PROGRESS IN CANCER RESEARCH . . . Page 199

SCIENTIFIC AMERICAN

NOVEMBER • 1942

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Welded Body, Tremendous Fire-Power

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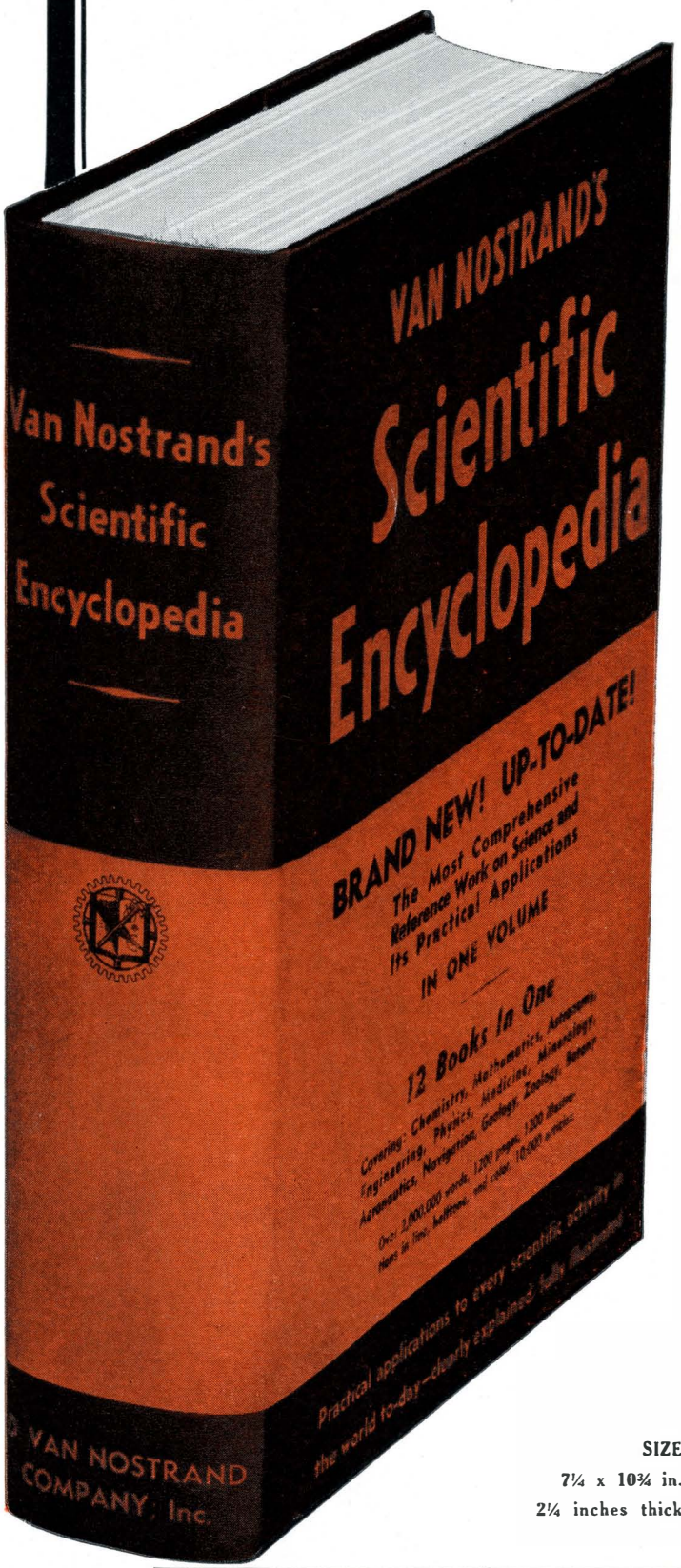

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SCIENTIFIC AMERICAN

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

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50 Years Ago in . . .

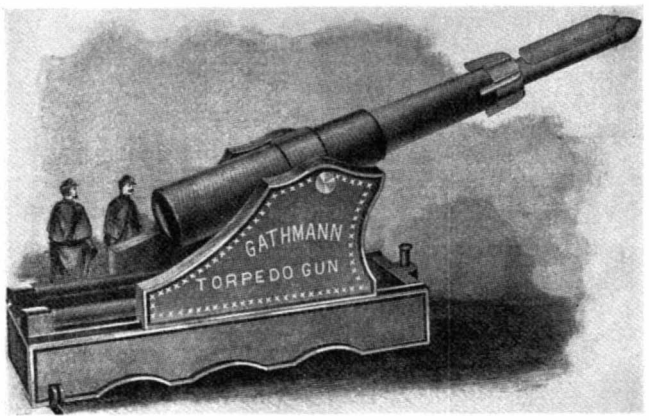
SCIENTIFIC AMERICAN

(Condensed From Issues of November, 1892)

GAS ENGINE—"It has generally been supposed that gas engines were necessarily limited to 30 horse power and under, and that where larger engines are required they must necessarily be made by compounding smaller ones. . . . However, a large gas engine made by H. W. Caldwell & Son Company, is rated at 100 horse power. It is operated by carbureted air, consisting of a mixture of common air and gasoline vapor. This provides a fuel which is not only invariable in quality, but is quite inexpensive."

RAILROAD—"The highest railroad in the United States is the Colorado Midland, at the Continental Divide—11,530 feet above sea level."

TORPEDO—"A torpedo designed to be guided in its flight on leaving the gun after the manner of an arrow from the bow, and to continue its course on or near the surface, should it strike the water, is shown in the accompanying picture. The piece of ordnance for starting the torpedo is preferably a breech-loading gun, the torpedo being loaded in from the muzzle. . . . The shape and inclination of the wings are such as is designed to uphold and direct the projectile in a straight course through



the air, retaining it also near the surface after it strikes the water, until its propelling power is completely exhausted. In addition to the propelling force supplied by the gun at the time of discharge, in the usual manner, this torpedo is provided with further means of propulsion, concealed within the rear portion of its body, the combination being designed to give the projectile a great range and high speed through either the air or water. A 12-inch torpedo of this construction is adapted to carry 350 pounds of a high explosive."

GUN TRIALS—"Some rather surprising results were lately obtained with a new multicharge gun, of Haskell's pattern, half-inch bore. . . . A solid hammered wrought iron target, 7½ inches thick, was penetrated entirely through, backed by a boiler plate ⅜ of an inch thick, which was also penetrated through, making a penetration of 7⅞ inches. This shot was made of Carpenter steel, and the charges of powder were 10 ounces. This penetration is nearly sixteen times the diameter of the projectile, or more than four times greater than has ever been obtained by any other gun."

WIRE GLASS—"The subject of protecting glazed skylights is one which of late years has acquired additional importance. . . . In such structures as the Grand Central Depot in this city, light is given to the interior by large skylights. These are placed in the roof of the building and are of very large area. At a height of nearly a hundred feet above the floor they are a constant menace to life. . . . Wire glass, a substance designed to overcome these difficulties, consists of rolled glass, with iron wire netting embedded in its own substance. Thus the wire is hermetically inclosed, and is secure from corrosion for any length of time."

VOWEL STUDY—"At the recent International Congress of Physiology at Liege, Professor Hermann demonstrated his method of photographing the sound of vowels. The vowels were sung out before one of Edison's phonographs. Immediately afterward they were reproduced very slowly, and the vibrations recorded by a microphone. The latter was furnished with a mirror, which reflected the light of an electric lamp upon a registering cylinder, covered with sensitized paper and protected by another cylinder with a small opening which gave passage to the rays of light from the reflector. By this means was obtained very distinct photographic traces, and the constancy was remarkable for the different letters."

ARTIFICIAL RUBBER—"Isoprene, which can be prepared from turpentine, under certain circumstances changes into what appears to be genuine India rubber. . . . The same change could be brought about by heat. The material so produced resembles pure Para rubber in every way, and, whether it is genuine rubber or not, it may be equally good for all practical purposes. It is said to be capable of vulcanization."

MAGNETIC EFFECTS—"At the Edison Laboratory, Dr. Fred Peterson and A. E. Kennelly have sought to prove that no therapeutic effects are resultant from the application of magnetism to the human system. For the purpose of experiment the armature was taken from a dynamo, and in the cylinder formed by the inner ends of the set of powerful converging field magnets a dog was confined and kept for a period of five hours. . . . At the end of the time the dog was set at liberty, and beyond his apparent joy at thus being set loose the operation did not seem to affect him in the least. A boy was also confined for a short time in the same position and was also uninfluenced. Several other experiments of like nature were made. Dr. Peterson and Mr. Kennelly conclude from their experiments that the human organism is in nowise affected by the most powerful magnets known to modern science."

PHOTO CANE—"In a new photographic cane, the head forms a camera while the tubular body of the cane forms a reservoir for the sensitized celluloid strip. . . . In the cane head near the film is secured a plate, provided with a rectangular aperture through which the exposure is made. . . . The lens is placed in the cane head in proper relation to the exposed portion of the film."

YERKES—"By the munificence of Charles T. Yerkes, President of the North and West Chicago Street Railroads, the University of Chicago is to have a gigantic telescope. His instructions are to secure the largest and best telescope in the world, regardless of expense, and send the bill to him."

98TH YEAR SCIENTIFIC AMERICAN NOVEMBER 1942

'DOWN-UNDER' SHIPS OF THE NAVY

A Submarine Force of Unprecedented Striking Power

WALTON L. ROBINSON

SUBMARINES are among the most effective types of naval craft in existence. Striking without warning from their haunts beneath the surface, they have torpedoed and sunk millions of tons of merchant shipping and ended the career of many a proud battleship and cruiser. In the present conflict Germany's famed U-boats, operating in numbers and with a ruthlessness unknown even in World War I, have sent over 1500 United Nations and neutral merchant vessels to the bottom. They have also destroyed two British dreadnoughts, three aircraft carriers, several light cruisers, and numerous lesser units. Japanese, Italian, and Russian undersea craft have likewise operated successfully, while Britain's relatively few but highly efficient submarines have compiled a truly marvelous record in their attacks on Axis convoys and naval units off the Norwegian coast and in the Mediterranean. More recently American submarines, striking viciously at Japan's sea power in the Pacific, have sunk several of the Mikado's cruisers and destroyers and a large number of his troopships and supply vessels. One submarine, the *Seawolf*, sank one and probably two Japanese light cruisers, a destroyer, and a large transport, and damaged a third cruiser, a transport, and an unidentified ship—all in a single cruise!

On the outbreak of war with Japan the United States Navy possessed one of the largest and finest submarine forces in the world. Germany and Russia had many more undersea craft, but their boats were considerably smaller than ours and incapable of operating as far from base over an extended period. Japan also possessed a large number of submarines, many of which could cross the Pacific and operate off our west coast. Most Japanese submarines were somewhat larger than ours, but they have had only limited success against our warships and transports.

● Fifth of a series of analytical articles on ships of the United States Navy. Previous articles covered battleships, aircraft carriers, cruisers, destroyers, and appeared in our issues for May, August, September, and October of this year.—*The Editor.* ●

In December, 1941, a total of 111 American submarines were in service with 73 others under construction. Many additional boats have since been laid down, while still more will be commenced under the 200,000-ton increase approved by Congress last April. The submarines in service ranged in size from 480 to 2730 tons surface displacement and were of 12 distinct types, some composed of several classes varying in minor details. Forty-seven of our undersea craft—those completed since 1928—were of modern design. The remaining 64, commissioned between 1918 and 1926, still retained considerable value, particularly for training purposes. All of our submarines were painted black and carried their serial numbers in white on conning towers and bows.

SMALLEST and oldest of our submarines were the seven units of the "O" class, authorized in 1915 and placed in service three years later. Ten boats *(O 1-10)* originally comprised this class, but three were lost or scrapped. The *O 5*, wrecked in 1923, was salvaged, but not considered worth repair; *O 1* was converted into an experimental vessel in 1937 and scrapped the following year; *O 9* was lost June 20, 1941, by submerging beyond her safe diving limit, the pressure of the water crushing her old hull like an egg-shell.

The "O" boats are 172 1/3 feet long over-all and displace 480 tons in surface trim and 624 tons when submerged. On deck and forward of the conning tower they mount a 3-inch, 23-caliber anti-aircraft gun, while below the water-line in fixed positions in the bow are four torpedo tubes firing "tin fish" of 18-inch diameter. Eight torpedoes can be carried, four in the tubes and four in reserve. These submarines have two sets of 440-horsepower Diesels for surface cruising and two 370-horsepower electric motors for use when submerged. Current for the latter is supplied by storage batteries. On the surface a speed of 14.5 knots can be attained; while submerged, 11 knots is maximum. Cruising range is about 3000 miles. Each of these submarines is manned by 32 officers and enlisted men.

THE "O" boats were followed into service in 1918-19 by 20 units of the "R" class *(R 1-20)*. One of these, *R 8*, was scrapped in 1936 and another, *R 3*, was transferred to Britain late in 1941 and is now His Majesty's Submarine *P 511*. The "R" boats, measuring 186 feet in length and displacing 530 tons on the surface, are simply enlargements of the "O" design from which they differ principally in having a 50-caliber 3-inch gun and more powerful electric motors (two sets totaling 934 horsepower). Most of the "R" boats spent many years in reserve until recommissioned during 1940-41, but about six of them were always retained in service for training duties at the Submarine School, New London, Connecticut.

In 1919 the submarines *S 3* and *S 4*, first of a very numerous group, were placed in service. During 1920-25 they were followed by 49 additional "S" boats. Twelve units *(S 2-4, 6-10, 19,* and *49-51)* were scrapped during 1930-37; one, *S 5*, was lost in 1920; and another, *S 25*, was transferred to Britain last year and now serves as the Polish *Jastzrad*. Thirty-seven boats

were, therefore, still in service when hostilities with Japan commenced. One of them, *S 26*, was lost by collision off Panama in January last.

The "S" boats are of five types. The *S 1*, *S 18*, *S 20-24*, and *S 27-41*, all completed in 1920-24, are 219¼ feet long, displace 800 tons on the surface, mount one 4-inch, 50-caliber gun, and have four bow tubes firing 21-inch torpedoes. Eight reserve torpedoes, additional to the four in the tubes, can be carried. Two sets of 600-horsepower Diesels give a surface speed of 14.5 knots, and two 750-horsepower electric motors a submerged speed of 11 knots. About 45 officers and men comprise the complement of each of these submarines.

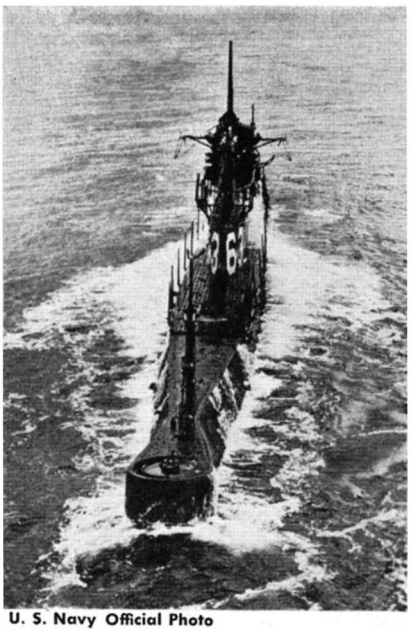
THE *S 11-13* displace only 790 tons, but are a half-knot faster on the surface, have an extra torpedo tube (located in the stern), and carry 14 torpedoes. They are engined with two sets of 1000-horsepower Diesels and two 600-horsepower electric motors. The *S 14-17*, also of 790 tons, have only four tubes, twelve torpedoes, and 14 knots speed.

The *S 48*, commissioned in 1922, is the largest of the "S" boats. She is 267 feet long, displaces 1000 tons, and is armed with a 4-inch gun and five torpedo tubes (four bow, one stern). Very handy for her size, she can "crash dive" in 60 seconds.

The last of the "S" series were commissioned in 1924-25, when the *S 42-47* entered service. They are 850-ton craft with armament and engines similar to those in the *S 1* group.

After the completion of the "S" boats, submarine construction in the United States dropped sharply, and only nine new undersea craft joined the fleet during the period 1925-34. With three exceptions, however, they were of remarkable size and cruising range. First of these boats were the *V 1*, *V 2*, and *V 3*, now the *Barracuda (B 1)*, *Bass (B 2)*, and *Bonita (B 3)*. Built in 1921-26, they displace 2000 tons (2506 tons when submerged) and have an over-all length of 341½ feet. Their armament consists of a 3-inch, 50-caliber gun, six 21-inch torpedo tubes (four bow, two stern), and 10 reserve torpedoes. Diesels developing 6700-horsepower provide the surface motive power, but designed speed of 18.75 knots has never been realized in service. There are also two auxiliary Diesels which drive generators supplying current to the 2400-horsepower electric motors, which under this arrangement can be used for cruising on the surface without depleting the storage batteries. Radius of action is about 12,000 miles and submerged speed is 11 knots. A complement of 80 officers and men is required to operate each of these big submarines.

In 1928 the Navy commissioned its first mine-laying submarine, the 2710-ton *V 4*, which is now the *Argonaut (A 1)*. When placed in service she was the largest undersea craft in the world, this distinction having previously been held by Britain's *X 1*, experimental giant of 2450 tons. The *Argonaut* was laid down in 1926 and cost about $6,000,000 to build. She is 381 feet long, displaces 4080 tons when submerged, and has a complement of 88 officers and men. Two 6-inch, 53-caliber guns are mounted fore and aft of the conning tower and four 21-inch torpedo tubes are in the bows. Aft is the mine-laying gear and stowage for 60 mines. The *Argonaut* was originally engined with 3175-horsepower Diesels designed to give a surface speed of 14.6 knots, but these engines proved unsatisfactory in service and new ones, incorporating Diesel-hydraulic drive, were recently installed. Submerged speed is 8 knots, obtained by 2400-horsepower electrically driven motors.



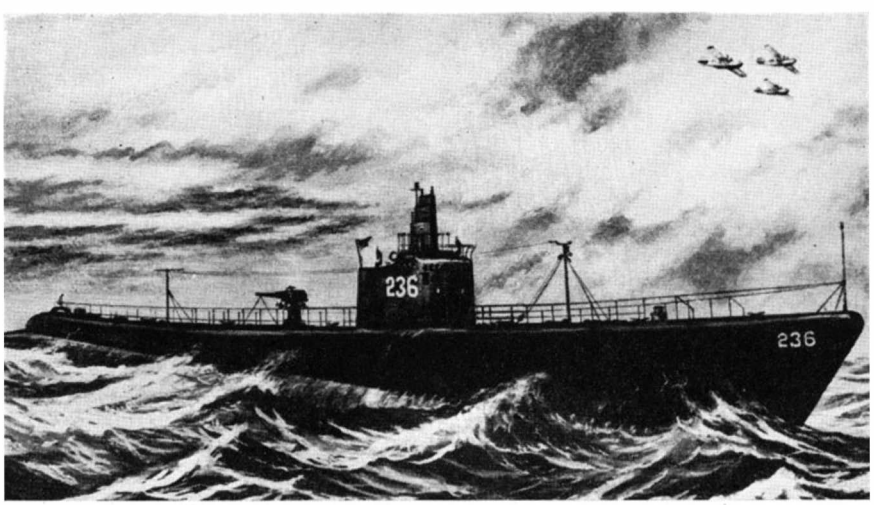
U. S. Navy Official Photo

At the command, "Blow ballast tanks!" this submarine training ship surfaced

The *Narwhal (N 1)* and *Nautilus (N 2)*, commissioned in 1930, are of about the same size as the *Argonaut* and greatly resemble her in appearance. They are 20 tons heavier on the surface, but are not quite as long (371 feet) and displace only 3060 tons when submerged—120 tons less than the *Argonaut*. These three submarines are our largest and, since the loss early this year of the huge Free French *Surcouf* (2880 tons), the largest in the world. Laid down in 1926 as the *V 5* and *V 6*, the *Narwhal* and *Nautilus* have two 6-inch guns and four bow and two stern tubes. Eight reserve torpedoes can be carried; they are stowed externally under the half-deck amidships. These two submarines were completed with 5450-horsepower Diesels for a surface speed of 17 knots, but this was never realized in service and new engines were ordered in 1940. Electric motors of 2540 horsepower give a submerged speed of 8.5 knots.

IN 1932 the *V 7*, now the *Dolphin (D 1)*, was completed. Displacing only 1540 tons on the surface and 2215 tons submerged, she marked a distinct breakaway from the huge dimensions of the earlier "V"s. Her over-all length is 319 feet and her armament consists of one 4-inch gun and six torpedo tubes, four bow and two stern. Three reserve torpedoes are stowed externally. Engined with 4200-horsepower Diesels and 1750-horsepower electric motors, the *Dolphin* can make 17 knots on the surface and 8 knots submerged. She requires a complement of 64 officers and men.

Last of the "V" boats were the *V 8*



U. S. Navy Official Photo

One of the *Albacore* class, authorized in the 1940 program

U. S. Navy Official Photo

The *Gato* goes down the ways to the sea

and *V 9*, now the *Cachalot (C 1)* and *Cuttlefish (C 2)*. Begun in 1931 and completed in 1933 and 1934 respectively, they were the first all-welded submarines built in the United States. The *Cachalot* (1110 tons surface displacement) and the *Cuttlefish* (1120 tons) differ from the *Dolphin* as much as she differs from the *Narwhal*. Only 271¾ feet long, they mount one 3-inch anti-aircraft gun *abaft* the conning tower and have four bow and two stern tubes. There is no external torpedo stowage. Surface speed is 17 knots (3100-horsepower Diesels) and submerged speed 9 knots (1600-horsepower electrics).

With the advent of the present administration in 1933, American submarine construction took a sudden spurt and during the period 1933-39 work was begun on 40 undersea craft, all of which were completed before Japan struck her Pearl Harbor blow. These submarines were of four distinct classes, three of which contained two or more groups varying slightly in minor details.

Ten "P" class submarines, authorized by the 1933 and 1934 Naval Building Programs, entered service in 1935-37. They were armed with a 3-inch gun abaft the conning tower and four bow and two stern torpedo tubes. Diesel engines of about 6000 horsepower gave them a surface speed of at least 20 knots. Radius of action approached 12,000 miles and cost averaged $2,400,000 exclusive of armament. This fleet of 10 submersibles included the 1310-ton *Pike* and *Porpoise*, the 1335-ton *Plunger* and *Pollack*, the 1315-ton *Shark* and *Tarpon*, and the 1330-ton *Perch*, *Pickerel*, *Permit*, and *Pompano*. Winton Diesels were in all boats except the *Plunger* and *Pollack*, which had Fairbanks-Morse, and the *Pompano* (Hooven, Owens and Rentschler). Six boats had Elliott electric motors; three, General Electric; and one, *Pompano*, Allis-Chalmers. Two of these submarines, *Shark* and *Perch*, were lost in the Far East early this year.

Sixteen submarines were authorized in 1935-36. They were simply enlargements of the "P" design with two additional torpedo tubes in the stern. The 1935 boats were the 1450-ton *Salmon*, *Seal*, and *Skipjack*, and the 1445-ton *Snapper*, *Stingray*, and *Sturgeon*. The 1936-37 boats were the *Sargo*, *Saury*, *Spearfish*, *Seadragon*, *Sealion*, *Sculpin*, *Squalus*, *Searaven*, *Seawolf*, and *Swordfish*. Displacing 1475 tons, they were slightly improved editions of the *Salmon* group, from which they differed principally in having somewhat larger conning towers and heavier periscope housings. Each cost about $5,000,000 fully equipped.

One of these "S" boats, the *Squalus*, foundered on diving trials May 23, 1939, but was subsequently raised and repaired; she is now in service as the *Sailfish*. Another, the *Sealion*, was undergoing repairs at the Cavite Navy Yard, Manilla, when hostilities broke out; she was badly damaged by air bombs and eventually had to be blown up to prevent her falling into enemy possession. She was our first submarine loss of the war.

The 1938 Program provided for six more submarines, the *Tambor*, *Tautog*, *Thresher*, *Triton*, *Trout*, and *Tuna*, all of which were completed in 1940-41. They displace 1525 tons, have a 3-inch gun, *six* bow and four stern tubes, and a designed speed of 21 knots, obtained by 6400-horsepower Diesels. They can be distinguished from the several preceding classes by their hull form, particularly at bow and stern.

Eight submarines were authorized by the 1939 Program and entered service two years later. These were the *Gar*, *Grampus*, *Grayback*, *Grayling*, *Grenadier*, and *Gudgeon*, all 1525 tonners, near duplicates of the *Tambor* design. The *Mackerel* and *Marlin*, however, are relatively small craft of an entirely new design. They displace only 800 tons on the surface, are 253 feet long, mount one 3-inch gun, and have four bow and two stern torpedo tubes. Their Diesel engines develop 1600 horsepower for an estimated 14.5 knots. Submerged speed is reported to be 11 knots.

