on the copy sheet of metal in the form of black lines which have been formed by a deposit of metallic silver.

Goodyear officials pointed out that the Transphoto template process can be adapted also to producing similar layouts on masonite, plywood, and similar non-metallic surfaces if the material is coated first with a special zinc-base paint.

Once the pattern has been transferred to the material from which the template is to be made, the template is finished simply by cutting along the transferred lines.

SMOKE SCREENS

Mean Less Clothes Cleaning For Civilians

MOVEMENTS of United Nations' forces are being concealed by chemical smoke screens made from a chlorinated compound popularly known as a non-flammable dry-cleaning fluid; there has been less and less of this chlorinated compound — perchlorethylene — available for dry cleaning of clothes, because large quantities are needed to make smoke-screen chemicals for all the armed forces, and because its related compound—trichlorethylene—is used to clean metals going into airplanes, tanks, trucks, guns, ships, and other ordnance.

The dry-cleaning fluid, according to E. I. du Pont de Nemours and Company, is converted into another compound — hexachlorethane. The latter reacts vigorously with fine metallic zinc to form zinc chloride. This reaction liberates a large quantity of heat, which instantly evaporates the zinc chloride and generates a dense cloud of white smoke.

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CLOTHESLINES—Housewives have found that an application of clear synthetic resin sealer will protect clotheslines against rust, will also make them easier to clean and to keep clean.

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FLUORINE

Dental Health Requires Enough, Yet Not Too Much of It

EPIDEMIOLOGICAL, analytical, and biological research has culminated in the seeming establishment of trace amounts of fluorine as a dietary essential for sound, decay-resistant teeth. This may well rank as a classical achievement in nutritional and dental research.

The problems inherent in the orderly evolution of present knowledge have been peculiarly complicated because of the development of the mottled enamel defect resulting from too high a fluorine intake. Because the difference between the amounts of fluorine producing mottled teeth and the amounts producing decay-resistant teeth is so small, empirical and promiscuous fluorine fortification of

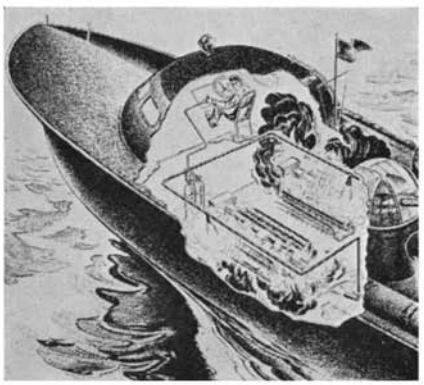
food as a caries-prophylactic measure is neither desirable nor expedient.

Adequate fluorine intake appears to be possible through natural foods. It is particularly significant that milk and milk products can contribute an appreciable quota of the fluorine required for caries-resistant teeth during the critical age period up to 8 to 10 years without the danger of toxic fluorosis and mottled enamel.

This subject has been explored in the light of the more recent findings of nutritionists in *Borden's Review of Nutrition Research.*

EXTINGUISHERS
CO_2 Type Used on Torpedo Boats

NAVY torpedo boats and subchasers are now equipped with a new carbon dioxide fire extinguishing system which consists of shatter-proof steel cylinders containing liquid carbon dioxide gas under a pressure of 850 pounds per square inch



Remote control for fire extinguishers

at 70 degrees, Fahrenheit, a valve for instantaneous release of the gas piping leading from the valve to the engine compartment, and shielded discharge nozzles located over the engines—where most fires start. The release valve of this equipment, developed by Walter Kidde and Company, is operated by a remote control pull-box located at the helm, while an auxiliary release is provided just outside the engine compartment. Additional nozzles discharge gas directly into the bilge to smother any fire that may break out there due to fuel or oil seepage.

WAR VITAMIN
Ascorbic Acid Finds Place in Shock Treatment

EXTRA VITAMIN C is needed in the diet of soldiers under certain conditions and of workers exposed to industrial poisons, according to a survey of "Vitamin C in War," made by Prof. Harry N. Holmes of Oberlin College, president of the American Chemical Society.

"We must do more than supply our armed forces with a vitamin-rich diet," Professor Holmes declares. "Under certain severe conditions soldiers may need dietary supplements of certain vitamins. This is especially true of vitamin C—

ascorbic acid—of which the United States used 17 tons in 1940 and may soon reach an annual synthetic output of 100 tons. However, our allies are getting much of this."

Vitamin C, which is destroyed by infection and by a number of industrial poisons of a military nature, is also lost in appreciable quantities in heavy perspiration, Professor Holmes points out. He cites its use by industrial organizations to prevent heat prostration, and compares very hot factory and plant conditions with the situation existing in war areas in the tropics and in North Africa.

Experimental work with shock from a number of causes and with poisoning from benzene, toluene, trinitrotoluene, lead, and zinc indicates the usefulness of vitamin C treatment. Improvement in insomnia cases has also been attributed to to the vitamin.

"The function of vitamin C may go beyond mere replacement of the amount lost under very hot working conditions; it may combat heat shock," Professor Holmes says.

"Shock results from a number of causes, so vitamin-C therapy ought to be considered in all such cases. Dr. Georges Ungar, of the Free French Forces, now at Oxford University, found that guinea pigs injured to an extent that otherwise would have caused 100 percent mortality survived when given considerable vitamin C by subcutaneous injection immediately after injury. Delay of one hour reduced recovery to 50 percent.

"The question naturally arises whether shock of various types in man—surgical, for example—may not be lessened by adequate administration of this vitamin. Private reports from a group of physicians and chemists show that in numerous instances intravenous injection of a sterile solution containing vitamin C produced astonishing recovery from severe post-operative shock. This treatment is being tried in a few medical centers and might well be tested by surgeons in our armed forces. Numerous investigators have reported a decrease in the ascorbic acid concentration of the blood plasma following operations.

"Benzene and toluene are industrial solvents of importance to war industries as well as basic materials for manufacture of T.N.T. and other explosives. They are somewhat toxic in liquid or vapor form. Joseph Hagen (reporting in a German periodical) after studying the blood and urine of animals poisoned with benzene was convinced that benzene destroys vitamin C. His conclusion was that 'a detoxication as well as a repairing action of the poisoned blood formation centers may well be attributed to vitamin C administered in the case of chronic benzene poisoning.'"

Prof. Holmes reports that one of the large rubber companies gave vitamin C daily to 100 workmen exposed to a so-called safe concentration of benzene and toluene vapors in the factory air. After a short time 37 of the workmen felt "'less tired" at the end of the day, he says, 10 felt in better health generally, and only 31 reported no gain. Further experiments are being carried on. In a number of T.N.T. plants in the United States every workman is given a daily dose of vitamin C, he adds.

