SHOCKLESS SURGERY—WITH ICE . . . Page 182

SCIENTIFIC AMERICAN

APRIL · 1942

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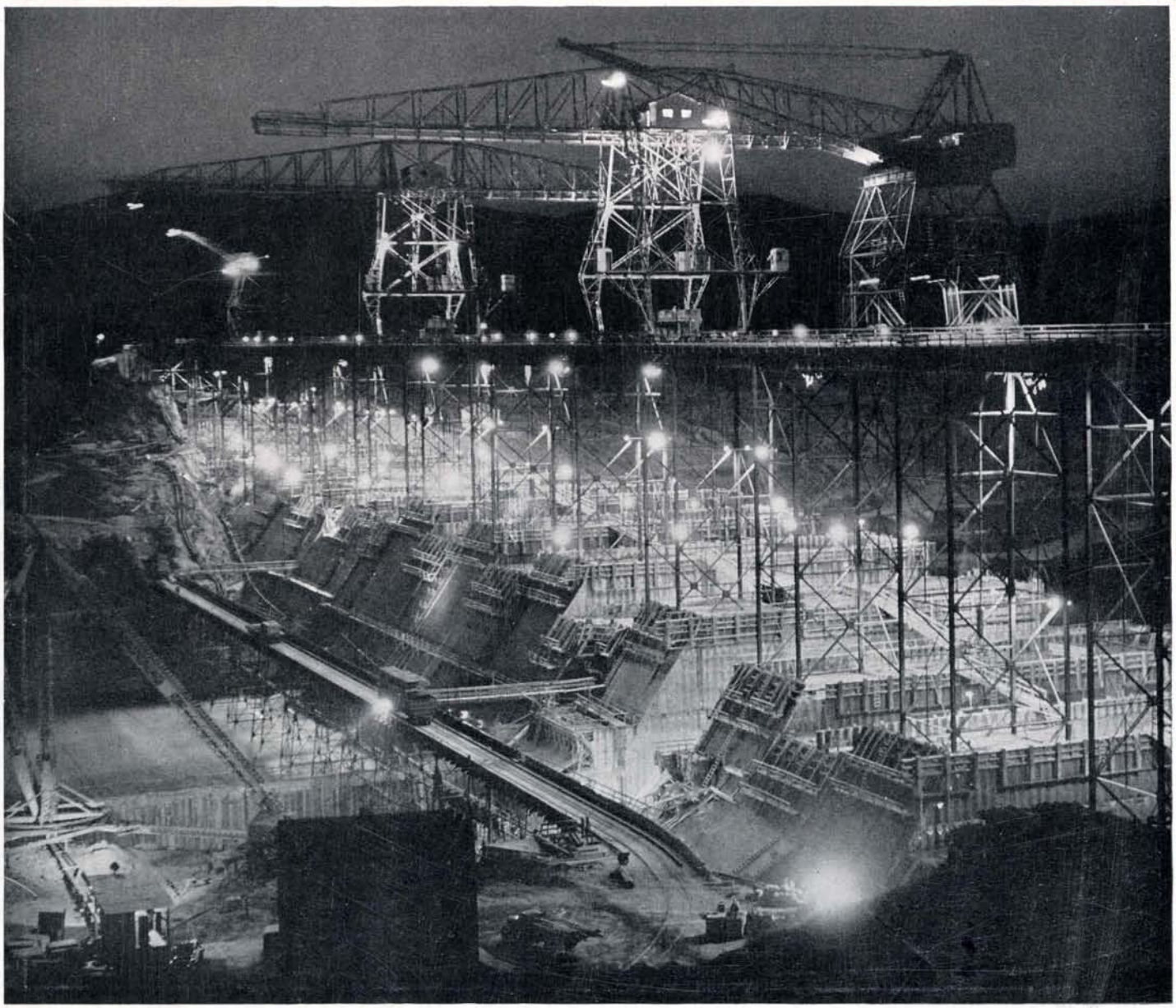
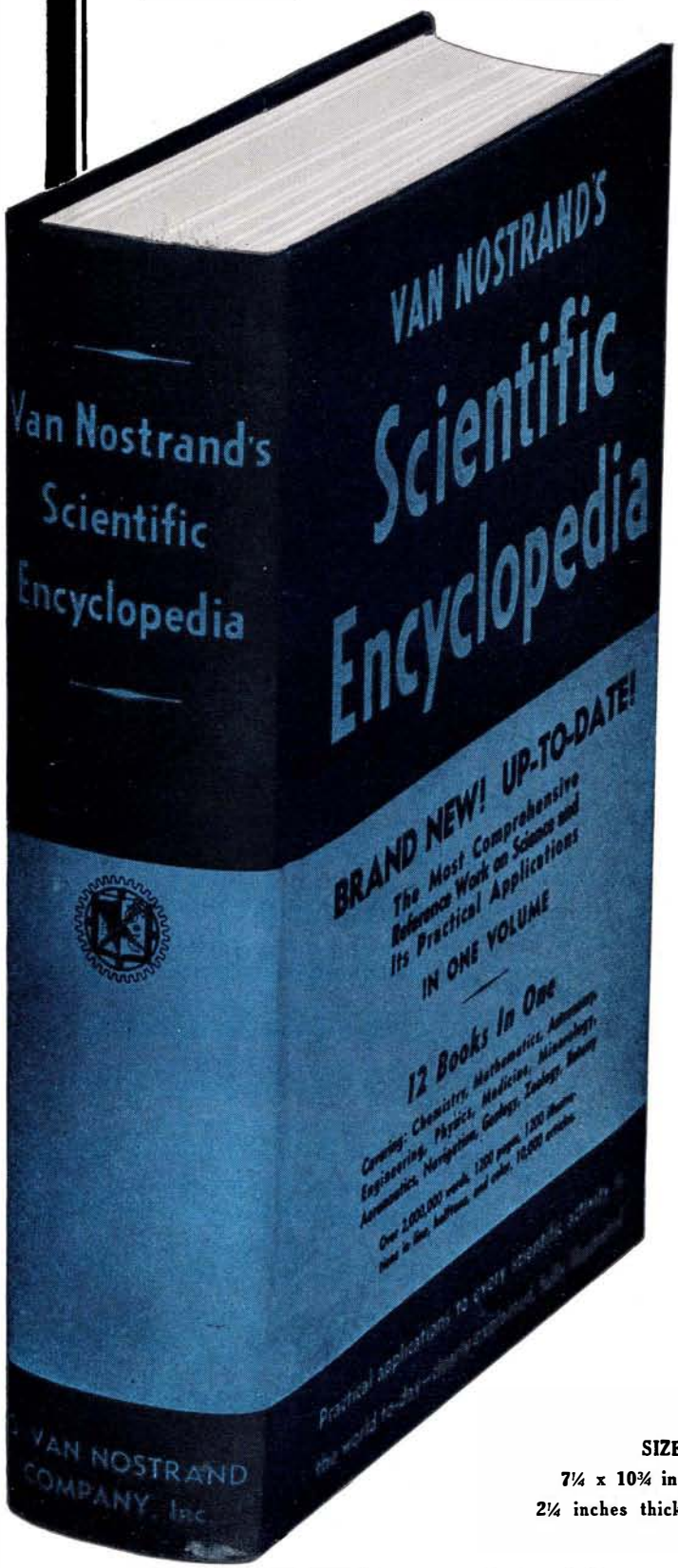


At Friant Dam Site, Central Valley Project, California

All the Sciences

1500 Pages

1200 Illustrations



SIZE
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THIS great new work presents—for the first time in one volume—a complete coverage of the terms of science and engineering. Principles are clearly explained—methods of calculation are fully described with the formulae and units—chemical structures and reactions, physical laws and instruments, engineering design, construction, and operation are merely suggestive of its tremendous scope — which extends throughout the entire range of technical knowledge up to the most recent advances and inventions. The great number of photographs, diagrams, and charts have been specially prepared and selected to show the salient facts most clearly. Innumerable tables and summaries make all this information easily available for instant reference.

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INTEGRAL part of California's Central Valley Project, described in detail on page 178, is Friant Dam, shown under construction in the reproduction on our front cover of a spectacular photograph taken at night under floodlights.

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; all at 24 West 40th Street, New York, N. Y.

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

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APRIL • 1942

SCIENTIFIC AMERICAN, April, 1942, Vol. 166, No. 4. Entered at the New York, New York, Post Office as second class matter June 28, 1879, under the act of March 3, 1879; additional entry at Albany, New York. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York City.

Subscription rate $4.00 per year. Canada and foreign $5.00.

BENEFITS OF WAR

In no sense questioning General Sherman's terse and forever accurate summation that "War is hell," and with not the slightest Pollyannish inclination, we nevertheless point out that the present world-wide conflict of blood carries along with it an educationally constructive phase that will benefit immeasurably every citizen of this country. For the first time in history the men, women, and children behind the men behind the guns *must* learn how to take care of themselves and each other when under fire—just as the soldier, the sailor, the marine must do in the course of his training.

More than five million men and women in civilian life—and the number grows every day—are attending classes, clinics, and demonstrations to master the intricacies of first-aid and nursing, the science of fire-fighting, the mechanics of road repairs and demolition of dangerously damaged buildings, the chemical knowledge necessary for use in the decontamination corps, the mechanics and dangers of unexploded bombs and delayed-action fuses, the manipulation of emergency telephone switchboards, telegraph keys, radio equipment, and many, many other things which most of us have never before felt it necessary to know. Thousands of women, heretofore completely competent to drive automobiles, are breaking manicured fingernails and acquiring "grease-monkey" hands in finding out what motivates their cars, how to make emergency repairs. Business men from every walk of life feel physically better because of the regular exercises incident to walking the beats and engaging in other physical aspects of the training of the air raid warden, the auxiliary fireman and policeman.

The enormous scope of this sudden national hunger for knowledge of "how to do it"—particularly since Pearl Harbor—is somewhat difficult to grasp. Indicative of its magnitude, Boston called for 400 volunteer firemen, found 1200 on hand for the first drill; New York City has graduated 20,000 volunteer "smoke-eaters" from an intensive 15-week course; Chicago's police force is recruiting 7000 members from 224 American Legion Posts to be trained as emergency police; more than a million Legionnaires have just been assigned by President Roosevelt the job of organizing and conducting—mostly at the Legion's expense—"schools for the training of personnel for the protective services in the Citizens' Defense Corps of Civilian Defense;" due to the unprecedented rush of men and women to acquire first-aid and other civilian medical information and training, the first-aid text book of the American Red Cross has been at a premium in many communities for weeks.

Where will all this lead us? What will be the effect on a nation of people who, equipped with knowledge gained the hard way—and it isn't easy, after the day's work is done, to devote four to ten hours a week to schooling—will know exactly what emergency treatment to apply in case of a highway accident? Will it not be constructive for thousands of industrial workers, as well as men and women in all branches of industry and civil life, to be familiar with the technique of resuscitation in accidents involving electrical shock, inhalation of gas, drowning, and so on? Can we not hope to become a nation of better automobile drivers, from the dual standpoints of safety and economy, if we understand more of the "whys" and "wherefors" of the "innards" of our cars? What of the benefits to be derived from a broader and more intimate knowledge of foods and their nutritive values, of general health and sanitation, of waste prevention and salvage?

The cumulative answer to these and similar questions—despite the long, hard road of war and its destructiveness and sacrifice—is the unqualified statement that we *shall* be a better nation, a vastly improved people. Still in hearty accord with General Sherman, we contend that the constructive forces at work today, on a hitherto unheard-of magnitude, will be productive of wide-spread benefit and welfare. As the war progresses, we shall learn—if we have not already found out—that the job of protecting our ways of life from totalitarian encroachment cannot be done with one hand while the other retains a golf club, a tennis racquet, a fishing rod, or a highball—and that doesn't mean we must deny ourselves recreation. To the contrary, now, more than ever, we need recreation to offset the additional stress of personal war efforts. But it does mean that we're faced with a two-fisted job that must be done in typical two-fisted American manner; that each individual, efficiently to perform his share, must make of himself a better executive for the accomplishment of his normal business, social, and recreative life, as well as his extra-curricular defense activities.

There can be no doubt but that the forces emanating from efforts of civilians to fit themselves into a nation and a world at war have constructive characteristics. There can be no doubt but that the concurrent attempts of fifty million or more men, women, and youngsters to find the answer to their question, "How can I help?" will, at first, produce a certain amount of chaos, many uncomfortable growing pains. But, as stated in these columns before, it is an absolute certainty that the people of this democracy are organizing, are building, and will maintain the greatest civilian war effort ever known—and they're being amazingly constructive about it.—*A. D. R., IV.*

FOR THE RECORD

Severe criticism has been leveled, in some quarters, against certain publications for the printing of information and illustrations that, allegedly, may have been of some value to the enemy. As to the truth of this claim insofar as it applies to each and every individual magazine and newspaper in the country, we are not in a position to speak with authority, but we question whether any reputable publication has knowingly violated the code of honor voluntarily assumed by most editorial desks long before hostile action against the United States.

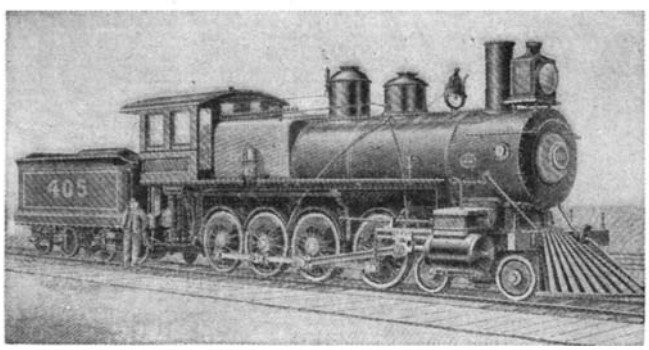
So far as Scientific American is concerned, no illustrations or text pertaining to our national defense efforts prior to Pearl Harbor, or to our war activities since that date, have appeared within our pages which have not received the approval of the proper officials of the Army, the Navy, or the Marine Corps.—*O. D. M.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1892)

LOCOMOTIVE—"The Brooks Locomotive Works, of Dunkirk, N. Y., have recently furnished the Great Northern Railway with fifteen of the heaviest locomotives in use in this country. The general appearance of these engines may be seen by reference to the accompanying illustration. The cylinders of the first ten of these engines are 20 by 24 in., five of the ten having wagon top and five Belpaire boilers. The other five have Belpaire boilers and cylinders 20 by 26 in., which is the engine shown in our illustration. . . . This locomotive will haul,



in addition to its own and the weight of the tender, the tracks being in good condition and comparatively free from curves: On a level—4,505 tons of 2,000 lbs.; on a 20 ft. grade—2,010 tons of 2,000 lbs.; on a 100 ft. grade—578 tons of 2,000 lbs."

STREETCAR—"The Woodland Avenue and West Side Street Railroad Company, of Cleveland, O., has been testing a new storage battery car, with the view of equipping its lines with the same should the test prove successful. The car measures 21 ft. inside over all and is equipped with 180 cells, which are placed under the seats, serving to operate a forty horse power Ford & Washburn motor."

INVENTORS—"The larger the number of patents granted, the greater will be the number of new industries established, and our measure of prosperity correspondingly increased. As a people we have everything to gain and nothing to lose by encouraging inventors, no matter where they live or where they were born."

PECCARIES—"A recent publication of the National Museum contains a paper, by Mr. Frederic A. Lucas, on animals recently extinct or threatened with extermination. He finds that in nearly every instance the cause is 'reckless slaughter by man.' As an instance of the way in which animals may be destroyed, he refers in the introduction to peccaries. In 1885 these little animals were so abundant in several counties of Texas that their well-worn trails were everywhere to be seen, while their favorite haunts could be readily picked out by the peculiar musky odor characteristic of the creatures. Shortly after that date, hogskin goods being in favor, a price of fifty cents each was offered for peccary hides, with the result that by 1890 the peccaries were practically exterminated."

OIL BURNERS—"The competition between oil fuel and coal is a most interesting one, and certainly shows an increasing use of oil where the conditions are favorable for its employment. Perhaps the most conspicuous of the advantages possessed by oil over coal as a fuel is the readiness with which the most intense heat can be employed at any special point desired, and the economy with which it can be used for just the period required. In addition, there is a great saving of labor in the use of oil, and, as there are no ashes, all the work around the boilers and furnaces can be kept in a much more cleanly condition."

CAVE DWELLERS—"The Russians have made a singular discovery in Central Asia. In Turkestan, on the right bank of the Amon Daira, in a chain of rocky hills near the Bokharan town of Karki, are a number of large caves, which, upon examination, were found to lead to an underground city, built, apparently, long before the Christian era. According to the effigies, inscriptions, and designs upon the gold and silver money unearthed from among the ruins, the existence of the town dates back to some two centuries before the birth of Christ. The edifices contain all kinds of domestic utensils, pots, urns, vases, and so forth. The high degree of civilization attained by the inhabitants of the city is shown by the fact that they built in several stories, by the symmetry of the streets and squares, and by the beauty of the baked clay and metal utensils, and of the ornaments and coins which have been found."

SPRINKLERS—"The introduction of automatic sprinklers has reduced the average loss per fire, within the experience of the Boston Manufacturers' Mutual Fire Insurance Company, where they were in service, to 8.3 per cent, and the average loss per claim to 6.9 per cent of what it is apparent that such fires and claims might have been under the previous conditions of protective apparatus."

GRIPPE—"There is much truth in the remark of one who observed: 'The worst thing about the grippe is that you are sick with it so long after you get well.' "

RAIL SPEED—"Engine No. 385 of the Central Railroad of New Jersey broke all records of high speed on February 26, by running a mile in 39¼ seconds, or at the rate of 91.7 miles per hour. The engine is a Baldwin compound. In speeding this engine the first mile was made in 76 seconds, the second in 62, the third in 53½, the fourth in 45½, and the fifth in 39¼ seconds."

PHOTO-ENGRAVING—"The first 'process' pictures, as photo-engravings were called, were very faulty, principally from the low relief obtained, which made them especially difficult to print in ordinary type forms, but by years of experiment and hard work this method of making pictures has been brought to such a degree of perfection as to practically supersede the more laborious hand engraving for quite a number of purposes."

MILITARY OBSERVATION—"The presence of balloons over the forts and encampments in Poland is becoming more frequent than ever, and this fact is causing much indignation among Russian army officers, who are helpless to prevent military secrets from becoming known to the German officers, who are known to be taking observations from a height that places them beyond the reach of any bullets aimed at them . . . Even modern cannon . . . could not be used against balloons, for the reason that gun carriages have not yet been made that allow of a perpendicular elevation."

"We're backing them up"

Marching right along with the armed forces of this country are thousands of telephone workers.

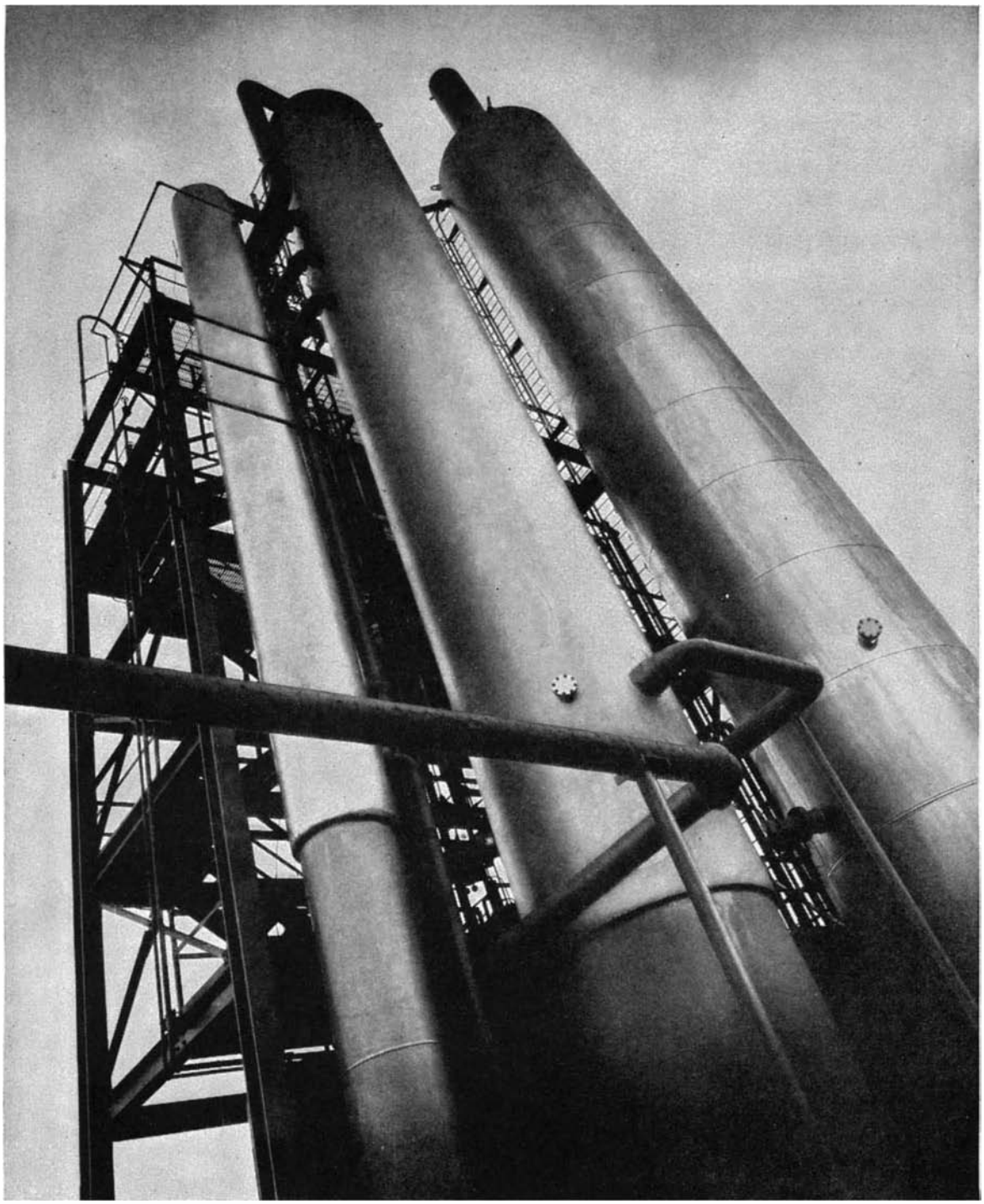
They work side by side with the Army and Navy. Wherever the need is communications, you are likely to find telephone men and their trucks and materials.

Day and night the order is for speed and more speed.

They wear no uniforms, these telephone workers, but men in uniform know how much they are putting into the Nation's biggest job. They see it first-hand and they know it is first-rate.

BELL TELEPHONE SYSTEM

"THE TELEPHONE HOUR" IS BROADCAST EVERY MONDAY EVENING OVER THE N. B. C. RED NETWORK



"GUNS" OF INDUSTRY POINT SKYWARD

In the manufacture of Koroseal, synthetic elastic material of many uses, made from plasticized polyvinyl chloride, a huge solvent recovery plant is needed. In relief against the sky, the towers of the Goodrich recovery unit present a striking appearance in the photograph above. The largest of the towers, at the right, is 10 feet in diameter and 78 feet high. The center one is 6½ feet by 68 feet, while the smallest is 2½ feet by 54 feet. All of the towers were received on the site completely assembled and were erected in one piece.

98TH YEAR SCIENTIFIC AMERICAN APRIL 1942

GASOLINE MIRACLES

Higher Octane Aviation Fuels, But Not for Hitler

SIDNEY J. FRENCH
Professor of Chemistry, Colgate University

At this moment gasoline is the most important commodity in all the warring world. It will win and lose the war. This does not mean just any gasoline; it means high-octane gasoline. It means the type of gasoline that Germany, for all of her much vaunted *Luftwaffe*, would give almost anything —except Hitler—to possess. It means the type of gasoline which is peculiarly an American product, which packs the eventual knock-out wallop for Hitler and his Axis partners.

Just what is this high-octane fuel and why is it peculiarly an American product? It is American because America has produced more automobiles than all the rest of the world combined. It is American because America produces 60 percent of all the petroleum used in the world. It is American because better motors kept demanding better gasoline. It is American because 25 years of intensive search and research, trial and error, comedy and tragedy, have gone into the job of producing a fuel to meet the perfectionist demands of motor makers.

With what success? With such success that even the experts would not have dared predict, 25, or ten, or even five years ago. With such success that motor makers are now striving to catch up with the perfection of available fuels.

High-octane fuel is tailor-made gasoline, made to order from the crude materials provided by nature—made by cutting, patching, and sewing the very molecules of nature's product into new designs. It is one of the most remarkable stories of modern science, of sheer brilliance, in the American chemical industry.

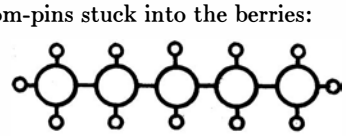
Petroleum, source of gasoline, is nature's cocktail, a grand mixture of chemical compounds known to the chemist as hydrocarbons. In a spoon-

SCIENTIFIC RESEARCH

ful of petroleum there are, literally, thousands of these compounds—and each one is composed of billions upon billions of tiny, identical molecules. In some respects all these invisible molecules are alike—they all consist of carbon and hydrogen atoms and, furthermore, nearly all of them have their carbon atoms strung together like cranberries on a Christmas chain. Decorating each "cranberry" are "glass-headed pins" representing the hydrogen atoms. It is principally in the *number* of cranberries that make up the chain that these various hydrocarbons differ. There may be anywhere from one to 30 berries, with the number of hydrogen pins always twice the number of berries plus two.

To distinguish one of these chain compounds from another, the chemist adopts a simple expedient; he counts (in Latin) and adds the ending *-ane*. Thus, a chain of five carbon atoms is pentane; of six, hexane; of seven, heptane; of eight, octane, and so on. Unfortunately, however, the counting scheme was not started soon enough and those hydrocarbons having less than five carbon atoms still bear names unrelated to numbers: one carbon atom, methane; two, ethane; three, propane; four, butane.

Here, then, is our cranberry-pin model of pentane, with its five-carbon-atom cranberries linked together and its five-times-two-plus-two hydrogen-atom-pins stuck into the berries:



The gasoline family includes those hydrocarbons which have anywhere from five to nine cranberries in the string, plus many more deformed relatives. Starting with a petroleum cocktail, how do we get these particular strings separated from the rest?

The answer is simple: The shorter the chain, the lower the boiling point of the hydrocarbon. Heat petroleum and the gasoline fraction boils off first. Next, as the boiling point of the mixture rises, comes off the kerosene fraction consisting of longer chains; followed in turn by the light lubricating oils, the heavy oils, the greases, and finally, paraffin. In this process of distillation some 20 percent of the original petroleum mixture is obtained as gasoline.

In the days when Henry Ford's Model T was beginning to make history, the small amount of gasoline obtained in this manner was sufficient. So was the quality. But the time soon arrived when neither the quantity nor the quality sufficed.

Gasoline is an explosive; that is what makes it function in an automobile cylinder. But what a difference there can be in explosives. No date-conscious person would take a swift kick at an old hat lying in his path on April the First. Instead, he would shove it gingerly, and then steadily, with his toe, and thus remove the hidden brick from his path without repercussions to the toe. This is the type of gasoline we need in modern motors—the type which pushes, not kicks; the type which explodes gradually, not suddenly. As long as we stuck to the Model T car, it didn't make much difference what we used, but when motor makers began increasing the compression in their motors in order to get a more efficient engine, the fuel began to kick.

Gasoline makers were placed squarely behind the eight-ball. How could they produce a fuel that would not knock, yet at the same time how could they increase the quantity of fuel needed by a nation rapidly taking to wheels? Surprisingly enough, they did both jobs with one stroke of the knife: They cut up long molecules into shorter ones.

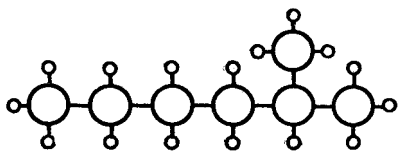
Suppose we were to cut a chain consisting, say, of 14 cranberries and the accompanying 30 pins; and suppose that we could cut it exactly in the middle. We would have two chains of heptane. Not quite, because there wouldn't be quite enough hydrogen to go around. Thus, out of one molecule of light oil we have produced two of gasoline. How was this done in practice? By heating the petroleum under pressure—in technical language, thermal cracking. This was the ingenious scheme that was developed as early as 1915 to increase the yield of gasoline. But it did far more; it greatly increased the anti-knock quality of the fuel. The very fact that there was not quite enough hydrogen to go around left these heptane molecules in what the chemist calls an unsaturated state, and these unsaturated molecules are better fuels than their saturated brethren. In one relatively simple operation both the quantity and quality of gasoline were greatly improved.