All of the 73 submarines under construction prior to December 7 last were 1525-ton craft. The *Gato*, *Greenling*, *Grouper*, *Growler*, *Grunion*, and *Guardfish*, authorized by the regular 1940 Program, are slight modifications of the *Gar* design with two engine rooms instead of one to reduce the size of compartments. The *Gato* was commissioned just after Pearl Harbor; the others followed her into service within a few months. These "G" boats are the last of our "Alphabetical" submarines.

Sixty-five undersea craft were ordered under the War Emergency Program of 1940. Two more were ordered in April, 1941; 23 in the following December; and others since. The 1940 boats are of the *Albacore* class which is practically a copy of the *Gato* design. Ten of them are being built in the Middle West; they will proceed to sea via the Mississippi and fit out in Gulf ports. Some of the newer submarines may be modifications of the 800-ton *Mackerel* type.

The completion of the above submarines and of the many additional ones to be built under the 1942 Program will give the United States Navy an undersea force of unprecedented striking power and cruising range. We shall then be able to maintain numerous submarines on constant patrol off Japan's principal naval bases and along her vital lines of communication in the Southwestern Pacific. Such an undersea offensive will do much to cripple Japan's strength and hasten her downfall.

While this description of America's submarine fleet completes the originally announced series of five analytical articles on ships of the United States Navy, we now have under preparation two supplementary articles which, when approved for publication by the proper authorities, will cover, first, the air power of the Navy, and, second, the tactical usage of each branch of our naval fighting forces. We hope to have these available for publication soon.—The Editor.

What Is Being Done About Cancer?

Recent Experiments Begin to Give a Discernible Picture of Cancer's Cause, and Provide Methods

● Research on cancer is pursued in many institutions the world over. Broad and significant is the research pursued at Memorial Hospital, New York. Outstanding is the accompanying account of that research, written for lay readers by Memorial's director, Dr. C. P. Rhoads, in the hospital's biennium report, "Record of Service," from which it is extracted.

Memorial Hospital is the pioneer American cancer hospital. In it, combined under one roof, are facilities for the treatment of every phase of cancer; also all equipment and facilities for cancer education and prevention, and, especially, cancer research. —*The Editors.* ●

THE body tissues are made up of quantities of cells, of which different types form different organs and body structures. When the normal body has reached its full growth, these cells stop increasing in number and, although they may die and continually be replaced by new ones, the replacement is held within the normal limits of body form. This control is exerted supposedly through the action of chemical processes which limit the rate of growth of the normal cells. Under specific conditions, however, some cells become immune to these chemical control processes provided by nature and are no longer subject to the growth restraint which handicaps the normal cells surrounding them. In this way the normal cells are overgrown and are killed by their inability to compete for nourishment. This overgrowth of uncontrollable tissue is called cancer. It seems clear, then, that the cancer cell, which is not susceptible to chemical control, must differ in chemical constitution from the normal cell, which is susceptible to control.

If a disease is due to uncontrolled malignant overgrowth, two possibilities for its cure exist: to render normal the abnormal cell, or to destroy that cell. The first possibility does not appear to be a likely one, since from all the evidence it appears that the malignant cell is irreversibly changed and can never be rendered normal again. The second possibility, that of destroying the malignant cell, is one already proved to be feasible by the vast amount of clinical experience with the partial destruction of cancer cells by X-ray and radium. These agents are only weakly effective, however, and better ones are required.

Research on the problem of cancer has been in progress for a great many years. A review of its progressive development serves to indicate its complexity and difficulty. The first method of attack was the application of morphological pathology, the science of the form of abnormal or diseased cells. This science made it possible to recognize, under the microscope, characteristics by which cancer cells can be differentiated from normal cells. The differences are of two types: one of shape, and the other of the affinities of the various types of cells and parts of the same cell for colored dyes.

The use of coloring brought into sharp relief the features of the affected cells. It revealed details, previously unknown, that clarified the way in which cancer destroys the body. Under the microscope, in a thin slice of an organ affected with cancer—the breast, for example—can be seen the finger-like processes of the parasitic cancer tissue invading and destroying the normal structure. It is perfectly apparent to any observer that the cancer destroys by its superior strength. In short, it wins a battle with the normal tissue—a battle which results in the destruction and dissolution of the defeated normal cells.

The ability of cancer tissue to outfight the structure of which the normal organ is composed has excited enormously the interest of scientists for over a century. From the appearance of the cancer cells, all sorts of deductions were drawn as to how the cancer cell gained its superior fighting ability, or, as expressed more commonly, its "malignant quality." The study of the form and staining qualities of the cancer cells became an invaluable tool by which various types of new growth could be distinguished one from the other. Once distinguished, the expected natural course, extent, and proper sort of treatment could be indicated.

IT was then observed that cancer developed in animals, and was indistinguishable in every respect from that occurring in man. Attempts were made to transfer animal cancer to normal animals. It was found that this could not be done unless closely related individuals of the same species were used as hosts. If such related subjects were available, some tumor tissue removed from the cancer-bearing animals could be inoculated into the closely related normal animals; it would grow and flourish, and could, in turn, be transplanted to other normal animals. The process could be continued indefinitely as long as related animals were employed in the experiments.

The proof of the transplantability of animal cancer was an important advance, since it indicated that, once a tissue cell has undergone the transformation into a cancer cell, it could be transplanted through an indefinite number of normal hosts and always remain a cancer cell. In other words, in cancer one deals with a mutation, or permanent alteration of the cell, which is reproduced through its offspring forever. This proved that it was hopeless to expect the return of cancer cells to normal. Clearly, then, in order to cure cancer, it was necessary to kill the affected cells, or to remove them from the body of the host.

A LITTLE later another advance was made. Peyton Rous showed that, in the case of tumors of fowls, the malignant tissue could be transplanted even though the affected tissue was ground up and passed through a filter which would not let cells through. The cell-free filtrate, when inoculated into normal fowls of the same species and strain, gave rise to cancer of the type from which the filtrate was devised. This proved that, in fowls at least, cancer could be caused by some part of the cell, and to this part the term agent or virus has been applied.

At this point two basic principles were apparent: 1) that of the abnormal form and staining qualities of the cancer cells, and 2) that of the transplantability of animal cancer. The next step required the development of an entirely new science, that of chemistry.

In 1756 Percival Pott conceived from pure clinical observation the unique idea that some cancer was due to tar. Later it was found that the application of tar to the ears of rabbits caused cancer. This experiment provided the possibility of isolating from tar and identifying the compound which caused the cancer. Two English chemists were finally successful in this attempt. They isolated from tar a few granules of a pure cancer-producing

substance and then many similar compounds could be quickly synthesized. The exact molecular structure required for cancer production was clearly delineated in this way.

At about this time the chemical nature of the compounds which are secreted as sex hormones by the body came under study. It was found that these compounds had a structure similar to the cancer-producing tar constituents. Furthermore, the injection into mice of certain human sex hormones resulted in cancer of the breast and other organs. Conversely, the injection of certain of the cancer-producing compounds caused sex changes in animals. Clearly, it was possible that cancer in man had to do with some improper or abnormal formation of sex hormones. The abnormal chemical manufacture might result in the formation, not only of normal sex hormones, but also of small amounts of "bad hormones," structurally allied substances which cause cancer. This possibility is considered to be so important that it warrants completely the serious investigation now in progress.

THE most recent experiments which bear on the cancer problem concern the effect of diet on the formation of chemically induced cancer in laboratory animals. The fact has been established that certain types of compounds will regularly cause cancer if they are administered while the animal is fed a diet lacking in certain vitamins and other food constituents. If these lacking constituents are added to the diet as supplements, and the administration of the chemical is continued, no cancer occurs. Obviously, in these experiments some food factor protects the animals against cancer.

The experiments described may seem to be unrelated and without application to the problem of cancer in man. As a matter of fact, the results now begin to form a discernible picture—one, to be sure, with many gaps, but still clearer than has ever been available heretofore. The picture is somewhat as follows: Something goes wrong with the manufacture in the body of those chemicals which are similar in structure to the sex hormones. The error in manufacture gives rise to small quantities of compounds which, by their structure, possess the power of changing normal cells into cancer cells.

This process of change is due to the ability of the chemical to interfere seriously with the life processes of normal cells. The cells are poisoned incompletely, and, in an attempt to live under these circumstances of chronic poisoning, they develop vital processes which are not affected adversely by the poisonous compound. In short, the cells become tough—so tough that they can compete successfully with normal cells in the race for nutrition. Then they destroy the normal tissues.

If we are satisfied to accept this hypothesis as the correct one—and its correctness seems to be attested to by

Memorial Hospital, New York City

the available evidence—another attack on the cancer problem may be at hand. One thing that could be done would be to examine carefully patients with cancer to see whether from their excreta we could isolate the abnormal hormone which caused the cancer. Perhaps in this way the difference in hormone formation between normal and cancer-bearing individuals could be distinguished. Perhaps the offending compound could be isolated and identified. If this were the case, undoubtedly we could develop methods for rendering normal the deranged hormone formation which led to the production of the poisonous cancer-producing substance.

This sounds like an easy task. On the contrary, it is one of the most difficult problems in modern chemistry. One example of the truth of this statement is the fact that the chemist who first described the chemical structure of the male hormones was able to isolate from thousands of gallons of urine about as much of the compound as could be placed upon the tip of a pencil.

At Memorial Hospital, with the help of Harvard University, we have had the temerity to attempt to isolate and identify all the compounds of this type in the urine of normal individuals and of individual patients with cancer. A number of new, hitherto undescribed substances have been isolated and are being identified. The existence of a difference as concerns these compounds in the urine of normal individuals and of cancer patients appears to have been demonstrated.

The study just indicated is an enormously expensive one, requiring a large staff of highly trained individuals, as well as a tremendous outlay for chemicals and equipment, but the reward is certainly worth the sacrifice. If an analysis of the urine of patients for the presence of these various hormone-like substances could be made, it might provide for medical investigation a technique of almost unimaginable scope. We feel confident that this will be the case, but it is not a matter of a few months or even a year or two.

A second line of investigation concerns the nutrition of cancer cells and of normal cells of similar origin. This may seem to be a fanciful type of study. It is not entirely so, however, since we know from our experience with the sulfanilamide type of drugs that one way of destroying foreign cells like bacteria is to starve them by withholding from them certain compounds which they require for nourishment. This can be done because bacteria—for example, the streptococci—are nourished by essential substances in their diet, exactly as the whole body of a human being is nourished by, and cannot survive without, food containing sufficient vitamins. Moreover, the requirement of these bacteria for food differs, certainly quantitatively, and almost certainly qualitatively, from those of normal tissue cells. In other words, by the administration of compounds, like sulfanilamide, it is possible partly to starve and to strangle (by an interference with the breathing mechanism) the bodies of bacteria causing disease. This can be done by concentrations of the drug which are not seriously poisonous and do not strangle markedly the normal tissue cells of which the body is composed.

IN view of what is known about the antibacterial drugs, it is clear that, in order to apply the same principle to the starvation, strangulation, and eventual destruction of cancer cells without exerting the same effect to the same degree on the normal cells of the body, one must know upon what substance cancer cells depend for their ability to breathe and to be nourished. This is a very difficult problem, but probably one not impossible of solution.

Two roads of attack are open: one, to measure exactly the requirement of the patient with cancer, as compared with the normal individual for essential dietary constituents. This is done by ascertaining the amount of these substances taken in and excreted in a given period of time, thus provid-

ing a level of nutritional balance. By the determination of such a balance, one can measure accurately amounts of food substances essential for different individuals.

A second method is the measurement of the amounts of essential or required dietary substances in the cells of normal organs and of cancer cells growing in the same organs. Suppose, for example, it were found that normal liver tissue contained a given number of units of a vitamin, whereas cancer tissue of the same liver contained and required a greater amount. We could then hope that the cancer could be destroyed by the institution of a deficiency of that vitamin.

The studies of nutritional balance have already provided information of interest and very possibly of eventual importance. The fact has been established, for example, that patients with cancer of the stomach have a strikingly disordered reserve of Vitamin A, the fat-soluble vitamin contained in cod-liver oil. It appears that, with the growth of cancer of the stomach, the ability of the body to store and to distribute vitamin A to its tissues is seriously impaired.

Even though enormous quantities of vitamin A are administered to the patients in an attempt to support in every way their general health and their ability to stand operation, it is very difficult to render normal their handling of this vitamin. This observation takes on even more importance in view of the fact, established last year and confirmed at Memorial Hospital laboratories, that the administration to animals of synthetic cancer-producing chemicals renders abnormal their handling of, and reaction to, Vitamin A. Indeed, a vitamin disturbance quite similar to that seen in human beings with cancer can be produced in these experimental animals.

In Memorial's child cancer department. Child cancer is not at all uncommon

Not only is a disturbance of vitamin A found in patients with gastro-intestinal and other forms of cancer, but in leukemia, a cancer of the blood-forming cells, striking disturbances of the utilization and activity of another vitamin, thiamin, or vitamin B_1, have been shown in the Memorial Hospital laboratory, to be present. This demonstration required the development of entirely new methods of assaying the amount of the vitamin in very small amounts of tissue cells. The substance is measured in the affected cells, the leukocytes or white blood cells, themselves. Since the actual volume of these white blood cells in blood samples which can be removed safely from patients is comparatively small, extraordinarily delicate methods for vitamin measurement were required. When these were applied, a very interesting fact developed. The white blood cells of cancerous nature, leukemic cells, have a much higher content of vitamin B_1 (thiamin) than do any normal white blood cells examined.

This observation has been extended to show that the leukemia, or blood cancer cell, appears to possess chemical activities which are not different from those in the normal blood cell. Rapid progress is being made in our knowledge of these significant differences. We hope, by taking advantage of them, to be able specifically to injure or kill the cancerous blood cells without injury to its normal analogue.

Not only must we search for differences between the cancer and the normal cells, but we must also find points of similarity, since otherwise the differences would not be significant for our purposes of developing methods of cure. Differently expressed, if the amounts of some vitamins in cancer and normal cells were the same, but the amounts of other vitamins were strikingly different, one would feel more secure in attempting to use the difference as a route of attack. Such experiments are also in progress.

No conclusion can be drawn so far, except that the methods hitherto described for the measurement of vitamins in cancer appear to be somewhat unsatisfactory. If this seems to indicate that little progress has been made, the fact should be recalled that every one of these determinations requires the development of exceedingly difficult technical methods.

A third set of studies is in progress in an attempt possibly to short-circuit the more prolonged investigations and to develop a method of cure without exact knowledge of the mechanism by which the cure would be effected. This means a purely empiric study and such a one has been instituted. A method was devised by which the effect of compounds in poisoning cancer could be measured precisely. The experience with the chemical antibacterial agents, the sulfa compounds, in inducing the death of bacterial cells by their starvation, suggests, of course, that similar methods might be effective in killing cancer cells.

As far as the experiments have gone, some 70 different compounds have been tested in the manner described. A type of chemical has been found which, in the test tube, appears to interfere with the health of one type of cancer cell of man—that found in cancer of the breast—and in the same concentration not to interfere with the well-being of any normal organ tissue so far tested.

The results may have a far-reaching significance. They prove apparently that there is a real difference between cancer cells and normal cells in their sensitivity to certain types of chemicals. The cancer is more sensitive and can be killed by compounds which do not kill the normal tissue. This observation alone is sufficient justification for the intensive continuation of the experiments.

• • •

BORN THAT WAY

A Practical Solution for the Constitutionally Inadequate

"The main trouble with many of the patients I see every day," says Dr. Walter C. Alvarez, noted stomach and intestinal specialist of the Mayo Clinic and author of the book "Nervous Indigestion," writing in *The Journal of*

the American Medical Association, "is that they are always weak and tired and full of pains and always getting sick in one way or another. Many have been operated on several times, but they still aren't well and they cannot get about and have fun as other people do.

"Again and again these patients go to some consultant or medical institution with the idea that this time they will get examined so thoroughly that the cause of all their troubles will be found and perhaps removed.

"Commonest among the diagnoses made nowadays in the hope of explaining the sufferings of these people are colitis, spastic colon, ptosis, pelvic disease, adhesions, chronic appendicitis, glandular dysfunction, low blood pressure, mild Addison's disease, low blood calcium, brucellosis, and chronic nervous exhaustion. That in a given case the diagnoses made in the past were wrong and the local abnormalities found were not sufficient to explain the illness can be seen from one fact alone, and this is that the extensive treatments carried out and the operations performed in an effort to correct the supposed diseases did not put an end to the symptoms.

"The question then is, How can matters be improved? It seems to me that, to begin with, we physicians must recognize more often and more promptly the constitutional frailness or sickliness of these patients and the inherent incurability of their disease. We must stop looking hopefully for some one lesion to explain the disability, the psychoneurosis, and the aches and pains everywhere, and we must not let ourselves be led astray by those little variants from normal that we can usually turn up during an examination.

"Treatment must consist mainly of keeping the patients from doing foolish things and wasting money. They must be taught, if possible, to acquiesce to the situation, to stop hunting for a complete cure, to hoard their energies, and to find a job that can be done without too much fatigue."

CHILD OUTLOOK

Mental Attitude Toward the Present War

CHILDREN between the ages of 7 and 13 reflect the cynical, disillusioned attitude prevalent just after World War I, with no positive idea of what we are fighting for this time, according to a study made on the Children's Ward by two Bellevue Hospital, New York, psychiatrists, Dr. Lauretta Bender and Dr. John Frosch.

The war so far has had no disturbing mental effect on these children, although they reacted with fear and anxiety to the threat of being separated from their parents. This conclusion, confirming British blitz experience, is reported by Dr. Bender and Dr. Frosch in the *American Journal of Orthopsychiatry.*

Although the children agreed that "war was bad," war has no very personal meaning to the average young child, according to these psychiatrists. Death and killing do not mean the same to them as to adults. In the few cases of anxiety over the war, this seemed to be due primarily to personal, emotional problems at home. "Glorification of war was conspicuous by its absence and surprisingly few thought of war in terms of bravery, heroism, freedom, and patriotism," these observers found. "If anything, there was a glorification of peace."

GERM KILLERS

Ultra-Violet Lamps Put To More New Uses

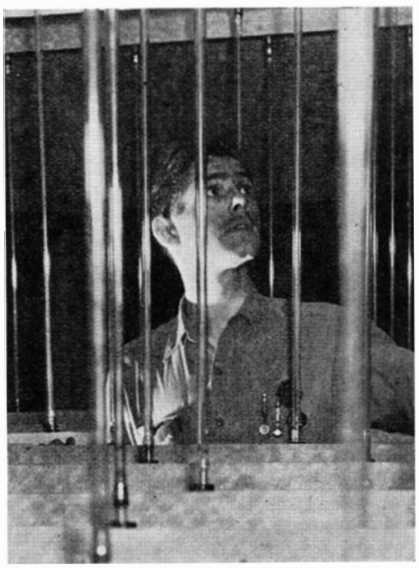
TWO new applications of the Westinghouse-developed Sterilamp, a source of ultra-violet radiation for germicidal purposes, have recently been put into practice. The principle of operation of

Electrical sterilization of footwear prevents spread of infection by shoes

the Sterilamp has been described previously in these columns, as have also various applications as developed.

First of these newest uses is to prevent foot infections being spread through the use of safety shoes in industry. In one of the Westinghouse plants approximately 1000 workmen buy steel-capped safety shoes every month, and most of them try on several pairs before making a selection. As one of our illustrations shows, those shoes which have been tried on and are to be put back in stock are first electrically sterilized by being placed over a U-shaped Sterilamp for from two to five minutes.

Second ultra-violet germicidal application recently announced is the use of these same lamps, but in larger



These ultraviolet ray lamps will help to purify the incoming air in ducts

sizes, to kill bacteria in air-conditioning air ducts. Another of our illustrations shows ultra-violet lamps arranged for this purpose. The air being drawn through the ducts passes over the surface of the lamps which are so staggered in placement as to stand guard over all of the passing air. It is claimed that such an installation will destroy 95 percent of the bacteria in the air passing through the duct.

JAP MALARIA

Scarcity of Atabrine May Cause Military Reverses

HIGHLIGHTS on how Chinese universities are carring on in spite of Japanese invasion and oppression were related at a recent meeting of the American Chemical Society by Prof. Clinton N. Laird of Lingnam University, who returned with Mrs. Laird on the *Gripsholm* after a wearing time while interned in Hong Kong.

Questioned about causes for the recent Japanese reverses and retirements, Prof. Laird said he thought one factor might be disease, especially malaria. The Japs depend more on atabrine than they do on quinine for treatment of malaria, and since their former bulk source of atabrine in Germany has been cut off they appear to be hard up for the drug.

Day After Tomorrow

A Continuation of the Report on How Industry is Planning Now for Peace-Time Operations

A. P. PECK

(In Two Parts—Part Two)

● IN last month's issue were presented the views of executives of Westinghouse Electric and Manufacturing Company, Aluminum Company of America, and Lincoln Electric Company as revealed in answer to questions, the essential one of which was: To what extent are research, development, and invention, as prompted by war-time production, being correlated with plans for civilian production in post-war days? The questions were asked as part of a survey to determine for the American people what sort of a post-war world they may expect if industry is permitted to apply to its operations the fruits of present-day research and development.

Exigencies of space prevent repeating here the introductory and explanatory material published last month, and it is therefore suggested that readers who missed the first part of this article refer to page 151, October 1942 Scientific American.—*The Editor.* ●

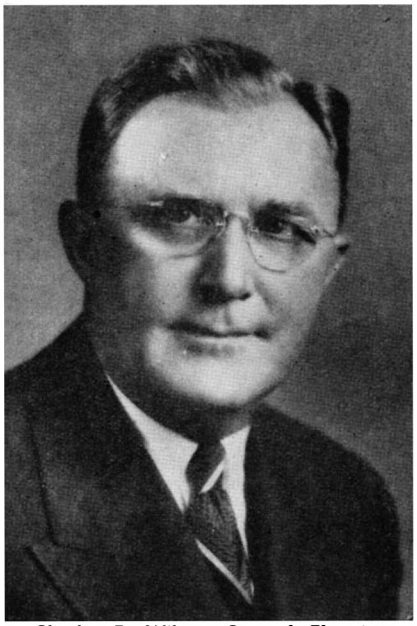
NEXT on the list of industrial executives to be questioned in the Scientific American industrial survey was Charles E. Wilson, president of General Electric Company.

"Obviously any plan for the post-war 'day after tomorrow' has to find its seed in yesterday," said Mr. Wilson. "This is particularly true, we feel, in the case of the electrical industry, in respect to both manufacturing and the distribution of power. The war effort has added tremendously, and is still adding to generating capacity. While the efficient use of these great amounts of electricity for the common good is primarily a problem for electric utility companies, it necessarily figures largely in the plans of equipment manufacturers such as General Electric, who build not only power-producing machines, but also the devices and appliances to use the power.

"There are two aspects of the 'war power' problem which are interesting to us," Mr. Wilson continued. "One is that existing central station installations are under a heavy strain—the turbines and generators and related equipment are being subjected to the severest kind of use and many of them may be worn out or have their operating efficiency seriously impaired. They will need to be replaced. The other aspect is that in certain sections of the country greater amounts of power will be available for use than ever before. once the emergency is past. Increased use of domestic home appliances, particularly for cooking and water-heating, will absorb part of this new capacity, but new industrial uses of electric power will also open up. There will be the need for modernization of plants to undertake new manufacturing tasks, and new methods of producing the highly competitive fabricated materials such as steel and aluminum will draw heavily on electric power. As we see it, these things all represent opportunities for post-war business — but opportunities in the sense that they must be planned for, sought out, and realized through aggressive action. They will not just fall into anybody's lap.

"There is still another aspect of post-war business planning that particularly concerns the electrical industry. We are proud of our war job with its vital production of needed weapons and tools. But more so than most industries, we have undertaken war tasks which flow most naturally from our particular talents. Most of the things we are making are electrical in character, and have to do with the generation, use, and control of electric power. Many of them are as applicable to peacetime as to wartime. The majority of the thousands of new employees we have taken on have been trained in tasks that need not necessarily cease when the conflict is over. Like most industries, we are acutely aware of the obligation which these added plants and added personnel imposes upon us, but we feel that we have a better-than-ordinary chance to keep them going afterwards.

"This industry has always had to face the so-called 'impossible'," said Mr. Wilson, "to seek an outlet for its talents and abilities beyond the horizon by means of original research and application. Our products, by and large, have not worn out; they have been made obsolete by the ambitions of scientists and engineers long before that. Therefore, to plan for the future is no new task. It seemed only natural that we should, from the beginning of the new world war, lay particular stress on the reconstruction years in our thinking and planning.



Charles E. Wilson, General Electric: "Any plan for 'day after tomorrow' has to find its seed in yesterday"

"Many months ago the General Electric Company set in motion a planning committee whose task it is to look into the laboratories for new ideas, to make preliminary surveys of potential markets, to inventory machines and plants and personnel. This was no visionary undertaking, and the detail in which some of these blueprints of the future operations have been drawn would surprise many outsiders.