"We know that Germany has, for a few years, been using vitamins for special fighting forces," Prof. Holmes continues. "Great Britain, too, has been alert to the value of vitamins A, B, and C as aids to the war effort. A confidential report from a T.N.T. plant in Britain strongly endorses the vitamin-C treatment of workers. The physician in charge firmly believes from tests that T.N.T. destroys vitamin C.

"A chemist employed during 1940 in a T.N.T. plant in Central Europe reports that the company physician noticed poorer health in the workmen during the winter season when these peasants had no fresh fruits and vegetables, rich in Vitamin C. At company expense each worker was given two oranges daily, with excellent improvement in health and vigor.

"Poisoning due to tetryl (booster charge in shells) is now occasioning medical concern. If it has not already been done, we should determine the vitamin-C level in the bodies of workers exposed to tetryl and if it appears to be lowered, start daily administration of vitamin C. No harm will be done."

Prof. Holmes and Kathryn Campbell found in 1939 that dust of lead or its compounds destroyed some vitamin C in the bodies of workers exposed to the toxic dust. Daily doses of the vitamin in most cases resulted in great improvement in health. The zinc oxide fume given off when brass is melted is now causing symptoms that are somewhat reminiscent of lead poisoning, Prof. Holmes says, suggesting that a possible relationship to vitamin-C destruction be studied.

"To complete this list of items of military value," Prof. Holmes concludes, "it might be mentioned that Dr. Louis J. Karnosh of Western Reserve Medical School had 100 cases of insomnia treated with vitamin C and observed excellent improvement. It would seem that both C and B could be useful in many cases of nervous disturbance."

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LUMBER—Postwar requirements for lumber on farms are estimated at 5.9 billion board feet a year, made up of 5044 million board feet for repair and replacement of buildings, 700 million for buildings on new farms, and 159 million for uses other than on buildings.

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TOMATO

Yield Improved by

Napthoxyacetic Acid

VAPORIZED napthoxyacetic acid will greatly increase the yield of greenhouse tomatoes by increasing the setting of the fruits, John W. Mitchell and Muriel W. Whitehead of the United States Bureau of Plant Industry Station, Beltsville, Maryland, report in the *Botanical Gazette.*

Dr. Mitchell is a Ph.D. in botany of the University of Chicago.

Unless greenhouse tomato plants are pollinated by hand or similar costly methods, only 2 to 5 percent of the blossoms during the winter months ordinarily set fruit. When plants in a closed greenhouse are exposed to napthoxyacetic acid vaporized by heating on an electric plate or alcohol lamp, an inexpensive method, the setting of fruits is increased to more than 80 percent.

Best results are obtained when the treatment is made when the first flowers on a cluster are beginning to open.

In addition to increasing the yield, the treatment produces a high percentage of seedless tomato fruits. The vitamin-C content and nutritional value of the ripe tomatoes is equal in all respects to the fruit of untreated plants.

There is no danger of toxicity from use of vaporous napthoxyacetic acid, so far as tests made by other experimenters indicate.

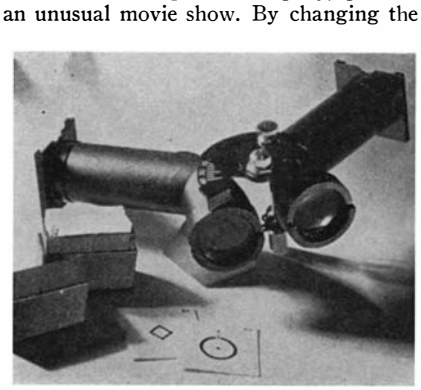
BLACK FINISH
Obtained on Metal Parts With One-Bath Process

ORIGINALLY developed as a gun blueing process for small arms, as well as for arms' parts, a one-bath process is now being applied to a wide variety of metals, including steel, grey iron, brass, aluminum, and zinc. The actual items colored by this process, called Black-Magic, range from paper clips to cartridge cases and from hooks and eyes to steel wire drums.

The black color produced by this simplified process is said to be equal in depth and rustproofing to other two-bath processes. It is supplemented by a coating of phenol-formaldehyde varnish and a hard wax coating that will not rub off.

CROSS-EYED
Children Aided by Exercise Device

DESIGNED to stimulate, exercise, and develop the fusion faculty of the eyes in certain eye ailments is an eye muscle exercising device which is particularly fascinating to cross-eyed children. Special lenses and object cards in the Amblyoscope, as the unit is called by its makers, the American Optical Company, provide an unusual movie show. By changing the angle of the two tubes shown in the illustration, and inserting different cards, birds appear to jump in and out of cages, two halves of a picture fuse into one, and three dimensional effects are seen.



Amblyoscope and cards

Using the Amblyoscope

The Amblyoscope, which consists of two separate members hinged together by means of a graduated arc, is described as a means by which a non-seeing squinting eye is trained to take its share of vision.

PEST CONTROL
Use of Parasites and Disease Spores

WITH many spray materials becoming more and more critical due to priorities for war industries, scientists at the State Experiment Station at Geneva, New York, are bending every effort toward the development of substitute insecticides and the use of natural agents, such as parasites and disease spores, to combat injurious insect pests.

A total of 526 colonies of a parasite of the oriental fruit moth were liberated during the past year throughout the peach-growing areas of the state. This is the largest number of colonies ever liberated by the Station workers and was made possible by improvements in the methods of rearing parasites in the Station laboratory. "Fruit counts in western New York peach orchards indicated that injury by the fruit moth was not greater than 5 percent," states the report which continues as follows: "Parasitism ranged from 48 to 90 percent throughout the Hudson River Valley and western New York, the lowest percentages of parasitism occurring in experimental orchards in which no mass liberations were made during the season."

In studies on the control of the Japanese beetle, parasites were liberated and spores of the "milky disease" of the grubs disseminated in heavily infested areas of the Hudson Valley and on Long Island as well as in isolated areas in other parts of the State. Thus far the area treated is too small to have any noticeable effect on the Japanese beetle population in the state, but the results are encouraging as an indication of what may be expected from biological control measures.

No Oxygen Needed

Circular Pressurized Cabin is Feature of New Airliner

Designed For High-Altitude Civil or Military Operation

ALEXANDER KLEMIN

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

BUILT by Lockheed, the gigantic transport airplane called the *Constellation* created a sensation in its recent successful trials. The new machine is powered with four Wright Cyclone 18-cylinder engines, air-cooled and delivering about 2000 horsepower each. The *Constellation* is said to be much faster than all existing air transports and also much larger. It can transport a crew of five men and 57 passengers across the continent in less than nine hours, or carry a light tank and a complement of troops across the ocean. It is equipped with a tricycle landing gear, and a supercharged or pressurized cabin which permits it to fly at 35,000 feet without use of oxygen by the occupants. One of the photographs shows the long clean lines of the fuselage, and the triple tail, which keeps down the overall height.

