DREADNOUGHTS OF THE U. S. NAVY . . . Page 221

SCIENTIFIC AMERICAN

MAY 1942 ★ 35c. a Copy
50¢ In Canada

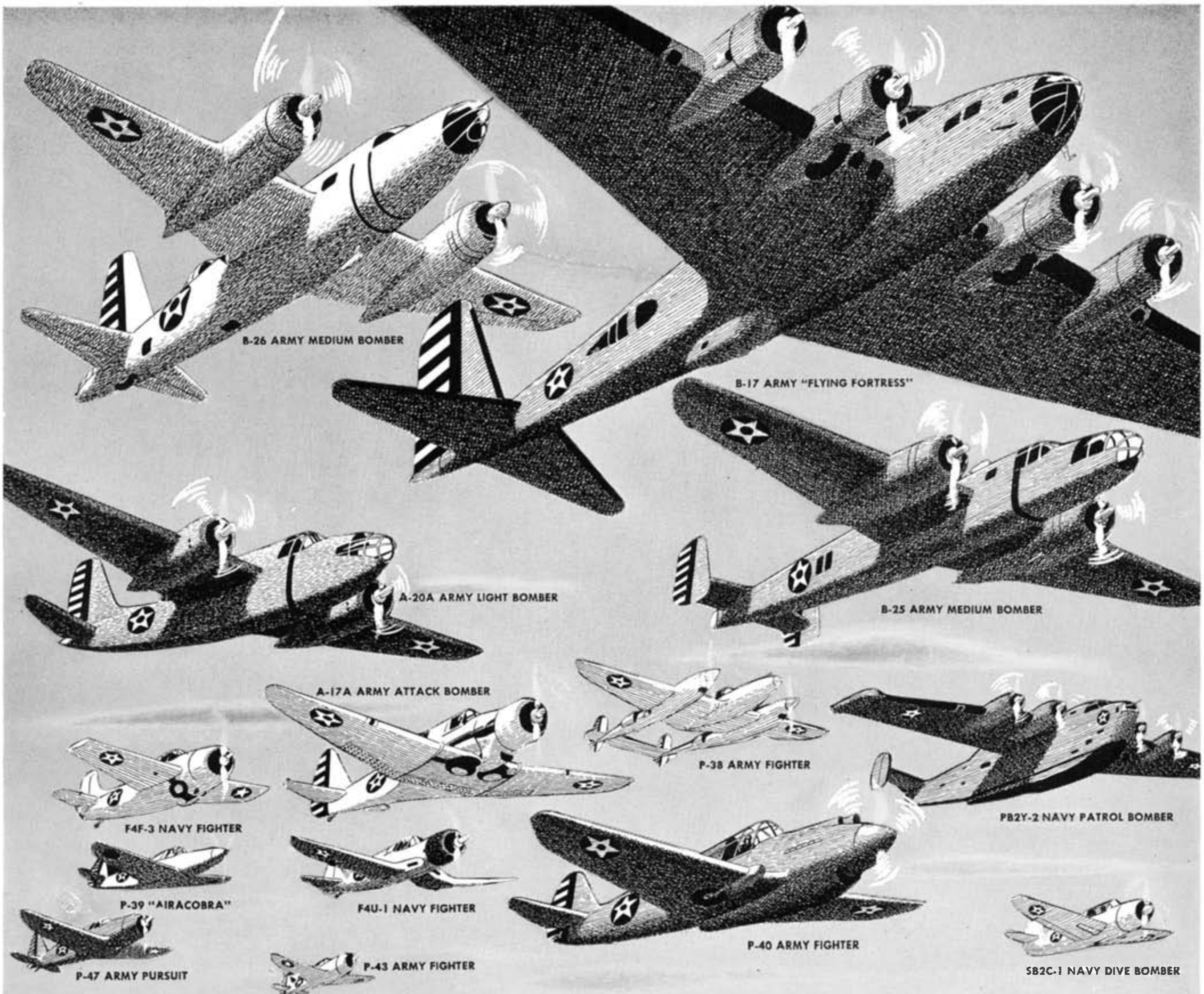
Potential Bombers in Liquid Form . . . See page 232

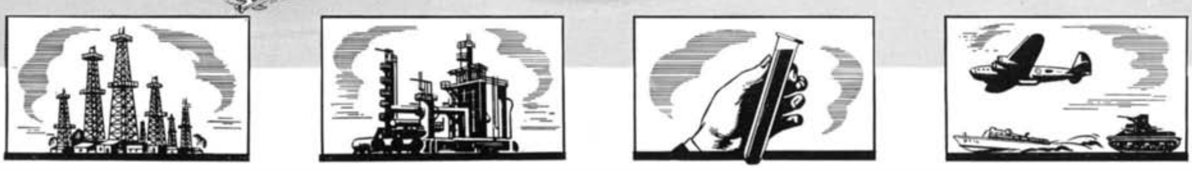
In ONE way all these American war planes are alike

★ All American fighting planes have one important feature in common: their engines are designed for high-octane gasoline. That's the basic reason why they have more power than similar enemy planes. And because they have more power, they will—plane for plane—outfly and outfight our enemies'.

We alone have ***all three*** things needed to produce high-octane gasoline—and plenty of it: *one*—vast resources of high quality crude oil; *two*—superior refining processes, developed by America's petroleum industry; *three*—adequate production of anti-knock fluid to improve octane ratings of military gasolines.

The makers of Ethyl brand of anti-knock fluid have geared their plants, laboratories and technical staffs to meet the oil industry's war needs. Until victory is won, our Army, Navy and Allies have first call on Ethyl fluid to make fighting fuels for planes, tanks, armored cars and other mechanized equipment.





AMERICA'S VAST RESOURCES OF HIGH QUALITY CRUDE OIL *plus* SUPERIOR REFINING PROCESSES DEVELOPED BY OUR PETROLEUM INDUSTRY *plus* ADEQUATE PRODUCTION OF ANTI-KNOCK FLUID *(containing tetraethyl lead)* = SUPERIOR FIGHTING FUELS

ETHYL BRAND OF ANTI-KNOCK FLUID — MADE BY ETHYL GASOLINE CORPORATION

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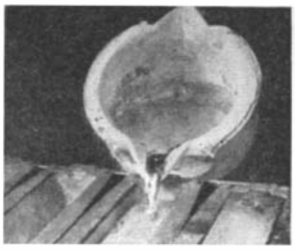

THE reason why aluminum has become such a choke-point in the present-day scheme of things is put forth in detail in the article starting on page 232. Our cover photograph shows molten aluminum being poured into molds from a ladle which has been filled from an electrolytic cell.

●

SCIENTIFIC AMERICAN

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

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MAY • 1942

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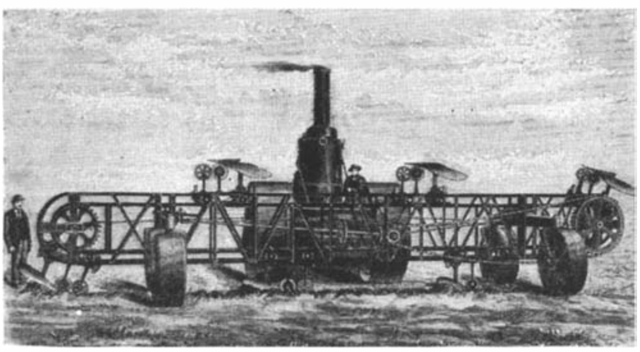
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1892)

RECLAMATION—"The business of securing waste rubber and recovering it obtained its impetus soon after the expiration of the Goodyear patents. Before that time the scrap, particularly that which was vulcanized, had been burned under the boilers or thrown away. . . . Briefly described, the process of reclaiming old rubber boots and shoes is as follows: The boots and shoes are roughly torn to pieces. These go to a grinding mill with a very decided friction motion which grinds the product to a fine powder. . . . The black powder is next put in iron pans, run into a vulcanizer and exposed to live steam for a number of hours at a temperature varying from 400° to 600° F. . . . Taken out of the vulcanizer, it may be put on a grinder, when it will readily form in sheets, and has very much the appearance of compounded stock that is unvulcanized. . . . There are few lines of goods in which recovered rubber cannot be used."

PLOW—"The accompanying cut, which is from a photograph taken while the machine was in operation, represents the rear view of a steam plow designed and manufactured by an engineer who has had some 18 years experience in steam cultivation and steam drainage in England, Germany, and Russia, and with every known



system. The apparatus is doing some excellent work, and is not only a working but a commercial success. As much as three acres per hour have been plowed in a most excellent manner, and the average of a day's work may be set down at 20 acres, which is being done at a cost of 45 cents per acre."

GUNS—"The largest of the modern high-powered guns, entirely of American manufacture, thus far completed, are the two 12-inch guns for the Monterey, the new monitor now nearly finished at San Francisco, and these pieces, as they were assembled at the Washington gun factory, were believed by our very competent ordnance officials to be equal, if not superior, to the best guns of the same caliber made anywhere else in the world."

PIGEONS—"Some important experiments have been recently made at Portsmouth relative to the use of carrier pigeons at sea. . . . On one occasion there was a thick fog on the other side of the channel; the pigeons set free circled for a few minutes around the boat, and then, getting their bearing, returned home."

COMET—"Prof. Lewis Swift, of Warner Observatory, reports a dispatch dated San Francisco, quoting Prof. Barnard as saying that his recent observations of the new comet reveal a remarkable state of affairs. Spreading out from the head is a complicated system of tails. At least a dozen distinct branches can be counted."

ELEPHANTS—"An elephant's digestive functions are very rapid, and the animal, therefore, requires daily a large amount of fodder—600 pounds at least. In its wild state the elephant feeds heartily, but wastefully. It is careful in selecting the few forest trees which it likes for their bark or foliage. But it will tear down branches and leave half of them untouched. It will strip off the bark from other trees and throw away a large portion."

MECHANICS—"A good mechanical eye is an almost essential requisite in a good mechanic. . . . No one can ever attain distinction as a mechanic unless he is able to detect ordinary imperfections at sight, so that he can see if things are out of plumb, out of level, out of square, and out of proper shape, and unless he can also detect disproportioned or ill-shaped patterns. . . . A little training and care is all that is necessary for success."

SAW—"Carnegie, Phipps & Co., who have the government contract for a portion of the armor plates of the new navy, are to add to the finishing plant of the armor department, a gigantic saw, weighing 110 tons, that will cut a nickel steel armor plate as an ordinary saw does a plank. . . . The saw has a blade 7½ feet in diameter, geared from above and revolving horizontally. With it an angular slab of cold nickel steel, weighing perhaps a dozen tons, is taken off like the slab of a pine log."

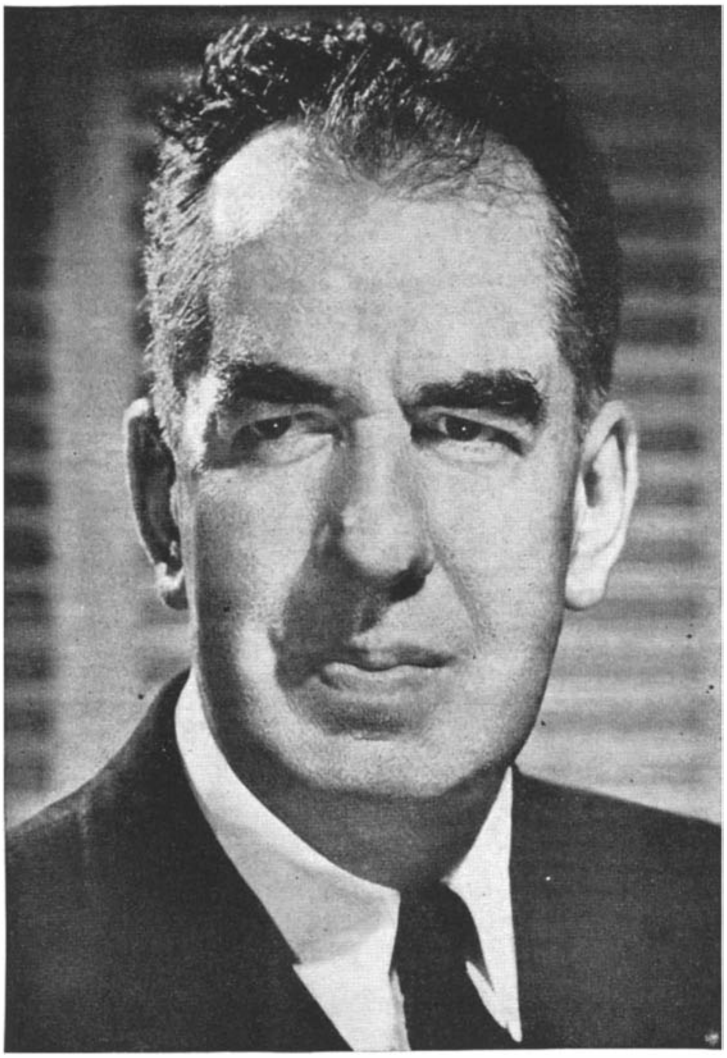
HIGH-SPEED PHOTOGRAPHY—"In a lecture on photographing bullets, delivered recently at the South Kensington Museum, Professor C. V. Boys explained his apparatus for the purpose. It consists of box lined with black cloth, in which the photographic plate is exposed, of a condenser, and of a system of wire circuits and knobs to give the spark which throws the shadow of the bullet on the plate, and thus takes the photograph. The bullet enters and leaves the box by two holes, covered with paper to exclude the light, and in passing the plate the bullet touches the terminals of two wires, composed of thin lead wire, thus partly completing the circuit, causing a flash to pass between the knobs of the plate condenser inside the box, and this flash, lasting less than one millionth of a second, takes the photograph of the bullet, no lens being employed."

LAND AND WATER—"It is estimated that the area of the dry land of the globe is 55,000,000 square miles and the area of the ocean 137,200,000 square miles. The volume of the dry land above the level of the sea is estimated at 23,450,000 cubic miles and the volume of the waters of the ocean at 323,800,000 cubic miles. The mean height of the land above the sea is 2,250 feet and the mean depth of the whole ocean is 12,480 feet. Of course these results are only approximate, but they help to render our ideas of these matters more definite."

FREIGHT FERRY—"The bold idea of ferrying loaded freight cars across Lake Michigan is soon to be put into practice. A large propeller is under construction at Toledo which will have a capacity of 21 cars, and it is expected to tow a barge carrying 15 cars, making 36 cars, or more than an average freight train."

MASONRY DAM—"The largest masonry dam in the world has lately been completed in India, in connection with the new water works for the city of Bombay. It is situated 65 miles north from Bombay, and stretches across the Tansa Valley. The dam is about two miles in length; 118 feet high; 100 feet thick at its greatest depth; 15½ feet at the top."

Personalities in Industry



A. W. HERRINGTON

RECENTLY elected president of the Society of Automotive Engineers, Mr. A. W. Herrington is the head of the Marmon-Herrington Company, manufacturers of specialized automotive equipment for civilian and military services, and chairman of the board of the Merz Engineering Company, a Marmon-Herrington subsidiary specializing in the manufacture of precision gages, instruments, and machines.

Mr. Herrington has an intimate acquaintance with military transport problems throughout the world, gained during World War I and since that time through frequent business trips to Europe, North Africa, and the Near and Far East. A forceful character, a dynamic speaker, and an accomplished organizer, it is his announced purpose, during the coming year, to use the influence of his position as head of the Society of Automotive Engineers to help synchronize the efforts of the entire industry into one great force for American defense and the successful prosecution of the battle against aggressor nations.

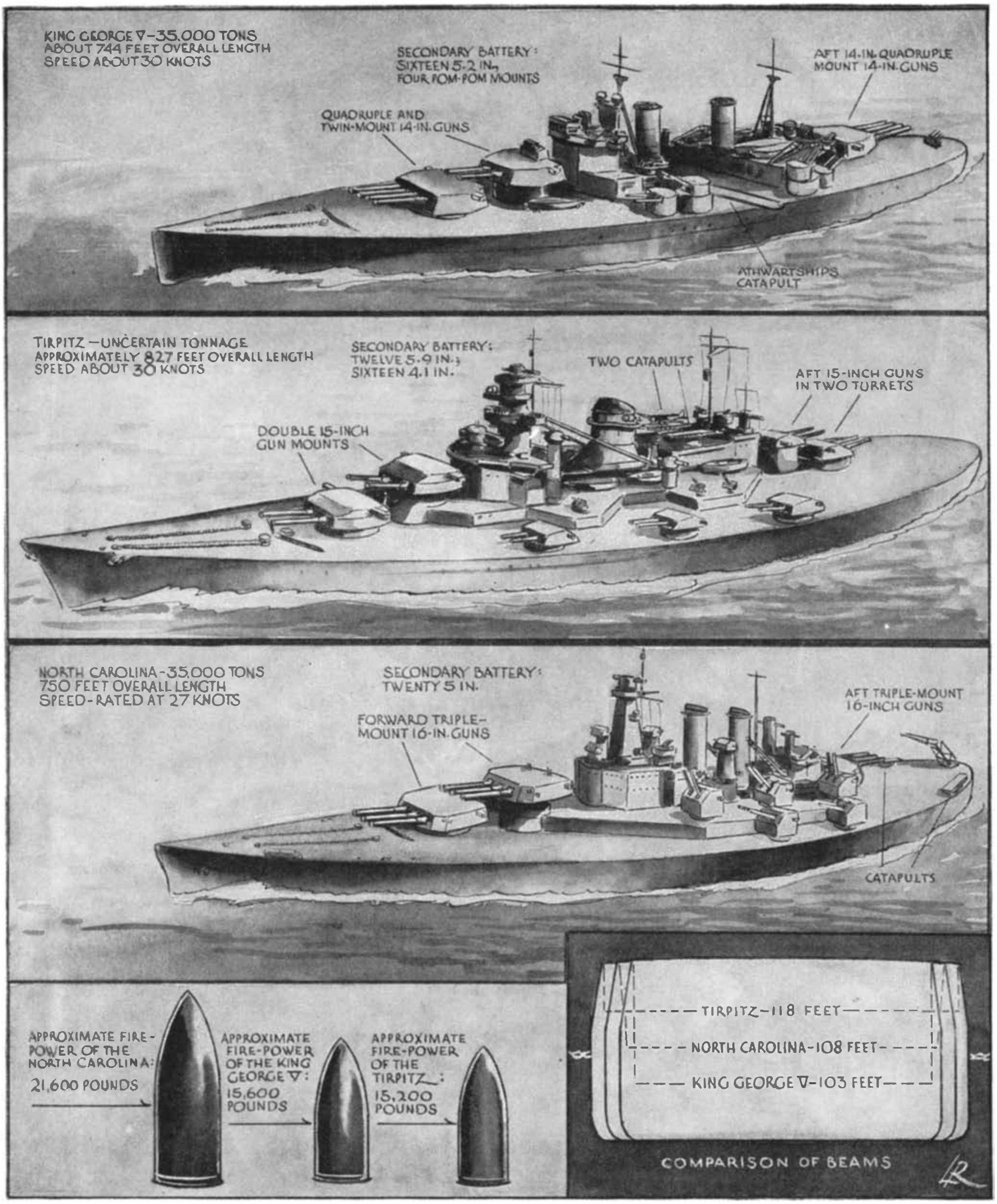
Born in Coddenham, England, Mr. Herrington came to America at the age of five with his parents, Arthur and Mary Matilda Herrington. He was married in Richmond, Virginia, in 1924, to Nell Ray Clarke, a newspaper woman of Washington, D. C. He has one son, Arthur Clarke Herrington, now 10. Mr. Herrington's primary schooling was received in Madison, New Jersey, and his technical education at Stevens Institute of Technology, Hoboken, New Jersey. His early automotive experience was gained with The Harley Davidson Motor Company, where he rose to the position of assistant chief engineer.

Mr. Herrington was in active service with the U. S. Army in the World War from October 1917 to September 1919. It was during this period that he became impressed with the futility of conventional drive automobile equipment for off-the-highway military service and determined to do something about it. Between 1921 and 1931, he was associated with several different motor car, truck and bus companies, and with the U. S. Army and Marine Corps as consulting engineer. He is the designer of various military vehicles and is also the originator of the idea of converting standard mass-production trucks to all-wheel-drive.

In March 1931 Mr. Herrington became associated with the late Walter Marmon, as vice-president and chief engineer of The Marmon-Herrington Company at Indianapolis, Indiana, in the design and manufacture of high-traction automotive vehicles of all types, for the most difficult civilian services, such as in the oil fields, logging camps, and so on, and for military usage. In August 1931 Mr. Herrington became president of the company, Mr. Marmon becoming chairman of the board.

As a result of his pre-war travels to far-away lands, Mr. Herrington's engineering ability is probably better known in such lands as Iran, Iraq, Australia, Africa, and China than here at home. His huge all-wheel-drive trucks are serving the oil industry in the jungles of South America, in the tractless desert wastes of Arabia, and in other remote regions.

Familiarly known to his friends and associates as "Colonel," Mr. Herrington is a member of The Indianapolis Service Club, an organization of World War Veterans, and never fails to attend the weekly luncheon meetings when he is in town. His interests, aside from business, are: squash, lacrosse, yachting, deep-sea fishing, hockey, and big-game hunting. He is a member of the Episcopal Church, a 32nd degree Mason, and a member of the Mystic Shrine. His clubs are the Indianapolis Athletic and Columbia Clubs, the Woodstock Country Club, and the Gibson Island Club, Maryland. He is also a member of the Society of American Military Engineers and a Fellow of the American Geographical Society.



Drawn by Logan U. Reavis especially for Scientific American. Approved by U. S. Navy

Battleship Types of Three World Powers

The comparisons of the three heaviest existing capital ship types of England, Germany, and the United States, given in the above drawing, indicate that the performance of the new *North Carolina* type may be awaited with confidence; in design, fire-power, and maneuverability it may, in some future encounter, justify the extraordinary care which has been exercised in its construction.

Resembling its ill-fated sister ship, the *Bismark*, it is probable that the *Tirpitz* is closer to a displacement of 50,000 tons than to the 35,000-ton figure usually assigned to her. Although the *Prince of Wales*, sister ship of the *King George V*, was somewhat punished by the *Bismark*, and later sunk by Japanese planes, it does not necessarily follow that this class is weaker than the *Tirpitz* under similar conditions. Theoretically the *King George V* has the advantage of later research.

98TH YEAR SCIENTIFIC AMERICAN MAY 1942

DREADNOUGHTS OF THE U. S. NAVY

A Two-Ocean Fleet is Our Nation's Ultimate Goal

WALTON L. ROBINSON

EVERYONE realizes that the bitter conflict between the United States and Japan, particularly in its early stages, will be fought largely at sea and in the air. There has been and will be hard fighting on land, but before American and Japanese soldiers can come to grips on the battlefield they must first be embarked in transports and safely escorted by warships to the scene of operations. Seapower, from the very start, has played an even more decisive role in the Southwestern Pacific than it has thus far in European waters.

For the past several years the United States Navy has been undergoing a rapid expansion toward its ultimate goal—a two-ocean fleet capable of repelling any likely combination of hostile powers in both the Atlantic and Pacific. This expansion continues at an ever-increasing pace, but now that war is actually here we must place our reliance in those ships which, fully manned by trained officers and men, are in every respect ready for active service. Warships in the blueprint stage or on the building ways never won a naval battle.

Early in December last, 17 American battleships, displacing 534,000 tons, were in commission, giving us the largest, though not the most up-to-date dreadnought force in the world. Between them these ships mounted 178 heavy-caliber guns having a total broadside weight of 277,640 pounds. Five of our ships were armed with 16-inch guns, eleven with 14-inch, and one with 12-inch. Great Britain followed with 13 battleships and two battle cruisers; while Japan, third largest of the world's sea powers, had 12 capital ships of some 385,000 tons and carrying 114 guns with a combined broadside weight of 186,460 pounds. Four of Japan's ships were armed with 16-inch guns and the remainder with 14-inch. The Imperial Navy also possessed three or four "pocket battleships" displacing around 15,000 tons and mounting six 12-inch guns each.

Mere statistics, however, cannot give an accurate picture of the relative fighting value of the American and Japanese battle fleets, for they fail to take into consideration such important factors as age, speed, armor protection, and hitting power of individual ships and the ability of each to operate in effective conjunction with the others. Our three oldest battleships are, for example, of very doubtful value, due primarily to their low speed and limited gun range, while several of Japan's are so scantily armored that a few hits from large caliber shells would certainly put them in serious trouble.

NATIONAL DEFENSE

• This thorough-going analysis of battleships of the United States Navy is the first of a series of five articles, each complete in itself, which will give an accurate over-all picture of our naval strength in surface ships and submarines. —*The Editor* •

Our battleships range in size and age from the 26,100-ton *Arkansas,* completed in 1912, to the giant 35,000-ton *North Carolina* and *Washington,* which passed into service last year. Fifteen new battleships are completing afloat, building on the slips, or authorized. Several may be ready by the end of this year.

The *Arkansas,* our oldest and least valuable dreadnought, was built as a sister-ship to the *Wyoming,* which some years ago was demilitarized in accordance with the London Naval Treaty of 1930 and converted into a training ship. The *Arkansas* carries a main armament of twelve 12-inch guns mounted in six turrets disposed along her center-line. These guns, measuring 50 feet from breech to muzzle, hurl an 870-pound projectile at an initial velocity of over one-half mile per second. Due to their very limited elevation (15 degrees), however, they have an effective range of only some 15,000 yards, which is far below current requirements; and the *Arkansas,* were she to encounter a modern cruiser, might well find herself unable to get within range of her harder-hitting guns while, at the same time, suffering numerous hits from the cruiser's lighter but longer-ranged weapons.