But there was one catch in the operation—the molecules did not always break in the right place; some of the molecules were too short to be useful in gasoline, others were too long.

EVEN this great improvement could not satisfy for long. Motor makers began stepping up the compression still more, and the gasoline makers found themselves behind the parade again. They began putting everything they could think of—except water—into the gasoline, in the hope of finding something which would silence the disturbing knock. Finally, they found the answer in that surprising substance, tetraethyl lead. Affectionately dubbed Ethyl, this compound, present in but trifling amounts, performs the miracle of retarding the explosion of gasoline—and increasing the horsepower of the motor. Just how and why it performs this miracle scientists are still trying to find out.

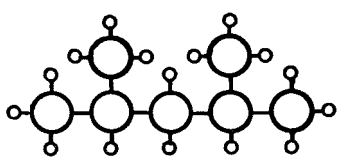
This great advance came in the 20's but it took the 30's to show the gasoline technologist just what he must do to make tailor-made gasoline. He had the goods, the raw materials, but he must cut them up, sew them, patch them, fit them to a form. It turned out to be a matter of just how the cranberries were arranged in the strings.

Given seven cranberries and 16 pins, how many different chain and cross-chain patterns can be made? The answer is, a dozen or more. We need consider only four in addition to the simple straight chain pattern. First, let us remove a cranberry from one end and place it on the side, thus:



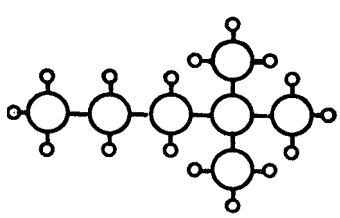
This is one of the numerous iso-heptanes. The surprising fact is, however, that this particular heptane has much better anti-knock qualities than its straight chain brother.

Now let us remove a cranberry from the other end and place it on the side; we have another iso-heptane, thus:



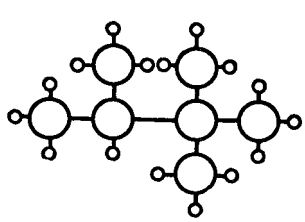
Once more the anti-knock qualities go up the scale.

Next, we arrange these side chains so that they are opposite one another, thus:



Up go the anti-knock qualities again.

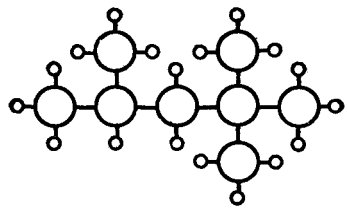
FINALLY, we remove another berry and place it on the side. We have the iso-heptane known as triptane:



This is the best anti-knock fuel yet discovered by man.

Here, then, is the secret of anti-knock fuel. Take a straight chain hydrocarbon of the gasoline family, pull off carbon atoms and sew them on the sides like sleeves in a coat. Tailor the goods. Much easier said than done, however.

A few years ago the fine anti-knock qualities of iso-octane were discovered. Iso-octane, like triptane, is a branched chain affair of the following pattern:



Since it was the best anti-knock gasoline then known, it was appropriately assigned an *octane number* of 100. At the other end of the octane scale was straight chain heptane, a highly audible knocker, with an octane number of zero. To determine its octane number, any given gasoline could be compared, in performance, with various mixtures of the two standards.

On this octane scale, old-fashioned gasoline used by the early Model T had an octane number of 40 to 60; thermally cracked gasoline, 70. With tetraethyl lead, the number could be boosted to about 80. Had we discovered triptane before iso-octane we would most certainly have had a scale in heptane instead of octane numbers, because this particular iso-heptane cannot even be placed on the octane scale. It is somewhere above 100. Actually it delivers about 50 percent more power than 100 octane fuel.

WHY not use triptane for aviation fuel? Largely because aviation has been geared to 100 octane fuel and in time of emergency we dare not take the time to make the necessary change in motor design. Then, too, triptane, worth $3600 a gallon just a few years ago and still worth nearly $40 a gallon, is just a little expensive, even for war. It is safe to predict, however, that this tailor-made super-fuel will soon be available at prices low enough for use by Uncle Sam's air force—if we can find the time to make the change-over in motor design.

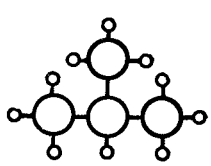
Yes, not too many years ago the gasoline makers were behind the eight-ball, but not today. They are ahead of the parade and calling to the motor makers to catch up. How did they do it? It is an easy matter to rearrange cranberries, but it is not so simple to rearrange atoms in invisible molecules.

The chemists have some strange chemicals which they call catalysts. Like traffic police, these chemicals can direct chemical traffic without themselves becoming too involved in the streams. They stand apart and somehow get other molecules into the right lanes—get them united or separated as

the particular case in hand demands.

It is these remarkable traffic police which have come to the aid of the gasoline technologist. First, the gasoline molecules are cracked into smaller bits by a modification of the old thermal cracking process. Then the catalysts take over and see to it that the fragments are reunited in the proper arrangement to give the branched chain hydrocarbons. True, there is always some mix-up in the traffic; some molecules never get cracked; some fragments never get united. But the vast majority go through as planned and the octane number goes up. If greater perfection is desired—if higher octane numbers are wanted—this, too, can be accomplished by the absurdly simple scheme of making the molecules go through the traffic lanes a second time. Many that were not caught on the first passage are properly apprehended and redesigned in the second attempt. To make automobile fuel, they go through once; to make aviation fuel, they go through twice. It is as simple as that!

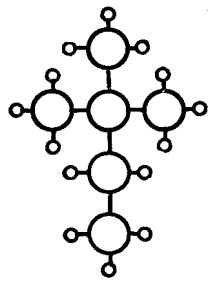
PERHAPS the most interesting of the very recent catalytic processes is that known as alkylation, coupled with another known as isomerization. Isomerization merely means the making of a branched chain molecule out of a straight chain brother of the same denomination. In the older thermal cracking process, some butane (four carbon chain) was produced and, since it was too short of chain to be useful as gasoline, it was often wasted. Now it finds a new and strategic use. It is redesigned with the aid of a catalyst into iso-butane, thus:



In this same cracking process the unsaturated brother of ethane (two carbon chain) was also produced, thus:

Notice that these cranberries are linked together with *two* threads.

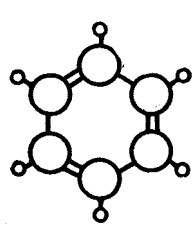
Now, presto, the traffic catalyst takes command; the iso-butane and the unsaturated brother of ethane are directed into the same channel and are ordered to unite. Out comes a molecule of iso-hexane with an octane number of 96, like this:



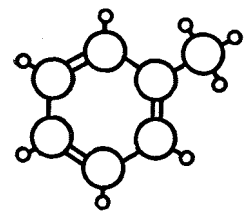
This is the type of reaction which is of great importance in the production of Uncle Sam's modern aviation fuel. Add a dash of tetraethyl lead and we get 100 octane fuel.

Octane numbers are very deceptive; they do not mean what they say because the power goes up much faster than the numbers. Triptane, with a power output of 50 percent more than 100 octane fuel, would actually have an octane number of about 110. The best that Hitler can get today is 87 octane fuel and this is 30 percent less efficient than 100 octane variety. This means that Hitler's planes must be content with less speed, lower ceilings, smaller cruising ranges, longer times for climbing to a given altitude, and more wear and tear on the motors—all to the tune of some 30 percent less in efficiency. What could we do if we could utilize our now available 110 octane fuel which should give us some 80 percent more effective power than Hitler can now get?

THERE is still another side to this amazing story of tailor-made products from gasoline. In World War I we heard much about Germany's stranglehold on coal-tar chemicals—dyes, drugs, and explosives—and we suffered much because we had naïvely depended on Germany to provide them for us. These coal-tar products are all based on hydrocarbons—but of quite a different type from those found in gasoline. Instead of being in a string, the cranberries are found in rings, six to a ring. And for each cranberry in the ring there is only one hydrogen pin, thus:



Note that the compound is unsaturated. It is our model of benzene, with its famous hexagon. To get others of these circular hydrocarbons, we may remove one or more pins and substitute decorated cranberries. Thus, we may have:

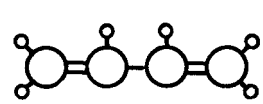


This is our model of toluene, famous as the basis of TNT, most important of modern high explosives.

A FEW years ago cyclic hydrocarbons of this type could be obtained only from coal tar. Now we can make them from gasoline. So desperate were we for toluene during World War I that city coal gas plants were stripped of their toluene. Today, in the brand-new hydroforming process, gasoline molecules are catalytically denuded of half of their hydrogen atoms, then are directed by the catalyst to curl up and tie their ends together. Presto! From straight chain heptane we get circular toluene.

So, today we can make our explosives—and even drugs and dyes, if necessary—directly from gasoline. We need no longer fear a shortage of toluene. Strange thing: in Hitler's country, with its paucity of petroleum, they are making gasoline from coal; in America, we reverse the process and make coal-tar products from gasoline. And incidentally, this same toluene is an excellent anti-knock fuel for motors, having an octane number above 100.

Gasoline can provide the premium fuel for our planes and the bombs to drop from them—what else can it do? It can—and probably will have to—provide the rubber for the tires. Gasoline provide rubber! Yes, strange as it may seem. The basic molecule from which rubber is formed is an unsaturated brother of butane. The chemist calls it butadiene. Here is the model:



Just as hydrogen can be stripped from heptane to make toluene, so, too, it can be stripped from butane to make butadiene. Again a catalyst is put to work directing a side chain onto this butadiene molecule. Then, much as iso-hexane is made, these fundamental units are tied together into long, folded strings of synthetic rubber. Given time, we can make all our rubber from gasoline and other simple substances. True, it may be a more costly process than draining a rubber tree, but the impor-

tant thing is that we now know how to do it.

There are many things yet to come from nature's cocktail. What they will be is hard to imagine as yet, but we have taken the most difficult step; we have learned how to re-design the molecules. We will live to regret the years in which we have wasted precious petroleum, wasted it as a child might tear up a rare volume to get one picture. In the future we will conserve it; we will treat it as we are learning finally to treat our forests, minerals, and our other God-given wealth of natural resources. We stand today where Germany stood in 1914—master of the most important commodity of modern war. Then, it was coal tar; now, it is gasoline—tailor-made gasoline.

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PYRHELIOMETER

New Instrument Measures Heat of Sun's Rays

PRINCIPAL use for a new type of pyrheliometer for measuring the heat intensity of solar rays that reach the earth is for atmospheric study, yet other potential applications present themselves.

A florist might logically install a pyrheliometer in his greenhouse to determine the intensity of the sun's rays that penetrate the glass roof at various times. Agricultural experiment stations also might find a use for the device in their studies of crops and soils. The intensity of the infra-red ray used for drying paints and for similar operations also might be measured. In fact, the instrument could be applied to the intensity measurement of radiated heat of long wavelength irrespective of the visibility of that wave.

The pyrheliometer, a type of thermocouple, looks somewhat like an electric light bulb. The "filament" comprises two flat, rectangular pieces of a nickel-chromium alloy and a copper-nickel alloy, each only 50 millionths of an inch thick, $\frac{3}{16}$ of an inch long, and $\frac{5}{64}$ of an inch wide, joined end to end. This thin single piece of metal is then welded at the outer ends to vertical lead posts that lead to a stem which is wired for hook-up to a millivoltmeter. The end of the stem to which the posts are attached then is sealed into an evacuated glass bulb which is a sphere about two inches in diameter.

The pyrheliometer is mounted vertically in a fixed position with the flat edges of the "filament," or element,

Thin alloy strips in an evacuated glass bulb measure sun-ray heat

parallel to the earth. The heat from the solar rays striking the element produces a voltage at the junction of the welded alloys. This voltage is measured by sensitive millivoltmeters and is automatically recorded on a chart. This record then can be compared with a master chart made from known heat intensities.

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EARTH RESISTIVITY: Recent attempts to correlate greatly differing electrical earth resistivities in different regions of the United States with the geological structure of the earth in the same region shows that the resistivity is usually lower in regions of recent geological origin. The resistivities vary from six ohms between the opposite faces of a cube one meter on a side in Oklahoma to 7000 similar "ohmmeters" in Maine and 10,000 in northern Georgia.—Bell Laboratories Record.

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ELEMENT 61

Appears Briefly Then Disintegrates

A FORM of element 61, believed to be the only element of the 92 in the chemist's periodic table not found in nature and never before produced artificially, made a brief appearance recently as a result of bombardment of other elements with atomic fragments whirled at them by the University of California's cyclotron.

The new substance stayed just long enough to show by its radioactivity that it was present and then disappeared completely by disintegration, according to *Science Service*.

The experiments were made by Dr. Emilio Segre, research associate in the Radiation Laboratory, and Dr. Chien Shiung-Wu, research fellow. The rare earths bombarded were sent to Dr. Segre a year ago by an Italian chemist, Dr. Luigi Rolla.

Element 61 belongs to the group of rare earths, of which there are 15. The atomic number 61 means that the nucleus or central core of its atom has a positive charge 61 times that on the nucleus of a hydrogen atom, and this is neutralized by 61 negative electrons revolving about it like planets around a central sun. Each chemical element has various forms, known as isotopes, and one of these of element 61 is believed to have been discovered.

From its position in the periodic table, scientists know that the atomic weight of element 61 should be about 148, and can predict fairly accurately its principal chemical and physical properties. But unless and until a fairly stable form is found, one that will at least stick around long enough to be measured, these predictions cannot be verified.

STEREOSCOPIC

Views Now Possible With Electron Microscope

THREE-DIMENSIONAL, or stereoscopic, pictures of infinitesimal bits from the submicroscopic world, are now possible by means of the electron microscope, it was announced recently by Dr. V. K. Zworykin and James Hillier, of RCA Laboratories, in presenting a joint paper at the annual meeting of the American Association for the Advancement of Science.

They revealed a new photographic technique, which adds depth to the length and breadth of images as they appear in the micrographs, as the photographs taken directly from the electron microscope are called. With this new method, the scientists reported, the electron miscroscope, which recently made it possible to photograph the influenza virus for the first time, becomes an even more powerful tool for use in pure science as well as industrial research.

The electron microscope is especially well suited to the preparation of three-dimensional pictures, Zworykin and Hillier said, because of its remarkable depth of focus. Two pictures of the object are taken in succession, the object in a special holder being tilted through a fixed small angle with respect to the instrument's axis, first in one direction and then in the opposite. When the two pictures so obtained are placed in an ordinary stereoscope, the object, greatly magnified, appears in its proper space relationship.

Testing with 'Lightning Bolts'

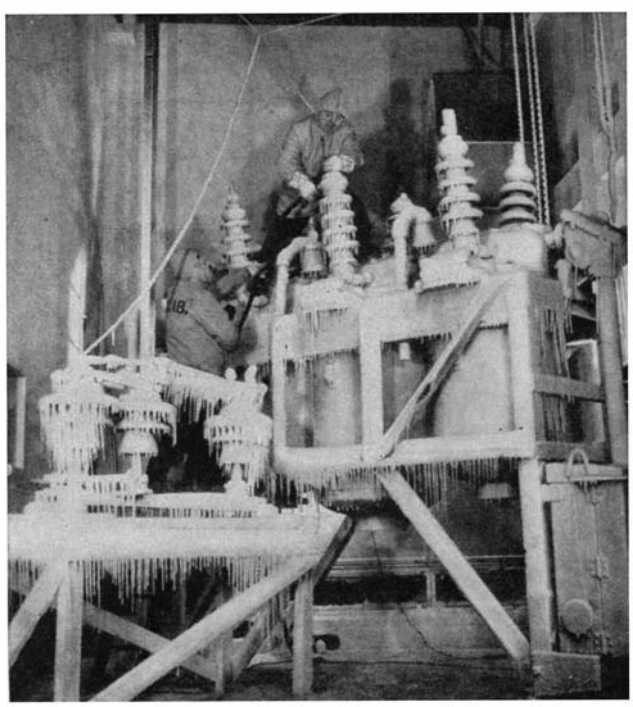
Mighty Generators Provide Two Million Kilowatts To Prove Efficiency of Power-Line Guardians

A. P. PECK

A SABOTEUR has gained entrance, by devious means, to a power station. Watching his chance, he slyly throws a metal bar across one of the main circuits. A blinding flash, as the power is short-circuited, and his work is done—if a circuit breaker fails to accomplish its designed purpose of standing constant guard over the line. Or a large bird, touching two wires of a power line, may accomplish the same end. Sleet and snow storms may break and ground line wires, and even rats crawling between conductors in a power house may cause short circuits. In all cases, however, circuit breakers of one sort or another are on the job to prevent the sudden surge of current, caused by the short circuits, from doing extensive damage.

But, in these days of increased power loads everywhere, brought about by the demands of defense industries, how can it be determined in advance that the circuit breakers will take the load, will cut off the power in the few seconds that spell the difference between protection and disaster? Since it is not practical to wait for such proof under operating conditions, or purposely to create short circuits in power lines in use, Westinghouse engineers have recently put into regular service a high-power testing laboratory where protective devices can be proved at powers in excess of those to which they might be subjected under the most severe field conditions.

The power source for the new testing laboratory is a twin 500-ton generator set capable of delivering test charges carrying twice as much power as is produced at any instant at Niagara Falls. Each of these two generators, the second of which was recently completed to make possible testing of the largest types of protective devices before they are put into service, is driven by a 6000-horsepower motor. They are designed to produce electric "knock-out punches" in excess of 2,000,000 kilowatts, the mechanical equivalent of which is over 2,680,000 horsepower. It has been estimated that if the generators could continuously deliver their combined output, they would supply sufficient energy to light enough tube-shaped fluorescent lamps to encircle the earth twice at the equator. The generators were designed, however, not for continuous service but for tests in which they deliver their energy over a time period of five seconds maximum. Thus they might be compared to a prize fighter who can pack terrific power into a knock-out punch but cannot deliver many such powerful blows in succession without resting. In the case of generators, the punch is produced electrically by short circuiting the output of the machines.



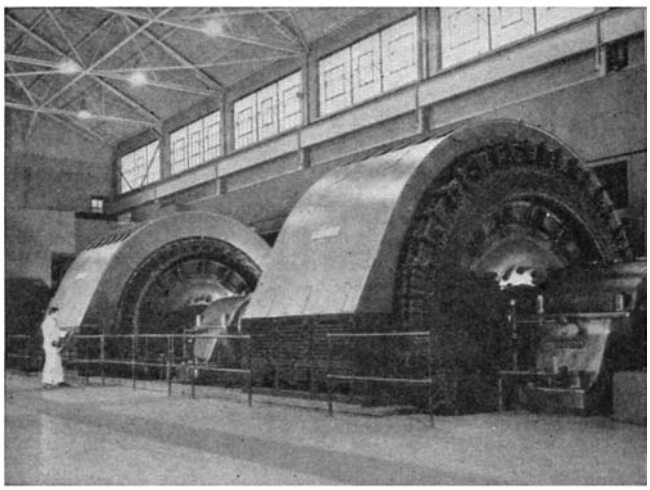
Man-made sleet storms test an oil circuit breaker

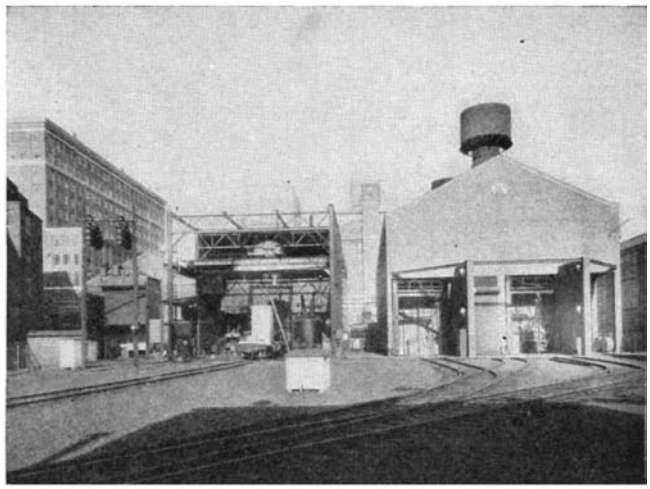
Spinning at their top speed of 514 revolutions a minute, the generators' two 300-ton rotors set up vibrations, when short circuited, that shake the very foundations of the laboratory building in which they are housed. When the energy is suddenly drained from the machines, the entire 1000-ton mass of the two units recoils like a gun. Special spring-steel mountings take up the shock to protect the reinforced concrete foundations.

The electric power output from the generators can be fed through a bank of transformers in an outdoor yard where the voltage can be raised to 396,000 volts for special tests on insulation. Other transformers can be cut into the circuit to increase the current to 345,000 amperes. Distribution of power from the generators is controlled from two switchboards in the power laboratory, each 20 feet tall and studded with knife-type switches made of copper bars about two inches wide and a quarter inch thick. Here, too, are switches which, a twentieth of a second after a signal from the control room, automatically snap shut under a pressure of 6000 pounds to release the power of the generators to the equipment to be tested.

For the protection of the high-power laboratory machinery, ten photo-electric cells are located at strategic points in the power house. If an arc should flash across the terminals of one of the switches or across the windings of one of the generators, the photo-cells would "see" the arc and set in motion the necessary mechanism to actuate switches that would disconnect the power before damage is done.

For use in connection with the test generators there has been set up a series of cells where equipment to be proved can be installed and tested. These cells, with one side open, are all visible from a control room where engineers supervise the testing activities through a system of loud speaking telephones. In this control room, also, is located an oscillograph which records the results of tests on photographic film. When a switch in the control room is closed, a row of notched rotating steel disks goes into action, synchronizing the release of power from the generators with the motion inside a circuit breaker being tested and with the recording instruments. A twentieth of a second after the notch of the first disk makes contact, the master switch in the power house closes automatically, releasing a "lightning bolt" into a circuit breaker, fuse, or other device under test. At





***Left:* Power twins that produce momentary torrents of 2,000,000 kilowatts. *Right:* Power house, other testing facilities**

the same time the oscillograph goes into action, recording by wavy gray lines the voltage and amperage of the electricity shot through the unit being tested, how quickly the device cut off the electricity, and, in a circuit breaker test, the pressure of oil or air which quenched the electric arc.

As noted earlier in this article, there are many ways in which a short circuit can occur on a high-power transmission line. If no protective devices were employed, such a short circuit would start a flood of power through the electrical system 20 to 30 times as great as the system was designed to carry. If not checked, this abnormal power would heat up wires, generators, and motors, burning off insulation in less than a minute and creating damage that it might take years to repair.

Such disasters are normally prevented by the use of circuit breakers of various types which stand guard on every power line and every branch of every line. Simplest of circuit breakers are fuses such as used in the home. When a short circuit occurs in a fuse-protected line, the fuse link burns out, disconnecting the defective part of the system until the short circuit is removed, yet allowing the remainder of the system to continue in operation without danger. Such fuses, although used on occasion even in high-power lines, require manual replacement before the defective circuit can be put back into service. Thus it is that circuit breakers are frequently employed to halt the flow of electricity into a short-circuited section of a power system until the damage can be repaired. According to engineers familiar with high-power circuit operation, a majority of short circuits—such as those caused by lightning, animals, and wind—last only for a fraction of a second. In such a case the circuit breaker opens for a short space of time and then automatically reconnects the line so quickly that the power interruption is scarcely noticed. Some circuit breakers are designed to re-establish the connection once and then, if the trouble has not disappeared, to open and remain open until manually closed; others will reconnect two or even three times before remaining open.

But the job of a circuit breaker is not finished when its contacts open. In high-power operation, an electric arc is formed in the gap between the device's opened contacts. As long as this arc continues, the power line is not completely disconnected and the destructive high power of the short circuit can continue to spread to all parts of the system. To accomplish the feat of extinguishing this arc, two general systems are employed. In one of them, the mechanism of the breaker is immersed in oil contained in a steel tank. As the contact breaker opens, under the influence of a short circuit, the arc is drawn into a chamber containing metal plates. Magnetic action set up by these plates forces the arc into constricted sections where it is smothered by the oil. In the most modern of the protective devices, compressed air is used to blow out short-circuit arcs. In less than a hundredth of a second a compressed-air circuit breaker can cool an arc from a temperature of 9000 degrees to 200 degrees, snuffing it much as a puff of breath blows out a candle.

In these compressed-air circuit breakers, a small relay is provided which instantly detects a short circuit and sets in motion the mechanism of the breaker. The relay opens a valve and releases compressed air against the top of a piston which spreads the breaker's contacts apart. This action also operates another valve, releasing a 150-pound blast of air which forces the arc into a fan-shaped chamber where the air pressure breaks the arc into short sections and annihilates it.

In a recent demonstration of the Westinghouse high-power testing laboratory it was shown how the output of the 2,000,000-kilowatt generators is used to test these line protective devices. To indicate vividly the amount of power employed in these tests, the laboratory generators were connected to two curved pieces of heavy wire extending upward from a fuse link. When the power was shot into the link, the fuse instantly let go, starting an arc which traveled upward between the two wires of the gap, eventually leaping the upper end of the gap in a 20-foot waving, flaming, thundering arc as bright as the mid-day sun and hot enough instantly to melt the hardest steel.

Continuing the demonstration, the same amount of power was then fed into an oil circuit breaker located in one of the test cells. Within a twentieth of a second after the release of the 2,000,000-kilowatt surge of electricity—simulating conditions more conducive to disaster than would prevail during the short circuiting of the highest power transmission line in existence—the circuit breaker emitted a mechanical grunt, blotting out the flood of power quicker than the blink of an eye.

In another test it was shown how a compressed-air circuit breaker blew out the high-power arc. To illustrate the magnetic forces in the cables carrying the charge in different tests, the inch-thick copper cables were sandwiched between six-inch timbers, which were bound with half-inch rope. The surge of power set up magnetic forces which thrust the cable apart with such violence that the rope was snapped like twine and the timbers split into kindling.

Another phase of power line protecting test work which is being accomplished at this new laboratory is

the checking of equipment operation at low temperatures. A room-sized refrigerator has been installed as a part of the laboratory, where temperatures of 20 degrees below zero can be produced. In this refrigerator can be set up various types of switches, insulators, and so on, to be tested with the high power under varying conditions of cold. During the recent demonstration, the temperature of the room had been reduced to a point where a power switch, mounted on porcelain insulators, was covered with a thick coating of ice. When current, at a pressure of 60,000 volts, was fed through the switch, a corona discharge formed around the porcelain insulator separating the switch contacts from the steel base. As the voltage was raised gradually, the corona increased in brightness until, at 120,000 volts, a crack of thunder filled the room and a brilliant arc jumped from the switch contacts to the steel base.

"Such tests as this tell how well insulated these switches must be when encrusted with ice," explained one of the engineers in charge of the work. "Since ice reduces the insulating quality of porcelain, the insulators on these winter-proof switches must be made tall enough so that electricity will not arc, or jump, from contacts to base when the line carries its normal voltage."

Thus, test torrents of electricity, created in the mightiest laboratory of its kind, make it possible to avoid interruption of the flow of vital power in the transmission lines of the nation, by making doubly sure that protective devices can cope with even the worst troubles that might arise.

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Recap to Keep em Rolling

Old Tires and Retreading Play Important Roles in America's Wartime Transportation Picture

JULIAN J. WILSON

Unless his automobile, truck or motorcycle is used directly in war production, or in activities deemed essential to the national welfare, the American car owner cannot buy a new tire for some time to come. Conceivably, this might not be possible until complete victory is achieved over Japan and her Axis partners. And, so far, no responsible official has stepped forward to predict that this is going to be a short war.

Just how much tire rationing may disrupt our national life is hard to say. For a people who have centered so much of their industrial and recreational habits around the easy transportation facilities of the automobile, the rubber shortage will not be painless. Realizing this fact, the motorist has been asking the gasoline station attendant and the garage mechanic one question:

"How can I get more miles out of my present tires?"

The answers to this question are brief and simple, according to development engineers of the rubber companies. They say emphatically that there are two things the motorist can and must do to get the maximum mileage life from his tires. First, he will have to eliminate those practices which *waste* the miles of service that are now available in his tires. Secondly, when present tires have delivered all of the safe mileage of which they are potentially capable, the car owner should have these tires retreaded, if possible, thereby insuring many additional thousands of miles of safe dependable service.

Taxicab owners, trucking fleet operators, and others have long recognized the economy of the extra tire mileage made possible by retreading. Instead of discarding a tire when tread wear has approached the danger point, these operators have had it retreaded for less than the cost of a new tire. Records show that one taxicab operator has had sets of tires retreaded as many as five times, and these tires are still in use after delivering over 100,000 miles.