"Complete as our plans may be," revealed Mr. Wilson, "we are aware that no one company, no single industry, can bring this off alone. It will require a broad and united effort on the part of all business. It will need an understanding of the risks involved for private enterprise, for we must gamble our bluest chips to ward off depression and economic chaos. We cannot sit back and be conservative and reactionary but must be prodigal with our time and our resources and our courage. Not only business is involved, but government and labor and agriculture as well. Because the scope of such an effort must be broad, we have tried to promote an interchange of ideas on planning and to set a good example.

"The pressure of war is tremendous, and its brighter side is that it has telescoped years of progress into months. Just as radio was a by-product of the last war, the plastics industry on a large scale seems to be a by-product of this one. It has been forced into an adult stage by government demands and the scarcity of other mate-

rials. Electronics has made similar progress. Electricity will play a giant's part in the growth of the building industry after the war. On the one hand, consumer wants for the products of better living are being stored up, and on the other hand, those products are being improved by war-born knowledge. Any one can picture the post-war possibilities in aviation as a result of the new devices and instruments and controls developed for bombers and pursuit planes. The food we eat will be more nourishing, more plentiful, and better preserved and prepared as a result of work now going on.

"Fortunately, intelligent planning is a state of mind and not an activity which requires the labor of many men," concluded Mr. Wilson. "It is not inconsistent with maximum war production and need not get in the way of that all-important job. Yet it is tied to it as surely as tomorrow is tied to today. A mere handful of thinking men can ride the crest of research, development, engineering, manufacturing methods, and fundamental economics and shape a working plan for tomorrow. It may not be perfect and it is forever subject to change—but it is a plan. With it we need not face the future empty-handed and confused."

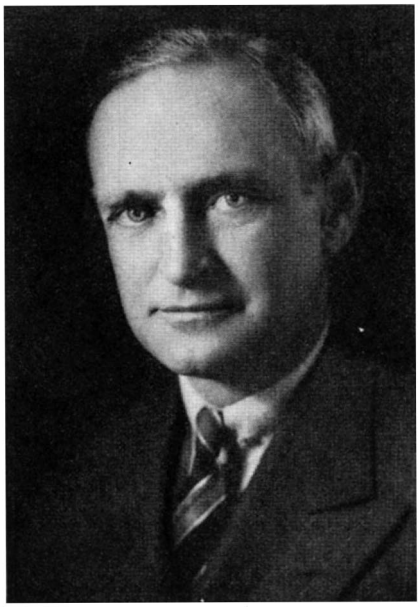
REPRESENTATIVE of the motor-truck industry is The White Motor Company, one of the country's largest manufacturers who are building motor vehicles for the armed forces—and at the same time learning many things that will be applied to the civilian motor truck of the future. Mr. F. T. Macrae, Jr., Executive Vice President of White, painted the following verbal picture:

"America recognized a long time ago that it might be drawn into the present conflict and it started marshalling its engineering and inventive genius to the task of turning out superior weapons. As evidence of work well done, we have highly efficient planes, tanks, trucks, and guns coming off the production lines today. With the best of equipment we will achieve victory—a victory with marked benefits for the peace-time era to follow.

"Not the least of the benefits to be derived will be the contribution of war tools to peace-time equipment, and certainly the influence will be most noticeable. Engineering and material progress has been so revolutionary that we can expect vast changes and improvements in many fields of human endeavor after the war is over.

"Quite naturally, the automotive and aeronautical fields will make use of the many developments precipitated by national defense," continued Mr. Macrae. "It is safe to say that some of these developments would have required 50 years or more without the driving force of war. Let us look at the strides we have made in the light of future significance.

"In the first place we have developed airplane engines of almost unbelievable power-to-weight ratios. This not only



F. T. Macrae, Jr., White Motor Company: "The finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared"

means far more efficient commercial airplanes in the future, but it means more efficient trucks, buses, and automobiles as well. Certainly the automotive field will inherit a great many things from aviation. As a matter of fact, some companies had already examined aeronautical standards before the war and had made better automotive products because of it.

"The White Motor Company went whole hog in adopting an airplane-type, air-cooled engine for its White Horse retail delivery unit as developed three years ago. And because of it, the company was able to boast unusual efficiency and economy of operation. White also took a tip from airplane design when it developed the Super Power engine for heavier duty units, thereby getting more power with less weight. But all this occurred before the present emergency period. The effect of World War II will be almost unlimited.

"For instance, farmers living in the vicinity of army camps have already witnessed the ease with which Half-Trac reconnaissance vehicles whisk across muddy fields and swamplands. And the question comes up: 'Why can't I get a vehicle like that for working my lowland acres?' When the war is over, that question will find friendly ears and designers will go to work to produce a domestic vehicle with all the operating advantages of the military unit.

"The Half-Tracs, as developed by White in collaboration with the United States Army Ordnance Department, are supported in the rear by a tractor belt. This gives them tremendous traction power on any kind of ground. With a wide range of gear ratios, these versatile units can vary their speed from a slow crawl in difficult spots to 50 miles an hour on hard ground or highway.

"This is but one example. Actually, the new tanks, planes, gun carriers, trucks, and other equipment will have a profound effect upon post-war operations. Soldiers home from the army will not forget the efficiency of mechanized military equipment and they will demand machinery of comparable efficiency for their peace-time work.

"When we look back, we can realize that World War I was the real birthplace of the airplane. When that conflict was over, commercial aviation came to the fore by leaps and bounds. Even the truck got its real impetus from that war. Obviously, where problems are forced upon us and competition adds its challenge, great things can be expected.

"The business world is already looking beyond the present conflict to the needs of the post-war period when defense employment gives way to domestic employment," concluded Mr. Macrae. "Certainly the finer, lighter, and stronger materials born in this war will serve as the basis for new industries when peace is declared. And the path of design, dictated by wartime progress and invention, is a guarantee that radically new products will make their bid on the active market to come. In the same way, we can be sure that our present all-out production effort will leave its impression in the way of new and better manufacturing methods."

AND now a few words from the petroleum industry, as represented by Gulf Oil Corporation. Here the statement obtainable was short and rather evasive, but understandably so in view of the manner in which the oil industry finds itself at present between the devil and the deep-blue sea. Here is what Mr. C. H. Hathaway, Assistant to the President of Gulf, has to say:

"We are, of course, bending every effort in all divisions of our business—production, refining, and marketing—that will aid in the successful prosecution of the war. This includes re-

search in all of its various branches.

"It is both natural and inevitable that along with this we are gaging our sights, so far as we can look ahead, in anticipation of the conditions that will prevail in the following days of peace. Rightly enough, many of the things that war research and war planning are helping us to discover will not be without some benefit in the post-war period. Already we know this to be true. New and better products for the public and for industry must be one of the peace-time goals—products that will meet demands which in many cases may be quite different from those of the past."

WHILE everyone may not consider agriculture to be an industry in the generally accepted sense of the word, it is so rapidly assuming that status that some consideration of it must be given in any survey which attempts to anticipate the possibilities of winning the peace after the war. We therefore give the following quotations from a speech by Secretary of Agriculture Claude R. Wickard, presented at the Second Inter-American Conference of Agriculture in Mexico City.

"There will be need after the war for some of the stocks now piling up in this hemisphere," said Secretary Wickard. "European agriculture has been disorganized. There is starvation in occupied Russia, Greece, and Poland, serious malnutrition and undernourishment in every country Germany has subjugated. When this war ends, there will be immediate and desperate need for relief. The food supplies of the Americas can win the peace as well as the war.

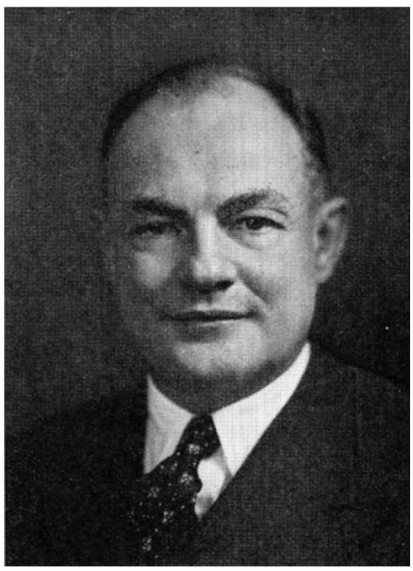
"In the United States we welcome the changes in our agricultural plant which the war has compelled, for we believe the result will be a sounder agricultural economy. Many people of our nation have never eaten enough meat, milk, poultry, and fruits. There has been malnutrition, as in every other country of the world. I have seen similar reports prepared by Argentine, Bolivian, Ecuadorian, Colombian, Canadian, and Cuban nutritionists.

"The war now compels us to produce more of the very things our people most need. After the war our task will be, not to adjust production downward, but to find ways of distributing our maximum production to our people. Well-planned introduction of new crops to our hemisphere will give us more purchasing power, higher living standards, and a better basis for reciprocal trade.

"There is no serious contradiction between intensive war production and our desire to establish a sound post-war economy," continued Secretary Wickard. "Indeed, there would be little point to winning the war if we did not have positive plans and ambitions for the future. We are not so complacent about our pre-war way of life as to look forward only to its restoration. Few people of our nations would wish to fight for a return to unemployment, poverty, and hunger. Our fighting strength will be immeasurably greater if every man and woman of every nation has a stake in the war, and sees in victory a step toward a better world.

"We may expect other problems as a consequence of war. We are now beginning production in this hemisphere of crops such as rubber. What will our position be when other parts of the world can resume production and export? Some people have suggested that we cannot hope to compete with these areas because of the low wages paid there, and that continued production of such crops will have a depressing effect on real wages in this hemisphere.

"I do not regard that problem as impossible of solution, nor do I think we can permit it to deter our production



Claude R. Wickard, Secretary of Agriculture: "The willingness of free people to fight for a better future is the strongest weapon . . ."

efforts. First of all, we do not know what the post-war demand will be; the needs for rubber, metals, and other items may continue at better than pre-war levels. Further, there will be a period of adjustment, since other parts of the world cannot possibly resume full production as soon as the war ends.

"The real question, of course, is cost of production. The scientists and technicians may strengthen our competitive position by better production methods, higher yields, mechanization, improved transportation, and new processing techniques.

"Both for the present and the future, the United States Department of Agriculture offers to the representatives of other nations, and especially the nations of the Western Hemisphere, the services of its scientists, economists, engineers, and technicians, and the facilities of its laboratories and experiment stations. The United States Department of Agriculture has sent specialists to a number of countries to help solve livestock problems, cropping problems, economic problems, and problems of insect and disease control. Last year we sent a group of soil conservation experts to one of the southern nations to survey the agricultural land and recommend a program of soil protection and improvement. The men returned to the United States praising the co-operation they had received and the great foresight of the agricultural leaders with whom they worked. We have agreed to furnish similar assistance to several other countries.

"We would like to see a greater exchange of agricultural students between the United States and the other American countries. Young men from several South and Central American countries are now in the United States studying our rural electrification program. Other young men are studying our soil conservation program by working on the land with technicians of the Soil Conservation Service. Still others are being trained in agricultural economics by the Bureau of Agricultural Economics, and a number have accepted scholarships in agricultural chemistry and engineering. We hope these training programs will be expanded. I think there is still much to be done to promote the exchange of information and ideas. The Inter-American Institute and the new experiment stations will provide new opportunities for American scientists and technicians to combine their knowledge and skill.

"Together we can map out a future for agriculture, a future of progress and economic well-being," concluded the Secretary. "We can offer to our peoples and those of other lands a better way of living. In fact, we must do so, for our war effort depends upon it. The willingness of free people to fight for a better future is the strongest weapon of the United Nations."

FROM agriculture to tool engineers is the next and last step in this survey. The skill and ability of America's tool engineers which have made possible the rapid conversion of industry

to war production will, in peace time, bring to America mass-produced commercial planes and a new type of automobile with a much smaller and higher compression motor, according to Frank W. Curtis, Chief Engineer, Van Norman Machine Tool Company. Jigs, fixtures, dies, and other forms of special equipment, the products of tool engineering, are the measuring stick of success in modern industrial war production, instead of being merely the overhead evil they were formerly considered, Mr. Curtis declared, and continued:

"The war efforts have resulted in the development of processes and products that otherwise might have been delayed. After the war, it will be another problem for the tool engineer to make it possible for these discoveries to be applied and made available for public consumption.

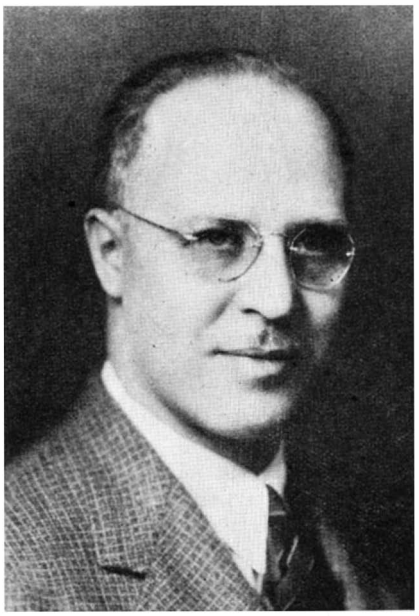
"Automobiles and airplanes are two outstanding products that will derive the benefit of scientific research and thus create a vast number of changes in our way of life. Just what the automotive engineer will do after the war is still a secret, but it is safe to assume that the industry will be reborn, as will many others.

"America's increased capacity in the production of aluminum and magnesium will bring about a tremendous expansion in the use of light metals for automobile uses. These metals will, no doubt, compete with steel for many purposes. Plastic materials will be available in larger quantities than ever, and automobile bodies of plastics are quite possible to conceive. Plastics capable of withstanding heavy blows are already available for many war uses and will find even more uses in peace-time.

"A refined gasoline many times more powerful than our present fuels has been produced, which will require entirely new automobile engines because present designs are not able to use it. This fuel is of a very high compression type that will require a small, high-speed motor with greater power per pound of weight than present motors.

"Since airplanes depend on lightweight motors, these engines will probably be used in the larger number of small planes that will be produced after the war, so that a new era of civilian flying can be expected, especially with the thousands of army and navy trained pilots who will want low-cost aircraft of their own. The rapid strides made in the building of warplanes have been made possible only under war emergencies, where speed has been so urgent. The mass-production methods will carry over to peace-time, so that we may expect the air to rival the road as a means of travel.

"Tool engineering has had an enormous effect upon nearly every phase of the advancement of civilization," Mr. Curtis explained. "The cost of automobiles, refrigerators, radios, and many other products would have been far beyond the reach of the average man if it were not for the science of



Frank W. Curtis, Van Norman Machine Tool Company: "After the war it will be . . . for the tool engineer to make it possible for . . . discoveries to be applied"

tool engineering. Not many years ago, interchangeability of parts was considered an expensive undertaking, limited to the manufacture of products in exceptionally large quantities. Today, however, through the close study of manufacturing methods, almost any type or style of product can be made interchangeably, even though the output may be considered relatively small.

"During the past few years management has learned that tool engineering is the backbone of successful manufacture. Not so long ago, however, some executives were not too familiar with the so-called hidden advantages of 'tooling', and looked upon special equipment as some kind of unnecessary overhead that merely 'cost a lot of money.' Today, the picture is quite different. 'Tooling' has become of vital importance, and management realizes how necessary it is to tool-up adequately to meet production demands within stipulated costs.

"Those engaged in the field of tool engineering know, perhaps better than anyone else, that tooling cannot be valued by its cost. Cost is a factor, of course, but performance is what counts and what we must attain if our tooling is to be succesful. Let us not forget that more can be accomplished with highly specialized tooling in a machine tool of an earlier model, than through the use of a most efficient and modern machine with inadequate tooling: something that could be likened to 'hitching a race horse to a plow.'

"When a design or an idea is born, we should first look to the tool engineer to offer his final analysis of whether or not the product can be successfully made. In plants where this practice has been adopted, the tool engineer has the opportunity to analyze the product from a production viewpoint, and without any selfish motive whatever can be very instrumental in showing how certain changes and modifications can be made to eliminate expenses and costs which might otherwise be overlooked. Often the product can be picked apart, piece-by-piece, enabling redesign, if necessary, to conform with modern day manufacturing practices.

"We should always remember that the design of a product is one thing, and the method of making it is another," concluded Mr. Curtis. "Both must tie in with each other, because any product, no matter how efficient it may appear, is no better than the tools used for its manufacture. The tool engineer, therefore, is as important in our industrial cog as the designer, who is called upon to develop a product, because without tools and a means of producing economically the most needed type of product would be restricted."

Thus, as Mr. Curtis so ably points out, the part of the tool engineer in shaping the future of the world is more assured now than ever before; the more rapidly tools can be produced, the sooner industry can turn from one product to another, from a crude design to a perfected unit, from old styles to new. Such rapidity of change-over, with resulting economies, will be an essential in the shift from war production to production for peace.

Upon such men as those quoted in this survey depends the future of industrial America, a future that will be assured in proportion to the speed and efficiency with which these same men complete their war-time production job. Their mental processes have been sufficiently revealed here, it is believed, to demonstrate beyond doubt that, given an even break to apply their know-how, the men of industry in the United States will do more than their share toward winning the war. Once this is accomplished, they will plunge just as enthusiastically into the winning of the peace, prepared for the

work of tomorrow by the foresighted planning that was a continuing process during the war-clouded times of today.

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SILVER LININGS

Are Being Proved Industrially Practicable

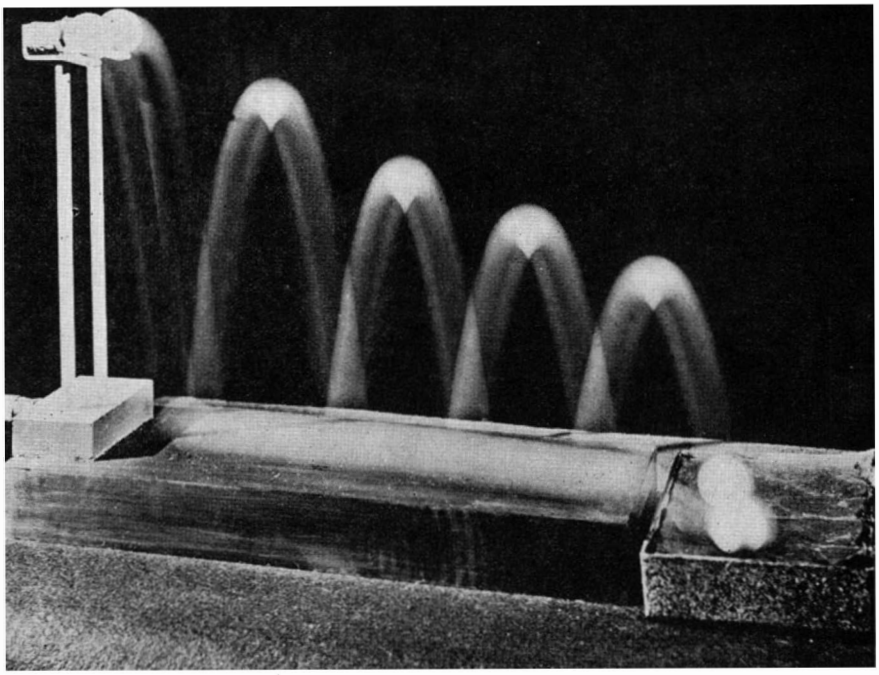
THE present-day tin can has been and continues to be a satisfactory metallic container for a vast number of purposes. Today, however, although we are faced with a dire shortage of this seemingly indispensable coating metal, we have at hand another metal —silver—which can be substituted for tin as a container lining with the outstanding advantage that it is resistant to many products which attack tin.

Silver is resistant to alkalies, organic acids, and certain concentrations of hydrochloric and other mineral acids. Most organic silver salts are free from color, thus eliminating the objectionable discoloration of contents, even though traces of the silver may be dissolved. For that reason, silver has long found wide use for a variety of equipment in chemical manufacturing plants. Silver is also bactericidal and may be used in contact with food, and may even be taken into the body in minute quantities without danger. Obviously, therefore, silver is eminently fitted for the linings of containers of such products.

Silver can be applied relatively economically to metal containers by electro-deposition on the sheet which can then be formed, soldered, and so on. It can be applied from the very thinnest deposits (0.0001 of an inch) up to very heavy thicknesses (0.05 of an inch) with equal facility. It has also been deposited, under laboratory conditions, at very high current densities up to 200 amperes per square foot, thus pointing the way to reductions in the time of "dwell" in the electroplating bath to a fraction of common practice.

The cost of silver plating depends upon, among other factors, the weight of the silver deposited: cost, approximately 28 cents per square foot for 0.001 of an inch thickness. From this should be deducted the cost of the material which it replaces such as: nickel at 2.5 cents for the same thickness, copper at 1 cent, tin at 2.5 cents and so on.

Interest in the use of silver-lined containers may be judged from the fact that they are being considered seriously for such products as foodstuffs, high-grade beverages, beer, cola syrup concentrates, condensed milk, evaporated milk, salves and other antiseptic materials, ether, aluminum chloride, and other chemicals.



Failure to bounce indicated a way to progress in electrical relays

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WOOD BENDING—Wood treated with urea or carbamide, and heated to about 225 degrees, Fahrenheit, can be bent or molded into almost any shape desired.

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BOUNCELESS BALL

Points Way Toward Improved Electrical Units

MORE positive operations of electrical relays—delicate, swift-acting switching devices which are used in communications systems—is now being assured as the result of experiments with bounceless balls. Engineers have found that a steel ball half filled with metallic powder will not bounce, as proved by the time exposure photograph reproduced in these columns. During the exposure of this photograph, two balls of the same weight—one empty and one containing powder —were dropped simultaneously from the top of the posts. The empty ball left a looping trail of light as it bounced on the steel plate, but the ball containing the powder rolled without bouncing. Rough surfaces of the metal powder particles, engineers explain, created frictional heat as they slid over each other, dissipating the energy which the ball would have used in bouncing.

The knowledge obtained by these experiments has been applied to relays in which contacts are made in hollow form and partly filled with powder. This eliminates bouncing and chattering of contacts. In some special cases, hollow powder containers are attached to the contacts for the same purpose.

MOISTURE IN WOOD

Determined With New Electrical Instrument

SPEEDY and accurate determination of moisture content in wood, by the dependable electrical resistance method, is now possible with a simple, moderate-cost instrument which supplies direct readings in moisture-content percentage terms. With such an instrument it is possible to meet various specifications covering the precise condition of lumber, as called for by the Army, Navy, F.H.A., critical architects and builders, lumber mills and dealers, furniture manufacturers, railroads, public utilities, and others.

This simplified wood-moisture tester, developed by Industrial Instruments, Inc., is a modified Wheatstone Bridge using a cathode-ray electronic tube as the null or balance indicator. The combination switch and control knob is rotated until the null indicator flashes, at which point moisture content is read directly on the dial. Since the bridge circuit is self-compensating, there are no variables to contend with or compensate for such as voltage fluctuations or varying tube characteristics.

The standard pin-type electrode furnished with the instrument will not permanently mar the surface of the material under test. It is readily driven into and extracted from the lumber

Indicates degree of dampness

or wood by the hammer-extractor furnished. Or if progressive checks on various lumber stacks are to be made throughout the curing period, leads may be soldered to properly placed and spaced nails, and tied into a panel board located near the instrument for periodic readings.

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LACQUERS—Until the development of quick-drying lacquers it was thought that lacquer finishes had to be slow-drying in order to be durable. Long-time tests of the quick-drying types have disproved this theory.

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GUAYULE

Compounded with Synthetic and Natural Rubbers

MOUNTING demand for guayule rubber resulting from its widened use for compounding with synthetic rubbers has led to doubling the productive capacity of Cia Hulera de Parras, important producer of guayule, according to an announcement by American Cyanamid and Chemical Corporation, representative of the Mexican company. The increased capacity is being put in with the co-operation of United States government agencies.

Use of guayule, a type of rubber derived from a Mexican shrub thriving in semi-arid regions, has in the past been small because of its high content of resin, which is undesirable in rubber. Present rapid extension of its use is based on the improved properties which guayule (containing its original resin) imparts to synthetic rubbers, particularly of the Buna S type. Guayule serves not only as an additive and extender for the synthetic, but at the same time it increases the adhesiveness or "tack" of the product, an important property in working the synthetic.

Aside from the decided benefits of compounding guayule with Buna S and other synthetics, its use in increasing amounts for compounding with natural and reclaimed rubber in many applications is urged to extend the life of our dwindling stocks of natural rubber.

