SCIENTIFIC AMERICAN

Diesel Power In The Big Woods (See page 285)

DECEMBER 1934 · VOL. 151 NO. 6 · 35c A COPY

THE NATION'S STRENGTH IS THE NATION'S HEALTH

The greatest threat to the nation's health is tuberculosis. It is the chief killer of men in industry between the ages of 15 and 45—20,000 men in this group alone die of it every year. No one is safe from the disease until every case has been found and placed under treatment. Help protect yourself and your family by using Christmas Seals on your holiday letters and packages. The funds they provide finance a program of prevention, discovery, and treatment of tuberculosis throughout the entire year.

The NATIONAL, STATE, *and* LOCAL TUBERCULOSIS ASSOCIATIONS
of the UNITED STATES

BUY CHRISTMAS SEALS

SCIENTIFIC AMERICAN

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NINETIETH YEAR • ORSON D. MUNN, Editor

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The SCIENTIFIC AMERICAN DIGEST

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ACROSS THE EDITOR'S DESK

Policies and Plans

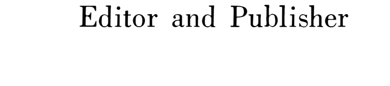
RESPONSIBILITY for settling wagers would not seem to come within the province of a scientific journal, and especially of one which is edited primarily for the business man and manufacturer. Yet wagers are sometimes made on scientific facts and we are sometimes called upon to give the correct answer, whether or not we approve of wagers, *per se*. In our position as the authoritative interpreter of the accomplishments of science and industry, we are considered the *ex officio* mentor of all things that savor in the slightest of science. Dozens of questions come to our desk daily, and on the answer to some of them—which we gladly give—may hinge the fate of some important enterprise.

The first thought, seemingly, of those who know our tradition is to ask SCIENTIFIC AMERICAN. This feeling of dependence is best exemplified by the statement of one correspondent—an investment broker—that "I know that anything you put in your magazine is correct." Naturally proud of that reputation and of our tradition dating from 1845, we keep faith with you by adhering strictly to fact. Obviously this delimits our discussions, keeps out sensationalism and wild and fantastic prophecies. (The thinking reader will see clear-cut and sane predictions of what the future holds in store in every proper evaluation of today's great works.) We find it necessary, moreover, to appraise a new discovery, development, or achievement in such careful fashion that often our discussion of a thing's *true* significance may follow by weeks the newspapers' first glaring headlines and naïve or unblushing distortion of it. The intelligent reader willingly awaits the critical analysis and interpretation of the accomplishments of science and industry for he knows that he will then get a sharper, clearer perspective.

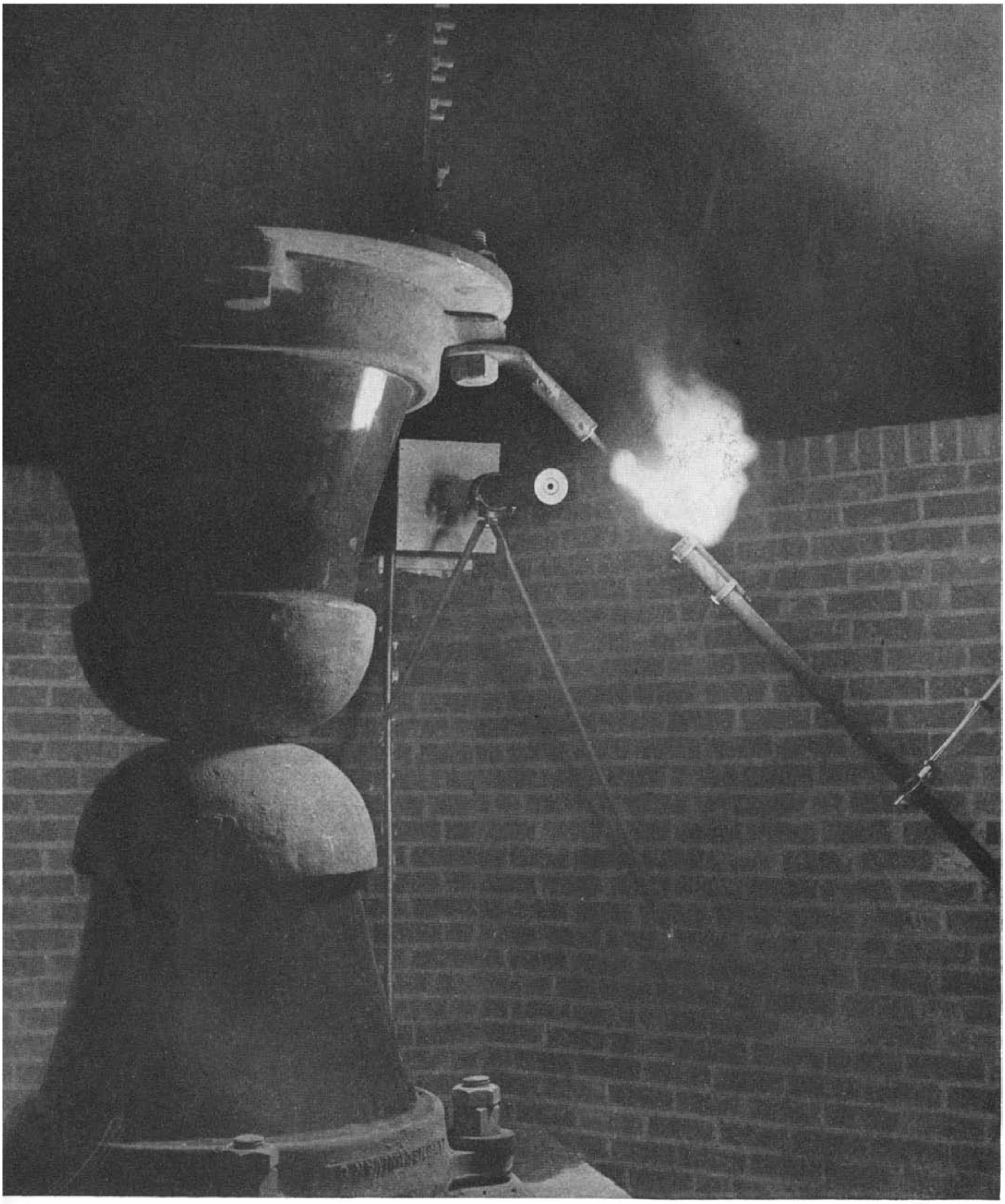
It is SCIENTIFIC AMERICAN'S job to answer questions—before they are asked, as a rule. Just now, due to the tremendous social and economic changes that are taking place, a number of questions cry for an answer. These can be given only through a consideration of conflicting opinions. In these pages, therefore, mental stimulants have recently been provided in the form of debates from which the reader can draw his own conclusions.

The business man, the industrialist, the professional man, the farmer, the investor—these would like the answer to questions that are more important in that they pertain strictly to the business in hand. These will be found in an outstanding series of well-rounded-out articles on a wide variety of major industrial subjects, giving the background, significance, present status, and a definite hint of the future—such as does our leading article on Diesels in this issue—that are planned for coming months. These will all give vitally important information to the alert, hard-fighting business man of 1935. And that reminds us that we intended to tell you to:

"Look for an important announcement in our next, January, 1935, issue!"



Editor and Publisher



Photograph courtesy The Crosley Radio Corporation

AN ELECTRIC EYE THAT NEVER SLEEPS

AT the base of the 831-foot vertical antenna tower of station WLW is a safety gap which grounds the electrical energy collected from the atmosphere by the mast. When this charge is great enough to jump the gap, a "power follow-up arc" will be formed which will drain off and ground virtually all of the station's 500,000 watts. To prevent this, a photo-cell (see illustration) keeps constant watch over the safety gap and instantly actuates a series of relays when the first arc is formed. These relays shut off the radio transmitter for a split second, effectively preventing the follow-up arc.

DIESEL ENGINES IN INDUSTRY

DIESELS STRIDE AHEAD

Dependable, Economical Motive Force . . . Air, Land, Water . . . Slowly, Surely Advancing in America . . . Great Future Possibilities . . . Saving Not So Much in Cheaper Fuel . . . Decentralization of Industry

By PHILIP H. SMITH

THE Diesel type of engine will become dominant, headlines tell us. News flash following news flash announces astounding performance on land and sea and in the air. A Diesel-powered racing car whirls the 500-mile Indianapolis race at an average speed of 86.14 miles per hour; a giant bus tears from New York to Los Angeles in 91 hours at a total fuel cost of $21.90; the Navy installs a Diesel in its newest submarine; and an airplane so powered covers leagues at a fraction of normal cost.

All these events are fact. The Diesel has been doing astonishing things and has established itself as a dependable, economical motive force. But headlines tell only part of the story. The value of the Diesel as to its future commercial possibilities has to be appraised in less sensational manner. Among engineers there is no unanimity of opinion regarding the Diesel's future, hence the potentialities of this engine will have to be gaged from the rate of progress made —internally, in the perfecting of the engine; externally, in its applications; and, finally, from a consideration of external factors bearing upon its commercial use.

Basically the engine is the same as when invented by Dr. Rudolph Diesel in 1892. It operates on the principle of igniting fuel by the heat of compression as contrasted to the spark ignition of the orthodox gasoline engine. Compressing air to 375 pounds per square inch is adequate to ignite the fuel when it is sprayed into the combustion chamber, but in actual practice much higher pressures are used. More heat is turned into power and less wasted in cooling water and in exhaust gases than with the spark-ignition engine and the advantage of burning low cost fuel and less of it is a very real one.

EARLY Diesels were cumbersome, rough in operation, and odorous, hence first application very naturally took place where these characteristics were no drawback. They were used in the stationary power field for generating electricity, pumping, and so on. Later they came into marine use. In both fields the Diesel has been widely applied, vastly improved, but its performance has not been highly dramatic. The public, being only indirectly concerned with the means of lowering power costs, has paid little attention to the inroads of this engine. Now, with Diesels appearing in trucks, airplanes, and railcars, it is a different matter. These most recent developments are arresting.

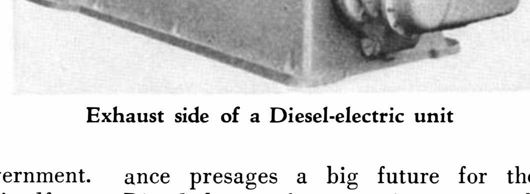
A Diesel engined Caterpillar makes light of a heavy job

Diesel engine power is now applied in six distinct fields as follows: Stationary power; Marine; Railcar; Trucks, busses, and tractors; Passenger cars; Aircraft.

Before we discuss what the Diesel has done in these various fields and what it may be expected to do in the future, let us look a moment at some cold figures, bearing in mind that we are considering Diesel development in the United States. Progress has been more rapid in Europe due to a variety of reasons, principally the need to offset high fuel costs. In this country, the Diesel is contemporary with the spark-ignition engine, though owing to basic patents, commercialization did not begin until about 1911. This gives 23 years of development against which to measure relative progress.

AT the close of 1933, Diesel horsepower to the approximate amount of 4,650,000 had been sold and of that amount about 95 percent was still in active service. As horsepower goes, this is not a huge amount and the figures serve more to show the reliability of the Diesel than wide adoption. The Census of Manufactures reports 1144 units sold in 1933, these units having a rated horsepower of 139,191 and a value of 4,704,540 dollars. Compare these figures with those of any automobile manufacture and the Diesel industry looks insignificant. The Lincoln division of the Ford business, for example, built nearly twice as many gasoline engines in the same year and the combined horsepower of the output ran over 100,000. Lincoln output is relatively small as automobile production runs, yet the wholesale value of its product was far greater than the value of the Diesel industry's entire output of engines.

Although Diesels are being used for a greater variety of purposes every year, bulk classification of uses remains much the same from year to year. Marine service now accounts for some 20 percent of existing Diesel horsepower, central power stations take 15 percent, the petroleum industry with its oil field and pipe line needs uses 11 percent, and the remaining 54 percent is scattered among industrial users and branches of the Government.



Exhaust side of a Diesel-electric unit

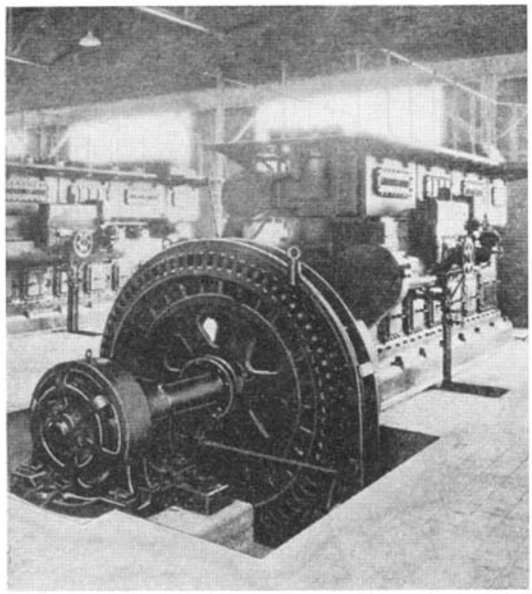
The Diesel has established itself securely in the stationary power field by demonstrating its ability to reduce power costs. In outlying communities it is providing power for industry and even in the heart of metropolitan cities it has made way in the face of supposedly adequate public utility facilities. An instance of this is found in the center of New York City. At Number One Park Avenue, an office building, a contract was made with the Chicago Pneumatic Tool Company whereby a 1080 horsepower Diesel plant was installed. Under the terms of the contract, the owners make a monthly payment for power to run elevators and pumps, and current for lighting, the contracting concern making installation and assuming full responsibility for service. The owners of the building, who paid a power and light bill of 45,000 dollars annually, expect to make a saving of 189,950 dollars over a period of 10 years.

Similar instances can be found in other cities and such striking performance presages a big future for the Diesel, but performance is not enough upon which to base a forecast. Since costs are the deciding factor for stationary power, the desirability of the Diesel over other power producers must be determined in each instance in the light of oil and coal costs, the amount of steam needed in process work and the local electric energy rate cost. We are likely to see Diesel development make most rapid strides in communities where electric power rates are high, where power must be transmitted long distances, or where a community is too small for an economical steam plant. There is nothing to stop public utilities from making use of Diesels and indeed we find them doing just that where the load factor can be handled best with Diesels alone or Diesels in conjunction with steam plants. Presumably more of this would have taken place had there not been excess utility power capacity in recent years.

Within recent months there have been many Diesel applications in municipal street lighting and water works. Costs are receiving more attention and municipal ownership has been given a boost three ways. First there is the willingness of the Federal Government to give financial assistance to communities wishing to establish their own plants; second, is the refusal of many public utilities to lower their rates; and the third boost comes from the action of state legislatures making possible more liberal funding programs.

SINCE the desirability of Diesel installation by municipalities and small manufacturing concerns hinges in many instances upon existing power costs, the future depends perhaps as much upon the attitude of public utilities as it does upon Diesel technical progress. This we do know—the Diesel is eminently suited as a producer of power and lends itself well to the decentralization of industry, since it provides the small user with the same low cost per horsepower-hour as the large user enjoys. If there is any inherent advantage in decentralization the Diesel will get the benefit of it and, by being readily available, may hasten the movement in that direction.

Diesels have been installed in every type of seagoing craft from the small privately owned vessel to the large ocean liner. It is a well recognized producer of marine power and a large proportion of the total Diesel horsepower in use goes to sea. It is growing more popular for small craft, but increases for large vessels appear to await a revival of interest in world shipping. Recently the Navy and Coast Guard have been among the most prominent buyers of Diesels, and this governmental use, together with installations in the new German "pocket battleships," is perhaps most responsible for drawing public attention to possibilities in this field.



In a Diesel-electric power plant

WHEN it comes to mobile equipment—installation in cars, trucks, railcars, and airplanes—the Diesel steps out into a field where it has yet to win its spurs. It has, however, accomplished feats which have stirred the imagination, created much controversy, and stimulated a vast amount of thoroughgoing research. It is safe to say that where there is so much smoke there must be some fire and what that fire is can best be told by surveying technical progress.

The development of Diesels has been mainly in the direction of cutting weight and raising engine speeds. The low-speed type of Diesel today weighs about 100 pounds per horsepower, whereas 400 pounds was once acceptable. And radically new types have been developed having weights and speeds comparable to their spark-ignition counterparts. For example, the six-cylinder Cummins Diesel for trucks and busses, delivering 125 horsepower at 1800 revolutions per minute, has a weight per horsepower of 15.6 pounds, while six-cylinder standard spark-ignition engines for similar use, of comparable horsepower and engine speeds, have a weight per horsepower ranging from 10 to 14.9 pounds.

This newest, fast engine has stimulated great interest among engineers and business men, for reduction of weight and quickening of speed have broadened the commercial horizon. And manufacturers have been prompt to sense the possibilities, hence among the 50-odd Diesel producers, which include such established houses as Fairbanks Morse, Ingersoll-Rand, International Harvester, Waukesha, Winton, and others, there are a score concentrating upon the high-speed type and an equal number adding such models to their line.

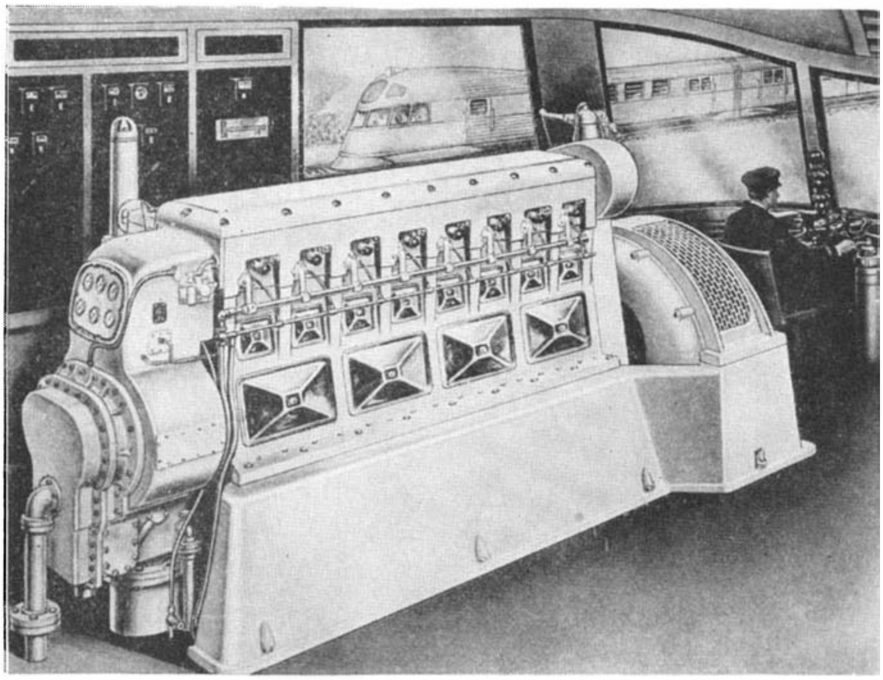
There are several types of Diesels being made, but in the main commercial types fall into one of four categories. They are four- or two-cycle and have either air or solid injection. The four-cycle, mechanical-injection type is the most popular and the two-cycle follows closely. Except for the manner in which the fuel is handled there is little fundamental difference from the spark-ignition type engine, but whereas the two-stroke spark-ignition engine has almost disappeared from sight, the two-stroke Diesel is coming in for a great deal of attention. Commercial use of this type is exemplified in the streamline, Diesel-electric propelled passenger train being built for the Boston & Maine R.R. by the E. G. Budd Manufacturing Company, which is to be powered by a Winton two-cycle, 660-horsepower Diesel. This engine will propel three stainless-steel cars, carrying 150 passengers, at a top speed of 115 miles per hour.

The problem which has faced the developer of high-speed Diesels has been complex because operation bases upon the use of slow-burning fuels. To better performance, designers have had to perfect fuel-burning systems which would measure out individual fuel charges, accurately proportioned to the load and in equal amounts to each cylinder, to be injected into the cylinders at just the right time and in such a near-gaseous state as to cause turbulence and complete combustion. That great progress has been made toward a satisfactory solution is evidenced by the performance of today's product.

Lumbering operations find wide uses for Diesel engines

IN the air-injection type, fuel is blown into the cylinder with a blast of compressed air, while in the solid injection type it is kept in a solid stream up to the point of injection. Variations in method of injection are not uncommon but they all aim at speeding up the combustion process and in the accomplishing of this the Diesel has become a more responsive engine, freer from vibration and smells.

It cannot be said that the Diesel of today can compare with the spark-ignition type of engine in smoothness of operation, speed of acceleration, or quick starting, and this must be weighed before forecasting the replacement of the spark-ignition engine in mobile vehicles, particularly passenger cars. At the same time, progress has been such that it would be foolish to say these handicaps cannot be overcome.



Diesel-electric installation in the streamlined *Zephyr*

It is logical to expect Diesel development where rapid acceleration, vibration, and easy starting are of paramount importance. And this is what we find. High-speed Diesels are going into railcars and meeting with great success. Who has not heard of the Burlington *Zephyr,* for example? This light weight, ultra-modern train, powered with a Winton 660 horsepower Diesel, covered the 1015 miles between Denver and Chicago in a non-stop run of 13 hours, cutting the normal running time in half and making a top speed of 112.5 miles per hour. Authorities predict that Diesels will play a major part in railcar development and that American roads will follow close on the heels of the European where Diesels have become prime movers for new equipment. Charles O. Guernsey, chief engineer of the J. G. Brill Company, builder of railcars, sums up the future of the Diesel as follows:

"THERE is probably no doubt that for high annual mileages where as much as 1000 miles per day may be reached, the Diesel engine will be the cheaper. It can be shown that for low mileages—200 miles per day or more, depending upon the amount of gas tax paid — the gasoline engine gives the cheapest over-all operation. For intermediate conditions, an analysis of each case is required to determine the most suitable equipment. There is no question but that for the larger cars and longer daily mileages, the trend is definitely toward the Diesel."

Another logical field for immediate exploitation is motor truck transport. Here again progress is being made. Within the past two years eight truck manufacturers—Gramm, Indiana, Kenworth, Kleiber, LeMoon, Marmon-Herrington, Sterling, and Ward LaFrance —have added standard Diesel-engined models to supplement their regular lines, and engine makers are offering Diesels for original installation or replacement.

Militating against immediate, widespread adoption of the engine is the fuel situation. Contrary to common belief, Diesels will not digest *any* fuel fed to them. With refinements in detail, they have become more particular about their diet and with the possible exception of kerosene there is no single fuel on the market which will satisfy them all uniformly. Where fuel supply can be maintained, excellent results have been obtained as the following two examples will show:

Pioneer Freight Lines boasts of making the round trip between Portland and Spokane, 800 miles, on 84 gallons of fuel as compared with 190 to 210 gallons of gasoline with a standard truck. The gross weight of truck, trailer, and load was 44,000 pounds, and with a 13-ton payload on the out trip and a 6-ton return load, this outfit maintained an average speed of 25.86 miles per hour. Power was supplied by a 4-cylinder Diesel rated at 100 horsepower. Here, the saving in the cost of a single round trip was 35 dollars.

ANOTHER hauler, Pacific Freight Lines, reports a saving of $51.80 in fuel on a round trip between Los Angeles and Fresno. This line operates 21 Diesels and has ordered 50 more.

These examples bring to the fore a fact of great importance. The Diesel consumes less fuel than the gasoline engine. And this is where the Diesel scores highest. The use of a cheaper fuel means little for the future since the price of Diesel fuel would tend to rise if there were heavy demand. Likewise, the avoidance of gasoline taxes means little for the future since taxes on Diesel fuels can be imposed at the will of legislatures. It is the smaller consumption which promises most for the Diesel and presages wider adoption for motor trucks.

Obviously, until fuel is more readily obtained there can be no overnight switch to Diesel propulsion and likewise fuel will not be standardized and placed on sale throughout the country until there is greater demand for it. Here is a jam which slows the rate of progress. Producers of engines and fuel are getting together, hoping to settle upon a standard for fuel and as this problem irons out the increased call for such fuel will create better sources of supply.

The foregoing indicates that the public is not going to ride around in Diesel-powered passenger cars for some time to come. Having become habituated to sensitive, reliable engines which will beat traffic lights at the slightest touch of the throttle and operate on fuel sold everywhere between these lights, the public has nothing to gain by switching, even if it could.

BEFORE we see Diesels in the hands of the motoring public we are more likely to see them propelling aircraft. While no airplane producer can be found who is pushing Diesel development at present—although Packard has a Diesel airplane engine—much attention is being paid to it by important research groups. The National Advisory Committee for Aeronautics, for example, has been investigating the two-stroke Diesel engine. And the Army and Navy continue to show active interest, because the low fuel consumption would afford wider cruising ranges and definite economic advantages on routes or flights exceeding 500 miles. Another advantage, very real in aviation, is the non-inflammability of the fuel used.

Certainly with the increasing interest in the Diesel and the devoting of more effort to its perfection, its use will grow. In the stationary power and marine field, its place is secure and the advent of the small, lighter-weight, high-speed type is giving a certain mobility to this power source. In railcar and motor truck transportation definite progress has been made but it promises to be some years before Diesels will cut any large figure in passenger cars. Here as in aviation much experimental research remains to be done before the Diesel becomes commercially feasible, but to state categorically at this time that the Diesel cannot dominate ultimately is to deny the experience of the past. There are people living who thought the "horseless buggy" a joke.

OUR POINT OF VIEW

The Death of the Death Ray

DEATH rays we seem to have perennially with us—in the newspapers. Yet there is no known "death ray," at least not in the sense which the sensational headlines and accounts intend to convey. Evidently we are asked to believe every now and then that some new kind of ray, always "diabolical," always "killing," invariably "mysterious," has been hit upon—something to make us shudder about the horror of the wars to be. People must, however, have become pretty well prepared by now to discount these frantic announcements, and most persons of scientific leaning are properly cynical about them.