It must be pointed out, however, that no tire can be retreaded indefinitely. Regardless of tread condition, a tire is only as good as its cord body. It is considered practical to retread a tire a second or third time, if the cord body and sidewalls of the tire remain in good condition. But if the cord body has been damaged or weakened to the point where it will not stand up for the additional miles which a retread is capable of giving, it is a waste of rubber to retread it the first time.

In a bulletin to the rubber industry establishing maximum prices for retreading, put into effect January 19th, the Office of Price Administration has given technical definitions of the terms used throughout the retreading industry, to clarify the rulings of that department. These definitions are as follows:

"Retreading means the process of reconditioning a tire by removing all the original tread rubber from the worn tire down to the fabric and applying new rubber to the tread surface and sidewalls;

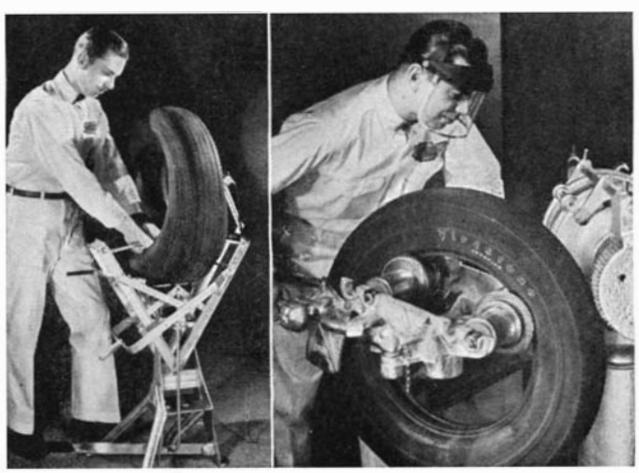
"Recapping means the process of applying a top cap or full cap to a used rubber tire;

"Top cap means a tread renewal where the worn tread of the tire is buffed off the top surface of the tire and new rubber is applied to the tread surface only;

"Full cap means a tread renewal where, in addition to buffing off the worn tread, the shoulders of the tire also are buffed below the shoulder design and new rubber is applied to both the tread surface and tire shoulders;

"Camelback means the uncured rubber compound applied to the worn tire to make the new tread in the process of retreading."

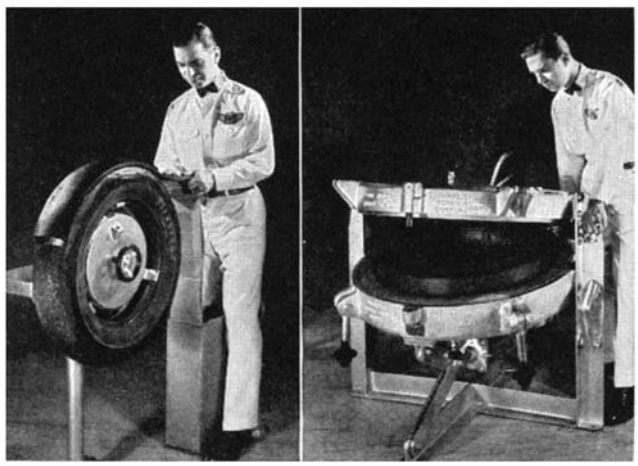
The retreading or full capping of passenger car tires, as defined above, however, was made impossible by an OPM order effective January 12, which stopped all production of camelback of the sizes used for "retreading" or "full capping" of passenger car tires. On



***Left:* Examination determines condition of cord body. *Right:* Rasp smooths uneven parts to a uniform surface**

February 19 an order went into effect rationing the camelback material for all purposes.

These rulings, made because of the necessity of conserving every possible ounce of rubber for wartime purposes, may, in reality, help the motorist to get more mileage from his tires. Before the rubber shortage it was the practice of many drivers to overwork their tires and to disregard simple rules for getting the greatest possible mileage from the original rubber. Too frequently, tires were run past the danger point, where the tread rubber was almost completely worn off, leaving parts of the cord fabric exposed to wear. As a result, many tires which could have been top capped a relatively few miles earlier, have had to be discarded. Longest mileage at lowest cost per mile can be obtained if the tire is top treaded when 20 percent to 25 percent of the normal tread life of the tire remains. This means a covering of $\frac{1}{16}$ inch to $\frac{1}{8}$ inch of tread rubber, which is sufficient to provide a solid foundation for the new tread rubber and, at the same time, protect the cord body.



Left: **Tread stock, or camelback, is applied and,** *(right)* **vulcanized to bond to tire body and to form new tread**

Before a tire is accepted for top capping at a well operated retreading plant, it is first given a thorough examination by an experienced tire repairman. If the cord body shows cuts, breaks, or any other weakness which would tend to shorten the life of the tire after top capping, it is rejected. Rubber is too valuable to waste on weak tires. Only if the cord body is in condition to stand sufficient additional mileage will the tire be accepted.

THE accepted tire is placed on a buffing machine which brings it into contact with a whirling rasp to buff the worn tread. This provides an even surface to which the camelback is applied. The camelback is then bonded to the surface with a special tire cement which holds it in place for further processing. Next, the tire is placed in the curing mold where the action of heat upon the camelback vulcanizes the tread and makes it an integral part of the original tire.

Those tires which are not accepted for retreading or recapping because of the weakened condition of the cord body, while useless in themselves, still are not a total waste. Through chemical processes, the rubber in these tires is separated from the cord body and the other materials that were used originally in making the tire. This reclaimed rubber can be mixed with new rubber in definite proportions and be used again for retreading.

The question most frequently asked is: "How will the mileage of a retreaded or recapped tire compare with that of a new tire?" No truly accurate answer can be given. That depends on the condition of the cord body of the tire, the methods under which it is retreaded, the quality of the camelback used, and the care it is given after it is returned to service.

If only three or four of the most simple rules of tire maintenance and driving care are followed, American motorists can extend tire life by untold millions of miles.

YOUR TIRES WILL LAST LONGER IF YOU:

1. **Keep them properly inflated**
2. **Have a regular day for inflation**
3. **Drive at moderate speeds**
4. **Keep the wheels aligned**
5. **Start and stop gradually**
6. **Have cuts repaired immediately**
7. **Have experienced tiremen check them every month.**

Regardless of the effect of the War Production Board's order of February 19th on rationing of retreaded and recapped tires, this informative article will help all motorists

The two most prevalent causes of mileage waste are high speeds and incorrect inflation. A tire driven at an average speed of 50 miles an hour will deliver only 60 percent of the mileage it will return at 30 miles an hour. If the speed is stepped up to 60 miles an hour, only 45 percent of the potential mileage will be returned—55 percent wasted.

Incorrect inflation is just as wasteful as speed. Thirty pounds of air is the recommended air pressure for tires on many cars. If such a tire is operated at 27 pounds pressure, 21 percent of its potential mileage is wasted. A drop to 21 pounds pressure will result in a waste of 52 percent of its normal mileage life. The average tire loses three pounds of air a week, and should be inflated regularly to keep it to the recommended level.

Nor should over-inflation be practiced if the operator expects to get full mileage from his tires. Over-inflation reduces the amount of tread in contact with the road, induces slipping or spinning of the tire in stopping and starting. An over-inflated tire is also more susceptible to cuts and rim bruises.

Another thief of tire mileage is a wheel which is not in proper alignment. This shows up vividly in field tests. When two opposite wheels on an automobile do not run parallel to each other, one grips the road and runs in a straight line. The other is dragged sideways at an angle. A tire on a wheel which is only one-half inch out of alignment is dragged sideways 87 feet in every mile, causing excessive wear on one shoulder of the tire. Other mechanical faults, such as loose wheel bearings, worn bushings, loose steering connections, uneven brake action, bent axles, or any mechanical condition that impairs the straight, true running of the wheels will cost miles in terms of tire life.

There is a definite schedule of rotation of tires which, if followed every 5000 miles, will add extra miles. It is not necessary to remove the tires from the wheels in making this rotation. The procedure is first to move the front wheels to the rear positions on the same side. On the second move, shift the rear wheels diagonally to the front position. It is good policy to put the spare tire into use every alternate 5000 miles, as it is subject to deterioration if left unused for too long a time.

National surveys, made by The Firestone Tire & Rubber Company, show that the average motorist normally operates his car 20,000 miles on one set of new tires before replacing or retreading them. From records of field tests, where cars are operated under normal driving conditions, it has been definitely established that this figure can be raised safely to 30,000 miles, or even doubled, when proper precaution is taken in the care of the tires.

As a result of these extensive surveys there has been prepared a table of rec-

ommendations for the care of motor-car tires. If these recommendations, set forth on the preceding page of this article, are followed by American motor-car drivers, the result will be an enormous over-all increase in tire life.

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RECLAIMED

Metals From Mill Chips and Scale

EVERY pound of mill scale, chips, and grinding dust accumulated in the past year in the plant of a tool-steel producer has been carefully saved. Periodically, they are gathered and shipped to a refining plant 550 miles away. There thousands of dollars' worth of vital raw materials like tungsten, chromium, and vanadium have been salvaged and shipped back to the tool-steel maker to help conserve the nation's reserves of those strategic metals.

WIRE SALVAGE

Made Economical by New Winch

WIRE reclaiming winches and reels, produced by Gar Wood Industries, Inc., are now being used for fast and economical reclamation of telephone line wire. The winch saves in the cost of removal and also in the cost of

Ten miles of wire an hour

maintenance since the wire removed is ready either for immediate re-use or to be sold to smaller companies for their requirements.

The wire reclaiming winch will reclaim all sizes of copper and iron telephone wire from poles. The winch will coil ten miles of wire in one hour and coil this wire in a form suitable for immediate use. When necessary to remove wire to put up new lines, it has heretofore been the custom to pull one short wire at a time on a collapsible reel. This was not only a slow process but also the wire was bent around the arms of the reel, making the wire useless except to sell as junk material. With the new winch, ten wires (each a mile long) can be coiled at the same time at a speed of 150 feet per minute; the reclaimed coils of wire are nearly as perfect as original factory coils of new wire.

IRON RESEARCH

Yields Method of Using Low-Grade Ore

A RESEARCH project on iron ore, which Henry Ford pushed steadily along for a dozen years despite meager results, now has opened additional possibilities in metallurgy and for automotive and defense manufacture. Experiments have produced a way to recover iron from vast deposits of unwanted, low-grade ore. But, even more significant, the iron obtained by the new method has some unusual characteristics that make it particularly useful in the new field of powder metallurgy.

Unlike ordinary iron recovered by smelting, the iron Ford has obtained is more ductile, it resists corrosion, and it has magnetic properties that improve motor-car performance.

Huge deposits of poor ore, much of it in Michigan's upper peninsula, were the original object of the Ford experiments. Smelting was ruled out as a method of iron recovery because of excessive cost. Research men tried a number of recovery methods and finally settled on electrolysis. The theory is not new, but Mr. Ford believes that an electrolytic method which would be feasible commercially has been perfected for special purposes.

The method of recovering iron from low-grade ore is really a system of electro-plating, and for work on an industrial basis, cheap electric power is essential. The system works this way: Iron is dissolved out of the ore in chemical solution, then is plated out of the solution by electrolysis. One electrode is coated with iron 99 percent or more pure, which can be removed in sheet form. Since the sheet contains a slight amount of hydrogen, it is easily pulverized for use in powder metallurgy. On the other hand, if the sheet is heated slightly, the hydrogen is driven off and the iron becomes ductile.

New avenues in industry seem certain to be opened by this method. The iron powder can be molded into high-precision gears in a single press operation, producing a gear that needs no machining. The advantages of electrolytic iron are not limited to manufacturing, according to Mr. Ford. Motor-car performance may also be improved by using it. For example, cores of distributor coils now in general use sometimes tend to lose their high spark efficiency at high speeds because the core remains partly magnetized between spark impulses. The electrolytic iron cores produced in the laboratory have shown high spark output at all speeds because this type of iron does not retain magnetism between electric impulses.

Of first importance in the decision to push the research program through to success was Mr. Ford's concern for communities near iron mines which had been abandoned because of the low quality of the ore. This has happened in several places in Upper Michigan. "Nobody wants that impure ore now because it costs too much to handle," says Mr. Ford. "If ore doesn't contain at least 40 percent iron, it isn't considered worthwhile to ship it to the furnaces. A lot of the ore in Upper Michigan is 20 and 30 percent stuff—it's full of dirt and other impurities. And that's just the kind of ore we have experimented with in working out our method of iron recovery."

CONDUCTIVITY CHECKS

Prove Their Value in Many Processes

BECAUSE of simplicity, accuracy, speed, and moderate cost, the electrolytic conductivity method of measuring and checking many materials is coming into extensive use in laboratories, industrial plants, and in the field. This technique can be applied to a wide range of chemical values, solution concentrations, water purity, the degree of rinse, and other matters. Indeed, whenever the electrolytic conductivity of a given item can be correlated with the desired factor such as concentration or moisture content, the conductivity bridge serves as the logical measuring and checking means in providing precise readings at the mere twist of a knob, thereby eliminating troublesome, time-consuming procedures, often requiring chemical analysis.

The conductivity bridge, of the type built by Industrial Instruments, Inc., for example, measures specific resistance of electrolytes from .2 to 2,000,000 ohms. Accuracy of measurements comes within 1 percent except for extreme ends of calibration, and is entirely independent of line voltage variations.

The conductivity bridge plays an im-

portant role in checking distilled water for purity, dissolved solids concentration of tap water, boiler feed water and condensates, acidity or alkalinity by conductometric titration, and water used in various processes where special characteristics are desired.

Many organic compounds in the pure state have exceptionally high specific resistance. Slight traces of impurities in these compounds, including traces of water, decrease the specific resistance to a marked degree. Conductivity measurements have therefore been found to be extremely valuable in detecting traces of moisture or impurities in organic compounds, and in some cases have been made part of the specifications since conductivity will reveal the presence of infinitestimal amounts of contaminant, or moisture, which defy other methods of analysis.

And of course the conductivity bridge can be used as a standard Wheatstone Bridge for conventional electrical work such as checking carbon and wire-wound resistors, calibrating rheostats and potentiometers, checking leakage, and so on.

COFFEE SEARCH

Fails, but Points to Better Diesel Filter

How one man's passion for good coffee resulted in a unique industrial contribution to the war effort was disclosed recently by the Moraine Products Division of General Motors. Better Diesel engines for submarines, tanks, trucks, and other vital power applications are being produced because Earl Patch, Moraine Products sales manager, wanted a better cup of coffee and didn't know how to make it.

Here is how the story is told:

Item 1. Moraine Products, a pioneer in the field of powder metallurgy, makes bearings that soak up oil the way a sponge absorbs water.

Item 2. One day Earl Patch brought a percolator to the office and said: "If we can make a piece of metal that will soak up oil, why can't we make a piece of metal that will drip coffee?" "Why not?" answered Roland Koehring, research engineer.

Item 3. Fortunately, neither Patch nor Koehring knew a thing about scientific coffee making. If they had, they never would have tackled the job. They experimented and experimented but without success.

Item 4. Then J. H. Davis, general manager, got interested. He suggested another approach, an approach so simple it had never occurred to the others.

Item 5. The new method works. Out of the sintering furnace comes what looks like a cake of coarse, bright-colored sand similar to those made by children. But, unlike a sand cake, it doesn't crumble.

Item 6. The first batch of coffee is perfect.

Item 7. The second is fair.

Item 8. The third is terrible.

Item 9. From a book on coffee Patch and Koehring learn why. They learn that the grounds lodged in the pores of the filter and turned rancid. They learn that a coffee expert can even spot a cracked cup by the taste of the beverage.

Item 10. But the story has a happy ending. The filter was found to be just the thing engineers of the Detroit Diesel Engine Division of General Motors were looking for to prevent the tiny holes in Diesel fuel injectors from clogging.

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BUSINESS BUILDER: As a result of industrial research, every fourth worker is working today in an industry which did not exist 40 years ago.

• • •

SOYBEAN FIBER

Now Being Produced on Limited Scale

Limited production of a synthetic fiber developed from soybeans—a fiber similar to sheep's wool—has been announced by the Ford Motor Company. Spun from a molasses-like substance that contains soybean protein as its principal ingredient, the fiber is derived from the lowly farm crop that has come into industrial prominence.

The company has been operating a "pilot" mill at its Highland Park plant for several months which is capable of spinning upwards of 1000 pounds of the fiber a day. For the present, the fiber production rate will be maintained at approximately this figure in a new plant in Dearborn.

The synthetic product is said to be best used when blended with sheep's wool. Research chemists who developed the material estimate that eventually the thousands of pounds of wool now used annually in upholstery can be supplemented by at least 25 percent of this new fiber. Early production will be put to this use, for which the new product is ideally suited because of natural crimp and a high degree of resiliency.

The complicated processing of the soybean begins with the extraction of the oil. Protein from which the fiber is made, after being removed from the oil-free meal, is dissolved to produce a viscous substance that emerges from a 500-hole spinneret looking not unlike fine noodles. The extruded filaments are run through an acid bath and later, after immersion in formaldehyde to completely set the fiber, they are cut to desired staple length and dried under controlled temperature and humidity conditions. The fiber is then submitted to a half dozen other operations, all of which prepare it for spinning. After being spun, it is shipped to the upholstery mills. Wool and other fibers are added there.

PIPE LINES

Many Miles Built During 1941

America's "underground railway," its network of petroleum pipe lines, gets longer every year. In 1941 the petroleum industry added more than 4500 miles of this unsinkable transportation to its systems, about half of it in strategic locations directly concerned with national defense. The remainder was built in the normal, continuing expansion of an industry which finds new oil fields every year and must connect them with its refineries; refined products are also carried from the refinery to the market by pipe lines.

MANGANESE

From Low-Grade Ores In the United States

Manganese sufficient for all our national needs can be produced right here in the United States as the result of a new process for the treatment of low grade ores developed by the Bureau of Mines. Success of the process depends on the use of a new reagent developed as a result of researches in the laboratories of the Bureau of Mines, and known as DLT-958. This reagent floats a good part of the worthless materials away from the ore, leaving a concentrate from which the metal can be extracted by the usual process. The Bureau has also developed other reagents of a similar character.

The Bureau has built, under a defense appropriation, a group of pilot plants at Boulder City, Nevada, of which the first unit has begun operations. The first test of the new reagent was made in this mill on ore containing 18 percent of manganese. It left a concentrate containing 53 percent of manganese.

INDUSTRIAL TRENDS

THIS RUBBER SITUATION

UP TO the tragic date of December 7, 1941, the chemical industry of the United States was planning, in the orderly manner typical of past performances, for production of various materials for national defense. But the bombs at Pearl Harbor changed all this. Where minor shortages of materials existed before, there were found drastic scarcities; where experimental planning for future possible production had been underway, there suddenly loomed the necessity for full-scale operation of plants still on the drawing boards.

Synthetic rubber was the one product of the chemical laboratory that received the greatest publicity after the declaration of war bit even deeper into the already critical situation in natural rubber. But even today, months after Pearl Harbor, there is still some misunderstanding about synthetic rubber and its production possibilities.

First, it must be understood that the term "synthetic rubber" applies not to one product alone, but to a number of synthetics produced from a variety of raw materials. Secondly, it is not the scarcity of these materials that is the choke point in synthetic rubber production; plants must be built, and electric power must be provided for operation.

The chemists are ready with a variety of formulas for compounding synthetic rubbers. For some time past Du Pont has been making neoprene from an acetylene base, the resulting product having been proved by practice in a number of industrial applications. Vinyl plastics, by Union Carbide and Carbon, have been substituting for rubber in many fields. Koroseal, a synthetic produced by Goodrich, is being pushed to greater production figures than ever before, and a vehicle tire of synthetic rubber is being made by the same company. Standard Oil of New Jersey will soon be heard from in a big way with another synthetic for tires. Into the same picture come Dow Chemical and American Cyanamid as suppliers of raw materials and Monsanto as a source of processing chemicals.

In the meantime, research laboratories are working overtime on new formulas for producing the synthetic rubbers. The possibilities are almost unlimited, there being literally hundreds of basic chemical forms, obtainable from coal, or oil, or both, that can be combined with other materials to produce innumerable types of synthetic rubbers with varying characteristics to suit almost any designed purpose.

It appears now that, subject to change without notice, the aim of the whole synthetic rubber industry will be toward capacity for producing some 150,000 tons annually; this is about half of the probable ultimate production that will be necessary, it being estimated now that the goal of this industry must be placed at producing about half of our 600,000 tons of rubber consumed annually. By the time the 150,000-ton point has been reached, it is probable that research will have developed newer and better synthetics that can be produced at lower cost.

In any consideration of this important phase of our all-out war effort, it must be remembered that chemists in the synthetic rubber field are working under a suddenly imposed handicap. For years they were experimenting in this field without any immediate pressure other than that of producing a material with industrial possibilities. Then came the natural rubber shortage—and insistent demands for synthetics in large-scale production. There are, thus, many phases yet to be fully explored, phases that will undoubtedly change the synthetic-rubber picture when they have been opened up by the ingenuity of American chemists.

50 PERCENT PRODUCTION

AN INDUSTRIAL production figure that has been widely quoted, but without sufficient explanation, has led to some misunderstanding regarding the total war effort of American industry. This figure places war-production requirements of all sorts at only 50 percent of the total productive capacity of the nation. This would seem, on the surface, to indicate a possibility of business as usual for many companies engaged in businesses outside the war effort. But the figure is one of those misleading overall estimates; there are thousands of firms engaged in luxury-item and other non-essential production that are finding raw materials more and more difficult to obtain. Many of these will be forced out of business, some will obtain only a bare minimum of supplies, while a few will be affected only slightly.

Unfortunately, that 50-percent figure can be spread only just so thin; then it tapers off to nothing.

PUTTING WORDS ON PAPER

TYPEWRITER manufacturers are feeling the demands of war production in two ways. The typewriter itself has become an implement of war, lubricating the wheels that produce the enormously increased amount of paper-work in defense industries and in government departments. At the same time, materials shortages have struck at typewriter production a bit harder, if anything, than at many other industries.

It is encouraging, therefore, to note, in a recent report from the Royal Typewriter Company, that these shortages have had, in certain aspects, a beneficial effect on the industry as a whole. Substitutes for critical metals have been developed and design improvements, incorporating these alternate materials, have been made. Net result is being shown in better machines for putting words on paper, and the foreshadowing of even more efficient machines for lubricating the wheels of peace in days to come.

IN NEW DRESS

THE packaging industry in general is hard at work following the general trend of re-design made necessary by the withdrawal from civilian use of many materials heretofore considered essential. Thus research is being directed toward plastic and paper tubes to replace the collapsible metal tubes used for toothpaste, shaving creams, and so on; the tin, lead, and aluminum formerly used will soon be out of this particular picture. Glass and wood are other possible alternates for use where the material to be packaged can be adapted to such containers.

Beyond substitutions in this industry there is a definite trend toward simplification of containers of all sorts. Soon will be gone ornate wrappings on soap and similar products. Double paper coverings will be a thing of the past. Possibly some industries will even turn attention to the design of packages which can be opened by the average person without the loss of at least a fingernail!

—*The Editors*

'Water, Water, Everywhere'

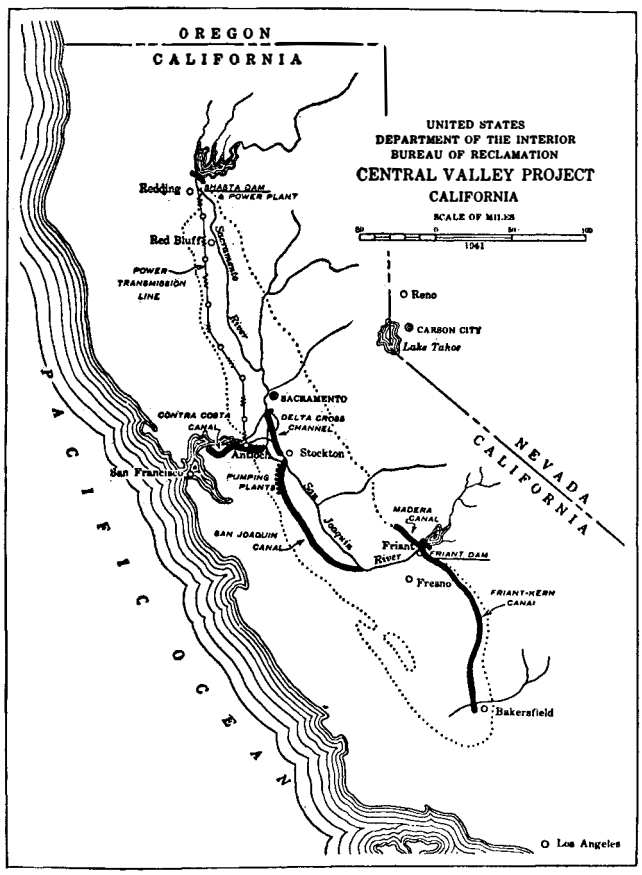
Multiple-Purpose Central Valley Project in California Involves Huge Dams, Five Canals

ANDREW R. BOONE

FROM sky-scraping Shasta Dam on the north to Bakersfield on the south, beneficiary of water to be carried by canals stretching like tentacles up and down California's great Central Valley a total distance of 393 miles, it's a case of "Water, water, everywhere."

The United States Bureau of Reclamation looks upon the Central Valley Project as holding greater potential benefit, both locally and nationally, than any conservation project attempted in its 38-year history. This undertaking is a multiple-purpose project, involving construction of two huge dams, Shasta and Friant, and five canals, which jointly will:

Improve navigation on inland waterways, reduce floods in the Sacramento and San Joaquin River valleys, furnish water to irrigate 2,000,000 acres of highly productive agricultural lands, control salt-water encroachment in the delta region of the two rivers mentioned, improve domestic and industrial water supplies in central California, and develop hydro-electric power for municipal, agricultural, industrial, and project uses.



Area covered by Central Valley Project

What the system of canals, and the water they will carry, mean to agriculture and industry may be noted in these facts and figures:

During the last season, ten times more rain fell at Kennet, in the northern end of the project, than at Bakersfield, near the southern tip. Kennet, in the future area of Shasta reservoir, which will back up 35 miles and impound 4,500,000 acre feet of water, received a total of 112.76 inches, while 11.61 inches (twice normal) fell at Bakersfield. Some of Kennet's surplus will flow into the north and central parts of the valley, and make available San Joaquin River water for diversion to the arid southern end of the valley.

Already, water is being delivered via the Contra Costa canal to Pittsburgh, an industrial city located in the upper bay region 40 miles east of San Francisco. Necessity for this supply arises from an increase in hardness of the local well water from 155 to 800 parts per million in 19 years, and difficulties of pumping against a head of 225 feet. Canal water is now being substituted for this and other pumped water.

Shasta Dam serves a far more important function than any other individual unit of the Central Valley project. "Shasta reservoir," explains Walker R. Young, assistant chief engineer for the Bureau of Reclamation, "will be operated to diminish the seasonal flood flows of the Sacramento River and thereby check annual waste to the sea of precious water, and correspondingly to increase the natural output of the river during dry months for purposes of navigation, irrigation, and salinity control. Reservoir releases will generate electric power to be carried by project transmission lines down the Sacramento valley to load centers. Finally, after the conserved waters of the Sacramento River have served all these functions and we have wrung the last squeal from the last drop, they will afford a surplus for export to the upper San Francisco bay region and San Joaquin valley through other features.

"These include the Delta Cross Channel to divert Sacramento River water across the delta, Contra Costa Canal leading from the delta westerly to a bayshore industrial and agricultural area, San Joaquin pumping system from the delta into the northern San Joaquin valley, and Friant-Kern and Madera canals to serve the southern San Joaquin valley. All these depend, directly or indirectly, upon Shasta Dam. In fact, no one feature can be fully utilized unless some or all the others are in operation."

Shasta—higher than Grand Coulee, second largest masonry dam ever built, with half again the mass of Boulder—staggers the imagination when you consider its proportions. Located 12 miles above Redding, on the Sacramento River, it will be 560 feet high and 3500 feet long. Six million yards of concrete will be placed before water climbs toward its crest.

Shasta will consist of a mass of pre-shrunk individual blocks, cooled by circulating river water through pipes imbedded in the mass. Upon completion of the blocks, they will be joined by pumping grout through another system of pipes, permanently imbedded for this purpose. Finally, a power plant, housed in a seven-story building, will involve operation of five 75,000-kilowatt generators turned by turbines developing 103,000 horsepower. The generators weigh 4250 tons, and 174 railroad cars will carry them from the manufacturing plant to the dam site. Of the 1,500,000,000 kilowatt hours of electrical energy developed each year, one-fifth will be utilized for project pumping, and the remainder made available for civil use.