The *Arkansas'* secondary or anti-torpedo armament consists of sixteen 5-inch, 51-caliber guns. These guns, firing a 50-pound shell, are of fairly modern design and constitute the secondary armament of all our battleships except the two newest. The anti-aircraft battery comprises eight 3-inch and numerous smaller guns. The 3-inch gun is inadequate for today's needs and in most of our battleships has given way to the more effective 5-inch, 25-caliber weapon.

ARMOR protection includes an 11-inch main belt along the water-line, 12-inch plates on the faces of the big-gun turrets, a 12-inch conning tower, and fairly thick decks over such vital spots as the engine and boiler rooms and shell and powder magazines.

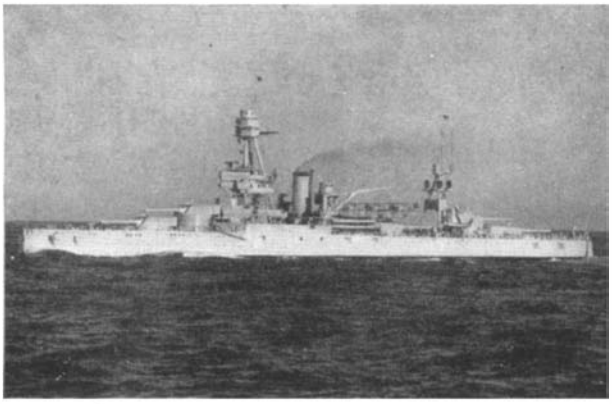
The *Arkansas* was designed to attain a speed of 20.5 knots, but can now do no better than 19 knots. This reduction was caused by the addition of anti-torpedo "blisters" when the ship was modernized some 15 years ago. Other alterations effected at this time included conversion to oil burning, stronger anti-aircraft defense, substitution of a tripod mainmast for the old cage or basket mast, and improved plane-handling arrangements. Three aircraft and a catapult are now carried atop No. 3 turret.

The *New York* and *Texas*, launched in 1912 and completed two years later, are our next oldest battleships. They displace 27,000 tons and are armed with ten 14-inch guns mounted in five center-line turrets. These guns are 45 calibers in length (that is, 52 feet, 6 inches), elevate to 15 degrees, and fire a 1400-pound projectile at a range of some 21,000 yards. Their secondary and anti-aircraft batteries are the same as those in the *Arkansas*. Armor protection includes a 12-inch water-line belt, 14-inch turret faces, thick decks, and a 12-inch conning tower. Anti-torpedo blisters, fitted some years ago, have reduced their speed to about 19 knots. Three planes and a catapult are carried on the amidship turret.

These ships are hard to handle and very poor sea boats in rough weather; they roll so badly, in fact, that waves frequently ride the blisters into the 5-inch gun casemates. One of the most interesting features of their design is the reversion to reciprocating engines in place of the turbines which had been fitted in the *Arkansas* and other earlier ships. This was done to show American turbine builders, who had refused to adopt the standards laid down, that the Navy Department was determined to have turbines built to official specifications.

The *Arkansas, New York,* and *Texas* are the "lame ducks" of our fleet and are no longer reckoned effective for war purposes. Judged by modern standards they are now quite obsolete and of little value as "line-of-battle" ships. Their presence in a major engagement might well prove a liability rather than an asset to our commander in chief, for their low speed and the limited range of their big guns would make it extremely difficult for them to operate with our faster and more powerful ships. Despite their deficiencies, however, these old battleships can still perform such secondary tasks as escorting convoys and attacking coastal objectives. They are hopelessly outclassed by Germany's trio of modern 30-knot battleships: the 35,000-ton *Tirpitz* (eight 15-inch guns) and the 26,000-ton *Scharnhorst* and *Gneisenau* (nine 11-inch guns).

The 29,000-ton *Nevada*, commissioned in 1916 as a sister ship to the *Oklahoma*, which capsized in Pearl Harbor last December 7, carries the same main armament as the *Texas*. Her 14-inch guns are differently arrayed, however, being grouped in two twin and two triple turrets with the former in the super-imposed positions. Moreover, they elevate to 30 degrees and have a range of some 30,000 yards. The *Nevada's* secondary and anti-aircraft batteries consist respectively of twelve 5-inch, 51-caliber and eight 5-inch, 25-caliber guns, plus numerous smaller weapons. She also carries three planes and two catapults—one on No. 3 turret and one on the quarter deck. Her secondary and anti-aircraft batteries and plane-handling arrangements are standard for all of our remaining battleships except the new *North Carolina* and *Washington*.



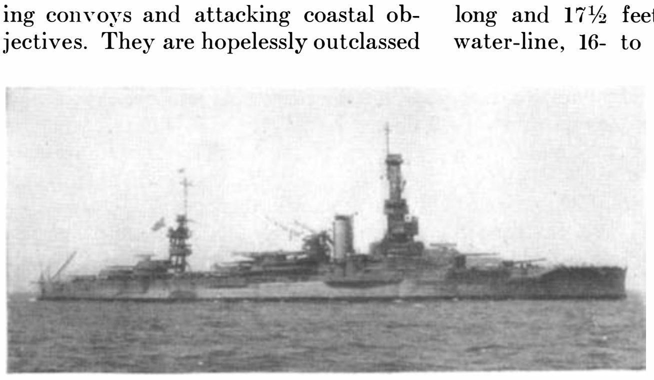
USS *Texas*, useful in convoy work

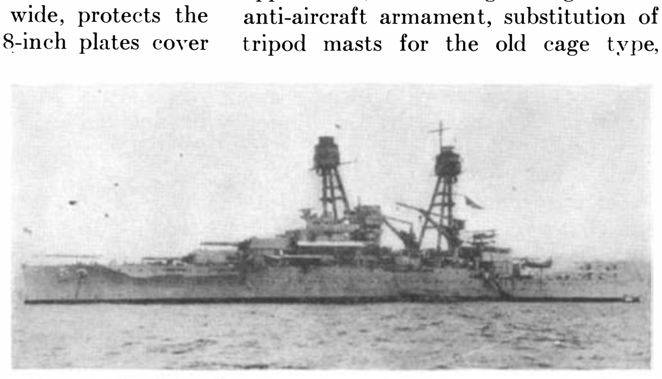
THE *Nevada* and her ill-fated sister-ship marked a new era in naval construction, being the first dreadnoughts to embody the "everything or nothing" principle in the matter of protection. A 13½ inch belt, 400 feet long and 17½ feet wide, protects the water-line, 16- to 18-inch plates cover the turret faces, 16 inches encase the conning tower, and 3-inch upper and 2-inch lower decks provide defense against aerial bombs and long-range plunging shellfire. All this protection, less the horizontal or deck armor, weighs nearly 8000 tons.

The *Nevada's* designed speed of 20.5 knots, obtained by Parsons turbine engines developing 25,000 horsepower, was unaffected by the $7,000,000 modernization she underwent some years ago. The addition of anti-torpedo blisters, however, has made her unwieldly at low speeds. She and the *Oklahoma* were the first American battleships to be fitted with all-oil-fired boilers.

The *Pennsylvania*, launched in 1915 and completed the following year, is a sister-ship of the *Arizona*, which sank in shallow water at Pearl Harbor. Displacing 33,100 tons, the *Pennsylvania* is simply an enlargement of the *Nevada*, which in appearance she greatly resembles. She has two more 14-inch guns, heavier armor protection, and a somewhat higher speed. The increase in the number of big guns was made possible by placing three of them in each of the four turrets. The water-line belt is 14 inches thick and two decks, a 6-inch upper and a 3-inch lower, protect the ship's vitals. The speed of 21 knots is obtained by 32,000 horsepower turbine engines driving four screws.

The *Pennsylvania* is a splendid sea boat, offering a very steady gun platform, and has proved a most economical steamer. She has always been regarded as a fine ship and for many years served as flagship of the CINCUS (Commander in Chief, United States Fleet). Some years ago both she and the *Arizona* underwent an extensive reconstruction at a total cost of nearly $15,000,000. Among the alterations effected were the raising of the anti-torpedo battery from the main to the upper deck, the strengthening of the anti-aircraft armament, substitution of tripod masts for the old cage type,

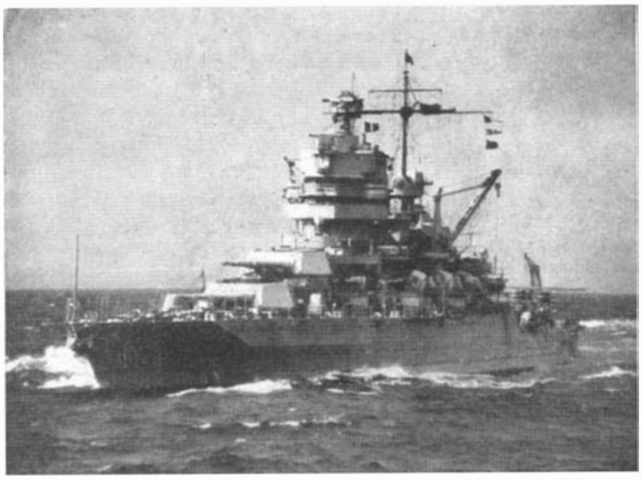




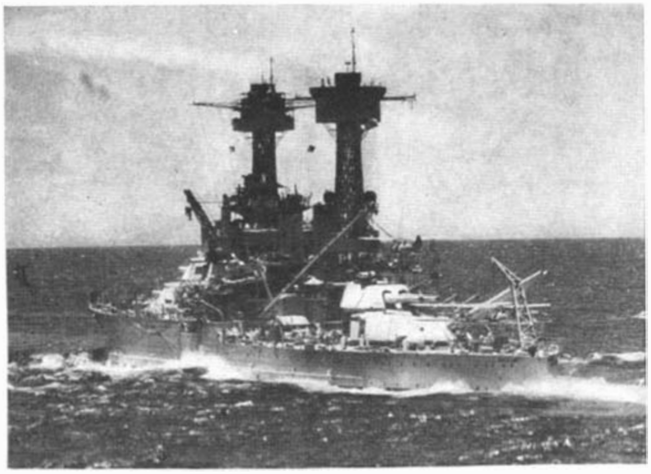
All illustrations Official U. S. Navy Photographs

USS *Arkansas*, our oldest dreadnought

USS *Nevada* marked a new era in naval construction



USS *Idaho* has been completely modernized



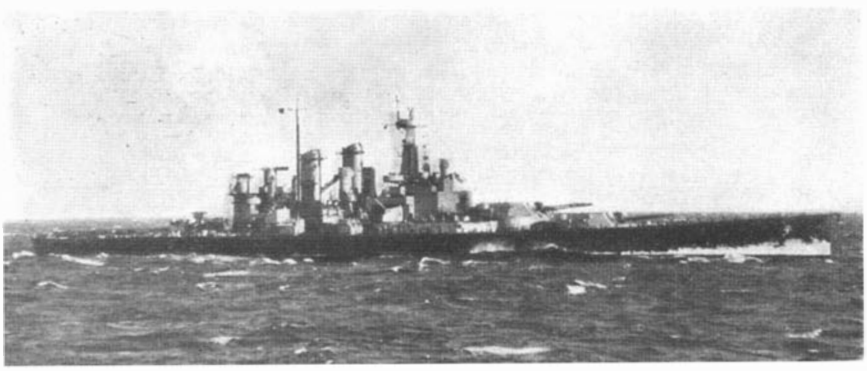
USS *Maryland* has not been modernized

addition of blisters, and the improving of the internal sub-division.

Between January and June, 1917, three fine ships, the *New Mexico, Idaho,* and *Mississippi,* were launched. As originally built they were slight improvements on the *Pennsylvania* design, but a few years ago they were so completely modernized that they may well be regarded almost as new ships. They are now the fastest and most stoutly protected of our older battleships and, everything considered, more formidable ships than the newer *California* and *Tennessee* and three *Marylands*, none of which has been modernized. Averaging just over 33,000 tons, the *New Mexicos* carry twelve 14-inch guns, have a 14-inch main armor belt, 18-inch protection for the big-gun turrets, minute internal sub-division below the water-line, and two decks (6-inch upper and 4-inch lower) over vital areas. Their 14-inch guns, of a more powerful model than in preceding ships, elevate to 30 degrees and have a maximum range of over 35,000 yards or some 20 miles.

One of the most noteworthy features of these reconstructed ships is their relatively high speed of 22 to 23 knots, obtained by 40,000 horsepower Westinghouse geared turbine engines. The *New Mexico* has four White-Forster boilers and the other ships six of the Bureau Express type.

The *California* and *Tennessee*, launched in 1919, are slight improvements over the original *New Mexico* design. They were scheduled for modernization during 1940-41, but the Navy Department cancelled the work because of the threatening international situation—just a case of keeping the powder dry. Displacing over 32,000 tons, they have the same armament and vertical protection as the *New Mexicos*, but are not as stoutly armored against air attack, having decks only 3½ and 2½ inches thick.



USS *North Carolina* can just barely squeeze through Panama Canal locks

These two ships are equipped with electric drive. Power for their four alternating current motors, one to each propeller shaft, is generated by turbines—General Electric in the *California* and Westinghouse in the *Tennessee*. Designed speed is 21 knots, which was reached on trials.

The *Maryland, Colorado,* and *West Virginia,* launched in 1920-21 and displacing from 31,500 to 32,500 tons, are almost identical to the *California* except for their main armaments of eight 16-inch guns and a 2-inch increase in the thickness of their waterline belts. The 16-inch guns, 45 calibers in length, elevate to 30 degrees and hurl a 2100-pound shell at a maximum range of over 33,000 yards.

The *North Carolina* and *Washington*, launched in 1940 and costing nearly $70,000,000 each, are our newest and finest dreadnoughts. They are larger, faster, more powerfully armed, and more stoutly protected than any of our older ships and utterly different in general design and appearance. With their length of 750 feet, their beam of 108 feet, and their draught of 36 feet they can just barely squeeze through the Panama Canal locks. Their designed speed of 28 knots is obtained by geared turbine engines.

Their armament consists of nine 16-inch guns mounted in three heavily armored turrets, plus powerful secondary and anti-aircraft batteries. The 16-inch guns, of a new and very powerful model, have a range of about 40,000 yards. Two catapults and several planes are carried on the quarter-deck. These two ships are unique in having no portholes along the hull, ventilation and lighting being entirely artificial.

Work on four additional units of the *North Carolina* class is now being pushed as rapidly as possible. Three of them, the *South Dakota, Massachusetts,* and *Indiana,* begun in 1939, were launched last year and may be completed in time to join the fleet the latter part of this year. The fourth ship, the *Alabama,* launched this past February, will not be ready before next year. These ships will constitute a powerful reinforcement to our fleet and give us a definite superiority over the Imperial Navy. Our main battle fleet, composed of the six *North Carolinas* and the eight units of the *Maryland, California,* and *New Mexico* classes, should then be strong enough to take the offensive.

We Need More Physicists

Military Activity and Industrial Requirements Have Created an Unprecedented Demand

E. U. CONDON, Ph.D
Associate Director, Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania

Dr. Condon

EVERYONE has heard of the science of physics, embracing our fundamental knowledge of the forms of energy—mechanics, acoustics, electricity, magnetism, heat, and radiation. And everyone realizes that the science is basic to every phase of our industrial activity. But how many of us know a physicist or have any conception of what he does?

The word "physicist" was seldom seen in newspapers until recently. Now these same news sources tell of a drastic shortage of professionally competent physicists, which shortage is leading to all sorts of emergency rush training programs. Asked by the editor of Scientific American to explain in what way physicists are essential to the war, I had, of course, to reply that this could be done only in the most general terms, since specific details of such war work are in the secret classification.

He replied that even so he felt that many people are quite uncertain about the distinction between physicist and engineer; that it ought to be possible to discuss their work in a way which would help the general understanding and especially would aid students in their choice of a career.

Until quite recently, the opportunities for physicists as such were almost entirely confined to college and university teaching. In the better universities this offers an attractive career, for with the work of teaching it combines facilities and a favorable environment in which to carry out research—to adventure in the unknown frontiers of knowledge with a genial band of like-minded explorers.

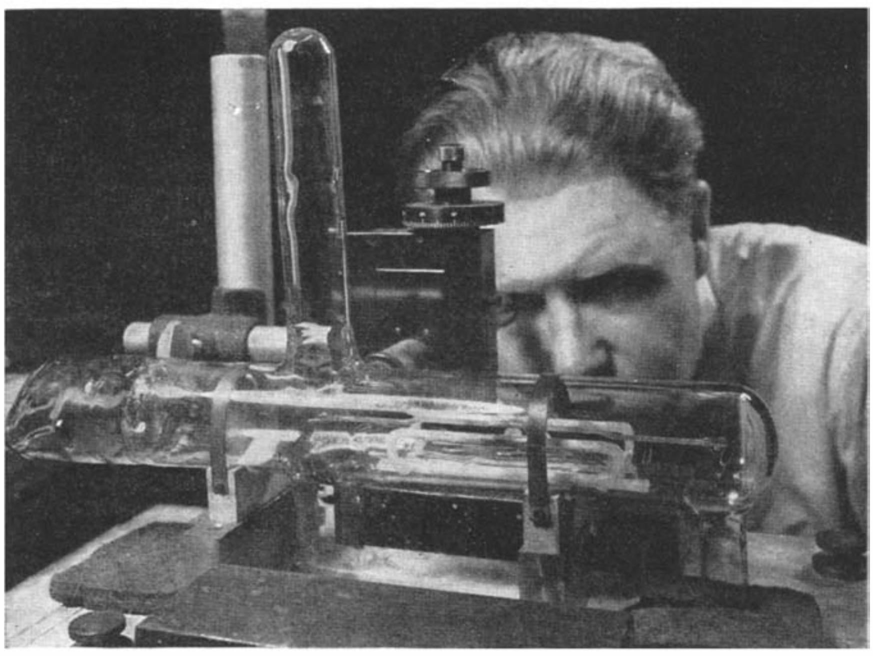
However, in the lesser colleges and universities the picture is not so attractive. In them the libraries and laboratories are usually inadequate for truly fundamental research, and the arrangements are such that the professor has so much teaching to do that he has very little energy left for original investigation.

In any case, the total number of positions available in university teaching is not great enough to support a very large number of physicists. Fewer than 3000 physicists find employment in this way in the entire United States.

In recent years, however, a rapidly increasing number of physicists have found employment in industry, first and still mostly, in research laboratories, but also in engineering and production units as well. Now everybody thinks he knows the difference between a professor and an engineer. But when a physicist works with engineers in an industrial organization this question arises: What is the difference, if any, in their function, and on which kinds of work should one use the physicist and which the engineer?

The difference in them, by which we shall decide which label applies, is that the physicist elected physics as his major study, usually in a liberal arts college, whereas the engineer studied one of the recognized specialties, such as electrical engineering, in an engineering college. Another difference is that most physicists have continued university work beyond the bachelor's degree, gaining thereby some training in independent original research methods. On the other hand, it is much more usual for the engineer to leave the university on graduation from a four-year course and to go at once into industrial employment.

This difference in training manifests itself in a difference in approach to a given problem which is approximately described by saying that the engineer is a conservative and the physicist a radical about new scientific developments. The engineer works best on the careful economic development of some applied science project whose general practicability has already been demonstrated. The physicist works best when trying to understand some newly-observed phenomenon that nobody as yet understands at all, or when trying some totally untried combination of ideas to get a new device of which



Some basic research must continue despite the war, for when peace comes we will have vast amounts of excess materials and the public demand for luxury items, long held in abeyance by military production, will come back

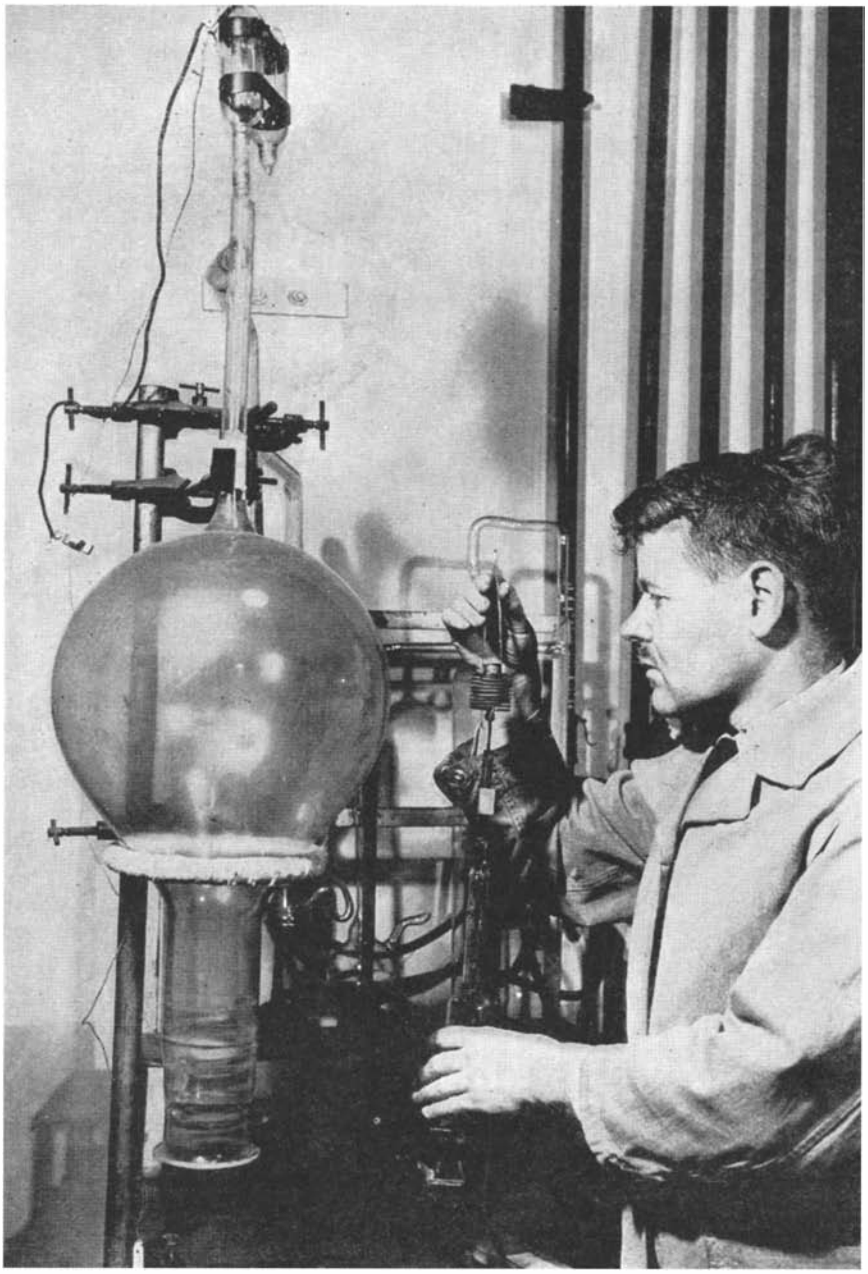
nobody is sure that it will be practical or even if it will work.

To any such broad generalization there are, of course, plenty of exceptions. Naturally, there are many scientifically radical engineers, just as there are some mighty conservative physicists. Here we are not trying to place a higher valuation on one type rather than the other: obviously both types are needed. As in other fields of endeavor, it must be noted that the conservatives and radicals often have difficulty understanding each other's view-point, even to the point of being sometimes mistrustful of each other.

But, anyway, it works out like this: The physicists are always busy looking into things in the physical world without much regard to their utility. In this way they are always aware of a lot of interesting phenomena which have not yet found, and may never find, any practical application, and they are trained in the art of digging up more such phenomena. The engineer, on the other hand, is busy with making important improvements and better application work in fields already established. Hence if a radically new device, or a radically new solution to an old problem, is needed, it is better to put a team of physicists on the job than a team of engineers. If nothing of the kind proposed has ever been done before, you are more likely to get it done (if it can be done at all) by physicists than by engineers.

THE device you get from the physicists as a rule will not be very well designed either for reliability of operation or simplicity of manufacture. When the engineer sees it, he is apt to sniff contemptuously unless he is an unusually broad-minded fellow. But he should not be too intolerant, for the chances are, if it is a really new device, that he does not know the new principles which it utilizes or at least is not familiar enough with them to have thought of applying them. After the physicist has made such a laboratory model, it is up to the engineer to make an engineering design, in the course of which many detailed improvements will be made, before the device can be put into production.

With this picture in mind it ought to be clear why physicists are so very valuable in preparations for modern mechanized war. The Services want devices for locating enemy planes or submarines, or for exploding bombs under special circumstances, or for protection against magnetic mines, or for fire control purposes, and so on. If it is a device of a general kind which they already have, they can get improvements and production designs by turning the job over to a team of engineers. But if it is a device that is completely unknown—simply an idea for a device which would be tactically valuable if it worked—then a team of physicists is called for as being most likely to produce the device . . . if it can be done.



We will know more about metals after the war is over; research metallurgists are working as never before in their search for metal substitutes

Our research preparedness activity on a large scale really dates from May, 1940, with the appointment of the National Defense Research Committee. By early autumn of 1940 the NDRC had decided on its main plan of action. Soon the best physicists of the country were organized into special teams and put to work applying the latest discoveries of the pure science laboratories to the solution of problems presented by modern warfare. It is fortunate indeed that the work was started this early—or rather most unfortunate that it was not started still earlier—since any new development of major importance calls for a tremendous amount of effort even before it is ready to be "engineered." Nevertheless, it can be said that several devices of great importance which have resulted from these efforts are already in production and many more may be expected soon.

Naturally, this "conversion" of the physicists has not been accomplished without completely upsetting their "business as usual." Up until recently their main concern had been the study of the great new field of atom-smashing or nuclear physics. Even a year ago nearly all of this fundamental research had come to a stop because of the demand for trained physicists to do war work. For example, our large four-million volt generator at the Westinghouse Research Laboratories has been shut down for months—not because this field of science is thoroughly explored or less significant, but simply because of the importance of the war job. The only cyclotrons operating now are those that are being used to prepare artificial radio-active materials for medical research.