Technical data are of course limited under present conditions, since the *Constellation*—built at first for passenger work—is to have a military utilization. Some information, however, has been released which is of highly interesting character.

The engine has two rows of nine cylinders each, with a low weight ratio of 1.1 pounds per horsepower. The fuel consumption is reported to be low. High horsepower is permissible at take-off, which permits heavy initial loading and increases the effective range.

An enormous amount of research and development went into the design of the airplane. Thus, more than 500 tunnel tests were made and a whole program of structural investigation was undertaken in regard to controls, pressurization of cabin, and the like.

Numerous novel features are reported. There is exterior spotwelding on 75 percent of the fuselage and 10 percent of the wing. De-icing is carried out by heating the leading edge, which seems on the whole a more logical way than allowing the ice to form and then knocking it off with rubber de-icers. A complete new power-plant may be installed in 45 minutes, a thing likely to be a great blessing to maintenance men and operators on the airplane. There is a new electrical system which locates and extinguishes a fire very rapidly. The nacelles and cowling are of stainless steel and are practically fire-proof.

From an aerodynamic point of view the

Cowls gently increase in radius

A long, circular fuselage characterizes the *Constellation*

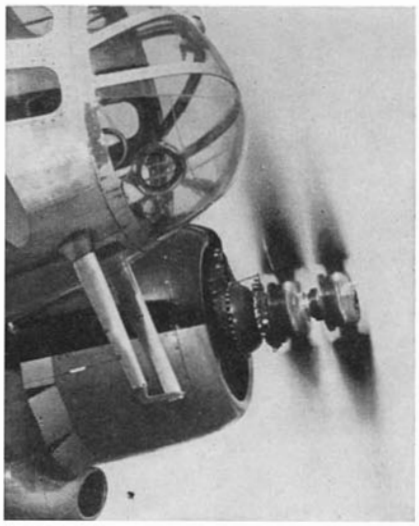
following advances have been made: The fuselage is of circular cross-section but has some camber as a whole so that it assists the lift of the long-tapered wings. The engine nacelles have been carefully designed so that drag is reduced to a minimum. In regard to the wing, a compromise was made between a low-drag wing and a high-lift wing. The so-called "laminar wing" was tried but not employed. While the laminar wing has wonderfully low drag in perfect tunnel tests, its good characteristics are apt to disappear in rough service. The gently increasing radius of the cowling of the engine is said to decrease "compressibilty" effects. Besides the engine, other rapidly interchangeable parts include electrical and plumbing lines, oil cooler flaps, cowl flaps, and so on. Most structural parts are jig built for production airplanes to secure interchangeability.

The interior arrangements of the airplane are just as interesting and well thought out as are the aerodynamic and structural features. The flight station is located in the forward upper portion of the fuselage. The pilot's seat is located on the left, co-pilot on the right. The flight engineer sits behind the co-pilot, facing outboard. The radio operator sits behind the pilot, facing forward. Aft of the flight station is the navigator's station. Aft of the navigator's quarters, space is provided for cargo on the right side and communication equipment on the left side. The main passenger compartment is located aft of the cargo spaces and is separated therefrom by a bulkhead and lockable door. Arrangement of this compartment varies according to the purpose of the flight, the range, the number of passengers, and the weight of cargo on board. Seats can be appropriately changed in position and number; berths can be provided if necessary. Such flexibility is advantageous both in military and commercial operation. Food lockers are installed aft of the main passenger compartment.

Other valuable features include hydraulic steering gear which lessens pilot fatigue; many thermostatic fire warnings in each nacelle, each of which turns on a light in the cockpit; and high performance on two or three engines.

Here is a truly remarkable ship, regarding which we can only await further details.

First huge dual propeller



Revving up

COUNTER ROTATING

Propeller Has Decided Aerodynamic Advantages

WHY IS a dual propeller of three blades each, rotating in opposite directions, far better than a single propeller with six blades all rotating in the same direction?

There are several reasons: The interference between blades is less; the rotation or whirl of the slipstream is eliminated, so that efficiency is increased; there is no torque reaction since the turning moment of one propeller is exactly balanced by that of the propeller rotating in the opposite direction. Other advantages of a minor but not negligible character include the smaller hub and in the elimination of gyroscopic moments. The only disadvantages lie in the fact that special gearing is required and in greater complication, but these are disadvantages well worth having in the light of the benefits.

At any rate, that is the opinion of engineers of Hamilton Standard Propellers, who have been developing a dual counter-rotating propeller for over six years. The first flight of the huge airscrew, on a medium size bomber, was entirely successful. The propeller used in the demonstration was 12 feet in diameter, and consisted of two three-bladed propellers mounted one behind the other on co-axial shafts and driven by one engine. Of course, it is only by a large number of blades that the enormous power of the modern engine can be absorbed, particularly in the thin air of high altitudes.

The counter-rotating propeller will be even more helpful on a single seater than on a large bomber, because in the relatively small single-seater it is much harder for the airplane to absorb the torque of a conventional propeller. Incidentally, the mechanism of the propeller embodies controllable pitch and constant speed operation, which, difficult enough on a single, propeller, offer still more complication on a dual airscrew.—*A. K.*

Industrial Growth

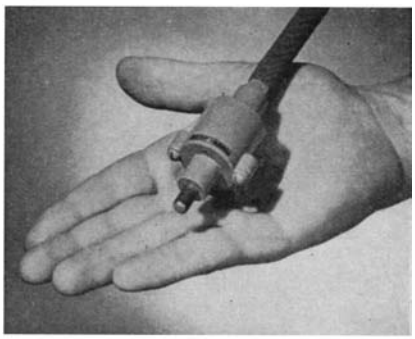
New Products and Processes That Reflect Applications of Research to Industrial Production

COPPER BABBITT
Lead-Base Metal Replaces Tin-Base

To take the place of tin-base babbitt in heavy-duty bearing service, a new lead-base copper-bearing metal has recently been placed on the market. This new material, called Stonewall by the manufacturers, United American Metals Corporation, has a yield point in compression of 8000 pounds per square inch. Available in three-pound ingots and 15-pound pigs, this babbitt is cast at 700 degrees, Fahrenheit, and can be remelted and used again.