Perhaps the most unusual feature connected with Shasta is the long ag-

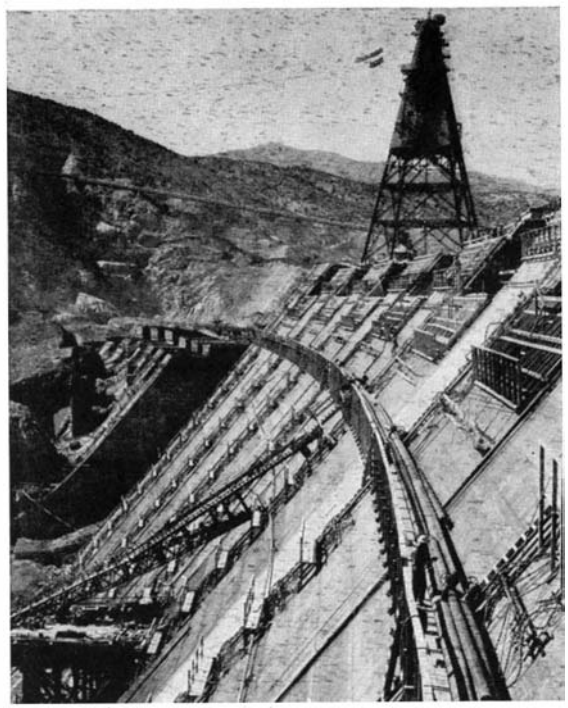
gregate delivery line. Were you abroad any morning in the vicinity of Shasta, say at 7:45, you would hear the combined blast of 30 horns stretching in a line 10½ miles long across the hills. And, were you standing alongside a small house at Coram, you would see an operator press a button starting a quarter-mile of loaded belting, known as flight 26, moving. In a few seconds, flight 26 would be up to speed, precisely six miles an hour, at which instant, flight 25 would commence turning. Six minutes after the button makes contact, all 26 belts, forming an endless delivery chain from the gravel plant at Redding, are rolling, carrying their load of 1700 tons of aggregate toward the hoppers at Coram. By nightfall, 20,000 tons of material, the equivalent of 400 freight cars, will have been delivered

Two conveyors at Redding alternately feed the main line. One runs under a huge sand pile, where it is loaded by several drawdown gates. The other extends under gravel piles, for loading with different size gravel. The loading operator "ships" one size aggregate for one hour, then shifts to another. When a change is made, he 'phones the operator at Coram. Exactly 88 minutes later, the Coram operator, noting a minute gap in the stream, notifies a shuttle operator to shift the delivery from one bunker to another, and delivery continues. The shuttle conveyor is shifted quickly to any of five bunkers.

This conveyor has been spoken of often as being a "ten-mile belt." It really consists, however, of 40 belts. Aggregate in the first eight miles is lifted 850 feet in 22 flights. During the next four transfers, it descends 700 feet, the motors acting as generators to restore some of the power consumed on the long uphill climb. At Coram, it starts another 14 flights for a 1.2-mile travel, at the end of which it goes through a 150,000-ton storage pile before being mixed with concrete and swung out over the canyon for placing in Shasta Dam. Total length of the 40 flights is 10.8 miles, and before Shasta is completed they will have transported 11,000,000 tons of sand and gravel to the site.

How concrete embodying the aggregates delivered along the belt line is placed represents certain engineering novelty. Flights seven to 14 of the second conveyor system transfer the aggregates from stock piles around and over the abutment to small storage bunkers at the top of the mixing plant.

This plant bears the appropriate name, "The House of Magic." During a single day's run, this plant mixes 10,000 cubic yards of concrete. The order of mixing is fully automatic, and is controlled by four men. The plant is hexagonal in shape, stands 130 feet high, and is fabricated of reinforced concrete and structural steel. At the top are five bins capable of storing 2165 cubic yards of aggregate, and two bunkers carrying 3200 barrels of cement. Following mixing, the cement is discharged into a hopper for the distribution cars, which operate on a circular track 420 feet in diameter. This track circles the base of the head tower, and over it the concrete is carried to the various highline buckets.



Shasta Dam, conveyor belt in background

You'd have to climb 257 feet to reach the hoist floor. In it you would find seven large three-drum hoists. Lines from the hoist drums lead to the top of the tower and through sheaves to individual cableways. Tail towers for the cableways are mobile, and operate on five radial runways. Each tower is controlled by an individual operator. From his station, the operator can move the bucket out, lower it, trip it, haul it up, and bring it back for reloading. All buckets used on the high lines carry eight cubic yards, and are permanently attached.

Friant Dam, near Fresno, will be completed sometime in 1943. Aside from a certain measure of flood control, Friant will have little value until its connecting canals are open into areas of critical water deficiency, especially the 160-mile Friant-Kern canal, of 3500 second-feet initial capacity, under which more than half the service area of the Central Valley Project is situated.

Friant presents a construction picture differing markedly from Shasta. No huge tower and cableways here. Rather, a giant trestle stretches from one side of the valley along the line being followed by the dam. Immense cranes, known as "hammer-heads," move along the tops of the trestle. From the cranes buckets of concrete are lowered. So high do the cranes stand above the valley they can continue handling the buckets until the dam is completed.

Friant's "house of magic," or mix-house, is located at one end of the trestle, and is fed with aggregates by means of a belt conveyor and cement through a pipe line similar to the Shasta arrangement. Railroad cars, each carrying four four-yard buckets are hauled from the mix-house along the trestle to the dumping area. There, cranes pick up the buckets singly, raise them in an arc to the dumping point, and return them to the cars. By this means, 5000 cubic yards of concrete are placed daily.

Like Shasta, Friant offers some new construction methods and practices. It is smaller than Shasta, yet a whopper in its own right. Friant will be 320 feet high and two-thirds of a mile long. With 2,200,000 cubic yards of concrete finally in place, it will be exceeded in size only by Grand Coulee, Shasta, and Boulder.

On the downstream face, which will be exposed to weather except during brief periods of overflow, an absorptive lining is used in the forms. This material is quite porous, and has the property of soaking up water as the concrete is poured, causing the surface to become more dense by drawing fines to the surface. Because the surface is denser, it will resist weathering longer.

The Central Valley Project not only will insure water for California's lush agricultural production. It also will restore thousands of acres lost in recent years to production because of water scarcity, and guarantee water to such defense industries and military establishments as may spring up in this region. All together, it represents a mighty effort at conservation which bids fair to yield tremendous returns in many fields.

New Pleiades

Recent Investigations of Proper Motions Have Added Two Dozen More Stars to the Famous Cluster

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

One of the most conspicuous objects in the sky is the cluster of the Pleiades. The brightness of its stars and their apparent closeness set it apart at a glance, and it was doubtless recognized long before the Greeks gave it the name by which we still know it.

Six stars are easily seen by any normal eye; keen eyesight may raise the number to eight, or even to ten. A field-glass shows dozens, and telescopes reveal numbers steadily increasing with their power. With a modern instrument, of high light-power, it would be easy enough to photograph 10,000 stars within two degrees of Alcyone—the brightest star of the group.

But, if we pointed such a camera to any other part of the sky and made an exposure of equal length, we would find a great number of stars on an equal area of our plates. The sky is full of faint stars everywhere, and there can be no doubt that our photograph of the Pleiades region must show a host of "field-stars" which have no connection with the cluster—most of them lying far behind it, and a few probably in front. How can we allow for this? The presence of the cluster should make no difference in the distribution of the stars seen in front of it or through it. We may expect to find the same number of field-stars per square degree as in other regions of the sky. Any excess (over and above the fluctuations reasonably attributable to random sampling) may be ascribed to the cluster.

For example, Trumpler, counting the stars of the Bonn Durchmusterung—which goes down to about the tenth magnitude—finds, for the number of stars in the vicinity of the Pleiades:

Distance from Center	Number	Number per square degree	Field	Cluster
0°—1°	63	20.0	12	51
1°—2°	56	5.9	36	20
2°—3°	79	5.0	60	19
3°—4°	87	4.0	84	3
4°—5°	104	3.7	108	(—4)

The number of stars per square degree, in the successive zones, falls off to a nearly uniform value of 3.8, which may be taken to represent the "field." If this was uniform, the number of field stars would be as given in the column captioned "Field." The excess of the actual numbers should represent the cluster members. The values 3 and —4 for the two outer zones are evidently due to random irregularities, but it is evident that the Pleiades cluster stars extend to about three degrees from the center. Within this region there are 90 cluster stars, and 108 field stars—with a probable uncertainty of not more than five.

By such counts it becomes certain that, among the fainter stars in this region, we must have hundreds of cluster-members, mingled indiscriminately on our plate with a larger number of wholly unrelated ones. To separate the two would be a thankless task, were it not for one fortunate thing. The Pleiades cluster is not at rest in the heavens. The brighter stars, which have been very accurately observed, are moving, slowly but definitely. Measures of their relative positions, made long ago, with the heliometer (then the most accurate instrument) and later by still more precise photographic methods, show that they do not change their distances and directions from one another at any perceptible rate, while the meridian observations reveal a motion of the whole group together southward and eastward, at the rate of 4″.8 per century.

This is a rather slow motion for stars as bright as the leading members of the group; but in 20 years it displaces the cluster by almost a second of arc. Measures of a single good photograph will locate even very faint stars with an error less than a tenth of this. So the astronomer who is lucky enough to have an old plate of the Pleiades need only take another—with the same telescope and of just the same region—measure the star-images on both, and apply the simple corrections which allow for the fact that the two plates were not put into the measuring-machine in exactly the same position. The great bulk of the fainter stars will show little or no change of position in 20 years—they are too far away. The nearer ones (and a few more distant ones whose actual velocities in space are great) will have moved, compared with the rest. Those which belong to the cluster will have moved by the amount and in the direction which follows from its known yearly motion, and can be picked out by simple inspection of the list.

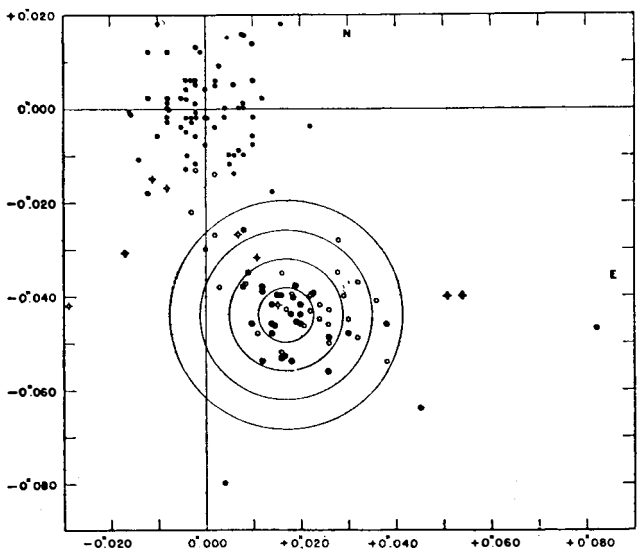
By sheer luck, a star or two out of the hundreds on the plate might appear to be moving in this direction and at this rate, though not really connected with the cluster, and so might get into the list where it did not belong. But this demands a double coincidence of direction and rate of motion, which is very improbable. The fainter the stars considered, the slower their average proper motions will be, and the smaller the probability of such an accident.

Even the best observations cannot be perfectly accurate, hence the final list has to be divided into three classes—stars whose observed motion agrees so closely with that of the cluster that it is almost certain that they belong to it; stars for which the discordance may arise from an accidental heaping up of the errors of observation, and which are "probable" members; and those for which the discordance exceeds any reasonable allowance for these errors—which are dismissed as non-members. The majority of these will be slow-moving background stars—seen through the cluster. A few, which move faster than the cluster, or in different directions, may lie in the foreground, or at more or less the same distance but do not belong to it.

Trumpler, in 1921, and Hertzsprung, in 1929, applied this method to the Pleiades. The latter listed 187 cluster members in a region two degrees square centered on Alcyone—some of them as faint as the 16th magnitude. The question whether still fainter stars—and how many—might be present could be answered only by long exposures with great telescopes. This has just been done by van Maanen at Mount Wilson. A few plates of the Pleiades had been taken with the 100-inch telescope in 1921 and 1922—covering a field 42 by 31 minutes of arc, with Alcyone in the center, and showing images of stars down to below magnitude 17.5—about 800 of them in this small area of little more than one third of a square degree. The best of these plates, compared with some lately

taken, gave two pairs with intervals of 15 and 19 years, upon which the motions of stars belonging to the cluster would be conspicuous. Indeed, when the earlier and later plates were "blinked" with the stereocomparator, 70 stars out of the 800 were found to have moved perceptibly. All these, regardless of their direction or rate of motion, were measured. It would have been an obvious waste of time to measure all the 730 other stars, only to get no perceptible motion. Sixty-seven of them—distributed evenly in position over the plate, and in magnitude between 13 and 16.5—were chosen as comparison stars, and sufficed to define a distant and substantially motionless background.

Of the 70 moving stars, 39 showed motions so nearly identical with that of the brighter stars of the cluster that their membership in it was practically certain; 9 others agreed well enough to be recorded as probable members, 8 were doubtful, and 14 clearly did not belong. Six of the latter turned out to be moving slowly, and probably were members of the background, while the other eight moved as fast as the cluster or faster, but in other directions or at other rates.



This diagram shows the rates of motion of the stars in the Pleiades observed by van Maanen. Imagine a set of points, each starting at the intersection of the lines marked 0.000, and each moving at the same rate and direction as one of these stars. At the end of a year they would present the appearance shown in the figure. The comparison stars (represented by the small black dots) are very remote, and move very little—indeed, their scatter about the starting point arises mainly from the small errors of observation. The large group of dots lower down and to the right represents the members of the Pleiades cluster which (within the errors of observation) are moving together. The black dots represent stars previously identified by Hertzsprung; the open circles, those found by van Maanen. Points inside the inner circles indicate almost certain members of the group; the next circle includes the "probable," and the last, the "uncertain" members. This group of points is almost completely separated from the one which corresponds to the "background" stars, and provides conclusive evidence of the existence of a moving cluster in this region. The small circles elsewhere in the diagram indicate "foreground" stars of relatively fast motion. From *Astrophysical Journal*

In this small area, then, there are almost certainly 39 and probably 48 cluster stars. This includes 26 previously identified by Hertzsprung; hence the inclusion of stars about two magnitudes fainter has nearly doubled the number. If the same proportion holds for the regions not yet photographed with the 100-inch, there must be about 350 cluster members in the two degrees square, and very likely 800 in the whole cluster, which extends beyond this but thins out rapidly.

There is no sign at all that the limit of faintness has been reached. Including the "possible" cluster members, there are 13 stars in the well-observed area between magnitudes 6 and 10; 10 between 10 and 14; and 31 between 14 and 18 with the last count incomplete.

It would be a conservative guess to say that there must be at least 2000 stars in the Pleiades cluster, and that fully half of them are too faint to photograph with the 100-inch telescope—but of course this *is* a guess.

The distance of the cluster—though too great to measure directly—is fairly well determined by a study of the absolute brightness of its stars, and appears to be 400 light-years. On this basis, the faintest cluster stars so far observed have an absolute photographic magnitude of +12—which means that they give out about 1/400 as much violet light as the Sun.

Hertzsprung has found that the faint cluster stars are all red, and redder the fainter they are down to his limit of observation at the 14th magnitude. The newly discovered members are doubtless still redder, typical faint dwarfs of spectral class M, running down to about 1/150 of the Sun's visual brightness.

Alcyone is 2000 times as bright as the Sun (photographically) and almost a million times brighter than its faintest known associates in the cluster. As in similar cases, this enormous difference doubtless arises from the concurrent operation of several factors. Alcyone is more massive, larger, and, above all, much hotter on the surface than its tiny neighbors. All but the brightest of the Pleiades appear to be normal main-sequence stars—heat-engines working in the same way and deriving their energy from the slow transmutation of hydrogen into helium by means of the now well known "carbon cycle."

Alcyone and a few others are abnormally bright for their spectral type, and their internal composition or constitution must be somewhat different. Unfortunately, none of these bright stars is double, and we cannot therefore find their masses, which might give us a clue to the reason for their peculiarities. There are several double stars, with slow orbital motion, among the fainter cluster members, and these appear to be of normal mass for their brightness.

To study still fainter stars, we must leave distant systems like the Pleiades, and search among the nearest stars. These are still being picked up, as parallaxes are measured for the faint stars of large proper motion which are detected by systematic "blinking" of pairs of plates taken years apart. There is still good hunting for the observer here. Dr. van Maanen, reporting on his last 25 parallax fields, finds eight stars—one of them double—within 50 light-years. Four of them are less than 30 light-years away, and two of these are really our near neighbors, with distances 10.3 and 11.2 light-years. These stars, like almost all faint ones, are known only by their numbers in the catalogue of the observer who discovered their motions—Ross 128, of magnitude 12.7 and Luyten 789-6 of magnitude 14.3. The second—and nearer—of the two is noteworthy as having the largest proper motion of all the stars found by Luyten in the great survey which he has made. Its motion of 3″.27 per year is exceeded by some 15 other stars, but none of these is as faint. The absolute magnitude +16.8 indicates that its photographic brightness is but 1/30,000 part of the Sun's, while its spectrum M6 marks it as one of the coolest dwarf stars which has ever been observed.

Shockless Surgery

Ice Anesthesia, Boon to Aged in Limb Operations and a Promise for War Wounded in the Field

BARCLAY MOON NEWMAN

JUST in the nick of time, for use in saving the lives of thousands of war wounded—civilians injured in air raids and soldiers on the battlefield—comes a revolutionary technique in surgery. Bloodless, shockless surgery, without any other anesthetic than cold, has been developed by the New York diabetic specialist, Dr. Frederick M. Allen.

Also, for the first time in medical history, we have anesthesia of the whole living tissue substance, instead of the former crude anesthesia of nerves alone—hence a remarkable freedom from pain and from deadly shock.

Infection is rendered far less likely.

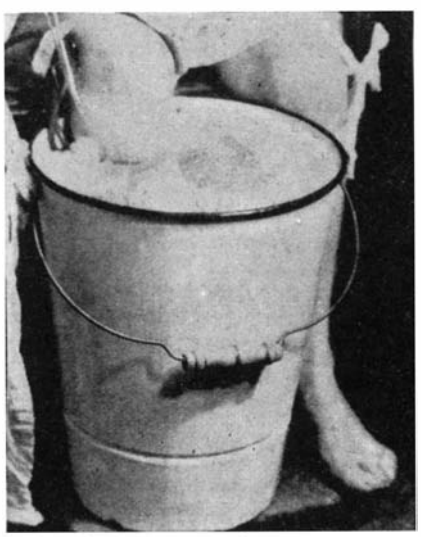
Emergency cases with shattered limbs can be painlessly, bloodlessly, shocklessly, transported great distances and, if necessary, kept waiting safely for many hours before operation; ice bags, a pail of cracked ice, or a special refrigeration apparatus, as well as a tourniquet, is all that is needed.

The patient is ready for immediate operation any time after the limb has been thoroughly chilled, without further ado, without even a local anesthetic.

Here is a veritable boon for China, for Russia, or on any battlefield where anesthetics, antiseptics, drugs, may be lacking; a boon, too, for the aged diabetic or sufferer from hardening of the arteries who must undergo operation for gangrene of the foot. More of the arm or leg can be saved, in young or old, than with the old techniques. More successful are the operations, which formerly, with the old techniques, were accompanied by a rather high mortality.

Though the first extensive trials were reported only within the past few months, this new "cold surgery" and "protoplasm anesthesia" are already adopted as routine in many hospitals, with City Hospital, New York, showing the way. At City Hospital, Dr. Lyman Weeks Crossman, Dr. Wilfred Ruggiero, and Dr. Vincent Hurley have used the new surgery in scores of gangrene cases, with such a high percentage of successes that the attention of the medical world has been attracted.

Most astonishing to the layman—and to many a surgeon, too—is the fact that a patient can eat breakfast while his wounded or gangrenous leg is being painlessly cooled to a few degrees above freezing, then can go into the operating room without further anesthetic or any drug whatsoever, chat with the nurse while the surgeon amputates behind a screen, and can return at once to the ward and eat a full lunch, as though nothing had happened. There is no pain, no shock—hitherto a great cause of weakness, and often of fading vitality long after such major operations.



Limb immersed hour and a half or more in ice water, cracked ice

In war wounds and in other emergency cases, where a limb operation or amputation is necessary, a rubber tube is used as a tourniquet to shut off the circulation, the degree of tension being just sufficient to stop all blood flow to the lower portion of the leg or arm. "The rule that a tourniquet cannot be applied to a diabetic or arteriosclerotic limb is set aside by cold," Dr. Allen points out, to the amazement of surgeons skilled in the older, very ticklish handling of gangrene in aged diabetics or others with poor circulation in the extremities. Then, the leg or arm is immersed in ice water to a level about one inch above the tourniquet. Weaker patients may lie with only a slight elevation of the head of the bed and, with the protection of a rubber sheet, the leg is placed on a layer of ice and then is covered completely with cracked ice. Or, again, rubber ice-bags may be used, salt being added to each. The newest development is an electrically refrigerated "blanket."

A 200-pound refrigerating apparatus serves four to six patients simultaneously, and can readily be fitted into an ambulance. Thus emergency cases can be prepared for operation en route—in fact, are out of pain, unshocked, uninfected, even unstrained in the meanwhile. The dual application of tourniquet and cold brings almost immediate, complete loss of sensation in the injured limb. The rest of the body can be kept as warm as desired. There is no general chilling above the tourniquet.

In ordinary hospital routine, where the case is one of gangrene and there is no bleeding, the limb may be first surrounded with a few ice bags at the level chosen for the tourniquet. Within five to fifteen minutes the skin is chilled so that the application of the tourniquet causes practically no discomfort. A preliminary morphine hypodermic or other sedative is sometimes used in instances where the patient is nervous and apprehensive, but otherwise no anesthetic or other drug is needed.

TESTS of the refrigeration are made by means of a thermometer held next to the skin. The desired temperature is about 40 degrees, Fahrenheit, eight degrees above the freezing point of water. This assures adequate chilling without risk of actual freezing.

"The time required for complete through-and-through anesthesia varies with the depth of tissue," Dr. Allen states. "It may possibly be as short as one hour for an emaciated shin, or as long as five hours for a rather thick thigh." Then, with the patient in the operating room, the limb is removed from its nest of ice bags or other refrigeration. Sterilization and operation are carried out as usual. The surgeon need not hurry: the chilled tissues stay cold long enough for an ordinary operation, and longer. For extraordinarily lengthy operations, the limb may be kept on a bed of ice bags. When the operation is complete, the tourniquet is released, blood rushes in, and any bleeding points are quickly caught and stitched up.

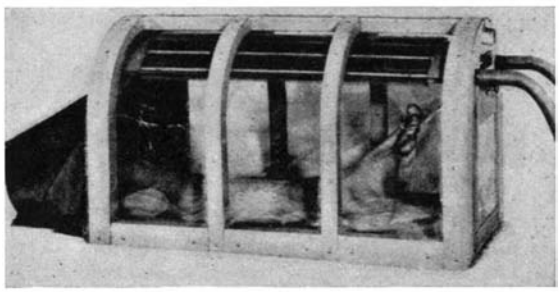
The surgeon has had the opportunity

of working in a bloodless and shockless field. Shock is at most that slight degree which may develop from the tissue injury left after the wound is finally closed and the temperature raised to awaken the "hibernating" life substance, protoplasm.

After the operation, the patient has neither nausea nor gas pains, so common in ordinary anesthesia. The practically complete absence of shock is evidenced by a steady pulse, constant level of blood pressure, steady rate of respiration—no changes occur during or after the operation. This is ideal for surgery of those who are so weak that ordinary operative shock would likely be fatal. In a series of more than 50 operations reported on at City Hospital, the average age was 68, and a number of these patients were four score years old. Almost all were suffering from heart disease, or diabetes, or hardening of the arteries, yet they successfully underwent the hitherto risky major operation of amputation. Formerly, four out of five died, when operated on by the older procedures. In the City Hospital series of cases four out of five lived.

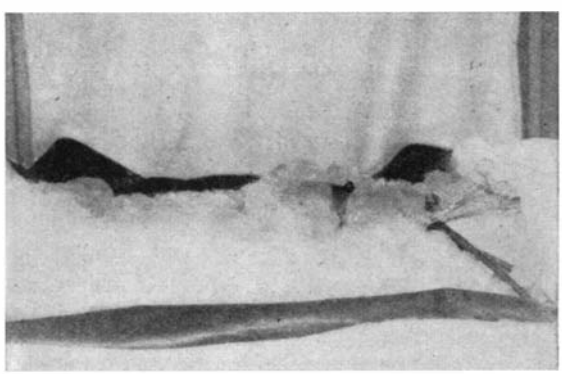
Not only shock but bacterial infection plagued the older surgery. We all know that refrigeration prevents the growth of bacteria. Doctors are all familiar with the preservation of living tissue in the ice box for weeks and even months—alive and uninfected. In cold surgery, as well as in the transportation of refrigerated wounded to the hospital, bacteria simply cannot grow.

After amputations, there is the ever-present danger of blood coagulation, sometimes extending rapidly up a limb and entailing a correspondingly rapid gangrene. Such phenomena are caused largely by damage of the blood vessel walls. Bacterial invasion may bring about the damage. In arteriosclerosis, damage to the walls arises from lack of nutrition and of oxygen, as well as from bacterial action. Now the clotting is prevented by cold, which preserves the vessel walls. Parts which have deficient circulation can be most effectively chilled and, by very gradual warming through several days after the operation, survival of the tissues is promoted. In ordinary cases under the new procedures, gradually lessening refrigeration is the rule, the manipulation of ice bags permitting a slow return to normal temperature. The wound margins can be kept healthy, yet not sealed. Discharge may continue abundantly. It cannot decompose or become infected, because enzymes and bacteria are checked by low temperature.



Electric refrigerator cradle for treatment of extremity — hand or foot — at low temperature

Of course, as Dr. Allen says, healing is slowed in proportion to the reduction in temperature. But there are advantages here, too. A whole series of important new controls become available when needed. When there are threatening signs of loss of vitality in wounds, the surgeon has previously had to stand helplessly by and watch the wound slough. The sloughing is due to deficient nutrition and oxygen. Now it is possible to reduce the tissue metabolism (use of food and oxygen) to a level for which the existing blood supply is adequate.



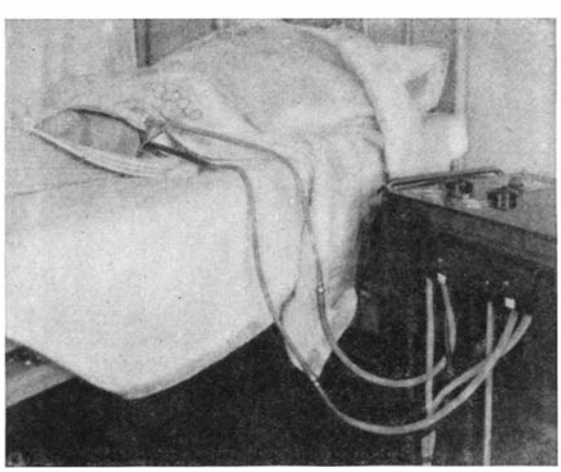
Ice-immersed extremity of patient lying in bed. Complete anesthesia in two and one half hours

The use of low temperatures opens up other striking possibilities — already realized in the hospital. In the most desperate cases, hitherto, surgeons have had to take the risk of a high amputation if the patient is to be considered operable at all. Such has been the situation in severe gangrene of the exhausted aged, diabetic, arteriosclerotic, and in rapidly advancing infections of the limbs of young or old. Refrigeration offers an alternative, and the tourniquet can add all the advantages of operation without the shock. The advance of infection, the pain, the downward trend of the patient, can be checked for several days by simple packing in ice.

Transfer of all these results to war conditions offers much. It offers the hope of transportation of limb casualties without hemorrhage, pain, or shock; without advance of infection or tissue devitalization; with minimum damage and maximum time limits of tourniquet application; and with freedom to operate without an anesthetic or to delay for several hours according to the exigencies of a crowded surgical service.

With regard to its practicability in war, refrigeration is usually available on naval vessels, and for modern mechanized armies the 200-pound apparatus is obtainable. This can be operated by the motor of a truck or ambulance and can refrigerate four to six limbs simultaneously, while ice is frequently available in less fortunate countries, from Finland to China, where the lack of anesthetics has entailed much suffering.