I first discovered Scientific American when I was about 14 years old, and reading it greatly influenced me in getting a clear notion that I wanted to do research in science. Knowing that this magazine must be playing a similar part in the lives of boys today, I would like to close with a little advice to them.

Industry and science are being linked together by this war more closely than ever before. During the present war new advances in applied physics are being made which have brought about an urgent demand for young men with sound scientific training. Any boy who has a real aptitude for scientific studies cannot serve his country better than by devoting his best efforts to learning as thoroughly as he can and as quickly as he can and as much as he can about mathematics, physics, and chemistry. He should not scorn the "theoretical" fundamentals for hastily-gained superficial "practical" knowledge.

It is a great misfortune that many of the administrative officers of our public high schools have failed to appreciate the importance of sound training in fundamental mathematics and science. The quality of mathematical instruction in the high schools has sagged steadily in the past 20 years to such an extent that even the boy who gets an "A" grade in mathematics has a poor foundation on which to build his future work in science. No doubt the war will soon focus attention on this sorry state of affairs and reforms may result, but, in the meantime, boys who really want to help in this war should set themselves higher standards of mathematical attainment than most teachers demand.

Not only can the boy who has a real aptitude for science find a great opportunity to serve in the war, but with the steady advance in science-mindedness in all industry, it is safe to assume that the opportunities for scientific research in post-war industry will be much greater than ever before.

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DELAYED JUMP

Of Strip to Magnet

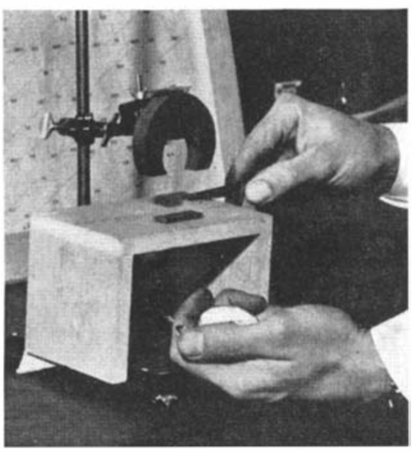
Demonstrates Atomic Change

A STEEL strip that, when placed under a powerful magnet, waits about a minute and a half before it jumps toward it, is the demonstration used by Dr. Herbert H. Uhlig, of the General Electric Research Laboratory, to show a delayed change in the strip's atomic arrangement. Exact knowledge of the nature of such changes is important in making magnetic materials for transformers and other electric equipment.

The strip used in the demonstration is a common type of stainless steel containing 18 percent chromium, 8 percent nickel, and the rest iron. This metal, known as 18-8, is not ordinarily attracted by a magnet, because it usually contains a little nitrogen. The nitrogen seems to cause friction within the metal, which prevents the atoms from rearranging themselves to the phase in which a magnet causes attraction.

If, however, the same type of stainless steel is made nitrogen-free, it takes on other properties; the demonstration strip is a piece of such nitrogen-free metal. When the strip is heated to a temperature of 1100 degrees, Fahrenheit, it again loses its magnetic property. This property does not return until the strip is cooled down to the boiling point of water. Dr. Uhlig, however, found that if the heated strip is suddenly cooled by quenching in ordinary tap water, and then placed under a magnet, it is not attracted, even though it is cooler than the temperature at which the change in the magnetic property of the metal should occur.

After about a minute and a half, however, it suddenly jumps to the magnet. Dr. Uhlig says that the atoms start rearranging themselves as soon as it is cooled, but it takes this time before a majority are shifted and at least a day before all reach a state of equilibrium.



Time needed for atomic rearrangement is demonstrated magnetically

The change is one in the crystalline structure of the metal. At the high temperatures, when non-magnetic, it has the face-centered arrangement, with the atoms forming cubes piled like bricks. The low-temperature magnetic phase has them in the body-centered arrangement, with cubes interlocking, so an atom in the center of one forms the corner of adjacent cubes.

"From these experiments," said Dr. Uhlig, "we hope to learn more about the heat treatment of steels and the preparation of alloys with better mechanical properties and corrosion resistance."

EYES

Are Most Sensitive

Light Recorders

PROOF that the eye is one of the most sensitive of all devices for recording light—far more sensitive than the best photographic emulsion or any other physical apparatus—was presented recently by Dr. Selig Hecht in reporting the first experiments to measure precisely the smallest amount of light which the eye will record.

According to Dr. Hecht, professor of biophysics at Columbia University, from five to fourteen quanta (a quantum is the smallest, basic, and indivisible unit of radiation, including light) will make an impression on the retina of the eye, thus leaving only a scant four smaller amounts of light which the eye is incapable of perceiving. He reported that for half a dozen observers, over a period of several months, the minimum energy necessary for vision was observed to be between 2.2 and 5.7 ten-billionths of an erg. This amount, he said, represents between 58 and 148 quanta of light emitted from the apparatus.

Most of this light is lost, however, through reflection by the cornea (outer shell) of the eye, absorption in the lens and other parts of the eye, and passage through the retina without absorption, Dr. Hecht pointed out. Subtracting this lost light, the amount actually absorbed by the retina is five to fourteen quanta, he said, adding that since each quantum reacts with only a single molecule of the receiving substance of the retina, as few as five molecule changes would produce light impression.

Have You Heterophoria?

Eye Exercises Using New Light-Polarizing Vectographs Can Improve Depth Perception

EVERETT WHITE MELSON

DON'T be shocked if an optical test reveals some day that you have heterophoria. According to some of our best eye authorities, this condition exists in about 80 percent of the eyes examined. Ordinarily, a mild contraction of the muscles that move the eyeball always exists. This is because the brain is attempting to fuse the images from each eye. It sends nervous impulses to the muscles to persuade them to pull a little more here or a little more there until the images appear on corresponding areas of each retina.

If there is a lack of balance in these eye muscles, one eye, or both, may be deviated so that the images appearing on the retinas cannot be fused and the binocular function of the eyes is lost. This function is most valuable, since it gives us depth perception, enables us to estimate distances, and provides us with contrasts and comparisons.

Heterophoria means that, due to some form of deviation of the eyes—one turning inward, outward, upward or downward—we cannot secure this binocular vision. We have to depend upon one image from one eye and thus lose the ability to judge distance and depth. Frequently this deviation is so obvious that anyone can see it, as in cross-eyes. More often, however, it is not apparent to an unskilled observer and the one who has it may be totally unconscious of it. In many cases there is no pain or discomfort. In other cases it is quite distressing, particularly in close work. One of its worst features is that it may drift into such conditions as amblyopia exanopsia, in which the vision of one eye dims from lack of use. This particular condition is generally agreed to be acquired and not congenital, and it can be cured.

If you have ever observed a baby's eyes you may have noted that many of their movements are not coördinated. He uses them independently, largely because the brain has not been trained by experience to evaluate objects and to demand a fused image. He will reach for a bottle or a rattle and miss it by several inches. When the brain begins to demand a fused image, one group of muscles becomes active in aligning the eyes for coördinate work while another set shapes the lenses to focus the objects. These acts of convergence and accommodation are to a great extent acquired faculties. That they are acquired faculties, subject in a large measure to voluntary control, is evidenced by the fact that most people can converge or rotate the eyes at will.

It is not enough that images shall be formed on corresponding areas of

Exercising at leisure

the retinas. They must be symmetrically distributed around the fovea, a tiny depression in the center of the macula. The fovea and the macula have a great number of little cones, or photo receptors, which are extremely sensitive to both detail and color. Further, the two images must be similar in size, shape, and alignment in order to be capable of fusion. Since the two images are formed at a slightly different angle, due to the spacing of the eyes, they are slightly different—just enough different, in fact, to create the sense of depth when they are superimposed. If they are not similar in size, shape, or location, a double image will result and the brain will be forced to suppress one image in order to see the other clearly.

To orientate both eyes for the production of images on the macular areas, the six muscles that move the eye in its orbit must act in concert, some contracting and others relaxing. These are known as conjugate movements because these muscles are linked together by the nervous system. Likewise, the ciliary muscles, which are responsible for accommodation, are busy increasing or lowering the convexity of the lens so that objects can be sharply focused at varying distances.

Defects in the refractive system of the eye can be corrected by proper glasses, and imbalances in the muscles that move the eye are frequently corrected by the introduction of prisms to offset the deviation, but since the action of these muscles is subject to voluntary control, it is possible to provide them with a system of calisthenics to improve their coördination, thus improving the overlap in the retinal images and resulting in better depth perception.

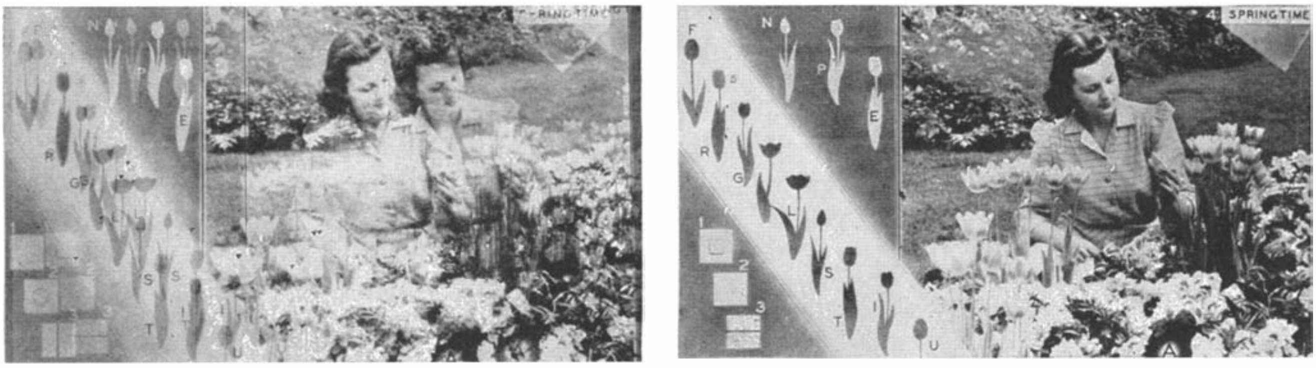
IT has been said that in some ways it is better to have one blind eye than two eyes in one of which vision is temporarily suspended, as is frequently the case in a deviation of one eye. The one-eyed person has two possible errors eliminated automatically—affections of symmetrical movement of the eyes, and image differences. On the other hand, his sense of perspective can be only moderate since he must rely on the one good eye. Some people, however, who have suffered the loss of vision in one eye at an early age have developed better judgment than their fellows who have defective binocular fusion, because the latter can be very dangerous in many occupations.

In nearly all cases of faulty fusion faculty there will be either a tendency to suppress the more disturbing image of the two—resulting in a dimunition of vision—or to cultivate a squint in an effort to shift the more disturbing image out of view. The latter may be unsightly, but at least the obvious defect may lead to early corrective efforts.

Usually, in cases of heterophoria, whether in children or adults, the patient complains of difficulty in close work as the chief symptom. If all refractive errors — irregularities in the transparent media of the eye—are corrected, a vast improvement can often be effected by proper exercises.

Occasionally, psychological cases are discovered, such as the one of a clerk, 30 years of age, doing close work and suffering from eyestrain, who was given a series of exercises to correct deviation. He obtained a full range of fusion but his symptoms were no better. The fact was elicited that he hated his job and wanted to be an engineer but lacked the initiative to set about it. In this case, cure of the condition did not produce disappearance of the symp-

Specially prepared for Scientific American by Mr. Melson, of Bausch & Lomb Optical Company.



***Left:* How a vectograph transparency looks to the unaided eye and, *right*, when objects are fused**

toms, as might have been expected.

In another case, a woman lawyer, aged 28, complained of eyestrain when reading or driving a car. She refused to be bothered with exercises and was not seen again for ten years, when she reported no symptoms whatever. Examination showed that several diopters of deviation outward still existed, with no voluntary convergence. In the meantime, however, the woman had married and had children. She was no longer worried and said she could read and drive with comfort. This is a case in which the symptoms disappeared with the patient's greater sense of security and life fulfillment, although the condition remained unchanged. These cases are in the minority, however, and most of those who realize their deficiency are willing to make the necessary effort to improve their sight.

The branch of optical science which specializes in developing the coördination of the visual apparatus in muscular deficiencies is known as orthoptics. It involves the use of a number of training instruments, lenses, prisms, and sometimes light therapy. In general, the patient is required to visit the doctor's office to take the treatments, since many of the instruments are large and complex and the exercises must be supervised and progress measured.

In the effort to provide a method of home training, under the doctor's supervision, a new device has recently been introduced by the Bausch & Lomb Optical Company which utilizes a carefully graded set of photographs which are viewed through polaroid lenses to train the eyes and exercise the muscles both in convergence and accommodation.

This device, known as an ortho-fusor, consists of a group of pictures made by the vectograph process of Edwin H. Land. It permits two complete and distinct pictures to occupy the same place at the same time, without distortion of tone, loss of detail, or interference with each other. To the naked eye these pictures appear flat and fuzzy, but they are transformed into lifelike reproductions when viewed with polaroid glasses. As thin as paper, the pictures appear as deep as the original scenes themselves.

In conventional photography, pictures are rendered in terms of the density of distribution of the tiny silver particles in the emulsion. In the new process used in the ortho-fusor system, they are rendered in terms of variation in the polarizing characteristics of the transparent sheets on which the pictures are printed.

The two views necessary for recreating the sense of depth are taken with a camera equipped with two lenses as far apart as the eyes. The pictures are taken on regular film and developed in the ordinary way. It is in the process of making reliefs or transfer films from these negatives that the introduction of two pictures in the same film is worked out.

The two pictures are first made into relief images, in which the picture exists as variations in thickness of a gelatine surface, thicker for dark parts of the picture, thinner for light parts. This relief film is used as a sponge to apply a chemical reagent to the final vectograph film.

This film has an invisible optical grain which runs in different directions on the two sides, as in a piece of plywood. When the relief films, soaked with reagent, are pressed against the vectograph film surfaces, the reagent combines with the vectograph film to form light-polarizing images; completely polarizing where the picture is to be dark and only slightly polarizing where the picture is to be light.

In the finished vectograph, two images are superposed, one on each side of the film. The picture thus appears blurred to the naked eye. The polaroid viewing glasses have the optical grain of each lens set in such a way that each develops the full contrast of one of the two images and makes the other invisible. Each eye sees the picture intended for it, as in normal vision.

The pictures comprise a variety of scenes. Boulder Dam, with its abutments, spillways, and generating station, makes a good subject. Others are an Indian squaw weaving a rug; a girl picking flowers; a famous Canadian cathedral. Around the borders of these pictures, cubes and other objects are arranged so that the eye follows them in a complete rotation while the head is held in a fixed position. Some of these objects are easily fused, others with greater difficulty.

The ortho-fusor is, of course, no substitute for glasses since the refractive media of the eye, such as the cornea and crystalline lens, must be corrected. With any necessary optical corrections made, exercises to improve the coördination of the extrinsic muscles—those that move the eye in its socket—may be undertaken under the advice of an oculist or optometrist. The small ortho-fusor kit, which contains the vectographs required for such exercises, may be carried in the pocket and used whenever a spare moment is available. Thus the heterophoria sufferer may take his exercise frequently and at convenient times, hastening full return of true binocular vision and all its desirable features.

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SULFANILAMIDE

Why the New Drug is "Unfair to Bacteria"

New research confirming earlier evidence that sulfanilamide attacks bacteria by literally starving the germs may provide a hopeful method of making drugs to order for specified germs.

Until recently, pharmacologists, the scientists who develop new drugs, have worked mainly on a hit-or-miss basis. Ehrlich, for example, tried 606 times before he hit on salvarsan, the specific drug for the organism of syphilis.

The new research is reported in *The Lancet*, British medical journal, by Dr.

Sydney D. Rubbo and Dr. J. M. Gillespie, of the University of Melbourne, Australia. They found that p-aminobenzoic acid is needed by a certain type of bacteria for growth. This acid is similar in its chemical structure to sulfanilamide. When the sulfanilamide is present, the bacteria are tricked into using it instead of the necessary acid. Since sulfanilamide does not promote growth, despite the similarity in chemical structure to the acid, the bacteria cannot develop.

However, only one part by weight of the acid will offset the growth inhibitory qualities of 26,000 parts of the sulfanilamide. This is a possible explanation of why such large amounts of the drug are needed in treatment of bacterial infections.

ANTIBODIES

Just How Do They Perform Their Half-Mysterious Work?

The possibility of made-to-order or custom-built substances synthesized premeditatedly to curb definite germs, recently has become more prominent as a result of studies by Dr. Linus Pauling of the California Institute of Technology.

He has been concerned with natural types of protective and life-saving substances found in the body—the so-called antibodies. When a person is attacked by typhoid or diphtheria germs, to choose two familiar cases, it is the chemical products of these invaders which cause the disease symptoms. The body fights these injurious substances, which are of albumin or protein character, by preparing special proteins of its own to destroy the foreign ones.

The amazing thing about the antibodies is their specific action. They are essentially the same proteins normally present in the blood—the chemist has not yet been able to show any difference between them. Yet these antibody proteins in the blood of a diphtheria or typhoid patient have a tremendous ability to destroy poisons which the almost identical normal blood proteins totally lack.

Dr. Pauling has developed preliminary tests in an attempt to do what has never been done before—synthesize disease-curbing antibodies in the laboratory. The work is based on the scientist's important studies of protein structure.

Proteins are made up of huge molecules many tens of thousands of times heavier than hydrogen. The atoms composing these molecules are arranged roughly as a long chain with numerous short side branches, and the whole chain is coiled up on itself to form a compact, ultramicroscopic, roundish mass. Dr. Pauling believes that the differences between various antibodies and the blood proteins with which they are so nearly identical, is only in the way the chain has become folded on itself.

The California researcher uncoiled the molecules of a selected blood protein by using known substances that would do the job. Then to the solution he added another chemical. The straightened-out protein chains gradually folded up again, but this time they folded in a particular way, using the molecules of the newly added material as molds about which to coil. According to Dr. Pauling, this process resembles what happens when normal body proteins are formed in blood contaminated by the molecules of diphtheria-germ poisons.

The specific action of antibodies may be the result of blood protein molecules which mold themselves to various disease poisons and neutralize the harmful effects. That tremendously powerful antibodies will be produced in the laboratory and a host of diseases put to rout, seems a reasonable expectation from this particular piece of research.

STUTTERING

It Starts With a Linkage

Study of 15 child stutterers show a neurotic family background in the majority of the cases, Dr. J. Louise Despert, of the New York Hospital and Cornell University Medical College, reports, according to *Science Service.* Nervous mothers who are always worrying about whether the baby or small child eats enough are likely to have nervous children who stutter. These stuttering children frequently have other neurotic traits.

"This is of considerable importance," Dr. Despert stated, "if one considers that the White House Conference of 1930 gave 1,300,000 as the number of stutterers in the United States and also that the majority of these cases are being treated by means of speech techniques which involve only the speaking organs and functions."

The stuttering results, Dr. Despert believes, from neurotic attention being focused on the mouth, usually with regard to the feeding situation in early years of life.

Children learn to talk at about the same time they learn to eat solid food and to feed themselves. They use the same structures to take in food and to form and pour out words. If their mother frightens them while they are trying to take in food, they are likely to be frightened also when trying to form and pour out words, and in consequence they may stutter and have difficulty in talking. The children themselves sometimes give the clue to this when they tell of their difficulty in attempting to bring out their newly formed words.

Treatment of these children consisted of general psychiatric treatment, with chewing-speaking games for the younger children or chewing-speaking exercises for the older children, in a few cases.

HOW TO RELAX

Doctors Advise Other Doctors Who Can't Sleep

The following is from an editorial recently published in *The Journal of the American Medical Association.*

Cut down on the intensity of your thinking half an hour before retiring. (Play Chinese checkers, plan an excursion for the week end, write a letter to a friend.)

Take plenty of time to get ready for bed (next morning's clothes, leisurely bath, and so on).

If you like to read in bed, choose nonfiction or a "hard" book. Force your mind to grapple with cumbersome facts, bore it into unconditional surrender to sleep.

Transplant your mind from fears or hates to a field which has interest without excitement.

Make your mind hop from one idea to another. Just as the mind loses consciousness and sleep comes, thoughts become disjointed and scattered.

To quiet the body, get rid of any pressure or pain. (Lighten weight of covers, clothes.)

Tepid bath without a rubdown. (Get into bed a little damp and chilly. As the body becomes warmed, it becomes more and more comfortable. If during the night one becomes sleepless, throw back covers until body becomes uncomfortably chilly. Then, when the covers are pulled up again, the body once more sinks into coziness.)

Imitate the slow, deep, rhythmical breathing of sleep. (Helps regulate the circulation and may ease the mind and emotions; also tensions in the abdomen.)

Relax the muscles completely.

Get rested before trying to sleep. (Get into bed an hour or more before your regular time for retiring. Do so night after night to build up a reserve of rest and fall asleep without the old struggle.)

Astrono-Mexico

North American Astronomers Assist at Opening of Mexico's New National Observatory

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

SOME time before the entrance of the United States into the War, the Mexican Government planned an Inter-American Congress on Astrophysics, to celebrate the inauguration of the National Astrophysical Observatory at Tonanzintla, and invited many astronomers and a few physicists and mathematicians from the United States and Canada to attend it. These lines are written on the return journey from one of the most conspicuously successful scientific meetings which the writer has ever attended, and an account of the new Observatory, of the general circumstances of the Congress, and of some of the papers which were presented, is very much in order.

The Mexican National Observatory at Tacubaya, founded more than 50 years ago, has long been known for its valuable contributions to positional astronomy, and especially for its work on a zone of the Astrographic Catalogue. Situated on a low hill but a few miles from the center of the City of Mexico, it has shared the fate of Greenwich, Paris, and other national observatories. The city, growing into a metropolis of more than a million people, has almost surrounded it, and its smoke and lights interfere with certain types of observation. A new national observatory has therefore been established at a site free from present, and probable future, disturbance of this sort. It is on a little hill overlooking the village of Tonanzintla, in the State of Puebla, about 50 miles southeast of the City of Mexico and ten miles west of the city of Puebla. For miles around stretches a nearly level, cultivated plain, some 7000 feet above the sea. Twenty miles to the westward the flawless, snow-crowned cone of Popocatepetl rises 10,000 feet above the plain and to the right is the older, rugged ridge of Ixtaccihuatl, almost as high, and snowier.

The writer has for years kept a record in memory of the amenities of observatory sites, and especially the views from them—and, of the many he has seen, Tonanzintla comes first. Its only rival is the outlook from Saanich Hill, at Victoria, on the semicircle of distant snow-mountains, from the Olympics to beyond the Canadian border—unless the works of man are included, when the near view of the Acropolis from the Observatory of Athens stands alone.

From the technical standpoint, Tonanzintla is an excellent site. Its altitude exceeds that of any observatory site in the United States except Flagstaff and the new Harvard coronagraph station at Climax, Colorado. The skies are free from contamination, the climate is favorable—with rains in the afternoon in the rainy summer season—and the latitude of approximately 20° gives it an enormous advantage. The Southern Cross rises well above the horizon, and the important galactic regions, Sagittarius and Carina, get high enough for satisfactory observation.

THE principal instrument at present possessed by the Observatory is a Schmidt camera [see page 262.—Ed.] of 24 inches effective aperture, which in these clear skies will be a really powerful tool for the study of stellar distribution, space-absorption, and other galactic problems.

The Harvard Observatory has been in close association with the new Observatory of Tonanzintla and with its director, Dr. Erro, all through its organization and construction, and the installation of the Schmidt camera. In grateful recognition of this relation, the people of the village have named the street which runs up to the Observatory "Calle Annie J. Cannon," as a memorial to one of the pioneers in Harvard's astrophysical work.

The Observatory was formally inaugurated on February 17th by the President of the Mexican Republic, General Avila Camacho. The ceremony, held in the open air and favored by perfect weather, was impressive. A great crowd of people from the neighboring villages and the city of Puebla filled the slope of the hill. Behind them was a display of the massed flags (at least 200) of all American nations, from Canada to Chile, while in the distance rose the great mountains. The Governor of the State of Puebla, Dr. Bautista, made an excellent address, and the singing of the Mexican National Hymn, at the close, impressed all the delegates from north of the Rio Grande by its genuine fervor.

The Astrophysical Congress was opened, later in the day, in the hall of the University of Puebla, by President Camacho. The next morning the astronomers began three very busy days of scientific sessions at the University (whereof more later); but none of the delegates was busier than the President of the Republic, whose program for the first of these days included the inaugural ceremonies of seven institutions—schools, water-supplies, hospitals, and the like—all for the public welfare.

AFTER returning to Mexico City, the delegates were taken to Tiripetio, site of the first school of higher studies in the Western Hemisphere. In the restored hall of this ancient school, honorary degrees were conferred by the University upon four of the delegates from the north, in a ceremony of equal simplicity and dignity. [The four were Doctors Shapley, Adams, Vallarta, and the author.—*Ed.*]

The scientific sessions, as befitted the international character of the Congress, were bilingual. Every communication, whether in English or Spanish, was accompanied either by the reading of an abstract in the other language, or by a running translation at intervals of a minute or two. As always happens in such international meetings, it was not the "Norte-Americanos" who were the interpreters. A few of us were able to present our results in passable Spanish; but for fluent and accurate translation we had to depend upon our hosts.

To take a typed abstract in one language and read it off freely in another is hard enough; but several of our Mexican colleagues performed the far harder task of translating talks in English—not read from manuscript, and often including technical descriptions of slides and tables—with completeness, accuracy, and more eloquence than the original speaker could boast.

Almost 40 scientific papers were communicated to the Congress.