PATTERN PLATES

Made from New Board Which Saves Metals

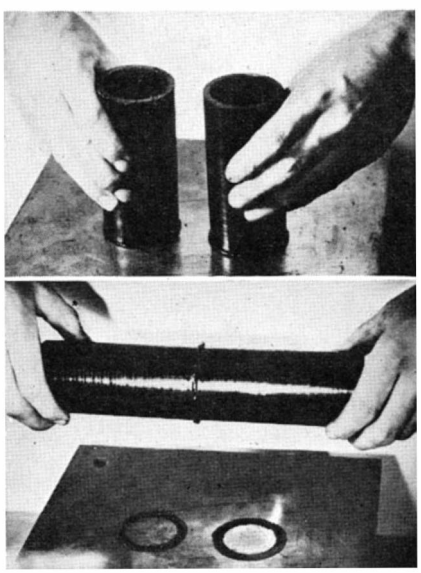
A LAMINATED plastic board which is available in a stock range of thicknesses is now being used for making pattern plates, as a substitute for aluminum or magnesium. The board, called Lignolite, does not warp, can be machined, and is impervious to moisture, oil, grease, and dilute acids. The surface of the board is designed to prevent sand from sticking to it and the stock itself has ample strength for pattern purposes.

PLASTIC PIPE

Has Many Applications to Replace Strategic Metals

A NEW plastic pipe, manufactured in the same dimensions as extra strong steel pipe of two-inch outside diameter or less, has properties of resistance to extreme moisture, chemicals, and solvents, coupled with high strength and long fatigue life. It is entirely unaffected by water, and only a few solvents exhibit any adverse effects. In many applications this new plastic pipe will undoubtedly replace strategic materials, such as vital metals and rubber, and release them for more urgent needs associated with the war effort.

This new pipe, developed by The Dow Chemical Company, is made of a new thermo-plastic resin known as Saran. The base resin is odorless, tasteless, and nontoxic. The plastic does not burn and its toughness and abrasion resistance are of a high order, the retention of these properties on aging insuring excellent wearing qualities. This pipe is non-scaling and withstands freezing. Heat resistance is said to be excellent up to 175 degrees, Fahrenheit.



Hot-plate welding of plastic pipe

Saran pipe is produced in smooth, round, accurately sized lengths having dimensions identical with those of strong iron pipe. It can be readily welded, heated, and bent. The pipe can be cut with a wood or hack saw and threaded with ordinary iron pipe dies.

ETHYL CELLULOSE

Is Base of Rubber-Replacing Plastic

A NEW plastic made from cotton and alcohol, which can replace rubber in hundreds of everyday articles, has a base of ethyl cellulose, which has been in production for some time by Hercules Powder Company.

New, soft formulations of this plastic can be used instead of rubber in hospital sheeting, gun covers, tents, garden hose, mason jar rings, surgical tape, gloves, electrical tape, wire insulations, impregnated and coated fabrics, washers, water tubing, footwear, raincoats, golf balls, and baby pants. Resistant to war gases, it can be used for gas masks. Flexible even at temperatures of 70 degrees below zero, it can be used for electrical insulation in motors of high-altitude bombing planes.

The new plastic formulations, while not now suitable for tires or inner tubes, will probably be suitable for a variety of other applications which before the war annually consumed 60,000 tons of rubber.

Raw materials used in the manufacture of ethyl cellulose are cotton linters or wood pulp, common salt, and alcohol from natural gas or from fermented farm products.

Ethyl cellulose is inferior to natural rubber in "bounce" or resiliency, it will tear more readily than rubber, and it is not as elastic. On the other hand, it can be made flameproof, a quality not found in natural rubber.

The soft type plastics now available are chemically related to rigid type cellulose plastics, based on ethyl cellulose, cellulose acetate, or nitrocellulose. Chemists can make a rigid or soft plastic by varying the plasticizing agent; for ethyl rubber, chemical or oil plasticizers, such as raw castor oil or cottonseed oil, have been employed.

INDUSTRIAL TRENDS

CHEMISTRY IN THE FUTURE

EVERY so often it is needful—and stimulating—to lift the lid of the chemical industry and see what's cooking. Much of the cooking, of course, is shrouded in the steam of military secrecy, yet enough is visible to serve as an indicator of what is going on within, and, therefore, as a key to general trends.

Regular readers of Scientific American have been able to follow in our monthly issues the story of day-by-day developments within the chemical industry. Spread over a period of time these developments often lose significance, a loss which can be recovered only by bringing the whole picture into clear focus and examining for general trends those phases which, at the moment, appear to hold the greatest promise for the future.

Such focusing was so ably accomplished recently by Dr. Charles N. A. Stine, Vice-President of Du Pont and its advisor on research and development, at a meeting of the American Chemical Society, that we can do no better than to skim the highlights of his address and let the shadows fall where they may.

Emphasizing that the war is compressing into the space of months developments which might have taken half a century for realization if necessity had not forced the pace, Dr. Stine said: "These pressures are unprecedented. Give us a victorious peace and the freedom of enterprise it should grant, and our progress will be unprecedented."

Some of the progress which has already been traced and which will be reflected in the trends of the future were enumerated by the Du Pont chemist. Aluminum production, for example, will be such by the end of 1943 that enough metal will be produced in one year to build three times the number of passenger cars now operating on our American railroads.

Petroleum chemists of today see existing motors as out of date, as a result of the war pressure to create better fuels for airplanes. In the same field, it is noted that the new motor-car models that are gathering dust in dealers' storerooms have aged technically at least two decades since they were manufactured. For example, the chemists have collaborated in the development of sealed cooling systems, now used in aviation, which will undoubtedly be applied to the automobile of the future. Power per gallon of fuel will increase, and fuels will yield much greater mileage.

In the field of plastics there will be available, after the war, the most versatile of materials on a scale beyond all previous comprehension. The high-pressure synthesis of ammonia, one of the major chemical exploits of the century, will so boost the production of fertilizer chemicals as to change completely the basic trends of agriculture.

Then there are such things as unbreakable glass and glass that floats, wood that won't burn, and laminations of plastics and wood that are competing and will compete even more with structural metals. Nylon, derived from air, water, and coal, one of the wonders of pre-war days, will be but a forerunner of many innovations from the same source. These new products will range from shoes that contain no leather and window screens that contain no wire to machine bearings that contain no metal.

In still another field there is magnesium, a structural curiosity only a few years ago, which today enters into the construction of every fighting airplane that is built. After the war it is now estimated that the nation's capacity for producing this lightest of all structural metal will be more than double that of the aluminum output of 1939.

In the rubber field, the United States alone, declares Dr. Stine, is now undertaking to accomplish, synthetically, in less than two years, the manufacture of chemical rubbers to a degree which, in the natural rubber field, required more than a century of development.

Many other new things are coming from the chemists' test-tube for use in the post-war world: New fabrics for clothing, steel that will challenge the new light metals, things to be made from the chemical building blocks of hydrogen and carbon that come out of the thousands of chemical compounds in every barrel of crude oil, new homes made inexpensively of new materials and painted with new paints, developments in medicine which may eventually outweigh even the staggering losses of this World War, and so on.

Here indeed is a heartening picture of the chemical industry as a whole, painted by one of its ablest members. From such a picture can be gleaned an assuring view of the future possibilities of this esoteric industry which holds such tremendous possibilities.

WELDING AND CUTTING

ONE of the hottest flames produced by man—at a temperature of some 6300 degrees, Fahrenheit—is being applied in many ways to aid forced-draft war production of fabricated metals in many forms. This flame, furnished by the oxy-acetylene torch, can weld metals together in a joint stronger than the metals themselves, can cut many metals apart in a fraction of the time consumed by other methods and with a minimum of loss, and can be used to surface-harden or to clean metal surfaces preparatory to painting and similar operations.

These lines are not intended to detract from the value of electric-arc welding, but rather are written to clarify the oxy-acetylene situation, to point out the uses of this versatile flame, and to indicate general ways in which these uses will extend into the future.

None of the welding methods in use today is exactly new, except in refinement. These refinements, and mass methods of application, however, have meant a tremendous speeding up of many industrial processes. Welded ships probably symbolize most graphically the construction methods using welding which are speeding the war effort. Within these ships, also, are found other products of the oxy-acetylene torch—metal sheets and plates of various thicknesses cut to exact sizes to fit the spaces assigned to them. These sheets have been cut—often in duplicate—by the same gas flame that later welded them together in an unrelenting embrace. So accurate is the cutting flame, in fact, that complicated machinery has been designed to guide the flame as the operator follows a pattern; many such machines use multiple torches to speed up work, or one torch may be used to cut a series of plates stacked one on top of the other.

Then there are methods of surface-hardening metals using the oxy-acetylene flame to heat the surface, which is then quenched by one of several means. Lastly, the same flame will clean surfaces of rust, paint, scale, and so on.

We have heard much of this industrial tool during the war speed-up; we will hear more of it in the future.

—*The Editors*

Portentous Eclipse

The Recent Eclipse of the Moon, an Odd One, Afforded Astronomers More Fun than Usual

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

GREAT numbers of people must have watched the eclipse of the Moon on August 26th. Observing conditions, in this part of the country at least, could hardly have been better—a brilliantly clear night with the eclipse coming on in the evening and at its maximum a little before midnight (more than an hour before, were it not for "war time") so that the eclipsed Moon, despite its southern declination, was well up in the sky. The writer, who has seen a good many lunar eclipses in his time, wonders how many of the thousands of watchers realized that they were beholding something so unusual that, to the experienced eye, it seemed to be almost what the ancients called a "portent."

The early stages of the eclipse passed off as usual—the dimming of the eastern edge of the Moon by the penumbra, or half-shadow within which the Earth hides part but not all of the Sun; the "bite" out of the Moon's edge as the actual shadow—the umbra—enters upon it; and the gradual realization that this shadow is not completely dark, but that the eclipsed part of the Moon is faintly visible.

As the Moon swept deeper and deeper into the shadow, one noticed, as usual, that this illumination was fainter and redder in the inner part of the shadow-circle than near its edge. Then came the surprise—the upper right-hand edge of the Moon became much fainter than the rest. The dark area spread and, near the middle of totality, the Moon looked as the writer, at least, has never seen it before—with dark center and a light ring all around its periphery. Then the eastern edge slowly brightened, and the dark area moved toward the western side as the Moon passed away from it toward the light.

The faint reddish illumination of the eclipsed Moon is normal: but the presence of a relatively small and conspicuously darker spot within it is so unusual that the effect was uncanny.

Like all other "portents" in the heavens, it has of course a perfectly natural and fairly simple explanation—which, this time, demands only the drawing of a few diagrams.

Figure 1 represents the general circumstances of a lunar eclipse. It is very far from being drawn to scale. The Sun is about 50 times bigger and several thousand times as far off in comparison with the size of the Earth: but it illustrates the geometrical relations none the less. Since the Sun is larger than the Earth, the true shadow, or umbra, of the latter from which all direct light is excluded is a cone (shown in cross-section on the diagram) which tapers to a point P lying about four times as far away as the Moon's orbit. Outside this is the widening cone of the penumbra—shown by dashed lines—from which part, but not all, of the sunlight is cut off.

IF the Earth, like the Moon, was a naked body without atmosphere, the umbra would be entirely dark, except for the very faint light of the Sun's extended corona, and the eclipsed Moon would be invisible. Close to the edge of the umbra where, for an observer on the Moon, the inner corona and perhaps some prominences would be visible, there might be illumination enough to make a ghost of this part of Moon show up against the dark sky. But with the Moon near the center of the shadow all the brighter part of the corona would be hidden by the Earth and there would be nothing to see.

The Earth's atmosphere, however, being denser near the surface, acts like a lens and refracts the rays of light which pass through it inward from what would otherwise be the dark shadow, lighting it up feebly; and it is by this refracted light that we see the eclipsed Moon—as is illustrated in the figure. Rays that have just grazed the surface of the Earth are deflected inward by about 68′—far enough to carry them a little beyond the Moon's center, even when it is nearest, but not enough to take them to its opposite edge; which, however, will receive sunlight that has come close to the other side of the Earth, as a glance at the figure shows. To be deflected to the center of the umbra, at the Moon's surface, the sun's rays must pass within about a mile of the Earth's surface. A deflection of half this amount demands that the rays shall pass less than five miles above sea-level; rays with a minimum altitude of ten miles will be deflected by about one seventh of the angle to the center.

Now rays which pass as close to the surface as the first of these have a long path through the atmosphere. Even with the clearest air they are greatly weakened by the scattering of light out of the direct beam. This affects the short waves most, and results in the redness of the setting Sun, as well as the faintness of its direct light.

If the Earth's atmosphere was perfectly free from clouds and haze, the Moon, at the very center of the shadow, would still be faintly illuminated by light of the quality of a clear sunset. An observer on the Moon who happened to be for this moment at the central point of the umbra would see a narrow brilliant line of light, completely surrounding the huge disk of the Earth, and colored as the setting Sun looks to us in the fairest weather. As the Moon's motion carried him off-center, this ring would grow fainter on the side where the rays were most deflected, and soon disappear; but on the opposite side it would grow wider, brighter, and not so red—since the rays which formed it had traversed fewer miles of air and been less depleted, so that the total illumination in this vicinity would increase.

A TERRESTRIAL observer, viewing the Moon under these conditions, would see it feebly illuminated—faintest and reddest at the point corresponding to the geometrical center of the shadow—and gradually grow brighter and less red in regions remote from this. The graduation of this illumination would be smooth, with no dark patches in sharp contrast—and this is very much what is usually seen during a lunar eclipse.

Suppose next that, all around the Earth's edge, as seen from the Moon at the time of eclipse, the weather was bad, with clouds and haze piled to a depth of four or five miles. The light which would otherwise have been directed into the inner parts of the umbra would be blocked by these clouds. In the symmetrical, but exaggerated, situation which we are imagining, no light at all would enter the

central part of the umbra. If a screen three times as big as the Moon could be set up, just behind the Moon, to show the whole umbra at once, we would find the outer parts of it illuminated much as usual, but the inner region black and big enough, in the special case which we have assumed, to hide the Moon completely.

Actually, of course, the weather will not be clear everywhere along the 25,000-mile belt of the Earth's surface along which the sun's rays graze it at the time of mid-eclipse, nor will it be cloudy everywhere. If the clear and cloudy regions are distributed at random along the belt, our imaginary lunar observer will see the ring of light surrounding the Earth interrupted in many places and the illumination of the surface will be weakened: but this weakening will be general all over the Moon's surface, with no conspicuous bright or dark spots. But if the clouds are localized in one region extensive enough to cover a considerable area of the Earth's edge as seen from the Moon, the illumination of the side of the umbra toward this area will be cut down, while that of the rest will be normal.

We have then to ask what distribution of clouds will account for the remarkable dark patch. The best way to answer this is to draw a diagram of the actual situation at mid-eclipse, which is shown in Figure 2. The large circle represents the umbra, as it would have been projected on a screen just behind the Moon, and the smaller one the Moon itself at the middle of eclipse — 11:48 P.M., Eastern War Time. At this time the Moon was about 11′ north of the center *C* of the umbra. At about this time (the writer unwisely failed to keep a note of it) the dark spot in the shadow was very nearly central on the Moon's disk and of roughly the size indicated by the dotted circle. It was therefore far out of center in the umbra, and the light which failed to reach it evidently did so because it found obscuration along the region of the Earth's edge indicated by the arc *AB* in the figure. At this time the Moon was overhead at a point in longitude 56° West, latitude 10° South in central Brazil, and the Sun at its antipodes in the China Sea West of the Philippines; and the circle half way between them, along which the Sun's rays grazed the Earth, ran from the Black Sea across the upper end of the Baltic, near Spitzbergen, across the northern edges of Greenland and the Arctic Archipelago, down to British Columbia, and into the Pacific about half way between California and Hawaii. All along this line, from Norway far into the Pacific, the weather must have been bad, or, at least, cloudy.

When the dark spot extended farthest from the center of the umbra, it reached nearly half way to its boundary. To produce so great an obscuration, the clouds above the Canadian shore of the Arctic Ocean must have extended to a height of about four miles—which is a reasonable enough figure.

Above Antarctica, on the contrary, the air must have been very clear, for on the Moon's limb, south of the center of the umbra, the illumination was fairly strong.

Just what distribution of open patches between clouds let in light enough at the edges of the obscured region to make the dark spot so nearly circular would be hard to figure out—especially as the problem probably admits of many solutions.

But it is evident that all that the weird celestial portent meant was that the weather was bad somewhere else.

There may still be romancers who may argue that the thing had something to do with the war. If such folks are amenable to reason at all, they may be recommended to consider that the region in which the obscuring clouds occurred is about as remote from military activity as any part of our planet, except the Antarctic where conditions were quite different.

The brightness of the eclipsed Moon is one of the few astronomical phenomena which is really unpredictable. Some day, when men know far more about the weather than they do now, they may be able to predict in advance how high the clouds (if any) will be in the Arctic and Antarctic — but, considering the complexity of atmospheric circulation, this seems very remote. Meanwhile, it is of interest to note that this unpredictable phenomenon is not only observable from the Earth, but that it would easily be observable and perhaps more easily measurable from Venus or Mercury, provided that intelligent inhabitants could exist upon them.

—Princeton University Observatory, September 3, 1942.

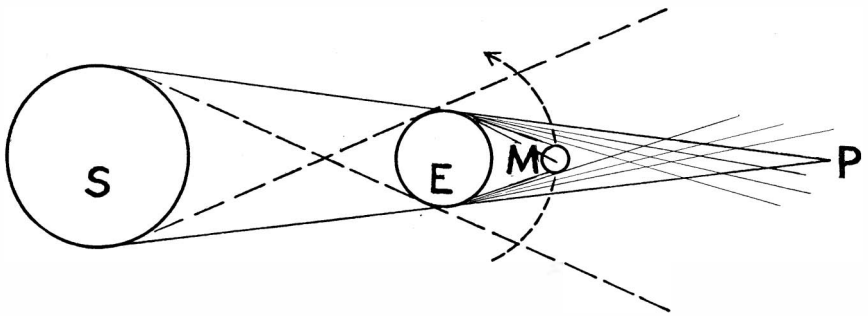


Figure 1: **See the text**

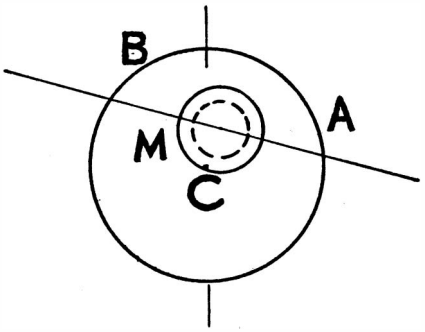


Figure 2: **The situation**

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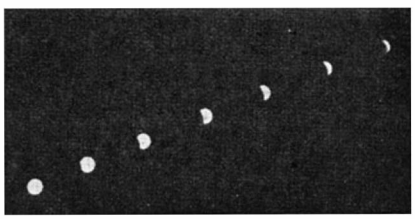


Part of the eclipse, photographed at 10-minute intervals (9:50 to 10:50 P.M., E.W.T.) by Dr. Henry Paul, Norwich, New York, amateur telescope maker. A series of eclipse photographs may be made with a camera, but the results will be disappointing. Without much difficulty a small telescope—say six inches aperture—may be rigged as a special camera to do a better job. In "Amateur Telescope Making," Harold A. Lower gives instructions for this. The image at the telescope's focus will be about half an inch in diameter, but it is so bright that it may be magnified by an eyepiece to about an inch and still be bright enough to photograph with an exposure of less than one second. The eyepiece is mounted in a simple box and a ground glass is used to determine the exact best focus. A plate in a plate-holder is then substituted and an assistant is posted in front of the telescope with a black cardboard, held over its front but not touching. The slide is removed, then the card is moved away edgewise and replaced as quickly as possible. If the exposure is short enough the image will not blur due to the moon's orbital motion. A clock-driven telescope will obviate these last difficulties.

Tunneling Under Difficulties

Part of the Delaware Aqueduct Was Drilled at Great Depths, Yet Was Finished in Half the Allowed Time

R. G. SKERRETT

EXPLOSIVE gas and high-pressure water, stored in bedrock 400 feet below sea level, were the unforeseen obstacles overcome by the contractor in excavating a stretch of 75,000 linear feet of tunnel beneath a spur of the Catskill Mountains. That section of tunnel, the longest unit of the Delaware Aqueduct, will help to carry greatly needed additional water to New York City's more than seven million people.

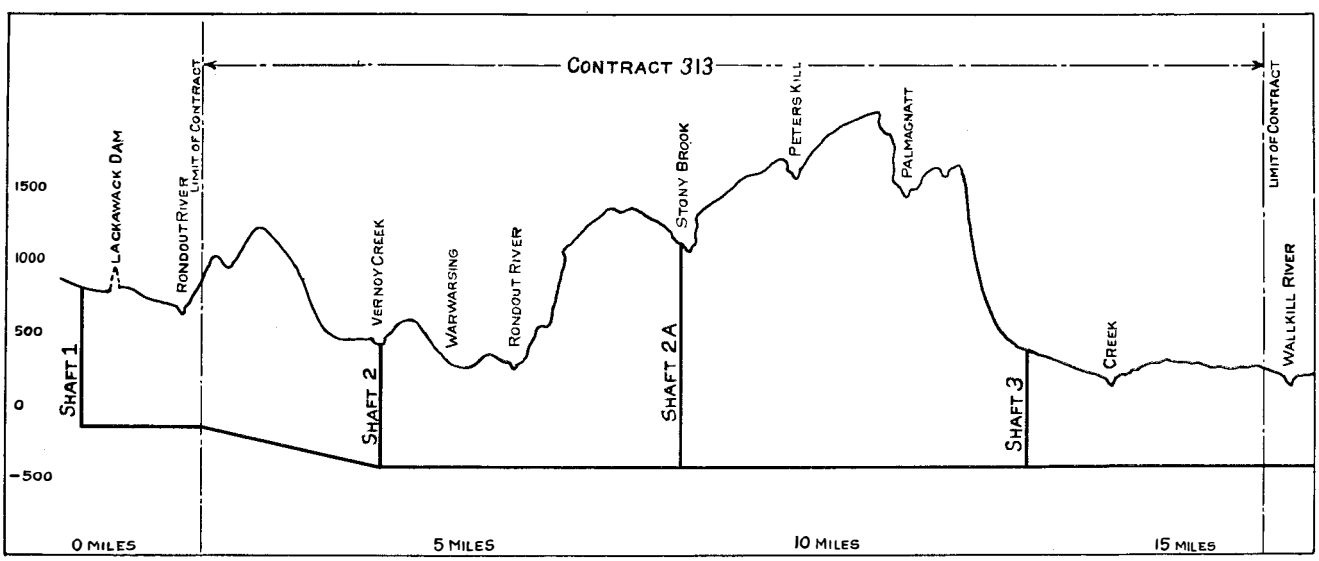
The engineers of the Board of Water Supply of that city designated that the tunnel should be driven deep in ledge rock, and that the conduit for the man-made river should have a finished diameter of 13.5 feet inside its thick concrete lining. At a depth of 400 feet below sea level, the engineers counted on finding sound rock to form the outer walls of a section of tunnel that would have to withstand a bursting pressure of 540 pounds on each square inch of internal surface. But Nature interposed difficulties.

Shawangunk Mountain, under which most of the more than 14 miles of tunnel passes, is a tremendous rocky mass that towers 2400 feet above the tunnel line and exerts an enormous downward pressure on the rock through which the bore has been excavated. When that mountain was shoved upward at some remote age, the previously horizontal layers of rock forming the earth's crust were bent, folded, and in places broken like a titanic jelly roll mishandled in the making. In time, great quantities of water and marsh gas—methane, highly explosive when mixed with ten times its volume of air—were stored in areas of the fractured and shifted rock.

STILL another hazard existed. The tunnel had to be driven through rock that was under very heavy stress, like an enormous spring under compression. When tunnel-driving offered release for those pent-up forces, the rock in the roof of the tunnel and at the heading burst inward with explosive force. To prevent the "popping rock" from injuring the workers or damaging tunnel-driving machinery, about 90 percent of the tunnel roof had to be supported by a strong protective grid of structural steel members requiring the use of 40,000,000 pounds of that metal. The roof support reached to the very rock face, where a battery of pneumatic drills drove 40 to 50 holes, into which were loaded the shattering explosive charges. Before the last of the rock was broken through in this tunnel unit, the contractor, Samuel R. Rosoff, Ltd., had used 1550 tons of dynamite in opening up the 75,000-foot section of tunnel, generally excavated from 17 to 19 feet in diameter. One stretch of that tunnel that penetrates unusually difficult ground had to be excavated to 24 feet in diameter. It was while doing this latter work that the contractor had to battle long and strenuously against grave odds to work his way forward.