A large number of both military and industrial wounds consist of mutilations of limbs. In warm weather ice is often available or can be especially provided. In cold weather, only precautions against actual freezing of parts may be needed. The chilling is so simple that it can be carried out by reasonably intelligent non-medical persons. The tourniquet, of course, is necessary to stop hemorrhage, and under appropriate conditions of reduced temperature may be kept in place for several hours without risk. The transportation of wounded persons can be made entirely painless, as far as limb injuries are concerned. There is probably better



To anesthetize, thermostatic controlled refrigerator keeps "blanket" at 40 degrees, Fahrenheit

preservation of strength and resistance than with large doses of sedatives. The wounded may then arrive at a hospital after several hours, ready for immediate operation without any additional anesthetic.

Even when any parts are potentially infected, perhaps by being contaminated with dirt and other foreign material, refrigeration holds everything in abeyance. The preservation of tissue vitality and resistance to infection should facilitate conservative and reparative operations and aid in avoiding amputations and crippling. Much more of the limb may thus often be saved, or even whole limbs that would under the older procedures have been necessarily removed.

These achievements are indeed revolutionary. So much so that they might not yet have gained recognition except for the courage and vision of Dr. Allen's colleagues, Dr. Crossman and his associates, in applying them on a scale sufficient to convince other surgeons. The greatest obstacle was and still is lack of financial support. As Dr. Allen has written: "The only support for this research has come from the American Medical Association, in the form of a $500 grant from its Committee on Scientific Research, for animal experiments, now conducted at the New York Medical College, and one of $300 from its Council on Physical Therapy, for the clinical study at City Hospital in New York."

Except for these obstacles, there need not have been the long delay since the report of the first human cases in 1937, and the world-wide adoption might have been possible before the outbreak of the present war. It might have been the means of saving the lives of soldiers and civilians the world over.

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AGAIN GUILTY?

Do Flies also Spread Infantile Paralysis?

THE case against flies as the culprits that spread infantile paralysis is strengthened by a discovery reported by Dr. Albert B. Sabin and Dr. Robert Ward, of the Children's Hospital Research Foundation and the University of Cincinnati College of Medicine, in the current issue of *Science*.

Flies caught in Cleveland and Atlanta in the neighborhoods of infantile paralysis patients were infected with the virus of the disease. Previous discovery of the infantile paralysis virus in flies was made in insects trapped in rural areas, in one instance near a privy used by three households in which there were infantile paralysis patients.

Discovery of the virus in city flies is considered more significant, especially since the infected flies were found in modern neighborhoods with good plumbing and in which several children had mild illnesses that might have been abortive infantile paralysis at about the same time other children had recognized attacks of the disease.

Flies as carriers of the disease fit with the theory, suggested by recent evidence, that the virus attacks through the alimentary or digestive tract rather than through the olfactory nerve from the nose. Suggestive also is the fact that the fly season and the infantile paralysis seasons coincide.

PRONOUNCIATION

Of Names of Two of the Sulfa Drugs

NOT laymen alone, but physicians also, have differed widely in the pronounciation of the words sulfanilamide and sulfathiazole, two of the sulfa drugs. *The Journal of the American Medical Association* now states that the Council on Pharmacy and Chemistry of the Association has recommended that the word *amide* be pronounced with the long *i* (amīde). Thus it rhymes with chloride and iodide. In the word sulfanilamide the syllable *il* is given the major accent.

Sulfathiazole is to be pronounced similarly with a long *i*, and the accent on the *thi*.

INFECTION

Depends on Both Bacteria and Host

LIKE the modern blitzkrieg and its aftermath, extremely virulent bacterial infections actually are ineffective from the standpoint of the bacteria, as parasites, because the microbes so rapidly destroy the tissues upon which they live and grow, according to Dr. Paul R. Cannon, professor of Pathology at the University of Chicago.

Time plays a commanding role, in infections, as important in the incipient stages as it is in a beginning forest-fire, said Dr. Cannon, continuing:

"The ability of bacteria to grow in living tissues depends upon forces inherent in both the bacteria and the host.

"At times, with highly virulent bacteria, this ability to grow is so predominant, that, under proper conditions, they can multiply rapidly, metabolize efficiently, and overcome quickly all efforts on the part of the host to prevent these actions. This type of infection, fulminating in development and quickly lethal in course, represents the maximal biologic growth efficiency of the bacteria concerned."

A return of scourges like the "Black Death" cholera and typhoid fever today is not so threatening as it was when these diseases ran riot in Europe, Dr. Cannon said, because of modern methods of keeping invading bacteria localized, and their toxic action checked until they can be destroyed by the defensive forces of the body.

PREGNANT?

Electric Recordings of Unborn Baby's Heart Beats

ELECTRIC recordings of the heart beats of an unborn baby can now be made successfully for practical purposes by means of a technique announced by Dr. Arthur J. Geiger, Dr. Willys M. Monroe, and Dr. Allan V. N. Goodyer, of Yale University School of Medicine, in the *Proceedings of the Society for Experimental Biology and Medicine.*

Doctors have tried for years, hitherto with only indifferent success, to obtain electrocardiograms of the unborn baby's heart beats, although these graphic recordings of the electric current produced by the heart muscle contraction have long been used in studying heart disease.

The new technique, the Yale investigators report, enables the doctor to tell promptly whether a woman is about to become a mother or whether she has a tumor. It does not give "false positive" results and takes less time than mouse or other biological tests for pregnancy.

"Will it be twins?" can be answered much earlier than by any other method of examination.

In their work the Yale doctors use a single stage resistance-coupled amplifier with a conventional portable electrocardiograph. The electric current accompanying the unborn baby's heart beats is picked up by disk electrodes placed on the mother's abdomen. They are amplified 20 times, which brings the recording into plain view, and the apparatus is arranged to minimize pickup of the mother's electrocardiogram. The small 12-pound amplifier of standard radio parts is simple to operate and can be easily carried with the electrocardiograph.—*Science Service.*

Torpedo!

Mechanics of the "Tin Fish" That is Writing a Terrifying Record of World-Wide Destruction

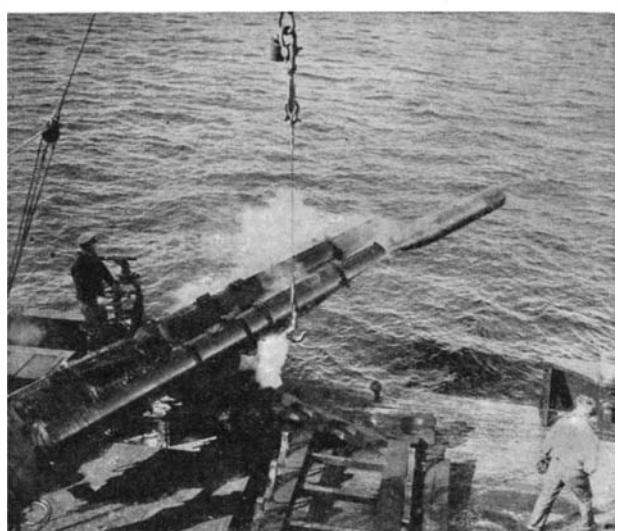
DONALD WILHELM

A TANKER, northbound with a cargo of oil, plows heavily through the Atlantic swell a few miles off Long Island. Suddenly the ship staggers as though from the blow of a titanic fist. A rending explosion rips open her side, and a torrent of water pours through the hole into the hull. Five minutes later she is awash. Then her bow slides under the waves. The stern tilts up, and she plunges to the bottom. A U-boat has struck again with the deadliest of modern weapons—a torpedo—against which the naval engineers have found no satisfactory protection.

Just what is this blasting hellion of the deep, this streamline horror called a torpedo? It is the most intricate and perfect engine of destruction which scientific military design has yet produced. It is the smallest warship afloat; 24 feet long. For it *is* a ship, complete in every detail. It has a wheel house, an engine room, a cargo, and a crew to steer and run it; a mechanical crew more precisely obedient than any human sailors. It takes and holds, exactly, the direction assigned its mechanical brain. If so directed, it will describe a complete semicircle before settling down to its course; or it will plunge ahead point-blank in the direction it is launched. It will travel precisely at the depth desired under the surface of the water. And it never wavers. Like a big battleship, it is given test runs and tried for any faults it may have before it joins the fleet.

A 3000-pound "fish" of steel with 600 pounds of high explosives in its warhead, it knifes through the depths at nearly a mile a minute, driven by more than three times the power of a V-8 car at full throttle. Without warning, it hits its victim with a blasting wallop which staggers even the heaviest battleship afloat. Britain's "unsinkable" *Prince of Wales* and Hitler's vaunted *Bismark* have succumbed to its sting.

Naval architects have tried every device they could think of to defeat the torpedo. "Torpedo bulges"—double hulls, constructed in the hope that the torpedo would explode between the outer and inner shells and not penetrate the ship's vitals—were tried and abandoned. Battleships are now divided into many compartments, so that if one is blasted by a torpedo, the others can be shut off from the inpouring water. But even these precautions are generally ineffective. The impact of a 16-inch shell is light by comparison to that of a torpedo. As Admiral Hart said recently: "When a torpedo hits anything, it stays hit."



Official U. S. Navy Photograph

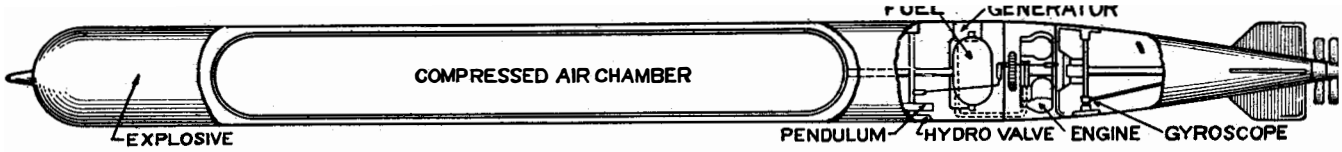
A "tin fish" takes to the water for test

This vicious little robot, capable of scuttling a vessel 20,000 times its weight, has made history in every naval engagement since the Japs sailed into Port Arthur in 1904. It nearly changed the outcome of the first World War, accounting for 2000 ships, totaling 6,000,000 tons. It was fear of torpedoes that kept the British from following up and destroying the German navy at Jutland. In the evil month of April, 1917, it cost the Allies nearly a million tons of shipping, a rate that soon would have stopped the beating of England's heart. Today Hitler is gambling on the torpedo to rupture the communication lines on which the Allied effort depends. Once again German U-boats lurk off our shores, waiting to send destruction—via torpedo—to the next vessel that comes within range.

Like most first-rate scientific achievements, the modern torpedo is a result of a long series of experiments, some of them abortive. Ever since ships first began fighting with gunpowder, naval men have sought means of bringing a large explosive charge against their enemies' hulls. In 1776 a scheme was proposed, but never tried, for breaking the British blockade of American colonies by approaching King George's men-of-war from under the water and fastening bombs to their bottoms. Later, Robert Fulton discussed with the governments of France and England his ideas for an underwater attack. The first torpedo actually to see service was the "spar torpedo" of the American Civil War. This contraption, a long ram with a bomb on the end of it, was a sorry forebear of today's "tin fish," but a terror in its day.

The torpedo as we now know it was born in 1864, when a Captain Luppis of the Austrian Navy went to the famous Scottish engineer, Robert Whitehead, with a plan for a self-propelled, self-steering underwater projectile. Whitehead, fascinated with the idea, began work at once, in a little shop in Fiume. Two years later the first Whitehead torpedo slid into the water—and worked. It was a crude little machine, only 10 feet long, traveling seven miles an hour by compressed air, and carrying 19 pounds of guncotton in its head. But it was the daddy of them all. So sound was the great engineer's work that his basic design has changed but little. Speed, size, and explosive power were increased, however, and by 1914 it was the most dreaded weapon on the high seas. With World War I, the torpedo came into its own.

THE early torpedo was notoriously tricky; even during World War I it was still a dangerous weapon to handle. So erratic was its course that it often menaced the mother ship more than the target; several German U-boats were blown up by their own torpedoes. They had other quirks. They left a wake of bubbles that betrayed the location of the mother vessel and often led to its destruction. They often jumped out of the water like porpoises. One U-boat commander's experience became a classic. Cruising on the surface, he was suddenly attacked by a



General arrangement of torpedo mechanism: Exact details are military secrets

British submarine. The Englishman fired a torpedo. The German saw it coming too late; he had no time to turn his sluggish craft, and stood awaiting his inevitable end. But as the torpedo was about to strike, it leaped out of the water, slithered across the U-boat's deck, and plunged harmlessly into the sea on the other side.

The torpedo of today—and the designs of different nations vary only in detail—has none of these vagaries. The world's navies have lavished the best brains available on getting the "bugs" out of it, made it so powerful it can knock a hole in the side of a cargo vessel even without its explosive head, so accurate it can run for miles without appreciable deviation from its set course and depth, so destructive that no ship that sails is safe from it. Its active life is short, ranging from a few seconds to six or seven minutes. When it misses, it runs for about eight miles, then automatically sinks, so it cannot be a navigation hazard or fall into the hands of the enemy. Its mechanism, comprising 3000 precision-built parts, is as intricate as that of a watch. To make one requires some thousands of man-hours of labor and $12,000 in cash. Foot for foot, pound for pound, it is the most expensive of all naval vessels. But it is the best investment any navy can make. Its one and only service voyage may decide the fate of a nation.

FROM bow to stern, the torpedo's 24-foot length is divided into four main sections. The first is the warhead, built like an armor-piercing shell containing 600 pounds of the most devastating explosive known. Behind the warhead is a large compartment holding compressed air, its main driving force, under the colossal pressure of 2800 pounds per square inch—several times the maximum in the most powerful locomotive boiler. Behind that are smaller tanks, in which the torpedo carries its own fuel, water, and lubricating oil. Another section is the "engine room," where the mechanical brain that guides the torpedo and the engines which drive and control it are housed. Finally, there are the twin propellers, revolving in opposite directions (a single propeller would only make the torpedo revolve in the water) and the two sets of rudders, one for direction, one for depth.

Torpedoes are launched from the tubes of submarines, the decks of surface vessels, or the bellies of airplanes —it's all the same to the torpedo. For it is every inch a seagoing vessel; once in its element—the water—it's a warship on its own. The duties of a launching vessel and its crew are merely to get the torpedo somewhere within five miles of its target (the closer the better), give it its orders, and get it started. In submarines, this is done by a blast of compressed air which pushes the baby vessel out of its tube. In the deck-tubes of surface vessels, a small explosive charge boosts the torpedo over the gunwales and into the water. Airplanes merely drop them.

When a torpedo is discharged, an amazing number of things begin to happen inside it, in an incredibly short time. A starting lever, tripped by the missile's forward movement, opens a valve, and a blast of compressed air starts the main engine. Another unit provides a highly inflammable fuel spray. Two slow-burning cartridges explode, go on burning like candles, to ignite this spray. In the same split-second an ingenious self-starting, self-regulating water-pot begins spraying water on the flame. Only a few feet away, remember, is 600 pounds of high explosive. The water-pot supplies water to make steam and, by regulating the volume of its spray, keeps the temperature in the fire-box exactly at 1250 degrees—no higher. The steam-gas-compressed-air mixture slams into the main engines with such force that 400 horsepower is instantly generated, quickly driving the torpedo's speed up to nearly a mile a minute.

EVEN more ingenious is the mechanism which guides the deadly "fish" on its swift little voyage. Just before it is launched, a torpedoman—on instruction from the fire control officer who has computed the position, speed, and range of the target—sets its direction and depth by adjusting a small, numbered spindle, like a radio dial. It is no longer necessary to aim the torpedo dead at its target. Whatever direction it may be launched, the mechanical "fish" will return to its set course before it settles down to its final straight run—a big help for the destroyer which does not want to turn its side toward the enemy and present a big target while firing its deck tubes.

The principal member of the torpedo's mechanical "crew" is a gyroscopic pilot. It is a bronze flywheel, the size of a teacup saucer, which is set whirling at 18,000 revolutions a minute by a jet of compressed air. Connected with this gyro-compass, and controlled by it, is a small engine, which operates the directional rudder. The gyroscopic pilot instantly corrects—through its engine and rudder—any deviation of the torpedo from this course. It never makes a mistake.

A torpedo must also hold to a second course, depth—usually about 15 feet below the surface. When hurled from a plane or a deck tube, it must not dive as deep as its immense weight inclines it to; it must not lunge out of the water like a tarpon on a line, or lose speed by gambolling up and down as torpedoes used to do. Its underwater course must be kept level. Another mechanical brain takes care of that. A sensitive pendulum and a hydrostat which measures the depth of the torpedo by external water pressure, control a second small steering engine which operates two horizontal rudders in the tail. If the torpedo is running closer to the surface or lower in the water than ordered, the rudders steer the "fish" down or up, until it is at the correct depth. All these mechanisms are fitted tidily within the torpedo's slim diameter—21 inches!

THE "tin fish" used to leave a wide tell-tale wake of lively white bubbles from the cold compressed air which streamed out its exhaust pipe. This sometimes gave the victim time to dodge the oncoming torpedo, and marked the position of the submarine which fired it. The modern torpedo leaves almost no wake. After the blazing, white-hot mixture of compressed air and steam has driven the torpedo's engine, it is exhausted through the hollow bronze propeller shaft. The steam, on striking the cold sea water condenses, turns back into water; the hot air forms tiny slow-rising bubbles which cannot be seen from any distance. The "tin fish" is noisy, and can be picked up on sound-detecting devices, but seldom in time. It gives no warning and leaves no trace.

The deadly torpedo has already written a fearful record of destruction in World War II—the *Prince of Wales* the *Repulse*, the *Bismark*, the *Ark*

Royal, the *Reuben James;* Taranto, Cape Matapan, Pearl Harbor; the Battle of the Atlantic, of the Mediterranean, of the Pacific. U-boat operations off our coasts indicate a new phase of torpedo warfare of unprecedented ferocity.

Before we entered the war, watchers reported that the big ship yards at Kiel, Bremen, and Hamburg had switched from big warships to small surface raiders and submarines. At Danzig and Stettin, large new submarine plants have been put up, and the torpedo school at Kiel has been enormously expanded. The United States Navy can play at that game too. Our own Torpedo Stations are humming as never before. Torpedoes used to be made almost exclusively in plants owned and operated by the Navy. Today scores of factories are working on confidential sub-contracts, turning out torpedo parts in an immense speed-up of their production.

The Battle of Macassar Straits has shown that we are as good at torpedoing as the Germans, if not better. The Japanese have learned that it is risky to move troops past the tubes of American torpedomen who traditionally pat their "tin fish" on the rump before they are loaded, care for them with the love of fine machinists for fine machinery, and dispatch them with an accuracy unparalleled by any other navy.

The decision in this next phase of the war lies in our ability to defeat the torpedo in the Atlantic, and win with it in the southern Pacific. The "tin fish" is still making history.

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SUCCESS

Workman's Suggestions Speed Production

How production of vital gunsight lamps has been increased by more than 2000 percent due to a factory worker's suggestions, is one of the many little "success" stories of the nation-wide national defense effort. The tiny lamp, about half the size of a walnut and used in delicate precision mechanisms for aiming big guns, was made entirely by hand only a few months ago; today, with the help of suggestions made by Matthew Westphal, a Westinghouse employee, it is machine made. As many as 2000 can be manufactured in a single day.

Mr. Westphal proposed a different type of stem and redesigned the mount for the filament. Due to his changes in the method of drawing air out of the bulb, it no longer has a pointed tip. Savings in material, labor and equipment have resulted from Mr. Westphal's suggestions. Valuable floor space formerly used by girls sitting at work benches is now available for other work. Girls have been released to do other important jobs. Only half as much glass tubing is needed in the lamp. Old equipment has been discarded and salvaged.

ALL-METAL YACHT

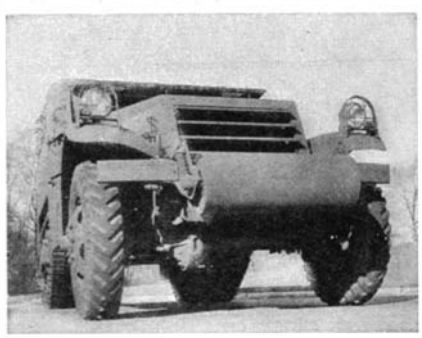
Will Be Used For Patrol Service

It has just been announced that the all-metal yacht "Revere," described on page 79 of the February 1942 issue of Scientific American, has been turned over to the United States Coast Guard for the duration of the war. The power and speed of this unusual water craft should make her particularly useful for waterway patrol service along the Florida coast, the work to which she will be put by the Coast Guard.

ROLLERS

Keep Reconnaissance Cars Out of Trouble

Reconnaissance cars are the advance scouts or feelers of the army and, as such, they must be versatile enough to cover all kinds of terrain. American-made units are not only the fastest of any comparable vehicles to be found in the world today, but they are built to travel over extremely

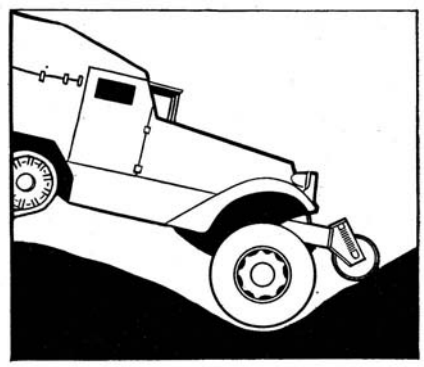


Mounted in front, like this . .

rough ground, not excluding trenches and shell holes. One of the features which permits this is the big forward roller—the guiding arm that lifts them out of difficult places.

The all-welded steel rollers on many of the military vehicles now being built by The White Motor Company and others have aroused considerable curiosity and comment among the general public. Many questions have been asked regarding their use, and the projected guesses have been both diversified and humorous.

Actually, the tough tubular rollers, four feet in length and 12 inches in diameter, have a definite and practical



. . it rolls the car up and out

use—to keep the vehicles from bogging down and to aid in pulling them out of the difficult spots. In short, these rollers afford the big lift to a machine in trouble. With their help, the Half-Tracs have climbed out of a 6-foot trench during testing operations.

The shell of the big steel roller is made of ¼-inch stock. Two reinforcement rings, as well as two bearing heads, are welded within at spaced positions. The need for great strength in the roller is recognized when one realizes the amount of weight and impact it must bear. Actually, the roller protrudes ahead of the bumper arm and thus takes the first shock when any forward contact is made. Then consider that the cars don't stop for bushes, small trees, fences and similar obstructions, and you can gain some idea of the impacts it must take. Add to this the lifting strength when half the weight of the vehicle may be imposed upon it going up a sharp incline. In order to be most effective, the roller has a spring mounting.

Success of the roller, of course, depends to a large extent on the traction power of the vehicle. The conventional scout cars, driving from all four wheels, can push up a 60 percent grade with a full complement of men. The Half-Trac, with its rear track system, exerts even more driving power and is well adapted to soft ground. When this modern reconnaissance unit pushes its front roller against a bank it gains the necessary lift to go on over.

These reconnaissance units are extremely maneuverable and are capable of traveling up to 50 miles an hour on highways or smooth ground. At the same time they can push over the roughest kind of country. The big steel roller in the front goes a long way in making this possible.

Glass Guns for Victory

Soil Testing in Gardens and on Farms Can Aid in Keeping Food Producing Machinery in Order

ARTHUR H. CARHART

In the enormous pattern of national effort, the growing of food crops on farms and in home gardens is of great importance. While our factories, mills, and mines pour out their war goods and raw materials, our good earth must go into full production to deliver a tremendous volume of food stuffs. While gasoline, coal, and electricity power the machines, food powers the men and women who run those machines.

The soil is thus a part of our national machinery for the production of war necessities. Food is as essential in war as guns and powder. The tremendous importance of this part of our war effort is indicated by the fact that, at a National Defense Gardening Conference held at Washington, D. C., last December, there was launched a Victory Garden Program. The national campaign to put the machinery of the soil into capacity production is under way. This is a war of science, and science will aid in garden and farm, just as in laboratory and factory.

The soil of our nation is one piece of defense machinery which may receive a hard and disastrous beating unless we give heed to putting it in top condition and keeping it so. Lowering of the production from our tilled soil may mean the difference between victory and defeat. With the crusade for total utilization of all tillable gardens and farms under full drive, the problem of keeping the soil in top condition and guarding against over-use and neglect must receive continuing attention.

Generally the soil is considered as a medium for growing things, without due recognition of the fact that it is a mechanism as definitely organized in its way as is the machinery within a factory. We plant seed, we water, we hoe weeds—and believe that nature will give us a good crop. Crop failure is often blamed on nature; but the real cause may be pure neglect of the soil machine.

No machine can be forced to produce to full capacity without proper maintenance. Parts wear. Essential cogs in the machine have to be replaced when they are worn. Just as certainly, forced production on tilled land produces wear and tear. Deficiencies occur in soil properties. Since the tilled land is a basic, indispensable part of the war production machinery, we must give it maintenance and replacements when needed, if it is to do its full part in bringing victory.

There are two objectives in such sound soil management as the Victory Garden Program will demand. The first is to bring the tilled ground to its fullest production as rapidly as possible. The second is to have that soil in as good condition at the end of the forced use as it was at the beginning of the drive. With correct management, the soil should not only be as good as it was at the start, but actually better.

Any program aimed at keeping field and garden soils in good condition has two sections. The first concerns the physical makeup. The most fertile soils often are those containing abundant organic matter. This humus is built up in the soil by turning under stubble in a field or spading leaf mold or similar material into the garden plot. Most tillers of the soil know of this need and will take care of it.

But it is the second and less easily determined procedure of keeping soil in first-grade condition that is likely to be overlooked. This involves the chemical constituents present or that must be added to the soil so that it will produce well and so that there will be no loss by excessive use, without replacement, of vital nutrients. This replacement is imperative if the soil is not to be worn out at the end of the forced production war effort.

There are four chemical factors in soil management or production processes that dominate the productivity of any tilled plot. First, there is the question of whether the soil is acid or alkaline. Some crops require one condition, some the other. To attain maximum production, the crop has to be fitted to the soil, or the soil to the crop. If the soil is acid, crops should be planted that will thrive in that condition of soil, or the reaction of the soil should be changed over to alkaline so that crops demanding that condition can be grown. The balancing of the acid-alkaline reaction is not difficult, but it is vital that this factor be known before a crop is planted.

The other three chemical factors involve the principal nutrients needed for maximum crop production. There are a number of plant food requirements in elements in the soil, but the three principal foods are nitrogen, phosphorous, and potash. And because these are the principal soil nutrients required by plants, they are the elements most heavily drawn from the soil in making growth and producing fruits and grains.

Just as milk cannot be drawn indefinitely from a cow without feeding good rations, so the soil cannot be

Soil sample is placed in test tube: testing kit with reagents at right

"milked" indefinitely without putting back some of the materials which roots must have in order to produce growth. High-pressure use of soil, where crops are forced for all they are worth, takes a heavy toll of these principal plant foods.

Furthermore, just as a dairy cow must have so much protein, so much carbohydrate, so much roughage, all in a balanced ration, in order to produce the maximum supply of milk, so plants feeding on a soil must have a "balanced ration." In other words, a soil that has adequate nitrogen and potash, but lacks a proper ratio of phosphorous, cannot supply a balanced ration to crops. It all goes back to the machine idea. If one of these elements is left out, an important cog in the crop-growing machine is not in gear.

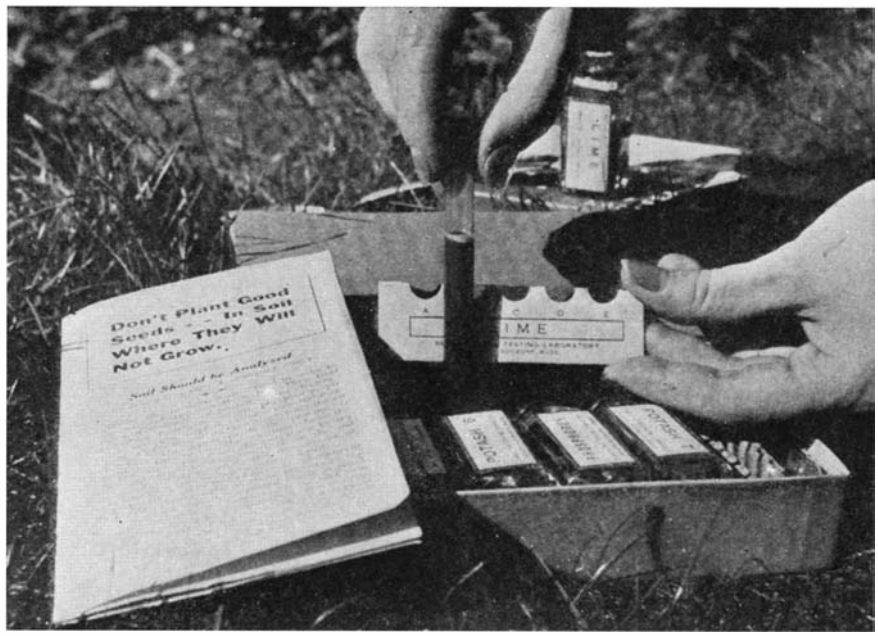
Of course, many farmers and gardeners are familiar with the general idea as it is presented here but it is a little too much to expect the average farmer or gardener to send soil samples every season, or twice a year, if that is better, to some laboratory; wait for the analysis to come back; and then add phosphorous or nitrogen or potash, or, if the soil is sour, to add lime. It's a lot of extra work. It may not show anything except that the soil is in fairly good shape, and the tendency all too often is to go ahead without analyzing the soil.