AIR CLAMP
In Midget Size, Saves Many Man Hours

Designed specially for use in the aircraft industry, a new low cost air clamp can save many man hours in operations involving welding, riveting, or bolting of two or more parts.



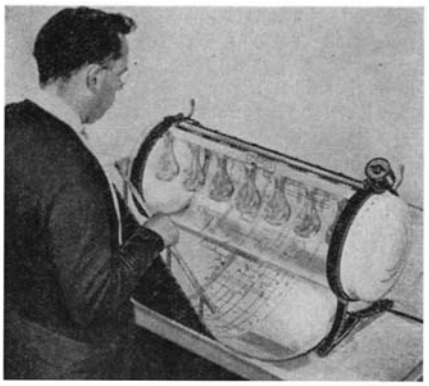
Less than a handful

The compact size of these new Midget air clamps, made by the Mead Specialties Company, permits installation in cramped corners, difficult to reach with more bulky mechanical clamps.

A series of these air clamps can be used in a set-up and operated by a single master valve, the lock-up and release of assemblies being virtually instantaneous. The clamps are designed to operate on a line pressure of 100 pounds and have a ram stroke of 5/8 inch.

PRINTER
Rapidly Produces Blue or White Prints

For fast reproduction of drawings in either blueprint or black-on-white form, a new printing machine has been developed by the Victoray Corporation. Essentially this machine consists of a glass cylinder about 14 inches in diameter which encloses eight 150-watt lamps. The whole unit is mounted on a frame which in turn is fastened to a table.



Produces prints rapidly

Clips are provided for holding the tracings and sensitized paper along one edge. Then a curtain is wrapped around both to hold them flat against the cylinder for even exposure over the entire surface. An interval timer is provided as part of the unit.

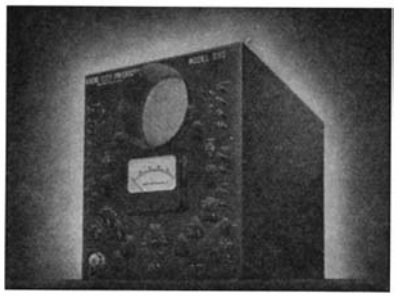
CONDUCTIVE FLOORS
Provide Safety From Sparks in Powder Plants

Designed to be used as a surface for floors, aisles, loading platforms, and so on in plants where explosive materials are manufactured, a new material has been developed which conducts static electricity to ground. This conductive material, which is known as Condurock, prevents accumulation of charges which might build up to sufficient intensity to create a disastrous spark.

This new material is supplied ready to apply to existing surfaces, has a mastic base, is dark red in color, and can be cleaned by conventional methods.

OSCILLOSCOPE
Has Wide Frequency Range For Industrial Measurements

A new cathode-ray oscilloscope has recently been introduced to meet industry's requirements for extended frequency measurements. The oscilloscope uses a five-inch cathode-ray tube operating on 2000 volts. Maximum D.C. voltage at input to amplifiers is 600 volts and direct to deflection plates is 500 volts. Input resistance is 3 megohms. Frequency response is ± 3 db from 20 cycles to 2 megacycles. Voltage gain is approximately



For industrial frequency measurements

275 times. Frequency range of sweep-signal generator is from 30 cycles to 350 kilocycles, linear from 50 cycles. Unknown peak input voltage can be read on a direct indicating multi-range voltmeter. This is accomplished by a comparison method with an internal voltage source. This instrument, manufactured by Radio City Products Company, Inc., operates from standard 115-230 volt, 50-60 cycle A.C. power supply.

PLYWOOD DRYING
Hastened by Use of
High-Frequency Current

MOLECULAR friction set up in plywood and its adhesive is now being used to promote drying action of the plywood during manufacture. This molecular friction is provided by the action of a high-frequency electrostatic charge. The plywood is placed in an insulated hydraulic press and pressure is applied; the high-frequency charge is then applied with the result that the temperature rises and the plywood is dried without the use of any other heat source.

SURFACE CONDITIONER
Also Promotes Metal
Plant Efficiency

SURBRITE, a new steel surface conditioner, has aroused interest in the metal products manufacturing and finishing industries, and has brought up a number of questions because of its peculiar characteristics which differentiate it from inhibitors in general. Surbrite is an inhibitor itself, but it is, in addition, a surface brightener as well, designed for use with either sulfuric or muriatic acid pickles.

Surbrite "H" and "S" are offered by the manufacturers primarily as surface conditioners and the reports of tests all confirm their judgment on this point. In many fields this function is vastly more important than the degree of acid saving which is commonly used to "evaluate" inhibitors. Surbrite "H" and "S" give highly desirable surfaces along with high efficiency in acid use and metal saving.

ASBESTOS FITTINGS
Developed for Use
In Airplanes

A NEW TYPE of asbestos fitting designed to take the place of critical metals in aircraft production is produced in any shape or form required and is made to withstand continuous heat of 350 degrees, Fahrenheit, or a temperature as low as minus 40 degrees, Fahrenheit.

The fittings are made from a form of asbestos fabric known as "Asbeston," which is considerably lighter than ordinary asbestos materials. They can be joined to ducts or hose by three methods: cemented, clamped by bands to metal sleeves inserted in both openings, or by the use of quick-grip couplings. Uses already developed include: carburetor air intake, heater hose nozzle, defroster attachment, gun blast boot, heat register, air connector to supercharger, and others.

SCALE
Equipped With Lens
and Slide Block

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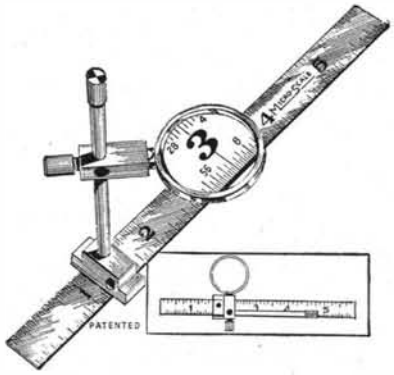

To 64ths, with magnifier

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MANGANESE DEPOSITS OF CUBA is a preliminary report based upon brief examination of 168 deposits. The report describes the geological setting and classification of the deposits and discusses their origin. Request Geological Survey Bulletin 935-B. *Superintendent of Documents, Washington, D. C.— 10 cents.*

METAL DUPLICATING WITHOUT DIES is a 32-page catalog which lists new and improved precision machine units for duplicating and forming parts or pieces to die accuracy but without time delay or the expense of die sets. The units and their uses are thoroughly described and completely illustrated. *O'Neil-Irwin Manufacturing Company, Minneapolis, Minnesota.—Gratis.*