Adams, discussing interstellar lines, reported that the sharp lines so far observed in the spectra of distant stars have now all been accounted for. There are two lines of evidence that the interstellar gas which absorbs them is not uniformly distributed. In the spectra of some stars, the interstellar lines of the compounds CH, CH^+, and CN are strong, compared with those of the metals; in others much weaker—while the metals are strong—showing that the interstellar gas is far from uniform in composition. Advantage was taken of this in the recent discovery of faint lines of interstellar iron, in the spectra of stars in which the lines of other more abundant atoms appear most strongly. Moreover, photographs with very high dispersion show that the H and K lines of ionized calcium are not merely double—as was discovered by Beals, in Canada, some years ago—but that in some cases there are three or even four components of different intensities. The only reasonable explanation appears to be that there are three or four different clouds of gas in different parts of the line between us and these stars, each containing calcium atoms, but moving with different velocities which sometimes disagree by as much as 20 kilometers per second.

INTERSTELLAR matter must be very patchy in distribution. This is also indicated by a report by Stebbins upon new photoelectric measures of star colors. The apparatus is now so delicate that it has been possible, with appropriate color-filters, to measure the brightness of many stars in six spectral regions, ranging from $\lambda 3500$ in the ultra-violet to $\lambda 10{,}000$ in the infrared. Very accurate determinations of star-colors may thus be made. The well known "space-reddening" of distant stars, above and beyond the color normal for their spectral type, may thus be precisely measured. The properties of the interstellar dust which produces this effect appear to be uniform, as regards the relative effects for different wavelengths, but the actual amount of absorption for stars at the same distance is very different, showing that the distribution of dust, as well as gas, is highly irregular.

An important, and previously unrecognized, function of this interstellar matter was discussed by Whipple, who showed — following Spitzer — that a cloud of such dusty gas, absorbing much of the starlight which passed through it, would be compressed by the pressure of starlight from the outside, as well as drawn together by its own gravitation, and might ultimately condense into bodies whose mass—depending on the density and other characteristics of the cloud—might range from that of an asteroid to that of a large star.

This may solve a very puzzling problem which the writer—discussing the present state of the problem of stellar evolution—had posed without answering. There is abundant evidence that the Earth, and our existing universe of stars and galaxies, is some two billions of years old, or a little more. It is well known that the stars of greatest mass and luminosity are spending their capital of available energy at such a rate that the greatest known source—the transmutation of hydrogen into helium—would keep them going for only a hundred thousand years or so. Whipple's work (corroborated by some of Spitzer's) opens the possibility that these stars may really be younger in years than the Sun. They may have existed, for most of the history of the universe, as diffuse, non-luminous masses of dust and gas, finally condensing and beginning their spendthrift careers as stars during the last few percent of the Earth's history.

STARS of the Sun's mass, however, live their lives slowly. Bethe showed, a couple of years ago, that such a star should become slightly larger in diameter, considerably hotter on the surface, and very much brighter, as its hydrogen became exhausted. In these later stages, such a star would have a spectrum of class B, but be very much smaller and less luminous, as well as less massive, than the general run of stars of this type. Few, if any, such stars have been observed. It has usually been supposed that this was because the stars passed through these stages so swiftly that there were few of them to be found there at any given time; but the writer pointed out that these stars, being bright, could be seen at large distances, which more than makes up for the time-effect. The fact that we do not find such stars (so far as our present search has gone) indicates that stars like the Sun have not had time to reach these late evolutionary stages since the present state of the Galaxy began. Incidentally, from a combination of the data of various investigators, it was shown that the known properties of the Sun can be well explained if its interior contains 51 percent by weight of hydrogen, 42 percent of helium, leaving 7 percent for all the heavier atoms—of which one tenth is carbon and nitrogen. These are rough values—adjusted to add up to 100 percent. More accurate studies —which may be hoped for in a few years—should lead to a better determination.

Several other papers dealt with the distribution and motions of stars in the Galaxy. Baker, from star-counts in Cassiopeia and Aquila, and Bok and his associates at Harvard, from similar studies of regions in Monoceros and Centaurus, find a general tendency for the star-density (that is, the number of stars in a given large volume of space) to fall off with increasing distance from the Sun—especially for parts of the Milky Way remote from its center in Sagittarius, and for stars of spectral classes near F. This is after allowance has been made for the effects of certain absorbing dust-clouds at distances of 500 parsecs and more. Mayall, from the radial velocities of 50 globular clusters—many more than have previously been observed—finds that the motion of the Sun, relative to the mean of the clusters, is in the plane of the Milky Way, at right angles to the galactic center, and at the rate of 170 kilometers a second. The first two results were to be anticipated: but the velocity is only about 60 percent of the 300 kilometers a second which has generally been adopted as representing the rotation of the Galaxy. A large number of clusters south of declination $-40°$ have not yet been observed, and cannot be until suitable equipment is put into service at some observatory in the southern hemisphere. Their inclusion may bring up the calculated velocity considerably. If it does not, we will then have to choose between two alternatives. Either the Galaxy is considerably smaller than we suppose at present, or else the system of globular clusters is rotating in the same general direction as the Galaxy, but more slowly.

TO pass from far to near, two papers dealt with astronomical phenomena in the Earth's atmosphere. Elvey, from observations at the McDonald Observatory upon the light of the night sky, finds that certain lines—notably those of sodium and the red forbidden lines of oxygen—increase greatly in brightness as the first direct rays of the Sun strike the uppermost layers of the air at dawn, and fade out rapidly after they leave them at twilight. Many other radiations, such as the familiar green line of oxygen, change little at this time, but show irregular variations from night to night. These require further study, but it is already clear that they are greater on nights when the Earth's magnetism shows disturbances.

It was a first-rate conference; and every one of the delegates will agree with the writer's expression of thanks to the Mexican Government, and to the Director and staff of the Tonanzintla Observatory, for the admirable planning and emphatic success of the Congress, and for the great and unfailing hospitality which all its members have enjoyed.

—On the Mexican National Railway, February 27, 1942.

Why are We Short of Aluminum?

Huge Quantities of Electricity are Needed to Reduce this Common Metal from its Ore

HENRY W. ROBERTS

AMERICAN troops go into Surinam and Dutch Guinea to protect vital bauxite ore deposits, to assure us of enough aluminum to win the War. . . .

Aluminum is *the* vital war metal. We need it for our battle planes; we also need it for a thousand other war uses—from canteens to battleships.

Aluminum is plentiful. One twelfth of the earth's substance is aluminum. There is nothing more common in nature. And yet we are now short of aluminum. Despite last year's record production, we are still short of aluminum for our defense needs, have none to spare for our civilian needs. It takes thousands of pounds of aluminum to build a bomber, a good deal less to build a fighter plane.

Three years ago Germany produced less aluminum than either the United States or Great Britain. A year ago the United States and Great Britain, together, produced less aluminum than Germany alone. Today, aluminum production by the United Nations is running neck and neck with the Axis countries.

What do we need to outstrip the Axis in the production of aluminum? Where is the choke-point that has so dangerously slowed up our production of this vital war metal?

Aluminum is one of America's contributions to the world's industries. Discovered in Denmark, in 1825, aluminum remained a scientific curiosity until 1886 when a young American, 22-year old Charles Martin Hall, succeeded in reducing aluminum oxide to metallic aluminum by a new process which made possible commercial production of this metal.

The first aluminum which Hall produced cost eight dollars a pound. Three years later, in 1889, the cost was down to five dollars a pound. Today, aluminum costs about 15 cents a pound.

In 1934, when Germany's rearmament program had already begun rolling, the entire American aluminum industry—which then meant the Aluminum Company of America—produced only 74,000,000 pounds of virgin metal. To this was added 42,000,000 pounds of secondary metal (scrap); another 18,000,000 pounds was imported. That gave us 134,000,000 pounds in all, just barely sufficient for our normal needs

Surface mining of aluminum ore—bauxite

during the normal years of peace.

By 1939, with the war in Europe obviously imminent, our production rose to 327,090,000 pounds. In 1940, with war at hand, we produced over 400,000,000 pounds of aluminum.

Last year, 1941, with war staring us in the face, we were still hopelessly short of aluminum. Including all the scrap that we could collect, our total aluminum production still fell short of the goal which was set for that year.

This year, 1942, with the aluminum industry being rapidly expanded, we should be able to produce considerably more of the virgin metal. Several million pounds may come in to us from Canada, and perhaps a like amount may be added through drives for scrap aluminum. This would give us barely enough for our 1942 military needs; still nothing for civilian needs.

What, then, is holding back unlimited production of aluminum, the most common metal on earth?

The principal source of aluminum is bauxite, a red-yellow ore rich in aluminum hydroxide. Bauxite occurs in nature in large mass deposits, usually found close to the surface of the earth. There are vast deposits of bauxite all over the world, principally in France, Hungary, Italy, Jugoslavia, Greece, Russia, British Guiana, Surinam, Netherland Indies, and the United States of America. The world's richest bauxite mines are in South America, in Dutch Guiana and Surinam. Four pounds of this bauxite make one pound of aluminum.

Control of these rich South American mines is vested largely in the Aluminum Company of America, which conducts the mining operations and maintains a large fleet of cargo ships to transport the bauxite from the ports of Moengo and Paranam, at the mouths of the Cottica and Surinam Rivers, to American and Canadian ports. More than two-thirds of all the aluminum produced in the United States is made from this South American bauxite.

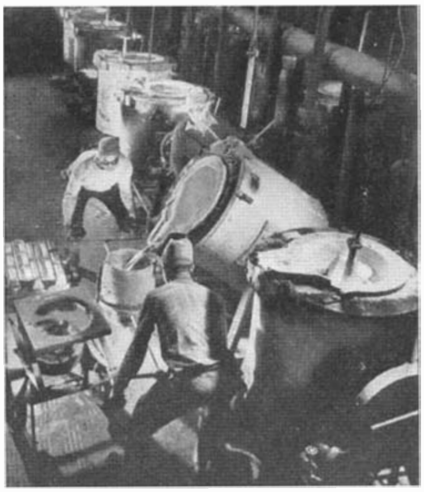
One of the more serious obstacles to increasing our aluminum production under wartime conditions is the current lack of sufficient shipping which can be diverted to the transportation of additional bauxite from South America to this country.

Meanwhile, tremendous deposits of low-grade bauxite (and of another aluminum ore, alunite) were recently discovered in the United States, in our South and Southwest, but principally in Arkansas. About half of the bauxite mined in the United States goes into the production of aluminum, the other half being consumed in the production of artificial abrasives, chemicals, refractories, and insulating materials.

These low-grade Arkansas bauxite

deposits are now being commercially exploited, principally by the recently organized aluminum division of Reynolds Metals Company. Despite its much lower aluminum content, our Arkansas bauxite competes successfully with the richer ores from South America, mainly because the Arkansas bauxite need not be transported by sea.

Unlike most metals, aluminum cannot be reduced directly from its ore, the bauxite. First, the impurities in the ore must be separated from the aluminum hydroxide; this is a chemical



Casting aluminum

process. Next, the aluminum hydroxide must be calcined to produce pure aluminum oxide, or alumina. Last, the alumina must be reduced to metallic aluminum. The entire process is rather complex, and quite expensive, requiring large investments in plant and machinery, and consuming prodigious quantities of electric power.

The first step in the processing of bauxite into aluminum takes place at the mines. The raw ore taken out of the ground is hauled to a nearby mill where it is crushed, screened, and washed. The lumps of ore, now less than two inches in the greatest dimension, are carried into classifiers, where the washing process is repeated several times to remove as much clay as possible. Clay contains silicon oxide, or silica, an undesirable impurity in the processing of aluminum. After the washing process has been completed, the ore is thoroughly drained, dried in long rotating kilns, and is then ready for shipment to the alumina reducing plants.

There are now only three alumina plants in the United States: those of the Aluminum Company of America, in Illinois and Alabama, and the new plant of Reynolds Metals Company in Alabama, completed late in 1941.

Several processes of reducing bauxite to alumina are known; the one commonly used in this country is the Bayer process, developed about 50 years ago by Karl Josef Bayer, a German chemist. The crushed, washed, and dried bauxite from the mines is further crushed, and finally ground to powder. The powdered bauxite is then mixed with a hot caustic soda solution, and the mixture of soda and bauxite pumped into large pressure tanks, called "digesters." The caustic soda dissolves aluminum hydroxide out of the bauxite, and the liquid becomes a solution of sodium aluminate. The impurities in the ore do not dissolve, and are removed from the solution by filtering.

THE filtered sodium aluminate solution is then fed into huge precipitation tanks, where it is cooled. As the solution cools, aluminum hydroxide settles out of the solution in the form of white crystals. The caustic soda solution is then pumped off, to be used again, and the white crystals of aluminum hydroxide are dried, and then calcined in special kilns. The calcining process removes the water chemically combined with the crystals, leaving a white powdery mass of aluminum oxide. This white powdery mass is called *alumina.* For each pound of alumina, two pounds of high-grade bauxite were required.

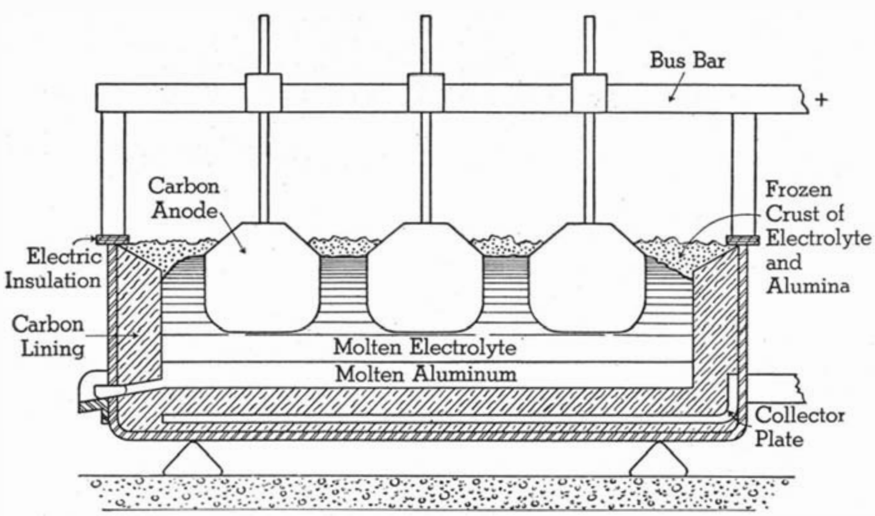
The next step is the reduction of alumina to aluminum. The process universally used is the Hall-Héroult electrolytic process, named after the American, Charles Martin Hall, and the Frenchman, Paul Louis Toussaint Héroult, who developed this process, independently of each other, in the last century. Because of the tremendous electric power requirements of the process, the aluminum reduction works are usually located near large hydro-electric plants where electricity is invariably both cheap and plentiful.

There are at present only five aluminum reduction plants in the United States—all of them belonging to Aluminum Company of America—distributed through New York, North Carolina, Tennessee, and Washington. A sixth plant, owned by Reynolds Metals Company, is nearing completion in Alabama, a seventh will be located in Washington.

The principal equipment of the aluminum reduction works is the electrolytic furnace, or cell. Each cell is a rectangular steel "bathtub," its walls lined with carbon which serves as the cathode or negative pole of the cell. The cell is filled with a rare white mineral, cryolite, or "ice stone," which is fused by the electric current into a molten mass. This molten cryolite is the electrolyte of the cell. Immersed in the cryolite bath are several carbon anodes, suspended from overhead bus-bars; these serve as the positive pole of the cell.

MOLTEN cryolite is the magic substance which dissolves alumina (aluminum oxide). The electric current passing through the molten cryolite bath decomposes the dissolved aluminum oxide into its component parts: aluminum and oxygen. The oxygen is liberated at the anodes and escapes through the crust at the top of the bath. Aluminum is deposited on the bottom and the walls of the cells (the cathode), and forms a molten layer of metal at the bottom of the bath, whence it can be drained off into ladles and cast into pigs.

The normal capacity of each cell is 250 pounds of aluminum, sufficient to cast five 50-pound pigs. Into the making of each pound of aluminum go four pounds of bauxite, three-quarters of a pound of carbon electrode, and 12



Illustrations courtesy Aluminum Company of America

Schematic diagram of an aluminum producing electrolytic cell

kilowatt-hours of electric energy.

The aluminum reduction process is a continuous operation. As the molten aluminum is drained off, more alumina is added to the cryolite bath. The cryolite itself is not affected by the process, and is used over and over again.

It is fortunate that cryolite is not affected by the process: the only commercial cryolite mine in the world is at Ivigtut, in Greenland. Greenland, you will recall, is now occupied by American troops. It is probable that more cryolite may be found in Iceland. We have troops in Iceland. But there is no connection between United States troops and cryolite. We have all the cryolite that we are likely to need; we could also make synthetic cryolite, fully as good as the real thing.

The pig aluminum still has to undergo several transformations before it becomes a battle-plane. The first step is to melt pig aluminum into ingots; this removes residual impurities and gives the bulk aluminum a more easily workable shape.

Sometimes an aluminum alloy and not pure aluminum is required; then the alloying is done at this stage. One of the best known and most frequently used alloys is duralumin. This remarkable alloy, after heat treatment, is as strong as mild steel, but weighs only one third as much. Duralumin is the alloy principally used in aircraft construction.

To become technical for a moment, aluminum has a specific gravity of 2.70: one fourth to one third of other common commercial metals. The metal is non-toxic, is resistant to corrosion, and has high thermal and electrical conductivities. What is more important, aluminum is a most versatile metal; it may be cast, rolled into bar and rod stock, drawn into wire, or rolled into plate, sheet, or foil. It may be drawn into tubing, or into extrusion shapes; it may be forged or pressed, or made into screw-machine products, rivets, or nails, or made into powder. There is no other metal which can serve industry in as many shapes and forms as can aluminum and its alloys.

Now, just where is the choke-point in our aluminum production?

There is no shortage of bauxite. We have, here and in South America, more than enough bauxite to make all the aluminum that we are going to need.

Is there a shortage of labor? Emphatically "No"! No skilled labor is required for the mining of bauxite. The processing of bauxite into aluminum is, essentially, an automatic operation, requiring very little labor.

There is no patent monopoly. All the important patents on the processing of aluminum expired long ago. Nor is there a monopoly in our aluminum industry; at least, the courts say so. In addition to Aluminum Company of America, the metal is being processed by Reynolds Metals Company, and Bohn Aluminum Company is expected to be soon added to the roster.

Admittedly, our aluminum plant facilities are still too few: there are as yet only three alumina plants, and only five aluminum reduction plants. But the few million dollars necessary to build additional plants will never present an obstacle to increased aluminum production so urgently needed.

THE real choke-point of aluminum production is electric power. Remember, 12 kilowatt-hours of electric energy are required to make one pound of aluminum. Last year, the aluminum industry needed, *each day*, enough electric energy to supply all needs of a modern city with a population of 25,000 persons for a whole year!

We do not have enough electric power. Already the towns and villages in the vicinity of aluminum reduction plants are feeling the pinch, will feel it more as time goes on. The great hydro-electric plants are all working at full capacity. Even the new Bonneville Dam project, barely completed, already has its entire output earmarked.

This choke-point is now being broken with the aid of our Government. Not so long ago Jesse H. Jones, Federal Loan Administrator, announced that the Defense Plant Corporation will provide $52,000,000 for the construction and operation of four aluminum plants by the Aluminum Company of America. With these additional plants American aluminum production should reach a much higher figure annually. Additional negotiations are now in progress with the Reynolds Metals Company and other aluminum producers.

The four new plants will be comprised of one alumina processing plant in Arkansas, and three aluminum reduction plants: one located in New York; another in a western state; and a third in Arkansas.

The ownership of the four new plants will remain with the Government. The Aluminum Company of America will merely operate them under a five-year lease, paying the Defense Plant Corporation 85 percent of net operational costs. The agreement provides that the new government plants must be operated at the same relative capacity as those now owned by the Aluminum Company of America.

With care and vigilance, we shall have enough aluminum—enough to win the War!

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INSULATION

Board Made of Glass Replaces Cork

WITH importations of cork from Spain and Portugal becoming increasingly hazardous and uncertain, and with existing supplies in this country under rigid priorities, a new insulating board, said by experts to possess all of the insulating properties of cork, and to be superior in some qualifications, holds considerable interest. This new board, produced by Owens-Corning Fiberglas Corporation for low-temperature and roof-insulation applications, marks a development of unusual importance in that it will tend to release the United States from dependence upon cork in meeting the tremendous war-created demand for cold-storage refrigeration of perishable food supplies and industrial materials.

Known as AE Board, the new insulating material is made of pure glass fibers, compressed to a density of six pounds to the cubic foot, treated with a thermosetting binder, and completely enclosed in a sheath of asphalt that has a high melting point. Its heat conductivity is 0.265 B.T.U. per square foot per hour, per degree Fahrenheit, per inch thickness, at a mean temperature of 60 degrees, Fahrenheit. This compares with a figure of 0.27 for cork. Since the new insulating board is made of materials which are found in adequate quantities within the United States, a supply sufficient to meet all essential needs is assured.

It is estimated that the 1942 need for insulating materials for low-temperature installations will be in excess of 200,000,000 board feet. The feeding of the armed forces, the tremendous shifts in the industrial population, and the enormous expansion of industrial plants, all augment the normal requirements for cold-storage refrigeration. Adequate refrigeration is needed in the preparation, storage, and transportation of perishable foods and is an essential element in the processing of quick-frozen foods which today play an important role in the nation's diet. The cold processing of industrial materials, including many oils, chemicals, and rayon, requires the control of temperatures within a narrow range, necessitating adequate low-temperature insulation.

The value of roof insulation for industrial buildings has been firmly established. Insulation of the roof cuts fuel and air-conditioning costs. It also tends to prevent condensation on the underside of the deck, and consequent damage which may be caused by roof drip—an increasing problem in air-conditioned structures. Frequently the installation of adequate insulation in the roof makes it possible to reduce the size and cost of heating and air conditioning equipment. It is estimated that 300,000,000 square feet of roof insulation will be installed on new industrial buildings between now and the end of 1943.

The Fiberglas board is made in the "American Standard" size for refrigeration insulation—12 inches by 36 inches—and in thicknesses of one, one and a half, and two inches. The insulation has high resiliency, and shows almost complete recovery in five minutes after loading to 1728 pounds per square foot—a load far above the normal encountered in refrigerated spaces or roof-deck service.

All special-size pieces can be made up on the job by cutting the board to size, and sealing the cut edges with hot asphalt. The material can be sawed with an ordinary saw if the blade is frequently lubricated with kerosene to prevent the asphalt coating from gumming the teeth. For curved surfaces of large radii, the board can be slotted on one face and bent to fit the required curve.

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PLYWOOD—Soybean adhesives glue up to 2.3 billion square feet of plywood yearly—enough to make a four-foot "board-walk" around the equator four times, with several thousand feet of the strip left over.

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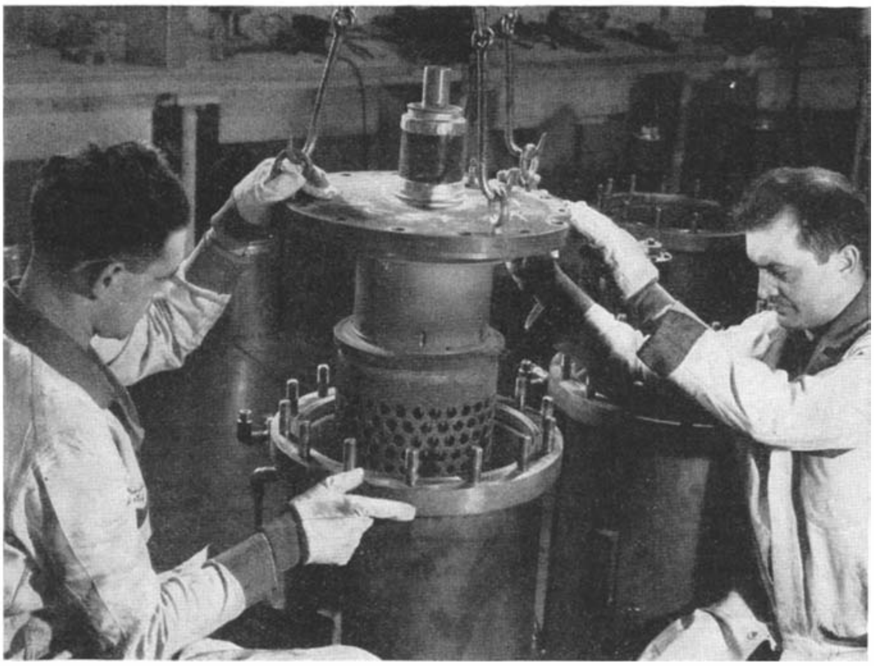
RESEARCH

Organization Plans For the Future

ANNOUNCEMENT was recently made by the Auto-Ordnance Corporation, manufacturers of the Thompson Sub-Machine Gun, of the formation of a Department of Research and Development at Stamford, Connecticut, for the purpose of expediting America's war effort, continuing improvements in its own manufacturing, and the development of post-war products to cushion industrial readjustment following all-out military production.

This department includes Don D. Myers, well-known designing and research engineer of Toledo; Dr. H. H. Sheldon, formerly Professor of Physics at New York University and a contributor to Scientific American, and Mr. Albert Thomas, well-known inventor and designing engineer who was recently associated with the Glenn Martin Company.



Anode plate being lowered into the steel tank of an Ignitron, an electrical rectifier that is playing a large part in present-day magnesium production

MAGNESIUM

Production from the Sea Aided by New Device

A BARREL-SIZED steel tank that sifts electrical charges through a pool of mercury is speeding production of two vital war metals by helping to "rescue" magnesium from the ocean and to extract aluminum from bauxite.

This "electrical alchemist"—known as the Ignitron—10 years ago was only a laboratory curiosity, but now is an important industrial tool for producing the lightweight metals urgently needed for military aircraft.