FARM and garden journals have been telling about these three most important soil elements for quite some time; state experimental stations have been sending out reports; speakers at short courses have discussed the subject quite fully. However, this has all seemed sort of visionary. The dirt farmer, the home gardener, did not have available, until recently, means of analyzing his soil without going to the trouble of sending samples to some distant laboratory.

Today there are soil test kits on the market so simplified that anyone who can read English, and is not color blind, can run his or her own soil test, not in hours, but in minutes and without complicated equipment.

The small soil test kits fit the pocket; others, slightly larger and a bit more accurate, can be carried in containers not unlike lunch boxes and really not much larger. The principal difference lies in the number of tests that can be made with either kit.

Here is how one learns whether the soil is acid or alkaline, what the nitrogen content may be, how much phosphorous is present, or whether or not potassium is lacking. Dig a soil sample out of the field with a common tablespoon, mixing several samples from different parts of the field if a composite test is desired. Put the soil in a glass test tube. (The spoon and test tube MUST be clean). Add the liquid for the desired test, such as for lime, potash, and so on. Shake. Each of the four tests has its own chemical reagent. The reaction of the soil with the solution poured on the soil sample gives a characteristic final color to the liquid.



Solution of soil and reagent, in test tube, is checked with color chart

In these kits are four color charts, one for each of the tests. Example: A soil sample has been put into a tube. The required reagent has been poured in. It has been shaken, and allowed to settle or has been filtered. Suppose it is a nitrogen test. Select the color chart which is marked nitrogen. Hold the tube up, hold the chart, and, by eye, make the nearest match between the tube color and chart color. Opposite the matched color on the chart is a capital letter. It may be "A" or anything on to "D". Having that, turn to the little printed manual that is part of the kit equipment. In that will be found the key letter of each test. The letter that designates the color on the chart, matched with the color in the glass tube, gives a direct answer.

That is the net process, for in the little booklet the key letter gives the answer as to how much of each nutrient is present in the soil. It tells how acid or alkaline the soil is in the alkaline-acid test, or how much or how little phosphorous, nitrogen, or potash there is in the soil.

If the soil needs the addition of phosphorous, the manual gives the approximate answer, not in technical terms, but in pounds per acre required to bring up that element to where it should be as a part of the machine to produce crops. It may save adding phosphorous when it is not needed, or upsetting the balance by adding a "complete fertilizer," which is a gunshot way of trying to bring the soil to high productivity, but actually may overbalance one food element already adequately present.

Whatever the primary or associated motives may be that prompt a grower to consider the production potentialities of his fields, every farmer and gardener now has, within reasonable reach, the means for putting the crop-growing machinery of the soil in condition to produce its best. The little glass test tubes and the liquids in glass bottles in a soil test kit are genuine weapons in your hands when you start to do your bit toward winning the war with your farm or garden. They are powerful glass guns for those who are getting ready to take their places in the ranks by enlisting in the Victory Garden Program for the duration.

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BREAD PROTECTION

By Addition of Mold-Inhibiting Agent

BY the simple addition to bread of a substance that is naturally present in many other foodstuffs, more than one and a half billion loaves of bread will be protected against mold in 1942, according to the du Pont Company.

Chemists say that the "mold inhibitor" has been proved to have such a

marked effect in delaying the growth of fungi in bread, that American bakers striving toward greater food conservation plan to extend its use by 10 to 15 percent during the coming year.

The lowest estimates of losses caused by mold growth on various foods run into millions of dollars annually. Now, with ever-increasing demands on the food supply, the elimination of as much of this loss as is possible becomes a national necessity, even though the rationing of food is not yet a probability.

Mold is believed to be caused by tiny spores of fungi in the air. Usually most active during the summer, these invisible particles develop in bread after baking. Their growth cannot be wholly eliminated even with the best sanitary precautions, air-conditioning, and ultra-violet lamp treatment, but it can be greatly retarded by the addition of the mold-inhibiting agent.

The agent is added to the bread dough before baking; it checks the development of mold particles in the loaf for a period of several days, thus allowing ample time for consumption of the loaf itself. A very small quantity of the mold inhibitor is sufficient for the protection of many loaves of bread, it is said; approximately two ounces of the agent will protect 100 loaves of bread. The agent does not affect either the taste or appearance of the bread.

MICROSCOPE

Identifies Compounds by Polarized Light

A VERSATILE and precise method for identifying organic chemical compounds promises to become a rapid and critical tool of chemical identification for these compounds. The method is one involving the use of polarized light transmitted through a microscope to determine the nature of an organic crystal. The physical principles are not new, but extensive work carried forward during the past decade has resulted in perfecting this system of analysis to the point where it may now be applied with confidence as a positive means of identification for a broad range of compounds.

In du Pont laboratories, a petrographic microscope is being employed that is similar to microscopes used to study the structure of rocks. Following accepted petrographic methods, colored interference patterns are created by passing polarized light through crystals of organic compounds, and these patterns are then compared with known standards to determine the exact compounds being analyzed. Use of light of various colors is an essential feature of the methods.

Although comparatively expensive equipment and considerable experience are essential to an identification of this type, it is said that once these are available, the method can be applied practically to all organic compounds, whether gases or liquids, provided that they can be converted to crystalline derivatives for observation. Only very small amounts of material are required.

The method is reported to be "able to stand on its own feet as a technique of identification, and offers considerable time-saving possibilities in distinguishing between compounds having chemical features in common."

PSYCHIC RESEARCH

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

GLUE . . . OR GLUE

When Is Plastic A Glue?

WITH plywood reaching a position of increased importance in industrial applications, there has arisen a confusion of terms as applied to those materials which are used to fabricate the finished plywood from thin strips of veneer. In this connection a letter recently addressed to the editor by Mr. J. F. Laucks, President of I. F. Laucks, Inc., Manufacturing Chemists, holds considerable interest. The following paragraphs, quoted from Mr. Laucks' letter, clarifies the situation:

"I believe it is time to call a glue pot a glue pot. As a glue manufacturer I am getting tired of hearing glued-up articles being referred to as 'plastics' either because of lack of comprehension of the difference between the plastic art and the glue art or because of some misguided notion that glue is not a subject of polite conversation.

"For some time back now I have been reading articles in the press, in the magazines, in the trade papers and technical journals about *plastic* airplanes, but I submit that these are nothing more or less than glued-up plywood formed into the proper shapes. A plain piece of plywood might just as well be called a plastic.

"Just the other day I saw in one of the nation's prominent newspapers a statement about plywood which ended: 'The old art of using glue has been supplanted.' This was the final straw.

"That there is a great difference between the gluing and plastic processes is commonplace knowledge to anybody who knows very much about either. I personally have good authority on which to base a statement about this difference. I once had to fight a patent suit in which my opponents claimed that there is no distinction between

Petrographic microscope. *Left insert:* Crystal of organic compound. *Right:* Optical picture created in microscope by polarized light through crystal

the plastic art and the glue art. After hearing testimony for two years, the court decided that these are two separate and distinct arts. This decision should carry some weight. If the Patent Office considers these arts dissimilar, and in practice they are entirely different, I think the general public should recognize the fact.

"Perhaps the present prevalent habit of calling everything a plastic that can be remotely included in that category is due as much to the fact that plastics are currently fashionable as from a general disinclination to use the word 'glue.' Plastics, of course, are new. The art of gluing, on the other hand, dates from at least early Egyptian times.

"Gluing might be defined as the art of binding two pieces of wood together to make a joint that is stronger than the wood itself. In this definition I do not state what the binding means are. The ancient glues were made of either bones, hoofs, and hides (whence I suppose the name glue first acquired a bad odor) or of casein. Later came starch glues which do not smell bad, still later came soybean glues which do not smell bad, and later yet came synthetic resins, some of which do and some of which do not smell bad. Now then, just because some glues smell bad, should the entire glue industry be made to feel that it ought to apologize for itself? Should the people who use our product do so on the sly and cover up this fact by declaring they are making plastics?

"I maintain that the art of making a joint stronger than the wood is a real art and an honorable one. It is the art of gluing, and neither the man who knows how to do it nor the man who knows how to make a glue to do it with need be ashamed of saying they are in the glue business or that they are using glue. I insist that the old art of using glue has *not* been supplanted but instead is expanding its uses into ever wider fields and is becoming of progressively greater importance every day."

GREEN BLUSH

When Euglena Blushes, Pigments Shift

How *Euglena rubra*, a species of microscopic freshwater animal, reacts to lowered temperatures by changing its color from red to green and taking on the characteristics of a plant, was disclosed in a recent issue of *Physiological Zoology*. Writing on the "Cause of the Green-Red Color Change in *Euglena Rubra*," Drs. L. P. Johnson, of Drake University, and Theodore L. Jahn, of the University of Iowa, revealed that the curious change of color which occurs when the animals are subjected to changing temperatures is due to the migration of red pigments from one part of the body to another.

Specimens of *Euglena rubra* were obtained from a small pond in Iowa, where they formed a bright red scum on the surface of the water. When the temperature of the animals was lowered to below 86 degrees, Fahrenheit, the red pigment near the surface of the cell migrated toward the center of the body, leaving chlorophyll at the surface, which gave the animal a green color. The red color was restored by heating, or by subjecting the animals to infra-red rays, artificial light, or sunlight.

Pure water, safe for drinking, from Los Angeles River, by "Sterozone"

PURE WATER

Produced by Portable Ozone Generator

A completely automatic, self-contained water purification plant that literally burns bacteria out of water has been developed for use in army camps and by troops on maneuvers, but has industrial and municipal applications as well. The "Sterozone" unit, as the plant has been named, has a rated capacity up to 9000 gallons per hour; automatic parallel operation of units can be made to supply larger requirements.

Raw water is pumped from the source through a filter to remove suspended matter and then passed to an absorber chamber where ozone, generated by a high-frequency silent electric discharge, oxidizes the bacterial contamination and delivers pure, sparkling, fresh water that has no taste or odor. Unlike water that is disinfected by the addition of chlorine, there is no danger of overtreatment which may result in an unpleasant taste that may force troops to prefer untreated, contaminated water.

Power for the plant is supplied from an automatic gasoline-engine driven 10 KVA., 220-volt, 3-phase power plant. This unit is self-starting and self-regulating. The only attention required is lubrication and fueling. All mechanism is driven by a five-horsepower, 220-volt, 3-phase electric motor on which is direct mounted the treated water supply pump and coupling. Connected to the other end is the raw water supply pump. Also driven from the motor shaft are the compressor, cooling water circulating pump, and the evaporative cooler.

Ozone is generated by the silent blue electric discharge between aluminum plates maintained at 13,000 volts by a 2.0 KVA transformer. Ozonized air is injected directly into the absorber through which it flows counter-current to the water in four separate stages. Diffusion, injection, turbulation, and scrubbing obtain efficient absorption of the ozone.

[For a more comprehensive discussion of the principles involved in water sterilization with ozone, the reader is referred to page 136, March 1942 Scientific American.—*The Editor.*]

DRY ROT

Occurs Only When Moisture Is Present

There is no real "dry rot" that attacks wood and causes it to decay. Wood must contain more than 20 percent of moisture before fungi can grow in it. What is ordinarily called "dry rot" is caused by one of a few species of

WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Co-operating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

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fungi that grow rootlike strands that serve as pipelines through which they draw into dry wood the water they must have to live and to destroy the wood. These rootlike strands must reach moist soil or some other source of moisture if the "dry rot" is to cause decay of the wood, say United States Department of Agriculture scientists who have studied the various forms of wood destruction.

Wood kept dry, they emphasize, is a permanent building material. One way to prevent decay of wood is to inject into it preservative chemicals that prevent fungus growth. The other way is to keep it dry so that fungi can not live. Even the "dry rot" fungi can not develop if water can be kept beyond their reach.

SULFA-DOG

The Sulfa Drugs Also Work Wonders in Canine Cures

THE big five in chemo-therapy—sulfapyridine, sulfanilamide, sulfathiazole, sulfadiazine, and sulfaguanidine—are proving to be valuable drugs in veterinary practice, according to Dr. Arthur Bryan, Baltimore veterinarian.

In compound fractures, no matter how serious the wound or the possibility of sepsis, sulfoamide powder can be dusted into the wound and healing occurs without infection or even wound fever. Peritonitis may be entirely prevented in small animals by implanting powdered sulfa drugs as a post-operative procedure. In fact, infections of all kinds in our domestic animals appear to be more or less doomed to extinction, if the new sulfa drugs are used in time. Infections of the eye and ear respond promptly to sulfapyridine, sulfadiazine, or sulfathiazole, when these powdered drugs are worked directly into the infected region. Summer diarrhea and dangerous food poisoning infections, particularly of small animals, respond to the recently developed drug, sulfaguanidine, which has a selective action on the intestinal tract.

These sulfoamide drugs, while performing modern veterinary medical miracles, are toxic and dangerous in the hands of the laity, and the up-to-date veterinarian alone is competent to prescribe these drugs for the benefit of our animal population.

FISH

And Their Reaction To Air Raids

MEMBERS of angling clubs in various parts of Britain, where heavy air raids have been experienced, report that fish bite much better on the day following a severe blitz in the district. It is believed that the loud noises caused by exploding bombs, gun-fire, and so on have the same effect on fish as thunder. A bad thunder-storm always upsets fish and prevents them from feeding and consequently they are apt to feed voraciously when the disturbance is over.

DECALCOMANIAS

For Chinaware Made by Photographic Process

A NEW process for making chinaware decalcomanias, which substitutes photo-lithography for hand-lithography in preparing plates from which decalcomanias are printed, makes possible exact and yet rapid reproduction of artists' designs. American independence in chinaware decalcomanias is expected when volume production by this method is attained. Seventy percent of the decalcomanias used by American chinaware manufacturers were imported at the start of the war. An increasing scarcity of decalcomanias helped create unprecedented backlogs in chinaware orders.

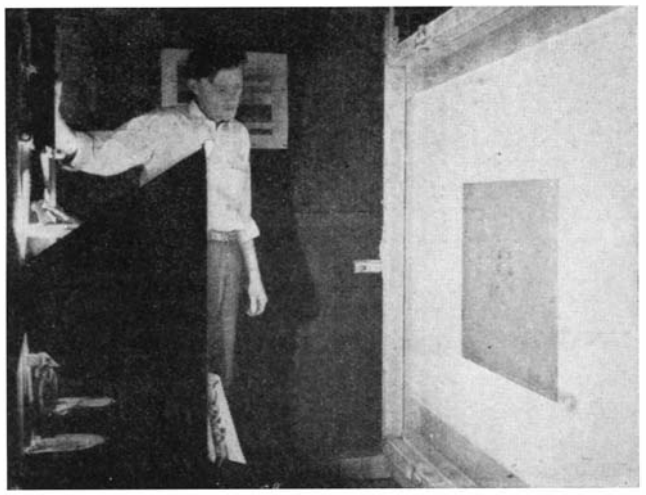
In the new process, artists' designs are photographed through color filters and reproduced on sensitized metal plates, instead of being tediously stippled by skilled craftsmen on soft stone. The designs are then transferred by use of a special offset lithograph press.

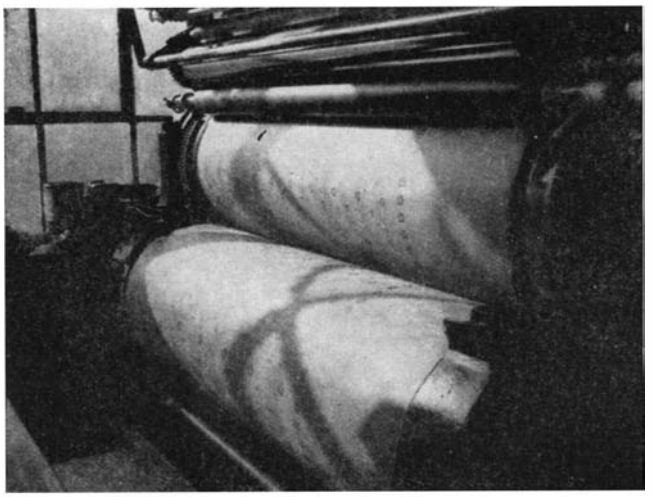
It is pointed out that a more beautiful chinaware will be available in all price ranges because photo-lithography can reproduce not only more intricate designs but do so with finer gradations of shading and blending of colors. The color shade of one plate is said to achieve an effect which formerly required three shades of one color, or three different stone plates.

In transferring an artist's design to a stone plate, the craftsman stipples a maze of tiny dots with stippling pens. However, even the most skilled workmen are unable to stipple all the fine dots necessary to copying the design exactly. By contrast, the sensitive photograph plate misses nothing because it actually reproduces the design itself.

The artist's work is photographed through color filters for each color in the sketch. The camera detects and reproduces every detail and vestige of a particular color in the design, though it may not be visible to the naked eye. From each negative a positive is developed, and from that positive is made a sensitized metal plate for the offset lithograph press. The plates, incidentally, may be reused by etching off and regraining.

Petit point decalcomania patterns—which American manufacturers formerly considered very difficult and have been hesitant in supplying—are now being reproduced on dinnerware by photo-lithography. On imported ware, such designs are completed by hand in order to obtain the delicate





Left: **Photographing an artist's design for decalcomania use.** ***Right:*** **Printing decals on high-speed press**

effect of many-colored needlework. The new domestic process eliminates the need of this supplementary touching up, as the camera exactly reproduces the intricate pattern and fine shadings of the artist's sketch.

Black and brown etchings of historic shrines and other scenic designs can be copied for the decoration of service plates with no loss of artistic quality. Pictorial designs transferred by the hand-lithograph process appear faded in comparison. Photo-lithography assures not only complete color control for decalcomania patterns but also combinations of line and half-tone which are beyond the scope of the hand method.

Research work on this new process of producing decalcomanias has been conducted by the Ceramic Products Division of the du Pont's R. & H. Chemicals Department, long experienced in manufacturing ceramic colors. After many months of work, a satisfactory process was developed and installed on a semi-works scale at a lithograph plant in New Jersey. These superior decalcomanias made by the new process found ready acceptance by chinaware manufacturers. Demand exceeded supply of decalcomanias from the start, and there is still no indication when equipment will be available to make decalcomanias sufficient to meet demand.

SOY BEANS

Uses Have Been Widely Developed by Research

THE Jack-and-the Beanstalk growth of the soybean crop and the soybean products industry in the United States has not been a fortunate accident. Instead, "it has been made possible through the results of research" by government agencies and by the industry, according to T. H. Hopper of the United States Department of Agriculture.

Some of the steps in this "phenomenal development," which has added a major crop to American agriculture, and two items already important in commerce—soybean oil and soybean oil meal—are the following: Improved varieties have been selected and bred from foreign seed; utility and climatic adaptations of superior varieties have been improved and farmers have learned to grow the crop; industrial equipment has been developed and greatly improved; the chemistry and physics of soybean oil have been investigated, and methods of refining and improving it for various uses have been studied, and the amount of the meal now used for the manufacture of adhesives and plastics may very materially increase; systematic marketing of soybeans has been instituted; official grade standards have been developed. As a result of this work soybeans have become one of the commodity items of futures trading.

TELEVISION LIGHT

Supplemented With Fluorescent Tubes

EVEN with the increased efficiency of television transmitting equipment which has been brought about in recent years, studio designers still are faced with problems of heat generated by the high-intensity light sources required for satisfactory television pick up.

As a new attack on this problem, Westinghouse engineers have recently installed in the Dumont experimental television studios in New York City a lighting system which combines both incandescent and fluorescent lamps. In this installation, 95 percent of the heat felt by the actors is generated by the filament lamps. Performers are normally placed about 10 feet from the lights, which consist of 12 300-watt incandescent spots and 12 40-watt

fluorescent tubes. The fluorescent lamps alone supply approximately 300 footcandles, the reflector spots being used to bring local lighting levels up to 1000 footcandles. The 480 watts of fluorescent lighting provide approximately 20,000 lumens of light, the 3600 watts of incandescent about 30,000 lumens. If incandescent lights alone were used, another 1500 watts or more would be required to provide the same number of lumens of light on the performers. This, of course, would result in greatly increased heat.

Incandescent plus fluorescent

In the experimental set-up shown in one of our photographs, the filament lamps are used only during actual broadcasting. Rehearsals and preliminary work prior to going on the air are done under the fluorescent lamps alone.

FINGER-SIZED

Small Fluorescents Require High Voltages

How fluorescent lamps may be stretched into long ribbons like neon sign tubing, was described recently by Dr. J. W. Marden and George Meister of the Westinghouse Lamp Research Laboratories. In their report presented before the Illuminated Engineering Society it was indicated that finger-sized fluorescent lamps must be a "high-voltage" type as compared with the 10,000,000 low-voltage fluorescent lamps now in use throughout the United States. High-voltage lamps were defined as operating at several hundred or more volts.

The research scientists explained that the biggest fluorescent lamp now manufactured is five feet long, 2¼ inches in diameter, and consumes 100 watts at line voltages. A 100-watt tube one-half inch in diameter would have to be 24 feet long and would need 2000 volts to supply as much light as the five-foot giant.

In discussing the practicability of high-voltage fluorescent lamps, Dr. Marden and Mr. Meister agreed that they would undoubtedly be used sparingly where high levels of lighting are required, because the amount of light per foot is low in comparison with orthodox lamps. In coves, however, and in places where concealed lighting may be wanted and low levels of illumination are satisfactory, they might have considerable utility.

AIR ARCHEOLOGY

War Fails to Stop British Archeologists

In the thick of the Battle of Britain, flying archeologist O. G. S. Crawford, by arrangement with the Air Ministry, undertook an aerial survey of ancient buried ruins of the Roman city of Verulamium near St. Albans.

Prolonged drought had scorched grass growing over part of the Roman city, causing brown streaks to form with unusual plainness on tennis courts and cricket grounds there. These streaks reveal a chess-board plan of the buried Roman city, its streets and buildings. Photographed from 3000 feet, the scorched field has added new features to archeological knowledge of one of ancient Britain's outstanding cities.

A widening of the ancient east-west road of the city formed what may have been a parking area of the 2nd Century A.D., Philip Corder, curator of the Verulamium Museum, reports in the British Journal, *Archeology*, from study of the air views, according to *Science Service*. The plan of a small Romano-Celtic temple and evidence of many other buildings are disclosed.

GLACIERS

Of Comparatively Recent Origin

Glaciers in the Sierra Nevada mountains are recent in origin and are not relics of the Great Ice Age as tourists are frequently told by guides, according to Dr. Francois E. Matthes, of the United States Geological Survey.

"The small glaciers of the Sierra Nevada are commonly believed to be shrunken remnants of the large glaciers of the Great Ice Age," Dr. Matthes says. "However, facts indicate that these glaciers have been in existence but a short time and are successors to, rather than remnants of, the Ice Age glaciers. They probably originated at about the same time as Owens Lake, which is fed by the snows of the Sierra Nevada. From its salt content, the age of the lake can be estimated as less than four thousand years.

"The lake and glaciers therefore may have been created with the advent of the present relatively cool and moist conditions which followed the Ice Age. It is probable that they made their last advances in the 17th, 18th, and 19th Centuries, and that the glacial deposits in the region date from the last great advance in about 1850."

Evidence of the youth of the Sierra Nevada glaciers is seen in the relatively small bulk of the material deposited by them, Dr. Matthes declares. This material could not represent an accumulation of ten thousand years, the time that has elapsed since the Ice Age.

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STERILIZER—Equipment used for canning salmon at Ketchikan, Alaska, is being used for packaging first aid kits. The kits are delivered by the machine sealed and sterilized.

• • •

DEODORIZER

Of New Design, For Home, Office

Four cannisters filled with activated carbon, a dust filter, and a circulating fan operated by a 40-watt motor are the essential parts of a newly designed odor adsorber recently announced by W. B. Conner Engineering Corporation. This unit, enclosed in a metal cabinet, is intended for use in homes, offices, hospital rooms, and so on where the air is sometimes contaminated by odors or certain gases.

Carbon does the trick

In operation, the contaminated air is drawn into the Dorex Odor Adsorber, as the unit is called, by means of a fan. It is then drawn through the dust filter and then through the acti-

vated coconut-shell carbon before being returned to the room. The carbon adsorbs the odors or gas in the air so that all the impurities remain in the unit and only clean, odor-free air is discharged. The carbon can be reactivated, upon saturation, and used over and over again. The air handling capacity of the unit illustrated in these columns is approximately 100 cubic feet per minute.

SKULL CUPS

Odd Drinking Vessels Used in America

SOME of the earliest Americans made drinking cups of human skulls, according to Dr. Ales Hrdlicka, Curator of Physical Anthropology of the Smithsonian Institution, who found new examples of this macaber practice in village sites on Kodiak Island.

The Kodiak Islanders whose remains were studied were among the first migrants from Siberia to settle on the North American continent. They were cannibals, so there was no shortage of skulls from which to make the cups.

The practice, it is believed, was not solely utilitarian. The Pre-Koniags, as Dr. Hrdlicka calls the long-vanished people, may have used skulls of valorous enemies for cups in the belief that some of the virtues of the former owner would be transmitted to the beverage.

At one time, Dr. Hrdlicka says, the practice was widely distributed over the world and dates back at least to the late Stone Age in Europe. In America it can be traced over both continents. The Araucanians of Chile honored some of the slain leaders of Spanish expeditions against them by converting their skulls into bowls.

EARLY SMOKING

Use of Pipes Dated to 5th Century

THE American Indians introduced the use of tobacco to early European explorers, but who introduced it to the Indians? This question is probably unanswerable, but evidence of the earliest known smoking of pipes, dated at some 1500 years ago, has been found by the Field Museum Archeological Expedition to the Southwest. The fuel may have been tobacco, or may have been oak leaves, grasses, or something else.

This is one of the discoveries reported by Dr. Paul S. Martin, chief curator of anthropology at Field Museum of Natural History, and leader of the expedition, upon his return from a prehistoric site which he and associate archeologists have been excavating in New Mexico.

The ancient village which the expedition brought to light, in the ruins of which a number of pipes were found, is estimated to have flourished about the 5th Century A.D., or approximately a thousand years before the first white man invaded America and learned about smoking. Members of all tribes of Indians in the area from the Great Lakes to Argentina have had the smoking habit for centuries, says Dr. Martin, but the people who inhabited the village he has unearthed may have been the very first to indulge.

MOTOR MOLES

Cars Operate Under Ideal Conditions

DOWN under Detroit, two topless roadsters without license plates roll over 22 miles of roadways many times daily. They travel in weather always dry and clear, climb no hills, halt for no traffic lights.

These roadsters are the foreman's car and the service car for a rambling,

160-acre salt mine 1100 feet under Detroit. The city traffic rumbles on above, neither affecting nor affected by the mine beneath it. The mine also has many miles of narrow-gage railroad and electric locomotives moving trains of cars loaded with lumps of blasted-out salt to the crushers, graders, and sorters. It also has an office and even a machine shop to keep the machinery in order. Getting the roadsters into the mine was a problem. They wouldn't fit into the elevator with the tops on. Since there was neither rain nor sun, nor snow, nor hail in the mine, the tops were removed and the cars were lowered into the shaft.

TARTARIC ACID

From Corn Becomes A Possibility

With imports of tartaric acid cut sharply by war, and with its price increased nearly 150 percent, the United States Department of Agriculture is watching the results of research that indicate the possibility of converting corn into tartaric acid.

Dr. O. E. May, Director of the Northern Regional Research Laboratory at Peoria, Illinois, has reported that research workers of the Laboratory have developed an efficient and cheap means of producing from corn sugar an intermediate product, 5-ketogluconic acid, from which tartaric acid may be synthesized. The method worked out on a laboratory scale will be tested in pilot plant equipment. The United States has a plentiful supply of corn sugar or glucose.

• • •

PORCELAIN — Defense-needed plastics, aluminum, and hard rubber are being replaced in many cases by a new type of porcelain developed by Westinghouse.