Oddly enough the newest newspaper death ray really *is* a death ray—but, just to rob it of most of its inherent interest, it is not new. The Smithsonian Institution has given to the press a report of recent researches of its director, Dr. Charles G. Abbot, who has been doing some temperature measurement work on the stars. This is not exactly new work; it is old work done partly in a new way. In the course of its completion it involved that part of the radiation of the stars which is in the far ultra-violet range. These ultra-violet rays are, at least technically, death rays, for ultra-violet radiations shorter than those normally contained in sunlight will kill protoplasm. The sun emits them, as do the stars, but the ozone in the earth's atmosphere entirely absorbs them. Were this ozone suddenly removed life on earth soon would cease to exist. The existence of this protecting gas is sometimes called a miraculous intervention, and sometimes it is said to be a remarkable coincidence that the ozone cuts out just the rays which would kill us. More likely, however, is the fact that protoplasm, from the beginning of evolution on earth, adapted itself to the wavelength of the sun. It would have adapted itself to other wavelengths had these been the ones in the sun's radiation. (Someone once remarked that it must be a Divine intervention that put fine harbors immediately adjacent to the largest cities. There is a possible similarity between the two arguments.)

But the ozone *is* in the earth's atmosphere, and the sun's rays down on its surface where life has its abode do *not* contain any death rays, hence there is not after all any earthly death ray. What the newspapers are doing in using somewhat dramatic headlines ("Death Stars Found; Screen Saves Earth;" "Blue Stars Sending Death Rays; Ozone Turns them from Earth;" and so on) is to give their readers an opportunity to enjoy a slight thrill of horror at a safe distance, a game we all enjoy. It is not a very serious distortion of existing scientific fact. Even the conservative old Smithsonian Institution, in its publicity release, points to the same permissible scare-you-all.

As for real death rays of a man-made nature: In the sense that such rays are asserted to be really potent at distances employable in war, they simply do not exist.

What of the Railroads?

BEFORE long, Congress will convene; and doubtless in his message to that august body of savants the President will outline the "Deal" he desires the railroads to be given. In the meantime—what? The railroads, "trustees" of the life-insurance savings of millions of Americans and of other important funds upon which more millions depend, face a puzzling future. The present uncertainty retards all planning as well as the adoption of constructive measures for salvaging something of the wreckage of years of depression and legal curbs to prosperity.

Are we to have some sort of government ownership? Joseph B. Eastman, Federal Co-ordinator of Railroads, advocates such ownership in principle. He has discussed the railroads' plight with the President, but neither he nor anyone else has given an inkling as to the Administration's leanings or plans. Given either a yea or a nay, the railroads could begin to gather in the loose threads looking toward Congressional action this winter, could go forward hopefully and progressively if government ownership is not intended, or could take steps to protect both themselves and the public and could drop the present complicated plans for further regulation if the experiment is to be tried again. We say "again" advisedly for it must be remembered that it was tried, or was forced upon us, during the World War emergency.

What are the plans for the future of the railroad? They should be announced at once, for all delay is dangerous. It is one thing for the gradually awakening railroads to work toward a great rejuvenation through adoption of the latest scientific discoveries; and quite another if they know that such rejuvenation, so far as their individual enterprise is concerned, is but a dream—a dream for federal bureaucrats to dally with under government control. Aerodynamically designed trains, fast Diesel power, weight saving, stainless steel, welded cars, rebuilt road-beds for 100-mile-an-hour trains—all these are evidences of the vision now inspiring railroad executives but subject to the policies of the government. These, and a considerable amount of necessary railroad reorganization, are in line awaiting the word to go forward strenuously and determinedly or stop for a period of readjustment and modification.

Bootleggers in "Gas"

SOME of the racketeers who built up fortunes during the days of prohibition have turned to other fields. One of the most enticing is the handling of gasoline, as two sources of excess profit are possible. First, they can sell to the public inferior grades of gas under the label of some well-known brand, and second, they can smuggle gasoline from one territory to another, thereby either evading entirely the state and federal taxes, or at least avoiding the payment of part of such levies.

How the tax evasion method of smuggling works out in one instance is essentially as follows: Gasoline for export to another state can be bought tax-free in New York State. A large quantity of fuel is purchased for that alleged purpose. Since there is no adequate check-up system, the gasoline can be taken to another part of the same state and sold to retailers. The sale can be made at a slightly lower figure than in the case of an honest transaction, yet with a four-cent-a-gallon tax to be evaded, the margin of profit remains larger than can be had by an honest dealer.

All this is reflected in the pocketbook of the public. When taxes are evaded, the state and federal incomes from those sources are lowered, and the tax rate is correspondingly raised. Thus is started a vicious circle, because as tax rates are raised, the profit from bootlegging becomes greater, more gasoline is smuggled, less taxes are collected, and the public continues to pay the bill.

One answer to the problem is better law enforcement. Another is a more reasonable and uniform tax rate throughout the country. Make bootlegging of gasoline—or the smuggling of any other commodity—unprofitable, and the illegal operations will be reduced to a satisfactory minimum.

Leonhard Seppala shouldering the tusk of a mammoth, which he found

BEFORE WINTER

By ELLA WILSON HILL
Fairbanks, Alaska

WAS Alaska once a semi-tropical land? Excavations going on near Fairbanks, interior Alaska, may answer the question definitely in the near future. An ancient, buried jungle has been brought to view, disclosing large extinct members of the elephant family and other strange animals which played their living, eventful parts presumably thousands of years before man arrived in the New World. The finds prove that ancient Alaska once teemed with species of wild life now extinct, and that a lush vegetation existed.

"But," cautions Otto Geist, archeologist of the Agricultural College and School of Mines, Alaska's higher seat of learning, "scientists have not yet determined why some of the finds had long hair."

Sealed in the muck of a few square miles and, curiously enough, segregated into restricted sections or bone pits, there have been unearthed, among other fossils, mammoths, tiny horses' hoofs, super-bison heads in vast numbers, an enormous elk's antler, extinct bears, the rare mastodon, the largest ivory tusk on record, and, to excite the wonder of all, the skull of an African type of lion. The skull was "—distinctly leonine rather than tigrine," writes Childs Frick, well-known paleontologist.

Above: A mastodon and, *to the right on the facing page,* a mammoth. Both are from paintings made by Charles R. Knight under the direction of Henry Fairfield Osborn. These two related mammals are often confused but were different in many respects which are explained in the text

To make the picture of prehistoric Alaska clearer, it may be well to state briefly how these extensive excavations were made possible. The Fairbanks Exploration Company, with its piping system and huge placer miners' "giants," in order to reach bed rock where virgin gold lies, started removing an overburden of brush and solidly frozen muck running in some places to a depth of 200 feet. It was during this stripping process that the workmen commenced to pick up curious bones and fossil ivories. The officers of the gold company at once invited Dr. Charles E. Bunnell, President of the Alaska Agricultural College and School of Mines, to examine the specimens, and he in turn communicated with the American Museum of Natural History in New York. There Childs Frick became interested and investigated the site.

How the finds came to be exposed: Stripping off overburden with a "giant"

NO vandalism occurs in Alaska's bone pits; no ruthless ivory looting.

"Here you are, Bone Boys," a mine employee will grin; "take a look at this ante-Adam ensemble." Needless to say, such co-operation goes far toward solving North America's rich prehistory.

The discovery of an almost complete mastodon (Pleistocene) took place at one of the hydraulic placer workings at Chatanika, one morning at five o'clock. A call was sent to Dr. Bunnell, and the "bone men" were sent out without a moment's loss. The remains of this locally rare animal (only a single find

CAME TO ALASKA

Extinct Animals in Warm Prehistoric Alaska . . . Modern Excavations . . . Mastodons and Super-Bisons . . . Monster Tusks . . . Hairy Elephants . . . Reconstructing an Ancient and Spectacular Past

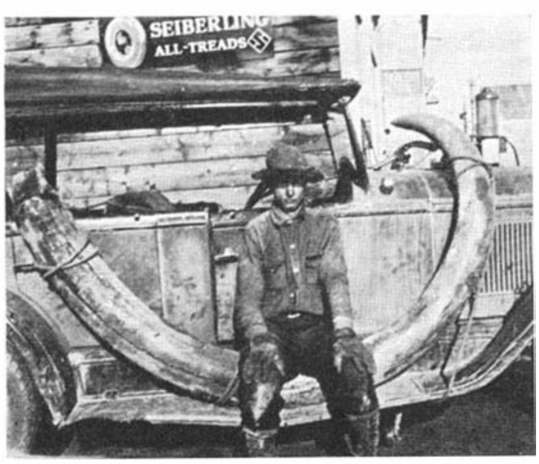
having been reported previously in Alaska) were discovered 50 feet below the surface and 40 feet above bed rock. The fore legs and feet were in an upright position, indicating that this extinct member of the elephant family met his death by sinking into a quagmire.

All of the men in the little town of Chatanika turned out to help. Excitement ran high. This was not just a gold stampede. These cheerful, sweat-streaked, bright-eyed, mud-bedecked pioneers were making history. Every bone, every tooth unearthed, called for a lusty shout. The early morning mastodon find is now listed in a bulletin of the American Museum as a new subspecies, and given the imposing name of *Mastodon americanus alaskensis*.

Leonhard Seppala, Alaska's dog-racing king, who made the "longest and fastest" historic antitoxin race with death, was one of the Chatanika boys who turned out to help save the bones for science. He may be seen in the illustration at the top of the page, leaning against a mammoth's tusk and admiring a super-bison skull found by a friend, though the modest and hardy Norseman made a find of his own—a 200-pound mammoth tusk, as shown in another illustration.

To scientists these gigantic ivory tusks are simply permanent second upper incisor teeth; ivory, just remarkably fine and elastic dentine. Professor Hendricksen and Wilson Walton, archeologists of the College, unearthed an incisor which measured 12 feet 11 inches in curved length, 26 inches in circumference at the base, weighed 295½ pounds, and proved to be by weight the world's largest tusk on record.

There was a marked difference between the mammoth, which thrived in colossal herds in ancient Alaska, and the rarer mastodon. Of the various forms of elephants—the group of mammals with a proboscis or trunk—the mammoth is in many respects the farthest removed from the primitive mastodon-like type. The mastodon is a much older form of life than the mammoth, having appeared in the Miocene Epoch, approximately 15,000,000 years ago, and

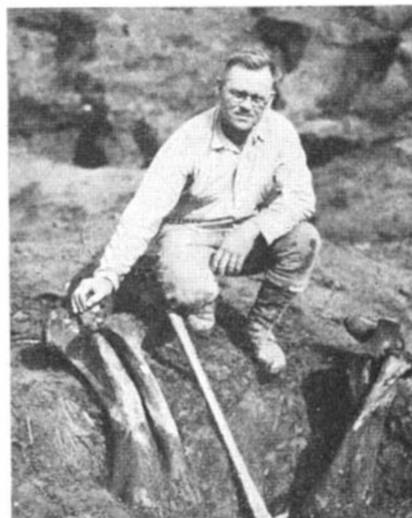


Leonhard Seppala with a mammoth's tusk and super-bison skull

having survived in parts of the earth up to the time when he may have been seen by man. Geologically speaking, the Miocene Epoch came before the Pliocene Epoch, and the Pliocene before the Pleistocene which is synonymous with the glacial epoch and is succeeded by the Holocene, Recent or Human, Period.

PHYSICALLY, also, great differences appear in these two extinct mammals. The mammoth's huge tusks, protruding from his upper jaw, were curved to as much as three fourths of a circle and in very old individual animals they turned inward and even crossed. This rendered them useless as weapons. The mastodon had shorter and relatively straight tusks in the upper jaw, and some species had short tusks about 18 inches long in the lower jaw as well.

From a scientist's point of view the most important difference seems to lie in the molar teeth. The mastodon had teeth with nipple-shaped projections



***Left:* Wilson Walton with record mammoth's tusk. *Above:* Prof. Hendricksen with bones of mammoth**

Skull of a super-bison, spreading twice as wide as the horns of the modern bison, or "buffalo"

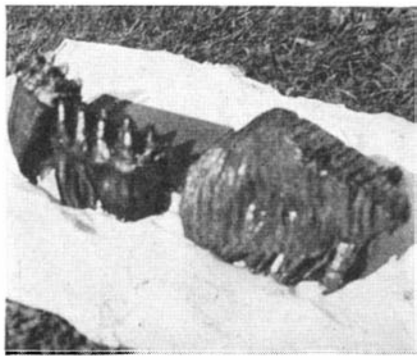
and simple roots, the cement in the intervening valleys being atrophied, while the mammoth had long, rooted teeth, flattish on top, reminding one of a child's washboard.

To those who are not especially interested in the nice distinctions of molar teeth, more obvious dissimilarities between these animals would appeal. For example, the mastodon possessed a decidedly receding forehead, while the mammoth was a highbrow in looks, though his forehead was developed not to hold brains, but to inclose the base of his immense tusks, and was mostly bone and sinuses. Even though the mammoth's high brow contained a comparatively small amount of gray matter and an enormous amount of ivory, the massiveness of the skull and its height in front must have given him a kind of scholarly look.

STANDING together (if they ever did), these two extinct mammals must have exhibited a striking contrast. The mastodon was just plain brown, and in size—though not in appearance—compared favorably with the existing Asiatic elephant, the male of which weighs in the neighborhood of three tons and reaches a height of 10 feet. Clothe the circus elephant in an inch thick coat of soft blond or brownish yellow hair and a formidable 20-inch rust-colored mane, insert through his upper jaw and about a yard into his head a pair of 200- to 300-pound incisor teeth, and you have approximated the great mammoths which moved in thundering herds across ancient Alaska and left their huge bones under our feet.

These herds of extinct mammals were herbivorous, which pointed to the fact that prehistoric Alaska was lavish in her supply of foliage. Supporting this theory there was found the lower jaw bone of an aged mammoth, in which the molars had been extruded and the tooth sockets healed over years past, yet the animal lived on. This indicates lush subsistence and a long, comfortable old age.

In a mammoth's molar, worn down to half its size, yet as bulky as a building brick, were found fresh looking pine needles, and caught in the great grinding surface of another molar, still rooted deep in the jaw bone of a mammoth, was some perfectly preserved green grass. Within the same general area and about ten feet beneath the surface were discovered the broken stumps of an ancient forest; and in other parts of Alaska associated with mammoth remains have been found large trees where now the soil is barren and the subsoil frozen throughout the whole year.



Teeth of the mastodon (left) and mammoth (right). The word mastodon means "nipple tooth," the chewing face being made of separate peaks. The animal browsed on leaves and twigs, mammoths ate grass

Strange and spectacular pictures come to view in Alaska's Pleistocene layer of earth. Before the coming of Columbus, horses, which originally evolved in America, were extinct there, but they roamed in ancient Alaska along with mammoths, mastodons, and great bovine herds, super-bisons whose spread of horns reach over twice the size of the American bison or buffalo. Bones belonging to horses large enough to haul a dray, and ponies' hoofs so tiny that one could rest in the palm of a dainty feminine hand, were picked out of the muck. Elk were thought never to have existed in Alaska, but Otto Geist and Peter Kaisen of the American Museum staff unearthed and photographed a single elk's antler measuring nearly five feet in length.

For the first time the great American lion is shown in Alaska's Pleistocene deposits. The skull was not that of a saber-toothed tiger—which, owing to its more northern range, might have been expected. Paleontologists point out that lions, originally of northern origin, may later have followed fat game herds to equatorial regions. Perhaps, they also suggest, the shaggy mane of the African lion, like the wooly forequarters of the bison, are remnants of a former frigid habitat.

TO-DAY truck loads of ancient bones, including "five peck" skulls, are being hauled along the college road at Fairbanks, but in all of Alaska, through deposits of the Pleistocene Epoch, no human bone has been discovered. Alaska's nearly 600,000 square miles seem to have belonged to animals in the restricted sense. Man was evidently not there to discover that the peculiar dentine of the mammoths' and mastodons' incisors had great commercial value. There were no Siberian hunters to covet the "white gold" teeth; no Chinese artists to admire the fine texture and exquisite, pale tint of the ivory. Oblivious to future man, these monsters lived in countless multitudes, played their parts here where moose and caribou are today seen crossing the very college campus, and made their exit, it is estimated, 100,000 years before man.

Skull of a mammoth. The author may be seen at the extreme left, bending over. Next stands Howard Thompson, of the United States Weather Bureau, and below is Captain McClelland, meteorological officer, United States Air Service

Drawn especially for Scientific American by Logan U. Reavis

Engineering Projects in the Southwest

THE Colorado River Aqueduct, Boulder Dam, and appurtenant projects have been described in past issues of Scientific American. The above drawing serves to show the geographical relationship between these huge developments and other projects under way in or planned for the Southwest. The data were supplied by the Department of the Interior, Bureau of Reclamation. The shaded portions of the Colorado River Aqueduct indicate the general location of tunnels, of which there will be 46, totaling 85 miles in length. The All-American Canal with its Coachella Branch will supply water to the Imperial and Coachella Valleys and will have a maximum section of 232 feet in width at the water line, 160 feet in width at the bottom, and 20.6 feet in depth. At Pilot Knob, seven miles west of Yuma, also at four drops in level of the canal, there will be opportunity for the development of 60,000 kilowatts of hydroelectric power. Of the 165,000,000 dollars provided for the construction of the entire Boulder Dam project, 38,500,000 dollars is to be allotted to the canal.

COULD A MANNED ROCKET

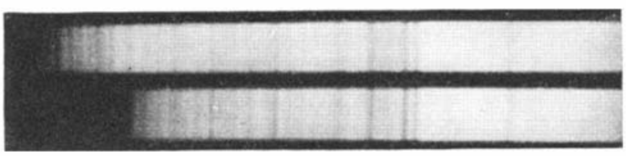
By HENRY NORRIS RUSSELL, Ph. D.

Chairman 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
Retiring President of the American Association for the Advancement of Science

THE study of the heavens touches a surprising number of affairs on earth—matters of fancy as well as of fact. For centuries, writers of romance have made bold from time to time to imagine voyagers leaving our planet and launching out boldly into the depths of space. What they find on their arrival in some other world does not concern the astronomer—except as he may individually enjoy fantastic adventures or social satire. How the imaginary travelers got there, indeed, is more in his line—for which reason he is usually likely to laugh, or groan, according to his temperament, and wish that the author had been less explicit. Too often some physical absurdity obtrudes itself and destroys for the moment, if not for good, the sense that "a tale is true while the telling of it lasts," which is the very life of fiction.

For a few of the best stories the illusion stands the strain, even for the technically informed reader; for example, in Jules Verne's "Voyage from the Earth to the Moon," and above all in that masterpiece among all imaginative romances, "The War of the Worlds." In both of these the voyage is made in great projectiles shot out from some vast gun, and then moving freely through space.

This notion, old as it is, tempts the imagination. There is certainly nothing absurd in the conception—though human ballistics are at present quite inadequate to the task—and the fate of the shell, once fired, can be discussed as a really scientific question. Some of the results are so simple, and yet so far from obvious, that we may be forgiven if, for this once, we turn from real problems to purely imaginary questions.



An interesting pair of spectra, not connected with Professor Russell's present article, but reproduced because available at the time. They pertain to the new aluminized or evaporated aluminum mirrors for telescopes, which permit astronomers to photograph the spectrum considerably farther into the ultra-violet than previously. Bottom spectrum reflected from silver mirror, top one from aluminum. Both are shown cut off in middle, at the green (right end). Kindly furnished by Dr. John D. Strong, of the California Institute of Technology, who has been largely responsible for the development of the evaporation process for aluminum and other metals

WHAT would be the best way of firing a projectile to reach another planet—for example, Mars? How should it be aimed? When should it be discharged, and what minimum muzzle velocity would be required to make success possible?

The great obstacles, as everyone knows, are two: the earth's gravitational attraction, and the resistance of the air at the start. For the moment let us forget them both, or a least postpone their consideration, and consider a simplified problem. Suppose that we inhabited, not our large and air-cloaked planet, but a little asteroid pursuing an orbit just like the earth's. Waive the question of how we could keep alive—suppose that we could, and that we had at our disposal resources of present human engineering and gunnery. We would have no air resistance, and the attraction of our little planet would not bother us seriously. What could we hope to hit?

If we ignore, too, the attraction of the planet which is our target, the problem becomes an easy one, involving only the laws of planetary motion. The formula for calculating the velocity of any body —planet, projectile, or meteorite—moving in an orbit about the sun, is so simple that, with due apologies, it is written here:

$$V^2 = C\left(\frac{2}{r} - \frac{1}{a}\right).$$

V is the velocity in the orbit (relative, of course, to the sun); r the distance of the body from the sun, and a the "mean distance," which is the average of the greatest and least distances in its elliptical orbit; while C is a constant. If we take the earth's distance from the sun as a standard for a and r, and measure our velocities in kilometers per second, $C = 866$. For the earth at its average distance, r and a both equal 1, so $V = 29.76$ kilometers per second. In what follows we shall neglect the small eccentricity of the earth's orbit, but Mars has too eccentric an orbit to neglect. His mean distance is 1.524 (the earth's mean distance being taken as unity) while his actual distance ranges from 1.382 at perihelion to 1.664 at aphelion. Our formula shows at once that his orbital velocity is 26.50 kilometers per second in the first case and 21.95 in the second.

If our projectile, after it leaves our asteroid in the earth's track, is moving slower, compared to the sun, its mean distance will be smaller, and most of its orbit (though perhaps not all) will be inside that of the earth. This is a poor way to aim at Mars. We must evidently aim our gun so that the shell will move faster around the sun than the gun itself. The best way to do this is obviously to point it *forward*, directly in the path of our planet's orbital motion. Our projectile will now move in an orbit with a greater mean distance than the earth. When it started it was going at right angles to the sun's direction and at distance 1; hence all the rest of its track will lie outside the earth's orbit, and we are doing better.

As we increase its velocity its orbit will extend farther and farther from the sun (on the side opposite to the point of firing) and at last will get out as far as Mars. We will do best to choose the *nearest* point on Mars' orbit as our target, when we will get the situation shown in the diagram, which is drawn accurately to scale.

The greatest distance of the projectile's orbit from the sun is equal to the least distance of Mars. The mean distance is the average of this and the earth's distance; that is, 1.191. Our formula now shows that, relative to the sun, our projectile has a speed of 31.80 kilometers per second at perihelion (P_0 in diagram). This is pretty high, but it is only 2.04 kilometers per second greater than the earth's velocity. By the simple device of pointing our gun "forward"—that is, to a point on the ecliptic 90 degrees west of the sun—we thus get almost 94 percent of the required speed from the orbital motion, and have to demand only a little over 6 percent from our gun.

REACH MARS?

Courtesy American Museum of Natural History

Mars from its inner satellite, as conceived by Howard Russell Butler on the basis of areographical study

Had we been so foolish as to shoot in the opposite direction, we would have required a muzzle velocity of 61.56 kilometers per second—or 30 times as great!

Even at best, the minimum velocity of 2040 meters, or 6700 feet, per second, is high enough. But according to such reports as were made public, the gun which, during the World War, bombarded Paris from within the German lines must have had nearly, if not quite, as great power.

If it were not for the earth's gravitation and the resistance of our atmosphere, a slightly improved "Big Bertha," would suffice to bombard Mars!

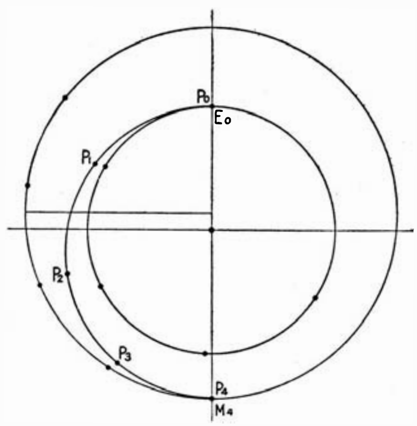
At its aphelion our projectile would have a speed of 23.92 kilometers per second, while that of Mars is 2.58 kilometers greater. Mars would therefore overtake it, and to a Martian it would appear to fall from the heavens ahead of the planet in its orbit.

THE time of flight is readily found by Kepler's third law to be 237 days, or almost eight months. The position of Mars, the earth, and the projectile, at intervals of two months, are shown in the diagram. At first the shell moves faster than the earth, but as it recedes from the sun it slows up, and at the last it is going slower than Mars.

At the time the shot is launched, Mars is nearly in the line of fire, but this would not be the case for a more distant target such as Jupiter. It would be possible to reach any other portion of Mars' orbit by increasing the velocity of the shell. Using a formula once more, it is found that to reach the aphelion of Mars we would require a muzzle velocity of 3.57 kilometers per second. This would make much severer demands on our artillery, but the shell in this case would reach Mars with a relative speed of 1.98 kilometers per second, so that a Martian gunner wishing to reach the earth would do best to shoot backward, at his planet's aphelion, at this speed.

When the gravitation of the earth and of Mars is considered, things look very different. Even in the absence of all air-resistance a velocity of 11.4 kilometers per second would be required to send a projectile from the earth's surface just clear of its attraction. A small increase above this limit would give it energy enough to escape with a good speed; for example, an addition of only 6.18 kilometers would produce the 2.04 kilometers at a distance which we have previously discussed. (This follows at once from the consideration of kinetic energy.) The atmosphere would exert an enormous resistance on so rapidly moving an object, but exact allowance for this would be difficult. Even without it the velocity demanded is far greater than has been attained or seems likely to be attained by any terrestrial device, so that the whole matter remains for the present in the realm of the imagination.

Even if we were back on our asteroid we would have a hard job to hit Mars, for it is a small target at that distance.



Path of a projectile from the earth to Mars, drawn accurately to scale

Even a small change in the muzzle velocity will cause the orbit of the projectile to enlarge, so that P_4 lies outside M_4 in the diagram, and the planet, as it overtakes it, will pass inside without a collision. A very simple application of calculus to our formula shows that a change in the velocity V of one centimeter per second will shift P_4 by 81 kilometers. The diameter of Mars is only 6700 kilometers. If our gun sends off its shell with a speed as much as 18 inches per second too great or too small, it will miss the planet altogether. No such precision, of course, is within the reach of present-day ballistics.

Curiously enough, the accuracy required in the direction of aim is not so exacting. A slight deviation outward at E_0 would cause the projectile's orbit to lie outside the platted track for almost all its course, but it would recross very near P_4, and so would stand a good chance of being hit from behind by Mars. The same would be true of an error in aiming up or down—outside the plane of the ecliptic—provided that Mars too was exactly on this plane. When he was not, serious additional complications would arise, which need be no more than mentioned here.