The Ignitron was developed by Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories, in co-operation with engineers L. R. Ludwig and J. H. Cox. The device expedites war production by changing alternating current electricity into the direct current required in electro-chemical processes used by magnesium and aluminum plants.

Half a million kilowatts of direct current electricity—enough power to drive 10,000 street cars—was added in 1941 to the power supply of aluminum plants in the United States and Canada by the installation of Ignitrons. Millions of pounds of magnesium are now being extracted from pumped sea water when magnesium hydrate is precipitated from the water, converted into magnesium chloride and reduced to magnesium by an electrolyzing process employing Ignitrons. About four and a half million tons of this important metal can be "rescued" from a cubic mile of sea water, according to statements by metallurgists.

Suspended in the Ignitron's tank is a graphite electrode connected to the alternating current supply. In the bottom of the tank is a shallow pool of mercury. Fastened above the pool is an inch-long pointed piece of boron carbide the thickness of a pencil. This dips into the mercury and is the spark plug or igniter that makes the Ignitron work.

In operation, positive electricity from the alternating current power line is conducted to the graphite electrode in the top of the Ignitron tank and also to the igniter. The instant this positive electricity reaches the igniter it forms a spark or "cathode spot" on the mercury pool and permits the power current to flow. When the current changes to the negative phase, the rectifying property of the mercury vapor prevents any discharge from passing in the reverse direction.

With 60-cycle current, this phenomenon is repeated 60 times a second, producing the required one-directional flow of current from the Ignitron to the industrial process for which such current is needed.

INDUSTRIAL TRENDS

NUTS, BEANS, SEEDS . . . AND OIL

COCONUT palms, swaying gracefully in the warm, scented breezes of the South Pacific, are an important part of the imaged landscape of song and fiction writer; of far greater importance are they to a wide range of industries which, today, are in somewhat of a dither as to what to do about those products of the coconut which no longer reach our shores from far-off lands of fabled romance.

Outstanding product of the coconut palm is the oil yielded by the nuts, which, together with other vegetable oils from the Philippines and points west, enters such differing industries in the United States as those concerned with the production of foods, paints, leather, soap, lubricants, metals, and explosives.

Here is what the Department of Commerce has to say about the situation in oils and fats, the twins that are usually linked together and which include those of both vegetable and animal origin: "We normally produce domestically such food fats as we need and export, but domestic production is a third short of supplying all the fats and oils we need for soap, slightly more than a third short of those necessary industrially, and half short of our paint and varnish needs. Curtailment of our Far Eastern imports will directly affect the soap and glycerine, tin-plate, and textile industries, and will necessitate changes in composition among our manufactured fats and oils products."

Agriculture in the United States is being stepped up in certain branches to contribute its share in making up these shortages. For example, during 1942-43, production of peanut oil will be aimed at a goal 600 million pounds in excess of that produced during the 1941-42 season; for soybeans the figure will be 350 million pounds more, and for flaxseed some 100 million pounds. These increases will go a long way toward filling in the gaps left by coconut and other exotic oils in certain applications, but there is something about the coconut that makes its products particularly desirable. The oil gives quick-lathering properties to soap, in the manufacture of which it finds its widest use. The food industry consumes large quantities of coconut oil in the production of margarine, salad oils, shortenings, and so on. From it is obtained glycerine, essential to munitions manufacture, and this harks back to the soap industry in which glycerine is a major by-product that, today, is overshadowing in importance the main product.

But oil is not the only thing that the coconut yields; its shell, for example, is made into activated carbon which has the peculiar property of adsorbing gases and odors and finds application in the chemical industry as a decolorizing and clarifying agent. Greatest demand of the moment on activated carbon is, of course, in the manufacture of gas masks.

Before discussing the general trend that is rapidly developing as a result of the current shortage in coconuts, it is interesting to note a specific case where research has already licked the problem in one typical American way. In the leather industry coconut oil has long been used for certain types of tanning operations, in which its non-oxidizing qualities are particularly desirable. Faced with the need for finding a suitable substitute, one oil processing company has developed from domestic vegetable products an oil for use on leather that is said to be comparable in every way with coconut oil. So satisfactory is it, in fact, that interested parties have gone on record as saying that it is doubtful whether coconut oil will be able to re-establish itself in this particular industry after hostilities cease and supplies are once more available.

It cannot be recorded, however, that the problem of coconut oil can be solved so readily in every case. But there is a silver lining which, properly developed, can undoubtedly eliminate completely the dark cloud, or at least reduce it to unimportant dimensions. South America holds the answer. In that vast continent are a number of natural nuts which yield oils that are chemically equivalent to coconut oil. They are available in large quantities and, at least in some cases, have shells from which can be made activated carbon for the uses mentioned above.

There must be a joker somewhere. Otherwise, why would these sources of vegetable oils have remained undeveloped for so long, while the coconut held the center of the stage? There are several answers. All of those South American nuts which yield sufficient quantities of oil to warrant commercialization have hulls that are hard to crack. Crushing the hulls bruises or crushes the kernels, which contain the oil, thus spoiling the nut for further processing. There have been small quantities of oil from the babassu and cohune nuts placed on the market by South American companies, obtained through the long and tedious process of cracking the hard shells by hand and then pressing the oil from the kernels. But since hand cracking proceeds at a rate of about 180 nuts per hour, the oil output is exceedingly limited.

A further obstacle, but one that is not insurmountable, is the reluctance on the part of many South American countries to permit export of uncracked nuts of certain varieties. Reason, of course, is to keep the cracking industry at home for the benefit of native labor.

Yankee ingenuity has gone to work on mechanical crackers for these tough nuts, with a considerable degree of success. Several crackers have been devised that will crack the hulls at a high rate of speed, leaving the precious kernel intact. With these available, and with increasing co-operation between the United States and its southern neighbors, there is every reason to believe that South American nuts of a variety of species will soon aid greatly in replacing the coconut.

Here, then, is a definite trend in the vegetable oil industry which will be carefully watched by all other industries that have heretofore been dependent on oils imported from the Far East. And with one eye on the development of South American nut oils, the other eye will be kept on the field of synthetics at home. With such an opportunity opened by Mars, it is not hard to believe that the American chemist will soon pull from the bag a whole family of synthetics which will fit neatly into the industrial needs of the moment.

SYNTHETIC RUBBER . . . AND OIL

THE petroleum industry which, directly or indirectly, supplies many of the sinews of peace and war, is going to play a much larger part in the synthetic-rubber picture than most people are aware of. Approximately three quarters of the production of this material at the end of 1941 was being made from petroleum-base raw materials. If the present trend continues, and it is indicated by government officials that it will, most, if not all, of the synthetic rubber being produced by 1943 will be made from products of the petroleum industry.

—The Editors

OUR *Point* OF VIEW

AN OPEN LETTER TO DONALD M. NELSON

Dear Mr. Nelson:

You are being widely quoted in the newspapers on the subject of dangerous complacency on the part of the American public in general and of American industry in particular. While I agree thoroughly with you that such complacency could, at the very least, prolong the length of the war and, at the worst, result in ultimate defeat of our nation, I feel that many of the charges of complacency are incorrectly aimed. Or, I might better say that some of them should be directed inward rather than outward.

My thoughts in this important phase of our all-out war effort are prompted by intimate contact with American industry. They are based on observation of progress and on conversations and correspondence with key men in a broad range of productive endeavor. Because I feel that these thoughts will be valuable to you in your work, I am taking this means of bringing them to your attention.

We—you and I and every other loyal American citizen—want to see this war prosecuted to a rapid and successful end. We all fully realize that the means lies in the hands of American industry. But such is the nature of present operations that American industry is not permitted, in many cases, to exercise its ability to produce tanks and planes, ships and guns with the same efficiency and speed that has characterized its work in the past in the fields of consumer goods and heavy materials for civilian use.

Why do I say "not permitted"? The reasons fall in several sectors, but, in my opinion, an outstanding one is in the limitations placed on production activities by the very men who should have the greatest interest in producing at the highest possible speed: Representatives of the Army and Navy charged with procurement and inspection.

Some cases in point will clarify the condition as I see it. While I cannot, of course, reveal the confidential sources from which these "case histories" are drawn, you may be sure that they are well authenticated.

First there is the case of a producer of machine-gun parts. The specifications to which machine-tool operators in this plant work call for tolerances so close that they can never be met in high-speed production. When they are met, by slow and tedious means, even the parts produced in that one shop are not interchangeable; assembly must be made by the cut-and-try method. Here is the direct antithesis of mass production methods, of the one system by which the production that we all want can be achieved. And the military inspectors of this work insist in one breath that the tolerances must be adhered to; in the next breath they call for production!

Then there is the case of a shipbuilding program where work was held up for a week because the government inspector on the job insisted that the welding electrodes being used were not the proper kind for the work. This insistance continued in spite of the fact that the workmen concerned were thoroughly familiar with welding procedure. It did not end until it was discovered that the inspector was using the wrong specification book! On this same job an inspector demanded that a certain part of the work be welded with 5/32-inch electrodes instead of the ¼-inch rods that were being used, again despite the practical working knowledge of the workmen. In this case, as in many others, the manufacturer must bow to the orders of the government representatives in order to keep things moving at all.

In a third case, finishing operations on 37mm anti-tank gun mount are being carried out with ½-inch grinding wheels, just because the specifications call for such procedure. In the opinion of men who are qualified by experience to know, this lengthy operation serves no good purpose as far as the final performance of the gun is concerned, and might well be eliminated, with a definite speed-up of production.

I could go on with several more examples, but I am sure that those given will serve the present purpose.

From these case histories it is apparent that a great obstacle to full-speed production is hide-bound tradition in military circles. It appears that the men who are vested with the responsibility of supervising production in various industries are seldom selected for their knowledge of the particular work which they are to control.

This brings us to suggestions for a possible solution of some of the troubles that are inherent in any system in which production control requires specialized knowledge, if production is to be kept at the highest possible peak.

Army and Navy procurement officers and inspectors should be selected from the ranks of industrial technicians, rather than from the Services. Draw them from the automotive industry for supervision of automotive problems, from welding concerns for inspection of welding jobs, from ship-building yards for control of ship-building operations. If it is feared that technicians so selected might be biased in favor of their own organizations, set up a ruling that no man is to represent the government with the specific company from which he was drawn.

This procedure would probably not be looked upon with favor by Army and Navy officials because these men would not be instilled with the proper military spirit, would not hold to the traditions of the Services.

Let us assume that these are valid objections. Then give to these technicians who are to speed up production an intensive training course in the Army or Navy, thus providing such background as seems essential. This course, consuming perhaps two or three months, certainly would not hold up production any more than it is being held up at present by the sort of thing outlined in the case histories above. And when these men finish their training they would be qualified to couple the requirements of the Services with their expert knowledge of the requirements of mass production methods.

What I have proposed is merely an adaptation of the fundamentals upon which American industry has grown to world supremacy. When the right man is put in the right job, things hum; when the wrong man is invested with authority that no one can question, there is created a choke point that is all too frequently blamed on almost everything but the one out-of-place factor.

Very truly yours,
A. P. Peck

Patents and Free Enterprise

Anti-Trust Laws Can Control Abuse of Patents Without the Necessity of Destroying Patent Rights

WILLIAM R. BALLARD
General Patent Attorney,
American Telephone and Telegraph Company

THE American patent system seems to do well the thing it was intended to do, namely, "to promote the progress of science and the useful arts." We are the most inventive and progressive people in the world, and during the past century and a half over two and a quarter million patents have been issued to inventors. Right now, however, there is agitation in certain quarters to change our patent laws radically on the ground that they are in collision with the anti-trust laws, that they take something from the public merely to benefit an individual, and that they are being misused by patentees. The reasons back of this agitation are wholly unsound, but there is real danger that they may prevail and kill the goose that lays the golden eggs.

A patent is not a private privilege carved out of the public domain. So far from being a means of taking something from the public and giving it to an individual, a patent is a means for getting something from an individual and giving it to the public. If a man makes an invention of the kind which can be protected by a patent, it is something which the public does not then have, and to which it has no claim. That invention belongs to the man who made it. He may, if he choose, keep it secret and practice it to his own profit. He may, if he choose, let the art die with him. If anyone surreptitiously filches his secret invention, he has his remedy at law for the injury. The patent system is designed to induce him not only to do the inventing but to disclose his invention and give it to the public gratis after the term of the patent, in return for the assurance that he will be protected in the exclusive use of his own for those seventeen years, notwithstanding the disclosure. In this transaction, it is clear that only the inventor gives up anything of substance. To purchase the residuary rights in his invention the public contributes neither money nor anything else it possesses. It gives only a promise of temporary protection for the inventor's own intellectual property so that he may, if he can, make a profit for himself during the period of protection.

As long ago as 1852 Daniel Webster stated it as plainly as this:

". . . The Constitution does not attempt to *give* an inventor a right to his invention, or to an author a right to his literary productions. No such thing. But the Constitution *recognizes* an original, pre-existing, inherent right of property in the invention, and authorizes Congress to secure to inventors the enjoyment of that right. But the right existed before the Constitution and above the Constitution, and is, as a natural right, more clear than that which a man can assert in almost any other kind of property. What a man earns by thought, study, and care, is as much his own, as what he obtains by his hands. It is said that, by the natural law, the son has no right to inherit the estate of his father—or to take it by devise. But the natural law gives a man a right to his own acquisitions, as in the case of securing a quadruped, a bird, or a fish by his skill, industry, or perseverance. Invention, as a right of property, stands higher than inheritance or devise, because *it is personal earning*. It is more like acquisitions by the original right of nature. In all these there is an effort of mind as well as muscular strength.

"Upon acknowledged principles, rights acquired by invention stand on plainer principles of natural law than most other rights of property. Blackstone, and every other able writer on public law, thus regards this natural right and asserts man's title to his own invention of earnings.

"The right of an inventor to his invention is no monopoly. It is no monopoly in any other sense than as a man's own house is a monopoly. A monopoly, as it was understood in the ancient law, was a grant of the right to buy, sell, or carry on some particular trade, conferred on one of the king's subjects to the exclusion of all the rest. Such a monopoly is unjust. But a man's right to his own invention is a very different matter. It is no more a monopoly for him to possess that, than to possess his own homestead.

"But there is one remarkable difference in the two cases, which is this, that property in a man's own invention presents the only case where he is made to pay for the exclusive enjoyment of his own. For by law the permission so to enjoy the invention for a certain number of years is granted, on the condition that, at the expiration of the patent, the invention shall belong to the public. Not so with houses; not so with lands; nothing is paid for them, except the usual amount of taxation; but for the right to use his own, which the natural law gives him, the inventor, as we have just seen, pays an enormous price. Yet there is a clamor out-of-doors, calculated to debauch the public mind." (Emphasis by Mr. Webster.)

• Even in times of economic uncertainty, the patent remains the cornerstone of business and industry, large and small. In view of current attempts to undermine our patent system by attacking it as a system which fosters "trusts" and makes it possible for an inventor to establish a "monopoly," the present article is unusually timely. By emphasizing that the inventor *gives* something to the public, rather than taking from it a right which the public should possess, the author stresses that phase of our patent law which is fundamental, yet all too often overlooked.—*The Editor* •

Chief Justice Marshal said of the patent: "It is the reward stipulated for the advantages derived by the public for the exertions of the individual, and is intended as a stimulus to those exertions . . . The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discoverer for 14 (now 17) years, is preserved; and for his exclusive enjoyment of it during that time the public faith is pledged."

IT is sometimes said that patentees have a practice of prolonging the life of their patents beyond the 17-year period. This is done, we are told, by taking out improvement patents.

The simple fact, of course, is that no patentee can prolong the life of his patent by so much as a single day.

When a patent has run its 17 years, it ceases at once to be a bar to anyone in any way. The making, using, or selling of the thing covered by the patent is as free to one man as to another; and this is true whether improvement patents have been taken out or not.

And during the life of the patent one man as much as another is free to make and to patent improvements on the preceding invention. Of course, the man who makes the best improvement will, after the first patent expires, be in a better position to compete (so far as patents are concerned) than the man who makes a poor improvement, or none. If the same man who conducted a business under the first patent makes the best improvements he, of course, will have this competitive advantage; but this is the result of his effort and ability in making the improvements—not in any sense because of an extension of the monopoly of his old patent.

In this matter of making and patenting improvements there is a field of perfectly free competition. If the outsider, who wants to get in, has the ability and is willing to spend the time, money, and effort required to make and to patent the best improvements, he will hold the advantage in the business over the original patent owner when that patent expires. If he has not the ability or is not willing to make the effort, there is no reason why he should be permitted to take, free of cost, the improvements of someone else who has spent time, money, and effort in perfecting them.

We sometimes hear it said that the *assignment* of a patent—especially an assignment to a corporation—diverts it from its intended purpose and turns it to an unforeseen and undesirable end such as "the pursuit of gain." There is no truth in this.

It seems almost too obvious to require stating that the very purpose of the patent law in granting an inventor a patent is to enable him to reap a profit on the invention. The chance to do that is his reward for contributing to the advancement of science and the useful arts by making and disclosing the invention. From the point of view of the public, it is of no importance at all whether the patentee makes the profit by manufacturing and selling the invention himself, or makes it by selling his exclusive right to someone else. If he sells his patent to someone else, the purchaser, whether a corporation or an individual, gets no rights which the original patentee did not have.

Obviously either the inventor *or* his assignee may use the patent unlawfully, just as he may use any other private property unlawfully. For example, he may make an agreement or combination in restraint of trade which involves his patent, just as such an agreement may involve his grain or his horses. But the cure for this is not to decry the sale of the patent or the grain or the horses, but to prosecute the perpetrator of the agreement (whether inventor or assignee) under the anti-trust laws if he transgresses those laws.

Some seem to assume that a patentee, as distinct from the owner of other property, is under some special obligation to society. Having read Article 1, Section 8, of the Constitution and found that the granting of the patent is intended "to promote the progress of science and useful arts," they jump to the conclusion that it is the patentee upon whom falls the duty of promoting the progress of science and the useful arts. Of course, this is plain foolishness. The Constitution expressly states that it is Congress that is to promote the progress of science and the useful arts. And the precise way Congress is to promote them is stated, namely: "by securing for limited times to . . . inventors the exclusive right to their . . . discoveries." So, it is the fact that the exclusive rights are granted which promotes the progress of science and the useful arts, and not something the patentee is expected to do after the grant is made. Once made, the grant, like any other piece of property, is something belonging entirely to the grantee. It is intended for his benefit and with it he may, as with his horse or his grain, do just as he pleases. The patentee's obligation to society is no greater, and of course no less, than the obligation of the holder of any other piece of personal property. The patent is merely property he has bought by yielding the price specified by the Government.

Of course, anyone so blind as to believe that human beings have already attained such perfection that we can now thrive and progress without the stimulus of any private ownership at all will object to the private ownership of the patent right, and, since it seems easier to vilify this right as a "monopoly" than it is the corresponding monopoly in one's horse or his grain, it is natural that such a person should pick on patent property for propaganda purposes.

Quite obviously, the right of any person in any private property does, to some extent, limit the freedom of others in conducting their business enterprises (and in other ways). If A owns a farm, B, of course, is not free to conduct an agricultural enterprise that would involve planting and cultivating A's acres. Just so, if A owns a patent on an invention, B is not free to conduct a manufacturing enterprise which would involve the making and selling of A's invention. And most certainly in neither case is there any reason why B should be "free" to do such a thing.

The American idea of free enterprise is not that a man should be free without permission to do business with the property of others, but that so long as he respects the property and other rights of his fellow men he shall be free to conduct whatever enterprise he will, wherever he will, and for such time and in such way as he may choose —and especially that he shall be free, so far as possible, from interference by the Government.

The basic relation between patents and free enterprise is so simple that it can be stated in one paragraph. It is precisely the same relation as between any other private property and free enterprise. While a man's, or a company's, ownership of private property is always in a true sense a monopoly of that property, and the control of it is often referred to as absolute, nevertheless it is also always true that the use of such property, whether it be patents, or grain, or horses, is subject to the general laws governing the use of property, as, for example, the anti-trust laws. And while, as already noted, private ownership of property is necessarily a limitation on the activities of others, it is also true that private ownership and a complete control of the property involved not only promote free enterprise but are almost essential to it. No one can have a really free enterprise based upon a farm or a grocery store unless he has complete control of the farm or the store, and the same is true as to patents. The ownership of patents and the complete control they give of the invention covered are the cornerstones of hundreds of small enterprises in this country.

To propose the destruction of useful property merely because it might be used as the subject of an agreement in restraint of trade, or otherwise in contravention of law, is childish. That, in substance, is what some now propose as to patents. History indicates that oil is more likely to be used as the basis of combinations in restraint of trade than are alphabet blocks or tigers, but that is no reason for destroying or for denaturing the oil; and anyone who suggested that as the remedy would risk a trip to a clinic for mental observation.

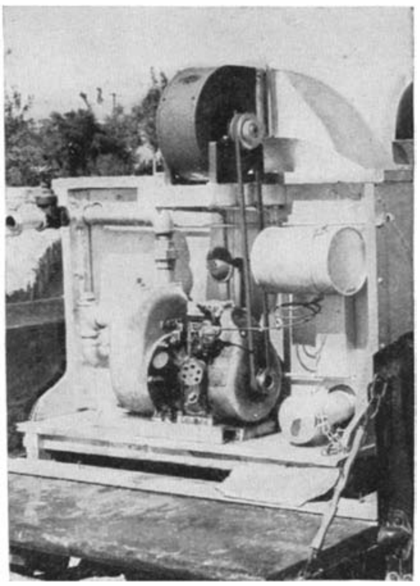
Experience shows that patents, like oil, contribute to the public welfare. Let them remain as they are and continue their good work of promoting science and the useful arts. If owners of patents use them as the basis of agreements or combinations to get control of things which the patents themselves do not cover, the remedy is not to destroy the patent right but to enforce the anti-trust laws.

Air-Conditioning Fish

Mechanical Means Used to Provide Oxygen, Keep Temperature Low When Transporting Hatchery Fish

F. WALLACE TABER

ARTIFICIAL rearing of fish fry has long been a constant headache to all concerned—not excluding the fish. Nevertheless, every state in the Union now rears fish fry for restocking depleted streams and lakes, some states boasting several million fry production annually; others only a few thousand. Nevada is in the latter category, but were she granted a handicap because of the many problems with which she must cope, she would undoubtedly be in the first rank.



Blower and motor

Fish require oxygen to live; lack of oxygen results in suffocation. Fish do not, however, utilize the O part of H_2O; they are not capable of breaking down the compound. The oxygen which fish breathe is that which has been dissolved in the water. The dissolved oxygen is extracted by means of the haemoglobin of the fish's blood, which comes into very close contact with the water as a result of the extremely thin gill membranes through which the blood freely circulates. Therefore, not all water is capable of sustaining fish life; fish must have oxygen dissolved in water to live.

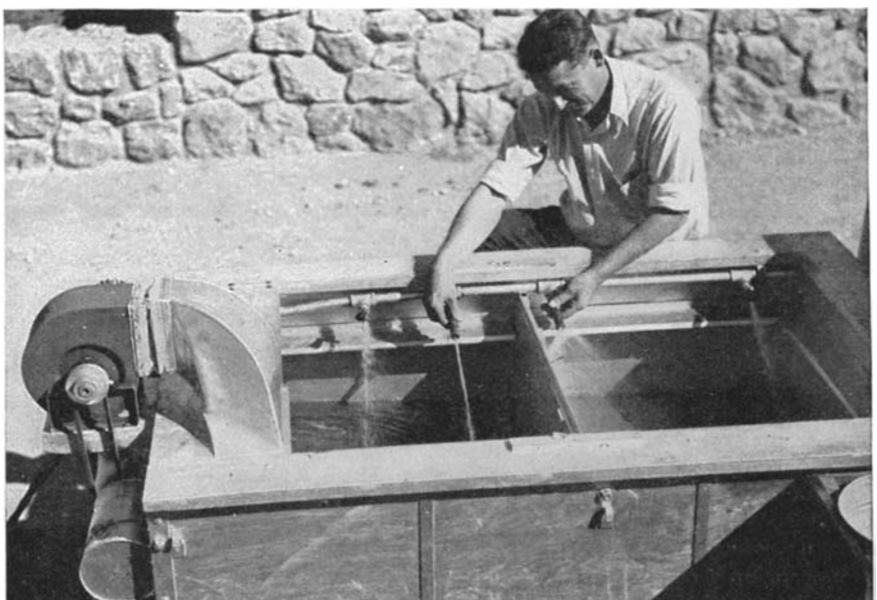
It is likewise a well-known principle of physics that colder water has a greater capacity for dissolved oxygen than has warm water. The lower the temperature, the greater the potential oxygen carrying capacity; conversely, the warmer the water, the smaller the dissolved oxygen carrying capacity. Therefore, it is desirable in transferring fish aboard a truck not only to keep the water constantly aerated, but also to maintain a low temperature so that the water will take on the oxygen as it is passed through the liquid.

In most states, when fish are transferred from hatchery to wild streams and lakes, an ordinary air pump supplies the necessary aeration and a cake of ice maintains the desirable low temperature. Not so in Nevada! There the sweltering desert temperatures hover around 118 degrees in the shade for days on end, and a cake of ice lasts about as long as the well-known snowball. Nevertheless, Nevada fisheries experts last year carried more than 120,000 baby fish well over 2000 miles with losses so small as to be negligible.