PRIOR to starting the driving of the long tunnel under Shawangunk Mountain, the Board of Water Supply had another contractor sink three shafts about five miles apart, along the tunnel line. (See the drawing.) The purpose of those shafts was to provide access later for the tunnel-driving contractor so that he could tunnel in each direction from the bottom of each shaft. Thus he had six points of attack which would help to shorten the time required in tunneling the whole 75,000 linear feet. The westernmost of the three shafts, Shaft 2, was sunk to a depth of 825 feet to reach the planned tunnel line. The central shaft, Shaft 2A, was sunk from a point high up on the western slope of Shawangunk Mountain and carried down to a depth of 1551 feet. It is the deepest of all the shafts on the Delaware Aqueduct. Shaft 3, near the eastern foot of the mountain, is 840 feet deep. The shaft-sinking contractor was required to drive 200 feet of tunnel, both north and south, from the bottom of each shaft to give the succeeding contractor space in which to set up his underground machinery for promptly beginning the main operation of tunnel-driving.

While driving the 200 feet of tunnel northward from Shaft 2A, some of the rock-drill steels penetrated a cav-



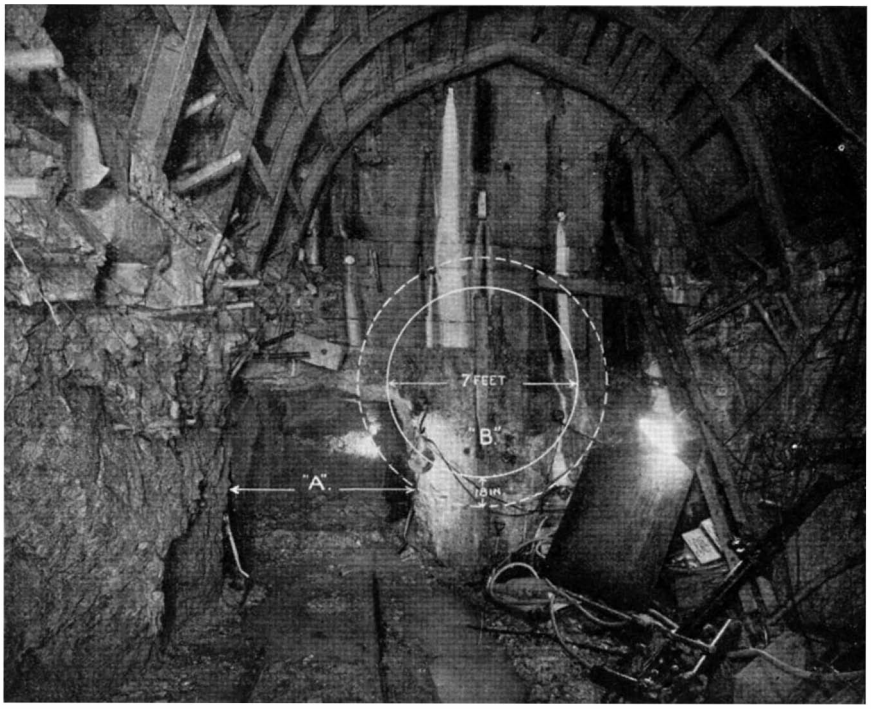
Route of the tunnel section described in text, showing depths, lengths, and shafts

ity filled with compressed methane, and the released gas poured out into the tunnel heading from the rock face, mixed with the air, and in some way was ignited. The scorching blast that followed injured to varying degrees all 18 of the men at work. That was the first warning of what lay ahead for the contractor who would have to drive the long tunnel section. Experts of the United States Bureau of Mines promptly visited the scene and reported that it would be hazardous to continue underground operations unless means were provided for quickly disposing of all incoming marsh gas before it could form an explosive mixture with the free air in the tunnel. They specified that at no time should the marsh gas in the tunnel air exceed the trifling amount of 0.25 percent. Care was also to be taken that there should be no sparking of electric machinery, bare flames, or smoking.

The tunnel-driving contractor prevented the marsh gas from doing harm by employing an unusual system of tunnel ventilation. Near the top of each shaft, he placed large motor-driven blowers from which two metal vent pipes, each 28 inches in diameter, led down the shaft and thence, one each, to the opposite headings. At the rock face of each heading, a battery of pneumatic drills, mounted on a mobile drill carriage, drove holes deep into the circular wall, and into each hole a charge of dynamite was loaded. When all the holes were fired, the rock was shattered for a depth of 10 or more feet.

At the front of the drill carriage, top and bottom, were two suction intakes, each eight feet long and five inches wide—like gigantic vacuum-cleaners—that continually sucked away the air close to the rock face. The strong suction at those intakes—that picked up both dusty air and any marsh gas that might issue from the rock—was created by a powerful Roto-Clone blower mounted on the drill carriage. The blower discharged backwards through a fabric duct into the nearby open end of the big metal vent pipe, and the suction of the blowers at the top of the shaft drew the inflow speedily surfaceward and scattered it to the breeze.

The suction of the blowers caused a replacement flow of fresh air down the open passages in the shaft and then steadily onward to the headings. This stimulated circulation prevented any dangerous accumulation of any marsh gas in the tunnel sections and kept the air at all times remarkably clear and comfortable for the workers. Normally, in similar tunnel operations, ventilating blowers force air down through the vent pipes and to the headings; but such a course on the job under Shawangunk Mountain would have speedily distributed any marsh gas coming from a rock face and have increased the likelihood of a disastrous explosion.

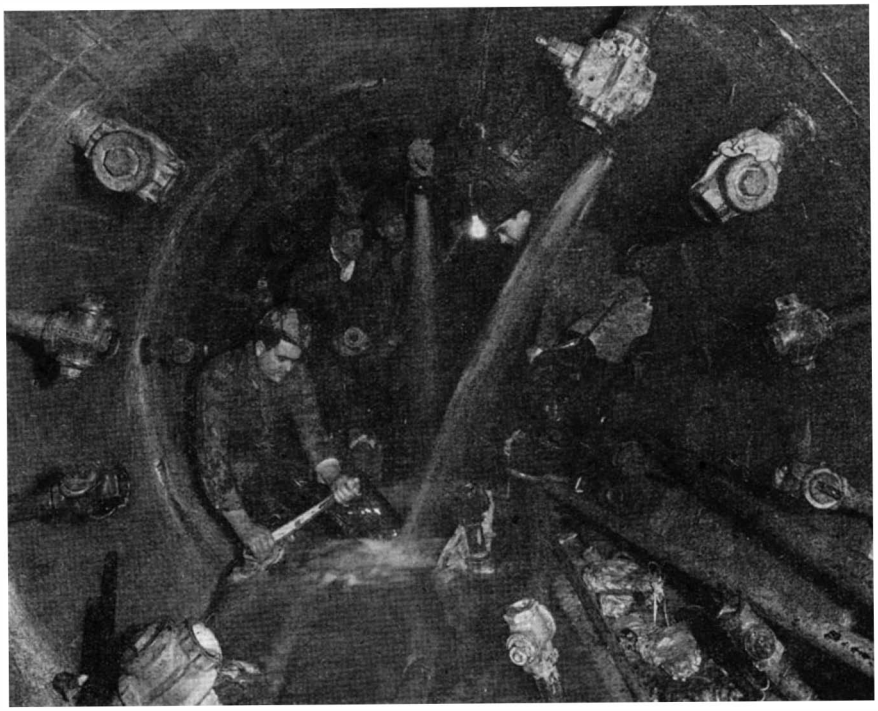


The bulkhead that closed the heading of the tunnel against rapidly inflowing water. Lower left, at "A", is the first flanking drift that had to be abandoned. "B" indicates the seven-foot "barrel drift" which was eventually lined with 18 inches of concrete

THE exhaust or suction method of ventilation made it possible to use Diesel locomotives, which previously were not permitted underground. The locomotives on this tunnel section have pulled heavy train loads of concrete for the tunnel lining at high speeds, thus hastening the work and shortening the time before more mountain water can be transmitted to New York City.

The resourcefulness of the engineers on this job was put to the greatest test in their battle with high-pressure water while driving the heading southward from Shaft 2. The gangs, working in three shifts of eight hours each, drilled, blasted, and removed the broken rock without cessation during each 24 hours. This work went on steadily for nearly seven months, during which the heading advanced a total distance of 6778 feet. Then scouting or exploratory drill holes, driven deep in the rock beyond the face, tapped water that flowed into the tunnel at an hourly rate of 24,000 gallons. Prepared for such a contingency, the men promptly moved special pumps up to the "firing line" and forced a mixture of cement and water—grout—into the hidden water-bearing limestone to arrest the inflow. It took 6000 bags of cement to bring the water under control. Tunnel driving was resumed and went ahead 175 feet, when another scouting drill hole again struck water that discharged forcibly into the tunnel. Once more grouting was used with some success; but shortly thereafter other exploratory holes increased the incoming water to 400 gallons a minute. Tunnel-driving was then halted lest a source of water be tapped that might inundate the entire tunnel section. The battle line had to be reformed and strengthened to avoid sudden disaster.

The entire rock face of the heading was covered and sealed with a reinforced-concrete wall or bulkhead 10 feet thick; and, when water still came through the lower part of that barrier and the rocky floor of the tunnel at that point, the bulkhead was fortified with a supplementing wall of reinforced concrete 18 feet thick, reaching from the floor up to nearly half the height of the bulkhead. Through the total thickness of 28 feet of the combined barrier, four-inch steel pipes, embedded in the concrete, were used to guide drill steels in making the next exploratory drill holes; at the tunnel side each pipe was fitted with a valve that could be closed to shut off water that might issue from the rock when penetrated. The same pipes, with the valves open, could be used to



Inside the "barrel drift" with water coming in through still-open pipes. Through these same pipes drills were run and a special grout mixture forced under high pressure

force grout into the rock ahead at pressures as high as 1000 to 2000 pounds per square inch.

Gages attached to some of the drain pipes registered a water pressure of 290 pounds per square inch, indicating that the water entering the tunnel was in some way connected with Rondout Creek, the surface of which lay 650 feet above the tunnel itself. The creek water had worked its way through the ancient bed of Rondout Creek, 400 feet thick vertically and formed of sand, gravel, and boulders deposited when glaciers had covered the countryside. This water had continued downward through fractured and fissured ledge rock that had a thickness of not less than 260 feet and that lay squarely across the line of advance for the tunnel. Here was difficult and dangerous ground that had to be penetrated with a minimum of lost time if the tunnel were to be completed. The methods that were used proved to be highly successful, although the first attempts at conquering the bad ground met with complete failure. But once more the engineers were resourceful and attacked the problem from another angle.

When grout, forced through drill holes to a distance of 70 feet ahead of the bulkhead, did not seal the water-bearing rock, a flank movement to sidestep the bad ground was made by driving a small tunnel or drift, eight feet square in cross-section, through the lower left-hand face of the bulkhead, to be used to try to consolidate the outlying water-bearing rock by grouting from that passage. When the inflow of water attained 2100 gallons a minute, after the drift was driven for a length of 87 feet, that excavation was abandoned and filled from end to end with concrete.

Before the drift was started, the engineers had erected a second line of defense in the form of a second concrete bulkhead 73 feet back from the bulkhead at the rock face. At the floor level and in the center of this bulkhead there was left a rectangular opening for carrying on operations, and that opening was fitted with a swinging door of massive steel that had an upper and a lower panel. It could be closed quickly, if needed, to prevent any sudden inrush of water sweeping back into the remainder of the tunnel. Large pipes, piercing the lower part of this bulkhead and fitted with valves, were to release water held between the two bulkheads and allow it to accumulate in a sump on the tunnel side of the barrier, where a group of pumps would pick up the water and send it onward to the bottom of Shaft 2. There another group of pumps, with a capacity of 9550 gallons a minute, raised the water up the shaft to ground level.

THE final means adopted by the contractor's experts to get through the bad ground and to plug the water-bearing rock was a small tunnel—a so-called "barrel drift"—circular in section and seven feet in diameter inside its 18-inch lining of concrete. That tunnel had its center just below the axis of the heading. It was advanced in five stages, of different lengths, for a total distance of 226 feet, and the forward end temporarily closed with a concrete bulkhead six feet thick. One hundred days were required to make that progress.

As the "barrel-drift" went forward, grout was forced into enveloping rock, at each of the stages. This was done through radiating holes, arranged like the spokes of a wheel, drilled through pipes embedded in the concrete lining and arranged in a ring-like formation every four feet of the length of the small tunnel. Each ring had 14 pipes that could be closed with valves at their inner ends. The drill steels, because of the confined space in the drift, were progressively lengthened in jointed sections like some fishing rods, and their full length was great enough to penetrate 10 feet of the rock outside the final excavated diameter of 24 feet of this particular tunnel section.

Grout of a special cement mixture was forced through the pipes and the drill holes of the "barrel drift" and into the water-bearing rock at a pressure of 2000 pounds per square inch, after each drill hole had been flushed with water at the same pressure to clear the way for the sealing mixture. When the heading of the drift reached sound rock beyond the water-bearing zone, the bulkhead in the "barrel drift" was demolished and drilling of the enlarged tunnel face was carried forward in the normal manner. Later, the main bulkhead, the "barrel drift," and the massive emergency bulkhead were cleared away, and the 24-foot tunnel section was excavated for 750 feet. That was done so that the ultimate diameter of 13.5 feet of the aqueduct could be successively lined with concrete, and reinforced outwardly with supplementing walls of steel plating and other steel and concrete.

BUT for the successful use of the "barrel drift" and the method used in sealing the bad ground which carried water at high pressure, the year of delay in advancing the heading south from Shaft 2 might have been a much longer one. The chief engineer for the contractor has stated that without using the means employed to shut out the water, the leakage might have reached the staggering total of 50,000 gallons a minute! The contractor was allowed four years in which to make the tunnel excavation, and yet, in spite of all the trouble encountered in battling with marsh gas and high-pressure water, the 75,000-foot tunnel section was holed through in a trifle more than two years.

OUR *Point* OF VIEW

PLANNING FOR PEACE IS PROGRESS

MUCH as normal man dislikes war, much as he yearns for peace and for the benefits that derive from peaceful pursuits, much as he protests against the wastefulness of war, he must grudgingly admit that many of the developments which are making war more and more horrible will ultimately make the peace more and more desirable. This, bear in mind, is no brief for war. Rather, indeed, it is an acceptance of the present war as a job to be done with at least a thought for the future.

In our issue of October was presented the first part of a two-instalment article surveying the effects of present operations in industry as they will be reflected in the peaceful world of day after tomorrow. Part two will be found on page 203 of this number. The thoughts presented in these two articles are, we feel, as completely divorced from wishful thinking as is possible under the stress of wartime production. They reflect vividly the determination of American industry as a whole to learn its lessons, no matter how distasteful these lessons may be, and to emerge from the present conflict with a completely new set of data on which to base a better world.

There can be no question but that the end of the war will find great changes in all industrial endeavors, that these changes will involve far-reaching dislocations on every industrial front, that these changes will in many cases be disastrous. Just how disastrous, of course, will depend largely upon how industry accepts its own responsibilities, how it plans today for the future.

It was with this last-mentioned thought in mind that the above described industrial survey was made. Every industry, large and small, simple and complicated, must realize now that not only its own future, but the future of the world as a whole depends upon this kind of planning. Such a realization will behoove every responsible man in industry to subject himself and his work to a critical analysis.

How is *your* industry planning now for the days of peace? How will *your* industry stand in the world of tomorrow when a new concept of living is rising from the knowledge gained through the war effort? What can *you* do now to aid in insuring industrial prosperity with a minimum of dislocations after the war?

A searching self-analysis on this basis can be stimulating and truly helpful. Others are doing it, as our survey results show. Everyone in industry should do it for the greatest good to the greatest number.—*A.P.P.*

IN APPRECIATION OF DOCTORS

YOU have worked too incessantly for too many years and are tired out, and you finally have to go to a doctor. He tells you what you probably pretty well knew already—that you must slow down or go down.

Let's assume that you follow this doctor's advice—but do doctors follow their own advice? Not too often. They keep on working till they drop. Is the tradition that doctors die too young from overwork true, or only a manner of speaking?

A Brooklyn doctor has found an interesting way to get the answer, which is: the more successful the doctor, the sooner he dies. Each week in *The Journal of the American Medical Association* there is a long series of obituary notices of deceased doctors. Each notice lists the dead doctor's life attainments. Naturally, some of these notices are long, some of medium length, others short, and it happens that, for reasons of appearance, the printer arranges the notices in order of length—longer ones preceding shorter ones. It occurred to the Brooklyn doctor that this weekly list, thus arranged, might provide an opportunity to determine "what price success" in medicine. So he analyzed 30 such weekly lists and found that the average age of death of the first ten doctors on them was 64.6 years, while the last ten doctors—they who had served faithfully but not gained prominence—lived on to 69.3 years. Thus the price of success proves to be about five years of a doctor's life.

The chances are that, if you are "successful" enough in your own vocation to be tired out from incessant work and forced to hunt up a doctor to tell you to ease up and go fishing, you will also be in a position to hunt up one of the more "successful" doctors. He, of course, will simply fortify your existing suspicions with enough added resolve to make them stick, and you then will take the needed rest, while he will go on working—and dying.

Now he's a doctor and he ought to know better and he does. But he also is human, and it's human to give advice that we don't ourselve take—most of us are a little that way.

But that's not the main reason for the tired doctor's keeping on and on. He doesn't find it simple to cut suddenly loose from his practice. Too many people have come to depend on him, or think they do. He can't simply fold up and walk out—or, if he can technically, he doesn't feel he can morally. All through his working life he has had to become accustomed to the fact—and it is a fact—that a doctor *doesn't really own himself;* he's a kind of public institution, or public utility. So in his subconscious if not in his conscious mind he knows he's digging his own grave. yet he's a kind of soldier—he's in it and will go through with it.

And for all of this, much of which it is feared the rest of us take for granted—if we even stop to think of it at all—the doctor richly deserves our appreciation. Five years is a high price.—*A.G.I.*

THE STRANGE CASE OF SYNTHETIC RUBBER

INTERESTING is the report of the Baruch committee on the rubber situation. Especially so is that part which criticizes governmental agencies for the handling of the rubber program and which refers to errors "growing out of procrastinations, indecisions, conflict of authority, clashes of personalities, lack of understanding, delays, and original non-use of known alcohol processes." Strange indeed is any failure to take advantage of knowledge that is already part of the record.

Science can point the way toward new processes and industry can put them into use, yet all efforts can be in vain in a national emergency if those in high governmental positions refuse to recognize their duties.—*O.D.M.*

Miracle Beans

Long called "The Cow of China," the Soybean is Now Invading Almost Every Field of Endeavor

AMERICA in general has just begun to "discover" the widely varied possibilities of the soybean. Henry Ford makes steering wheels of it, midwestern farmers look on it as a promising money crop, diet and health practitioners are starry-eyed about its protein, calcium, and iron content, but these things are only a start. Dig deeper into the subject and you'll find that the little bean is a capital meat substitute; that coffee, cheese, candy, salad oil, lubricating oil, printer's ink and celluloid and glue, airplane bodies and rubber substitutes, are made from it. It's good for cattle—good for dog food and linoleum and paint and rayon panties, good for explosives, good for building bone and muscle in fighting men. It's a fine forage crop, and, like alfalfa, it will enrich the soil.

But five years from now, when the present war has made the soybean as familiar an institution in American life as cellophane and synthetic rubber, it will be well to remember that the "discovery" of today was known to the Chinese thousands of years before the birth of Christ. The emperor Shen Nung speaks of it in his "Materia Medica," written in 2838 B.C. Whole ages before this—before man had learned to scribble on stone walls or papyrus—a legend was current which has been handed down in northern China and Manchuria to the present day, telling how man first became acquainted with the soybean.

A caravan of merchants, says the legend, was homeward-bound, loaded with gold after a successful trading expedition, when it was attacked by bandits. Taking shelter in an easily defended ravine, the traders held off the attackers for several days until their food ran low. Starvation threatened—until one of the servants returned to camp with a sack of beans he had found on a vine-like plant which the animals were eating. They mashed up these beans to a paste with a little water and baked them—and on this crude biscuit the famished men regained enough strength to hold off the attackers until help arrived.

The Chinese have looked on the soybean as their staff of life for ages. Many of them have never tasted any milk but that of the soybean, which costs a quarter as much as cow's milk but contains food values that are amazing. Long has it been called the Cow of China. The Orient uses the bean not so much as a vegetable as for making cheese, sauce, bread, and meat substitutes. For thousands of years it has been the basic protein food in Manchuria, China, Korea, Japan, and the Malay Peninsula.

Soybeans on the Ford Farms

Courtesy "Ethyl News"

Soybeans first came to America in 1804 on a clipper ship whose Yankee master had ordered several bags tossed into the hold in case his provisions ran low. Admiral Perry brought home two different varieties from Japan in 1854—but until the Department of Agriculture began a systematic study of the soybean shortly before 1900, it was regarded merely as a botanical curiosity in this country. William J. Morse, now senior agronomist of the department, is the man who has worked for 34 years with the quiet fervor of a missionary to bring the miracle bean prominently into the agriculture of this country.

His efforts are now bearing fruit. In 1929 we grew nine million bushels. In 1939 we grew 91 million bushels. It's our fourth ranking cash grain crop; we grow as much as Manchuria. The Cow of China has become a hundred-million-dollar American industry.

Why? Because the little bean really is remarkable. It actually does all those different things you hear about. The plant itself makes excellent fodder for animals, or a wonderful soil-enriching crop, and it brings nitrogen to the soil. It gained its first real impetus in Illinois, now America's biggest soybean region, when farmers planted it to revitalize the land after the reckless forced growth of corn there during the last war. But it is the bean itself, the actual fruit of the plant, which has turned out to be the treasure chest from which today's scientists are extracting food and industrial products.

The secret of the soybean's versatility lies in its chemical composition: 40 percent of it is protein, highly digestible, and another 20 percent is fat, which can be squeezed out or chemically extracted as oil.

More than three fourths of the oil now goes into food products, with the bulk of the rest going into paint, lacquers, and soaps. What's left after the oil has been extracted makes soybean meal, almost all of which is used at the moment in feed for livestock. Out of the 5 percent that does not go into animal feed we get plastics, flour for baking, glue, fertilizer, dog food, breakfast cereals, macaroni, baby foods, reducing diets, and diabetic foods—for which soybeans are admirably suited, having a very low starch content.

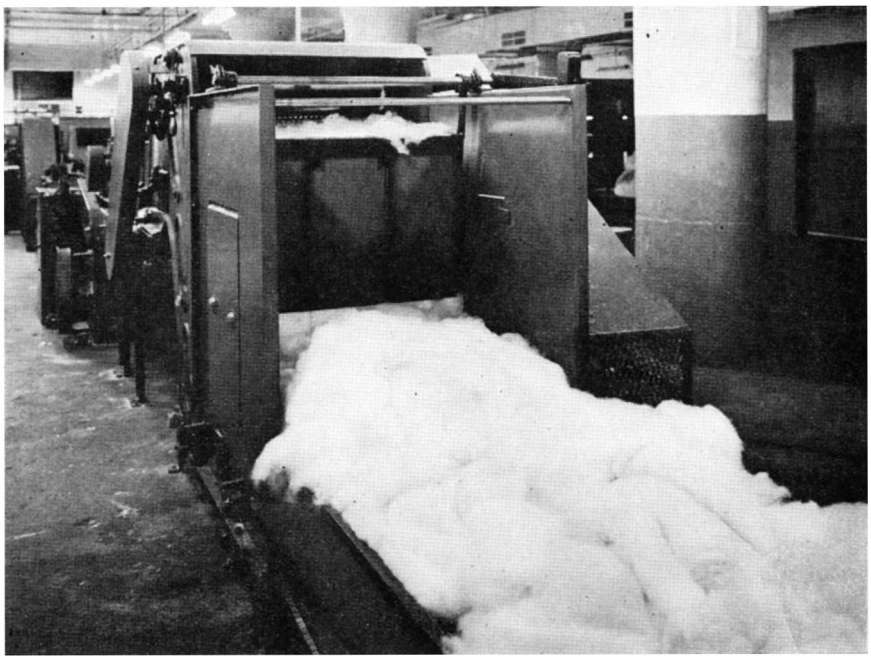
Soybean oil is now an economic rival of cottonseed oil and peanut oil in the commercial vegetable oil market. It has one great advantage here. Grown on mechanized farms with little human labor, the soybean crop can expand as rapidly as the industrial market demands. Soya oil, like many

petroleum products, is refined and hydrogenated; refining makes it sparkling clear and almost tasteless, while hydrogenation stiffens it to the consistency of cooking shortening—into which many tank carloads of it now go.