Any exact calculation of the path would have to take all sorts of things into account—the motion of the gun arising from the earth's rotation, the attractions of the moon and of the planets, and especially that of Mars as the shell came down. It would be an appalling task, even if the initial motion were precisely known.

Mr. Wells, in his great romance, makes a dozen or so shells containing live and very formidable Martians, fall on successive nights within 20 miles of London. The technical skill required to bring this about is certainly superhuman, but the Martians of the story showed plenty of other evidence of that.

It is almost a pity to point out that they could hardly have been fired off alive. To escape from Mars demands a velocity of 5 kilometers per second—to reach the earth, 5.4 kilometers. To get up this speed, even in a gun ten miles long, would demand an average acceleration a hundred times that of terrestrial gravity—which would crush and flatten out anything bigger than an ant, if not a microbe. The shock on hitting the earth would be still worse.

TO offer such arguments as criticism of a great novel would be folly. But there is really no hope at all that living things could be shot through interplanetary space. Rocket ships might imaginably do better, though their success seems very remote. There is no hope, either, that such creatures as we are could survive at all on any of the planets. But, even if some future ship could carry "fuel" for a round trip, its pilot would do well to follow the traffic lanes which have here been sketched.—*Mount Wilson Observatory, Pasadena, California, October* 1, 1934.

How Chemistry

Food Sleuths Stop Flour Spoilage . . . Olives Given Clean Health Bill . . . Chlorine Gas Saves Lives . . . Cautions For Home Canners . . . Truth in Canned Food Labels . . . Constant Vigilance Necessary

PREPARED flour in kitchen cupboards and on grocers' shelves turned brown, took on a rancid taste . . . went bad. Within a few weeks the perplexed manufacturer witnessed his business slipping away, for careful shoppers no longer would buy his attractive packages. In desperation he turned to a chemist.

"Find the trouble," he demanded, "and stop it!"

Professor Arthur R. Maas, a Los Angeles consultant who has trailed many invisible culprits of chemistry to their obscure lairs, smelled the flour. It proved to be rancid, but that was an effect and he was interested in causes. Then one by one he ran down the individual ingredients: powdered milk, flour, baking soda, salt, shortening.

Individually they proved themselves not guilty, but Professor Maas found a trace of copper in the milk. What had happened? When the ingredients entered the package the copper, being a catalytic agent, slowly oxidized the fats in the shortening. In time thousands of packages of the prepared flour became unfit for human consumption.

"Here, as in many foods," Professor Maas told me, "the constituents were harmless. Taken together, however, they permitted a chemical action which spelled trouble. Copper entered the milk from the mixing kettles, a source which the manufacturer had not suspected." The trouble was rectified, and now the product is as pure as man can make it.

This case is only one of many. Bacteria, yeasts, and molds, the three bad boys of chemistry as it relates to food products, march ever forward in their attacks on the nation's supply of food in its many forms.

In the background stands an army of chemists who throw their forces periodically into the counter attack, beating back these one-celled plants which multiply by budding and splitting into smaller plants, and the many-celled branching fungus plants which multiply by spores.

Yesterday olives spread death by carrying to their victims botulinus poison. The responsible bacteria entered the olives from the soil. Tomato puree blossomed with ugly mold, which spread rapidly over its red surface. Canned orange juice contained excessive acid and was too heavy. Innocent chocolate eclairs, though fresh from the ovens, spread disease among thousands.

TODAY, the chemist stands behind the nation's food supply, guarantees its purity. The manufacturer tells you truthfully what is contained within his labels or the majesty of Uncle Sam's food and drug laws and the health departments of various states draw up the heavy artillery to support the chemical brigades.

Behind the shelves of retail stores these scientific sleuths search constantly for chemical wrong-doers. Acting as detectives, prosecuting attorneys, juries, and judges, they sometimes convict whole chemical gangs, while again they fasten their fingers on lone culprits.

In my search for some of America's outstanding, though little known, cases where the chemist saved the health of thousands who otherwise would have eaten products made from spoiled food or foods which had changed in character since manufacture, I found some brilliant examples of super-sleuthing with test tubes and microscopes.

Only in recent years have scientists been able to study the problem of food poisoning intelligently. Now they recognize two general types. The more common—and more deadly—is botulinus poisoning, once erroneously known as ptomaine poisoning. Here the bacteria usually enters the food while it still is in the soil. In the second type the con-

Above: **At every step in the preparation of quality brands of canned foods, chemists make tests for purity. Here a laboratory test is being made to determine the acidity of one brand of canned spinach**

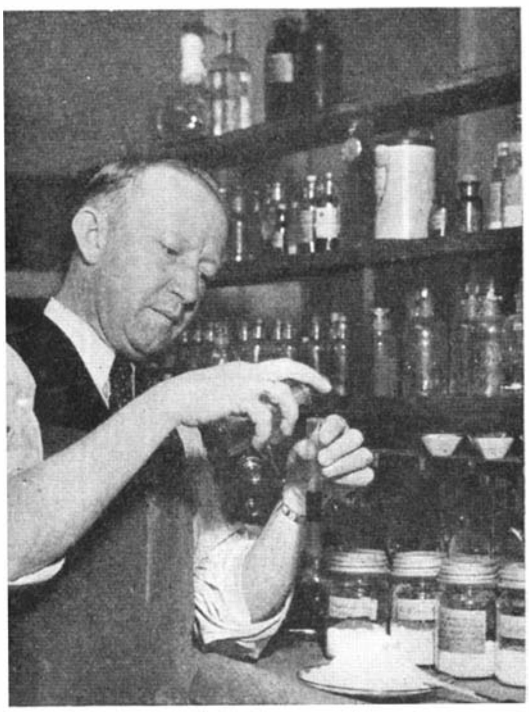
Left: **The microscope reveals the presence of objectionable spores in tomato puree which had developed a mold. With this information, future products may be kept pure and free from the undesirable spores**

Guards Your Health

By ANDREW R. BOONE

Right: Too great a percentage of solids in fruit juice may militate against complete preservation. Professor Maas applies a hydrometer test to canned juice

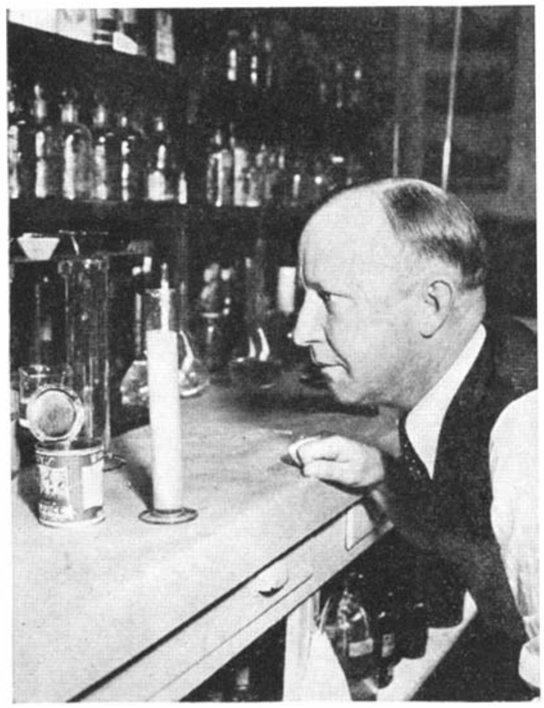
Below: Testing a prepared flour, which had gone rancid, for the presence of copper. The metal acted as a catalyst and oxidized the fats used for shortening



taminant usually reaches it through animal or human carriers, generally because of inadequate sanitation.

The expression, "ptomaine poison," is now almost obsolete, and ptomaine is perhaps the rarest of food poisons. It comes from the Greek "ptōma" meaning corpse. Medical men agree the term "ptomaine poisoning" should never be used.

One historic case of botulinus poisoning occurred after a score of men and women, some of them famous in national affairs, had gathered around the banquet table of a western host. They ate and drank and made merry—and a week later the city was saddened as several went to their graves, victims of a deadly poison. Within a few weeks an epidemic of botulism swept over the United States carrying scores of people to their deaths. In every case the fatal



illnesses were traced to canned olives.

Field agents for the Department of Agriculture's Food and Drug Administration bought samples of every known brand. They soon narrowed the culprits down to two packs, from western plants. So serious had the epidemic become meantime that the olive industry languished. But the deaths may have proved a blessing in disguise, for the cause was found: a toxin-producing anaerobium which entered the olives from the soil.

Preventive steps were quickly taken. The chemist prescribed a simple remedy: sterilization of the vats in which the olives soak before being canned, with a solution of chlorine strong enough to kill the bacteria, and today you may feel free to eat olives without fear of ill results. To make absolutely sure the chlorine does the job, however, chemists periodically slice open olives from the pack and make check tests.

Chlorine gas took thousands of soldiers' lives during the World War, but today it saves lives by killing the microscopic "bugs." These "bugs" are present in all foods, some being harmful, and others good. In the examination of certain canned products, such as tomato puree, the chemist usually can learn from the bacterial count whether the finished product was made from unclean, spoiled, or over-ripe material.

Widely separated cases of botulism prove the necessity for cleanliness both in commercial manufacturing and home cooking. A California man, after an automobile journey, complained of trouble with his eyes, then double vision, and finally loss of speech and inability to swallow. On the fifth day he died. These symptoms are typical of botulism, but where he encountered the cause could not be determined.

Another outbreak resulted in the death of two men. They had eaten liberal portions of homemade chili sauce with abalone steaks. When taken to the laboratory for testing the material was found to be unusually deadly, and chili sauce was added to the growing list of foods which have proved themselves possible conveyors of the botulinus toxin.

"In fact," Professor Maas told me, "we find the heat-resisting spores of bacillus botulinus practically everywhere. Absence of air and presence of food favors the growth of these germs when they become sealed in a jar or can of food which was not properly sterilized at the time of canning."

MANUFACTURERS throw all known safeguards around preparation of foods, which accounts for the rarity of such cases nowadays, but in the home . . . housewives, the California State Board of Health points out, should thoroughly boil all home-canned vegetables and meats for at least 30 minutes before tasting or eating. The board also recommends that when canning these foods they be cooked under steam pressure which will reduce the loss from spoilage as well as prevent illness, or worse.

In less serious forms of poisoning, the "bugs" may enter the food during or after manufacture—usually afterward.

Several school children, teachers, and parents of a western city recently became ill. Chocolate eclairs were suspected. When inquiries were made throughout the city, it was found all

Left: **To insure that dried spinach will be free from injurious properties, it is fumigated in long indoor ovens**

Below: **A sterilized platinum wire probes the interior of an innocent appearing eclair. A culture made from the custard revealed the presence of staphylococci which had made consumers of the delicacy ill**

the eclairs came from the same bakery. When the chemist plunged a sterilized platinum wire into the custard and took a culture he found the eclairs were heavily infested with staphylococcus germs. Several cats, it was learned, had access to the inside rooms of the bakery through a broken screen. Here was the source of contamination—one which was easily checked.

The fight for healthful foods is eternal, and you can be sure Uncle Sam means business in enforcing the food and drug laws. One manufacturer labelled cheap extract of ginger as "liquid medicine in bulk," and shipped it to customers in other states. Government chemists found the stuff contained "jake" poison, and was weak in Pharmacopoeia strength. Two years in prison and a heavy fine were that gentleman's reward.

Another sold an "improved" wine of cod-liver oil, which is bought for its vitamin values. Uncle Sam's inquiry showed vitamins A and D absent. Again the cheating manufacturer paid the penalty.

Better magazines, newspapers, and radio stations require that preparations affecting health be submitted for analysis before an advertising campaign is commenced. The government does not censor the advertising or pass on the formula, however. The manufacturer writes his own label, then Uncle Sam checks the product chemically.

Government agents shop constantly for food articles and submit them to federal chemists. Not long ago one of these investigators purchased a can of tomato puree—and found objectionable spores, the result of using defective fruit. This manufacturer unwittingly had violated a "must not" of the law by putting into his product something harmful. Another advertised that a concentrated food contained "all the body-building elements," but no vitamins were found. Both were forced to withdraw their products from grocers' shelves.

SOMETIMES minerals prove very harmful to plants, making the fruit unfit to eat. Thus plants often require water as pure as that which humans need. Black alkali is a destructive substance in irrigation water. One part in a thousand of this caustic slowly poisons the land. White alkali, containing sodium chloride or sodium sulfate, also wreaks havoc on both fruits and vegetables. Dates, figs, oranges, lemons, and all kinds of vegetables are checked constantly to detect the presence of any "blight" or bacteria resulting from such causes.

The chemist identifies the causes of food spoilage through his microscope as easily as he recognizes horses or people, and soon knows whether he is dealing with molds, bacteria, or yeasts.

A producer of canned spinach found his pack acquiring too much acid. Analysis revealed that bacteria were attacking it. Chocolate candy literally exploded. Yeast was doing to it what it does to bread dough—harmful in one case, beneficial in the other. Bread turned ropy, shot through with wild yeasts infesting the air in an otherwise clean plant. Another baker's bread spoiled in the wrappers, molds taking their toll. Bacteria, yeasts, and molds are everywhere, and only constant vigilance keeps the nation's food supply clean and sweet.

Long sterile rubber aprons and constant attention to cleanliness in every step of the handling of oranges by these workers safeguards the health of the public

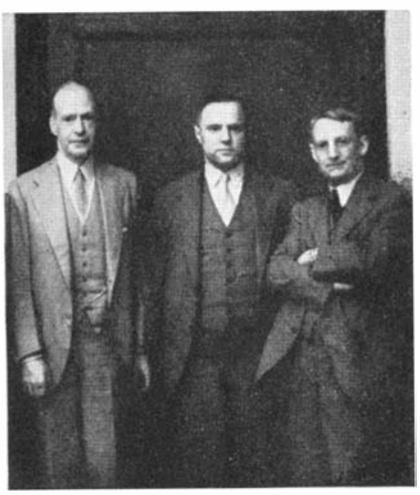
ADVANCED AMATEUR PHOTOGRAPHY

INFRA-RED AND ULTRA-VIOLET

By ALBERT G. INGALLS

THERE are several strictly utilitarian uses for infra-red and ultra-violet photography. With the former, distant landscapes may be photographed through a haze that renders them wholly invisible to the eye, or the worker may go a-sleuthing and photograph doubtful documents; with the latter there are fluorescence photography, astronomical photography, and photomicrography for extreme magnification. With both methods photographs may be made in the dark.

Most of the utilitarian purposes are largely professional, which means no more than that the intelligent amateur can learn to use them fully as capably as the professional does. But as a starter, the majority of readers are likely to try something simple, and will do it just for fun. This may be what we are living for, anyway, hence no apology is needed for it. So we shall try taking an infra-red photograph in the dark, and later we shall try an ultra-violet picture, equally in the dark. The latter is not difficult but is considerably more complicated than the former.



Infra-red photograph. Total darkness. Tungsten lamps with filters

Obtain some Eastman infra-red sensitive plates, Type 1-R, to fit your own camera. No special camera or apparatus is required. Stand an electric flatiron on end and turn on the current, set the diaphragm at *f*.4.5, entirely darken the room, and open the shutter. Expose for five or ten minutes—longer if a smaller stop is necessary. Develop the picture.

You knew in advance that it was possible to do it, but there is quite an unexpected kick, is there not, in discovering that it will really perform for you as well as for the professional?

The next stunt may be indirect infra-red photography. Set up one or two hot flatirons facing some object and expose much longer—say an hour at *f*.4.5. You may have to make a few trials before you work out the correct exposure time with the set-up you are using.

You may, of course, do both of these things with other heat sources: a hot iron or hot plate or a Sunbowl lamp, but with none of them heated enough to glow visibly if you want to be able to say you did it in the dark.

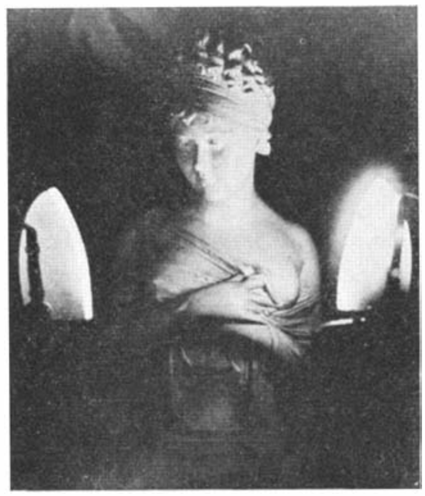
Suppose you next try photographing a group of persons, or one person, in the dark. Here the source of radiation is preferably common tungsten filament lamps, a lot of them—about 1000 watts per hundred square feet of floor space. To do it in darkness, however, will require a filter to stop all the visible rays. Use Wratten No. 87 filters over all of the lamps. Exposure: Try one second at *f*.3.5, which would mean two seconds at *f*.4.5, and so on in proportion to size of opening available. This stunt is more difficult to set up than the others, but is more fun. At a party, for example, you photograph everyone in total darkness, or elsewhere you may try a bit of Sherlocking—if you can find a way to make the persons you are sleuthing stand or sit or remain still.

PERHAPS next, try infra-red photography out of doors. You must first exclude all the visible light from the plate or it will not be infra-red photography. A Wratten filter No. 25 will be suitable for this, or else a Tricolor Red, or an *A* filter. You will have to experiment again and feel your way, but a first trial may be at 1/50 to 1/5 second with stop *f*.4.5. As you ordinarily will try this in bright sunlight, 1/10 second may prove to be about right. Focus in the normal way. Develop as for panchromatics.

The landscape, as photographed, will seem weird and spooky and unreal. The sky will photograph black because it is relatively lacking for rays which affect plates made for the red end of the spectrum. Leaves of vegetation will be white because they reflect infra-red wavelengths much better than visible ones. Shadows will be deep.

By the time you have practiced with a few of these stunts you will feel a lot like an advanced amateur photographer, and may want to perfect your skill as far as this is possible. Special developer formulas, hypersensitizers and so on, are available for such workers, but one can do most of the things described without more trouble than that required to buy special plates and a special filter.

Ultra-violet photography is not so simple as infra-red work. There are two methods: (1) In the "reflected" method use a mercury arc lamp covered with a filter (Ultra No. 586, Corning Glass Works, Corning, N. Y.), ordinary camera, and Eastman 33 plates, and expose about one minute at *f*16. (2) In the "fluorescent" method use same lamp and same filter. Cover camera lens with Corning Noviol O, No. 306, 4-millimeter filter, optically surfaced. Use Wratten panchromatic process plates and expose 20 minutes at *f*.4.5 when 20 inches from object. This method is the one used in deciphering altered documents. It actually does its work in visible, though faint, light; that is, in fluorescent light, which is ultra-violet radiation with its wavelength transformed (lengthened) until visible, by the substance of the object.



A bust, photographed in radiation from two hot but invisible irons

Most of the above data on ultra-violet work are included merely to give a rough idea, and the worker will doubtless require some study of detailed sources of information. He will also require patience, a good temper and a better lined purse than infra-red photography will ask of him.

NEAR ABSOLUTE ZERO

IN the Quest of the Absolute or Real Zero Temperature, Known to be 273 Degrees Centigrade or 459 Degrees Fahrenheit Below Our More Familiar "Zero," Scientists Have Now Come Within One-Twentieth of a Degree of Their Long-Sought Goal

By J. G. CROWTHER
London
Author of "An Outline of the Universe," "Science For You," "The Progress in Science" and other books

DURING the last 12 months two first class advances in low temperature physics have been made. Professor Peter Kapitza, the director of the Royal Society Mond Laboratory at Cambridge in England, has succeeded in constructing a new type of machine for liquefying helium. His machine makes the preparation of relatively large quantities of liquid helium much easier and cheaper than before, so that large quantities of liquid helium will soon be within reach of anyone who constructs a replica of this machine.

The other first class advance has been made by Professor W. J. de Haas of the University of Leyden, Holland, who has made experiments in which temperatures within one-twentieth of a degree of absolute zero have been reached. The lowest temperature reached by earlier methods was Keesom's seven-tenths of a degree above absolute zero. The measure of de Haas' remarkable advance is given by the consideration that seven-tenths of a degree is 14 times as high a temperature as one-twentieth of a degree above absolute zero. The measure is given, not by the difference but by the division of the two temperatures. Another illustration can be made by comparing the effect with a similar fall in another part of the scale of temperature. In the attempts made by Faraday to liquefy oxygen 90 years ago, the lowest temperatures reached were about 168 degrees on the absolute scale, or about 100 degrees Centigrade below the freezing point of water. Fifty years later, scientists had produced temperatures of about 12 degrees above absolute zero, a limit about 14 times lower than Faraday's. Keesom's minimum of 0.7 degrees absolute was reached in 1929. Hence after five years de Haas has pushed the lower limit of temperature down the scale through a drop comparable with the drop achieved by his predecessors after 50 years of research.

What is the practical value of research at very low temperatures? The consequences of it in the future will almost certainly be very great. The industrial and military importance of processes conducted at the temperature of liquid air is already large. The use of gaseous oxygen compressed in cylinders is already being superseded by liquid oxygen, which is so much more compact, and can be transported so much more economically, because no heavy steel cylinders are needed to contain it.

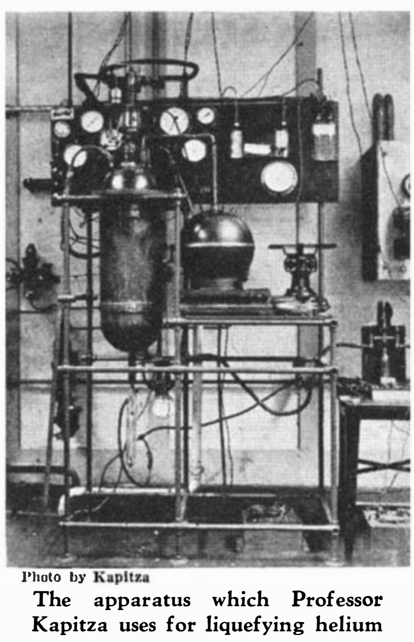


Photo by Kapitza

The apparatus which Professor Kapitza uses for liquefying helium

The separation of gases by boiling at low temperatures is already used on a vast scale in the manufacture of various industrial products and explosives.

But the great applications of the future will probably be connected with the phenomenon of super-conductivity. When various substances are exposed to a very low temperature, their resistance to electricity suddenly disappears. Research may discover how to produce perfect electrical conductors at relatively high temperatures, say at the temperature of liquid air. What would happen to electrical engineering if perfect conductors could be preserved by a product such as liquid air, which could easily be provided in vast quantities? Shall we have non-resistant cables, filled, not with metals, but with some peculiar salt, and surrounded by a pipe containing liquid air? When humanity has gained control over natural phenomena between 0 degrees and 10 degrees absolute, it will probably conduct in that region a large part of its productive activities.

BEFORE giving an indication of the chief methods of obtaining very low temperatures, some features of Kapitza's apparatus may be described. As the photograph at the left shows, his apparatus is quite compact. It is very much smaller than the complicated apparatus and heavy machinery previously necessary for the production of relatively large quantities of liquid helium. The practical differences between large and small quantities of liquid helium may be appreciated when it is explained that some of the expert research workers whose work is only possible through the use of liquid helium, have never in their lives seen liquid helium. This is because in all of their experiments they had produced the liquid helium within metal tubes, through which it was not visible to the eye. Their knowledge of the existence of liquid helium in the tubes depended entirely on their observation of its effects, not of itself. One of the advantages of the preparation of liquid helium in relatively large quantities is that it can be handled in glass apparatus which allows direct optical observation of its effects.

After the preliminary cooling of the helium gas to the temperature of liquid nitrogen, Kapitza's apparatus will after 25 minutes' working begin to liquefy helium at the rate of two liters, or about two quarts, per hour. About one and a half liters of liquid air are consumed during the preparation of each liter of liquid helium. This is a minimum performance, and in the future the rate of production will be very much increased. But even this performance compares very favorably with the original method of preparing liquid helium, which, according to Meissner, requires the consumption of five liters of liquid hydrogen in addition to six liters of liquid air for the production of one liter of liquid helium.

What is the principle of Kapitza's apparatus? It is the invention of a reciprocating engine which will work at any temperature down to absolute zero. Hitherto, no reciprocating engine has been made which will work at a temperature lower than that of liquid air, which is about 100 degrees above absolute zero.

THE difficulty of making a reciprocating engine work at low temperatures is familiar. Everyone knows that in cold weather the pistons stick in the cylinders of automobile engines, owing to the thickening of lubricating oil. At very low temperatures the difficulty of preventing a reciprocating engine from freezing increases enormously. Claude very ingeniously made a reciprocating engine work at the temperature of liquid air by using liquid air as a lubricant. But the same dodge won't work with hydrogen and helium. Hence there appeared to be no possibility of constructing a reciprocating engine which would work at temperatures lower than that of liquid air, that is about 100 degrees above absolute zero. Kapitza has accomplished the almost magical achievement of making a reciprocating liquefier that will work without needing lubrication. The solution is, of course, like so many remarkable inventions, fantastically simple. The nature of the device will be described, after it has been explained why liquefiers whose action depends on the use of a reciprocating mechanism are so superior, when the difficulties of making them work at very low temperatures can be overcome.

The cooling and liquefaction of gases is done by the exploitation of two entirely different principles. The nature of these two principles may be illustrated by the consideration of the properties of gases. A gas consists of a multitude of molecules flying about at a high speed. The molecules of the ordinary air in rooms fly about at an average speed of 500 yards a second. The energy of a moving particle is proportional to the square of its speed. Now the energy of motion of molecules is the same thing as their heat, hence the measure of their heat—that is, their temperature—must be proportional to the square of their speed; or, in other words, their speed is proportional to the square root of the absolute temperature. At absolute zero they have no heat energy, and therefore no speed of motion. Hence the reduction of the temperature of a gas *means* the reduction of the average speed of its flying molecules and can be accomplished directly by this reduction.

How can the speed of motion of the molecules of a gas be reduced? One effective way is by putting heavy movable obstacles in their path. They can bump into the obstacles and transfer to them some of their energy of motion. Convenient obstacles for taking the speed out of swiftly moving molecules of gas are the blades of a turbine or the piston of a reciprocating engine. As the bombarding molecules lose their speed the turbine wheel or the fly wheel gains speed. Hence the size of the increase of speed of rotation of the fly wheel is a measure of the amount of speed—that is, the amount of heat—which has been taken out of the molecules of the gas that have passed through the engine.