THE USE OF SECONDARY ELECTRON EMISSION FOR TRIGGER OR RELAY ACTION, by A. M. Skellett, is a 12-page illustrated report on an experimental vacuum tube and the necessary circuits by which the action described in the title is achieved. *Bell Telephone Laboratories, Incorporated, 463 West Street, New York, New York.—Limited free distribution.*

WELDWOOD is a 16-page thoroughly illustrated pamphlet which deals with modern methods of gluing wood which has been developed to contribute a new and versatile material to the world's progress. Methods of using and final results are dealt with in detail. *United States Plywood Corporation, 616 West 46th Street, New York, New York.—Gratis.*

MEET THE NEW SOLDIER is a 12-page folder giving general data on plastics in extruded form. Properties of plastics are listed, as are also various available standard and special shapes. *R. D. Werner Company, Incorporated, 380 Second Avenue, New York, New York.—Gratis.*

EYES FOR INDUSTRY is a 26-page catalog describing in some detail industrial stroboscopes for use in the design, production, testing, and application of moving mechanisms. The principle of operation of the stroboscope is briefly described. *General Radio Company, 30 State Street, Cambridge, Massachusetts.—Gratis. Request this bulletin on your company letterhead.*

GULF CUTTING OILS is a 32-page engineering report which first gives brief information on various types of cutting oils and then describes their use in various machining operations on a variety of materials. *Gulf Oil Corporation, 3800 Gulf Building, Pittsburgh, Pennsylvania. —Gratis.*

PRESSURE AND TEMPERATURE CONTROLS is an eight-page bulletin illustrating and describing a range of accurate, rugged, and compact units which are adaptable to a wide variety of pressure and temperature applications. Request Bulletin 836. *Allen-Bradley Company, Milwaukee, Wisconsin.—Gratis.*

RADIO AND ELECTRONICS is a 16-page illustrated pamphlet giving a brief description of electronics as it exists today, and a glimpse into the future possibilities of electronic development *Department of Information, Radio Corporation of America, 30 Rockefeller Plaza, New York, New York—Gratis.*

PIPE AND TUBE BENDING, by K. W. Knutson, is a 29-page pamphlet described as "a time and work saving set of original tables for rapid calculation of any bend with a minimum of error," also center line and gain tables; with accompanying explanations. *Cornell Maritime Press, 350 West 23rd Street, New York, New York.—$1.00.*

FACTS ABOUT PRESTITE is a 12-page illustrated booklet describing a superior insulating porcelain and its industrial uses. Graphs give mechanical properties and a number of illustrations show molding methods and design suggestions. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. —Gratis.*

METALURGENCY is a 16-page booklet describing what Army Ordnance is doing to conserve nickel, chromium, vanadium, and other vital alloying materials. It shows how such conservation can be accomplished by new manufacturing methods, redesign of equipment, and so on. *Ordnance Department, U. S. Army, Pentagon Building, Washington, D. C.—Gratis.*

SNUBBER CALCULATOR is a 3½ by 10 inch slide rule developed as a time saver for engine salesmen and operators in choosing the correct size for exhaust "snubbers" to provide quiet engine exhausts. *Acoustic Division, Burgess Battery Company, 2815 West Roscoe Street, Chicago, Illinois.— Gratis.*

DESIGNING MOLDED PLASTICS PARTS is a 16-page illustrated booklet which gives succinct information on various properties of plastics and shows how they must be taken into consideration when designing new applications for plastics. *General Electric Company, Bridgeport, Connecticut.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

BICYCLES having now become once more fashionable, the city or town owner of a richest-field telescope ("RFT") can ride to the open country where the magnificent star fields afforded by this special type of telescope are far better visible than in town where there is competing light.

C. B. Moore, Jr., Tech Box 2742, Atlanta, Ga., a chemical engineering student, does this, as shown in Figure 1. "The RFT has a 6" f/3.5 Pyrex mirror," he states, "with full 100 percent correction. The eyepiece is a Ramsden of 1.14" f.l., giving a field of 2.5°. Tube and mirror cell are of aluminum. The telescope weighs only 12 pounds, hence it can be carried on the sling (an old rifle sling) without discomfort. In other words, please add my name to the list of satisfied RFT owners."

The left-hand side of the illustration shows a typical mounting for the RFT —simply held in the arms like a baby. That, in fact, is one of its strong points—simplicity and lightness.

SECOND story of a two-car garage is the spacious observatory (Figure 2) of Charles A. Morrison, 39 Radcliffe Road, Rochester, N. Y. The supporting pier of concrete blocks rises from an earth foundation and passes through the second floor without contact, to prevent transmission of vibration to the telescope. The dome is a frustrum of an octagonal pyramid.

The tube is made of wooden strips, beveled and glued.

The mounting (Figure 3), was made from castings purchased from a dealer, and these required a rather complete shop to machine them.

Figure 1: Moore and his RFT

The diagonal is an elliptical plate, the second diagonal being the outside surface of a prism.

The 8" Pyrex mirror deviates not more than 0.07 wavelength of sodium light from a true paraboloid, Morrison states, and a lunar photograph submitted but not shown here justifies that claim.

All three reflecting surfaces are aluminized.

The telescope has a Telechron drive.

BEGINNERS who are learning the conventional stroke used in grinding and polishing a mirror, and who have noted Ellison's description of the three motions ("A.T.M.," page 77), often inquire whether the mirror should be rotated in the same direction as the worker walking around the barrel, or in the opposite direction. In ordinary work this makes little noticeable difference. The purpose of this second of the three motions will be seen best if we stop to analyze and separate the purposes of all three.

First, the "travel to and fro" of the

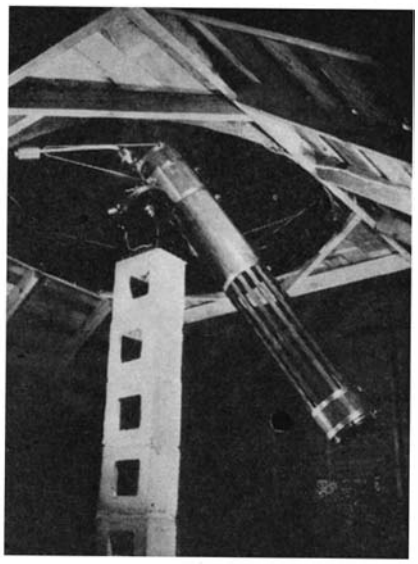

Figure 2: Morrison Observatory

upper disk across the lower has the purpose of wearing away the two differentially, so that the one will become concave by an effect explained in "A.T.M." page 2—that is to say: "the pressure per unit area, and therefore the amount of abrasion, is increased on the central portions of the upper disk and outer portions of the lower one when the upper disk overhangs" during the stroke.