Machinery made possible this success. Mounted on the back of a truck, a pump driven by a one horsepower engine circulates water through the fish tank. In operation, water is drawn from the bottom of the tank and discharged with considerable force from small spray jets spaced along a common delivery line. The tank is completely covered with a tight-fitting lid into which is cut a slot-like opening in the rear part of the cover. A funnel-like ventilator situated forward on the cab collects air when the truck is in motion, passes it through the spray of water, to be finally exhausted through the opening in the rear of the cover. Not only does the continual breeze adequately aerate the falling water but at the same time the evaporation thus brought about is sufficient to keep the water several degrees below the atmospheric temperature. On one trip of a hundred miles with the air temperature oscillating between 112 and 114 degrees, Fahrenheit, spring water with an original temperature of 77 degrees gained but a single degree over the entire trip. A tank of water similarly treated, but minus the ventilator, jumped from 77 degrees to nearly 90 during the first hour of running. Needless to say, the bass fry in this check tank were all dead long before the destination was reached.

A SECOND method of aeration is now being tried because of the difficulties encountered when the truck has to stand idle with the fish on board. In such a condition there would naturally be no air circulation. In these experiments a blower of the squirrel-cage type is mounted above the motor and connected by a belt to the motor shaft. The blower is in turn connected to an air duct that leads the air into the spray chamber above the water.

This mechanical method of forcing



Photos by National Park Service

Blower supplies air; pump produces water spray the air through the spray has the advantage of cooling the tank water while the truck is at rest as well as when the truck is traveling along the highway. It also produces a uniform air flow throughout the spray chamber at all times, while the flow of air introduced by the funnel mounted on the cab varies with the velocity and direction of the wind and the speed of the truck.

Ralph H. Olson, inventor of this cooling system, tested the apparatus during last July and August, the hottest season on the desert. Some 15,000 miles were chalked up under the most adverse desert conditions, with temperatures often ranging up to 120 degrees in the shade. During this time 300,000 bass and blue-gill fry were carried through in fine shape. "The fish arrived at their destinations just as lively, if not more so, than when they left the hatchery," Mr. Olsen said. "Some of the trips were as far as 600 miles one way, yet I have never used a single pound of ice even though the trips are often made during the heat of the day."

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OZONE

Still Much to be Learned About its Effects

Chemists are reaching a better understanding of the toxic effect of ozone on humans, concerning which there has been a surprising lack of agreement among investigators, according to Clark E. Thorp of Chicago, industrial chemist, in a report to the Americal Chemical Society.

Ozone, a faintly blue form of oxygen which is present in minute amounts in the atmosphere and is encountered in many phases of modern electrified industry, is formed in practical quantities by spark discharges and by ultra-violet rays. Spark discharges also form nitrogen oxides from air. Tests reported by Mr. Thorp show a large difference of toxicity between pure ozone and ozone containing nitrogen oxides.

"Ozone free of oxides of nitrogen is non-toxic in concentrations below 20 parts per million." Mr. Thorp says. "Ozone containing 47 percent nitrogen oxides has bactericidal properties.

"Ozone plus nitrogen oxides may be more toxic than nitrogen oxides alone and should be investigated further. The variance of opinion to ozone toxicity is probably due to results obtained with ozone containing varying amounts of nitrogen oxides."

Two hundredths of one part of pure ozone per million can be detected only by chemical analysis, but five-hundredths of a part per million is detectable by a keen sense of smell. One tenth of a part per million of pure ozone results in an easily detectable, but not unpleasant, cloverlike odor.

At one part per million, the odor still is not unpleasant, although continued exposure became annoying to 25 percent of those tested. Exposure of seven hours a day for five days did not cause irritation of nose and throat.

Three parts per million of pure ozone has no killing power on coli (bacteria) in water, or on bread mold spores in air; nor has ten parts per million any effect on mice after six hours' exposure. Fifteen parts per million bubbled through a representative sample of algae, tiny tree plants growing in water, for one hour had no noticeable effect; after six days the algae had tripled in growth.

Four hours' exposure to air containing 20 parts per million of pure ozone did not affect mice, nor produce soreness of nose or throat in humans. But 30 parts per million caused coma in mice after five hours' exposure, though coli were not killed. The mice revived when subjected to normal air. Five hours' exposure to 50 parts per million killed mice, but this proportion used in six hours' aeration of flour did not kill any weevils or affect larvae.

One hundred parts per million of pure ozone were lethal to mice in one hour, and a one-minute exposure of humans resulted in dried skin, severe sore throat. One hundred parts per million also killed 20 percent of the coli in water containing 500 coli per cubic centimeter with one hour of aeration per liter.

The effect of impure ozone, containing 47 percent oxides of nitrogen and 53 percent ozone, was quite different. According to parts per million, the following observations were reported: one-hundredth of a part per million—threshold for keen smell; two-hundredths—easily detectable to people; five-hundredths—odor objectionable to some people; one-tenth—acid odor highly objectionable, causing sharpness in throat.

One part per million, the limit at which a test was made on humans—produced headache after two hours and sore throat after three hours; three p.p.m.—kills all coli in water when coli number less than 220 to the cubic centimeter, five hours' aeration per liter; five p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five hours' aeration per liter.

Ten p.p.m.—lethal to mice in five hours' exposure; 15 p.p.m.—kills algae after ten minutes' bubbling through water, and algae did not grow again in the water; 30 p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five minutes' aeration per liter; 50 p.p.m.—kills flour weevils and 80 percent of larvae after 30 minutes' aeration through flour, turns flour light brown in color.

"The toxic limit for nitrogen oxides has been determined to be 2.3 parts per million by weight," Mr. Thorp says. "The toxic limit for ozone containing 47 percent nitrogen oxides is shown in this report to be only 1 part per million, which would be the equivalent of about 0.5 part per million for the oxides of nitrogen. The presence of ozone evidently increases the toxicity of nitrogen oxides to a considerable degree. Although it would require a comprehensive physiological test on humans, this action should be investigated further by some one equipped to carry out such research."

Each molecule of pure ozone has three atoms of oxygen. Used commercially for sterilizing water, purifying air, and bleaching, ozone is one and a half times denser than ordinary oxygen gas. It is created every time a silent electric discharge goes through a current of oxygen or air.

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GASOLINE—Motor fuel for highway use, reported in these pages in our February issue as totaling 22,000,000 gallons in 1940, should have been placed at 22,000,000,000 gallons.

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SPORTS EQUIPMENT

Must be Conserved "For the Duration"

At the recent National Sportsmen's Show in New York (also at numerous others held throughout the country) exhibitors generally cautioned sportsmen to treat their equipment kindly and thereby help win the war. Before long the shortage of metal, rubber, cork, and other materials will be very evident. One material which must be conserved is wool, for it is used not only for clothing, but to a very large extent in felt, and felt is utilized to a greater degree in sports goods than the average person realizes. Its application ranges from boot and moccasin linings to shoulder pads for hunters and heavy fishing tackle harness, archery arm guards and targets, camping equipment. In motor boats and airplanes it is employed to absorb vibration; it is used for canoe and boat seat cushions, helmets for participants in speed events on land, air, and sea, and so on. It finds its way into skiing outfits and many other sports costumes and accessories, golf club grips, and hundreds of other items.

Variable cushioning properties make felt an ideal shock absorber. For example, in a baseball catcher's mitt felt with non-resilient qualities must be used; otherwise the ball would bounce out of the palm. And yet, for various other purposes, high resiliency is called for, as in helmets, tumbling mats, basketball knee-pads and so forth. Thick felt insoles are unsurpassed in cases where boots are too large, especially when long hikes are in prospect. These insoles can be cut with scissors to give maximum foot comfort.

OIL TRANSPORT

On the Mississippi Will Reach 200 Million Barrels in 1942

Nearly 200,000,000 barrels of crude oil and petroleum products will be moved on the more than 5000 miles of the Mississippi Waterways System to inland refineries and markets in 1942, helping to relieve the railroads now when they are so burdened, and when tank cars are needed in unprecedented numbers for West Coast and East Coast services to replace tank ships.

The increase in the movement of petroleum on the inland waterways has been phenomenal, according to authoritative reports. The estimated 1942 total will be more than four times the less than 50,000,000 barrels moved in 1933. Not only has transportation on the main waterways increased spectacularly, but new oil ports, such as Minneapolis-St. Paul, have been opened up within the past two or three years. Prior to 1939, scarcely any petroleum moved into the Twin Cities by water.

Petroleum moves in barges out of all the great oil ports on the Gulf of Mexico, from Corpus Christi to New Orleans, up the Mississippi to the Missouri, the Illinois, the Tennessee, the Cumberland, the Ohio, the Allegheny, the Monongahela, and the other navigable rivers in the system. On the Ohio and Monongahela, barge-borne petroleum is transported from the southwest to ports 100 miles above Pittsburgh. On the Kanawha, petroleum reaches Charleston, West Virginia. Using the Illinois River and canal, shipments from the Gulf of Mexico can enter the Great Lakes waterways system. Up the Missouri petroleum moves to new terminals in Iowa and Nebraska.

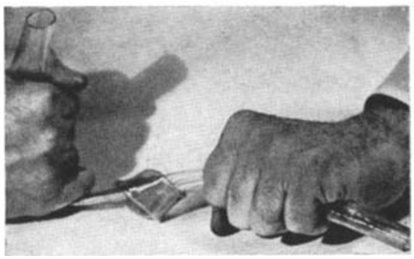
The number of river-side oil terminals on the Mississippi system has grown tremendously. At the end of 1941 there were listed 252 terminals at 135 points in 17 states. Two years before, in 1939, only 160 oil terminals were reported. The terminals are of all sizes, some of the most modern providing storage and terminal facilities for more than 5,000,000 gallons of petroleum products.

Nearly one fourth of the country's entire refining capacity is concentrated along the Texas and Louisiana Gulf Coasts, from which the inland barge movement gets most of its supplies.

TUBING

For Electrical Insulation is Strong, Flexible

A new tubing with excellent resistance to brittleness down to —50 degrees, Centigrade, has been developed by the Irvington Varnish & Insulator Company.



Can be tied in knots

This transparent tubing, known as Transflex, was made especially to secure continued, effective insulation on aircraft flying at high altitudes; it has already been utilized by such companies as Douglas Aircraft and Curtiss-Wright. However, its toughness and rubber-like qualities make it useful for a variety of other industrial and electrical applications. For example, the transparency of Transflex permits quick location of wire breaks and ready identification of wires which have been snaked through it.

Transflex is a Fibronized tubing available from size No. 14 to ⅝ of an inch inside diameter; it is extremely flexible, as shown by the accompanying photograph. Its tensile strength is 3000 pounds per square inch. Its dielectric strength (conducted on a tubing with a wall thickness of approximately .020 of an inch) is 850 VPM when dry and 815 VPM when wet. Water absorption is 0.4 percent in weight after 24 hours immersion.

USEFUL PLANT

Bamboo Can Supply All Human Needs

What is the most universally-used plant that grows? Is it, as many have stoutly maintained, the coconut palm? Or sorghum, maize, sugar cane, or peanut? No, not one of these, according to Dr. Willard M. Porterfield, Jr., of the United States Soil Conservation Servive. It is bamboo.

There is not a category of human needs which cannot be supplied by some form of product of bamboo, declares Dr. Porterfield. Food, weapons, shelter, implements, clothes, furniture, baskets and containers, bridges, conduction pipes, paper, cable, ornaments, and many very specialized articles are made from it.

The Forest Research Institute of Dehra Dun in India believes that the final solution of the world's recurring shortage of raw material for paper will only be found in the forest and waste lands of the tropical and sub-tropical belts, with bamboo the most important product.

Bamboo has figured largely in the past history of Asiatic and many tropical peoples and has been the subject of artistic rendering in all the arts. The famous Bamboo Books, containing more than 100,000 seal characters, comprising 15 different works dealing with the history of China for 2200 years, were written on tablets made of bamboo which were strung together like a fan.

To bring the uses of bamboo up to date, a bamboo basket has been designed and used by the Chinese to protect their most important buildings from Japanese air raiders. According to W. R. Peck, Counsellor of the United States Embassy, Chungking, China, the Chinese construct a three-story bamboo framework atop buildings and load all three floors with cut bamboo. When a bomb hits, it is harmlessly detonated before it reaches the building itself.—*Science Service.*

ROAD-RAIL

Vehicle for Use in Explosives Plants

A speedy motorized vehicle which rolls on rubber tires on the highway or on a railroad track, is being used

At home on road or rail

to eliminate some of the hazards in the movement of explosives at arsenals and powder depots. Called the "Auto-Railer," the vehicle employs special rubber tires, developed by The B. F. Goodrich Company, which work in conjunction with conventional flanged guide wheels for operation on railroad tracks. Designed and manufactured by the Evans Products Company, the Auto-Railer has a top speed forward or reverse of 60 miles an hour, either on highway or rail, and, thanks to the windshield-wiper action of the non-skid treads, it can be stopped as quickly on the rails as can a modern automobile on the road.

The transition from highway to rail takes but a few seconds. The rail assembly is operated by a hydraulic jack, controlled from the driver's seat, which lowers or raises the flanged steel guide wheels. On the rails, the rubber tires bear a portion of the load normally carried entirely by the flanged rail wheels.

Weighing 8750 pounds, and capable of carrying 3000 pounds of explosives, the vehicle is completely spark-proofed, with exterior wiring throughout, while the cushioning properties of the rubber tires eliminate jolts and jars.

Several of the vehicles are already in use at one of the Ordnance Department's bomb and shell loading plants in Ohio, and more units are in manufacture for use in other arsenals.

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. ●

REPAIR KIT

For Nicked and Scratched Furniture

With the proper materials available, enterprising householders can, with but little practice, restore marred furniture surfaces to the appearance of the original condition by removing scratches, filling in nicks, dents, gouges, and so on.

A new furniture finish repair kit, just announced by the American Household Bureau, contains every essential material and piece of equipment necessary to turn out professional-looking repair jobs quickly.

This new kit contains an assortment of shellac sticks, bottles of light and dark stain, shading lacquer, alcohol lamp with fuel, spatula, scratch stick, liquid penetrating scratch polish, steel wool, felt rubbing pad, shellac rubbing liquid, sandpaper, and touch-up brushes. These materials and equipment make it possible to repair any finely finished furniture surface in a matter of a few minutes time.

● ● ●

MAN MADE—Hardly a single component of an airplane or the fuel it burns or the oil which lubricates it or the liquid which cools its engine is a simple, natural product; even the metals of which it is in part constructed have been so changed by scientific research that metallurgists of 20 years ago would not have known them.

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WINCHES

Pull Army Cars Out of Trouble

Half-Tracs of the United States Army are designed to go where no other vehicles except tanks will go. This means that the reconnaissance units and personnel carriers will go through mud and water as well as across the roughest kind of terrain, not excluding trenches and shell holes. However, there is a type of ground which is closely akin to quick sand—a surface so fluid that any vehicle, even with tractor belt support, will sink. In order to take care of such conditions, the new Half-Tracs designated for quick-sand territory are being equipped with sturdy winches which drive from the transmission. These winches are used not only to help pull the vehicles out of difficult places, but for any other purpose requiring a winch.

Hard to stop; hard to stick

The winch on Half-Tracs made by White Motor Company is mounted on the front so as to be more quickly available. In this handy location it is always ready for action. The vehicle can be headed in wherever direction the winch is needed and it is never necessary to unload the Half-Trac in order to use the winch, as would be necessary if it had a body location. With this equipment, the Half-Trac is ready for any eventuality and becomes a vehicle of even greater utility.

PIERCING FOG

Yellow Lenses Hold No Advantage

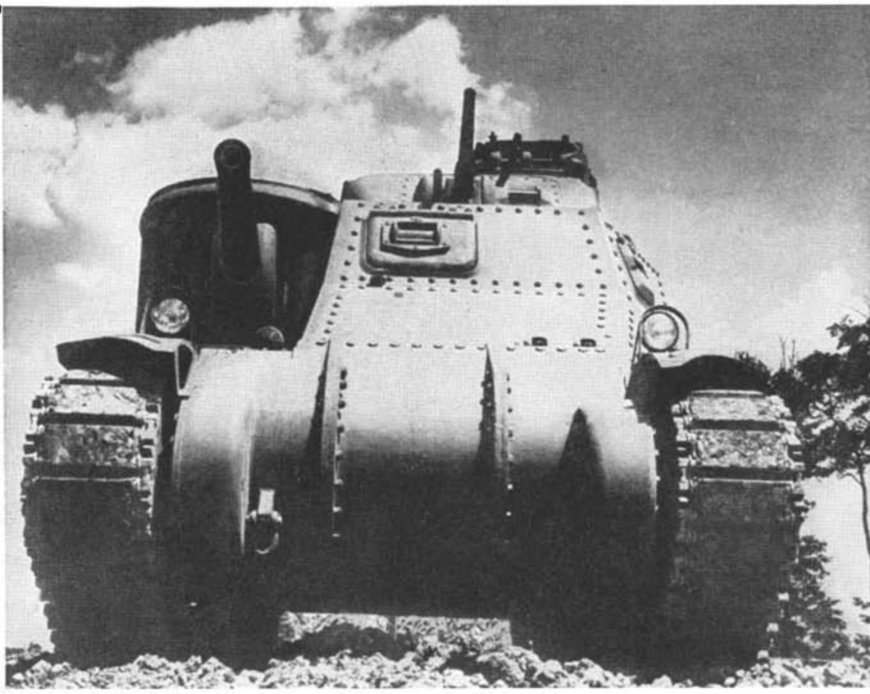
That yellow light is no better at piercing fog than the light of an ordinary tungsten lamp is shown by experiments recently carried out by Dr. Matthew Luckiesh, research physicist and Franklin medalist, and L. L. Holladay, of the Lighting Research Laboratory of the General Electric Company, Nela Park, Cleveland, and reported in the *Journal of the Optical Society of America.*

The so-called fog-lamps, consisting of yellow lenses which absorb from 20 to 35 percent of the tungsten-filament light, must contribute something to the seeing to offset the loss due to less light. No satisfactory tests have been published, but the present investigation makes it more than unlikely that they have any advantage. Similar fog-piercing claims have been made for the new sodium lamps. In this case there is no loss of light by colored filters, for the light is inherently yellow and practically monochromatic. Yet even this lamp showed no significant superiority over the tungsten lamp in fog-penetrating qualities.

The two lamps of equal intensity were tested side by side in clear weather, moderate fog, dense fog, mist, and snow. They were tested by day and by night. Also, a pair of lamps of low intensity and a pair of high intensity were used. Many experienced observers made many readings on a Luckiesh-Moss visibility meter at a distance of 1000 feet. No significant differences showed in the averages.

The report explains that the fog-penetrating power of a light does indeed depend on its color or wavelength, as has been generally known. Thus, blue light, which is of short wavelength, penetrates fog less than red light, which is of long wavelength. The sodium lamp emits yellow light that is practically of a single wavelength. This wavelength is about midway between those of the red and blue lights. Hence the fog-penetrating power of the sodium light is just about middling.

The white light of the tungsten fila-

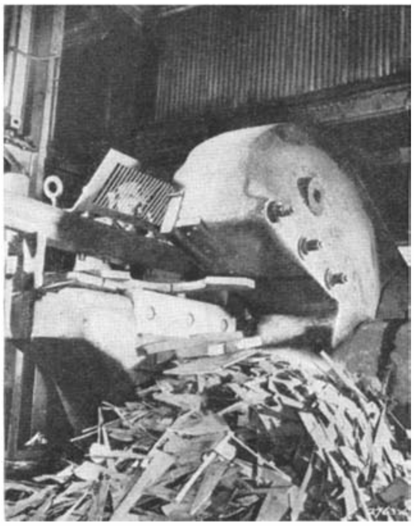


ment contains all the colors from red to blue. It is true that the blue rays are cut down by the fog, but the remaining red rays have a fog-penetrating power superior to the yellow light of the sodium lamps. This evens the score.

METAL "WHALE"

Has Appetite of 25 Tons A Day

Twenty-five tons of steel is the daily dish of this whale-like machine in the metal conservation department of the Westinghouse Electric & Manufacturing Company. When parts of motors, generators, and other electrical machines are punched out of steel sheets, many odd-shaped pieces are left. Fed to the furnaces of steel mills, this scrap again becomes usable steel valuable to the nation's war effort. But because the scrap is worth $3 a ton more if cut into sizes that fit easily into the furnaces, it goes first to the "scraphouse whale"—a great shearing machine driven by a 50-horsepower motor. This mammoth shear bites off chunks of five-inch-thick metal as easily as scissors snip a piece of paper. Each month it helps salvage enough steel to build 30 medium Army tanks—one a day.



Five-inch-thick metal at a bite

DOUBLE CHECK

On Insecticide Reveals Unwanted Features

Insecticide chemists of the U. S. Department of Agriculture have a continuing program of trying to find new and better insect poisons. What they seek are new chemicals that, on the one hand, are deadly to insects and, on the other, are not harmful to humans. They first synthesize new compounds which entomologists then test on insects. If results are promising, a stock of the material is sent to San Francisco where the Bureau of Agricultural Chemistry and Engineering and the Stanford University School of Medicine cooperate in maintaining a pharmacology laboratory to find out whether new poisons are safer than the poisons they would displace.

Entomologists are working particularly to find safer substitutes for the lead, arsenic, and fluorine poisons now in use.

Recent experience with the one new poison, reported by Bureau scientists Wilson, DeEds, and Cox in *Cancer Research,* illustrates how this protective research operates. A compound called "2-acetaminofluorene" tested well as an insect killer. At the Stanford laboratory heavy single doses were not harmful to rats and rabbits. The animals eliminated the poisons. So far, so good! But it turned out that with lighter doses in the food day after day, the growth of the animals was checked and they sickened and died within 100 days. Not so good!

To make the test even more thorough, the dose was reduced until it did not check growth—and the result was even less favorable. After continued feeding for from five months to a year it was discovered that even minute doses were causing cancer in many of the rats. When this report came back to Washington, the work with this new insecticide was dropped. Entomologists are not much interested in a poison that might cause cancer—no matter how effective against insects.

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PREFABRICATED — The "monocoque" engineering principle of airplane construction is now being employed in prefabricating houses. By this method the walls are glued to the framing members and become stressed covers carrying part of the weight burden.

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ICE GHOSTS

Difference Between Solids and Liquids is Not Sharp

Ghosts of ice lurk in water melted from water that has been frozen, and other liquids have some slight residual structure which is like a vague recollection of a former crystalline solid state.

This finding of science was reported by Dr. John G. Kirkwood, professor of chemistry at Cornell University, in a lecture under the auspices of the Society of the Sigma Xi, the national fraternity for the promotion of scientific research.

When a solid melts, Dr. Kirkwood explained, the long-range crystalline order, that extended throughout the whole mass of the solid, disappears completely, but some trace of the short-range local organization persists. Each molecule in the liquid tends to retain a smaller or larger group of its former neighbors about it.

The description of liquids as mobile and formless, and of solids as rigid and resistant to any attempt to deform them, is not a satisfactory distinction. Glasses and other vitreous substances are to be regarded as under-cooled liquids—liquids that have solidified without crystallizing but which under different circumstances would have crystallized. These have strength and rigidity, while true crystalline solids may exhibit creep and plastic flow at elevated temperatures.

Liquids and gases are qualitatively similar in structure and the qualitative distinction vanishes entirely above the critical point. Both possess a certain degree of local order. Crystalline solids, on the other hand, possess a high degree of structural order extending over wide domains.

Only at the absolute zero of temperature is an ideal crystal, possessing complete orderliness, possible. As the temperature is raised, various types of disorder set in, until at last the crystalline structure is disrupted and fusion begins.

MOLDING

Of Plastic, For Use With Linoleum

For use with conventional linoleum and with the wall-lining material designated as Linowall, a new line of plastic trim has been introduced by the Armstrong Cork Company. Included in the line are binding strips, cap strips, inside and outside corners, and right and left-hand end stops. Corners and end stops have floor and wall flanges which extend behind the linoleum to anchor them in place. Installation is said to be simple and the units are available in a range of colors to harmonize with shades of linoleum.

MIMA MOUNDS

Curious "Geological" Formations Turn Out to be Artificial

The origin of "Mima mounds," large oval-shaped structures which dot the prairies of western Washington, and have long puzzled geologists, was explained recently by Dr. Walter W. Dalquest of the University of Washington and Dr. Victor B. Scheffer of the United States Fish and Wildlife Service of Seattle, who gave the solution in the *Journal of Geology* (Chicago).

According to the scientists named, the mounds, some as large as 40 feet across, were formed over a period of thousands of years by generations of pocket gophers.

The Mima mounds—so named from Mima prairie in Thurston County, Washington, where the mounds are largest and most numerous—were first discovered a century ago. Since that time geologists have believed them to be formed by geologic processes.

The mounds, round or oval in shape, are ten to 40 feet in diameter and one to seven feet in height. They are formed of loose dirt and gravel. Thousands are found scattered through western Washington, giving the impression of huge spheres nearly buried in the earth.

The pocket gophers which formed the mounds migrated into western Washington shortly after the last glacial period when the outwash prairies

THE EDITORS RECOMMEND

Best Sellers in Science

ATOMIC ARTILLERY—By John Kellock Robertson. Electrons, protons, positrons, photrons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radio-activity. $2.35

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

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

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produced by the melting glaciers were quite smooth. The process of continual burrowing, which loosened the soil and stimulated the growth of vegetation near the burrow, gradually produced the mounds.

The theory is strikingly confirmed by the fact that large rocks, too heavy to be moved by gophers, are found at the base of each mound. This results from the fact that gophers burrow around and beneath large stones, permitting them to settle.

Previous attempts to explain the mounds include the theories that they were formed by the thawing and freezing of water, by the activity of ants, and by ancient Indian tribes.

PHONE HOLDER

Permits Free Use Of Both Hands

Both hands are freed for writing orders, thumbing through files, and so on, while using the telephone, by the use of the Phone Ease attachment illustrated in one of our photographs. This unit, made of molded rubber, fits over the telephone and snaps into place. It forms a shoulder support for the phone when in use, yet rides in the clear in a vertical position when the telephone is returned to its cradle.

"Shoulder — phones!"