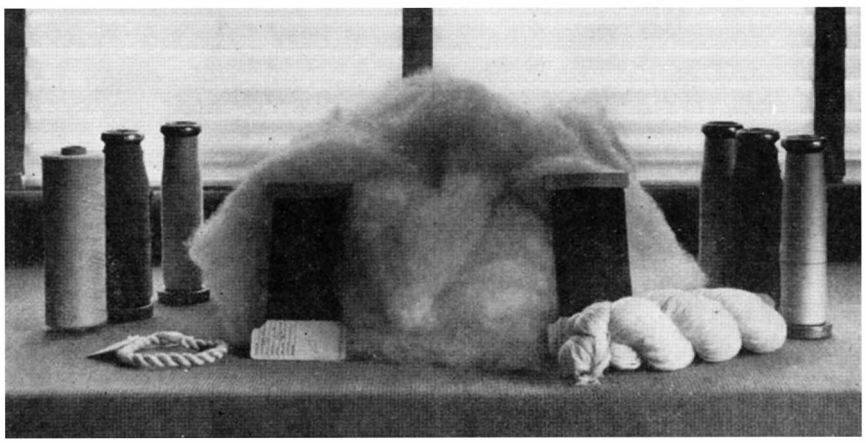
It has an overwhelming advantage as a protein food also. Usual sources of protein are meat, fish, milk, and eggs — all of which need refrigeration. But soybean meal contains a great amount of protein—and it can be shipped dry, with no cooling. This fact, plus its high nutritive value, are two reasons why the Army is using it in its new super-pemmican, Para-ration. Although our national demand for soybeans in recent years has run only about 25 million pounds a year, in 1941, Lease-Lend to Britain took 40 million pounds.

One proof of the value of soybeans in a wartime economy is the importance the Germans attach to them. When Hitler and Stalin were still "friends," Germany siphoned a steady stream of beans from the Orient across the trans-Siberian railway; there were all sorts of disappointing delays, but enough beans got through to give the Germans a four-year supply. The Russians also were growing a fine crop of beans for Hitler but somehow the harvest went into Russian bins instead of railroad cars headed for the German border. This was just as well for the Allies, because the two dictators had a misunderstanding shortly afterwards and Hitler put his chemists to work on the task of making a super-explosive out of soya oil.

To show how versatile a vegetable is the soybean, look at a list of the other things Hitler could make from soya oil besides explosives. He could produce (and we're doing all this in the United States today) glycerine, printer's ink, waterproofing for umbrellas and other fabrics, leather dressing, paper coating and sizing, lubricating oil, lighting oil, enamels, varnishes, paints, soap, rubber substitutes, and lecithin. What is lecithin good for? It makes an excellent coating for chocolate confections — keeps them fresh and adds a certain nutlike flavor. It's used in the manufacture of linoleum for your kitchen floor, and rayon for eking out the country's supply of silk. And it's used a good deal as an anti-sludge stabilizer in gasoline.



Soybean fiber, being carded here, has possibilities as wool replacement



Soybean fiber, loose skeins, bobbins of yarn, on cloth made from the fiber

Most of us recall a newspaper picture some time back of Henry Ford whanging an axe into the rear of one of his cars. He was demonstrating, dramatically, the toughness of a trunk door made of soya plastics as compared with a similar door made of standard sheet metal, in which a similar axe-blow left a gaping wound. Such pictures and stories have helped greatly toward making the public realize how much pioneer work Ford has done in finding industrial uses for the soybean and other products of the farm. In the past few months alone his laboratories have developed from soybeans water paints which stand up under a lot of abuse from the weather, and which photograph poorly from the air. They are thus excellent for camouflaging buildings, an important phase of defending our industries from attack—and have the further advantage of being easily washed off after the need for camouflage has passed, provided they are applied over the proper preparatory base. Soybean meal, made into a protein solution, can be coagulated into thread for fiber; this fiber has possibilities of replacing wool, which is now on the priorities list. It resembles wool in its general characteristics, has a natural crimp, and is about 80 percent as strong, with good possibilities that the strength will be increased. Ford fiber has been used by commercial mills to augment the supply of wool; apparently it will eventually make satisfactory felt blankets, hats, sweaters, and suits. Henry Ford has a suit made of 25 percent soybean fiber. His Highland Park mills, set up originally as a pilot plant, produced 1000 pounds of fiber a day at half the cost of sheep's wool before they were moved to Dearborn to go into increased production. Robert Boyer, his brilliant young soya reasearch chief, points out that two acres of land used as grazing pasture for sheep will produce eight to ten pounds of wool a year. Two acres planted in soybeans will produce 400 pounds of protein suitable for fiber.

Boyer's most interesting contribution, however, has not been soybean cloth or even the plastic dashboards and in-

Preparing a soybean plastic molding compound

strument knobs he casts in such bright colors. He has devised tough, lightweight, fiber-and-plastic sheets suitable for molding into automobile, jeep, or airplane bodies—tough enough to resist even an axe, as Henry Ford demonstrated for the newspaper photographers.

In these structural sheets, soybean meal furnishes the bonding resin rather than the actual fiber. (Experiments with soya fiber show that it produces very hard but very brittle sheets.) Long and short fibers of hemp, flax, and ramie are mixed and floated in water into a mat which is roughly the shape of the mold to be used. This mat is dried and impregnated with the soybean resin binder, then placed in a mold where heat and pressure shape it to the proper form —tough, polished as smooth as the mould itself, already colored without painting, and practically impervious to heat or moisture.

Since this molding process took six times as long as stamping out steel sheets for bodies, Boyer developed a method of stacking six molds simultaneously in the same press, so the output was the same. And since the plastic sheets had only half the tensile or "tearing" strength of steel, they were made doubly thick—and turned out to have collision-proof qualities ten times superior to those of steel. No jagged edges, no permanent dents. The post-war automobile body, as Ford envisions it, will be made of these plastic forms bolted in place to a tubular steel framework which will replace the conventional chassis. The body will weigh only half as much and the car as a whole will weigh only 85 percent as much as the 1942 models did.

One company is now making military airplanes with molded bodies in which soybean resin is used as the waterproof binder. Controls and ignition parts on many planes are cast of soya plastics—and the sand cores used for castings, both metal and plastic, in many defense plants are held together with a soya binder. This war has truly been an incubator for the soybean, giving it new life in a hundred new uses which would have been beyond the conception of those beseiged merchants who, in desperation, first ate the bean to stave off starvation so many centuries ago.

But let us not lose our perspective, and succumb to the popular misconception of soybeans as being primarily grown for industrial uses or for sauce in Chinese restaurants. Only 5 percent of the soybean meal produced and only 15 percent of the oil extracted go into industrial use. Soybeans are still primarily a food crop, for animals and for us. If we have to feed half another continent after this war, we could not ship any other food as nutritious, as full of minerals and vitamins, as rich in protein, as versatile in such a variety of dishes and forms, as the soybean—and this is worth noting, since we may find ourselves the Granary of Democracy after we get through being its Arsenal.

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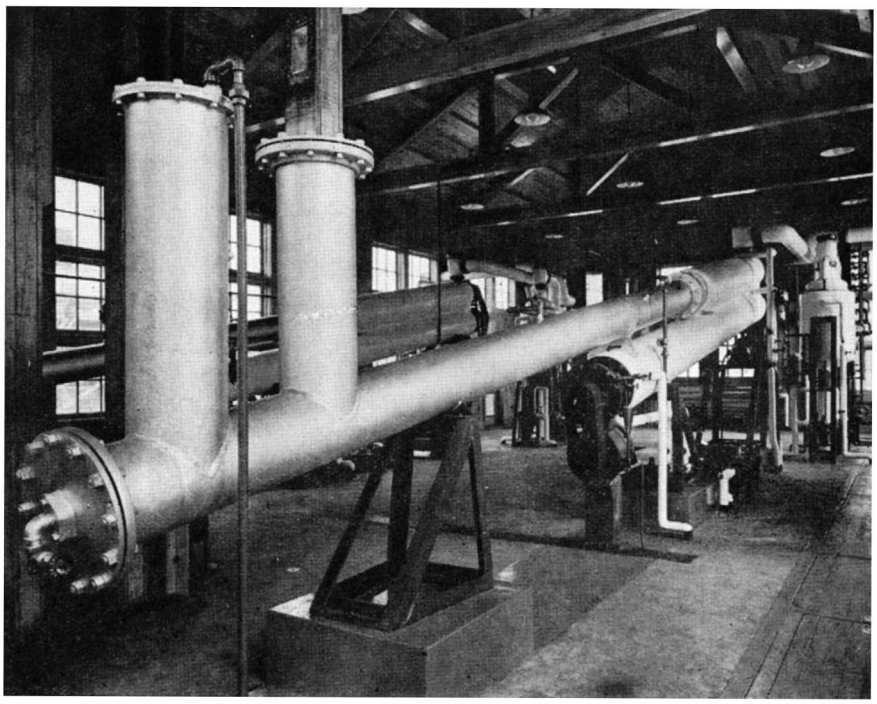
PARTIAL PREFABRICATION

Modern Phase In Building Construction has Advantages

WHEREAS the prefabricator of six years ago constructed the "packaged" house in its entirety and shipped it to buyers throughout the country, ready to be assembled on the site in a few hours, the mushrooming of the prefabrication industry in the last six months, due to necessity for immediate large-scale housing units, has introduced a new factor into house construction. This is the advent of a middleman into the prefabricating field—the partial prefabricator—who justifies his existence by supplying "parts" or sub-assemblies to the actual "prefabricating contractor" at the job.

After a trial-and-error period, a number of prefabricators found the "packaged" house construction impractical except in the immediate vicinity of the mill. Now, however, a number of companies that have gone into the partial-prefabrication field are producing portions of houses for which their plants are most fitted—wall sections, windows, doors, steps, and so on. These parts are then supplied to the actual prefabricating firm on the job



Equipment used by Ford for extraction of oil from soybeans

Next to the Stars and Stripes . . .

AS PROUD A FLAG AS INDUSTRY CAN FLY

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

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

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

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

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

Make Every Pay Day "Bond Day"

U. S. WAR Bonds ★ Stamps

This Space is a Contribution to Victory by SCIENTIFIC AMERICAN

though it may be thousands of miles distant.

An example of this is the Speedwall Company, a division of I. F. Laucks, Inc., which started as prefabricators in 1936, and have built hundreds of prefabricated houses for various government and private agencies throughout the country.

The Speedwall Company is using its machinery almost entirely now for partial prefabrication. One of its principal products is giant plywood board for both exterior and interior use. A feature of the Speedwall board is that its construction is such that it is applied cross-grained to the studding. This gives a wall construction more than four times as rigid as when the plywood is applied with face grain parallel to the studding. The giant board is eight feet wide, and is run off in a continuous line like newsprint paper. Thus it can be cut to any length as required by the prefabricator.

Another partial-prefabrication is the construction of double-wall sections—containing both the interior and exterior walls of a house. The company has found that they can glue up double wall sections at the rate of 310 lineal feet of 8-foot-high partitions per hour, or 2480 lineal feet per 8-hour shift. This is enough double wall sections for 20 complete average 5-room houses per day.

The prefabricator, now that a great deal of his work has been taken over by partial-prefabricators, has become, in many cases, virtually a local distributor or assemblyman—often a general contractor, or an alert dealer. He purchases prefabricated portions of homes from various partial-prefabricators throughout the country, assembles them for occupancy on the home grounds, speeding the job and bringing all of the building industry's factors into the prefabricating picture.

PIPE FINDER

Makes it Possible to Avoid "Striking Oil"

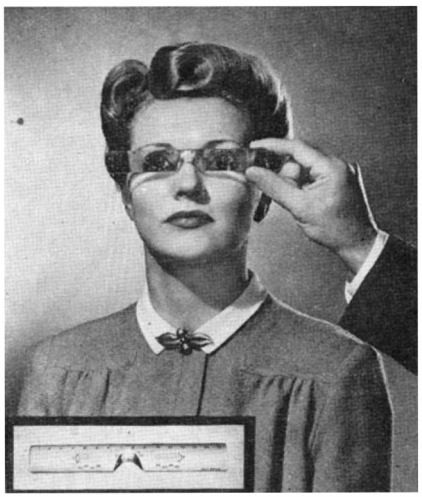
THERE have been many sorts of divining rods for locating buried treasure, ranging from the forked hazel twig of the "water-witch" to the modern electrical detectors for locating buried cable or pipe. Perhaps the "last word" among the lot is the type developed by the Bell Telephone Laboratories, which is so accurate that it can determine within less than an inch, both laterally and in depth, the position of a telephone cable buried three feet or more underground.

This detector is also useful in locating pipes and other metal obstructions beneath the surface, as, for example, where a new cross-country cable is being plowed underground. On one 83-mile run recently in constructing a major telephone route, there were 91 crossings of oil pipe lines. By determining these locations, telephone engineers were able to avoid "striking oil" the wrong way, and also saved valuable time.

DISPENSOMETER

Aids in Accurate Fitting of Eye-Glasses

A NEW optical dispensometer molded of crystal clear "Lucite" methyl methacrylate resin combines in one instrument everything required to obtain



"Has everything" for eye-glass fitting

measurements for accurately fitting glasses to a patient's face.

The transparent plastic instrument magnifies the pupil of the eye almost three times for vertical measurements, affording greater accuracy and easier visibility to the optician.

Fitting snugly over the bridge of the nose and containing all the necessary rules and scales, it is light in weight, virtually unbreakable, and can be sterilized in any of the usual cold antiseptics.

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KEROSENE—Even in this age of progress in electricity, there are still more than 2,000,000 dwelling units along the Atlantic seaboard which use kerosene or gasoline for household lighting.

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SHELTERBELT TREES

Set New Survival Record

TREES planted in the shelterbelts of the Prairie States Forestry Project last year made the highest survival record since the project, now completing its seventh year, was started. According to the United States Department of Agriculture's Forest Service, the survival shown by sample counts taken in the six prairie states was 82 percent compared to 79 percent in 1940, the highest previous record, and the low of 52 percent in 1936, the worst drouth year.

Last year's planting of 2702 miles of shelterbelts on 4696 farms brought the total to 16,104 miles on 26,375 farms. The field windbreaks, many of them more than 35 feet high, will provide the basis for protection of crops and soils on approximately 3 million acres of land or an area almost equal to the size of Connecticut. This protection, afforded where trees are already high enough, will aid in meeting food production goals.

Many of the belts planted six or seven years ago, the Forest Service reports, are already yielding fence posts and some fuel for their farm owners as a result of thinnings being made under the general supervision of foresters charged with responsibility for the project.

CONCRETE SEALING

Liquid Material Retains Water for Curing

A CLEAR liquid that is sprayed on wet concrete after finishing or on formed concrete after the form has been removed, seals the surface to retain water and thus facilitates curing. This liquid, known as Tru-Cure, does not affect the color of the concrete yet gives moisture retention of about 96 percent after 24 hours at 110 degrees, Fahrenheit, and 90 percent after seven days.

CONTAINERS

Use Cellophane to Replace Metals

A THIN transparent film of cellophane—a thousandth of an inch "thin," to be exact—is tackling the job of replacing thousands of tons of steel, tin, and rubber in the packaging of foods and other essential items for America and her allies.

One of the most important of the new cellophane applications is in the fiber "can," where it adds its protective values and strength when laminated to cardboard. Some of these "cans" resemble the familiar cylindrical ice cream container; in others the metal can body is replaced by laminated board and cellophane, with the metal ends attached in the usual way, saving 60 to 80 percent of the metal. Already hundreds of thousands of this type of package have been used to pack lard and baking powder. Ex-

periments have shown that many other products now packaged in metal containers, such as syrups and greases, powdered foods, coffee, and various oils, may also be packaged in this manner. Even concentrated fruit juices have kept fresh for months in such cardboard, cellophane-lined packages.

Another widely used form of package might be termed the bag-and-box; a leak-proof cellophane bag is formed inside a carton—or fabricated as an integral part of a carton—and tightly sealed merely by heat. Vegetable shortening and quick-frozen foods are among the foods packaged in this manner.

Curiously enough, when cellophane is added to paperboard, as in the cardboard "can" or the bag-and-box package, its use is exactly similar, both in principle and actual weight, to tin added to steel in the form of tin plate. So cellophane is replacing tin pound for pound and is enabling cardboard to replace steel many times its own weight.

Still another saving achieved by cellophane is in its conservation of metal through substitution for foil which has been used in great quantities in wrapping processed cheese. Until fairly recently the 325,000,000 pounds of processed cheese produced annually in this country used 4,600,000 pounds of foil. Air-tight, moisture-proof film does this job effectively, preventing the cheese from becoming rancid and moldy and dry.

VITAL MATERIALS

Formerly Imported, Now Produced at Home

A BRIDGE of ships spanning the Atlantic, spaced only a trifle over one mile apart, would be required to bring to America just five of the many vital war products which the chemical industry has developed synthetically since 1917.

That is the direct contribution which research laboratories and chemical developments have made in the last 25 years to alleviate the acute shipping shortage of today.

The five products are nitrates for explosives production and other uses; rubber for a mechanized army and necessary civilian transportation; dyestuffs for uniforms, various types of military equipment, and civilian clothing; fibers for parachutes, powder bags, and essential industrial uses; and camphor, used medicinally and in the manufacture of many chemical products essential to the war.

To bring these things to America in the quantities either required this year, or, where such figures are unavailable, actually imported before the chemical equivalent was in production, would require 2682 sizeable cargo ships. The distance from New York Harbor to Queenstown is 2842 miles. These ships spread over that distance from the Battery to Ireland would be just over one mile apart.

Of the products, the only one that would actually be obtainable, no matter how many ships were available, would be nitrates, with Chile the main known commercial source of natural supply. Before being made in America by the chemical industry to meet peacetime needs and now translated to vital wartime necessities, all the other products came from what are now enemy sources.

Not only is there no necessity now for protecting the 2682 ships on a voyage from Ireland to New York or its equivalent, but these ships are vessels which in all likelihood will never need to sail again. For when this war is over, the greater part of American needs for rubber may well be supplied by the man-made chemical equivalent.

A few years ago the only source of camphor was the natural product from Formosa. Du Pont now makes

all the camphor it is called upon to provide from Southern pine and at a fraction of the cost.

Importations of crude rubber in 1940 amounted to 814,604 long tons, according to figures of the United States Department of Commerce. It would take 270 medium sized ships to carry a cargo of that amount from the East Indies to the United States. Because of the great distance this is the equivalent in ton-miles of at least twice as many ships, or 540, making the run from Europe to the United States.

To bring from Chile the nitrogen needed to sustain the rate of explosive and fertilizer production, and other necessary chemical uses, during the second half of the calendar year 1942, would take 300 sizeable ships making seven round trips a year.

Since dyestuffs, silk and camphor are relatively concentrated products, comparatively little shipping space is required for them. Yet in 1940, a year of very restricted buying of silk, Department of Commerce figures show 44,857,055 pounds were imported. During 1913, the last year of unrestricted purchasing of dyestuffs from Germany, 42,840 tons of dyes were imported, chiefly from Germany. During 1917, before the development of synthetic camphor, 8,621,000 pounds were imported.

The shipping requirements for these products would be 42 ships making a 2800 mile run—equivalent to the Atlantic crossing—yet the requirements of the American industrial machine now for the equivalent of these products are larger than in the years during which the Commerce Department figures were taken.

Thus the long arm of chemical research reaches out, not only to make the American industrial war effort easier, but to relieve the most acute of all present problems—shipping—and to give the United Nations the vital materials required to win the war.

MORE BUTTER

Assured by Protecting it from Mold

More than 75,000,000 pounds of butter will be wrapped in specially impregnated parchment paper during the current year to protect it from losses due to mold, reports the Du Pont Food Research Laboratory. Great quantities of butter are expected to be saved from spoilage as a result, thus helping to conserve stocks.

Mold rarely can be recognized in butter except by an "off" taste, according to food experts. Its growth can be retarded, even in warm weather,

however, by wrapping the butter in paper treated with a mold inhibitor. The baking industry also is attacking the mold problem in baked goods by incorporating mold retardants in increasing quantities of bread, pies, and cakes.

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FISH PONDS—Fertilization of fish ponds results in increased growth of small plant life. This in turn makes possible a greater production of fish, in a ratio of about 500 pounds of fish per acre from a properly fertilized pond to 100 pounds for the average unfertilized pond.

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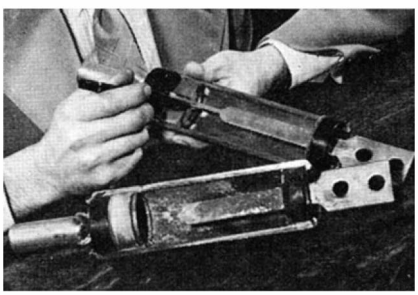
CIRCUIT BREAKER

Designed to Foil Sabotage of Power Lines

DEVELOPMENT for war factory power systems of a new noise-proof "safety valve," called a limiter, that snuffs out 54,000-kilowatt torrents of electricity—equivalent to more than 70,000 horsepower—has made possible a new sabotage-proof method of distributing high-voltage power in factories.



Power-snuffer guards against sabotage

"In this new system of industrial power supply, known as a secondary network, two separate circuits supply power to all parts of the factory," said Mr. J. M. Wallace, Westinghouse engineer who developed the limiter. "If one circuit is damaged, by sabotage or a short circuit, the other circuit keeps electricity flowing to machines turning out war materials.

"The limiter was needed to protect these double-circuit cables against serious damage from a short circuit, which might be caused by worn out insulation, by water seeping into a cable, or by a wrench falling across bare conductors.

"Such a short circuit melts a pencil-sized copper bar inside the limiter, disconnecting the circuit. Otherwise, the short circuit might damage the cable more seriously and spread to adjoining cables. Once blown, the inexpensive limiter can be replaced by a new one."

The average 600-volt factory power cable is expected to carry only 460 kilowatts of electricity normally. The engineer stated that the limiter is so designed that it will not go into action as soon as this normal power is exceeded, but will wait until the short circuit power builds up to many times the normal amount.

"This delayed action is desirable, because most cables can carry an added electrical load for a short time," he said. "If the limiter waits, the trouble may clear itself, avoiding power interruption for the replacement of a blown limiter. For example, if a wrench were accidentally dropped across the power lines, it might soon melt, ending the cause of the short circuit."

But if the short circuit becomes serious, the limiter goes into action, stopping the electrical flow in a sixtieth of a second, Mr. Wallace explained. It does this by heating a narrow section in the copper bar through which the electricity is flowing to more than 4,000 degrees, Fahrenheit, transforming it into a vapor. Heat of the flowing electricity also releases a blast of gas from a piece of fibrous material surrounding the bar. The gas quickly blows out the electric arc between the melted ends of the bar, extinguishing the flow of electricity.

LIFE-SAVER SUIT

Can be Worn By Sailors on Duty

A LIFE-PRESERVER suit built to cope with today's wartime sea hazards and featuring "built-in" flashlight, knife, whistle, and yellow hood and yellow-palmed gloves is another contribution to the safety of American seamen. It has special construction affording improved protection for long exposure.

The new self-buoying garment being made by the B. F. Goodrich Company weighs a few ounces over 14 pounds and slips on over a sailor's regular clothes. In an emergency, it can be donned in a few seconds.

Weighted soles keep the wearer upright without effort, so that he floats

Not a "Zoot suit," but the latest equipment for saving lives of seamen, this zipper-equipped cover-all is self-bouyant, quickly donned in case of emergency

head and shoulders above the water. A specially designed neckband prevents leaking of air or water.

Tests have shown that the suit is "manageable" enough to be worn during duty on shipboard as a shield from wind and spray. In that case, the "non-skid" material of the gloves permits handling of equipment without slippage.

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WAR PROGRAM—For every hundred dollars spent in the United States War Program, $23 goes for airplanes; $21 goes for tanks, guns, and ammunition; $12 goes for transport, equipage, and miscellaneous supplies; $10 goes for naval ships; $9 goes for industrial facilities; $8 goes for posts, depots, and stations; $5 goes for merchant ships; $4 goes for stockpile and food exports; $3 goes for pay, subsistence, and travel for the armed forces; $1 goes for housing; $4 goes for miscellaneous war expenditures.

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ASIA'S SECRET

How Long Has Man Been in America?

SIBERIA holds the secret as to when the first human beings came to America, how they got here and whence they came, according to Dr. Edgar B. Howard, vice-director of the University Museum, Philadelphia.

But science cannot yet give a definite answer to the query: How old is man in America. Opinion in archeological and anthropological circles revolves around the estimate of about 10,000 years ago for the advent of man on this continent, Dr. Howard explains, but extreme estimates range from about 2000 B.C. to 70,000 years or more ago.

"Many secrets, so far as our own country is concerned, are locked up in Siberia," Dr. Howard said. "Until we know more of the glacial geology, anthropology, and archeology of this region, we cannot hope to answer, with any degree of satisfaction, questions such as that relating to migration routes, the culture stage reached by these early wanderers, and many others which are necessary as a foundation to a real understanding of American prehistory." — *Science Service.*

MINIATURE MOTOR

Runs on Dry Batteries, For Specialized Applications

AN electric motor that weighs only six ounces and measures approximately one by one by two inches, has recently been designed by Delco Appliance Division of General Motors for specialized industrial and other applications in war production. These motors operate at speeds ranging from 5000 to 12,000 revolutions per minute, with outputs of from one to two watts. Operating voltages may be 6, 12, or 24 volts, supplied by dry batteries, as required.