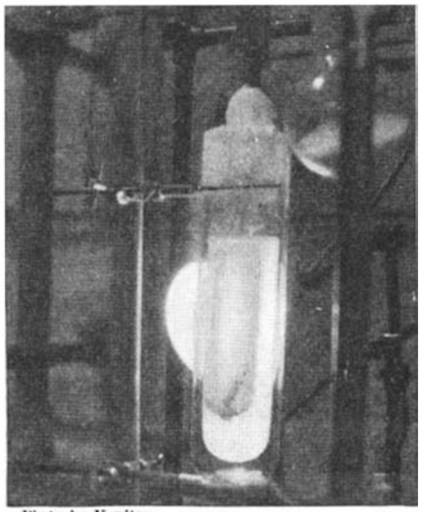


Photo by Kapitza

Helium liquefied by Prof. Kapitza. It looks hot, but is 450° below zero

Suppose you have a very large tank containing a vacuum, and fitted with a large tap. If you suddenly open the tap, air will rush in. As the molecules of the in-rushing air will meet with no sensible resistance (until sufficient air has collected in the tank to begin to offer a noticeable back pressure) their speed will not be decreased, and hence the temperature of the in-rushing gas will not be reduced in spite of the fall of pressure. If an engine were fixed on the tap, so that the air would have to pass through and make the fly wheel speed up before it could get into the vacuum, then the molecules that reached the vacuum would have given up and lost some of their speed to the fly wheel, and hence some of their temperature.

The method of cooling a gas by allowing its molecules to give their speed to a movable piston or wheel is very effective. Everyone has seen how a billiard ball which has been aimed at a stationary ball loses speed after impact, and how the struck ball goes off with some of the speed of the striking ball. Hence one can imagine that if a swiftly moving molecule of gas impinges on a suitable sort of movable obstacle, it may be reduced almost to rest, and the movable obstacle will go shooting forward with the energy of motion it has gained from the molecule. But the molecule, having been reduced almost to rest, its temperature must therefore also have been reduced almost to absolute zero.

Since the impact of gas molecules on movable objects such as pistons connected with fly wheels can effect very large reductions in the average speed of the molecules, the method of cooling by expansion through engines is very efficient.

BEFORE a gas can be cooled by expansion it must be at a higher pressure than that existing in the chamber into which it is to be allowed to expand. So in practice gases must be compressed to a pressure above the atmospheric before they can be cooled by expansion. The compressing requires work to be done. But as the expansion-against-movable-objects-such-as-pistons method of cooling is very effective, a considerable part of the work done by the compressor is gained by the fly wheel of the expansion engine. Hence the expansion engine method of cooling allows a fair part of the work done by the compressor to be used for taking heat out of the gas which is being operated upon.

Compressors have to be driven by electric motors or oil engines. The user has to spend money on the electricity or oil, so he wants the maximum amount of cooling to be done for the minimum expenditure on fuel.

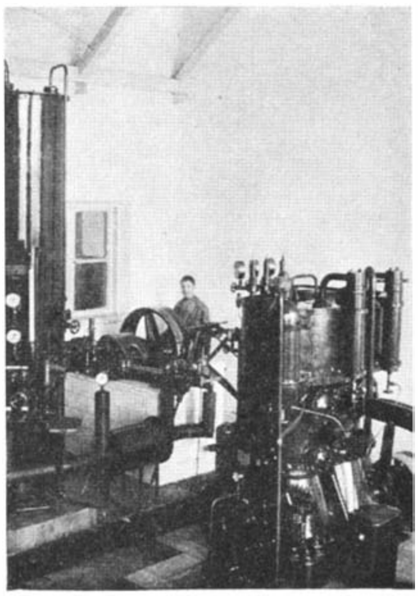
While the expansion engine is theoretically very efficient, it is very difficult to operate at low temperatures. As already mentioned, the pistons freeze up, owing to the lack of lubricants effective at low temperatures. Also the metal of the reciprocating parts tends to become brittle at low temperatures. If the machine is not designed and constructed with great attention to the properties of its materials, it flies to bits through brittleness when it is run at a low temperature. Hence, until Kapitza invented his special form of expansion engine, the method of cooling a gas by making its molecules give their energy to a piston could not be used for obtaining very low temperatures, and no advantage could be derived from the high theoretical efficiency of the method.

So, until recently, low temperatures have been obtained mainly by the exploitation of an entirely different principle. Gases such as air are not "perfect." That is, their molecules are not entirely without effect on each other; they have a slight mutual attraction. When the average distance between the molecules of a gas is increased, a little energy has to be consumed in forcing them farther apart against this slight mutual attraction. This energy is taken from the energy of motion, or heat, of the molecules of the gas. The slight fall in temperature of a gas when the average distance between its molecules is increased, was discovered by Joule and Thomson over 80 years ago. As this cooling effect is due merely to the increase in the average distance between the molecules, and not to the bumping of the molecules against a piston or any other movable object, cooling machines based on the application of the Joule-Thomson effect can be constructed without any moving parts, so that no lubrication problems or serious difficulties owing to the brittleness of reciprocating parts need arise.

IN cooling machines operating on the Joule-Thomson effect, the gas to be cooled is compressed to a high pressure, and the heat produced by the compression is taken out by a cold water circulating system. The gas, now at high pressure and room temperature, is allowed to expand through a fine nozzle. Owing to the increase in the average distance between the molecules after they have passed through the nozzle, the issuing gas is cooled slightly. The slightly cooled gas is sent around the tube conducting the fresh lot of compressed gas to the nozzle, so that the fresh lot of gas is slightly cooler than the room temperature when it reaches the nozzle. After expansion through the nozzle its temperature drops, owing to the Joule-Thomson effect, but to a slightly lower temperature than the first lot of expanded air, because it started to expand at a slightly lower initial temperature. This system of employing the last lot of cooled gas to pre-cool the oncoming lot of high pressure gas is named the regenerative system of cooling. By it the temperature is steadily reduced as more and more gas is forced through the nozzle.

As the Joule-Thomson effect produces such a slight fall in temperature for a big fall in pressure, a great deal of compressor pumping must be done to achieve a substantial fall of temperature. Hence a large amount of fuel must be consumed in order to produce a useful fall of temperature. Cooling machines operating on the Joule-Thomson effect are therefore, in the scientific sense of the term, very inefficient. They consume much power in producing a small fall of temperature. Meissner has calculated that the liquefaction of helium by the application of the Joule-Thomson effect must theoretically consume about 100 times as much power as liquefaction by an expansion engine which succeeds in directly transforming the energy of the moving helium molecules into mechanical energy.

But at low temperatures the cooling efficiency of the Joule-Thomson effect increases considerably in comparison with that of expansion engines. The magnitude of the slight attractive force between the molecules of a gas increases slightly with the fall of temperature. Hence the Joule-Thomson cooling becomes rather more effective at low temperatures. But the cooling by an expansion engine becomes less effective at low temperatures. As already mentioned, the speed of the molecules of a gas is proportional to the square root of its temperature. A reduction of ten percent in the speed of the molecules of air



The low temperature laboratory at Kharkov, mentioned in the article

at room temperature, that is at 289 degrees absolute, produces a fall of about 50 degrees, but a reduction of ten percent in the speed of the molecules in air at −100 degrees Centigrade, or 173 degrees absolute, produces a fall of about 30 degrees only.

Hence the most efficient method of liquefying gases that condense at very low temperatures is to cool the gases down to within 10 degrees of absolute zero with an expansion engine which makes the gas molecules do work, and then produce the further cooling by increasing their mutual separation through the use of the Joule-Thomson effect. This is the plan that Kapitza follows.

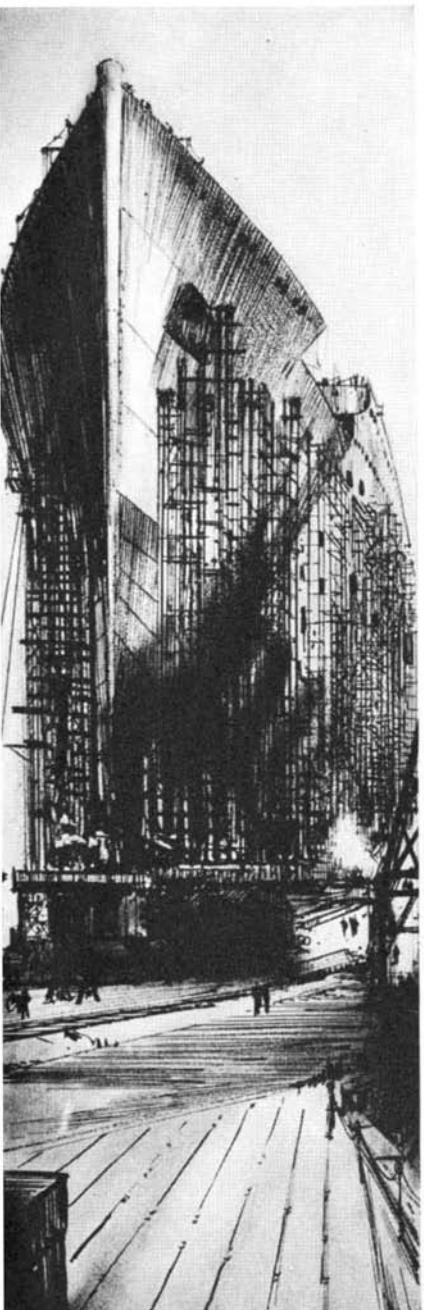
How does he make his reciprocating expansion engine work within ten degrees of absolute zero, when no one before has made one work within 100 degrees of absolute zero? He solves the problem of lubricating the piston by avoiding the necessity for lubrication. He deliberately arranges that there should be a clearance between the piston and the walls of the cylinder, so that they are not in contact, and lubrication is unnecessary. But how can a leaking piston take energy out of the gas? Kapitza arranges that the piston moves very rapidly on the expansion stroke, so that the expansion is completed before much gas has been able to leak past.

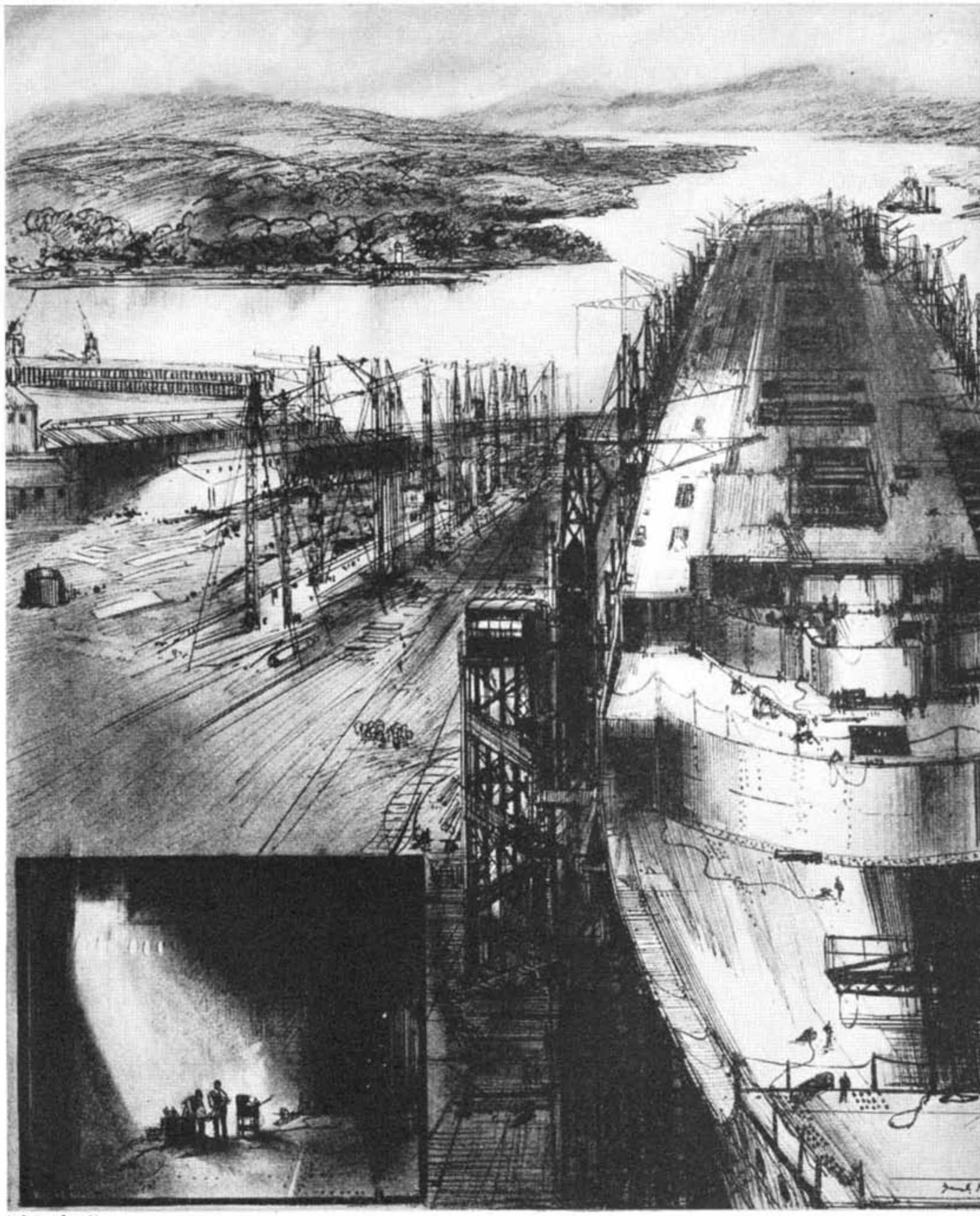
This engineering device is characteristic of Kapitza's genius, and reminds one of the device by which he produced magnetic fields of 300,000 gauss by short-circuiting a dynamo through a solenoid. In both cases, he has produced effects outside the ordinary range of mechanics by evading the limitations of the ordinary ranges of working velocities.

He is now about to combine his two powers of very intense magnetic fields with very low temperatures, in an attack on the fundamental atomic properties of matter. Whatever he discovers, he will enter a region of investigation that has hitherto been closed to man.

FOR the production of small quantities of liquid helium the method of F. Simon has been of great value. He showed how liquid helium could be obtained by an expansion of highly compressed helium gas. His apparatus is in principle an expansion engine that makes one stroke only, and therefore avoids the engineering difficulties presented by reciprocation at very low temperatures. By working with small quantities of material many important experiments can be made with small quantities of liquid helium. Simon's apparatus is simple and inexpensive and has been used with great success in low temperature investigation by himself and K. Mendelssohn at Oxford, and by M. Ruheman at Kharkov in Russia.

The method used by de Haas for producing extremely low temperatures depends on a phenomenon first pointed out by Langevin in 1905, who remarked that when magnetized oxygen is demagnetized, its temperature should be reduced. In 1927 W. F. Giauque again pointed out that the demagnetization of a magnetized body should produce a fall in temperature, and afterward with Clark employed the method experimentally. In 1926 Debye independently calculated the size of the fall of temperature to be expected in gladolinium sulfate when it is demagnetized. The calculation depends on the conception of a magnetizable body as a collection of a great number of very small magnets. When such a body is not magnetized, the little magnets are pointing in random directions. The act of magnetizing removes this random arrangement and alines all of the little magnets in a certain direction. Hence a magnetized body is in an ordered state. By recondite thermodynamic considerations it can be shown that if the ordered magnetized system is destroyed, energy is absorbed from the heat motions of the molecules, and the temperature of the body decreases.





Courtesy *The Illustrated London News*

A bow view of the huge *Queen Mary* while under construction at Clydebank

The *Queen Mary*, known only as *Number 534* during her construction, showing, in the background b yond the Clyde River, the River Cart which had to be widened and dredged to permit launching the vess

'QUEEN MARY'

NOTWITHSTANDING widespread opposition to the construction of huge transatlantic liners, the British have deemed it worthwhile to finish and launch the giant Cunarder *Queen Mary*, which within 18 months or so will make her bid for the mythical "blue ribbon" of the Atlantic. Shrouded in deep secrecy during the construction period, exact details of the ship have been unattainable. The drawings reproduced above were prepared by Frank H. Mason, the only artist allowed access to the ship before her launching. Construction of the ship was started several years ago, only to be stopped by labor troubles in November 1931. Work was not started again until last December and the ship was finally launched in September 1934. The actual launching operations were extremely delicate, due to the tremendous bulk of the ship, but the River Cart provided the necessary space, as shown above. As the ship became water-borne, massive drag chains took up the strain and checked her momentum. The *Queen Mary* had a launching weight of 34,000 tons, nearly 10,000 more than the *Aquitania*, and will have a gross tonnage of 73,000. She is 1018 feet long with a 115-foot beam, will tower 234 feet from keel to masthead, and will have an estimated speed of 32 to 35 knots. For comparison of size: *Leviathan*—48,943 registered tons, 907½ feet long, 100¼ feet beam. *Majestic*—56,621 registered tons, 915 feet long, 100 feet beam.

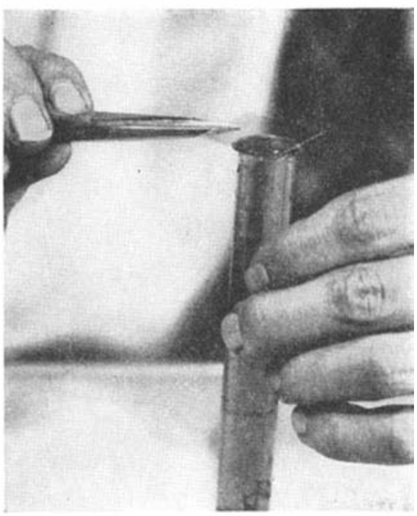
THE AMATEUR AND HIS MICROSCOPE—XIII

PLANTS THAT SWIM

By KEN G. NIBLACK
Bausch and Lomb Optical Company

THE riddle of early microscopists—the diatoms—is exactly as fascinating, if not as mysterious, in 1934 as it was in 1834. These forms of life swim about like animals or fish, yet their life chemistry is like that of plants! Are they animals or plants?

It was a plunge into the calm waters of a woodland lake that stirred my first curious interest in these odd denizens of the aquatic world. Muddy brown water ruined the refreshing bath I had counted on. What is this shiny stuff in small lakes that gets into the eyes, ears, nose and mouth, but is rarely encountered in large, or swiftly moving, bodies of water.



On the under side of a glass, some scum from top mud of a small lake

Enthusiasm about microscopy prompted me to dig up about a pint of bottom matter from a small lake, so that I might compare it with the bottom matter of Lake Ontario and learn why there was such a marked difference. I knew, of course, that in the large lakes I was dealing principally with mineral matter, and in the smaller, quiet lakes with vegetable and animal matter. I determined to learn their true nature under the microscope. This is how I went about it:

I permitted the sample of water from the large lake, and that from the small lake, to settle for several minutes. Then I examined the water on the top, which still seemed somewhat clouded. I next examined the top mud at the waterline and the mud at the bottom. By this method I learned that most of the living things existed in the top mud, while the matter at the very bottom consisted chiefly of sand and heavy debris.

Every sample of top mud contained about 90 percent of uninteresting junk, which looked like rotted wood and seaweed. Lively protozoa pushed their way through—some lingered in the most densely packed areas. Many other creatures whirled and darted across the field, but the objects that interested me most were the tiny airship-like forms that floated past the remaining things. These, the free-floating diatoms, were long the enigma of biologists. They travel on their way with determination—going nowhere in particular, and this is one of the clews to their nature. They are not animals, as their gypsy habits would suggest, but plants that move about only to maintain a fresh supply of carbon dioxide and water flowing to their protoplasm. They consist only of protoplasm and an external skeleton. They are streamlined like a fish or airship for ease in slipping through the mud and water. Inside their siliceous skeleton is everything needed for the existence of a one-celled plant.

I SINGLED out this phase of the material for further study, neglecting all of the other jumping, whirling, darting, and creeping forms disclosed in the water from the two lakes. I found practically the same kind of objects in the large lake that I found in the small lake, but the water from the small lake contained more of them.

When looking for information on fresh-water diatoms my attention was attracted to the beautiful forms found in other parts of the world—in the ocean and in the rocks. I learned that these elementary living cells were found everywhere, even in the dirt in our fields; that 6,000 species were known—all beautiful, symmetrical in shape—circular, triangular, square, oval, or in combinations of geometrical forms.

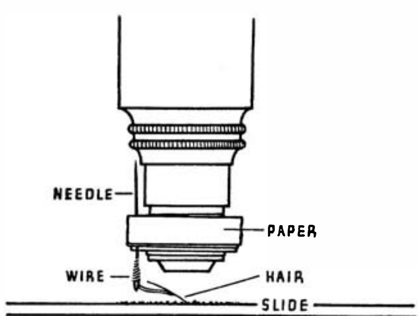
The disk forms of diatoms are not free swimming but are anchored by gelatinous stalks excreted by the cells, the stalks often branching profusely. These diatoms have the form of the old-fashioned pill box and in reproducing, the smaller or inside section becomes a new diatom, which means that among the progeny there are a series of individuals of diminishing size. When this series has reached a minimum, what are called auxospores are formed — reproductive cells which start new diatoms of full size.

Diatom skeletons from accumulations are used commercially: in tooth paste and for polishing brass or varnished surfaces and the surfaces of optical equipment such as calcite prisms. They are also used as filters and as an absorbent in dynamite. Diatoms are sold on the market under a number of different names—diatomaceous or infusorial earth, rottenstone, kieselguhr.

I have seen diatomaceous earth from the biological supply company, and diatomaceous material from several other sources. All this can be examined with a microscope giving about 100 magnifications, but to see the more intricate details, higher power is desirable. The *Amphipleura pellucida* has been used as a test for microscopic equipment for over 50 years. Although its general form can be seen with 100 or even less magnifications, the fine ribs that maintain its shape cannot be resolved except with the highest powered equipment. You can only hope to see the ribs or beads if you have a microscope with an oil immersion objective and a condenser that can be used in oil contact with the bottom of the slide. The condenser must have a numerical aperture equal to the objective, and the illumination must come in

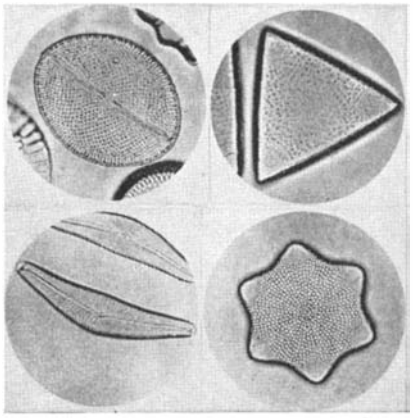
Diatoms as they look when seen in their natural scummy surroundings at an angle, perpendicular or obliquely to the lines in the diatom. Oblique light may be obtained very easily by cutting a disk of cardboard to fit the filter holder under your substage condenser. A quarter-inch hole through the periphery will give the oblique illumination necessary, and by rotating the disk, resolution of the lines may be accomplished—if you are a good enough microscopist.

In order to prepare photographs to illustrate this article I mounted a few diatoms in Canada balsam, in the following manner: For fresh water diatoms I took the fine top mud known to have diatoms in it and poured this into a test tube full of clean water. Diatom skeletons and some other debris remained on the top of the water in the form of a scum, and by touching my cover glass to this I was able to pick up the scum on the under side of the cover glass. Then, to continue outlining the procedure, by examining this under a low power (50x), a certain section containing many diatoms is selected, and while watching it through the microscope, other sections of the cover glass are cleaned free of all debris so that the material and diatoms in view under the microscope will be the only material on the slide. This material, still moist, is spread, by means of a fresh drop of water, to cover the entire center part of the cover glass. When this is thoroughly dry a drop of Canada balsam is placed on a clean slide and the cover glass inverted over this Canada balsam and pressed down. Now, by watching the section that it is desired to preserve under the microscope, the cover glass may be moved around on the slide until the diatoms and remaining debris are so well separated that photographs or a permanent mount can be made.



How the hair is connected directly to the objective and brought into focus under the lens, then used to pick up the diatoms, and clean and arrange them

If, on the other hand, you wish to follow the Old World custom of cleaning the diatoms and arranging them in a pattern on the slide, and think you have the patience required, the following procedure might be useful: Wrap the low power objective with gummed paper until you have built up a cushion through which you can pierce a needle. A bit of fine copper wire can be used through the eye of the needle, in order to hold a hair, and this hair, secured by wax or glue, is adjusted to focus. The gummed paper wrapped around the objective serves as a needle holder. A needle serves to hold a hair in position below the objective's focus. This gadget can be adjusted easily to the center of the microscope field. (See drawing below.)



Beautiful diatoms may be found in many alluring shapes and patterns

When the objective is focused on the hair, and also on a diatom, the hair can be used to lift the diatom from its position among broken pieces and place it in a clean spot on the same slide or on another slide. The hair can be moved up and down with the fine adjustment, and the slide moved in the horizontal plane by hand. If it is found difficult to lift the diatom with the hair, mix a solution of Canada balsam and xylol to make a paste thin enough to wet the hair, and sticky enough to pick up the diatom. A drop of xylol on the slide where you wish to deposit the diatom will help to free it from the hair, when you have it in position.

The procedure is very simple if you are of a patient nature. Draw a black mark around the section containing diatoms that you want to move, also a mark with a black grease pencil around the section in which you want to place the diatom. Focus your objective on the selected diatom, in order to find the diatom on the hair. Then raise the objective by means of the coarse adjustment until you can see that the diatom is free from the slide, but that some objects on the slide are still visible. Move the slide by hand until the other area where you want to deposit the diatom comes to view. Then lower the objective and lay the diatom in position.

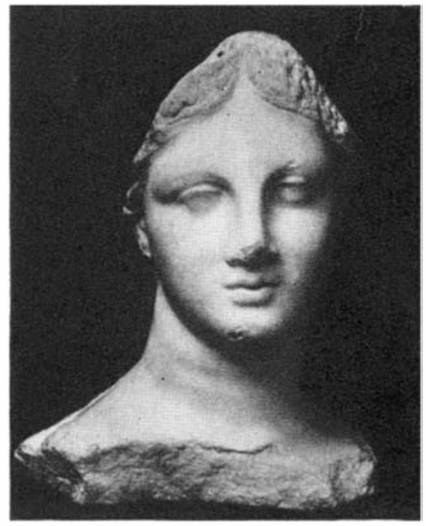
Cleaned, selected diatoms mounted on a slide make beautiful designs

The diatoms should be covered as soon as possible, to prevent dust from getting on them. Canada balsam is the usual mounting medium, but mediums of higher refractive index are sometimes used, to give higher visibility. These can be obtained from a biological supply store. After mounting, your slide should be prepared in the usual way and sealed with shellac around the cover glass.