• • •

CORROSION

Resisted By Powder For Damaged Tin Surfaces

When tin surfaces have been damaged by handling, or worn away through use, or burned away in welding, the defective area can be repaired with a new metallic coating powder made by American Solder & Flux. The repair material, however, is not intended for use in containers that come in direct contact with food.

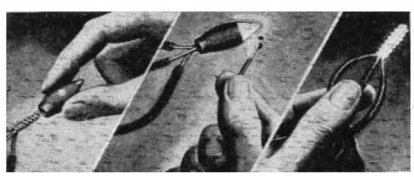
In use, the metallic powder is placed on the area to be repaired and heat is applied. Since the powder has a lower melting point than tin, the heat used for melting it does not disturb the original surface. It is stated that a surface repaired with this powder is rust and corrosion resistant and resembles a tinned surface in appearance.

MATCH SOLDERING

Made Possible With New Units

Strong, perfectly soldered electrical connections can be obtained without the use of the conventional soldering iron or torch, through the medium of "Jiggers." Each Jigger is a small self-contained soldering unit consisting of the correct amount of 50-50 solder and flux hermetically sealed within a waterproof heat-generating outer shell.

The sequence of operations in using these soldering units is shown in one of our illustrations. The wire splice is



Slip it on twisted wires, ignite with match: Soldered joint results

pushed into a Jigger and a lighted match is applied to the outer shell. The shell ignites and produces the correct temperature to flow the solder into the splice. The burned shell is then dropped off, leaving a clean soldered splice.

PEAT

Brown Gold Of Alaska Muskegs

Alaska has a virtually untouched "Klondike" in its 110 million acres of peat muskegs—if anyone can develop satisfactory and inexpensive ways of packing and transporting the peat. Farmers and gardeners use commercial peat to supply soil humus. They also use peat for bedding in stables and as poultry litter that, in turn, becomes valuable manure. Several kinds of peat make good composts when combined with waste materials. Alaska fertilizer supplies also include fish-canning wastes.

The United States Department of Agriculture recently concluded a preliminary survey of the peat resources of Alaska, with a view to possible encouragement of a small-scale peat industry. Many muskegs are accessible from the coast.

The survey revealed sphagnum moss peats and sedge peats, both desirable for improving soils and for other agricultural uses. Through ages, this peat has accumulated on the surface and now forms layers from four to six or more feet deep. Only simple tools are needed to dig the peat. The surveyors made no exact estimates of supplies, but the reserves are ample.

Chief obstacles to marketing Alaskan peat are the short summer season, sparse labor supply, and transportation problems. Local plants could dry, shred, and pack the peat, but economic studies will be needed before the Department can recommend development of an Alaskan peat industry.

POWER ALCOHOL

Not Yet Feasible or Necessary in United States

Periodically there crops up a discussion regarding the use of alcohol as a motor fuel in the United States. Sometimes this discussion is motivated by a desire to conserve fuel obtained from petroleum and sometimes by a desire to create more extensive outlets for agricultural products. It is known, of course, that power alcohol is being widely used abroad and hence would seem to be a logical development in this country.

Because of the uncertainty of the exact status of power alcohol, from the standpoint of both technology and economy, it is interesting to note a part of a letter recently addressed by President Roosevelt to Honorable Gordon H. Garland, Speaker of the Assembly, California Legislator. This letter was in answer to a communication from The Honorable Mr. Garland regarding a joint resolution urging the establishment of plants for the conversion of surplus fruit and vegetables into alcohol for use in national defense as an auxiliary fuel.

"While it is true," stated the President, "that a number of foreign countries process agricultural materials for the production of alcohol as a motor fuel, it is equally true that the motor fuel economy of countries possessing no petroleum resources is very different from such economy in the United States. It has never been established in this country that the conversion of agricultural products into motor fuel is economically feasible or necessary for national defense.

"On the other hand, it has been recognized for some time that a real need exists in this country for the development of all the information possible on this very contentious subject. Hence a pilot-plant is being set up at the Northern Regional Research Laboratory of

the Department of Agriculture at Peoria, Illinois, to make such studies. Until this plant is completed and has been in operation on a variety of agricultural products for such time as may be required for the collection of essential data, it would not seem advisable to undertake the project advanced in Assembly Joint Resolution Number 21."

FIRE-SAFE

Air-Conditioning System Fire Yields Lessons

FIRE-SAFE air-conditioning equipment is of primary importance to public buildings and stores where large numbers of people congregate. For this reason a fire which originated in the air-conditioning system of a Toledo, Ohio, department store has been carefully studied with a view to determining measures to safeguard against similar occurrences in the future.

The Toledo fire occurred in a four-story and basement structure, starting in the room housing the air-conditioning equipment. First indication of fire was smoke issuing from a louvre in the wall of this room. Then haze poured out of the air-conditioning ducts. The manual controls for the louvre openings and the control switch for the air-conditioning system were located in the air-conditioning room. Fortunately, an engineer was able to work his way into the room housing the equipment and pull the control switch just before the sprinkler heads operated and extinguished the fire.

The only direct fire damage was to the interior of the air-conditioning room and its equipment. Damage by smoke to merchandise was remarkably small, apparently because some of the particles were removed from the smoke by the fiber-glass filters of the air-conditioning system. These filters, coated with a non-flammable dust-holding oil, also acted as a fire barrier to prevent spread of fire through the ducts.

It is apparent that the fire actually started in an accumulation of flammable material which may have been drawn into the air-conditioning room through the return louvres located at floor level. Since the fire these louvres have been relocated seven feet above the floor. Also, the louvre and motor controls have been removed to the outside of the air-conditioning room where they can be more easily reached.

This fire clearly shows that the important factors to be considered in installing air-conditioning equipment are as follows: Automatic dampers should be provided on both sides of filter chambers; fine screening should be placed in all return ducts or louvre openings to

prevent flammable material from entering; air filters should be of a type that will not burn; horizontal ducts should have a number of door openings for ease of cleaning; remote control at an easily accessible point should be provided for louvres and motors; all portions of the room housing the air-conditioning apparatus should be equipped with sprinklers.

BLACKOUT BULB

Yields Blue Light, Directed Downward

DESIGNED for blackout lighting in air raids, a new blackout bulb provides downlighting in a soft beam of blue light that is safe for indoor visibility during blackouts. The bulb, just announced by the Wabash Appliance

Blue light for blackouts

Corporation, is lined inside with a silver reflector lining that hides all filament glare and projects the light downward. Light leaks are prevented by a black silicate coating that covers the bulb up to the extreme lighting end, which is a deep blue.

FLAMEPROOFING

Made Possible By Laboratory Curiosity

EVERY minute and a half—on the average—a home catches fire somewhere in the United States. Blazes often start from fireplace sparks. Sometimes a flimsy window curtain blows over a gas range burner. Smoking in bed is a common dangerous practice. And children still play with matches.

From now on, such fires need never happen. Thanks to chemical research, all the flammable fabrics in the home may be "flameproofed" simply and effectively. With many of them, it's as easy as starching on wash day.

MISCELLANY

Annually, some 8700 fatalities from burns are listed, along with countless injuries. Many of these are attributable to clothing that caught fire.

A great decrease in such accidents is foreseeable by "flameproofing" our clothing. The sheerest negligee, a velvet evening gown, the arc-welder's overalls, the little girl's frilly party frock, all may be treated by dipping or spraying with the chemical so that, though they may char upon contact with flame, they will not flame or support combustion.

Fabrics immersed in a solution of one pound of the new fire retardant, ammonium sulfamate, to one gallon of water, and then dried, will remain incapable of supporting fire until washed, when the treatment is repeated. Drycleaning does not remove the fire protection quality or appreciably impair it.

Moreover, this chemical newcomer, first announced on page 140, March 1942 Scientific American, is said to be unique because it does not affect the "feel" or appearance of fabrics. Indeed, it takes an expert—or a flame—to distinguish between treated and untreated goods.

Until three years ago, sulfamic acid, the crystalline powder from which the ammonia salt for flameproofing is made, was a laboratory curiosity. All known methods of producing it were prohibitively costly, and had always been since the acid was first tediously prepared by the Swedish chemist Berglund 63 years ago.

Then, in 1939, at the Experimental Station of the Du Pont Company, an economical way of making sulfamic acid was developed. At that time scarcely a single practical use was known for the acid.

But a few weeks ago a plant to manufacture the new industrial chemical by the tons was opened. It is the first and only plant of its kind in the world. The reason for it being built is that sulfamic acid and its derivatives are now known to be useful for more than a dozen important purposes, ranging from leather tanning and dyeing processes to killing poison ivy and ragweed—and now flameproofing textiles.

Because it affords such a high degree of protection against flame and flying sparks, the fire retardant has for some months been used in airplane manufacture, in workmen's clothing in steel mills and in shipyards. A disastrous fire in the chemical laboratory of a large university recently led to the flameproofing of students' "lab" smocks.

Of particular importance, safety engineers point out, is the flameproofing of pile fabrics. These are prone to "flash" burn—that is, flame will liter-

ally sweep across the nap in an instant.

Broad usage of the fire retardant is fairly certain to open up in two other fields where safety is an urgent need. One is in paper, especially for decorative purposes. The other adaptation lies in treatment of insulating materials to prevent the spread of flames in frame dwellings.

Some progressive dry-cleaners and laundrymen already are offering customers a fire retardant treatment for clothing, bed-sheets, blankets and the like. It is predicted that textile mills will shortly begin flameproofing fabrics in course of manufacture.

FOREST FIRES

Greatly Reduced in Protected Areas

THE forest lands of the United States are now better defended against fire than ever before, according to the United States Department of Agriculture. Vast strides have been made in the increase of forest area being given fire protection and in the fire control methods and equipment being used.

In addition, the Forest Service points out, fire lookout towers and both federal and state lookout stations are available, if needed, in the present war for use as air-raid spotting stations and detection of possible enemy signal fires or incendiary sabotage. These mountain stations, once vulnerable to telephone-line service troubles, are now made much less so through the adoption of shortwave radios by the Forest Service.

Like modern armies, up-to-date fire control organizations have been mechanized. Portable power water pumps have replaced the 10-quart pail and, whenever practicable, handtool fire line construction is supplemented with the use of portable power-driven equipment. Airplane transportation of supplies, equipment, and manpower to inaccessible fires where delivery is made by parachute, now regular procedure, is a practice unknown during the last war.

A little more than 11 million dollars in funds will be available for this forest fire protection during the 1942 fire season. The Department's foresters estimate that an additional six million dollars would be required to protect all forest lands needing it. A total of 146,000,000 acres of forest land in the United States still lack any organized fire protection, according to the Forest Service. The unprotected area amounts to about one-quarter of all the country's forest lands needing protection.

Fires on unprotected forest lands accounted for 87 percent of all the area burned over in the United States last year.

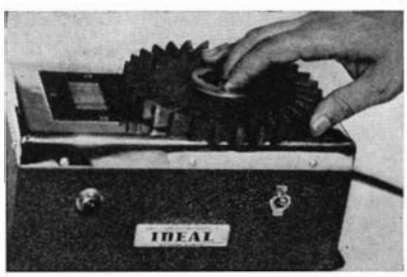
Industrial Growth

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

DEMAGNETIZER

For Equipment Used In Production

WHEN tools, drills, punches, and other machine shop equipment and work pieces become magnetized, as they do when being used with magnetic chucks, they are bound to attract small and sometimes almost invisible



Prevents metal pick-up

chips and dust. These particles, clinging to the magnetized cutting edge of a tool, act as an abrasive between the tool and the work, causing the tool to bind or heat and dull quickly.

Such magnetized machine shop equipment can be quickly demagnetized with a powerful, portable demagnetizer recently announced by the Ideal Commutator Dresser Company. The tool or work is merely passed across the magnetic poles of the unit or, in the case of large parts, the magnetizer is moved over the work. Tools that have been demagnetized will stay sharp longer, will cut faster, and are more accurate than magnetized units.

INDUCTION HARDENING

Saves Much-Needed Copper for Defense Use

BEFORE induction hardening was adopted by a large automobile plant, it was necessary to use copper bushings in the rocker arms to prevent them from wearing out the shaft. Increasing the shaft hardness from 20 to 50 Rockwell C by high-frequency heating and quenching has resulted in a hardness sufficient to prevent shaft wear when the rocker arm is used without the copper bushing. Nearly five million shafts have been processed during the past two years without a single reject that could be traced to improper heating. Since about 14,000,000 bushings weighing four-fifths of an ounce each were needed annually, a savings of 35 tons of copper resulted.

In the manufacture of rocker arm shafts, the steel is cut in 12½-inch lengths out of ¾-inch bar stock, and ground. Shafts are then bored, counterbored, and faced for length simultaneously in one machine at the rate of 185 per hour, using 26 machines to maintain the present schedule of 12,000 units daily. The shafts are then hardened inductively by a "two shot" process, necessary because localized hardening at six different points around each oil hole in the shaft is desired. Units are dropped into holes where they are held in position by a cam supporting the end. High-frequency current from a Westinghouse 240-kva, 3000-cycle generator is applied at three sections which are heated to about 1500 degrees, Fahrenheit, and quenched. The cam then releases the shaft causing it to drop two inches, and the process is repeated. Hardening of the entire shaft is not desirable as it would become brittle and susceptible to breakage.

Shafts are hardened six at a time in an upright hardening furnace in which the heating and quenching cycle is 4½ seconds. No oxidation of the surface results, and there is no grain growth of the unhardened metal sections. Although there is some distortion of the hardened shaft, further machining except for finish grinding and lapping is unnecessary.

STRAIN GAGE

Prevents Breakdown of Industrial Machinery

IN some types of machines, such as punch presses, shears, and press brakes, the strain during a cycle of operation occurs for a very short period of time —rising abruptly to the maximum and then falling sharply to zero. It is this kind of machine for which a new electro-magnetic gage has been developed.

It is now more serious to have a machine out of commission than ever before. The loss in production is doubly great because a longer-than-normal idle period is probable. Men, materials, and

machines that are sorely needed in building new machines must be diverted from their production roles to replace a broken part.

The gage need not be applied directly to the vital part of the machine under strain but it can be applied to any part of the machine whose stress represents the equivalent stress on the vital part. The gage, comprising a rod, lever arm, and head, looks like a side view of an automobile jack. The handle is the gage rod, the jack is the lever arm, and the base is the gage head.

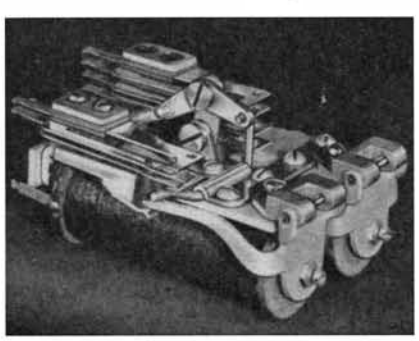
The rod is fastened at either end to the machine in the direction of the strain. The lever arm, attached at its outer end to the machine, is at right angles to the rod. The gage head is mounted on a plate that also is attached to the machine at a point on a line with the lever arm. The gage head consists of an armature operating within two coils.

Before the job is started, the position of the armature within the coils is adjusted so that a zero reading is registered on a connected instrument. When the machine is put into operation and strain exerted, the rod pulls down on the lever arm. The arm in turn pulls down on a pin in the armature and moves the armature to a new position within the coils. This affects the electromagnetic relationship between the armature and coils in accordance with the amount of strain exerted. The instrument, previously calibrated against known strain loads, then indicates to the machine operator the extent of the unknown strain.

RELAY

Uses Current Only When Operating

POSITIVE operation and low current consumption are features of a new start-stop relay which has been recently designed for remote-control starting and stopping of radio transmitters, drainage pumps, and other appliances. This new relay, announced by Automatic Electric Company, operates and releases over two wires, with a common return. A typical method of operation is by the use of a two-way key, which is thrown into one position to close the relay and into the other position to release the contacts. The operating circuit of the relay opens immediately after the contacts open or close; thus operating current is consumed for only about 1/10th of a second.



Economical of operating current

This new relay, available with any number of contacts up to 18, has been tested under operating conditions over a temperature range of from −22 to +131 degrees, Fahrenheit.

CART

For Easy Transportation Of Welding Tanks

HANDLING of welding tanks is facilitated by the use of a new narrow-width cart recently designed by Gar-

Through a narrow door

linghouse Brothers. This cart, shown in one of our illustrations, has a total width of only 24 inches yet carries the two tanks required for oxy-acetylene welding. These tanks, instead of being placed side by side, are set one behind the other, making possible the narrow width which is so desirable for use in crowded shops or narrow aisles.

Either tank may be moved independently of the other, as the acetylene cylinder is inserted at the front while the oxygen tank rests on its own platform in the rear of the cart. A tool box and two rod holders, for long and short rods, are attached to each cart in convenient positions.

The chassis is mounted on large pneumatic tired wheels so that the cart may be wheeled over rough, uneven ground or littered floors.

The Thunderbolt

Although Complete Specifications for New Interceptor Cannot be Told, It Promises to be Most Effective

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

CONGRESSIONAL reports would have it that our pursuits are not equal to the pursuits of other nations and that our P-40 is well behind the times and only suitable for advanced training. The Congressmen who voiced this opinion did not know that the P-40 was followed by the P-40 A, B, C, and so on, which may be reckoned among the world's fastest and most effective fighters. Perhaps, also, the Congressmen in question had never heard of Republic Aviation's Thunderbolt, known technically as Republic XP-47B. This remarkable interceptor plane is perhaps the very first single seater to be powered with a 2000 horsepower engine. While specifications remain secret, there is reason to believe that the Thunderbolt is the most effective interceptor produced anywhere in the world. Tests of the ship, which is shown in our photograph, were remarkably successful. The Thunderbolt is an interceptor which has the strong fire power needed to attack enemy bombers and fighters. Readers will note that to absorb the enormous amount of power developed, a four-bladed airscrew of large diameter has to be employed. On the under side of the wing a hole is shown, uncovered. Into this the landing gear retracts, with the surface automatically smooth after retraction. The picture shows a very wide tread of the landing gear in relation to the span of the wing. Any pilot who has to come down at the speed of a heavily loaded airplane of this type will understand fully why.

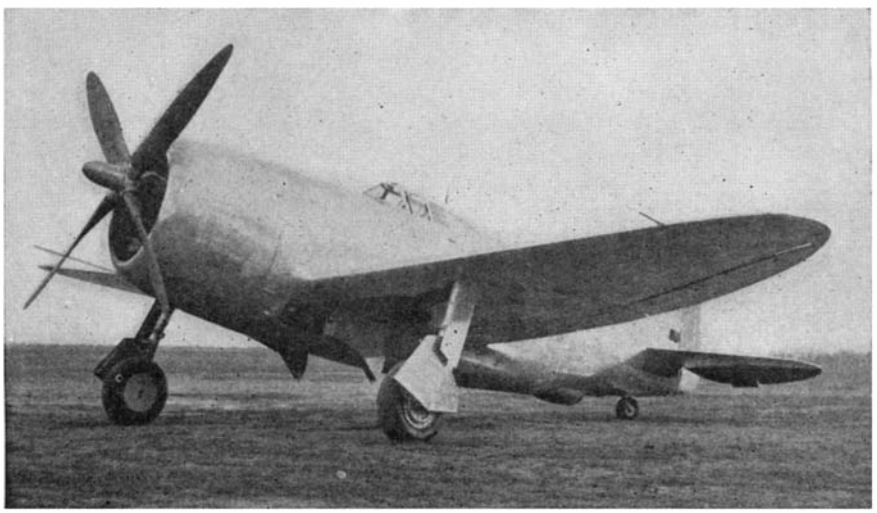
It is an open secret that the Thunderbolt will be built in large numbers and it is certain to give a good account of itself. Another remarkable thing about this new ship is that it was in the air exactly eight months after the order to begin work had been received from the Army Air Corps, an indication of sound knowledge on the part of the engineers.

PLYWOOD

Utilized as Float, Conserves Aluminum

IN these days, when every pound of aluminum is precious, it is only logical that resort should be had to plywood, particularly in the aircraft industry for civil use. It is not surprising, therefore, that the Heath Company has produced a laminated plywood float with plastic bonding or glueing. In earlier days, when glue was of animal or vegetable origin, it was never quite bacteria-proof and never quite waterproof. Floats built then had the unfortunate habit of peeling off.

In the floats shown in our photograph, Honduras mahogany veneer is used for the skin, fastened together with perfectly waterproof and resistant cold resin glue. Another advantage of



When 2000-horsepowered Thunderbolts are hurled at the enemy . . .

the use of plywood in floats is that the top skin of the float is one piece of plywood 15 feet long, bonded to the float structure in a large hydraulic jig that applies pressure evenly to the whole surface. The float is left in this jig for four hours. No nails are used so that the outside surface is perfectly smooth.

Another innovation lies in the transparent inspection covers which enable the operator to check with a flashlight

For inexpensive conversion

for water in the floats. Water rudders are placed at the end of the floats and actuated in conjunction with the ordinary rudder located at the tail end of the fuselage.

These floats, which weigh only 69 pounds apiece, have been approved for seaplanes not exceeding 1,560 pounds in weight. It is an attractive idea to have a low-powered airplane which can be used either as a land plane or, with these cheap and efficient floats, as a seaplane. Perhaps the only criticism we might make is that the landing gear may have too many exposed resistance parts in struts and bracing wires.—*A. K.*

CIVIL AIR PATROL

Offers Possibilities of Varied Services

THE Office of Civilian Defense has had the good fortune to secure as Aviation Aide to the Director, Major Reed G. Landis, famous American pilot of the first Great War.

The first and most important task of the aviation aide lies in the organization of the Civil Air Patrol which is prepared to enroll all persons qualified as flyers, owning their own planes and wishing to give service to the nation. It is easy to enroll. There is no specific examination and a man who is a pilot but has no airplane may act as co-pilot for a pilot-owner. Special training will be given to the enrollees in military and naval air tactics, navigation, air raid warning service, and similar tasks.

Perhaps the most important question to be asked by people wishing to enroll would be: "What are the services that the Civil Air Patrol could render in national defense?" These are enormous and important. To begin with, they might guard all airports, and the guarding of airports has been proved to be vitally important by the events in Hawaii and the Philippines; and there are two thousand airports to be guarded in the United States. Courier service may be of great importance to the Army. No matter how many military pilots and planes we may have, observation patrol of back country areas is likely to be desirable. C.A.P. pilots may be required to tow aerial gunnery targets, thereby releasing military equipment for more important duty. C.A.P. personnel, familiar with all types of aircraft, can assist the air raid watchers. Highway traffic control from the air may, at times, be of value. When a military aircraft is forced down, the new organization may help to find them.

Obviously, not all of the possibilities of C.A.P. are yet understood, but the Army is backing the new organization to the fullest extent.—*A. K.*

ICE

Combatting a Scourge of the Upper Air

ICE is prevented from forming on the windshields of airliners operated by United Air Lines by a system which has been 18 months under development and has proved completely satisfactory.

The windshield used in this system consists of a front pane of quarter-inch safety plate glass and a rear pane of eighth-inch transparent plastic, with a quarter-inch air space separating the two. Air, heated to 175 degrees, passes through a duct from the plane's cabin heating system, on through the air space of the windshield, and then through an exhaust duct to the outside of the plane. The air, controllable by the captain through the operation of a valve at his elbow, moves at the rate of 60 cubic feet per minute. In installing the double windshield, 10 by 35 inches, on the captain's side of the cockpit it has become possible to eliminate the small vertical post which has been standard between the large fixed panel and small sliding panel of the DC-3 windshield, thereby providing the Captain with unobstructed vision. It is noteworthy that J. A. Herlihy, Executive Vice-President of United, tried fluids, windshield wipers, and the application of heat to the inside of the windshield before deciding on the system now being installed.

CAMERA ANGLES

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

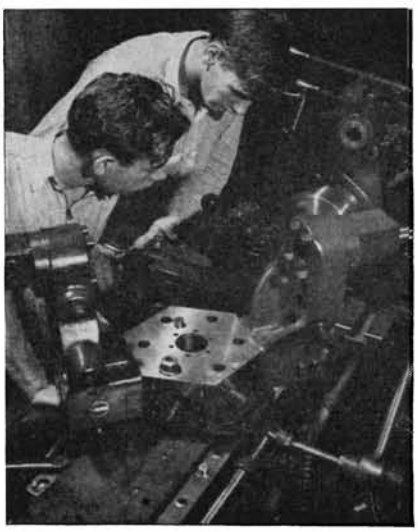
The Camera Enlists

FREQUENT requests have come to us recently asking how photography amateurs can do their bit in the defense effort. Individual instances will vary but, as we see it, the opportunities are twofold: educational and publicity. Defense workers in various branches of activity must be taught how to perform their duties most efficiently, and publicity concerning these activities must be spread, in order to inspire non-workers to enlist part of their leisure time in some phase of defense work.

Publicity pictures, therefore, should demonstrate the many ways in which lay persons may help in one or another of the many branches of defense work. Also, they have the equally important benefit of advising the general public as to how public and defense workers must co-operate when the time comes—air raids, fires, and so on.

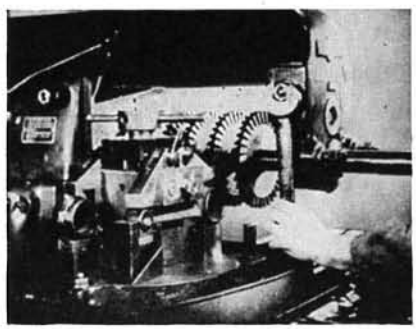
It is in the educational field, however, that the greatest opportunity lies. Volunteer services form the bulk of many defense activities. This means lack of experience or skill and, in frequent instances, even lack of knowledge. Volunteer teachers instruct the tyros, but this is slow work at best. A picture tells a thousand words, and even the best of teachers can do his or her job better if pictures or slides are used to supplement the lesson. In fact, a good set of pictures illustrating a task, step by step, in clear, sharp images placed where they receive good illumination, often can substitute for a teacher entirely, which means fewer teachers, more workers, and a wider dispersion of knowledge among many scattered groups. Paucity of teachers would have no meaning because you would not need them; all you would have to do is strike off duplicate sets of prints.

The power of the pictured lesson is well realized by the United States Office of Education, which is now in the process of directing the production of 50 reels of sound films covering various phases of machine-shop work. These are being reproduced in 16mm size and distributed, for the most part, to vocational schools and in industries where machine-shop training is being given.



Learning by seeing

By the nature of the assignment, educational pictures made with the still camera must show the details of the task as clearly as possible. This means close viewpoints, sharp focus, small diaphragm openings, and generous illumination with full exposure. From such negatives enlargements must be made that have good contrast throughout with adequate shadow detail. The size of the enlargements will vary in accordance with the requirements; for small groups perhaps 11 by 14 inches will do, for larger groups 16 by 20-inch prints may be needed. The slide would do the trick best of all, but the disadvantage here is that you must have a projector and a screen, whereas ordinary prints may be simply set on an easel and adequately lighted.



The movie camera teaches

The slide and the motion-picture film can tell a story more efficiently than the still picture, it is true, but there is this point also to consider: projection implies a darkened room which means that during the showing, the student can only watch and take mental notes. In the case of prints, however, a series of prints may be lined up on a wall to illustrate a practical sequence in some craft, and the student may actually build, or sew, or whatever, in accordance with the instructions indicated in the prints.

However, various crafts call for different approaches, and whereas in one case the print sequence would do the trick; in another, more complicated instance—as in the case of a machine-shop operation—the movie would be the more practical method of teaching.

When Condensers Are Scratched

THE plano side of a double condenser system is always subject to abrasions, particularly if it is of the type too large to be fixed in place. In one instance, such a condenser was injured

when it was being replaced with a smaller condenser unit for small negative work. This scratch showed up beautifully on every print projected with that particular condenser unit in place. This was obviously to be expected since the scratch was on the plano side of the condenser lens closest to the enlarger lens, therefore projecting on the easel almost as sharply as the negative itself. The remedy was to reverse the two condenser lenses in the condenser case, placing the good one on the bottom and the scratched one on top. The scratch was so diffused that it made no impression on the print.

Candid's Still With Us

"You can't take a picture in this light", said our table companion, to which we replied: "That's what you think," and went ahead and did it. The result is reproduced, an honest-to-goodness candid shot of a lad in a listening mood.

"The Problem"

The illumination was from a 100-watt bulb in the ceiling, reflection from the white tablecloth helping to fill in the shadow areas. Made with an Automatic Rolleiflex on Plus X film, the exposure was *f*/3.5 at 1/10 of a second.