Second, if the mirror were not rotated in the hands, it would soon tend to develop into a trough, or cylinder, instead of a sphere. It would have astigmatism.

Third, if the worker did not "walk slowly round the barrel" the lower disk would after a time tend to become worn more on one side than on the other, though the mirror itself, because it is rotated, would not be similarly affected. (Thus No. 3 is the least important of the three elements, and this explains why the work may be done at a bench, as in the frontpiece of "A.T.M.," provided the lower disk is turned around once in a blue moon; it also explains why there is no real need, even when a barrel is used, to take a step

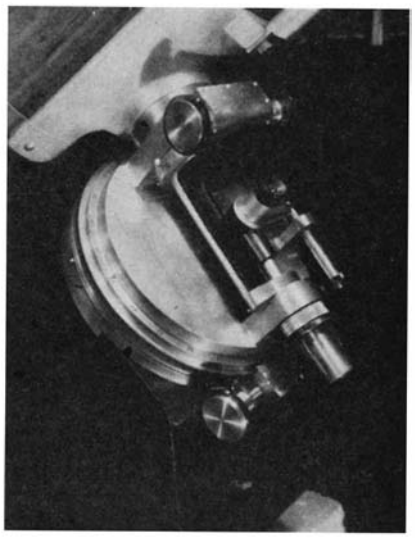

Figure 3: Morrison's mounting

with each stroke, as some have supposed necessary, and why it is entirely in order instead to stand in one place and work for some time, though in polishing and especially in figuring this should perhaps be taken less literally.)

Now it will be evident that, with regard to elements 2 and 3, if the upper disk is rotated in the same direction as the worker, it will rotate faster with regard to the lower disk than it will when it is rotated in the opposite direction; the difference between the two being possibly quite marked. Even then it should, however, make little or no appreciable difference, and thus the question is largely academic. In other words, the worker should suit his own whims.

But when a machine is used to drive the mirror, some have observed a difference. Years ago Leo J. Scanlon of Pittsburgh observed that rotation in the same direction deepens the mirror's center, while reversing it brings the wear upon the edges, and the late S. H. Sheib of Richmond verified this by speeding up the tool still faster on a machine. He, too, found that at low speed the abrasive collected in the center but traveled to the edge with higher speed. "Apparently," he wrote, "this movement of the abrasive is due to centrifugal force, and hand work

is too slow for this effect to be felt."

C. G. Wates of Edmonton analyzes the factors thus: First, centrifugal force, and second, relative speed between tool and mirror. (Centrifugal force increases as the square of velocity and directly as the radius.)

On a machine, then, and perhaps in some workers' hands, this phenomenon may be used to control the curve of the mirror. As Wates states it: Relative speed slow—center deepened; relative speed fast, edge deepened. But the beginner is likely to find these latter considerations too subtle to concern himself about.

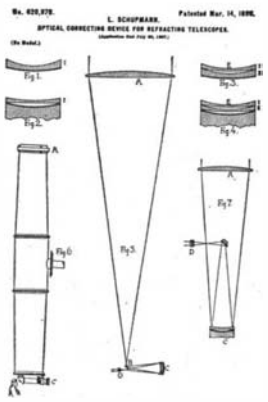

Figure 4: "some time ago!"

IN SEPTEMBER 1941, in *The Sky,* Carl Hellman of Washington, D. C., described a peculiar telescope invented by Ludwig Schupmann, and gave basic data. He also gave details of a 4" and a 10" Schupmann which he had made or was making. *The Sky* added an analysis of the optics of this type of telescope, and in April 1942 gave an account of a Schupmann which had been made, though it had given multiple images.

Since the dates of Schupmann's patent was not stated in *The Sky,* further than to say that it was "some time ago," it looked as though the Schupmann might be reasonably recent. On digging out the patent (Figure 4) its date was seen to be 1899. However, this, at that, was "some time ago!" (What is the elastic limit of a word?)

Its age is not, however, a reflection on the Schupmann. In fact, suspecting that other long-forgotten patents may be better appreciated by the present generation of constructors than in earlier times, your scribe hopes some day to find time to explore all optical patents systematically back to say, 1893, and re-present some of them here. If this is done, the dates will be stated.

Since you can obtain a copy of the Schupmann patent, giving full details, simply by sending a thin dime (Government will not accept stamps) to the U. S. Commission of Patents, Washington, D. C. and asking for U. S. Pat. 620,978, only the basic details will be given here. In *The Sky,* Hellman pointed out that, by using, in combination with the Schupmann's one-element objective, a concave-convex correcting lens of the same glass as the objective, and with its nearer surface curved to produce a chromatic aber-

TELESCOPTICS

ration equal in magnitude but opposite in sign to that of the objective, and with its farther (lower) surface silvered as a concave mirror curved to produce a convergence equal in magnitude to the divergence of the nearer surface, Schupmann had found a way to correct the chromatic aberration of the simple objective without at the same time losing its convergence. This gave a telescope having many advantages: low weight of glass; low light absorption; corrector easier to work than that of a Schmidt; silvering permanently protected by paint; all surfaces spherical; tube closed; eyepiece conveniently placed.

Hellman used the arrangement in Fig. 7 (note: of the patent in Figure 4) except the corrector, which was like that of Fig. 1 (of the patent).

Figure 5: Dwight's Schupmann

In 1942, Joseph Dwight, Hyannis, Massachusetts, advised this magazine that he had been experimenting with an unfinished Schupmann (Figure 5). He modified the design used by Hellman, substituting for the corrector used by him one which, it later proved, had been anticipated by Schupmann (Fig. 2 of the patent, which Dwight had never seen).

"The Schupmann" he writes, "is a good type for an amateur since the mirror and convex face of the objective can be ground together, and the bottom of the mirror and flat faces of the corrector and objective can also be ground together. Then the outside plane of the objective can be silvered and painted for protection while the figuring of the telescope is done on the convex face of the objective. Then paint and silver are removed.

"I used 8″ disks of rolled optical crown (N = 1.523; V = 58.8) from the Pittsburgh Plate Glass Co. The objective and mirror radius is 58.5″ and that of the plano-concave lens is 26.25″. The objective has a f.l. of something under 120″. From objective to concave lens is 65″ but this should be decreased in order to give more correction. The objective was stopped down to 6″ and the e.f.l. was about 150″.

"Though the lenses were not even well polished, and the mirror was only partly figured, a 1″ monocentric eyepiece (150X) gave pretty lunar views at sunset but later the Moon was too bright, with prismatic effects on some of the sunlit craterwalls, due perhaps to undercorrection or to bad alinement. An orange-tinted 'Mars' glass concealed this trouble and removed the glare. Since the paper tube, sheathed with galvanized iron, tilted unsteadily on a rickety wooden 'mounting,' I could not count the belts on Jupiter, though at least one was visible.