I discovered that these tiny skeletons would do ghostly things under high magnifications, and I was uncertain as to which of the many forms that I saw as I focused was the true form of the diatom. I read several books on the subject and learned that when no interference bands appeared I was looking at the true detail as it existed; and that when bands appeared around the object, I was probably looking at a light phenomenon caused by interference of wavelengths of light as they pass through the very fine structure of the skeletons.

If one wishes to follow diatoms as a study, there is much to be learned. Books have been written on the subject, much time devoted to it. Photomicrographers pride themselves on their prints of diatom structures. Diatoms are full of mystery to the most profound student of biology and an intriguing subject to every owner of a microscope. You can buy slides of various grades, ranging from the simple Strewn slide at 50 cents, to the most beautiful pattern slide of test objects at five dollars. With these and slides which you can make, you can entertain yourself and your friends. The leisure hours will slip by unnoticed while watching this gala parade of micro plants.

From the Archeologist's Note Book



Chios Goddess, 4th Century B. C.

A Fortress Emerges

ONE of the old landmarks of Rome is the Castel Sant' Angelo, originally the tomb erected by the Emperor Hadrian for himself and his successors. It was completed in 139 A.D. by Antoninus Pius. On a substructure 275 feet square rises a cylinder 210 feet in diameter. The whole structure was once faced with marble. The great building was formerly surmounted by a smaller cylinder on which a colossal statue of Hadrian was placed. The total height was then about 165 feet. In 537 A.D. it was turned into a fortress and was many times besieged. Various additions were made and there were constant encroachments which destroyed the physical appearance of the structure. Now under the Fascist régime the ancient cylinder has emerged from the scrap heap and the whole area has been converted into a beautiful park which adds another beauty spot to Rome, one of the most attractive cities in Europe. A feature of the present work is the restoration of the overhead passageway, connecting the Castel Sant' Angelo and the Vatican, which was almost obliterated. The official name is now the Mole Adriano or the Tomb of Hadrian. We are indebted to the Italian Tourist Information Office for our photograph.

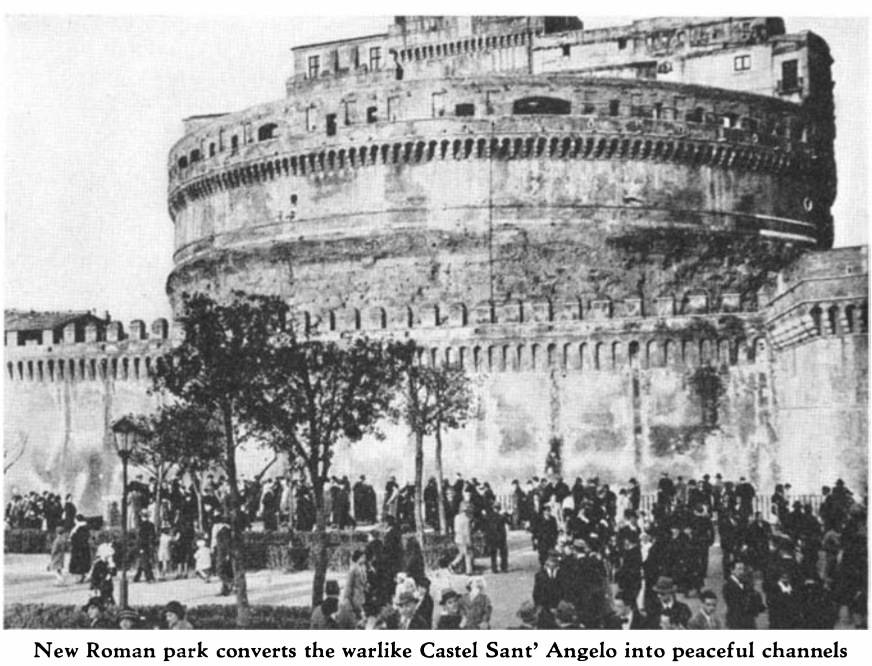
A bronze dish of Etrurian origin

An Etrurian Bronze

THE Metropolitan Museum of Art, New York, has acquired a bronze *Kyathos* (cup) emanating from southern Etruria, end of the 6th Century B.C. It is shallow with an offset, flaring lip, a foot with mouldings, and a high handle with lotus finial. The bronze has acquired a bluish patina, which is very attractive. The bowl was hammered, planished, and then spun to remove the marks of the planisher. The style is unmistakably Greek; this nation inspired much Etrurian metal work.

Greek Marble Head

THE Boston Museum of Fine Arts has a beautiful marble head which comes from the island of Chios, dating from the 4th Century, B.C. It was not unusual for the Greek sculptor to make the head of a figure separately and attach it to the torso. The present head apparently rested in a mortise in front of the torso; dowel holes are present. Persephone, Queen of Hades, best fits the character of the head, although Hera or some heroine or nymph may have been impersonated.



New Roman park converts the warlike Castel Sant' Angelo into peaceful channels

Sassanian silver dish

Sassanian Hunting Scene

AMONG the recent accessories of the collection of the Metropolitan Museum of Art is a Sassanian silver dish decorated with a hunting scene. Persian silver vessels of the Sassanian period (A.D. 226-637) represent the highest achievement of Oriental metal-work. The Sassanian artists excelled not only in stone sculpture but also in wall paintings and such minor arts as metal-work and textiles. Their metal-work, particularly on silver vessels, are extremely rare, only about 40 pieces being in existence. The royal hunt here represented was a favorite subject with these early silversmiths. The ibex is the animal being hunted.

Motordom's Ghosts Walk Again

By WILLIAM S. DUTTON

THAT most modern of institutions, the automobile industry, seems to have set out to demonstrate anew the truth of the adage that there is nothing new under the sun. Ghosts of the past are stalking in the laboratories of the industry's most ultra modern designers.

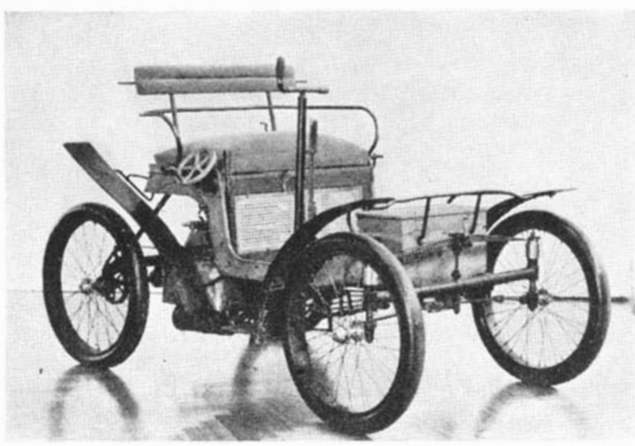
One feature of the big show presented by Henry Ford at the Chicago World's Fair, just closed, was a motor car body so radically different from the conventional that before it some millions of visitors stood in wonder of what a boldly progressive industry would dare next.

The shell was offered by a manufacturer of motor car bodies as its "suggestion for the motor car of the future." Daringly streamlined, the familiar hood in front merely furnished a compartment into which to stretch the legs and store baggage. Space for the engine was provided in the back of the unique body directly over the rear axle.

Rear-engine cars have been the dream of automotive engineers for the last several years, but to date no manufacturer has had the nerve to risk placing a model on the market. Such a wide departure from the established practice of putting the engine in front has been held to be too long a step forward for a habit-bound public to countenance, so that even now it is doubtful whether the "car of the future" will make its debut in dealers' sales rooms for two or three years more, if then. The public must be "educated up" to it, feel the automobile manufacturers.

"Educated back" to it would be a more accurate description. The facts are that in the proposed rear-engine car the engineers and designers are merely dreaming of the day when they can correct a 25-year-old blunder, which some day perhaps may be rated in transportation history as one of the automobile industry's most serious mistakes.

In another part of Mr. Ford's big white building at Chicago was presented a spectacular display of vehicular history from the chariot of ancient Egypt to the newest type motor car on our highways. Sixty-seven vehicles were in the display, the pick of a vast permanent collection of vehicles at Dearborn, Michigan, which numbers 220 automobiles of all types and makes and 560 horse-drawn carts, wagons, and carriages. Each vehicle presented at Chicago was significant of a step in transportation progress or change.



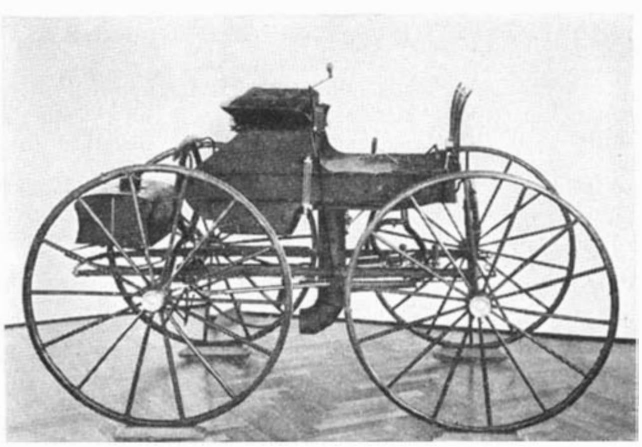
The Eisenbach car—1898-99—introduced a simple form of "knee-action," a feature just revived in this country

The earliest automobile in this most instructive "Drama of Transportation," since returned to Dearborn, is a steam-driven car built in 1862 or 1863 by one William Austin, of Lowell, Massachusetts. While resembling outwardly a horse-drawn carriage of its day, this 71-year-old equipage is, from the engineering standpoint, further removed from the influence of the horse than is the present-day motor car in all its glistening grace and pride and speed. Austin placed his engine, clumsy as it was, at the rear-center of his power-propelled buggy. The carriage had a wheelbase of 54½ inches and a tread of 55½ inches. The wheels were 45 and 46 inches in diameter, front and rear respectively. The fuel used was charcoal, chip-wood or scrap coal. The two-cylinder engine, held in place by a frame, had piston valves. The drive was direct to the rear axle, the latter acting as a crankshaft. The water tank was located at the rear end of the carriage.

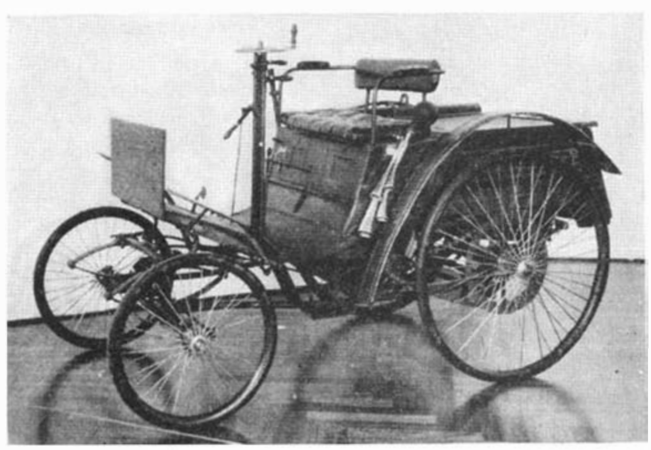
Later the Benz Company of Mannheim, Germany, founded by Carl Benz, famous in automobile annals, struck even further away from the influences of the horse and its traditional place in front of the cart. A Benz car built in 1891, and another of 1892, are in the collection and each has its engine located uncompromisingly in the rear.

Ford's own first successful car, built in 1893 and still in good running order, was a rear-engine type. Likewise was the Daimler of 1894.

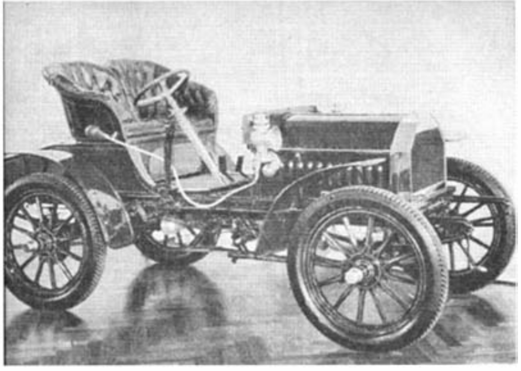
Looking back over these ghosts of progress as they have been arrayed side by side, even the lay visitor can-



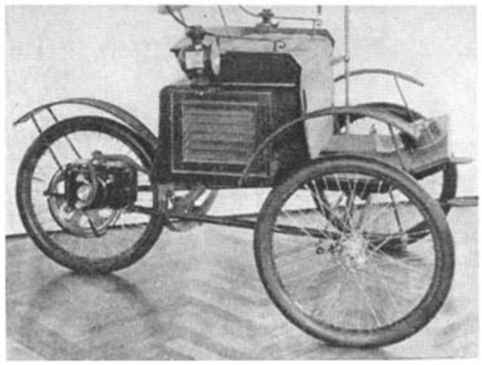
Austin—1862-63—was a steam-driven vehicle in which the power plant was located in the center under the body



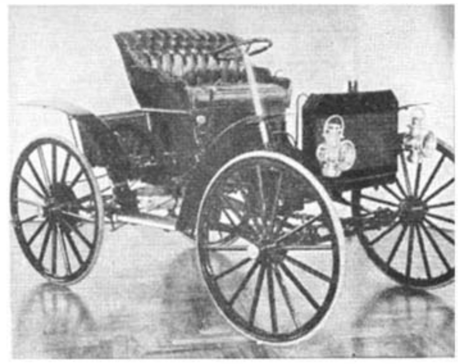
Benz Velociped—1892. Rear engine mounting. Many a sport roadster today proudly displays the same type of horn



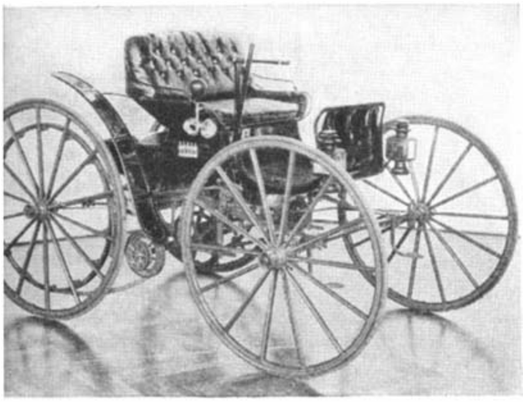
Pierce—1904



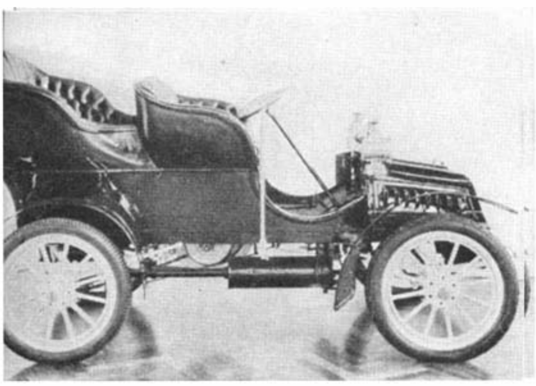
Riker Electric Tricycle—1896



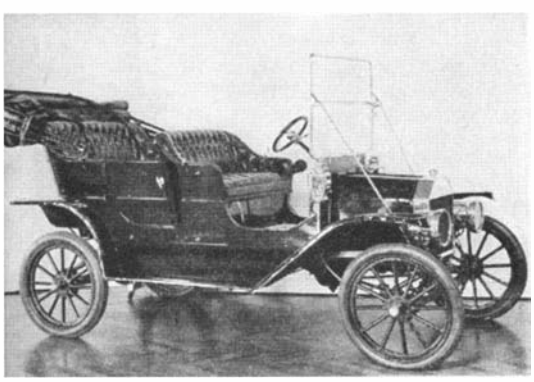
Schacht—1909



Holsman—1903



Pope-Hartford—1904



Ford T—1908

not help but be impressed by the unanimity of the pioneers' vision of what a motor car should be. Among a total of 37 significant automobile models introduced prior to 1910 and exhibited at Chicago, 14 were of the rear-engine type, six had their engines in the rear center, seven in the center, and only ten in front. That is to say, front-engine models were in the minority by the overwhelming odds of 27 to ten.

Of course it must be granted that the early builders were probably influenced more by expedience than vision. Power transmitted directly to the rear axle was the simplest and most economical form of construction. The fact remains, nevertheless, that it still is the simplest and most economical way to build a motor car, and the most sensible way. Engine heat, engine noise, and engine odors are removed to the place where least objectionable and noticeable when the power plant is in the rear of the car. There is more leg-room in front, and lack of leg-room was long an indictment against the earlier models with the power plant in front.

TRADITION and habit, the ever-present human reluctance to break loose from established forms, was the main reason for the front-engine automobile. The horse always pulled its load, and so the automobile makers finally contrived a way to get their power-plant where the horse would otherwise have been, though they continued to transmit the propelling force to the rear. And thus the new vehicle became a hybrid sort of thing, which presented the appearance of being pulled and yet actually was pushed from behind. It was neither fish nor fowl.

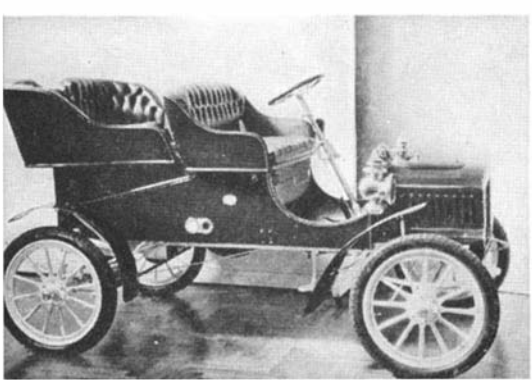
Just how many years of progress were sacrificed by the automobile industry to the tradition of the horse, or, to state it in another way, how much further advanced would be automotive design today if the pioneers had been guided solely by logic instead of by deference to age-old custom, is a nice question over which future historians may well speculate. It has taken us a quarter of a century to reach the point where a handful of advanced thinkers in automotive design are ready to admit cautiously that the car builders of the '90s were right when they placed their power plants behind.

INDEED, study of the motorized section of the Drama of Transportation is likely to lead one to wonder if there is anything fundamentally new or envisioned in the automotive industry of today of which the old-timers did not think. Lack of proper tools and materials, especially of metal alloys, made many of their ideas impractical at the time but none the less they had the ideas and in their experiments forecast the trend of future development with uncanny accuracy.

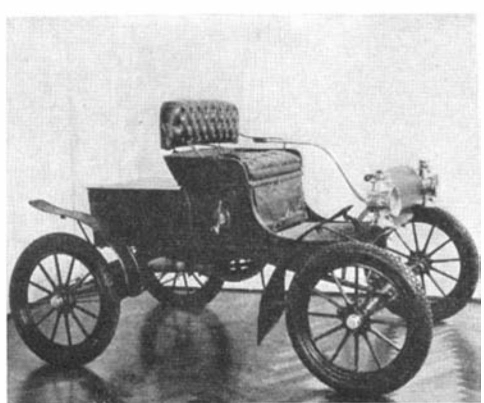
The self-starter is popularly supposed to be of fairly recent origin and one of the most important of later-day improvements to the motor car, yet it appeared on a Winton car in 1896. Standardization of parts, also thought of as a modern idea, was introduced by Ransom E. Olds, the designer and builder of the Oldsmobile, on an Olds car built in 1900. This car, known as a curved dash runabout, weighed only 800 pounds and was built in one style, with one paint finish, and each and every part was made to standard. The car averaged 25 miles to a gallon of gasoline and combined the principles both of air and water cooling.

Three-wheel cars have recently been the subject of experiment, though not by any of the larger manufacturers,

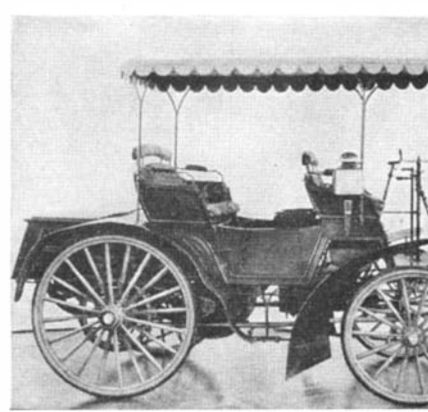
Ford C—1905

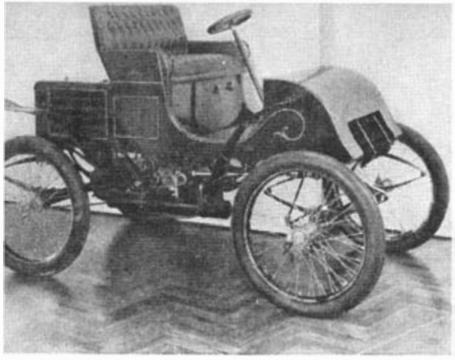


Oldsmobile—1900

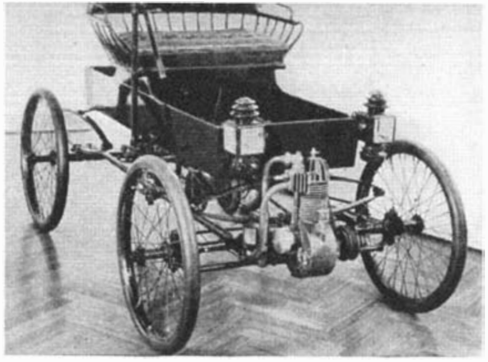


Benz Phaeton—1892-96

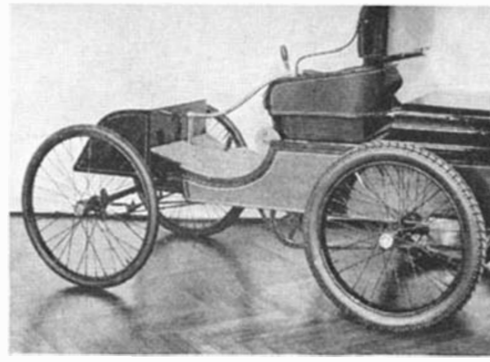




Ford No. 3—1898



Crestmobile—1901



Michigan—1903

and the idea has been considered novel enough to interest motion picture audiences via the news reels. A car of the tricycle type, illustrated on the opposite page, was built by Anderson L. Riker in 1896.

AIR cooling and opposed cylinders are thought of today largely as innovations of the aviation industry, but about as many of the early engines were air cooled as water cooled. Such cars as the Holsman of 1904, the Stevens Duryea of 1904, and the Kilbinger of 1907 employed both air cooling and opposed cylinders in their motors. A Knoxmobile of 1902 introduced a most advanced principle of air cooling. Steel spines were inserted in the cylinder walls, screwed into place and grooved throughout their length. There were from 1500 to 2000 spines $\frac{3}{16}$ of an inch in diameter and two inches long.

Even independent wheel suspension, popularly known as "knee action" and widely exploited as a radical improvement of the past year or two, is really a ghost out of motordom's past. A car known as the Eisenach, built at Eisenach, Germany, in 1898 or 1899, incorporated a simple form of knee action in its front end suspension.

Progress of any kind is dependent on the past and its accomplishments, and Mr. Ford's huge collection of ancient and modern vehicles at Dearborn shows this unmistakably. Inventors do not draw new creations out of the air, like magicians, but working at the right time with the right tools they coordinate and assemble the findings of countless experimenters who have gone before and who, in their time, probably worked at the wrong time and with deficient tools and materials.

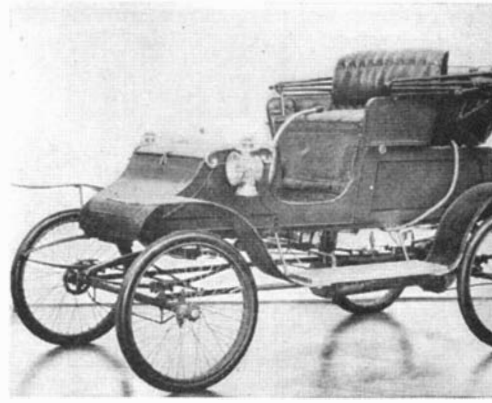
Even as late as 1893, the year Ford built his own first car, the mechanical facilities available were so meager that they would have been utterly inadequate to build a modern automobile. Prior to that date no sort of a successful car was possible, regardless of how complete and inspired the conception of the man who tried to build it. Too many needed things were then lacking.

In this connection it is interesting to note the roundabout course taken by automotive design in its present trend back toward the original rear-engine models.

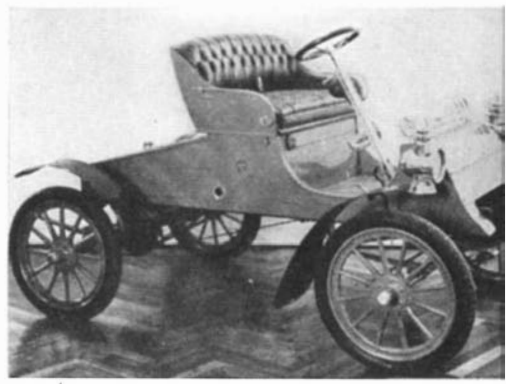
First, the horse led designers gradually to work their powerplants forward, though they had to overcome engineering difficulties in order to do so. Then along came aviation and we began to learn something of a new science, streamlining. Its discoveries quickly showed a glaring fault in the modern automobile: with its bulky engine and radiator in front it butted its way through the air instead of slipping easily through it. Streamlining suggested a rear-end power-plant, if a perfect job of streamlining was to be done.

SO our newest transportation industry, aviation, is exerting its influence upon motordom to free it from the last vestige of influence held over it by transportation's oldest industry. And the ghosts of the '90s walk again.