Retouching Easel

A 14 by 17-inch unfinished wood picture frame found in an art store gave Mrs. Flora K. Howes, of New York City, an idea for a retouching stand. She bought the frame and had the frame maker build her another frame 14 inches square. The two were then hinged together, the square frame, serving as the bed of the easel, having a white card set in it for reflecting the light to the glass in the easel. A strut attached to each side of the bed held the easel upright at the desired angle. The easel was fitted with a 14 by 17 sheet of ground glass. When not in use the device easily folds up and occupies little storage space.

Easy Road to Composition

Composition is the bugaboo of most photography amateurs, although its basic principles are simple enough. In a recent one-man show in New York City, W. M. Westervelt, a teacher of photographic design and a member of the art staff of an advertising agency, demonstrated by a group of abstract studies that composition is simply a matter of working within a definite area to achieve "a comfortable picture."

"When I want to figure out how to get an interesting shot of some small object," he explained, "I set it down on a table, put one spotlight on it, and then I walk all around it, looking at it through a rectangle 2½ by 3½ inches in an 8 by 10-inch piece of cardboard. I never look at my subject matter except through this cardboard viewer. You can't compose just in general; you have to compose within a definite area."

Print Reducer

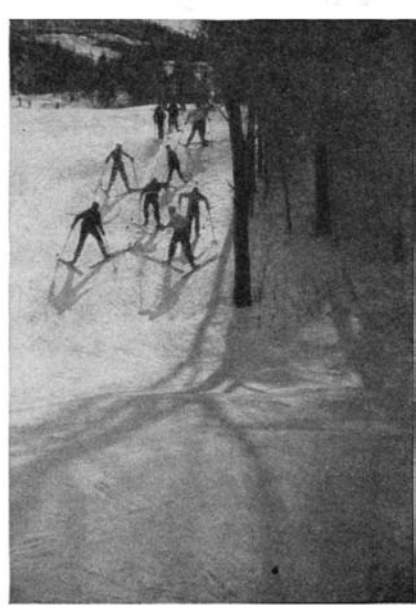
For toning down local areas in prints with distracting highlights and other spotty areas, the following formula has been successfully employed:

Solution A:	
Sublimated iodine.....	20 ozs.
Alcohol	10 ozs.
Solution B:	
Thiocarbamide	1 oz.
Water	10 ozs.

For rapid action use five drops each of Solutions A and B. Slower action is recommended, however. This calls for the use of five drops of A to 10 drops of B. The solution is applied with a bit of cotton on the end of a toothpick. As soon as applied to a particular spot, the area is immediately swabbed with a wad of cotton dipped in alcohol. The routine is repeated as often as necessary to achieve the desired tone.

Helps to Perspective

A picture in the distance, but only space in the foreground: How to shoot that distant picture without being handicapped by empty foreground? That was the problem facing LeRoy Roselieve, New York ski enthusiast, who invariably totes an Ektra with him wherever he goes, shooting Plus X. The long shadows



"Up Again"

in "Up Again" saved the day by darkening the foreground mass, which served also the auxiliary purpose of continuing the "frame" provided by the trees. The result gives an excellent idea of distance, which would have been killed by a white foreground.

In "Haven," meaning is lent the ski paraphernalia leaning against the wall by the distant figures and ski slopes. Here

"Haven"

the interest lies chiefly in the foreground, but without the distant scene the subject-matter would lack completion. Situations like these provide opportunities for introducing some of the tricks and methods by which photographers attempt to give their pictures the three-dimensional values they always strive for.

New Infra-red Material

An accidental observation by Dan Grossi, of the Wabash Photolamp Corporation, resulted in making available an infra-red emulsion which, when used with blackout flash illumination, is said to have a speed much greater than that of regular infra-red film. The film (made by Eastman) had previously been used exclusively for aerial infra-red photography. A piece of the film was cut up into 4 by 5 sheets for use experimentally. The results were so phenomenal that efforts were made to have Eastman furnish a regular supply. So now we have Infra Red Safety Film, Aero Type II, at present in size 4 by 5 inches only. At this writing, the emulsion is coated on thin Aero base, but Eastman plans shortly to use a heavier base similar to that used for other cut film.

Estimates of the speed range from three to 10 times the regular infra-red speed. We have not attempted to test the speed as yet, but results we have seen indicate that a negative of good density can be made outdoors at night with stop *f*/8 at a distance of 15 feet, shutter at 1/25 of a second.

Because the film is rather perishable, said to be good for only 60 days, the manufacturers recommend it be kept in the icebox when not being used. Due to this factor, also, film is ordered by the dealer for each customer. The film is sent by Eastman directly to this customer; the dealer bills the customer. This assures that the user will get the film without any delay.

Readers who desire further information on the subject of blackout flash work in general are referred to this department in the October, November, and December issues. Here they will find details on bulbs, exposure time, and so on.

• • •

What's New

In Photographic Equipment

Albert President Tripod ($25): Built-in swing camera platform permits vertical angle or horizontal shots with turn of knob. Adjustable camera screw fits all cameras. Leg tips reversible from points to rubber. Made of three-section tubular steel. Complete with tilt-head, weighs five pounds. Leg-lock adjustable from 28 to 62 inches.

"Flicker Frolics": New series of home movies produced by Official Films. First subject "The Race for Life," described as an old-time slapstick melodrama, with Mabel Normand, Mack Sennett, Ford Sterling, the Keystone Cops, and Barney Oldfield.

Da-Scope Kodachrome Viewer ($1.95): Folding slide viewer with translucent white plastic top, on which slide is mounted when viewer is open, permitting diffused illumination. Viewing lens magnifies image. Device measures $2\frac{3}{8}$ by $2\frac{3}{4}$ by $\frac{5}{8}$ inches.

"Britain's Commandos in Action!": Castle film record of raids by Britain's suicide squads on two Nazi-held Norwegian islands, available for users of 8mm and 16mm projectors in five sizes and lengths.

Agfa Finex Fine Grain Developer (now available in quart size at $1.75): Through recommended laboratory replenishing system, quart permits total of 60 rolls of 36-exposure miniature (35mm) film or 60 rolls B2 or 120 rolls, or equivalent, to be developed. Finex Replenisher sold separately at 75 cents an 8-ounce bottle.

Hollywood Titler ($9.75): Title cards may be photographed at 4, 6, 8 and 12 inch distance. For 8mm and 16mm camera users. Permits making zoom and superimposed titles; accurate alignment with custom-made camera base for your particular camera. All parts adjustable on base, permitting use for table top, copy work and extreme close-ups. Complete with two auxiliary lenses, celluloid target, instructions and titling data. Professional attachment ($5.50) makes possible turnover, turnabout, turnaround, flop up and down, revolving, and other titling tricks.

Our Book Corner

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

AERIAL BOMBARDMENT PROTECTION

By Harold E. Wessman and William A. Rose

DETAILED technical, rather than popular, discussion of making building construction resistant to effects of bombing, including characteristics of bombs, design procedures, present construction practice and proposed modifications, evaluation of shelter zones in existing buildings, air raid shelters, camouflage. Data were obtained from British experience, supplemented by extensive studies and governmental experiments applicable to American structural and architectural practice. Authoritative. Valuable to engineers, architects, technical advisers, construction material manufacturers. (372 pages, 5¾ by 9 inches, profusely illustrated.)—$4.10 postpaid.—*A. D. R.*

BETWEEN THE PLANETS

By Fletcher G. Watson

ONE of the new Harvard books on astronomy. It deals with comets and meteors, asteroids and meteorites. Written by a professional astronomer (at the Harvard College Observatory) for the advanced amateur astronomer—which is to say, for the rather serious home reader rather than for the reader who wants a book for the entirely uninitiate. It gives a thorough coverage of its subject, including the most recent findings. (*222* pages, 5¾ by 8⅜ inches, 106 illustrations.)—$2.60 postpaid.—*A. G. I.*

DEFENDING AMERICA

By Creighton Peet

JUST the right book to present to that 10 to 14 year-old lad who keeps asking you questions about the Army, the Navy, the Air Corps, and so on. It gives a clear picture for juveniles. (160 pages, 6¾ by 9¼ inches, well illustrated.)—$1.60 postpaid.—*A. G. I.*

TECHNICAL DRAWING

By Giescke, Mitchell, and Spencer

SECOND edition of the probably best book on its subject—most thorough, complete, and detailed. It is essentially a general introduction to drafting, suitable for college and high-school graduates. Chapters on: instruments and materials, instrumental drawing, geometry of technical drawing, lettering, projections, auxiliary views, revolutions, sectional views, axonometric projection, oblique projection, perspective, intersections and developments, dimensioning, shop processes, working drawings, gearing and cams, pipes, fittings and valves, welding representation, technical sketching, shading, patent office drawing, graphs, architectural drawing, structural drawing, topographic drawing, reproduction of drawings. Excellent sourcebook for men now polishing up to undertake defense drafting jobs but who feel a bit shaky. It gets down to brass tacks (thumbtacks). (687 pages, 6 by 9 inches, 1001 illustrations.)—$4.10 postpaid.—*A. G. I.*

THE RADIO AMATEUR'S HANDBOOK

"THE most widely read technical volume on radio" is the way the publishers characterize this volume which is published yearly. The text is literally the Bible for thousands of radio "hams" throughout the world, but it now assumes increased importance due to the fact that thousands of copies of the new edition will be used in defense classes throughout the country. The subjects covered range throughout the entire field of radio, from fundamental principles to the design and construction of transmitters and receivers, all concerned with short-wave activity. (Completely illustrated with photographs and drawings.) —$1.10 postpaid.—*A. P. P.*

INTELLIGENCE, POWER AND PERSONALITY

By George Crile

STUDIES of the force that energizes man and animals, and accounts for their intelligence, power, and personality, by the noted Cleveland surgeon-scientist. Based mainly on thyroid and adrenals, heart and brain. Mainly of zoological interest. (347 pages, 6 by 9 inches, 41 illustrations.)—$3.10 postpaid.—*A. G. I.*

PLASTICS CATALOG 1942

WHAT—a catalog reviewed in the book column? Yes indeed, because here is one catalog that is so much more than a mere listing of products that it has made for itself a definite place in the literature of the plastics industry. Bound in simulated leather, this volume has become an indispensable source of information and reference for anyone connected with or interested in plastics in general. The text

is divided into nine main sections, the titles being: Plastics in Defense; Materials; Plastics Engineering; Production Operations; Machinery and Equipment; Laminates, Vulc, Fibre; Plastic Coatings; Syn. Fibers and Rubbers; Index and Directory. The article material has been compiled by the foremost authorities and experts in the field. (More than 600 pages, 9½ by 12 inches, completely and thoroughly illustrated.)—$5.00 postpaid. —*A. P. P.*

MISSION TO MOSCOW

By Joseph Edward Davies

COMPOSED of extracts from the diary, journal, personal and official correspondence, and the "Secret and Confidential" documents of the former United States Ambassador to Russia, this book is a report to the American people, with the sanction of the Department of State. A moving, fascinating delineation of facts and personalities in Russia from 1936, as observed and studied by an official representative of this country, of whom President Roosevelt said: "You exercised a happy faculty in evaluating events at hand and determining with singular accuracy their probable effect on future developments. Your judgments of men and measures were sound and dependable." (663 pages, 6 by 8½ inches, indexed, illustrated.)—$3.10 postpaid.—*A. D. R., IV.*

THE ADVANCING FRONT OF MEDICINE

By George W. Gray

SUMMARY of the high points in our present-day knowledge of the nature of disease, under the headings of alimentation, high blood pressure, the sulfa drugs, influenza, allergy, anxiety, insanities, sleep, pain, smoking, drink, cancer, aging. This is not a dashed-off book—quite the opposite. For Gray spends about three years on such a book, writing, checking, painstakingly submitting his copy to everybody that's important in the whole field (literally scores of these), re-writing in the light of their suggestions, and polishing off with not merely accurate statements of fact but correct emphasis and interpretation, which are still more important. There is no flashy writing here, just a good sound style without self-conscious trimmings; in other words, a book designed to appeal to conservative readers who want truthful pictures of the status of medicine. (425 pages, 6 by 9 inches, unillustrated.)—$3.10 postpaid.—*A. G. I.*

HANDBOOK OF CHEMISTRY AND PHYSICS

ANNUALLY this classic reference book is revised to keep pace with research work, the revision process necessitating extensive changes during recent years. To attempt to give a comprehensive idea of the contents of the book would take far more space than is available. About all that can be said here is that an attempt has been made to include material on all branches of chem-

The Editors Recommend

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PLEXIGLAS FABRICATING MANUAL is a 48-page booklet prepared specifically for organizations fabricating Plexiglas for defense purposes. It is of immediate interest, however, to other users of thermoplastics. The text of the booklet covers such phases of the work as machining, forming, cementing, finishing, and repairing. A large number of illustrations supplement the text. *Rohm & Haas Company, Washington Square, Philadelphia, Pennsylvania.—Gratis.*

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ON THE PIPELINE FRONT is a 12-page booklet devoted to a description of the pipeline industry. The text tells the dramatic story of the men and machines composing this industry which is contributing greatly to the progress of commercial and domestic life all over the world. *Form 7218. Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

ELECTRON MICROSCOPES AND THEIR USES, by Joseph A. Becker and Arthur J. Ahearn, is a 16-page illustrated booklet which gives a bit of the history of microscopes in general and describes the design and construction of the modern electron microscope. Included are a number of reproductions of photographs made with this instrument, showing details never seen by men until the development of the electron microscope. *Bell Telephone Laboratories, Inc., 463 West Street, New York, N. Y.—Limited Free Distribution.*

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A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

DR. PLASKETT'S detailed account of the acceptance tests for the great 82" mirror for the McDonald observatory, reprinted from *Contributions from the McDonald Observatory, University of Texas,* begun here last month, is concluded as follows:

The focal length of the completed mirror was carefully measured before the reductions of the final measures, as 319.656", or 811.928 cm; and with this focal length the intersections of the 12 zones used in the visual tests and the 15 in the Hartmann test were computed anew, and are given in Table I. On the left-hand side the units are inches and on the right centimeters, as the separation of the zones, which are those of the diaphragm used in the Hartmann test and the pitch of the screw used in measuring the photographs, are given in these units. The recomputation was necessary, as the difference between these positions and those for the focal length of 320" amounts to 0.005", or 0.12 mm, which is quite significant with so good a mirror as the 82".

The visual measures of the intersections of the pencils from the various zones were made on October 12 and October 14, immediately after the parabolizing was completed, and again on October 25 and November 1, after the mirror was aluminized. There were four independent sets of measures on October 12 and six each on the other three dates, equally divided between, and alternated by, Mr. Lundin and myself. The separation of the scratches was measured by dividers on a steel rule divided into fiftieths and hundredths of an inch. These measures, or rather the differences between the observed and the computed position ΔR, are given in thousandths of an inch; for, although in a single setting three places are not significant, they more nearly approach it in the mean of four, and still more of six settings. The probable errors of the mean of six settings is 0.0022" for the outer four zones, 0.0033" for the intermediate, and 0.0043" for the inner four zones.

The results of these four measures are given in Table 2, where the first column contains the zone number, the second and third and the succeeding three pairs of columns give the ΔR's, the difference between the observed and computed positions of the zonal intersections, and their transformations into the curve of shape for the four dates. It will be noted that the values of ΔR which, it must be remembered, are expressed in thousandths of an inch and are four times the longitudinal aberrations at the principal focus, vary somewhat on the different dates, being lower on October 12 and 25 than on October 14 and November 1. While the accidental errors of the means of the sets, varying from ±0.002" to ±0.004", and increasing from edge to center of the mirror, may account for a considerable fraction of the variation, there may be something systematic about the differences, such as temperature variations on the different dates, or change of figure produced by irregularities in the thickness of the aluminum coating.

So far as the latter effect is concerned, it may be dismissed as negligible, as there is no appreciable systematic difference in the run of the ΔR's before the coating, on October 12 and 14, and after it, on October 25 and November 1. There may be, however, some evidence of a temperature effect on the figure of the 82" mirror. On October 12 and 25, when the variations in the ΔR's were somewhat smaller than in the other two measures, the decrease in temperature, taken from a thermograph near the mirror, between midnight and the time of the tests, about 11:00 A.M., was 1°.2F, while on October 14 the change was 2°F. However, on November 1 the temperature was constant within 0°.3F, so that, on the whole, a variation of figure with small temperature changes is not demonstrated.

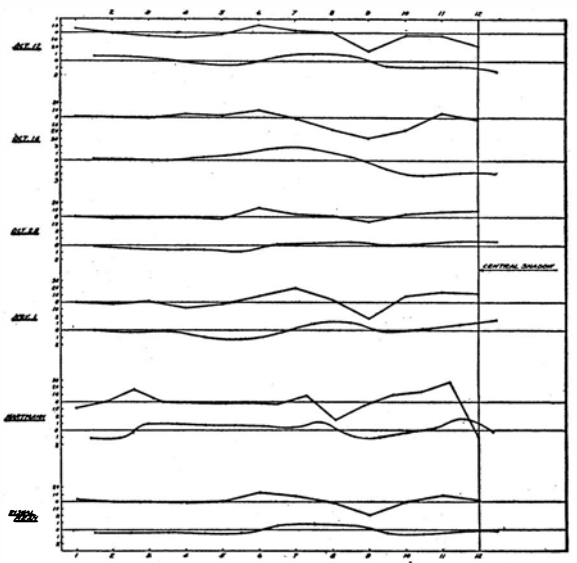

Figure 3: **Final test. Upper curves of the ΔR's. Lower curves are the curves of shape**

We may, hence, consider that the variation in ΔR's are mainly accidental and use the mean values of the 22 different settings as best representing the figure of the mirror, and these means are given in the last three columns of Table 2. The mean ΔR's are all remarkably small, less than 0.004", or 0.001" at the principal focus, except for zones 6, 9, and, to a smaller extent, 11. These indicate only a very small deviation from a perfect figure, the maximum longitudinal aberration at the principal focus in the last column being 0.005", or 0.12 mm, as compared with the 0.4 mm allowed by the specifications. The total area of the three divergent zones is only 15 percent of the area of the surface, so the effect on the resultant image will be small. The maximum diameter of the circle of confusion, computed geometrically from the largest longitudinal aberrations, is 0.014 mm, as compared with the 0.05 mm of the specifications. Furthermore, 85 percent of the light is concentrated in a diffusion disk of an average diameter less than one-third the foregoing.

The ΔR's from Table 2 are represented graphically in Figure 3, the scale divisions being in hundredths of an inch, although numbered in thousandths (these being used rather than millimeters since all the measures were more conveniently

Zone	Radius of Zone (In.)	Diff. Radius (In.)	Zone	Radius of Zone (Cm)	Diff. Radius (Cm)	Hartmann Meas. ΔR	Hartmann Meas. ΔF	Mean Astigmatism (Mm)
1.....	40.250	2.539	1....	101.5	6.365	−0.32	−0.08	+0.11
2.....	37.711	2.229	2....	97.	5.808	−0.11	− .03	+ .06
3.....	35.211	1.942	3....	92.	5.224	+0.36	+ .09	− .03
4.....	32.721	1.677	4....	87.	4.653	−0.11	− .03	+ .04
5.....	30.227	1.431	5....	82.	4.149	−0.15	− .04	− .01
6.....	27.736	1.204	6....	77.	3.658	−0.16	− .04	− .02
7.....	25.231	0.996	7....	72.	3.206	−0.12	− .03	+ .07
8.....	22.727	0.809	8....	67.	2.776	−0.17	− .04	+ .08
9.....	20.231	0.641	9....	62.	2.374	+0.13	+ .03	+ .01
10.....	17.738	0.492	10....	57.	2.007	−0.72	− .18	+ .01
11.....	15.217	0.362	11....	52.	1.671	−0.22	− .06	+ .01
12.....	12.744	0.254	12....	47.	1.363	+0.15	+ .04	− .02
13.....	10.277	0.165	13....	42.	1.090	+0.24	+ .06	+ .08
14.....	7.729	0.093	14....	37.	0.846	+0.62	+ .15	− .10
Center..	0	0	15....	32.	0.632	−1.34	−0.33	−0.06

Table 1: **Positions of intersections (max. diam., 0.025 mm)**

made in those units). The curves of shape computed from these ΔR's are given immediately below each curve of ΔR, the units here being millionths of inches. The maximum departure from the mean paraboloid in the lowest curve is 0.0000007", considerably less than a twentieth of a wave.

The Hartmann Test: There remains one further test of the surface, the well-known Hartmann test, which was requested by the purchasers early in the negotiations, the diaphragm being made according to their specifications. The latter contains 60 holes, each about 38 mm in diameter, spaced along twelve radii 30° apart. The holes cover 15 zones of the surface twice, the two sets being 90° apart to determine the astigmatism. The radii of the zones are given in Table I in centimeters, successive zones being 5 cm apart except that the distance between No. 1 and No. 2 is 4.5 cm. This diaphragm was placed directly over the aluminized mirror, which rested on the table of the polishing machine and was turned into a vertical position for both visual and photographic tests.

Several precautions were taken to insure reliable results on these tests. The principal difficulty encountered in my earlier tests of the 72" Victoria and the 69" Delaware mirrors had been temperature stratification in the Brashear testing chamber. This difficulty was much less troublesome at Cleveland, owing to the better temperature correction and to the tests being made in an open room instead of the closed 6' square tube at Allegheny. Nevertheless, it was still present, as the images of the zonal apertures on the plates were all elongated in the vertical direction. To overcome as much as possible such temperature difficulties, the mirror was always kept horizontal, except for the few minutes the photograph was being made, so that it must have been at practically constant temperature throughout. Four exposures were made in each set, the mirror being rotated 90° each time, so that the longitudinal aberrations and the astigmatism could be tested not only from the two sets of apertures on each plate but also from the horizontal sets only, on successive plates, in the hope of overcoming stratification effects.

The four plates yielded four determinations of the ΔR's and four of the astigmatism. The average probable errors of the mean values, which, unlike the visual settings, did not increase in the inner zones, was ± 0.21 mm, which, compared with the visual average of ± 0.082, makes the photographic probable error over 2.5 times greater than the visual. The values of the photographic ΔR's and of the longitudinal aberrations at the focus are given in the seventh and eighth columns of Table I. These, reduced to the same scale as those of the visual tests, are shown graphically in the fifth group of Figure 3. Although these show a trend similar to the visual graphs, they are naturally, owing to the higher probable errors, considerably more ragged and are entitled to considerably less weight.

The principal value of the photographic method is its definite test of the presence

Zone	Oct. 12		Oct. 14		Oct. 25		Nov. 1		Mean ΔR	Mean Curve	ΔF at Focus (Mm)
	ΔR	Curve	ΔR	Curve	ΔR	Curve	ΔR	Curve			
1	+0.006	+0.7	−0.001	+0.1	+0.001	−0.1	0.000	0.0	+0.0035	−0.4	+0.02
2	− .001	+0.6	.000	+0.1	− .002	− .4	− .003	−0.3	.0000	− .4	.00
3	− .005	+0.2	− .001	0.0	− .001	− .0	+ .001	−0.2	.0000	− .4	.00
4	− .007	−0.4	+ .005	+0.5	.000	− .6	− .008	−1.0	− .0022	− .5	− .02
5	− .003	−0.5	+ .003	+0.8	− .003	− .9	− .003	−1.3	.0000	− .5	.00
6	+ .011	+0.6	+ .011	+1.7	+ .013	+ .2	+ .009	−0.5	+ .0125	+ .6	+ .08
7	+ .003	+1.0	− .001	+1.6	+ .004	+ .4	+ .020	+1.0	+ .0008	+ .7	+ .01
8	+ .001	+0.7	− .016	+0.5	+ .002	+ .5	+ .004	+1.1	− .0015	+ .6	− .01
9	− .025	−0.7	− .023	−1.2	− .006	+ .1	− .023	−0.3	− .0190	− .6	− .12
10	− .004	−0.8	− .017	−2.1	+ .004	+ .3	+ .009	+0.2	− .0005	− .6	.00
11	− .004	−0.8	+ .007	−1.8	+ .008	+ .6	+ .014	+0.8	+ .0078	− .2	+ .05
12	−0.019	−1.4	−0.003	−1.9	+0.010	+0.6	+0.012	+1.5	+0.0015	−0.2	+0.01

***Table 2:* Visual measurements of ΔR (max. diam., 0.014 mm)**

of astigmatism. The mean differences between the longitudinal aberrations at the principal focus in two azimuths on the mirror 90° apart are given in the last column of Table 1. If not wholly due to accidental errors, as seems likely from those determined above, there is certainly no systematic trend of the signs, the algebraic mean being only +0.02 mm, and it may be safely said that the surface is free from astigmatism.

The Hartmann criterion T, obtained from the formula

$$T = \frac{200{,}000}{F_0^2} \cdot \frac{\Sigma r^2 \Delta F}{\Sigma r}$$

where F_0 is the focal length, ΔF the longitudinal aberration at the principal focus, taken without regard to sign, and r the radius of any zone, simply gives the weighted mean value of the diameter of the geometrical confusion circle expressed in terms of $F_0/100{,}000$, while $2.0626T$ is its apparent diameter in seconds of arc. The values of T were computed for each of the four visual measures and for the single photographic test, and are given in Table 3. This was done for completeness only, as the value of T obtained from the mean of the 22 visual measures of ΔR at the center of curvature (given in the last line of Table 3) is obviously of much greater weight and is taken as more truly representing the optical qualities of the mirror. The maximum diameter of the diffusion disk was calculated above as 0.014 mm, less than one third the 0.05 mm permitted by the specifications, but is nevertheless nearly four times larger than the average diameter of 0.0039 mm in the last line of Table 3. There is, however, such a small proportion of the total light entering into this expanded disk that, in comparison to the central condensation, it will be quite inappreciable.

It will be of interest to compare the optical qualities of the 82″ mirror with those of other large reflecting surfaces which have been similarly tested. For this purpose the criterion T forms the best guide, as the errors or aberrations and the diameter of the geometrical diffusion disks are directly proportional to T. The following list comprises all those known to me, as the Mount Wilson 60″ and 100″ mirrors have had, to the best of my knowledge, no measures of their aberrations published.

72-inch Victoria mirror[1]..... $T = 0.12$
69-inch Delaware mirror[2]..... $T = .14$
74-inch Toronto mirror[3]..... $T = .20$
82-inch Texas mirror..... $T = 0.050$

Not only has the Texas mirror much smaller measured errors than any other, but such a relatively large proportion of the figuring was performed with large tools that the surface must be remarkably smooth and regular. This was, indeed, amply demonstrated by the Foucault and Ronchi tests, and it can be safely stated that the quality of the 82″ mirror of the McDonald Observatory is unequaled by any mirror previously made and tested.

[1] Computed from the aberrations published in *Pub. Dom. Ap. Obs.*, 1, 41, 1920.
[2] *J. Opt. Soc. Amer.*, 23, 293, 1933.
[3] *Pop Astr.*, 44, 349, 1936.

Kind of Measure	Date	Number of Measures	Hartmann T	Weighted Diameter of Geometrical Diffusion Disk	
				Millimeters	Seconds
Visual.....	Oct. 12	4	0.080	0.0064	0.17
Visual.....	Oct. 14	6	.070	.0052	.14
Visual.....	Oct. 25	6	.042	.0032	.09
Visual.....	Nov. 1	6	.085	.0068	.18
Photographic.....	Oct. 26	4	0.100	0.0078	0.21
Mean of all visual measures.....		22	0.050	0.0039	0.10

***Table 3:* Results of the tests**

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And the Navy said, "Well done!"

Today, over the Westinghouse plant, there floats the Navy's "E" pennant—for excellence—eloquent testimony to the manner in which this Westinghouse plant performed the job. How was this plant able to get into growing production of these mounts so quickly? The answer lies in a Westinghouse characteristic called "know how"—the ability to get things done in the best possible way.

This Westinghouse "know how" makes itself felt wherever Westinghouse craftsmen build things. Whether for the common defense or the general welfare, this "know how" is doing a job. The same skill and ingenuity that made so many splendid things for peacetime living are now being applied to many important war weapons.

"Know how" will work for you again

We look forward to the day when we can give your home, your farm, or your factory the full benefit of Westinghouse "know how" again. To speed that day means just one thing to us: to produce, in ever-increasing quantities, the tools with which to get the victory job done.

Westinghouse

For the Common Defense

Sterilamps
Bomb Fuses
Tank Equipment
Military Radio Equipment
Plastic Plane Parts
Seadrome Lighting Equipment
Navy Ship Turbines and Gears
Blackout Plant Lighting Equipment

For the General Welfare

Air Conditioning
Electric Refrigerators
Switchboards
Lamps
Steam Turbines
Elevators

These lists mention only some of the many thousands of Westinghouse products.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., PITTSBURGH, PENNSYLVANIA