"This compact, long-focus type of telescope, with a lasting silver film and few air-currents, seems well worth further trial, especially as it may be relatively easy for the unskilful to make—I write as one of them. Of course, care must be taken to have the lens edges of uniform thickness. And any change in glass or proportions requires the tracing of red and blue paraxial rays. To make a good telescope is impossible for me under present conditions. I can only show that it is feasible."

The photograph in Figure 5 was taken at this department's request, to show the readers that tangible work had been done, and Dwight apologizes for the telescope's general lack of finish and sex appeal. It was only a sort-of test set up.

PROBABLY few persons not instructed in astronomy sense the stupendous difference in volume between the Sun and Earth—those so instructed do not always find it easy to sense it. Even the difference in diameter is difficult to realize. Simple little stunt, in case you happen to own a hemispherical observatory dome, is to let the dome represent the Sun's diameter and then hang up inside it somewhere a ball representing the Earth's diameter, also a bead representing the Moon's diameter. In the average case the Earth ball will not be far from an inch in diameter, the Moon's a quarter inch. This was done at the Municipal Observatory at Preston, Lancashire, England, as described in *The Journal of the Royal Astronomical Association*. When visitors come, this makes an interesting demonstration. There is no attempt at spatial relationship—just size. Ratio of 864,390: 7914:2160 (miles) is close enough. In fact, for a thing like this, 100:1:¼ is probably good enough.

MAKERS of objective lenses must try to keep the edges the same thickness all around. To facilitate keeping track of the edge thickness when grinding, C. L. Barton of Hollywood does as follows:

Divide the lens into eight equal sectors, or for finer grinding, 16.

Measure the edge thickness of each sector and mark the thinnest zero, thicker sectors 1 or 2 or 3, or whatever it is, these figures corresponding to thousandths of an inch.

Mount the lens on the pedestal, first laying a piece of paper over the latter.

Extend to this paper the radii that bound the sectors.

Take grinding strokes in numbers proportioned to the numbers on the paper.

Taper off with a couple of rounds of ordinary strokes.

Repeat the above process till the diminishing errors have been resolved.

This method conduces to a clear knowledge of exactly what goes on. Thus it forestalls a large loss of glass due to centering the O.G. where the lens is finished non-uniform in edge thickness.

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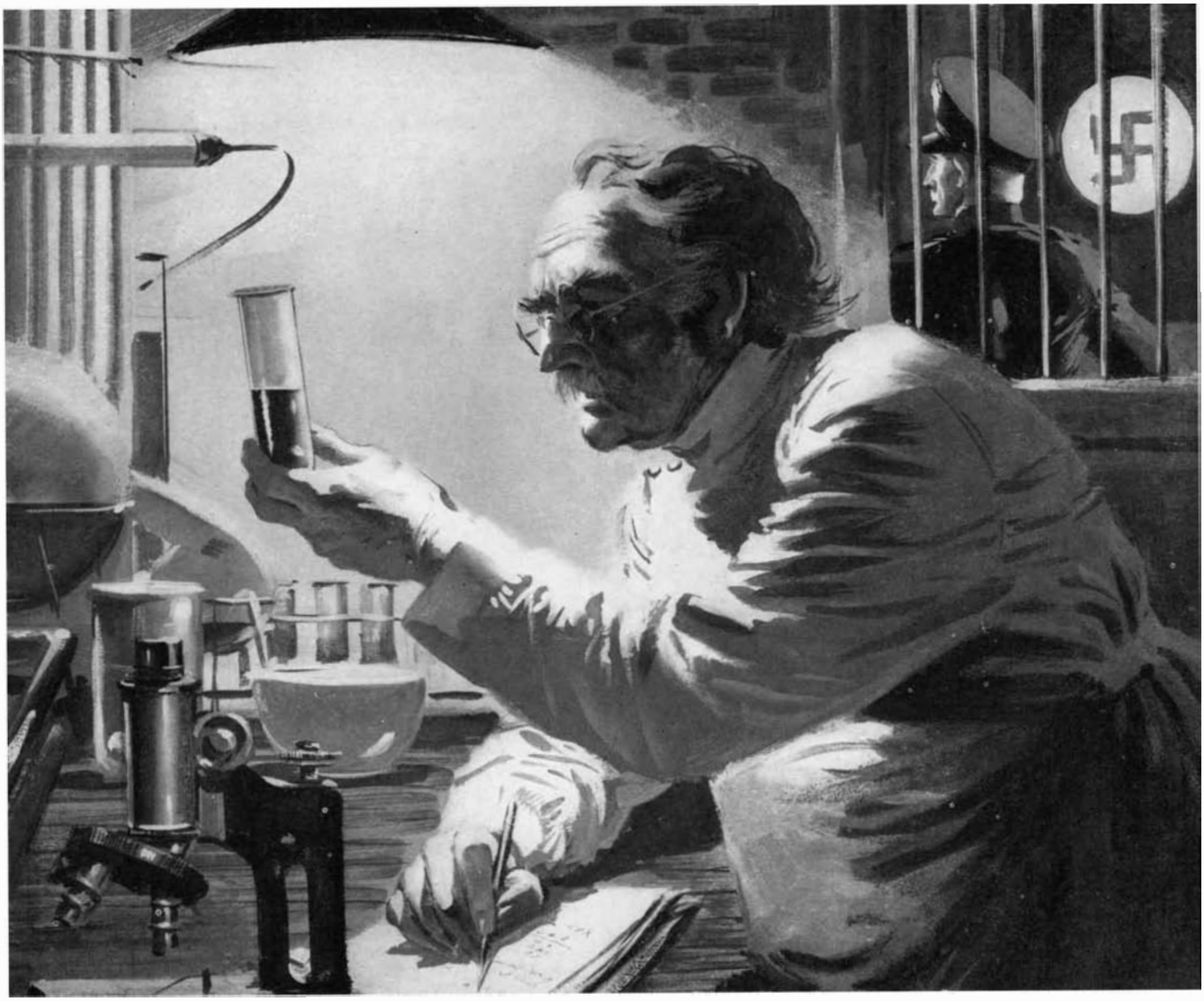


The man behind the Hun

This "Battle of Production" we hear so much about isn't any pushover for our side.

Back of the Axis armies are some of the world's most capable scientists, engineers, inventors and research workers, *stretching to the utmost their materials for making the weapons of war.* In the Axis factories are millions of skilled workers, producing for their very lives.