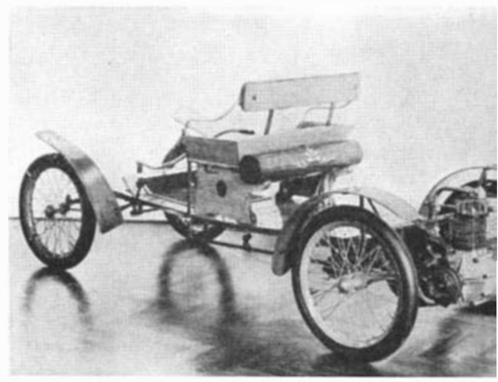
The photographs bordering these two pages admirably illustrate the points brought out in the accompanying article. Old as are the cars shown, they contain at least germs of ideas which are only now being developed. Old timers will recognize many familiar "gas buggies" of bygone days in this collection; the younger generation will smile at some of the seemingly grotesque designs, but can learn many lessons from a study of them.



Stanley Steamer—1902



Ford A—1903

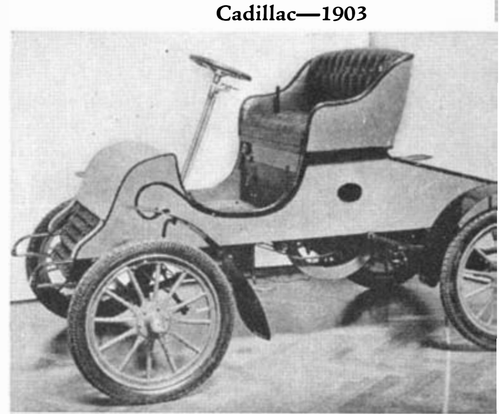


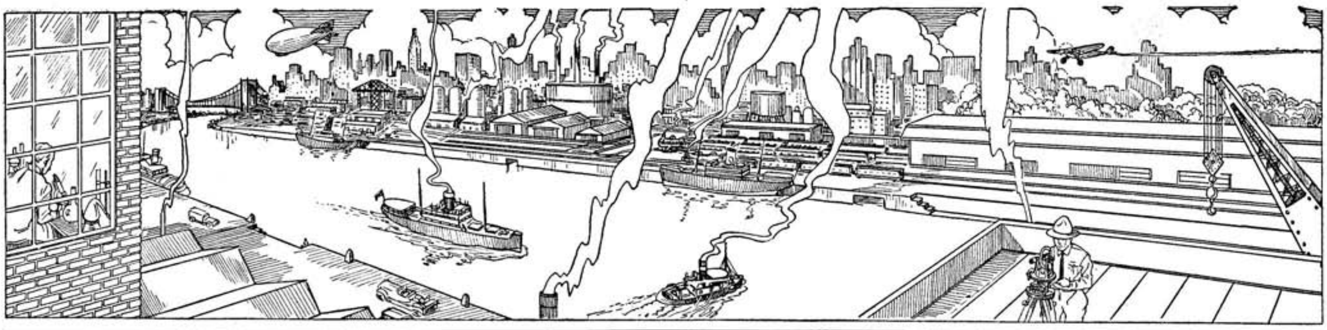
Orient Buckboard—1903

Daimler—1894

Winton—1900-01

Cadillac—1903





THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

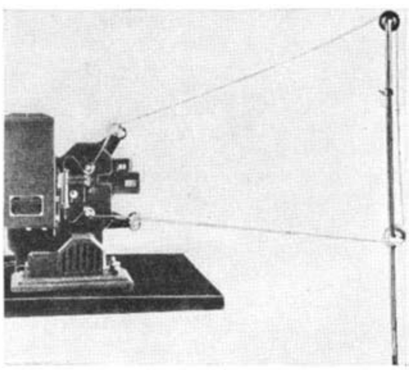
ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.
Lehigh University

Movies Analyze Industrial Operations

A UNIQUE type of motion picture apparatus which visibly measures time in relation to human and mechanical energy was demonstrated recently to groups of industrialists in Rochester and New York City.

Chief features of the apparatus, which is sponsored by The Chas. E. Bedaux organization of industrial engineers, are a perfectly synchronized camera and Kodascope projector using a super-sensitized 8-millimeter film. Powered by a constant-speed motor having an electric governor, the film travels through the camera at a rate of 1000 frames per minute in normal use and 4000 frames per minute for slow-motion pictures.



Closed loop film set-up for analyzing movies of industrial operations

The camera, known as the Bedaux Measurement Cine-Kodak, weighs only six pounds with its built-in motor. It carries 100 feet of film which records 16 minutes of action, and is equipped with a lens held to a focal range of two to 20 feet.

Another feature of the apparatus is described as the "measurement loop system." This permits the recording of a large number of episodes, such as the multitude of operations in an industrial plant, and the cutting of the film into varying lengths corresponding to each episode, each length then being spliced into a loop capable of continuous projection at any desired rate ranging from one to 1400 frames per minute.

This apparatus was conceived to fulfill the need for a permanent record of every basic operation in a manufacturing plant, both as to the process and the exact time value of every motion involved. Through the use of these picture records it becomes possible to measure progress in processing, analyze motion for the elimination of faulty or unnecessary moves, permit management to see in terms of speed and fatigue their labor requirements and to demonstrate the fairness of these requirements, and give workers a constant and equitable gage of their performance uninfluenced by good times or bad.

With this system each complete scene is returned by the processing station to the owner as a separate film formed into a closed loop and coiled in a specially designed file container card on which can be placed the data necessary to identify and classify the scene therein contained. Thus, as contrary to the procedure heretofore in vogue, when one desires to project the specific subject in interest he need not waste time viewing all the other activities photographed on the same roll of film.

Motor-driven portable movie camera in use in an assembly plant

The principle of a closed loop is of decided advantage during projection. The picture can be viewed as many times as desired without change of reels or rewinding. Therefore, the analyst, freed of the need of watching the mechanical operation of his projecting machine, can concentrate on the study of the picture itself for as long as he desires. When not in use, the loops are coiled in the loop record cards and filed in a loop record humidified cabinet for safe storage.

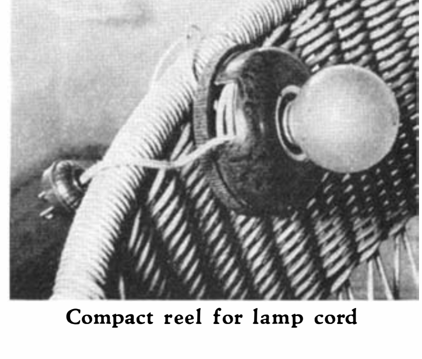
Water Purified by Iron and Carbon Dioxide

A NEW method for chemical purification of waste water, the iron-carbon-dioxide process, has been developed by German chemists, according to *Chemical and Metallurgical Engineering*. In this purifying process the waste water is treated with carbon dioxide in the presence of metallic iron, whereby iron is dissolved as iron bicarbonate. The dissolved carbon dioxide is then expelled from the water by strong aeration, the iron bicarbonate is oxidized and the hydroxide coagulated with the impurities in the water.

Waste flue gas with about 10 to 15 percent CO_2 may be used as a source of the carbon dioxide gas. Iron turnings from a machine shop are suitable for the other reagent. The total time required for treating the waste water is 30 to 45 minutes.—*A. E. B.*

Flexible Cord Reel

A CONVENIENT device for use in connection with reading lamps, electric irons, toasters, and other electrical appliances, takes the form of a compact reel in which 15 feet of flexible lamp cord can be



Compact reel for lamp cord

contained. One end of the cord is connected to a standard type of plug and the other to a receptacle in the center of the reel. Any length of wire needed to reach the nearest convenient outlet may be withdrawn from the reel or, when the device is not in use, the wire is easily rolled up.

A flexible wire arrangement makes it possible to clamp the reel to the back of a chair, a table, or any other desired point, or the reel may be merely placed upright on its flat base.

Texas "Oil Crop"

A SURVEY recently completed by the Texas Petroleum Council shows that oil has become the big "money crop" of Texas, far surpassing cotton. Returns from crude oil in 1933 totaled 237,872,000 dollars, compared with returns of 204,040,000 dollars from the cotton crop in the same year.

Stuttering Cured by Hypnotism

HYPNOTISM has been successfully used by United States Public Health Service doctors at the Marine Hospital in San Francisco in curing patients of stuttering, Dr. Victor H. Vogel, United States Public Health Service, reports.

The method includes revelation and aeration of the cause, and suggestion to the patient under induced hypnosis. It is especially applicable when the cause is psychic injury, such as severe abuse or fright occurring early in life, when the mind is most impressionable.

In some of the cases the causative incident remains only in the patient's subconscious mind and can not be recalled during the normal waking state; but when hypnotized, the patient readily relates all details. The suggestion is then given to the patient while in the state of hypnosis that, knowing the cause of his stuttering, he can overcome it. Success is not so marked when the cause is not revealed.

One patient, who could not recall the causative incident before being hypnotized, readily related it under hypnosis and recalled it to mind after being awakened. In this case the patient when about seven years of age had been severely whipped. While under hypnosis he spoke without stuttering. He was cured by three treatments. Two months later he wrote that "new worlds are open to me now." A year later he wrote that he was "selling insurance, which calls for enough talking." In normal conversations his speech was perfect, he said, while he slightly lost control and stammered "a bit" in times of excitement.—*Science Service.*

Science Service photograph

Florida's "Fountain of Youth" failed to bring eternal youthfulness to these Indians of Ponce de Leon's day. But archeologist J. R. Dickson reports that this old Indian graveyard, which he is unearthing, contains an array of strong-framed skeletons with remarkably fine teeth. The graveyard, recently unearthed, has revealed over 90 burials. Mr. Dickson calls them some of the earliest Christianized Indians in the United States, because many lie with arms crossed as in prayer, and because of the lack of offerings and equipment for the future world

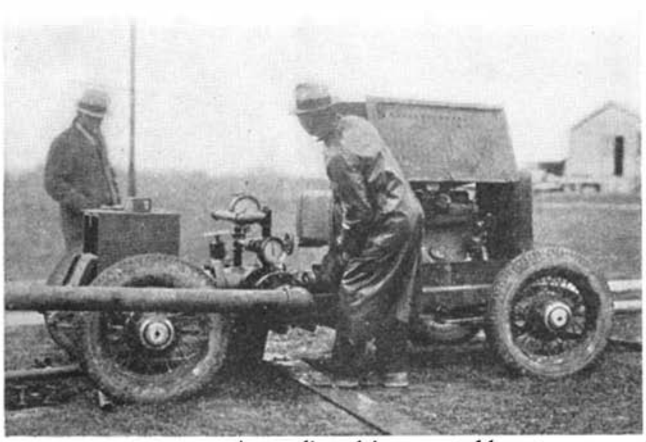
A Portable Rotary Pumping Unit

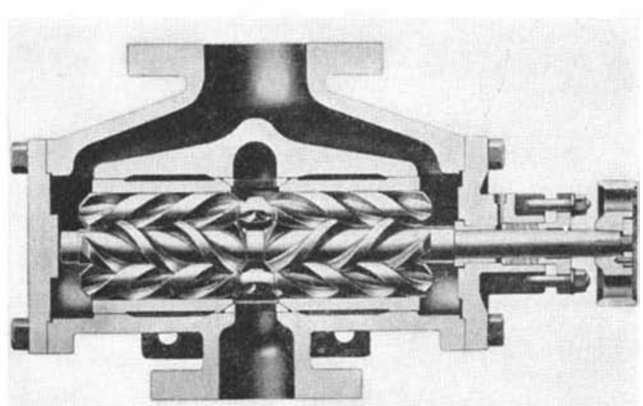
THE development of a high-speed rotary displacement pump has made possible the compact and comparatively light weight transportable gasoline engine driven unit mounted on a trailer, which is shown in an accompanying photograph. The pump is known as the De Laval-IMO. Driven at approximately 1675 revolutions per minute by a 60-horsepower gasoline engine, it delivers 90 gallons a minute against 495 pounds per square inch pressure with a suction lift equivalent to 14 inches of mercury. The pump itself weighs only 398 pounds, and the complete unit, with engine, about 2000 pounds. The pump has only three working parts—a central power rotor and two sealing rotors, which mesh in such manner that the liquid is carried through, as by a continuously acting piston, without shock or pulsation. There are no timing gears or separate bearings, and but one stuffing box, which is subjected to suction pressure only.

The rotating parts are in complete rotational balance and, except for suction pressure against the area of the driving spindle at the stuffing box, are also in hydraulic balance axially.

How to Paint Cast Aluminum

AN improved technique for painting cast-aluminum surfaces is reported by J. E. Greene in a recent issue of *Industrial Finishing,* as a result of work done to improve the finish and durability of street and road signs. In the finishing of cast aluminum, the first and most important job is to clean and prepare the surfaces properly before applying the first coat of finishing material. Two





A gasoline driven portable rotary pumping unit, and a sectional view of the pump

solutions for this purpose are recommended: One is a caustic potash or concentrated lye mixed on the basis of two pounds to the gallon of water; the other is a 25 percent solution of acetic acid.

Aluminum castings are dipped in a tank of one of these conditioning solutions and allowed to hang submerged for 20 to 30 minutes, or until the surfaces turn to a grayish black. Next they are dipped into a tank of cold water to rinse and neutralize the first treatment, and then into a tank of hot water. Following this, the castings are allowed to dry naturally, after which they are ready for the priming coat.

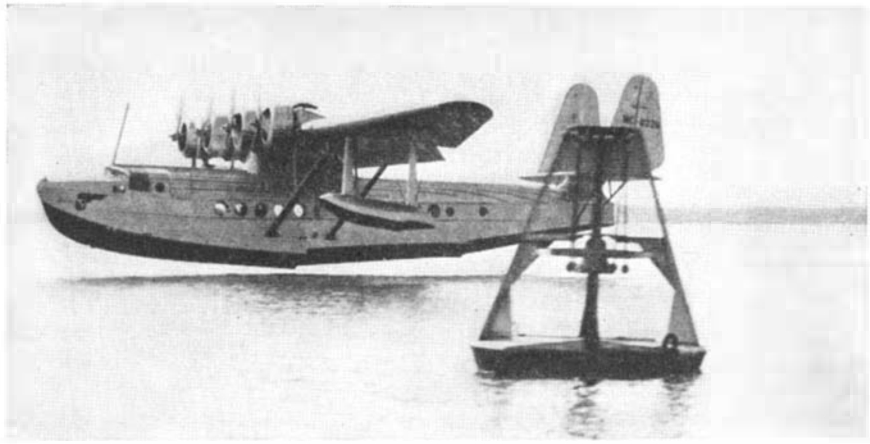
In one modern plant, exterior lacquer enamels are used; another uses air-dry and bake-type synthetic enamels. For the lacquer finish a red oxide lacquer primer is first applied. The work is then painted in various combinations of color and finished with a final protective coating consisting of one or more coats of exterior, tarnish-proof, clear lacquer.—*A. E. B.*

Brazilian Clipper Triumphs

THE *Brazilian Clipper*, the Sikorsky S-42, which we have already briefly described in these columns, has gone from triumph to triumph, exceeding the specification performances, breaking many records, and cutting time in its regular South American service. The S-42 has aroused world-wide interest and we feel fully justified devoting space to the latest information regarding this splendid ship.

The performance with various engine combinations is of particular interest. With full load—36,000 pounds total—and all the four Pratt & Whitney Hornets, rated at 700 horsepower each, in commission, the top speed is 190 miles per hour at 6000 feet altitude. With any of the three engines, the top speed at sea level is 153 miles per hour. With four engines, climb is 1000 feet per minute from 3500 feet; with any three engines, the climb there is still at the comfortable figure of 400 feet per minute. In this flying boat the question of enhanced safety by use of a multi-engined power plant is fully answered, with no further argument possible.

The weight empty (that is, fully equipped but without fuel, oil, crew, or pay load) is 21,945 pounds, so that the useful load is at least 14,055 pounds. Since the S-42 only loses a couple of miles per hour in speed when overloaded up to 41,000 pounds and is then perfectly easy to handle, its maximum useful load is 19,055 pounds or nearly 50 percent of the gross load.

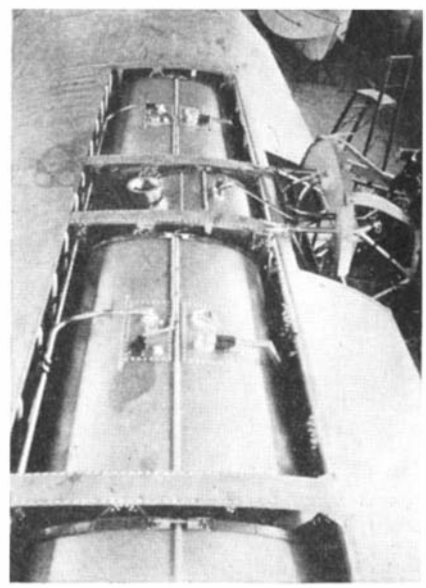


The *Brazilian Clipper* alighting with flaps depressed

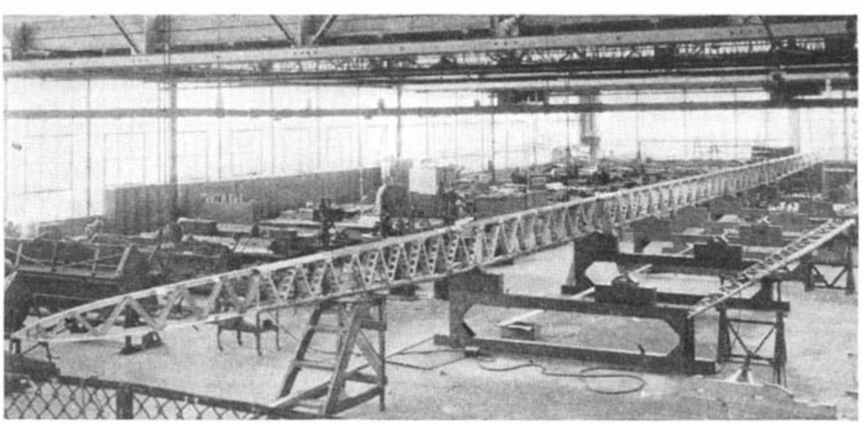
We have always claimed that large flying boats suitable for oceanic service should be equipped with the same care and completeness as an ocean liner. In the *Brazilian Clipper* the total weight of equipment is 2181 pounds, and comprises the following list of items, not one of which is superfluous and all of which are desirable:

Hat Holders	Tool Kit
Fish Oil	Water Containers
Flash Light	Tables
Hand Axes	Coat Rails
Utility Rope	Smoking Stand
10 Quart Pail	Table Racks
Air Rafts (3)	Life Buoys
Spare Parts Kit	Fire Extinguishers
Automatic Pilot	Drinking Fountains
Flit and Spray Gun	Towel Holders
Machete	Toilet Paper Holders
Paper Cup Holder	Sanitary Pad Holders
Radio Wiring	Signs and Frames
Food	Magazine Holders
Life Jackets	Batteries
Anchor	Landing Lights
Anchor Cable	Generators
Fog Horn	Towing Pendant
Ship Bell	Pilot Seat Cushions
Very Pistol	Safety Belts
Boat Hook	Anchor Winch
Heaving Line	Radio Table
Water Canteens (3)	Radio and Mech. Seats
Food Box	Carpets
Bilge Pump	Curtains
Sea Anchor and Line	Steward's Seat
First Aid Kit	Radio, Complete
Parachute Flares	Radio Antenna
Misc.	Starter Handle
(Books, et cetera)	Starters
Entrance Railing	Ring Cowling
Strong Box	Engine Fire Extinguishers
Cupboards	Oil Regulators

Colonel Charles A. Lindbergh is the Technical Consultant for Pan-American Airways who purchased the ship, and himself carried out a number of the acceptance tests. One of our photographs shows the *Clipper* just about to land with Lindbergh at the wheel. Our readers will notice that the landing is made with flap depressed. It is true that the flap extends only to the ailerons, but it is huge nevertheless and no pilot can quickly operate it by manual strength. Hence an ingenious flap control mechanism has been worked out. This mechanism is shown schematically. The mechanism is hydraulic, with control handles suspended from the cockpit roof near the throttles. A master actuating cylinder, supplied with oil under pressure from an electric power-supply unit, pulls the flap down through direct cable and pulley connections to the control horns. The flap is raised by the action of six small cylin-



Two gasoline tanks are mounted behind each engine on the *Clipper*



One of the huge wing beams of the *Brazilian Clipper*

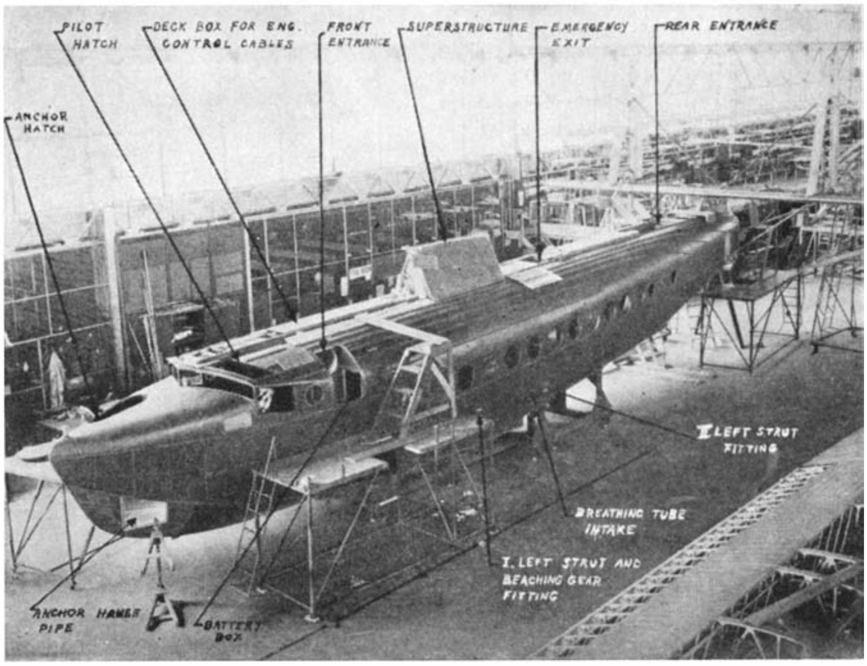
ders (three to each flap section) mounted in the trailing edge of the wing, with plungers directly connected to the flap horns. An important safety feature is embodied which prevents the use of the flap when the flying speed is too high for it to be safely employed. In such a case the air loading on the flap becomes too high and by an ingenious arrangement of pressure relief valves and by-pass connections the flap is allowed to rise till its loading is again normal. As air loads ease off, the flap automatically returns to its original position.

In the photograph of the hull nearing completion may be seen many important points. At the very front end is the anchor hatch, with the anchor hawse pipe at the bottom. Then there is the pilot hatch. On the top of the hull is the deck box for the complicated engine controls and cables. The front entrance is on the left or port side. Immediately in back of the superstructure on which the wing is mounted, there is a rear emergency exit. The rear entrance is on top of the hull. Strut fittings are also indicated in this photograph.

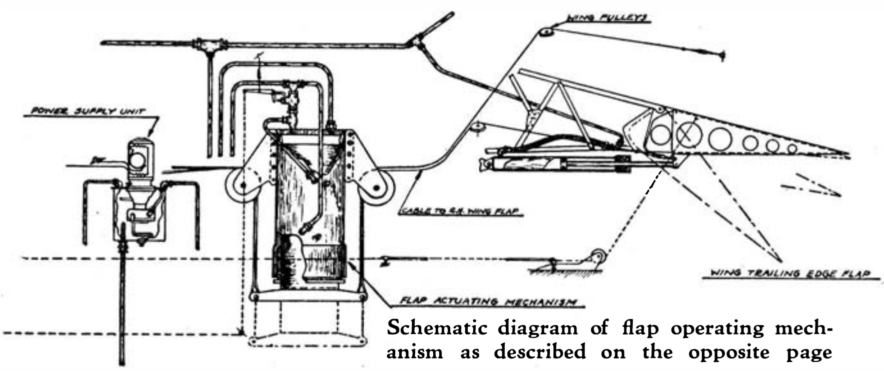
There is not space in these columns to illustrate all the complex devices and structural elements required. We can only select vital elements.

The tremendous wing spar is continuous from tip to tip, of a modified Warren truss type, and is composed of extruded and built-up dural sections, assembled by riveted and bolted-on gusset plates. For the flange members (that is, the long members top and bottom) a very ingenious extruded C section with a uniform thickness of $3/16$ of an inch is employed. In highly stressed locations the C section is reinforced by the insertion of telescoping half-round tubular liners of dural. Where extra strength is required steel bolts are also substituted for rivets.

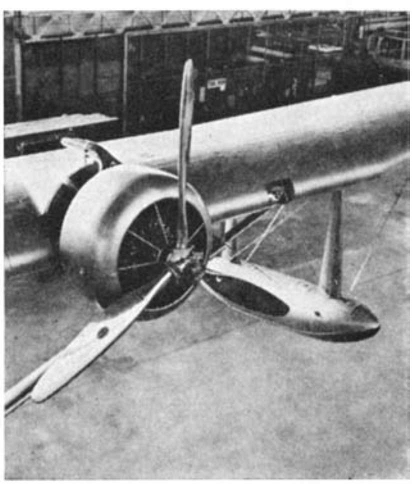
In the interior of the hull, accessibility for maintenance is excellent. The main hull framing consists of a deep girder keel of



The *Brazilian Clipper* hull nearing completion



Schematic diagram of flap operating mechanism as described on the opposite page



Mounting of an outboard engine; wing-tip pontoon in background

which the stem and stern posts are integral parts. There are eight built-up bulk heads all equipped with leak-proof doors to divide the hull into nine water-tight compartments. The many stringers, longitudinals, and outside plating are riveted together to form a structure almost as solid and permanent as the hull of an ocean liner! All seams are sealed with impregnated cloth during fabrication. To guard against corrosion, anodic treated dural is used throughout. Flush riveting is used so that the outside surface is perfectly smooth. The main bulk head extends downward to form the front step and upward to provide the rear superstructure bulk head to which the rear wing spar is attached.

Another photograph shows the mounting of the outboard engine on the wing, with its Venturi cowling, and three-bladed adjustable pitch propeller. The engine is carried by welded steel tubing attached directly to the spars and no attempt has been made to insulate engine mounts with rubber. Nevertheless, no vibration from the engines is noticeable in the cabins. The mass of the wing is evidently large enough to dampen out engine vibration before this reaches the cabin. The fuel is carried in eight elliptical riveted dural tanks of 150 gallons each, supported by the drag trusses between the main wing spars. The tanks are arranged in pairs behind each engine.