KNIFE SHEATH

Made of Plastic, is Light in Weight

REPLACEMENT of aluminum in non-military production is one of the side-

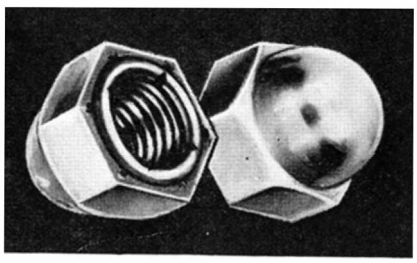
Another war-time metal replacement

line accomplishments of Plexiglas, which in itself plays an important military role in the form of transparent observation sections and turrets in bombers and fighters. One of its latest uses is in a knife sheath which fastens to the belt of packing-house workers; aluminum was previously used in order to reduce weight. The new sheath, formed from scrap pieces of aircraft plexiglas, is even lighter in weight than the aluminum, can be easily washed, has a sanitary appearance, and is extremely tough.

LOCK NUT

Locks to Bolt, Not to Work

A ONE-PIECE lock nut which anchors the nut firmly to the bolt and not to the work is shown in one of the illustrations in this column. These An-cor-lox lock nuts are provided with



Locking ring prevents "walking off"

a locking ring permanently inserted and forming an integral part of the nut. This ring is of a soft, non-springing metal which, when the nut is drawn up to the required tightness, spreads and flows inward around the bolt threads. This locking ring stays deformed even after removal and offers positive drag which prevents the nut from working off under conditions of vibration or shock.

SPEED IRON

Soldering Heat Reached In Five Seconds

A NOVEL departure in the design of soldering irons is shown in one of the accompanying photographs. The heating element of this unit is a loop of No. 11 copper wire, the ends of which are held firmly in place by means of two removable plugs. Contained in the housing just above the grip of the iron is a transformer, designed to operate on any standard 110-120 volt A. C. circuit. When the trigger in the handle is pressed, current from the transformer flows through the loop of copper wire, bringing it to soldering heat in an average of five seconds. The trigger switch is so arranged that

when the operator releases his grip on the iron the switch cuts off.

The manufacturer of this "Speedy Iron," Weller Brothers, states that the speed of action is such that there is virtually no waiting for the iron to attain heat. It requires an average of five seconds to pick up the iron and

Gun-like soldering iron heats quickly

place it on the work; the soldering tip is ready for operation by the time this has been accomplished. Since a standard type of wire is used for the tip, replacements are easily made.

GOLD LEAF

Production Aided by Air Conditioning

ONE of the most ancient arts and one of America's 20th Century industries have joined hands to facilitate the production of gold leaf, used in innumerable phases of modern life.

In order to obtain uniform gold leaf so thin that a pile of 1200 sheets is thinner than a sheet of writing paper, Hastings and Company, Philadelphia, one of America's oldest gold beating firms, utilizes Carrier air conditioning. For centuries, gold beaters, among the most skilled craftsmen in the world, were faced with the fact that variations in temperature and humidity caused the production of variable gold leaf. Goldbeater's skin for example, between which the fine sheets of gold are pounded, is exceedingly sensitive to moisture and its characteristics change if it becomes too moist or too dry.

Air conditioning equipment in the Hastings and Company plant, maintaining the temperature at 80 degrees and the relative humidity at 50 percent regardless of outside weather conditions, has made a modern contribution to this ancient art.

SOUND HELPS

Installations Made by Railroads, Ship Yards

THE American railroad system, hard-pressed under war emergencies, is being helped in its job of transporting men, war material, and the necessities of civilian life by a number of new sound installations recently made by

RCA. The Illinois Central is using sound to direct operations in one of its most important classification yards, and has installed complete radio and paging facilities on its new "Panama Limited." The Michigan Central is increasing the efficiency of its Detroit terminal by the use of a complete sound installation. A comprehensive system has also been installed by the Chicago-Northwestern Railroad in its Chicago offices and yards, while the Pennsylvania is putting special sound equipment in 40 coaches.

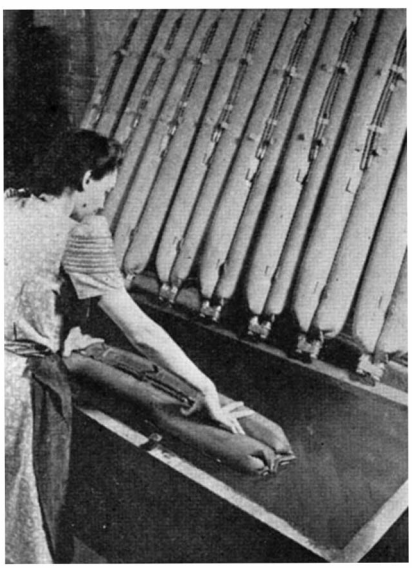
Among other important new sound installations is a "military" mobile public address system placed at the Tank Destroyer School in Texas. This unit is mounted on a trailer which can be moved to any part of the camp where it may be needed for both instruction and entertainment. So successful has been the installation that the first unit has been enlarged and expanded in usefulness.

A southern shipyard is using sound equipment to carry the ceremonies of launchings to all parts of the yard, so that employees can know what is happening without leaving their jobs. A second southern yard is using sound for communication between shore and ships being moved about from dock to dock during fitting operations. A measurable increase in efficiency has been noted.

BELT AT AXIS

Inflated With CO_2, Has Auxiliary Mouthpiece

DESIGNED to cope with today's sea hazards, a two-pound self-inflating life belt is now under production at a B. F. Goodrich plant. In one of our photographs is shown a rack of these belts awaiting test in a water tank. In use, the belts are inflated by a carbon-dioxide cartridge, but a mouthpiece and tube is attached to each of two rubberized chambers to enable wearers to maintain buoyancy when necessary.

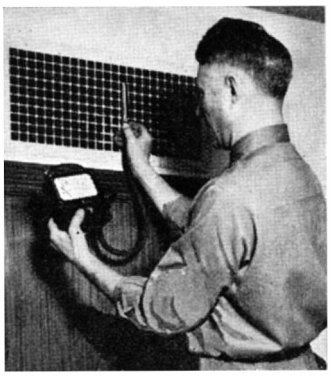


It floats, and supports the wearer

VELOMETER

For Direct Measurement of Velocity of Air Streams

AIR conditioning systems, both winter and summer, which require the use of forced air ducts, have developed a need for simple and accurate means of measuring air velocities. Thus, air conditioning engineers, architects, and others concerned with the distribution of cooling or warming air, will find many uses for the Alnor Velometer, shown in one of its forms in an accompanying photograph.



Indicates air currents on scale

In this instrument, which may be used with a variety of jets for application to different air measuring problems, there is a vane to which a pointer is attached, hair springs to control the vane, and a magnetic damping system.

It is unnecessary to include the time element in measurements with this instrument, as the pointer indications are a direct measurement of air speed.

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MOTHS—One female moth and her decendants in a single year, if unmolested, can destroy as much wool as 13 sheep can produce in the same period.

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WINDOW CURTAINS

Stop Light and Flying Glass Splinters

REINFORCED felted cattle hair is now being used to produce a blackout curtain which also serves as protection against flying glass. The reinforcement is in the form of wire mesh or a fabric center, and the curtain material is supplied in rolls measuring nine or twelve feet in width by 50 feet in length. Known as Ozite, this felted hair curtain is manufactured by American Hair & Felt Company.

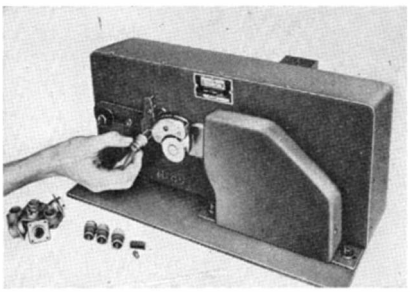
Industrial Growth

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

MARKING MACHINE

Uses Acid Dye to Make Permanent Mark

INK marking of tubular parts such as collars, rings, flanges, and so on is simplified with the new motor-driven



Speedy and easy to operate

machine shown in one of our illustrations. The marking may be applied to either smooth or sand-blasted finishes.

A marking speed of as high as 30 pieces per minute can be attained under ordinary conditions. In operation, the part is placed by hand on a protruding mandrel and the rotating die imprints the mark, whereupon the part is automatically ejected.

The ink used in this marking machine, manufactured by the Acromark Corporation, is a liquid dye with an acid content, dissolved in alcohol. The slight amount of acid in the dye quickly exhausts its energy after having etched the surface sufficiently to cause the dye to adhere permanently. The etching is so slight that the ink does not injure the surface nor is it dangerous to use.

It is claimed that marks made with this machine remain permanently in weather and handling tests as well as salt water, gasoline, and oil tests.

SAFETY SOLVENT

Developed to Replace Naphtha, Gasoline, Kerosene

A NEW hand-wiping safety solvent which is to be marketed as a safety replacement for naphtha, gasoline, and kerosene in removing cosmoline from rifles issued to troops, is also applicable for industrial use as a naphtha substitute for grease cleaning and hand-wiping operations in ordnance factories or shell plants. The new solvent, developed by The Curran Corporation, is marketed under its blanket trade-mark of Gunk XP-92; it is to be used as a concentrate and to be diluted with water.

This new solvent, in spite of its high solvency against mineral oil or dirt, does not de-oil the skin, has no toxic vapors, no flash or fire point, and leaves a rust preventive film so thin it cannot ordinarily be detected.

SHOP TRUCK

Motorized, Carries Loads to Half a Ton

POWERED by a single cylinder, four-cycle gasoline engine which develops over 7½ horsepower, a simple friction-drive truck is now available for industrial transportation. The body of this truck is so designed as to conveniently carry bulky material, boxes of parts, or long bars and tubes. The rear of the truck can be quickly fitted with seats so as to make the unit available for transporting officials and visitors around large plants.

The steering of this vehicle, recently announced by The Buda Company, is accomplished by one hand through an easily operated lever. The truck will turn completely around in a seven foot, three inch radius and, because of its three-wheel construction, can be maneuvered easily in narrow aisles.

Engine and gasoline tank are located under the seat, which can be quickly

For plant pick-ups and deliveries

thrown back to provide access to the entire power unit and drive. The brake is so arranged as to be controlled by a conventional pedal or to be automatically applied the instant that the operator leaves his seat.

PROTECTIVE OIL

Removes Surface Impurities,

Prevents Corrosion

OIL which is claimed to have the valuable property of completely removing perspiration, water, oil, and dirt from steel surfaces is known as Polar K, and is a development of The Curran Corporation. The new oil is said to be superior to alcohol for dehydrating and cleaning steel surfaces, bearings, or similar parts which have become wet or have been left with a film of grinding emulsion. It instantly displaces and absorbs water and leaves a thin film of lubricant and rust preventive. The Polar oil is completely soluble in hydrocarbon and lubricating oils and no subsequent cleaning procedure is necessary to remove the film.

WET GRINDER

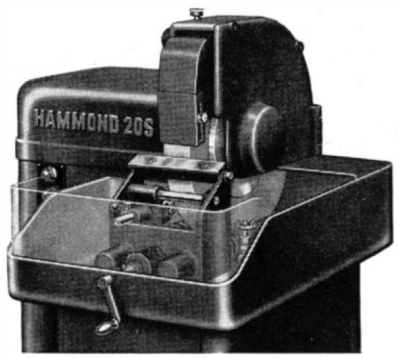
Large Wheel For Grinding

Hard Metal Tools

A NEWLY designed 20 inch wet tool grinder incorporates in its heavy, streamlined construction improvements for grinding all hard metals, alloys, and tungsten carbide.

The standard machine illustrated features a new tool rest and wheel dresser. The tool rest is adjustable to any desired angle and has a replaceable steel wearing plate. The wheel dresser adjusts in and out from the wheel by means of a detachable hand crank which actuates a protected screw mechanism. The circulating coolant system with regulating valve located in the sludge pan to the right of the tool rest, provides quick, easy regulation of the coolant flow.

The grinding wheel furnished with this product of Hammond Machinery Builders, Inc., is 20 inches in diameter by 2½ inch face with a 9 inch hole for mounting on a large-hole wheel flange. The heavy cast wheel hood with hinged cover provides easy and quick wheel changes.



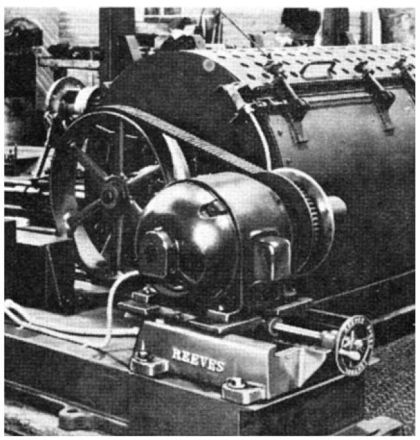
For heavy duty, high production

VARIABLE SPEED

Built Into Pulley

On Motor Shaft

INFINITELY adjustable over a three-to-one ratio of speed ranges for motors from fractional to five horsepower, a new self-contained motor pulley forms the actual drive element between the motor and the driven shaft. Thus all auxiliary equipment such as chain drives, gears, and so on are eliminated.



Not steps in speed, but any speed

This variable-speed device, manufactured by Reeves Pulley Company, consists of an assembly of two facing cone-shaped disks. One is stationary while the other slides laterally and is loaded by an adjustable compression spring. This whole assembly is mounted on any standard motor shaft. A motor base with an adjusting handwheel is also an essential part of the variable-speed drive. By means of this handwheel the motor, and hence the disk assembly, may be moved forward or backward. By means of this motion, the special V-belt used for driving is made to contact a changing arc on the disks. Thus, when the motor is nearest the driven pulley, the V-belt is at the largest arc of contact and maximum speed is obtained on the driven machine. Turning the handwheel so that the motor moves away from the driven shaft causes the V-belt to run over a smaller arc of contact and to reduce the speed.

With this pulley, belt, and motor base arrangement speed adjustability is infinite between maximum and minimum. Changes are made while the driven machine is running, and any required speed is accurately maintained as long as desired.

A Troopship Of The Sky

Cargo Planes of the United States Army Are Now Carrying Troops, Jeeps, Trucks, and Military Supplies

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

THE Germans were the first to grasp the tremendous possibilities of the theory that greater mobility in both offensive and defensive warfare could be secured by transporting troops and weapons by airplane. Their Junkers 52, a relatively slow and plodding but roomy and reliable type of plane, has been carrying supplies, weapons, infantry, and parachutists to Norway, to Libya, to the Russian front.

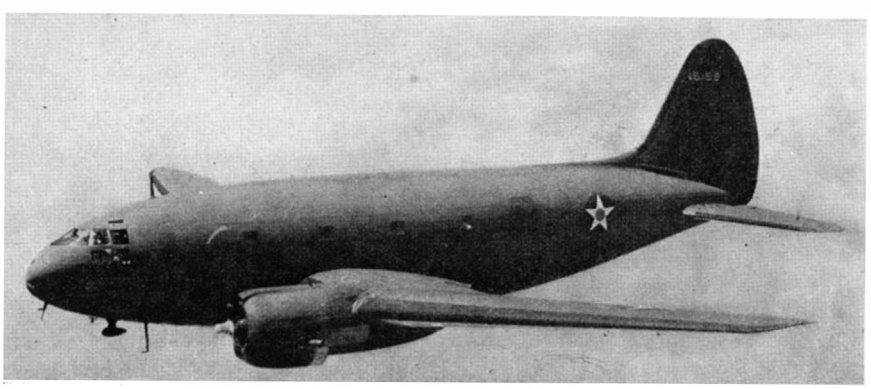
Our own Air Corps, or let us say rather our Army, was a little slow in realizing the potentialities of air troop transport. Today, however, thanks in part to the conversion of some splendid transport airplanes, we are as well equipped as any for aerial transportation; an endless stream of cargo ships is flying to China to replace the Burma road, to Northern Africa, and to other fighting fronts.

Now, for the first time, the War Department has permitted the release of pictures and information on the Curtiss Commando or C-46, a huge twin-engined airplane which originated as an airliner, and on which $2,000,000 has been lavished in five years of development and research. The Curtiss Commando has a wing span of 108 feet, a gross weight of 50,000 pounds when fully loaded, and is powered by 2000 horsepower Pratt & Whitney engines. (It is a sign of the fully cooperative spirit of the times that a Curtiss-Wright subsidiary readily accepted the installation of Pratt & Whitney engines because these were quickly available, instead of insisting on the use of Wright Aeronautical Corporation "Cyclones," which are in all respects the equivalent of the Pratt & Whitneys.)

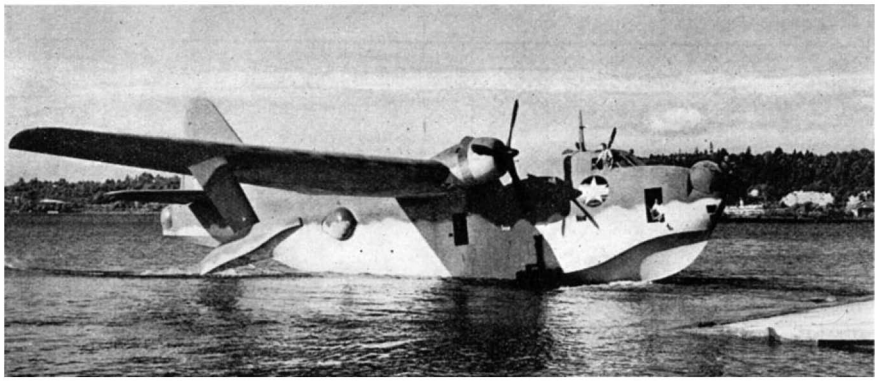
Special ramp permits rapid entry and exit of soldiers and vehicles

A huge door split in two parts and swung over head gives access to the interior of the Commando. With this door open and a specially designed ramp in position, a large group of soldiers can rush up or down the ramp at the double and enter or leave the spacious interior of the huge ship. The Commando can carry many other things than large bodies of men. Jeeps, for example can be driven up the ramp and right into the cargo compartment.

No details are given as to size or useful load of this transport, but we do know that the plane was originally planned as a 36-passenger luxury liner. Soft upholstery, roomy seats, wide aisles, and convenient lavatories



Windshield of pilot's cockpit in Curtiss Commando blends imperceptibly into streamlined fuselage. Small windows replace normal lavish window space of the airliners



While armament details of the side blister and peculiarly shaped nose of Boeing's new Sea Ranger are not available, they doubtless spell "trouble" for the Japs

have now given way to the vast interior of the cargo cabin. In one of our photographs is seen a "jeep" in the cabin, together with a number of fully equipped infantrymen occupying specially designed side seats.

The all-metal frame of the commando has been specially reinforced to accommodate heavy concentrated loads such as artillery, army tractors, trucks, aircraft engines, aviation gasoline, and other equipment and materials which may be required by a modern Army. That such reinforcement may well be necessary will be clear when we remember that in maneuver and under the action of gusts the dead weight of a two-ton truck may be multiplied into an effective, although temporary, weight of 10 tons or more.

While the Commando lands much more slowly than pursuits or bombers, as may be vitally necessary when landing in rough fields, and flies more slowly than such speed demons, it has managed to span the Atlantic in a nonstop flight of little more than nine hours.

To illustrate the cargo-carrying capacity of the Commando we are given this interesting piece of information by Burdette S. Wright, Vice-President in charge of the Airplane Division of Curtiss-Wright. "Twenty-five transports of this type would have transported all of the estimated 30,000 tons of material carried by 7700 trucks over the tortuous Burma Road during an entire month."

Commando's reinforced fuselage supports both troops and jeeps

THE SEA RANGER

From its Appearance, Bodes Ill to Japanazis

BOEING AIRCRAFT has produced a new type of naval aircraft, designated as the XPBB-I, which is intended for use as a patrol bomber, with a very long range, powerful armament, and a heavy bomb load. The Sea Ranger as shown in the photograph is to be in the same class for over water use as the Boeing Fortress for over land use. Why, then, only two engines? Because two enormously powerful engines will enable the craft to do all that four smaller engines can do, and reduce the complexity of installation. We have an analogy in the four-engined Douglas DC-4 for which the Curtiss-Wright CW-20 with its two engines furnishes a substantial equivalent. The Sea Ranger is of all-metal construction and has complete living accommodations for ten men when on an extended operational flight. The enormous size of the boat is well illustrated by comparing the size of the man with the cockpit from which he is looking out, and also by the man seated in a door of the hull proper. The nose has a curious shape and probably carries powerful guns. The windshield slopes back quite gently. We see a blister on the side of the hull which must mean more trouble for the Japs if they should ever attack the Ranger. One of the beauties of these large aircraft is that they can defend themselves against the most agile single-seater fighter. The boat has a pronounced, sharp keel line forward, which looks as razor-like as the keel line of the fastest surface vessel. The tip float mounted on a single cantilever strut seems to have the same hydrodynamic design. For the enormous powers involved, the three-bladed propeller is none too large.—A. K.

CAMERA ANGLES

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

At Service Centers

RECREATION centers for service men on leave have been set up in several places in New York City and in other parts of the country as well. Some of the visitors, whether of American, English or other nationality, make unusually fine subjects, especially when rigged out in their service costumes. Occasionally, one meets

"Eddie, of the Royal Navy"

very unusual characters, such as the 16-year-old English lad here pictured. Flash is the only practical lighting to use, in most of these cases; this one was taken with a single flash off the camera. Placing the figure against a dark flag made for a striking arrangment, and the lively expression gives the picture animation.

New Varigam Filters Cut Printing Time

A NEW type of filter for use with Defender Varigam enlarging paper has been introduced to cut the printing time without impairing contrast or other qualities. The new filters, which reduce the exposure time by half, are identified by the letter "F" following the usual designation, which now reads, for example, VG-3F. Filters nos. 9 and 10 remain unchanged, however.

Birds in Color

AN amateur ornithologist's color flash shots were recently exhibited at the Bronx Zoo, New York, where they were admired both by photographers and ornithologists—for their excellent technique by the first and their fidelity to colorings by the second. Dr. Eliot Porter, of Hubbard Woods, Illinois, who made the pictures with the aid of a Guggenheim Foundation Fellowship in Arizona and Illinois last year, achieved good results by adopting a standard technique: employing a 9 by 12cm Linhof equipped with an 18.5cm Zeiss Protar in a Compur shutter, and a Kalart Micromatic synchronizer, he shot Daylight Type Professional Kodachrome at *f*/18, with two G.E. No. 21B flash bulbs in 11-inch Victor aluminum reflectors, one on either side of the camera, with their rims 18 to 20 inches from the subject.

Incidentally, bird photographers may be interested in the standards Dr. Porter has adopted in his work:

"First, the birds must be neither out of focus nor blurred by motion; second, they must be identifiable insofar as is possible within the limitations of black and white representation; third, all other essential parts of the picture must also be in good focus and recognizable; fourth, pictorial standards of composition and execution must not be relaxed."

"Bleed" Prints

SOMETIME back someone approached us with an easel idea for making bleed prints—pictures without white borders—in which a great many criss-crossings of Scotch tape were to be employed to hold the paper in place during enlarging. The idea seemed rather impractical from several standpoints. However, we now see that someone is actually using a greatly simplified adaptation of the idea that serves the same purpose, without the necessity of purchasing a special easel. All he does is attach several strips of Scotch tape to his regular easel, sticky side up. You put the paper down and it sticks, flat overall.

Silhouette in a Gallery

SILHOUETTES have many variations. A bed sheet is a doorway with a light behind it and the subject in front is not the only way to shoot silhouettes. The accompanying one was taken from the

"Silhouette"

entrance to an art gallery, with a lady on a couch nonchalantly pulling on a cigarette as the unobserved photographer made his shot at *f*/6, 1/25 of a second. Two fluorescent lights illuminated the pictures on the wall; the lady, near the door, was almost completely in shadow. A straight print produced this result.

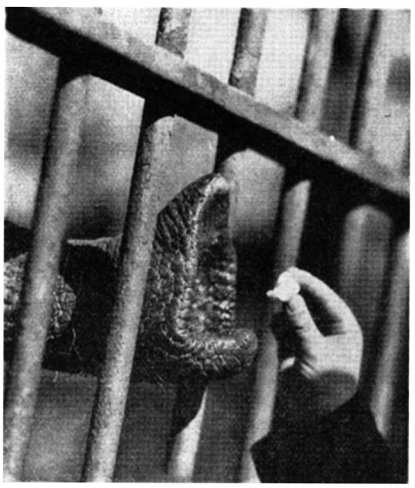
How Far from Subject?