FIRE ALARM

Detonates Blank Cartridges To Warn Of Blaze

A simple fire-alarm unit which requires no electric wiring of any kind is designed to be hung on walls in areas where fire may occur. When the air temperature surrounding the unit reaches 160 degrees, Fahrenheit, sensitive fuses release firing pins which explode two blank cartridges. Through a delayed action built into the unit the second cartridge is fired a few seconds after the first. The first report serves to awaken even the soundest sleeper while the second adds to the realization of danger and aids materially in locating the fire.

The blank cartridges are inserted under the threaded bases of the two firing-pin housings that are attached to the main body of the unit. They are easily replaced after being fired.

STOPS DRIP

Cork Coating For Pipes, Tank, Walls

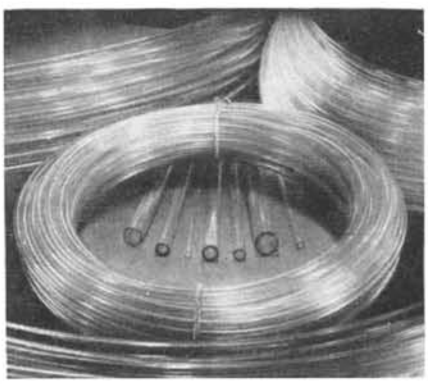
SEVERAL months ago there was reported in these columns the development of a plastic cork coating which could be sprayed on pipes, walls, ceilings, tanks, and so on, to prevent condensation drip. This product, marketed under the name of NoDrip, has now been improved in composition to a point where it can be quickly and easily applied by using an ordinary paint brush.

In practice, the cork composition is spread to a thickness of ¼ of an inch over any metal, concrete, tile, or other surface on which condensation tends to form. The cork composition stops dripping from such surfaces and also acts as a protective coating, preventing rust on metal surfaces. It can be painted in any color.

TRANSPARENT

Tubing, Of Plastic, Is Virtually Unbreakable

EASILY bent, formed, or curved to fit almost any condition, tubing of transparent Tenite is now available for general use in sizes ranging from 3/16 to ¾ of an inch in diameter. The tubing is seamless and is extruded in continuous



Tubes of tough Tenite

lengths. The Tenite of which it is formed is virtually unbreakable.

The ends of these new plastic tubes may be readily adapted to standard flared fittings with the same tools that are used for copper tubing. Standard thread-cutting tools can be used on the larger diameter tubing, the wall thickness being .0625 of an inch.

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HUMAN EAGLES—The number of civilian airplane pilots in the United States passed the 100,000 mark during 1941. At the close of that year there were 60 percent more civilian pilots than the 63,113 reported the year before.

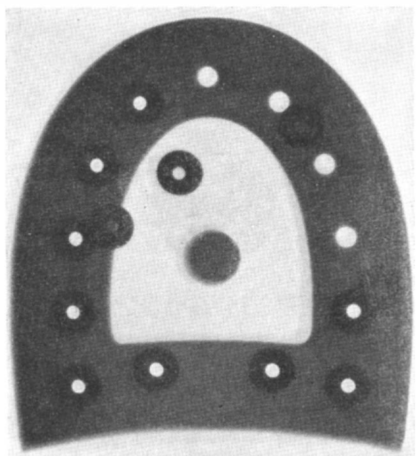
• • •

RUBBER HEELS

Inspected for Perfection With X-Rays

WITH millions of rubber heels going to our military forces, the necessity for rigid inspection of the finished heels has become even more important. One of the conditions found in defective heels in the past has been occasional misplacement of the steel washers which are imbedded in the rubber heel to hold the nails which attach the heel to the shoe.

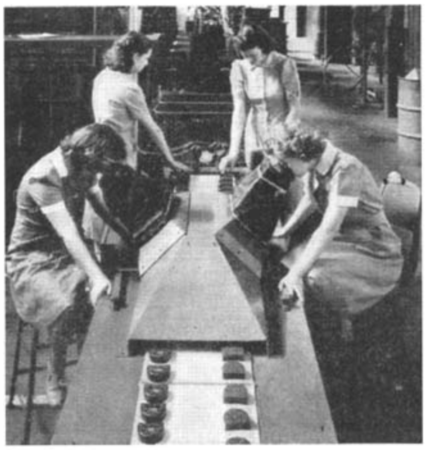
Misplacement of one or more of these washers in the heel means that when the nails are driven in, they will have nothing but rubber to hold them in an upright position. Under severe wear they might give way, making the heel loosen and wobble. To make certain that every washer is in its allotted place, The B. F. Goodrich Company has installed new type X-ray machines in its principal rubber heel manufacturing plant.



Not acceptable

The stream of rubber heels which comes from the vulcanizers passes through these machines, at each of which sit keen-eyed, alert girls, their eyes fixed on the moving heels as the conveyor belt carries them under the X-ray eye.

If a single washer is even minutely out of place, so the nail will not go



X-rays detect out-of-line washers

cleanly through it, this machine immediately detects it, and the heel is discarded. The proportion of rejects is minutely small, compared to the flood of products which go under the machine's searching gaze, but the operation of the X-ray machine is one more step in product perfection before it reaches the consumer.

PAPER BLEACHING

Chlorine Conserved by Change in Process

A PROCESS of bleaching paper pulp stock, which promises to reduce substantially the amount of chlorine needed for this important purpose, has as its basic principle the addition of the chlorine to the pulp for bleaching purposes while the pulp is flowing through a piping system and is in a state of turbulence. This method of application, the inventors of the process state, insures a uniform mixture of chlorine and pulp, so that the pulp is evenly treated and the chlorine is used with maximum efficiency. In processes now in common use, some of the chlorine is generally wasted.

An automatic system of chlorinating paper pulp, that embodies the new process, has been developed by the Mathieson Alkali Works and the Gulf States Paper Corporation, working in conjunction. In this automatic system, the rate of feeding of the chlorine is controlled by an air-operated regulator, which varies the amount of chlorine being added in exact proportion to variations in the amount of pulp flowing throughout the entire piping system.

Industrial Growth

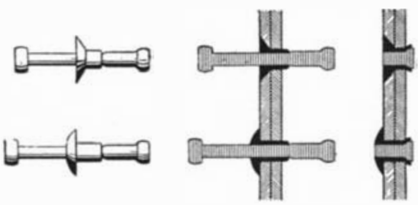
New Products and Processes That Reflect Applications of Research to Industrial Production

BLIND RIVETS

Can Be Set From One Side Only

A NEW type of aluminum rivet for light-weight metal assembly has been developed which can be applied and headed up in locations where the workman has access to only one side of the work. Application and heading up is accomplished with a pneumatic "gun" which completes the operation at a rate of 540 solid rivets per hour or 1200 hollow rivets.

One of our photographs shows the pneumatic gun in operation; the drawing shows two types of solid rivets and indicates the method of application.



Two types of blind rivets

The rivet, before being placed in position, is similar in appearance to the two views at the left in the drawing. Each rivet is a two-piece assembly, the stem sliding on the rivet body proper. The center view in the drawing shows stem and body in position for heading up; the third view gives a cross section of two completed rivets. These rivets are of the self-plugging type; in a second type the stem falls out of the rivet after it has been used to produce the inside head, leaving a hollow unit in place.

Air gun sets rivets

Heading up of these new rivets, called Cherry Blind Rivets, is accomplished by a combination push and pull motion imparted by the pneumatic gun. This tool has a piston which attaches to the head of the stem; an area surrounding the piston applies pressure against the factory-formed head of the rivet to hold it in place. When the gun is operated, the piston pulls the enlarged stem section and finally the head at that end into the shank of the rivet. This movement enlarges the shank and finally forms the head on the opposite side of the work. The stem is then broken off flush and any protruding part is trimmed off with a cutting tool. The rivetting gun used for this work operates on 90 pounds air pressure and exerts a 1300 pound pull on the stem.

TAP RECONDITIONER

Gives New Life to Old Taps

DESIGNED to alleviate current difficulties in securing the vast numbers of precision ground taps required for war production needs, a tap reconditioner has been developed by Detroit Tap and Tool Company. Combining in one unit facilities for chamfering, for spiral pointing and for point polishing, the tap reconditioner serves to eliminate delays in tap replacements by simplifying reconditioning of taps. In addition, the tap reconditioner is said to reduce tapping costs by increasing the output per tap during its useful life. The machine thus also means the avoidance of delays in securing tap replacements by endowing old taps with new life, time after time.

The tap chamfering unit, located at the left of the machine, is of the precision collet type, assuring maximum locating accuracy with quick changes. Taps of from two to seven flutes may be handled through the provision of an indexing drum. Safety stop pins limit the movement of the chamfering unit for taps of different numbers of flutes. A manual type diamond dresser is provided for the chamfering wheel. Hand-

Eliminates tap-replacement delays

wheel adjustment for wear of wheels is provided by mounting the entire grinder assembly on rails.

The spiral pointing unit to the right of the machine employs a saucer type wheel, and its fixture is designed to accommodate taps from the smallest machine screw to ½ inch diameter, using the same precision chuck.

MOTOR

Light Weight, Designed For Aircraft Accessories

A NEW direct-current, explosion-proof motor, built to United States Air Corps specifications, is now being produced in a range of powers from .005 to .2 horsepower, wound for 12 or 24-volt operation. These small units, some of which employ glass insulated wire, are light in weight by virtue of the magnesium alloy frame employed and the use of aluminum bolts, screws, and other small parts.

These motors are being employed to drive airplane accessory equipment, such as fuel pumps, deicers, propeller featherers, and recording and control devices.

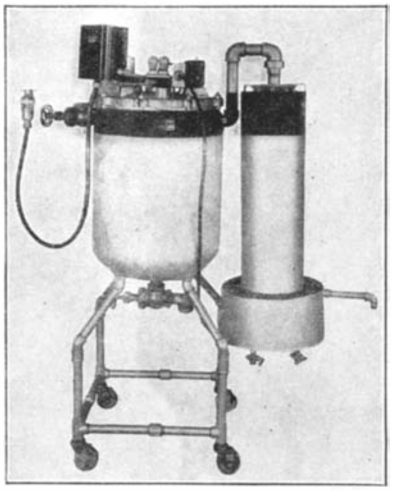
SOLVENT RECOVERY

Made Practical by Air-Cooled Still

THE necessity for full recovery of chlorinated solvents (used principally in vapor type degreasers) in industrial plants, due to O.P.M.'s order M-41 governing the restricted rationing of such solvents, brings a timely development by the Phillips Manufacturing Company of an electrically operated and controlled, fully automatic, air-cooled, portable still and condenser. The unit is constructed to recover perchlorethylene, and can be modified to recover carbon tetrachloride and triclorethylene.

Principal feature of these stills is that all heaters and controls are mounted integrally on the easily removed pot head, assuring easy cleaning and servicing, as well as access to the pot with no fixed fittings on the interior to trap solids.

In operation the still is plugged into a grounded circuit receptacle, and dirty solvent is then pumped or poured into the pot. A sealed float switch indicates by a green pilot lamp when pot is full, and automatically energizes the heaters and starts the cooling fan on the condenser tower. When the liquid level drops to a point just above the heater, the float switch cuts off the heater and pilot lamp until a new charge of dirty solvent is placed in the pot. When the oil residues reach a pre-determined specific gravity and temperature, indicating a 98 to 99 percent solvent recovery, the heater is de-energized, and a red pilot lamp signals the operator to dump the residue before filling pot.



Air cooled; recovers solvents

The still produces 15 gallons per hour. Operating on single or three-phase, 220 or 440 volts, 60 cycles, A.C., it is classified under maintenance equipment priority rules.

COUNTERSINK

With Adjustable Depth Gage And Center Drill

COUNTERSUNK holes can be rapidly produced to accurate depth for rivets and screws without the need of particular care on the part of the operator through the use of a new unit produced by the Aero Tool Company. A center drill is provided which makes it possible to start holes accurately to punch-marked locations. A micrometer depth adjustment, built into the tool and carrying graduations reading in thousandths, limits the end movement of the countersink.

Jet Propulsion

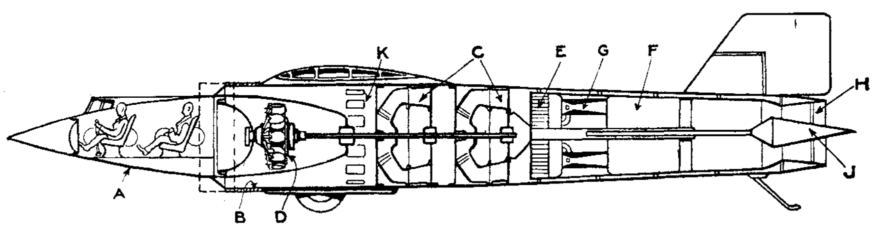
Italian Experiments With an Airplane That Uses No Propeller for Flight at High Altitudes

ALEXANDER KLEMIN

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

WE have had occasion to refer to the news from Italy that a jet-propulsion machine has been flown somewhere out of Milan at the Forlanini aerodrome. Somehow or other, *Flight*, of London, has obtained more definite information on the new jet-propulsion aircraft, which is perhaps the very first machine ever flown without an airscrew. It is the conception of an Italian engineer, Campini, and has as its objective the replacing of the orthodox propeller power plant which loses efficiency at high altitudes.

The design of the airplane as a whole is of no particular interest, but the sectional view shown in the sketch illustrates what is of great interest, namely: the principles of the new power plant. At (A) is the front of the cabin in which two occupants are seated; (B) is a cylinder enshrouding the radial aircraft engine. Air is subjected to an initial compression by the forward motion of the aircraft and is additionally compressed by means of two blowers, (C), driven by the engine. The exhaust of the engine discharges directly into the main airstream, adding heat and still further increasing the pressure of the air. At low altitudes, apparently the engine drives an ordinary propeller, and behaves like a conventional power plant. For high altitude flight, a further supply of fuel is introduced into the combustion space (F), into which the compressed air and fuel are guided through (E) and the annular mixing chamber (G). The products of combustion are discharged through discharge nozzle (H), with cone (J) for varying nozzle orifice. The reaction of the jet issuing at (H) supplies the forward thrust. Some reports have it that even at low altitudes, the apparatus can function purely as a jet reaction device.



Sectional view of the original Campini jet-propulsion plane design

The above description is not adequate and does not give us information as to the possible efficiency of the apparatus, but in these days of secrecy and censorship, we must be thankful for having even meager data.

TEMPLATES

Rapid Process Used in Aviation Industry

IN aircraft production work, at least one extra copy of a template is always needed and sometimes as many as six may be required. With the conventional hand method, each time a work template is needed, it is necessary to scribe laboriously a duplicate copy of the master layout on a metal sheet, using the master as a reference drawing. The process may require hours, days, or weeks depending on how large and complicated the master drawing may be.

Under a new electrolytic process, developed by Lockheed Aircraft, a work template can be produced in five minutes! There are only three steps in making work templates by the electrolytic process: The preparation of the original drawing by the engineer; the scribing of the drawing on a specially treated metal sheet to make the master layout; and the transfer of the scribed layout to an inexpensive metal copy sheet from which the work template will be cut. The copying operation is routine and can be readily mastered by an unskilled employee. Besides the saving of time, the errors possible with hand work are eliminated.

The electrolytic process may be described as follows: A master layout is scribed from an engineer's drawing on a piece of galvanized sheet iron of suitable size and thickness, the surface of which has been prepared with a special coating of insulating paint. The lines produced by the scribe are very accurate and extend through the insulating paint coating into the metal surface. The layout thus formed is sprayed with a transfer solution and the wetted surface is pressed into firm and uniform contact with a copy plate. An electric current of suitable intensity is then passed between the plates, resulting in the layout on the master plate being transferred to the copy plate. At the end of a few seconds the press is released and the two plates removed, separated, washed, and dried. The copy plate is given a thin protective coating and is then ready for immediate use by the template cutters. Any number of copies can be made from the master plate, and, if the press is large enough, a 48- by 144-inch plate can be used. The cost of templates produced by this method is extremely low. Almost any hydraulic press may be put into service for the work.—*A. K.*

MULTIPLE MOWER

Keeps Grass on Air Fields in Proper Trim

With the enormous number of air fields to be put in service by the Army and Navy, concrete or other hard runways become peace-time luxuries and, because they have high visibility, invite bombing attacks. Properly conditioned turf becomes of great importance. But the rub lies in the words "properly conditioned." How can an enormous field of say 500 acres be kept in condition? The modern golf course equipment using a seven-gang mower cannot be operated at speeds exceeding six miles an hour and at this speed can only cut 11 acres an hour or 88 acres during an eight hour day. That would mean five and one half days to trim a 500 acre flying field.

To meet the difficulty, the engineers of the Worthington Mower Company have developed a gang mower hauled by a fast and powerful tractor which operates efficiently at 20 miles an hour. At this speed the mower has the enormous capacity of 368 acres in an eight hour day.

The mower is shown in our photograph and it involves many new principles. Heretofore all types and styles of cutting units have established the height of cut from the ground up. On rough air field conditions at high speeds the rollers and casters transmitted all shocks, jars, and vibrations to the cutting unit. In the new framework, the rear of the cutting unit is suspended from the frame and the height of cut is regulated through this suspension so that nothing touches the ground except the large pneumatic rubber traction tires. The increased simpleness of operation can be readily understood thereby.

Airport grass must be dense

A thick, dense turf is helpful on an airfield because it covers loose particles of stone, gravel, and so on, which are a source of considerable danger to metal propeller tips. A thick, dense turf also helps to absorb rainfall but a thick, dense turf is only developed by frequent cutting. Hence, the great advantage to be derived from the new, high-speed mower.—*A. K.*

FLIGHT CLOTHING

Being Developed for Alaskan Use

Alaska is going to assume increasing importance in our operations against Japan and it is obvious that flight clothing used during the Alaskan winter must give protection both inside the airplane and while walking outside away from an electric outlet.

Therefore, both heated and unheated clothing is being developed in the Equipment Laboratory of the Materiel Division of the Air Corps at Wright Field. Unheated suits have been made of various types of insulating materials such as furs and quilted down. Electrically heated units meet the requirements of temperatures as low as −60 degrees, Fahrenheit. The heated suits are apparently worn as underwear beneath light flying clothes or a coverall. One type uses a coiled wire heating element; another type eliminates 95 percent of the wire by using a carbon impregnated material which conducts the current through the material itself. The regulation is obtained by changing electrical resistance. Heated gloves and shoes are used with the suit. It is even claimed that the heated suit, gloves, and shoes provide sufficient heat inside an unheated cabin to eliminate frosting of the windshield.—*A. K.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Spotlights Solve a Problem

CONTAINED in a shipment of rough diamonds received by Reinhold Brothers, New York City, from an African exporter, was a rough diamond less than a quarter of an inch in diameter. It was distinguished from the other diamonds by the fact that on one of its faces was engraved the letter "V." This was quite a find, so the importer asked us to make a picture of the diamond showing the engraved V as clearly as possible.

That was easier said than done, even though on the surface it seemed like a simple job of cross-lighting. The problem was to light the tiny walls of the letter with sufficient brightness to make them prominent, at the same time creating a dark background for the letter *within* the glass itself. The subject was not to be tampered with in any way; the job was to be done entirely with light.

A "V" in the rough

To obtain a fair magnification of the stone, we used a 5 by 7 view camera, its bellows extended the full 19 inches, equipped with a 6-inch Dagor lens. Reaching as close as we could with this set-up, we obtained a fair magnification, later enlarging the diamond image to a diameter of a little more than 1½ inches, even though the Super Ortho Press film we used was developed in 1-to-1 D-72.

The lighting arrangement took two or three hours, believe it or not, because the clean-cut result we strove for did not come as easily as we had thought it might. We used from one to three spotlights, these being employed because of the great control possible, placing the spot-focus beam as nearly on a line with the stone as possible. The idea was to shoot the light through the side of the stone. We found, eventually, that two spots, the direction of which may be seen from the position of the shadows in the illustration, would do the trick better than one or three, the first not being sufficient to bring up sharply both lines of the letter, and the second tending to flatten the crispness obtained by using two spots.

The letter V formed by the two shadows is purely accidental but helps the subject.

Are Flash Bulbs Scarce?

RECENTLY an ugly rumor went the rounds that there were to be no more flash bulbs, at least not for a very long time, because the Government needed the aluminum. However, the veil has been lifted and it appears that an order had gone forth freezing distribution of flash bulbs temporarily. Now the order has been lifted and flash bulbs are again available, though the supply is not inexhaustible. In any event, we can take nothing for granted. The war is still on, and freezing orders may come again. The general advice is to behave, buy only in normal quantities and thereby show the Government that you will use flash bulbs economically and not in the profligate manner we have been accustomed to when things were different a short while ago. In that way, sufficient materials may come through to make it possible for the manufacturers to keep the amateur and professional supplied.

Reducing Static in Darkroom

SPRAYING moisture into the darkroom air through an atomizer helps to reduce the presence of static, which is the cause of lint and dust adhering to the surfaces of negatives. If you have been having trouble on this account, try this atomizer stunt and see if it helps.

Large vs. Small Cameras

THEY say larger cameras are coming back. The illustration shows one lad who is bringing them back in a big way; a 5 by 7 Graflex, no less! There is considerable talk on the subject of miniature versus larger cameras, but it is surprising how many persons still think highly of the 35mm minia-

Staging a come-back?

ture, believe it is superior in many ways to the larger cameras. The general feeling, however, seems to be that the 2¼ by 2¼ negative is the smallest feasible, yet the admission is frequently made that the miniature—because of its small, compact size—is still the camera par excellence for candid work and wherever it is advantageous to keep the camera on one's person most of the time.

Sound Films Train Workers

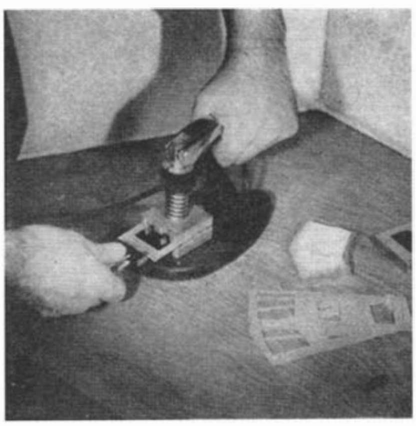
WORKERS in armament production are being trained through the medium of sound films produced under the direction of the U. S. Office of Education, Federal Security Agency. Of the 50 reels of film comprising the program, 18 have been completed and are now being reproduced in 16mm size, according to Castle Films, Inc., which was awarded the contract for distribution.

"The U. S. Office of Education has produced a series of motion-picture films dealing with mechanical skills and knowledge, expressly designed to be used by vocational teachers and shop instructors," said Dr. John W. Studebaker, U. S. Commissioner of Education, in describing the purpose of the films. "These films will assist potential and employed defense workers more rapidly to learn and more thoroughly to comprehend the instruction being given them in the vocational schools throughout the United States."

Following a detailed course in the handling of machine tools in precision work, 40 of the films cover the subject of machine-shop practice. Seven reels are devoted to the engine lathe, five to precision measurement, five to the vertical boring mill, five to the milling machine, five to the use of drill presses of various types, seven to bench work, three to the shaper, two to the action of single point cutting tools, and one to centering and layout. Operations in ship building are covered by 10 more films, still in production.

Slide-Binding

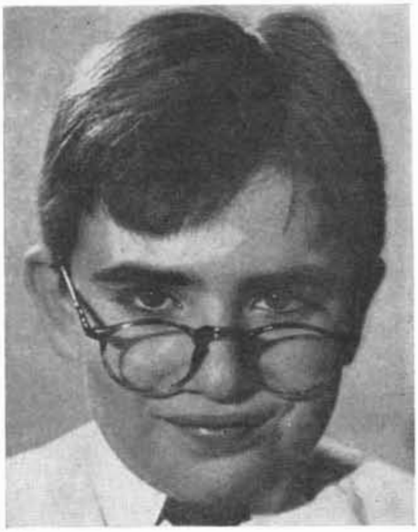
COLOR transparency slides may now be bound in about the same manner as prints are mounted in a dry-mounting press. A completely new departure in the field of slide-binding, the method is made possible by a vise-like affair containing a heating element. The slide is inserted, as usual, in a paper mask called "a scientifically prepared thermo mask," and then between two pieces of 2 by 2-inch glass. The assembly is held together with a small clip, no tape or frames being used, and then fed between the flat jaws of the vise, the bottom surface of which is electrically heated. The jaws are slowly brought together and allowed to remain thus for about 30 seconds, at the end of which time they are separated by pushing down the lever and the slide is complete, firmly held together by the adhesive with which the mask is impregnated.



No tape, no frames

Make 'Em Clown

DON'T take on too serious an attitude when you're shooting a child's picture. It scares the child into awkward, stiff poses and expressions, with the result that the pictures you get lack life and naturalness. Try making them clown; that is, let them mimic whatever or whoever they think is funny. Children have their own sense of humor, which adults often fail to appreciate. But if you will try to put yourself in the child's place, forget that you're grown up, make believe you're a child again, you will see pictures even when the child clowns. Some of them will be very bad; many will be very good because they are spontaneous and because the child is unconscious of the camera. The boy in the illustration expressed a wish to wear glasses and imitate a grown-up. The photographer complied and the subject was happy. So is the result, we think.



Smile, and subject smiles, too

Correction

IN the item "Print Reducer" which appeared on page 208 of our April 1942 issue there was an error in the formula given. Solution A of the reducer should consist of 200 grains of sublimated iodine and 10 ounces of alcohol, not 20 ounces of sublimated iodine and 10 ounces of alcohol as was originally stated in these columns.