The boat represents the results of a lifetime of experience for Igor Sikorsky, and his able Chief of Design M. Gluhareff. —*A. K.*

Air Capers

IT is sometimes refreshing, after reading the learned but endless reports of the aerodynamic laboratories of Europe and North America, to have a heart-to-heart chat with a practical and finished flyer. We are referring to Gevhard Achgelis, a German pilot, pupil of the famous Udet, who thrilled thousands of spectators at the Cleveland Air Races with his wonderful stunts. Strange to say, Mr. Achgelis understood the writer's German, spoke no English, and was glad to converse freely in his native tongue.

We have in this country the most finished naval and military aviators. At Cleveland the "Flying Trapeze," composed of three planes flown by service pilots, flew but a few feet apart and simultaneously performed loops and wingovers with delightful ease. The "Lufberry Circus" was also amazing to watch. Planes flew in single file, each imitating the one ahead, and playing a gigantic game of "follow the leader" in the air.

Al Williams made power dives, zooms, and wingovers with his usual precision. But there is one art in which our pilots perhaps lag, and that is the art of fantastic capers near the ground, and this art Achgelis demonstrated to our heart's content. It is true that he had a very lightly loaded ship with oversize controls, but to watch him side-slip within a few feet of the ground, cut the grass with one wing tip, and make his plane stagger in drunken fashion, all quite evidently with perfect control of his craft, was awe-inspiring. We criticize him only for making an inverted loop over the grandstand—a perfect feat, but one which meant danger to dozens of spectators.—*A. K.*

The Cleveland Air Races

THE Air Races of 1934 were a remarkable success. Every event passed off with perfect smoothness and without the slightest confusion, in brilliant sunshine and cool weather. On Labor Day some 90,000 people witnessed the most interesting events of the series. Instead of Air Race Week dragging along over a period of ten days it had been compressed into four days with great benefit to all concerned, spectators and contestants alike.

Air Race Week was marked by one disastrous event—the death of Doug Davis—who had already won three prizes and was leading in the Thompson Trophy Race for machines with unlimited power—the air speed classic of the United States.

The cause of this accident is readily explained. Times are hard nowadays and backers for entirely new ships are difficult to find. Hence, instead of exhibiting novel planes of more refined design, the racing aircraft constructors contented themselves with merely installing more powerful engines and relying on brute force to give greater speed.

Now, the installation of a more powerful engine in a good plane is not so very dangerous in straight, cross-country flying in moderately bumpy weather, but in the Thompson Trophy Race, with its short laps of 8⅓ miles around four pylons (the short laps were arranged, naturally, to give the crowd a greater thrill) the pilot is almost never flying on a straightaway. With his high burst of speed, something over 300 miles an hour at times, he flashes over the course and attempts to negotiate the 90-degree turn at the pylon with a minimum loss of speed. To lose little time at the pylon the proper procedure is neither to zoom up nor to dive down, but simply to make a rapid, tight turn. The more powerful the engine the greater the speed, and the greater the centrifugal loads which may be imposed on the ship in such a turn. At the same time, the more powerful the engine, the more violent the slipstream of the propeller, the greater the control available to the pilot for tightening the turn.

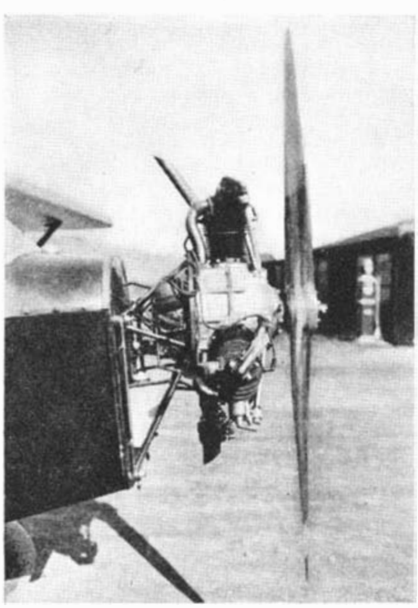
In Doug Davis' ship the power had mounted from something like 430 horsepower in the Junior Wasp to perhaps 730 horsepower in the Senior Wasp. With the fever of the race in his blood, leading the field by half a lap, Davis perished through failure of a wing, brought on undoubtedly by the tremendous centrifugal forces experienced.

Next year a Racing Pilots' Association is to be formed to inspect the planes before each race.

Light Planes and Moderate Power Engines

THERE is at the present time quite a revival of interest in low-powered planes; that is, planes with engines of something under 60 horsepower.

Our light plane designers have met the challenge of moderate price combined with



The "Cub" with engine cowling in place, showing the enclosed cabin

The new Luscombe "Phantom" for private flying

good efficiency, and for less than 1500 dollars it is now possible to buy an efficient, thoroughly good flying machine of easy maintenance suitable for the private owner flier of moderate means.

An excellent example of the low-powered plane lies in the Taylor "Cub" which is powered with the Aeromarine AR3-40 engine and illustrated in the two photographs. The occupant of this small ship is given enclosed cabin protection by a very complete wind shield in front with openings at the side of the fuselage.

The Taylor "Cub" has, according to the manufacturer, the following specification:

Weight Empty	528 lbs.
Useful Load	412 lbs.
Gross Weight	940 lbs.
Take Off Run	120 ft.
Climb (first minute)	600 ft.
High Speed	94 m.p.h.
Cruising Speed	85 m.p.h.
Cruising Range	175 miles
Gas Consumption	3½ gals per hour
Gliding Ratio	10 to 1
Landing Speed	30 m.p.h.
Landing Run	100 ft.

A great deal of the increase in interest in the low-powered plane lies in the fact

Simple yet strong engine mounting used on the Taylor "Cub" described

that satisfactory engines are now available. Thus in the Taylor "Cub" the engine employed develops 40 horsepower at 2050 revolutions per minute. The AR-3, which is very similar, develops 50 horsepower at 2100 revolutions per minute.

The Aeromarine light engines have been approved by the Department of Commerce, are in use in many light planes in this country, and have also been shipped to Brazil and Czechoslovakia. While only three cylinders are employed, the balance and smoothness are all that can be desired. The weight without hub and with two magnetos is 150 pounds. The bore is 4⅛ inches and the stroke is 4 inches.

Some elements in construction are as follows: The cylinders are of forged steel with heat-treated aluminum-alloy heads. The valves, push rods, rocker arms, and tappets are entirely enclosed in oil tight castings. The magnesium crank case is divided into two parts which are very easy to assemble and maintain. The entire assembly of the crankshaft and its adjacent parts is made independent of the rest of the engine. The regular standardized mount is provided for starter and generator.

A light engine of this type is bound to help private flying considerably.—*A. K.*

Private Flying Goes Ahead

WE were recently invited by a prominent private flyer to take a hop in his new "Phantom" put on the market by Don Luscombe a short time ago. Just a short flight over North Beach Airport brought home to us very forcibly what remarkable progress planes built for private owners have made in recent years.

First of all there was perfect vision. The Pyralin windows, front, side, toward the rear, and up above, gave us as complete a view of the landscape as in the most unprotected open cockpit. A scoop at the front and a ventilation opening at the rear of the cabin gave fresh air, without drafts, with all windows closed. A comfortably padded seat with a safety belt that snapped shut in an instant made an excellent impression. With the monocoque dural fuselage to replace the old fabric covered fuselage, there was not the slightest rattle or vibration anywhere. This freedom from vibration is due also to the perfectly running and well balanced engine, rubber mounted.

Of course, our host and pilot was a master of the art. Nevertheless, it is remarkable how such a modern cabin plane as the "Phantom" responds immediately, neatly, "tidily," to its controls. The writer of this note, a most indifferent pilot, was strongly tempted to take a hand. The rapid take-off was matched by the easiest of landings, using the flaps.

The flaps nowadays are no longer manually controlled, which is fortunate, since control stick and throttle usually engage the pilot's attention in landing. The flap on the rear of the wing is actuated by a small electric motor which turns the shaft about

which the surfaces hinge. The motor stops automatically at the proper full position without any attention. The only adjustment required is a slight lowering of the horizontal stabilizer to prevent any possible nose heaviness.

These new private planes are equipped with everything the heart of a man can desire—luggage space, instruments of every kind, landing lights, starting motor, and so on. They are fully as well equipped in their way as the large transports.

With a 145 horsepower Warner engine and a gross weight of 1950 pounds, a cruising range of 560 miles and a top speed of 168 miles an hour are realized. The landing speed with flaps down is 45 miles an hour.

Our photograph shows a front view of the machine with its trim lines. The reader will note that the landing gear is entirely cantilever with all bracing hidden.

With planes such as the Luscombe "Phantom," and with more and more airports and landing fields, it is not surprising to hear that at the Cleveland Air Races some 45 Monocoupes and as many Fairchilds and Wacos were flown in to see the races by private flyer-owners.—*A. K.*

Indoor Bombing

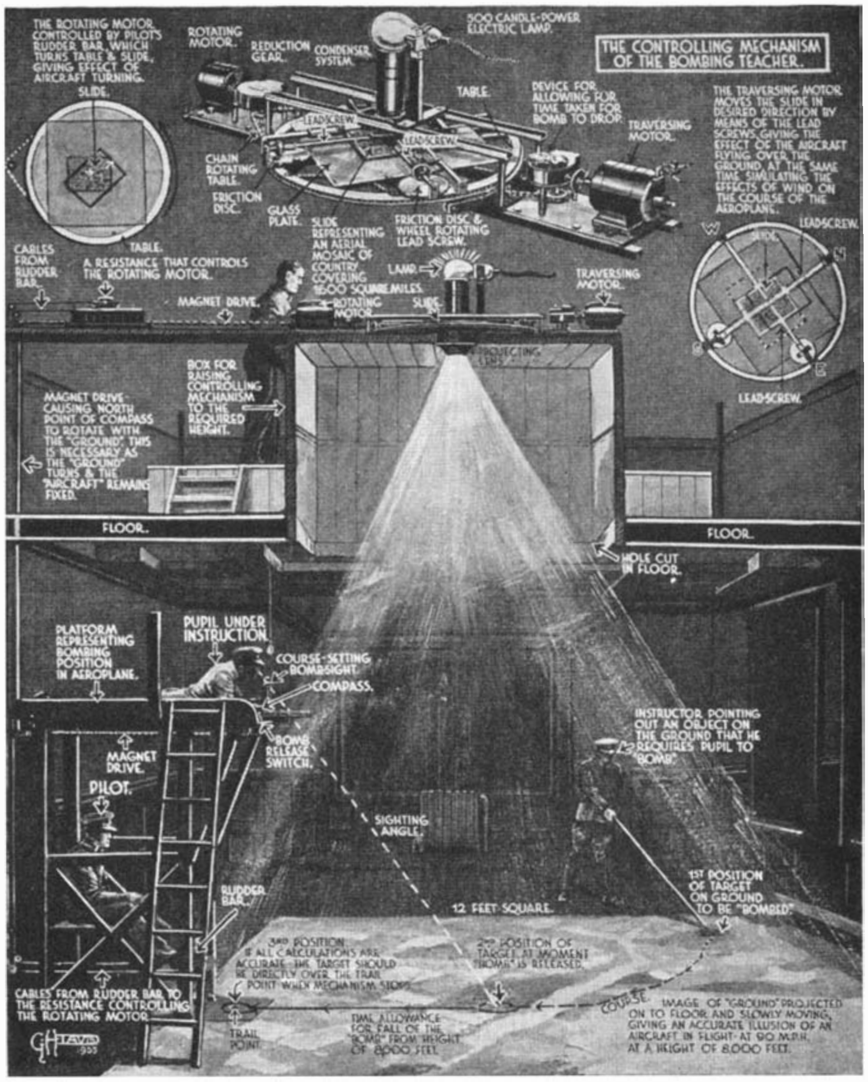
BOMBING from the air is now a very complicated art and is no longer simply a matter of flying an airplane over a target. A great many factors have to be taken into consideration, such as the altitude and speed of the plane, the direction and speed of the wind, the aerodynamic properties of the bomb, and so on.

The most sensitive instruments, involved calculations, and close co-operation between the bomber and the pilot are required. To train a bomber is a long and delicate business. It requires much work with practice bombs dropped from an airplane, as well as a lengthy course of instruction on the ground.

British aircraft squadrons are now adopting the Vickers-Bygrave Bombing Teacher with excellent results. An artist of *The Illustrated London News* has prepared a diagram of the new bombing trainer which is almost self-explanatory, with perhaps the following additions:

Instruction takes place in a darkened room, the floor of which is whitened. On this floor is projected, by means of a lantern slide, an aerial photographic mosaic printed on a transparency 10 inches square. This represents some 1600 square miles of country. The scale of the transparency is about 1 to 200,000 so that it is impossible to show very fine details. There is, however, sufficient detail for the recognition of ground marks and for production of a realistic representation of the ground as seen from a height of 8000 or 9000 feet. The pupil under instruction is lying prone on a platform which represents the airplane. By means of the mechanism shown, the image of the ground is moved towards the platform from various directions, thus simulating the effects of wind on the course of the aircraft. Thus it is possible, by means of this apparatus and various timing devices, to imagine the airplane as approaching the target from any direction at a variety of speeds, with flat, slow turns, and so on.

The platform itself is fitted with navigation and bombing sighting equipment for



The equipment used for indoor bombing practice

the use of the student under instruction, and a seat and rudder bar for the pilot. Pupil and pilot are in communication by means such as are normally used in bombing airplanes.

When the pupil has calculated the direction and force of the wind and has sighted on the target, he throws a switch which represents the bomb release. A device defines an interval equal to the time taken by the bomb to reach the ground. At the end of this period the movement of the projected slide is stopped. Painted on the floor of the room is a fixed trail point which marks the point on which a correctly aimed bomb should drop. Any error may be seen by the difference in the positions of the target and the fixed trail point. Exercise with this device is said to save a great deal of time and expense in the air.—*A. K.*

Glass Wool Made by Centrifugal Force

SHREDDING glass into wooly fibers by centrifugal force is the unique process developed by a Swedish manufacturer of glass wool. Melted glass runs down upon a disk which rotates with great velocity. By action of the centrifugal force, the glass is disintegrated into a mass of extremely fine threads. A current of air is blown downward around the edge of the rotating disk, carrying the formed glass wool down upon a cutting and transporting apparatus, by means of which the product is continuously carried away for further working. The fineness of the glass threads can be controlled within certain limits by regulating the temperature of the melted glass and the amount of glass fed upon the rotating disk per unit of time. By the method described, much finer threads can be produced than by other methods. Insulating mats manufactured from the glass wool by pressing and sewing contain only approximately 4 percent of glass by volume.—*A. E. B.*

Milk In Tuberculosis

SINCE ancient times milk has been recognized as a valuable adjunct in the feeding of the tuberculous sick. With all the advances in the treatment of tuberculosis this perfect food has not lost its prestige but still remains the one most important article of diet for these patients.

At one time before the modern era of clean, pasteurized milk, and the eradication of tuberculous cattle, other forms of tuberculosis, not of the lungs, were not infrequently encountered. Whether because of, or coincidental with these procedures, true it is that analysis of all types of cases of tuberculosis reported shows a steady decline in the actual and relative numbers of extra-pulmonary types of tuberculosis. Certain it is we now no longer seem to see as

many people with spinal, hip or glandular disease walking the streets as in former years. In other words, milk in general, always the best of all foods, is now also safe for human consumption.—*Health News* of the New York State Department of Health.

Mustn't Cuss on Short Waves

BECAUSE of the large numbers of possible listeners-in on short wave radio sets, Forest officers are finding it necessary sometimes to tone down their working vocabularies, even under the stress of battle with the flames. Strict orders against "cuss-words" in radio messages have been issued, the Forest Service revealed recently, in reporting that more than 600 radio stations have been installed for emergency communication in the national forests.

Now that short wave receivers have become so popular, radio gives far less privacy than even the old-fashioned party telephone line, according to the Forest Service. Thousands of listeners are picking up the Forest Service messages, and occasionally getting a real insight into the many difficulties and problems foresters have to meet in quelling fires in the woods.

Movie Camera and Projector Combined

A COMBINATION camera and projector for taking and showing amateur motion pictures has recently appeared on the American market under the name of Midas. This instrument not only has the feature of

combining two functions, but the actual taking of the pictures is achieved without the use of either a hand crank or a spring operated motor.

The camera is composed of two separate housings, one of which contains four standard sized flashlight cells. These operate a tiny but powerful electric motor which drives the film during exposure. It is claimed that the four small cells will operate the motor long enough to take 50 reels of film, each 30 feet in length. When the instrument is used as a projector, the cells furnish current for lighting a small incandescent bulb. While it is also possible to operate the film during projection by means of the contained electric motor, better lighting of the screen is obtained if the hand crank is used for running the film.

The lamp usually used is a 4.8 volt light operated on an over-load and consuming approximately 2.5 watts. The illumination is sufficient to throw a picture about three feet to a screen approximately 16 inches wide. The motor which drives the film consumes from .5 to .8 of an ampere under load.

The film used is 9½ millimeters wide with center perforations between the frames. Thus a picture on the film is obtained which is almost as large in area as on a 16 millimeter film, since the 9½ millimeter frame extends to the very edge of the film. The 30-foot reel of film will give approximately 2½ minutes of continuous action.

The camera is equipped with a *f*2.5 fixed focus lens which is provided with a diaphragm for controlling the amount of light. The same lens is used for both taking and projecting pictures.

Cellulose Acetate Business "Booms"

ONE of the industries that have been "booming" in spite of the depression is cellulose acetate. Indeed, cellulose acetate sales during the worst year of the depression were over twice as high as in the top year of the preceding boom. Of

Left: **Amateur movie camera-projector that uses dry cells. *Above:* Battery box open, showing cells. *Right:* Inserting the center-perforation film in the simple gate provided**

course, this was due to the fact that many new and important outlets for this chemical product have been developed since the depression began—"Celanese" rayon, safety glass, non-flammable film, transparent wrapping material, and plastics. Arthur D. Little's *Industrial Bulletin* explains some of the reasons for the growing use of cellulose acetate as follows:

"Acetate rayon, such as 'Celanese,' consists of fibers of cellulose acetate instead of the simpler regenerated cellulose of viscose rayon. As dyes used for other fibers have in general no effect on acetate, and since many of the new dyes developed for acetate affect no other commercial fibers, acetate is widely used for cross-dyeing. The low moisture absorption of acetate tends to prevent its shrinking and swelling. Its extensibility reduces bagging and wrinkling. Early difficulties in weaving acetate yarns have largely been overcome, and distinctive new fabrics developed. The popular dull finish is excellently produced upon acetate without loss of the fiber's soft 'feel.'

"The trend of demand for rayon is strongly toward finer filaments, as these may be woven into softer fabrics, with better appearance, feel, and covering-power. Acetate lends itself particularly well to the spinning of these fine filaments, for, whereas the spinning speed for viscose rayon must be decreased with decrease in filament size, acetate filaments of even the finest commercial deniers may be spun quite rapidly.

"Increase in the use of cellulose acetate sheeting, as the plastic filler sandwiched between two glass plates to form safety glass has been spectacular. Since 1932, before which its use for this purpose was negligible, acetate has all but entirely displaced Pyroxylin.

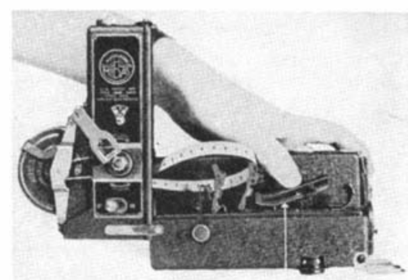
"Cellulose acetate films include not only the slow-burning safety-film used for home movies, X-rays, and so on, but also a transparent wrapping material which is claimed to provide a closer, more even, and more uniform fit in packaging. Cellulose acetate plastics, though as yet relatively unimportant, continue to find favor for certain applications, chiefly because of their slow-burning qualities and their stability to light and heat, without discoloration or loss of transparency or translucency."—*A. E. B.*

When to See a Doctor

OUR present system of consulting a physician only when pain or distress drives us to it is old-fashioned. As a result we are not benefiting as fully as we might by the modern discoveries of medical scientists.

This, in effect, is the contention of Dr. Stanley H. Badock, Pro-Chancellor of the University of Bristol, England.

The physician could do much more to keep us healthy if we laymen were not "still



thinking of recipes for keeping the doctor away," Dr. Badock pointed out in his presidential address before the Congress of the Royal Sanitary Institute.

We are still thinking of the doctor "exclusively as the curer of our diseases instead of as the guardian of our health," he charged. This is not in keeping with the new viewpoint of physicians with its emphasis on the preventive aspects of medicine.

The physician is now equipped with an armory of weapons to confer immunity against many diseases and he is increasingly conquering disease by working with nature to stimulate the natural defenses of the body. Physicians generally are agreed that their services are often sought insufficiently early, when the disease has already made itself felt and is perhaps somewhat advanced, and when a much earlier consultation would have made a complete cure more possible.

"It is obviously undesirable that we should be watching for early symptoms in our own bodies, even if we were qualified to observe them," Dr. Badock stated. "But it is equally clear that the present system does not give the general practitioner the preventive scope which he desires."

One solution of the problem which is favored by physicians and health authorities both in England and America, although Dr. Badock did not specifically mention it, is the system of yearly examinations or birthday health examinations, as they are sometimes called.—*Science Service.*

The Plumber Had a Silver Mine . . .

HOW a smart plumber in Hollywood called attention to the need for some chemical engineering in the studio is related by A. B. Laing in *Chemical and Metallurgical Engineering.* In the laboratories of the movie producers, where vast quantities of film are developed and printed every day, the solutions used in the processing were known to contain considerable quantities of silver dissolved from the film during "fixing." One particular studio had constant trouble with clogging of the pipe line leading from the tank in which used "hypo" was stored. Each time the same plumber was called in to make the necessary repairs. To every call he responded with remarkable promptness, digging up the pipe, removing the old lengths, and replacing them with new pipe.

Suspicion was finally aroused, particularly because the bills presented for this service seemed too low in view of the work involved. Upon investigation it was found that by laying some lengths of pipe out of level, at the end of the line, which would always be filled with old hypo solution, the plumber had deliberately constructed a hypo-trap of about 100 feet length, in which silver dissolved from the films during the process of developing was precipitated on the metallic iron.

It was therefore a veritable silver mine which the ingenious plumber had been diligently working up to the time when the owner of the studio, exercising his priority rights, jumped his claim and terminated his highly profitable "contract."

Since that time several methods of processing high-silver hypo solution have been worked out with the result that much silver is recovered from the spent "hypo," and, in addition, the new methods keep the hypo fresh and simplify film development. —*A. E. B.*

Where Old Oil Tankers Go

UNSEAWORTHY oil tankers are being used as storage tanks in the lake and bayou regions of the Louisiana gulf coast area.

American College of Surgeons Not Teaching Body

WHAT is the American College of Surgeons? is a question often asked. The American College of Surgeons is not a teaching institution but an association of surgeons and surgical specialists of competency and of character who are engaged in a common pursuit to improve the service which they are rendering to the public; to better the hospitals and other surgical environments; to improve surgery that is necessary, and to eliminate careless and unnecessary surgery; to conduct practical research into surgical problems; and to give the public personal acts that will tend to preserve health and prolong life.

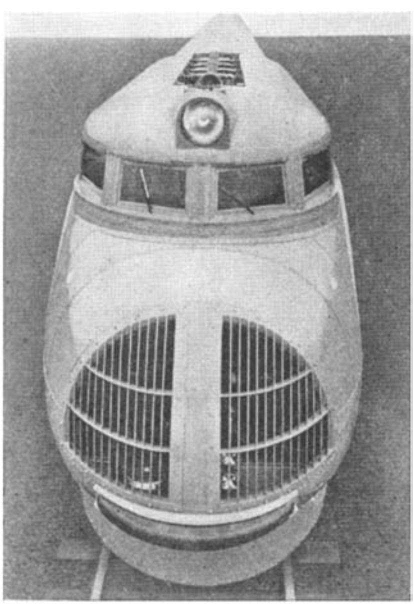
This College of Surgeons is not a political or governmental body. It is a great fraternal organization, guided by public requirements, and universal laws that have resulted from centuries of service.

Each candidate for Fellowship in the American College of Surgeons must furnish positive evidence of preliminary primary and college training; a four or five year course in an approved medical school; a degree of Doctor of Medicine; a license to practice in his community; one to three years of training in a good hospital, or its equivalent; satisfactory assistantship in surgical service; at least seven years of medical and surgical practice; 50 to 80 percent of his work devoted to surgery or a surgical specialty. Above all, he must be morally, ethically, and professionally acceptable.

As practical evidence of his diagnostic, scientific, and professional judgment and his surgical qualifications, he must submit to the College for approval 100 case records of surgical operations which he himself has performed, and finally he must sign a Fellowship Pledge which declares that he does not obtain his patients by paying commissions, or through other unworthy commercial transactions.—*Science Service.*

The Effect of Streamlined Trains on Railroading

THE new streamlined trains of the Union Pacific differ from the average conventional passenger equipment of today in design, weight, power, speed, and control. These five fundamentals are complementary



Front end of new Union Pacific streamlined train, showing air intake

and interdependent. The results expected to be attained by this departure from the conventional are two-fold: greater comfort and convenience for the traveling public, and lower operating costs.

The first streamlined train, of three cars, was delivered to the Union Pacific in February, 1934. For purposes of exhibition and demonstration it was taken on a tour which extended from coast to coast in which it was subjected to varying operating conditions of gradients, curvatures, climates and altitudes. During this tour, which embraced nearly 13,000 miles and which took the train over the lines of fourteen different American railroads in twenty-two different states, there were no road failures and no accidents and every one of the scheduled 68

Carl R. Gray, President of the Union Pacific System

exhibition stops was made and the train returned to Chicago five minutes ahead of the time set when the tour began some twelve weeks before.

The second train, just being completed, and in which has been incorporated corrections of minor details developed through the testing of the first train, consists of six cars, three of which are Pullman sleepers. The third and fourth trains are on order for delivery this winter. These will consist of nine cars each, four of which will be Pullman sleepers.