WHAT is the correct distance between subject and camera for good perspective? This is a question that seems to bother a lot of people. The advice ranges anywhere from six to 12 feet. But there's a scientific rule that settles the matter not only for portraiture but for other subjects as well. Measure the distance from the part of the subject nearest the camera and the part farthest away; then multiply this distance by eight. The result is the distance at which the camera should be placed, measured from the nearest plane.

Thus, if the distance between the two limiting points of the subject is one foot, the camera should be eight feet away from the nearest plane. In the case of a head portrait, the distance might be five or six feet. If the image is too small, use a lens of longer focus, if this is available, or enlarge the wanted part of the image.

Zoo Epitome

THE simplest elements still make the most striking pictures. We don't have to see the elephant, nor the child in this picture to appreciate completely the familiar but always exciting experience recorded for us in the illustration by David B. Eisendrath, Jr., staff photographer for *PM's* Picture News. Part of a recent exhibition at the Bronx Zoo, the picture invariably brings a smile from both young and old, for who has not at one time or another offered peanuts or popcorn to the zoo elephant in return for the delightful experience of watching this favorite zoo attraction stretch forth his great, yawning snout to receive it? By concentrating his lens on essentials, Mr. Eisendrath has created a sort of symbol that fetches a universal response. The extremely shallow depth of field is due to the use of a 17-inch lens on a 4 by 5 Graflex, but note how the close view lends drama, life, and uniqueness to what might have proved just another shot of an already too familiar subject.



"Gimme"

Auto-Tire Frame

NOW that automobile tires have become so precious, why not take that spare into the house some time and use it as a photographic prop? As a frame, for example, per the illustration. A white-walled tire is best. The tire was placed on a box covered with black cloth, the lady put her head into the circle as well as she could and held the tire upright. One light at a 45-degree angle for general illumination and another very low in front to take care of the shadows, completed the lighting scheme.

Lady and the Tire

Typing On Glossy Prints

SHOULD you have occasion to typewrite on glossy photographic paper, we understand there is a ribbon specially produced for this purpose. It is called "Clear Presidential Silk Litho No. 3, Special Ribbon," and is available from the distributors, Stanley W. Arend Company. When ordering, it is necessary to specify spooling and to give the make and model of the typewriter.

Have You Tried Proof Paper?

IN the title we do not refer to the proof paper which produces the familiar reddish-image that is here today and gone tomorrow, but to the so-called Portrait Proof Paper produced by Eastman. Single weight, developing-out type, slightly slower in printing speed than Vitava Projection, Portrait Proof is intended for making proofs by contact, with reduced illumination, or by enlargement. Supplied in matte and luster surfaces in one degree of contrast for normal negatives, this paper has such a pleasing surface and produces an image of so fine a quality that it is steadily becoming rather popular as a medium for the finished print. Particularly suitable for soft portrait results and pictorial studies, Portrait Proof lends itself beautifully to toning.

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THERE are many general sex books—too many, some think, because these tend to be about alike, and they cover thinly a large territory. But the present work is rather more specialized—counsel on the more subtle refinements of sexual adjustment in married life. The authors are respectively a professor of sociology at the University of North Carolina, who also gives courses on marriage and the family; the director of a marriage and family counsel; and a social worker. The book contains an introduction by the

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CURRENT BULLETIN BRIEFS

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

PATENTS AND INVENTION is a 20-page pamphlet, in which is presented, in question and answer form, the relationship between the patent system of the United States and the war and industrial progress. *National Association of Manufacturers, 14 West 49th Street, New York, New York.—Gratis.*

LEARNING THE RADIOTELEGRAPH CODE is a 34-page booklet, plus advertising, which presents a new method of learning based on the aural system of approach. With this system it is possible for an individual to make steady progress even though the constant supervision of an expert operator is not available.—*American Radio Relay League, West Hartford, Connecticut.—25 cents.*

BIRD MIGRATION IN THE WESTERN HEMISPHERE, by Frederick C. Lincoln, contains data on bird migration and an invitation to Central and South American residents to take up bird banding as a research hobby in science. *T. Gilbert Pearson, The International Committee for Bird Preservation, 1006 Fifth Ave., New York, New York.—Gratis.*

SEEING IN THE BLACKOUT is an eight-page illustrated bulletin giving details of phosphorescent and fluorescent materials which are commercially available for use in the home and elsewhere. These materials, in sheet form, can be cut to size and nailed or cemented wherever luminous indicators are needed. *Continental Lithograph Corporation, 952 East 72nd Street, Cleveland, Ohio.—Gratis.*

ACCIDENT FACTS—1942 EDITION is a 116-page statistical yearbook which gives most of the answers to safety problems. This book was listed in this column in our October issue as being available gratis. Instead, it should have been noted that a charge of 50 cents a copy is made in quantities up to ten copies. *National Safety Council, Inc., 20 North Wacker Drive, Chicago, Illinois.*

REFERENCE GUIDE TO ULTRA HIGH FREQUENCIES is a 52-page bibliography covering 593 articles on ultra high frequency and associated subjects. *Miss E. Kelsey, Zenith Radio Corporation, 680 North Michigan Avenue, Chicago, Illinois.—Gratis.*

A PRELIMINARY LIST OF FOREIGN PERIODICALS CURRENTLY AVAILABLE ON MICROFILM is an eight-page booklet which is precisely described by its title. *Microfilms, Inc., 313 N. First Street, Ann Arbor, Michigan.—Gratis.*

CIVILIAN CONSERVATION OF THE B.T.U. is a 24-page manual dedicated to users of equipment who want the continued benefits of their air conditioning, refrigerating, and heating systems. The book serves as a handy reference guide to the simple care of existing equipment. *Carrier Corporation, Syracuse, New York.—Gratis.*

PLASTICS FROM AGRICULTURAL MATERIALS, by O. R. Sweeney and L. K. Arnold, is a 52-page bulletin which reports the results of several years of research on plastics of high impact strength and low water absorption. Four plastic products were studied, all of which showed definite commercial possibilities. *Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.—Gratis.*

BOOST PRODUCTION THROUGH INCREASED EMPLOYEE MORALE is a special report designed to help executives to make an inventory of working conditions, of management policies, and of their workers, all aimed at possible production increases and better employee morale. *Labor Relations Institute, General Motors Building, New York, New York.—Gratis.*

A GUIDE TO WARTIME CARE OF ELECTRIC MOTORS is a 24-page illustrated pamphlet which takes a fresh and up-to-date look at the over-all problem of motor care. The information given, of interest to production and maintenance men as well as to executives and others concerned with the use of electric motors, applies to all makes of standard general-purpose units. *Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.—Gratis.*

SOME FACTORS INFLUENCING THE HEAT OUTPUT OF RADIATORS is a 16-page booklet which gives comprehensive engineering data on the most important of the factors involved. Bulletin Number 29. *College of Engineering, Cornell University, Ithaca, New York.—25 cents.*

MOUNTED WHEEL MANUAL is a profusely illustrated booklet which gives detailed instructions on the operation of mounted wheels and accessories specially designed to fit perfectly into the industrial war pattern. Content of the booklet includes a selection guide, giving detailed information on the application of mounted wheels. Another section is devoted to mounted polishing wheels. *Chicago Wheel & Manufacturing Company, 1101 West Monroe Street, Chicago, Illinois.—Gratis.*

SOUTH BEND LATHE CATALOG No. 100-B is a 48-page illustrated brochure which describes this entire line of engine lathes, toolroom lathes, and turret lathes. Machine specifications are tabulated to facilitate the selection of the lathe required for any desired application. *South Bend Lathe Works, Dept. S7, South Bend, Indiana.—Gratis.*

COULD IT BE MADE FROM FIBER? is a four-page folder which gives physical properties of vulcanized fiber, data on working this material, and a list of possible uses for it as a satisfactory replacement for a wide range of metals and other materials which are now difficult to obtain for any purpose. *Wilmington Fibre Specialty Company, Wilmington, Delaware.—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"

MOSQUITOES in summer, and cold in winter. Most amateur astronomers put up with these troubles in observing because the construction of a warmed observatory room, such as those described by Porter and others in "A.T.M.," is relatively formidable. One such type is the turret telescope and of these there are now about half a dozen. One of them, warmed electrically, has just been constructed by Roelof Weertman, of Dutch descent, member of The Amateur Astronomers Association of Pittsburgh, residing at Division Lane, Observatory Hill, Vanport, Pa., 25 miles north-west of Pittsburgh (mailing address, R.F.D. 1, Beaver, Pa.), and is shown in Figures 1, 2, 3, and 4. This is a larger, heavier, more elaborate installation than the illustrations at first suggest, the parts above the roof-line alone weighing 1500 pounds.

The telescope itself, when examined closely, proves to be more conventional in type than the first glance suggests. It is a simple, ordinary Newtonian, 12½" in aperture, an *f*/9; its 100-pound counterweight being carried on an extension of the tube rather than in separate form. This makes the tube 14' long. There are no added reflections—no siderostat as, for example, at Stellafane's turret telescope. This, of course, entails reversing the dome—toward the building as shown.

In this type of telescope the observer within the dome looks into an eyepiece which lies *in* the declination axis. He

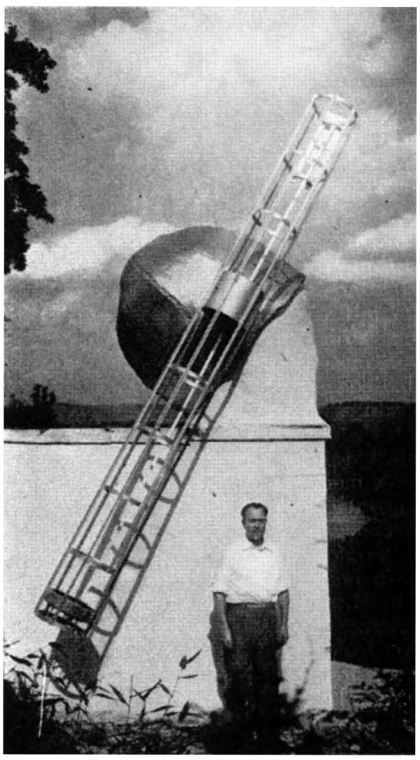


Figure 1: **From the west**

also stands within the polar axis, which is expanded into a big ring to permit his entrance into it.

Starting at the bottom and working upward, as in the actual construction, we have in this telescope the following catalog of elements:

A reinforced concrete foundation on bed rock.

A hollow tile building of dimensions shown in Figure 4—narrow enough (56") to permit the tube to reach the zenith on either side.

A 2" plank floor and a 2" plank roof deck, the latter covered with tinned iron and painted.

Inside the building a stairway, as shown (Figure 4). This is only 24" wide and is on the side nearer the reader. At its head is a trap door 24" wide, and beyond this a fixed section of platform also 24" wide. The entering observer

Figure 2: **From the south**

pushes up the trap-door, climbs up on the fixed platform, lets the trap-door down, and thus is on a platform 33" wide and 48" long. There is ample room for two observers, but three's a crowd. Well, sometimes.

Surrounding the rectangular opening through the roof deck, where the dome emerges, a large, rectangular, horizontal, iron base, 51" by 33".

Welded to this, four upright struts of 2" pipe, to carry the tilted ring.

Fixedly welded to these four supports, a 315-pound ring of 50" inside diameter, made of 3⅝" by 4⅜" angle iron, and slanted at 49°15'. The web space between the basal rectangle and the fixed ring is filled in with metal lath and plastered inside and outside with 2" of concrete, through which there is a window (Figure 2) 14" by 27".

Bolted to the fixed ring, three 3⅛" ball-bearing rollers from automobile rear axle housings.

Pressed on one of these three rollers a 10" worm wheel to provide the friction

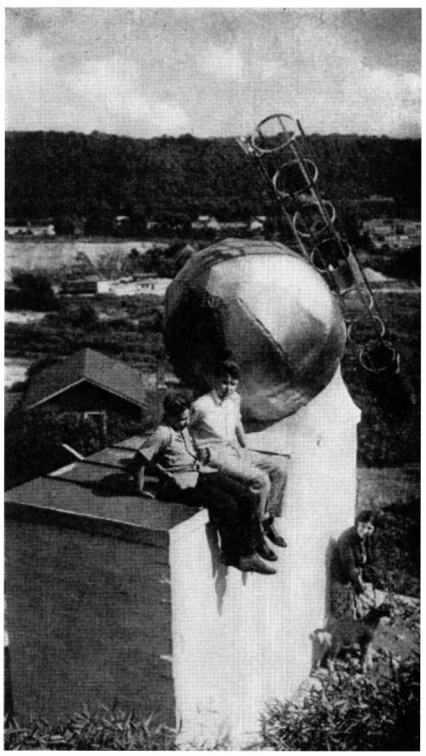


Figure 3: **From the north**

drive to rotate the dome (done by an automobile window crank).

At right angles to these rollers, two 4⅜" thrust bearing rollers to prevent the movable ring and its attached telescope from slipping off.

A 215-pound movable ring of 3⅝" by 4⅜" angle iron. This carries the telescope, the dome, and the hour circle.

Welded on the movable ring a 2' length of 4" by 6" angle iron, as a base, and on this a square piece of 12" flange beam, stood on end. This unit carries the mounting for the tube, also a declination slip plate, eyepiece holder, holder for 2½" elliptical flat, declination and setting circle, declination worm, and ball bearings. A blueprint of these details may be had gratis from the owner.

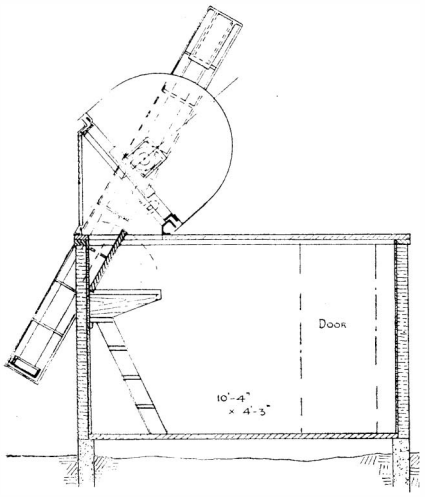
In its swing, or traverse, the eyepiece does not rise more than 1' above its lowest (E. and W.) positions.

On the above unit the tube, 14" inside diameter, built of 1" by 1" tee-bar straights and 1¼" by ¼" by ½" hoops.

At its upper end the tube carries a 100-pound counterweight.

Attached to the movable ring a dome of galvanized, riveted, sheet steel. Its interior is marked with latitude and meridian circles. Prominent stars and nebulae are indicated on it, with their R.A. and Dec., so that these and other landmarks can be found instantly.

A 12½" mirror which, before silvering, was subjected to the criticism of Norbert



Redrawn by Russell W. Porter

Figure 4: Side elevation

J. Schell, Beaver Falls, Pa., of off-axis and criss-cross off-axis telescope fame.

When the telescope is not in actual use, the mirror is left in it covered by a latched lid. A 3' sack, like a big mail-sack (Figure 3), is drawn over the end of the tube as a protection against rain, and the tube is then turned mirror end up.

The 300-pound tube unit, including the tube's own 100-pound counterweight, is hung on one side of the movable ring. This is balanced by a 570-pound counterweight mounted inside the dome opposite the telescope.

In the photographs (Figures 1, 2, and 3) are seen respectively: Weertman; Billy Weertman, Mrs. Weertman; John Cool, Billy again, and at ground level, Mrs. Weertman again with Betty Tulip Weertman, Billy's goat (not, however, a billygoat). All—especially Mrs. Weertman—assisted in the work, even Betty. That is, when anybody made a mistake, Betty was the goat.

Weertman says the observatory once served as a fort. No sooner had he finished the concrete doorstep than a "halitosis kitty" ambled up, drove him inside, and left his or her footprints in the soft concrete.

Altogether, this is a notable telescope.

PARTIAL silvering, sometimes spoken of as half-silvering, is sometimes desired for optical instruments. Accomplishing it by the familiar Brashear process often requires agility and involves an element of uncertainty, since the silver ordinarily is deposited too quickly to permit calm, steady observation and quantitative control. Two readers of this department, Dr. Henry Paul, of the Norwich Pharmical Company, a chemist, and Dr. Wilbur Silvertooth, of Paramount Pictures, Inc., a physicist—both amateur telescope makers—have called to our attention a new method of partial silvering originally described in *Industrial and Engineering Chemistry* (May, 1942) by Robert D. Barnard, M.D., of The Chicago Medical School, as follows:

"The surface should be cleaned with hot chromate sulfuric acid solution and thoroughly rinsed with distilled water. It is unnecessary to use the application of

TELESCOPTICS

caustic soda so often recommended. If a drop of distilled water will spread evenly over the entire surface, it may be considered free from grease or other organic matter.

"About a half liter of (1) a 10 percent silver nitrate solution containing one or two drops of concentrated nitric acid and of (2) a 10 percent solution of technical triethanolamine are conveniently made up. Both solutions will keep indefinitely.

"The surface to be mirrored is placed face upward in a clean Petri dish of sufficient diameter to accommodate it. To 25 cc. of solution 1 in a large test tube are added 10 cc. of solution 2; then, with constant agitation, further additions are made of 2 or 3 cc. at a time, just to the point where the precipitate which forms on the first addition clears completely. The mixed solution is poured immediately over the object to be plated so as to cover it by a layer of at least 0.25 inch. The deposition of silver begins within a few seconds.

"For the half-reflecting surface required for interferometers, a layer of silver which transmits about as much light as it reflects is ideal. Such a layer has a distinct violet tinge and appears within 10 minutes at room temperature.

"For completely reflecting surfaces, the immersion may last for 24 hours; this particular bath is unique in that the deposition seems to be continuous for that length of time.

"The Petri dish gives good visual control of the extent of plating, since deposition of silver occurs only on a surface and not through the body of the solution. It is possible that the low surface tension of the triethanolamine may be responsible for this phenomenon.

"When the desired thickness is deposited, the plated object is taken from the bath, only the edges being handled."

Dr. Silvertooth, mentioned above, states that "We have used the method here at Paramount Pictures, Inc., with considerable success, in preparing partial transmission films."

Dr. Paul, also mentioned above, suggests caution in adding nitric acid to as concentrated a solution of silver nitrate as is used in the Barnard Method—risk of explosion (see warnings in "A.T.M.," pages 412-415). In this, Dr. Barnard concurs.

The triethanolamine needed is easily obtained through chemical supply houses.

Replying to a private communication, Dr. Barnard emphasizes again that his method was devised particularly for partial transmitting surfaces, and points out that, for full reflecting surfaces which require a heavier coating, the original triethanolamine method developed by Professor M. Meltsner, of the College of the City of New York, described in U. S. Patent No. 1,988,764, is more suitable. "Difficulties will arise in the latter case," he writes, "and the directions in the present article will have to be modified by using a much higher concentration of triethanolamine, even up to a concentration of 90 percent. Because of the difficulties encountered with the variation in composition of commercial triethanolamine solution now available, the method used in the cold, as I described it, requires a certain amount of manipulation for best results. Samples of triethanolamine containing a large amount of volatile alkyl amines (strong fishy odor) should be rejected, as should those with a large amount of chloride present. These do not appear to interfere with the Meltsner Method as much, though the last method is inapplicable to surfaces which cannot be heated."

DRIVE, clean, simple, free from gadgets and hickerpickers, made by N. J. Schell, 1019 Third Avenue, Beaver Falls, Pa., is shown in Figure 5. Asked to describe it, Schell writes:

"The drive is used with an equatorial

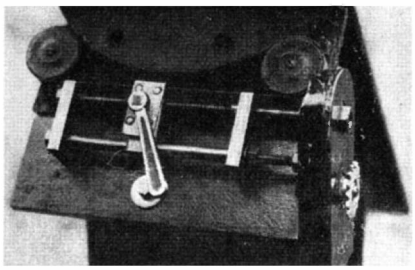


Figure 5: Schell's drive

which has for its upper polar bearing a large cast iron flange, or plate, which rolls on two ball-bearing rollers (Porter's design, I believe). I found it would be necessary to re-build the whole thing if a worm-wheel was to be used, so tried using a thin band or belt of phosphor-bronze (continuous) which passes around both rollers and under the large flange. This band is just taut when the weight is on it.

"The band is pulled by a screw of 12 threads per inch, by means of a nut which has a yoke over the top—the band passing between the top of the nut and the yoke. An eccentric pin or shaft enables the band to be clamped firmly to the nut at any point, a simple wrench turning the eccentric pin, as shown. When not clamped, the band can slide freely as the mounting is moved in right ascension.

"The drive begins with a 12-watt Telechron motor which is enclosed in a box below the main plate, continues through a train of helical gears in the narrow box at the right, terminating in the screw. The knobbed wheel on the gear box is a clutch to disengage the gears, which is necessary in order to run the nut back on the screw after it has traveled from left to right. This takes only a minute or so and, as it takes about three hours for the nut to travel the length of the screw, a single resetting will take care of an entire evening.

"The whole assembly, with the exception of the band, is in one piece and is attached by the single bolt shown just below the wrench (the pin and yoke are first slipped off, however, and the band remains on the mounting). The base of the assembly is ½" steel plate. The bar below and parallel to the screw serves the dual purpose of tie-rod and guide for the nut.

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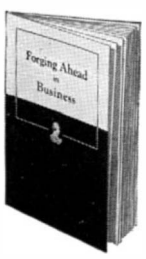

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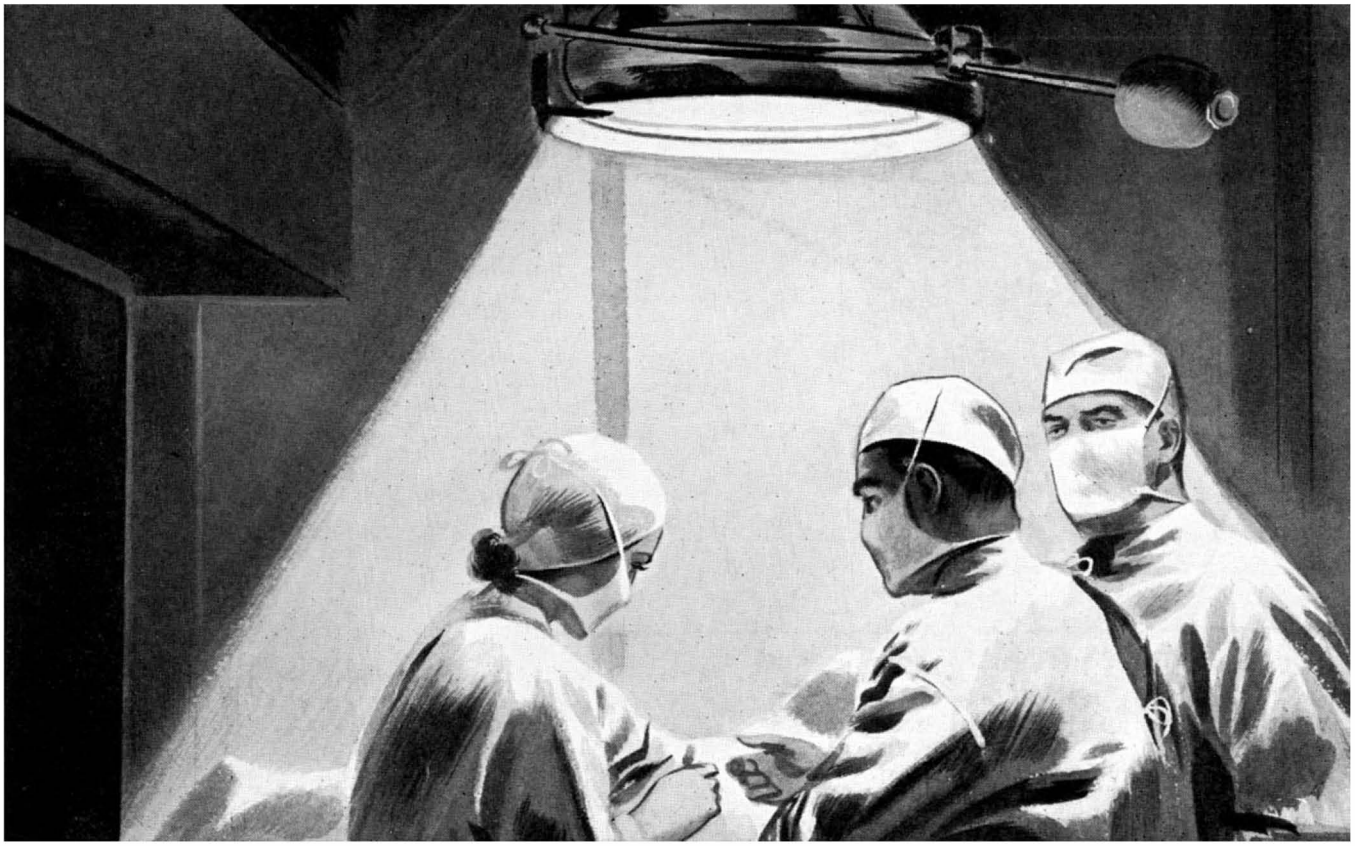

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