Night and day the air forces of the United Nations are over Nazi industrial centers to cripple production with bombs. But that alone won't do it. In the last analysis it's up to American industry and American workers to "beat the man behind the Hun." Plant for plant, man for man, we must outproduce our enemies' huge industrial armies.

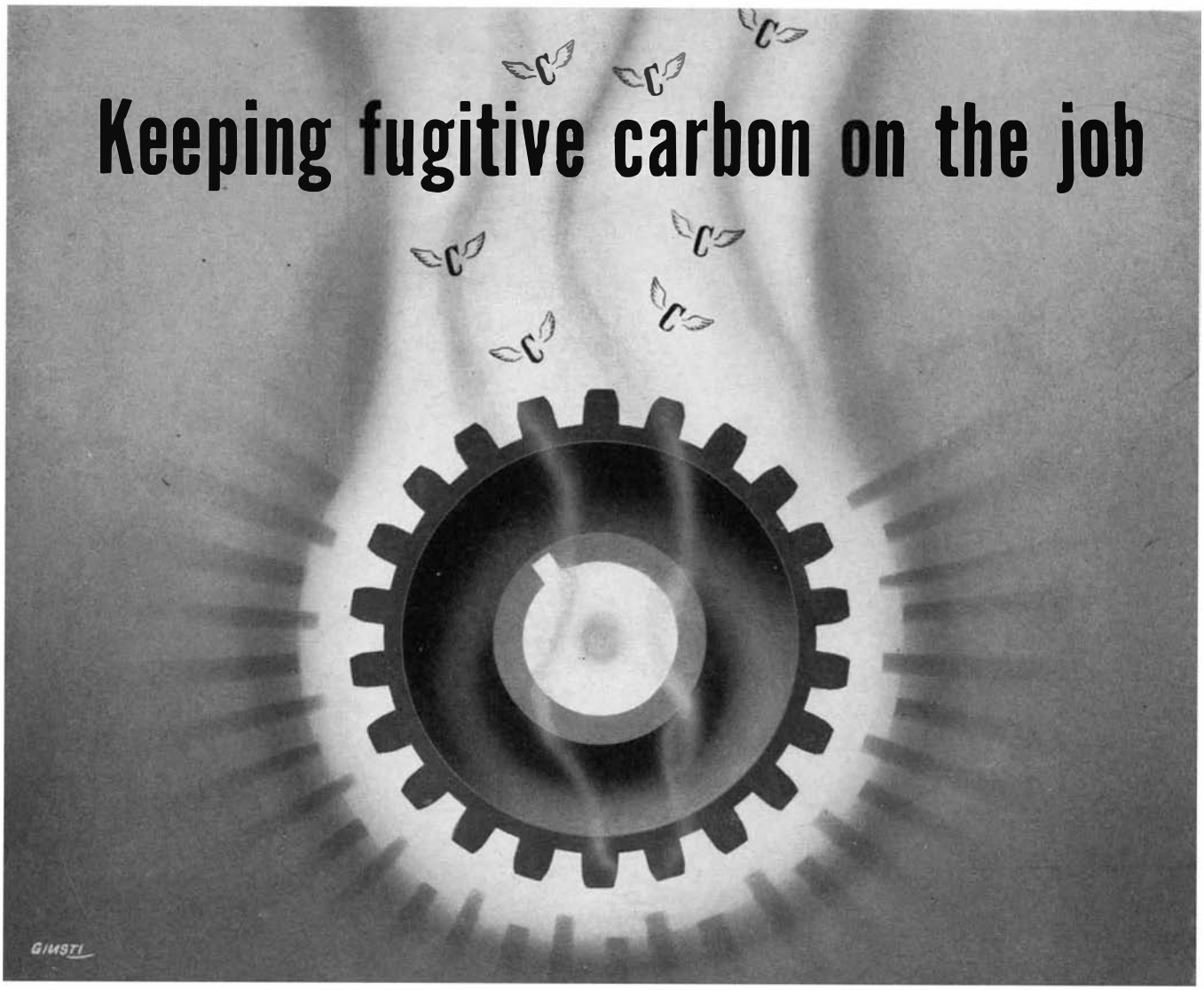
Ethyl antiknock fluid is one of the thousands of war materials needed by the United Nations. But to the some 4000 men and women today engaged in the processes of making Ethyl fluid, it is the *only* material. They know that Ethyl fluid goes into every gallon of America's superb military gasolines. Their slogan is: "*Every drop of Ethyl counts.*"

ETHYL CORPORATION

Chrysler Building, New York City

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

Keeping fugitive carbon on the job



TO WIN A WAR, we *must* have hardened steel gears, pinions, and other essential parts that can take a terrific beating —and keep on going.

All steel is basically a mixture of *iron and carbon.* To bring out its stamina and strength, steel must be heat-treated at high temperature.

But the carbon in steel is a *fugitive* thing. When exposed to highly heated air, carbon literally "boils off" the metal. The steel surface gets softer through loss of carbon.

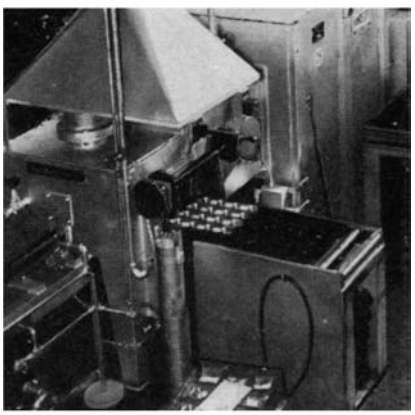
The problem in heat-treatment is to keep fugitive carbon on the job—in the steel surface where maximum wear and strain occur.

Fortunately, Westinghouse Engineers tackled this problem years ago. They developed an "artificial atmosphere" in heat-treating furnaces that would not rob steel of its fugitive carbon—that left hardened steel parts *clean and free of scale.*

It is known as the Westinghouse "*Endogas*" Balanced Atmosphere. It is made from inexpensive natural or manufactured city gas—in a self-contained mixing chamber which is simple and easy to operate. It is exclusively a Westinghouse development.

And the balanced atmosphere in the "*Endogas*" Furnace may be varied, at will, for heat-treating practically *any kind of steel*—by merely changing the proportion of fuel gas and air in the mixing chamber. A typical result of Westinghouse "know how" in solving a problem that has perplexed metal workers since primitive man hammered out his first battle-ax!

Today, Westinghouse "*Endogas*" Furnaces are heat-treating vast quantities of gears, cams, dies, and other steel parts. They are setting the pace as



America's astonishing war-production shifts into high.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Penna.

Westinghouse

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