Our Book Corner

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

FIRST PRINCIPLES OF FLIGHT

By D. Hay Surgeoner

ALTHOUGH the text of the present book is prepared from the British viewpoint, the information presented is of such fundamental nature that a perusal of it will serve to give a satisfactory foundation for the average reader who wants to know a little more about the "why" of flight. The chapter titles indicate the scope of the work: The Atmosphere, Fluid Motion, Aerodynamics, Practical Considerations, Stability, Control, Airscrews. (108 pages, 5 by 7½ inches, a number of line drawings.)—$1.30 postpaid.—*A. P. P.*

DEAD MEN DO TELL TALES

By Byron de Prorok

RACY, lively account of the travels of a noted archeologist-explorer, mainly in the region of Ethiopia before the momentary conquest by Mussolini. To readers of scientific leaning the anthropological sidelights on primitive peoples will be of significance. In Ethiopia the author met and hobnobbed with Hailie Selassie. The book abounds with exotic adventure and will be difficult to put aside until finished. (328 pages, 6 by 9 inches, 19 illustrations.)—$3.60 postpaid.—*A. G. I.*

SOUTHWESTERN ARCHEOLOGY

By John C. McGregor

ORGANIZED groundwork on which the student—amateur or professional—may build his knowledge of the rapidly advancing discoveries in Arizona, New Mexico, south-west Colorado, Utah, parts of Nevada, California, and northern Mexico. This work is likely to become outstanding—a landmark—among archeologists. (403 pages, 6¼ by 10 inches, illustrated.)—$5.10 postpaid.—*A. G. I.*

PHOTOGRAPHY, ITS SCIENCE AND PRACTICE

By John R. Roebuck and Henry C. Staehle

AFTER an amateur photographer becomes thoroughly familiar with the operation of his equipment and has thoroughly grasped the technique of photography, he frequently wants to delve into the fundamental science of this subject. It is for this ever-expanding group that this present book is intended. The text surveys the modern science of photography, presents a brief sketch of the historical developments, and then gives detailed attention to the properties of photographic materials, the factors determining correct exposure, and the sensitivity to color needed to preserve tonal values. This is followed by a consideration of the chemical processes of development and of the positive processes such as printing, enlarging, and making slides. A chapter is devoted to the latent image theory and another to lenses and the optical aspects of photography. Color photography is fully discussed and a section of the book gives a concise presentation of the subject of composition and other aids in making good pictures. A "laboratory manual" presents a series of practical experiments. (283 pages, 6 by 8½ inches, 96 illustrations.)—$5.10 postpaid.—*A. P. P.*

BOATBUILDING

By Howard I. Chapelle

SO far as this reviewer can ascertain, this is the most complete book on boatbuilding. It isn't for the greenhorn; the user should already know things about boats and tools. It was written in detail because the magazine articles usually skip the parts a designer and builder most needs to know. This book, by a well-known builder, is a practical shop book, no mere armchair companion. It stresses especially mold loft work—laying out beforehand in full size—the lack of which so often lands landlubbers in jams. The craft employed as examples are all sailing craft, and many are Chesapeake Bay types, but the principles explained in so much detail are basic to all types. (624 pages, 6 by 9¼ inches, 186 illustrations.)—$5.10 postpaid.—*A. G. I.*

NOSTRADAMUS SEES ALL

By Andre Lamont

THE author, born in the Orient, educated in Europe and America, known for his articles on astrology, the Kabbala, and various methods of reading character, utilized all available books on Nostradamus—many rare and in several languages—plus the Houdini collection, and other original source material to present this volume of interpretations of the prophecies by Nostradamus, the 16th Century astrologer. Also, a comprehensive and interesting biography of the medieval physician who foretold World War I, the rise of Communism, Fascism, Nazism; the emergence of Stalin, Mussolini, Hitler, Franco, Churchill, Roosevelt, Petain, and others. (341 pages, 5 by 7½ inches, illustrated.)—$2.60 postpaid.—*A. D. R., IV.*

TIME AND TIMEKEEPERS

By Willis I. Milham

RE-ISSUE of a book dated 1923, now available at greatly lowered cost and, even today, out of date only in minor degree, but a book which still has no equal in the sense of its "all-aroundness." Author is Professor of Astronomy at Williams College and the subject is his scientific hobby. The book covers the whole field of the history, construction, care, and accuracy of clocks and watches, without assuming previous knowledge on the reader's part. Aspect most emphasized is the history of early clocks and watches. A book for other hobbyists. (616 pages, 5½ by 8⅜ inches, 339 illustrations.)—$2.10 postpaid.—*A. G. I.*

DANA'S MANUAL OF MINERALOGY

Revised by Cornelius S. Hurlbut, Jr., Ph.D.

FIFTEENTH edition of a standard work of great prestige, prepared by professor of mineralogy at Harvard. Standard text and reference. Covers crystallography (hard labor), also physical, chemical, descriptive, and determinative mineralogy, that corner of geology dealing alone with the description, classification, and correlation of mineral species. Is solid meat, no concessions to entertainment but would be entirely suitable for amateurs who want reliability and aren't afraid of study. (480 pages, 6 by 9 inches, 436 illustrations.)—$4.10 postpaid.—*A. G. I.*

THE LATHE MANUAL

By The Staff of the Metal Trades Department of the William Hood Dunwoody Institute

JOBS on the engine lathe, the turret lathe, and the hand screw machine are thoroughly covered in the mimeographed text of this volume. In addition, the reader is shown the common methods of laying out work for center drilling and for grinding lathe tools. The text is prepared as a course of instruction for beginners in machine-shop technique and as such has been proved effective by use in industrial and trade schools. (143 pages, 9 by 11 inches, thoroughly illustrated.)—$1.45 postpaid.—*A. P. P.*

DON'T BE AFRAID

By Edwin Spencer Cowles, M.D.

ANXIETY, apprehensiveness, usually from no known cause, but vague and general, afflicts many persons who do not know that this often is a symptom. Emotional instability, irritability, easy fatigability, palpitation, often accompany it. Neurasthenia, even suicidal melancholia, sometimes follow, if the cause is not removed; and the cause, according to the theory of this layman's book, on which the author, who is director of the Body and Mind Clinic, also the Park Avenue Hospital, New York, has based his life work of healing, is fatigue, often not realized, which lowers the body's defenses against fears and phobias. Many of us Yankees harbor anxiety complexes which may have this basis. (229 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

HOW TO MAKE YOUR OWN FURNITURE

By Eugene O'Hare

DETAILED—some, unless beginners, would think too detailed—instructions for making a bookcase, a couch end, a desk and bench, a table, a coffee table, a dressing table, a picture frame, a magazine rack, a hinged-top chest. Not fancy cabinet work and not soapbox carpentry, but intermediate. The types are all modern, not period. (94 pages, 8½ by 11 inches, illustrated.)—$2.60 postpaid.—*A. G. I.*

UNIVERSAL PHOTO ALMANAC 1942

Louis H. Lanctot, Editor, and Jacob Deschin, Technical Editor

MANY photographic problems will be solved by the article text and illustrations presented in this latest edition of a photographic annual which has come to be looked upon as one of the standards in the hobby. Sixteen articles cover various phases of photographic technique. A formulary section gives complete information on developing, printing, and toning, as well as on film speeds, paper speeds, flash exposures, and so on. The pictorial section presents 26 reproductions of salon exhibition prints by famed photographers. The Market Guide lists a thousand names and addresses of organizations which purchase free-lance photographs. The bibliography lists photo trade magazines and current photographic books. (270 pages, 6 by 9 inches, numerous illustrations.)—$1.10 postpaid.—*A. P. P.*

MODERN AMERICANS IN SCIENCE AND INVENTION

By Edna Yost

INSPIRATIONAL book, not for youngsters but for young men seeking to set worlds aflame. Accounts of careers of Cornell (telegraph), Appleby (knot-tying device), Smith (father of health laws), Brashear (famous precision optician), Ambrose Swasey (machine tool builder), Gorgas (Canal Zone), Wiley (pure food), Sperry (gyroscopes), Carver (Tuskeegee), Baekeland (Bakelite), Carrier (air-conditioning), Kettering (inventions), Cottrell (precipitator), Williams (vitamins), Zworykin (electronics), Truog (soils). Author was once with A.S.M.E. (270 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

HOUSE CONSTRUCTION DETAILS

By Nelson L. Burbank

SECOND and revised edition of a successful book published three years ago. Amateurs who are tool-handy, but uncertain about detailing the steps in putting together their design of a house, will find here the crutch that complements them. It abounds in details, mainly drawings, of how the many parts go together. Chapters on: plans, foundations, roofs, stairs, wiring, insulation, and other details; also on cabins, cottages, farm buildings, painting, heating, and other work. (313 pages, 8½ by 11 inches, heavily illustrated.)—$3.10 postpaid.—*A. G. I.*

BENJAMIN FRANKLIN'S EXPERIMENTS

Edited by I. Bernard Cohen

FRANKLIN'S own accounts of his experiments and observations on electricity have long been inaccessible because publishers were mainly interested in his political and diplomatic aspects. Millikan rates him as one of only 14 most influential men in the whole of science since 1473. The editor, a scholar working under auspices of Carnegie Institution of Washington, here presents wise old Ben's original, unaltered writings so that the reader may study his keen mind at work on electricity. (453 pages, 5½ by 8¼ inches, 4 illustrations.)—$4.10 postpaid.—*A. G. I.*

CURRENT BULLETIN BRIEFS

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

How Small Industries Can Go After War Work is a 20-page pamphlet which tells how industries can secure loans for equipment to make war armaments, how small companies can form pools to obtain contracts, and other helpful data of value under present conditions. *Copper and Brass Research Association, 420 Lexington Avenue, New York, New York.—Gratis.*

Construction Glues is a large folder which presents, partly in question-and-answer form, pertinent facts regarding the use of glues in the building field in prefabrication and in laminated arches and beams. A number of photographs show varied application. *I. F. Laucks, Inc., 911 Western Avenue, Maritime Building, Seattle, Washington.—Gratis.*

Osgood Mobilcranes is a 12-page fully illustrated booklet describing different types of cranes, mounted on pneumatic tired chassis, which are powered with only one engine and operated by only one man. This one operator can control all the motions of the crane, including traveling.—*The Osgood Company, Marion, Ohio.—Gratis.*

Laboratory Rheostats is a four-page circular describing "Lubri-tact" instruments which have many important applications in industry. One of the distinguishing features of these instruments is a graphite lubricated contact which eliminates wear and makes smooth adjustment possible. *Request bulletin 1705. James G. Biddle Company, 1211–13 Arch Street, Philadelphia, Pennsylvania.—Gratis.*

Pressure-Treated Wood for Permanent Low Cost Housing is an illustrated leaflet showing those parts of buildings which need protection against decay and fungus, and suggested treatments for painted and unpainted wood. *Wood Preserving Division, Koppers Company, 2000 Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

The Care and Use of Electric Appliances in the Home is a 32-page indexed booklet which tells housewives how they can help in the present national emergency by the efficient use and proper care of their electrical apparatus. It also contains food buying and menu suggestions, as well as housework short cuts. *Westinghouse Appliance Dealers or direct from Westinghouse Electric and Manufacturing Company, 40 Wall Street, New York, New York.—Gratis.*

Handbook for Drillers is a 48-page illustrated manual prepared especially for students in war production work, yet of equal interest to anyone in any way concerned with modern and standard shop practice. It gives an introduction to the theory underlying the use of the twist drill and considerable data on speeds, feeds, and general operation. Exceptionally well illustrated. *The Cleveland Twist Drill Company, 1242 East 49th Street, Cleveland, Ohio.—Single copies gratis. Price on quantities on application.*

Ideal Quality Transmissions is a 52-page handbook which includes recommendations, application data, photos, and engineering information on variable speed pulleys and transmissions. The data presented are of interest to design engineers, mechanics, purchasing agents, and so on. *Ideal Commutator Dresser Company, Sycamore, Illinois.—Gratis.*

Industrial Research in the United States During 1941, by William A. Hamor, is a 36-page reprint that covers in considerable detail the subject of its title. Industries treated in this study run the whole gamut from coal to ceramics, from glass to chemistry, from metals to agriculture, and so on. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

"Dustube" Dust Collectors is a 58-page pamphlet prepared as a manual to serve plant engineers and officials in the selection of proper control equipment for specific dust problems. It includes practical and essential data for efficient operation of dust control systems, technical layouts and engineering tables and charts for use in planning applications of dust control units. Catalog No. 72. *American Foundry Equipment Company, Mishawaka, Indiana.—Gratis.*

The Wreckord is a 36-page analysis of the facts about street and highway accidents in which 40,000 persons were killed and almost a million and a half were injured in 1941.—*The Travelers Insurance Company, Hartford, Connecticut.—Gratis.*

"Trans-Ceiver" is a four-page leaflet describing a four-pound combination ultra short-wave, self-contained radio transmitter and receiver. *Weltronic Corporation, 3080 E. Outer Drive, Detroit, Michigan.—Gratis.*

Metal Duplicating Without Dies is a 32-page engineering catalog which describes in detail a simplified system for expediting industrial and military production. The system involves a series of standardized shop units that, almost universally adjustable, will often take the place and do the work of dies, jigs, and fixtures. Many defense plants are speeding up their work by applying this system to short-run requirements. Request this bulletin on your business letterhead. *O'Neil-Irwin Manufacturing Company, Minneapolis, Minnesota.—Gratis.*

Airport Lighting is a 42-page bulletin which covers the lighting and electrical distribution equipment involved in the design of an airport. Typical layout plans with C.A.A. recommendations are given. Photographs and brief descriptions of all necessary floodlights, beacons, contact and boundary lights are included. Bulletin B-3046. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—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"

In his astronomical article, page 230, Professor Russell states that the principal instrument possessed by the newly inaugurated Mexican National Observatory is a Schmidt camera of 24" effective aperture, and he stresses its great value to astronomy. Amateur telescope makers are also keenly interested in the constructional side of any such instrument, and the Perkin-Elmer Corporation, now in a bright and shining, newly-built plant at Glenbrook, Connecticut, was therefore invited to submit a brief note for these pages. The note:

"When the Mexican Government contracted with the Perkin-Elmer Corporation for a large Schmidt camera, the aperture was specified as 24". The very outermost zones of a corrector plate, however, do not come to proper curve by the treatment which is best for the inner zones. In the case of a 24" Schmidt previously made by this company for the Harvard College Observatory, the plate was not oversized, and consequently the edge zones delayed the final figure. For the Mexican instrument, therefore, Halley Mogey, Chief Optician, requested a larger blank, so that the 24" clear aperture could be obtained in the least time. The grinding and edging operations were directed by T. J. La Lime, head of the grinding department.

"Although the curve on this corrector plate is imperceptible to the eye (the focal ratio is $f/3.5$), the difference between it and a perfectly flat plate is an amount of glass as big as a lump of sugar (about a quarter of a cubic inch) all removed by polishing alone.

Figure 2: **La Lime and 31" mirror**

"Both the knife-edge and the Ronchi grating were used in the test set-up, which involved auto-collimation from a flat mirror and the use of a small periscope for looking at the image without obscuring much of the beam. When the mirror and plate were completed, no errors at all could be seen under this test over at least a 24½" aperture."

The three shop photographs, Figures 1, 2, and 3, were furnished at our request by Richard Perkin. They were taken by the former amateur telescope maker, Robert E. Cox, who a year or two ago "went professional" with the Perkin-Elmer Corporation; another former amateur employed there being Daniel E. McGuire who similarly went professional several years ago. Amateurs are now in so many professional optical shops that this department finds it almost impossible to draw a line between the two. There actually is no such line; it has been washed out. Most of the professionals were amateurs at one time.

Figure 1 shows the 31" Schmidt mirror disk in the last stage of emery before polishing. The machine itself will also interest our readers. So will chief optician Halley Mogey, who stands beside it. (Some

Figure 3: **Mogey's expert digit**

day this department may publish a series of personality articles on prominent people in professional optics.) Your scribe believes Halley Mogey's name never is mentioned without the inevitable after-question, "Was he named for Halley's Comet?" Halley Mogey really *was* named for Halley's Comet. What was more logical—his father a telescope maker and the two arrivals coinciding? The boy grew up in his father's shop at Plainfield, N. J. (now run by another son, William Mogey, assisted by Messrs. Brown, Lojas, and Grosswendt, all former amateurs). There he gained the "feel" of glass and abrasive. Then he went off to college and gained theory, and returned equipped on both sides, practical and theoretical, to make maximum application of the mind-and-hand team. When Schmidts came along, a few years ago, he went to the Mt. Wilson optical shops to learn special Schmidt technique; and left there some of his own. In Figure 1 he is seen in shop clothes. A good optician, no manner how much theory he has in his head, never is too lofty to get into working pants and use his hands.

Figure 2 shows the same 31" disk fine-ground, with T. J. La Lime, head of the grinding department, measuring the radius of curvature with a spherometer.

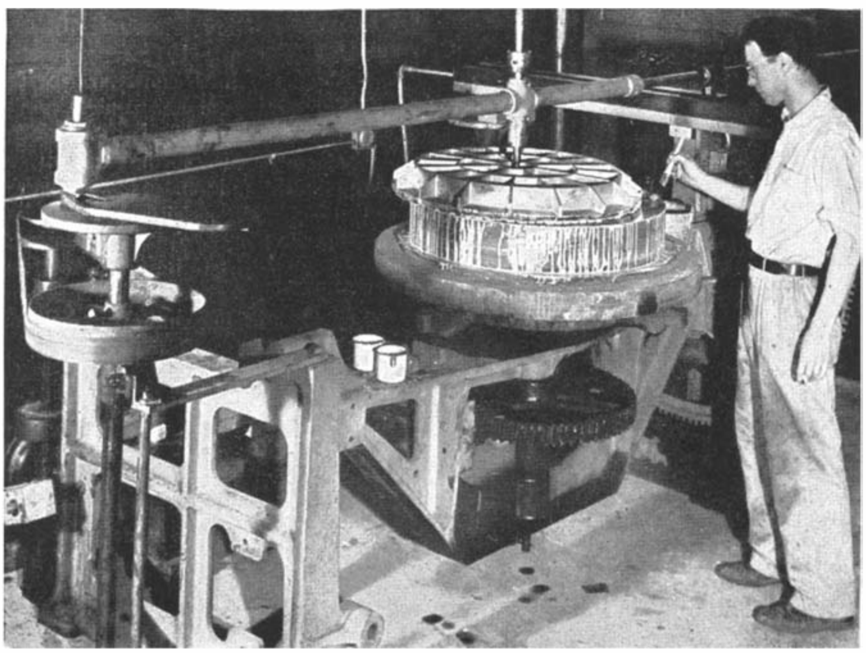


Figure 1: **Machine, mirror, Mogey**

Figure 4 (right): **Schmidt evolution**

In Figure 3, Halley Mogey is hand-touching an outer zone on the 26" corrector plate of the Schmidt camera. Some years ago amateurs argued whether the tradition that the old-time professionals used their hands as a "rubber" (as non-telescope making persons styled it) for local touching, was true or just a story. While some argued, others tried it, and it worked. Since then it has been amply proved by other evidences that the old-timers did use this method; the popular tradition was quite correct. Besides, the method is not in any way remarkable; simply, instead of a small tool of pitch, a small tool of fine leather is used—that is, the hand or whatever part of the hand is the user's own pet method. In Figure 3 you see this method in the flesh. This photograph, now published, will be useful to show to occasional doubters about hand touching among professionals.

No clearer, simpler, more direct explanation of the working principle of the Schmidt camera has been seen by this department than one found in a booklet describing the newly added equipment at the Warner and Swasey Observatory of the Case School of Applied Science at Cleveland. The drawings from the booklet are reproduced in Figure 4, and here is the explanation:

"In 1931 Bernhart Schmidt, an optical worker at the Hamburg Observatory in Bergedorf, published an account of a reflecting telescope free from nearly all the inherent defects common to such instruments. This was accomplished by introducing a thin lens in front of a spherical mirror.

"His reasoning was clear and logical, in spite of the fact that he avoided all mathematics. He ended his article by stating: 'The method of producing the lens is assumed.' In other words, he was not going to reveal the secret, a characteristic common to optical workers, particularly of the past.

"It seems that the first Schmidt telescope was completed in the summer of 1930, when Schmidt and a friend amused themselves by reading the epitaphs on the tombstones in a nearby cemetery. A remarkably detailed photograph of a windmill a mile and a quarter away, made with his first telescope during a moonless night, is now of historic interest.

"In 1936, Dr. R. Schorr of Hamburg Observatory finally disclosed the secret of how Schmidt, who had died in 1935, had produced the surface of the all-important lens. Schmidt placed a plane-parallel disk of glass on the open end of a circular cylinder of nearly the same diameter and evacuated the cylinder until the desired bending of the glass disk was secured. Then he polished the glass surface to a perfect plane. After allowing the air to re-fill the cylinder, the plane polished surface took the desired form of the lens.

"The Schmidt-type telescope employs a spherical mirror instead of the usual parabolic mirror of the reflector. Parallel rays incident upon a spherical mirror do not come to a focus at the same point. The rays striking the center of the mirror come to a focus at a point *F*, midway between the mirror and its center of curvature; while rays striking the outer zones come to a focus somewhat nearer to the mirror.

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"If, however, we make the light striking this outer zone slightly divergent, all the rays can be brought to a focus at *F*. This is accomplished by placing a thin lens in front of the mirror and at its center of curvature. The shape of such a lens is shown in the second diagram.

"This results in the combination in the third diagram.

"The same results may be accomplished by introducing at *R* a lens with a shape shown in the fourth diagram.

"In this case, the outer rays are less divergent and the center rays slightly convergent. The resulting combination, with the focus now a little closer to the mirror, is shown in the final diagram.

"If the parallel rays are directed to the telescope from an angle different from the one shown in the above figures, they will again come to an exact focus. This is due to the fact that the mirror is spherical and has no axis, and the lens is at the center of curvature of the mirror. The optical system thus remains exactly the same as before.

"The bundles of parallel rays striking the mirror from all angles will thus be focused on a photographic plate bent into a slightly spherical surface. In practice it is easy to bend ordinary flat photographic plates into the necessary spherical form.

"Stated in another way—rays of light entering the telescope from stars widely separated in the sky will be brought to an exact focus; a condition not realized in the usual reflecting telescope. Thus a large area of the sky may be photographed at one time.

"Since the lens employed is relatively thin, it produces an instrument which is free from the color defects associated with refracting telescopes. Also, since the focal ratio of the telescope can be made small without sacrificing other desirable properties, the instrument is 'fast' in the same sense as the word is used with respect to cameras.

"The wide-angle field, the achromatic properties, and the speed, are the three principal advantages of the Schmidt telescope."

The new Schmidt camera at the Warner and Swasey Observatory has a 36" Pyrex mirror of 14' radius of curvature, with a 24" lens of Vita-glass, .3" thick. Maximum departure from a plane is .0005" and the optical work was done by C. A. Lundin of the Warner and Swasey Co., Cleveland, Ohio.

Before the beginner has picked up from here and there a modicum of general background about telescope principles he is almost sure to run up at least one blind alley in pursuit of a beautiful illusion. Your scribe, for example, in 1924, when quite innocent of telescoptical background, saw a picture of a group of reflectors made by the Telescope Makers of Springfield, Vermont. One of them was short, chubby, compact, unlike the others. Obviously that one would be *much* better, hence the one to make. Now it happens that a short chubby telescope (short focal ratio) is an ideal one for the tyro not to make, because the curve of the mirror is much more difficult when deep—more advanced work. Russell Porter explained this fact and your scribe desisted.

On the opposite extreme are telescopes having great length—long focal ratio—and when the tyro discovers that these give high magnification he is inclined to plump for one as his first job. These, however, are a headache in other ways. As John Pierce puts it: "Made a 4" of 90" focal length with very poor results so far as comfort in observing goes—hard to point—diagonal large and field necessarily small, since the large-lens eyepieces are not available."

Commenting on a tyro's proposal to make a "high-magnification" telescope with focal ratio 40, Alan R. Kirkham made apposite observations in an old letter dug up by your scribe from the lower, or pre-Cambrian, strata of his desk (had a house-cleaning):

"Focal ratios of longer than $f/20$, which itself is extreme, cannot be recommended because they do not give full fields with any but eyepieces whose magnifying power is above most practicable limits. The focal image of the Moon in a telescope of 6" aperture and focal ratio of 40 is big—about 2.088" in diameter—it is true. However, compare the size of the field lens of a 1" eyepiece with this and see how miserably small the field actually seen will be. In order to get down within the magnifying power universally agreed to be best for seeing, about 16 diameters to the inch, or perhaps 10 to 20 diameters depending on various factors, we require a 2½" eyepiece with such a telescope. Good eyepieces are easily designed for a useful field of 40°, but the ability to give this apparent range depends on the field lens being large enough to receive all the rays of 40° magnification. The condition is met with in all eyepieces of about 1¼" focus, down. A 1½" eyepiece needs a field lens 1⅛" in diameter, a 2" eyepiece one of 1½" diameter, and a 2½" should have a field lens about 2" in diameter. These 'out' sizes are hard or impossible to find—it's about like asking for a size 22 shoe at a shoe store. In a nutshell, we get only a narrow field, caused by the telescope itself having wrong proportions. Moreover, these eyepieces would have great spherical aberration. They also require several inches of rack and pinion work for focusing from the longest to the shortest of them, and require diagonals of too great size. They also suffer from curvature of field.

"If that is not enough, there are other reasons why the existing range of eyepieces became more or less standard—for it didn't just 'happen.' The long focal ratio takes a very long and awkward tube, and this means trouble in keeping the optical elements in alinement. Besides, try figuring an $f/40$ mirror—I did. Just like looking at the head of a pin. Diffraction effects are very great, and the mirror even seems to move around with the motion of the eye. In focograms, such mirrors are surrounded by a diffraction edge half the radius of the mirror itself. Finally, the image is poorly illuminated."

Persons who urge the beginner to adopt conventional designs in anything, just because these designs are conventional are, of course, simply gratuitous irritants; but on the other hand there often—though not always—is some sound reason behind a convention, representing the experience of those who came before.

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