As previously mentioned, it is hoped that the new streamlined train will provide greater comfort and convenience to the traveling public and at the same time result in lower operating costs.

Greater comfort on the new train is attained through the fact that the trains are completely air-conditioned and also by reason of complete insulation against the usual vibration and train noises. The articulation of the cars and the employment of roller bearings throughout, together with the cushioning effect obtained by the liberal use of rubber between the trucks and car bodies, improves riding qualities. The lowered center of gravity, while primarily a safety factor, causes the train to "hug the rails" and gives the forward motion a gliding quality.

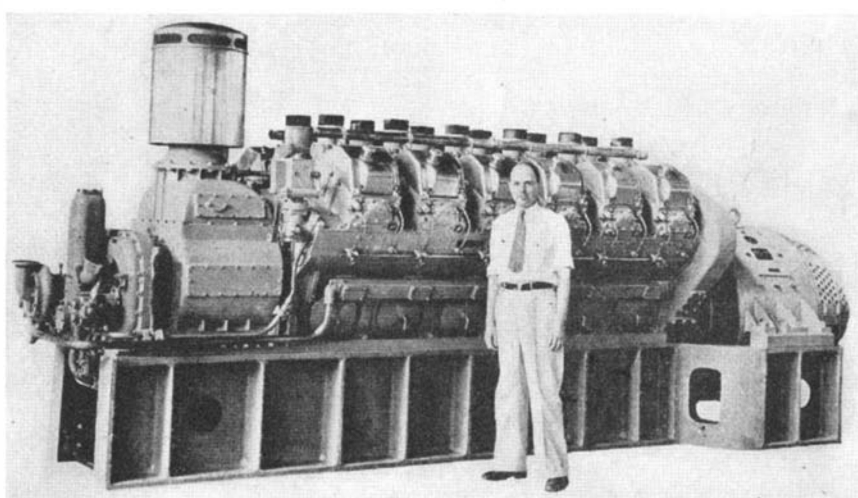
A feature of the Union Pacific streamlined train is the development of a new type of Pullman sleeping car. Each berth, both upper and lower, has a collapsible washbowl. An illuminated mirror in each berth adds greatly to convenience. Every section, every berth in fact, at night is enclosed with sliding aluminum panels, making them individual small rooms and insuring absolute privacy for the traveler. The passenger in the upper berth uses a folding stairway which has a small platform at its top, sufficiently large so that one may stand while dressing.

As to the matter of economy there is involved, first, the question of original cost as compared with present standard equipment, and second, operating costs. Original costs now are necessarily high as these early trains include research, engineering, and laboratory expense. Each train, so to speak, is "tailor-made." Mass-production costs will be quite different. However, the power units of our six-car train and our nine-car trains will pull a transcontinental train all the way from Chicago to the Pacific—a job now done in relay by five steam locomotives, costing 80,000 dollars each. Because of the greater speed, five of the streamline trains will take the place of seven conventional steam trains on a Chicago to Pacific coast schedule.

As to operating costs, there will be no change in the size of crews involved. Fuel costs of the Diesel-electric drive are expected to be one fourth that of steam.

The important still "unknown quantities" are maintenance and depreciation. There will be less servicing enroute during operation and a reduction in periodic overhaul. These new streamlined trains are in process of development and improvements are likely to be made.

I do not foresee any disorganizing and "revolutionary" over-turn in re-equipment of our railways. It seems to me more likely that progress will be steady—evolutionary



V-type, 900-horsepower Diesel-electric engine on Union Pacific train

rather than revolutionary. Initially at least the streamlined trains will be operated in addition to the present steam train schedules; that is, the present steam trains will not for the near future be displaced. Later, new types of trains will progressively succeed old types on a steady, "normal replacement" basis.—*Carl R. Gray, President Union Pacific System.*

Portable Grinder

A NEW portable electric grinder of the universal type which has a built-in air filter, effectively filtering all air entering the motor, weighs four pounds, turns up 17,000 revolutions per minute, and has ample power to pull a wheel two inches in diameter. The motor housing, of heavy cast aluminum, extends out over the motor shaft and air filter, and is encased with an insulating cushion grip, giving positive control and operating flexibility. This new tool, made by the Chicago Wheel and Manufacturing Company, is compact, well balanced, and, with suitable grinding wheel or cutter inserted in the universal case-hardened chuck, will work at an angle and get into and around corners, irregular shaped holes, and other hard to reach places.

Portable grinder for small hand operations, weighing only four pounds

The filter is of the viscous type and can be easily removed for cleaning or re-oiling. Tests running over a period of a year in various shops have proved the air filter a most efficient protection for keeping all dust and abrasive matter out of the motor and bearings. Ventilation is in no way impaired even when the filter becomes extremely loaded with foreign matter.

Rubber in Tree Surgery

A PLASTIC rubber tree cavity filler has been perfected as the result of experiments conducted by the Goodyear Tire and Rubber Company and the Akron, Ohio, parks department. The filler readily adheres to the cavities or scars of damaged trees and prolongs their lives indefinitely. Supplementing the cement is a new tree paint for minor cuts and scars that may be used to cover cuts resulting from pruning and trimming.—*A. E. B.*

New Poison Gas Discovered by Accident

A NEW type of "poison gas" that has an even nastier disposition than the hideous concoctions of the World War, was described at the recent meeting of the American Chemical Society in Cleveland, by Dr. George H. Cady. Chemically, this new substance is something of a freak, being composed of nitrogen, oxygen, and fluorine according to the formula NO_3F. Because of its freakish composition it is very unstable and explodes violently when heated. Thus, it would be theoretically possible to flood

(*Please turn to page* 324)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

FREQUENT demands for instructions for calculating the optical system of a rifle telescope sight led us to invite Alan R. Kirkham, of Tacoma, to prepare an article telling how it is done, and the first half of that article is presented below. Mr. Kirkham is the author of two chapters in "Amateur Telescope Making" and has made a variety of telescopes, eye-pieces, and microscopes. More recently he has undertaken telescope sights, at the request of various riflemen, and with success. If the article which follows is not wholly clear to all readers this may indicate merely that they have not, as they should before attempting a rifle sight, previously made an ordinary refractor from the instructions in "Amateur Telescope Making." A rifle sight is a special case of the refractor. Mr. Kirkham writes:

Telescope Sights

THERE are so many ways of building a telescope sight that to describe any single way is almost certain to invite hearty disapproval if not derision from various sources. However, in the following account, we shall describe a simple method which, beside requiring neither knowledge of mathematics nor tedious computation, has in practice been used to produce sights which have at least no obvious faults. It should be borne in mind that more refined and theoretically superior sights can be designed, but only at a tremendous cost in time spent in ray tracing and analytical calculation. While not extremely difficult, such computation is very complicated and time-consuming, and if the improvement is really only theoretical, its value may be questioned. Should one aspire to such things, the best recourse is to Conrady's "Applied Optics and Optical Design" or kindred treatises, of which the one mentioned is no doubt the most exhaustive.

Figure 1 shows the paths of light rays emanating from an element in the bull's-eye with the rifle expertly aimed. The rays are considered to be parallel up to *O*, the objective. They converge to a focus F_1, after which they diverge, falling on *I* and *I'*, the erector lenses, which cause them to converge again to a new focus at F_2. At F_1 the image is inverted, while at F_2 it is erect and is viewed through a low power eyepiece. In order to have the requisite eye distance, this should be a *thin* cemented doublet. The focal lengths of the four lenses are f_1, f_2, f_3 and f_4, respectively. The erector magnification is f_3/f_2, and the focal length of the objective should be multiplied by that value, in order to find the equivalent focal length of the entire sight exclusive of the eyepiece. Calling this *F*, we have F/f_4 for the magnification with any eyepiece of focal length f_4. If there is a separation between the erector lenses, the distance doesn't count, but once worked out, a variation in their separation will result in different magnification. The use of this property in securing adjustable magnification is nevertheless attended with considerable difficulty, since the whole unit must move as the separation is varied if the telescope is to remain in focus.

The exit pupil diameter is perhaps the best place to begin in finding the diameters of the lenses and stops. In general, a large exit pupil will necessitate a large objective. The exit pupil diameter, d_3, is the effective diameter of the objective, d_1, divided by the magnification. A large exit pupil is therefore obtained with low magnifications, and is desirable for hunting sights where it is inconvenient to take time in getting the eye exactly in line with the telescope. For this class of sights, 2× to 4× with exit pupils 1/4 to 1/6-inch diameter is suggested. For target shooting, smaller exit pupils may be employed, even as small as 1/10 to 1/12 inch, which makes higher powers obtainable. The apparent field of view is about equal to the stop diameter S_2 seen at the eye distance. The diameter of the eyepiece should be equal to the stop diameter plus the exit pupil diameter. The erector lenses should be f_3/f_4 times the exit pupil diameter, after allowing a rim for mounting. If they are separated somewhat, make them a trifle larger and put a stop of that diameter between. The diameter of the stop S_1 is is now f_2/f_3 times that of S_2. The objective diameter is given by

$$\frac{f_1}{f_2} d_2 + \frac{f_1+f_2}{f_2} S_1$$

The first part of the expression gives the "effective diameter" mentioned above, while the second part is that which is added for the displacement of the cones of rays from objects at the edge of the field, as shown in Figure 2. The width of any field *w*, at a distance *D* (*i.e.*, to a target), is $w = (S_2/F)\,D$, to a close approximation. Curvature of field depends directly on the focal powers of all the lenses added together, hence very short focus lenses are to be rigorously avoided in any design.

Figure 2 indicates how the lenses should be turned, and also shows the paths of light rays from an object at the edge of the field. Figure 3 gives the construction of each lens. The hatched component represents ordinary flint glass of refractive index 1.615, and dispersion 36.6. The convex lenses may be made from borosilicate crown glass of refractive index 1.517 and dispersion 64.5, or of barium crown having an index of refraction 1.576 and dispersion 57.3. The radii for an aplanatic lens are given in the table in Figure 3, and have only to be multiplied by the desired focal length to obtain working data. The first row is for borosilicate crown and dense flint, as above, and

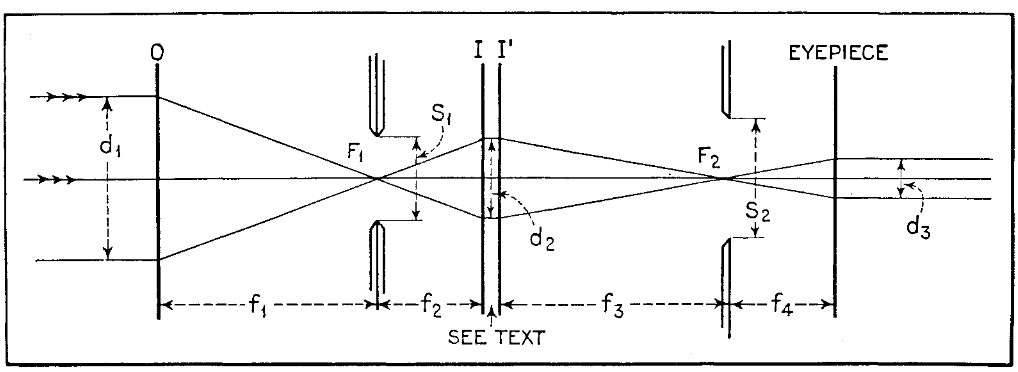


Figure 1: **Ray paths through a typical rifle telescope sight**

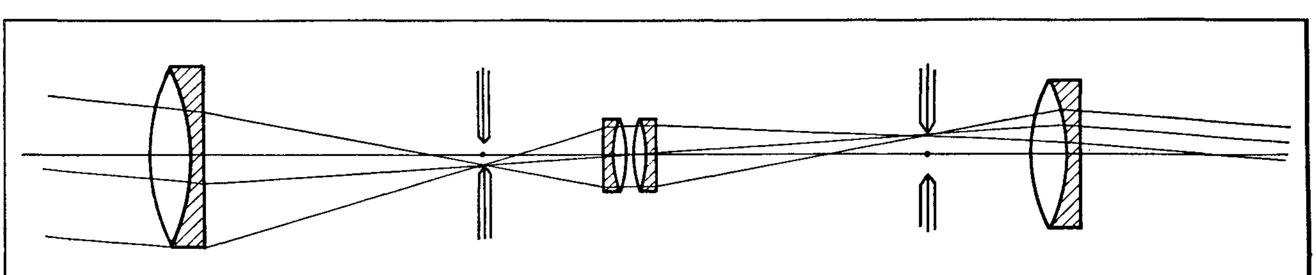
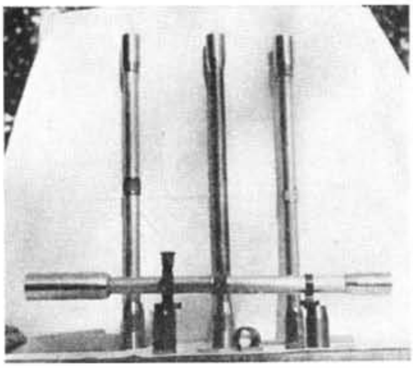


Figure 2: **Diagram of the lenses; also showing rays from objects at edge**



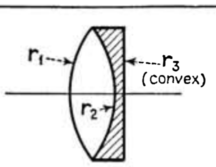
Four rifle sights made by the author. Their mounts, or attachments to rifle, at bottom, are by Lyman

the second is for the barium-crown-dense-flint combination, which has somewhat better color correction, and a considerably flatter field. The barium crown is not as durable, however and requires making more laps.

(*To be concluded.*)

IN the October number we published the Tinsley Laboratories' statement that not 5 percent of the mirrors sent them for silvering were fully polished out. Between the time when that note was inserted and its later appearance, two others wrote us virtually the same statement. B. L. Souther of Pittsburgh, who does silvering, and the American Telescope Company of the same city, who do aluminizing, each state that the great majority of mirrors sent them are far from polished out. Apropos this, J. H. Hindle of England gives the following method of detecting the most minute pits and scratches: Place a lamp at the right of center of curvature, where the pinhole normally goes in the knife-edge test. Then place the eye where the knife-edge would go. Move the head so that just the edge of the cone of reflected rays is seen. Defects of a kind normally seen only on focograms will be rendered visible. Mr. Hindle also commented, when on a recent visit to this country, on our note in the September number, regarding fictitious accuracy in measuring the radii of zones to thousandths of an inch. He does not undertake to measure closer than one 150th inch and believes closer attempts to be self-deceptive.

YOUR scribe complains that dealers omit to send him their catalogs, and leave him guessing where to direct inquirers for this and that. But one—a nice one, at that, with included star charts—has now come in unsolicited from the Optical Research Associates, of Plainfield, New Jersey, and this was so affecting that three big bandanna handkerchiefs were cried soaking wet. Mention of name is for revenge on others, and is not a precedent.



	r_1	r_2	r_3
1	.425	.425	10.00
2	.636	.309	2.825

Figure 3: **Radius factors (see text)**

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 321)

enemy trenches with it, poisoning all living creatures which breathed it until the gas reached a high enough concentration, at which time a shell, dropped in the gassed area, would cause the whole surrounding "atmosphere" to explode.

According to Dr. Cady: "When a small amount of the compound is inhaled one starts to cough, and a deep breath, even of fresh air, taken after a coughing spell produces still greater irritation in the lungs. In this respect the gas is something like phosgene.

"Although the substance appears quite harmless, being a colorless gas, it has a strong odor and is very reactive chemically. Its most interesting, as well as its most treacherous, characteristic is that it explodes violently when heated.

"The discovery was made during a study of some of the reactions of fluorine, an element something like chlorine. It was found that the reaction with cold, moderately dilute nitric acid produced a gas which could not have been anything previously described in chemical literature. Further research revealed the chemical composition of the compound."

This unpleasant substance was discovered quite by accident and its inventor is not particularly interested in it as an instrument of destruction. Rather, he hopes to find some industrial application in which the gas would be useful as a chemical reagent.—*A. E. B.*

Coal Burning Motor Truck

A RECENT demonstration in the United States of a coal burning steam truck has aroused considerable interest in road transport circles. These trucks are made by an English concern which has been continuously engaged in the production of steam road vehicles for the past 30 years. Thousands of these trucks are in service in England and other foreign countries where they have given satisfactory operation both from the standpoint of economy and reliability.

One of these Sentinel trucks is illustrated in an accompanying photograph. This vehicle has a maximum speed of 50 miles per hour with a normal cruising rate of 30 to 35. The steam generator consists of a cylindrical water tube boiler of 250 pounds pressure which is simple in design and readily taken apart for cleaning and inspection. There are 28 tubes, each two inches in diameter.

Automatic stoking and water level control are provided, permitting operation by one man. The water-tanks and bunkers for fuel are conveniently located in the rear portion of the cab. Sufficient water is carried for a normal run of 40 to 60 miles while the bunkers will hold sufficient fuel for a 150- to 180-mile run.

The motor unit is mounted on a three-point suspension carried below the frame and consists of a four-cylinder, 5½-inch bore, 6-inch stroke single-acting engine with cam operated poppet valves. Because of the horizontal mounting of the engine all moving parts are readily accessible. The output is 120 brake horsepower at 600 revolutions per minute. The fuel consumption is stated to be only 4 to 5 pounds of coal per mile.

Due to the flexibility and even torque of the power plant no clutch or gear changes are required.

The vehicle is equipped with two sets of brakes, one set to be applied by hand and the other actuated by steam power controlled by a pedal.

The Last Word in "Freshness" (?)

SO much emphasis has been placed on the "freshness" of coffee by ingenious advertising schemes, that the chemist has evolved a new kink that seems to cap the climax. Purchasers, confused by conflicting claims of freshness, need no longer wonder whether or not they are getting "fresh" roasted coffee, for chemistry is going to tell them as soon as they open the can. Foster D. Snell, prominent consulting chemist, has worked out a chemical indicator for the purpose. As an example, one form of this

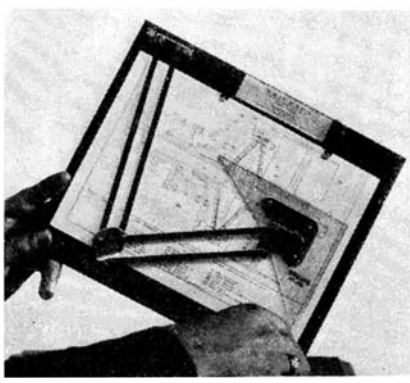
A type of coal-burning steam lorry used in England

indicator, when placed in a vacuum-packed can of coffee, is sensitive to oxygen. Therefore, when the can is opened, if it is a "leaker" the indicator will be pink. If the seal is tight, the indicator will be white, but it will turn pink in about 5 minutes, thus assuring the customer that the can has not been defective and that the coffee has not deteriorated. For foods where deterioration will liberate ammonia, the indicator is similarly a version of the well-known Nessler's reagent. In another form, it detects sulphides.

This system is to be properly visualized as a form of insurance to the customer as to the quality of the product, since the number of cases in which deterioration actually occurs is very small.—*A. E. B.*

A Drawing Board for Field Use

ONE of the accompanying photographs shows the Junior model of the Wrigraph draft block which was developed to meet the need of a low-priced unit for engineers and others, that can be carried in a brief case for convenient use in the field, on the train, in the office, or home. It consists of a board and a parallel device



Small drawing board of many uses

with drawing attachment in a single compact unit. The board is made of 3/16 inch Masonite and is equipped with paper clips which will hold either a single sheet or a pad of letter size paper. No thumb tacks are required.

The parallel device is made of heavy nickel-plated arms, connector, and wrist plates all accurately reamed and assembled with bronze bearings. Either of two drawing attachments is provided. One is a combination of the 30, 60, and 45 degree triangles in one. With it, angles of 15, 30, 45, 60, and 90 degrees can be accurately drawn and other angles can be approximated. The right-angle sides of the device are graduated to 1/8 or 1/10 inch and provide ready drawing edges for horizontal and vertical lines without shifting position. The other drawing attachment consists of a protractor and graduated straight edge which can be set on degrees to any angle required. This is particularly suited for surveying and navigation.

With this device and a pencil compass, even a novice can make accurately dimensioned drawings.

Largest Welded Gasoline Tanker

WITH the launching of the motor tanker *Poughkeepsie-Socony* recently at the Staten Island Plant of United Dry Docks, Inc., the American merchant marine witnessed perhaps the most significant challenge of half a century to ships of less modern design. This vessel, one of the initial units in a 5,000,000-dollar shipbuilding program, is the largest all-welded merchant vessel ever built in the United States and probably in the world.

Nicholas J. Pluymert, Socony-Vacuum naval architect, recently voiced his conviction regarding the electrically-welded ship as follows:

"While the all-welded hull is no newcomer among service vessels of smaller size and Government craft of larger size, there doubtless will be some who will regard as revolutionary the use of that method for such a vessel as the new tanker.

"As ship operators planning to gain the utmost from cheap water transport, we could not overlook the lower first cost of construction nor the fact that at once we save 50 tons in weight, all of which becomes additional cargo space to be used as long as the vessel runs. It is possible that, from this source we might gain a full 'free trip' every year or so.

"The elimination of nearly a quarter of a million rivets and the substitution therefor of 105,000 feet of electric welding is in large part responsible for the weight-saving, but lighter, stronger members also add their proportion to the result," the marine executive explained. "When the time comes that steel fabricators provide appropriately designed shapes for electric welding, I predict new economies that will be even harder to ignore."

The *Poughkeepsie-Socony* is a tanker of typical "canal" characteristics; she is of 1242 gross tons, 260 feet long overall, with 40-foot beam and 14-foot depth. Her cargo capacity is 712,500 gallons and, in addition, she carries some 300 barrels of bunker fuel. Her power plant consists of two Diesel engines of air-injection type, aggregating 750 brake horsepower and driving twin screws. For facility in maneuvering the confined spaces of the New York State Barge Canal, she is equipped with twin rudders. The ship has normal speed of about 10 knots and carries a crew of 18 officers and men.

This latest addition to the Socony-Vacuum fleet will transport gasoline in the Canal-Great Lakes trade where, in normal transit, she will be called upon to pass through locks perhaps 2600 times in a single year. By reason of her bottle-tight construction, many of the hazards of canal transportation commonly associated with rivets will be eliminated, her designers declare.

An Amateur Radio Operator's Record

AN Australian radio amateur has established two-way voice communication with other amateur stations in each of the six continents of the world using a power of less than 10 watts, according to reports received by the American Radio Relay League, an association of amateur radio operators.

The record-breaking operator is G. Pollock, owner of amateur station VK2XU, at 9 Acacia St., Belmore, New South Wales, Australia.

A comparison of the distances covered,

approaching a maximum of 10,000 miles, with the illumination obtained from a 10 watt electric light bulb becomes especially striking when it is considered that commercial radio services use powers a thousand times as great to cover similar distances.

New Urea Plant to be First of Kind in U. S.

ANNOUNCEMENT has been made by E. I. duPont de Nemours and Company, Inc., Ammonia Department, Wilmington, to the effect that a plant for the manufacture of solid urea is under construction at Belle, West Virginia. This plant will be the first of its kind in this country and will have a capacity sufficient to fill the entire domestic demand for urea. The product, to be called DuPont Crystal Urea, will be offered in grades suitable for the various technical uses.

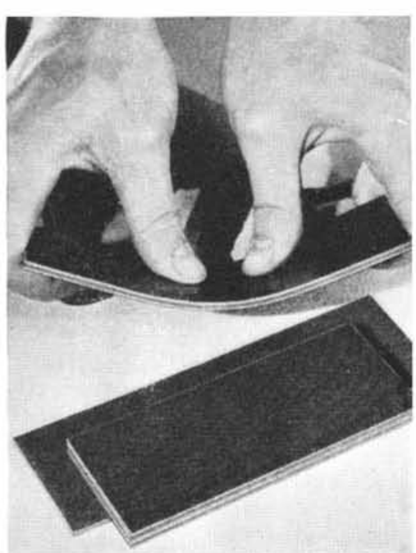
Since September, 1932, the duPont company has manufactured urea-ammonia liquor, a liquid product containing urea and which has attained wide acceptance as an ingredient of mixed fertilizers based on super-phosphate. DuPont Crystal Urea is a logical extension of urea-ammonia liquor manufacture. At present, domestic industry is dependent solely upon Germany for urea supply.—*A. E. B.*

Flexible Plastic "Sandwiches"

MEETING a need for a product that must be "as soft as rubber and long-wearing as Bakelite Resinoid," Synthane Corporation is manufacturing a new material consisting of layers of soft rubber "sandwiched" between sheets of Bakelite. An infinite number of combinations are possible, since the layer thicknesses may be varied, as well as the number of alternating layers of rubber and laminated material.

Many uses suggest themselves. For gasket applications where a combination of axial resiliency with strength and rigidity is required, the material is said to give satisfaction. Vibration-absorbing machine mountings are another important outlet for the product. This is of particular importance today with the trend definitely toward quieter and longer-lived machinery and equipment.

One can visualize the material employed



Bakelite "sandwiches"

for table tops and serving trays, furniture construction, perhaps even for wall paneling. In fact, wherever strength, quietness and resiliency are demanded, this new development holds promise.

Chicken Cannibalism Control

POULTRY raisers report that young chicks have a tendency to pick at everything bright. Often they will pick to death another chick which becomes slightly scratched or injured because they are attracted by the sight of blood.

A poultry authority has conducted some experiments which indicate that blue Cellophane can be successfully used to control this trouble. The Cellophane is simply placed in wooden frames similar to those used for wire screens and then fitted into the windows of the chicken houses. The resulting blue light in the coop makes a spot of blood appear black and hence the chicks are no longer attracted to injured chicks.

Highway Trees Now Coming Back

ROADSIDE tree planting is being revived in New York State. In the early days this practice was almost universal. Nearly every country road had its rows of maples but with the advent of the automobile and modern highway construction no provision was made for shade trees or other roadside beautification. It has taken a great deal of effort on the part of public-spirited citizens of the state to set in motion the resumption of tree planting along the highways, according to the New York State College of Forestry, Syracuse, N. Y.

In 1930 a tree nursery was authorized by the Legislature. This nursery was for the purpose of raising hardwood trees for highway planting. In 1931 the first trees from this nursery were set out on a new road at Hillsdale, Columbia County. Since then approximately 4500 trees have been planted along the highways in the state.

The esthetic improvement of the highways involves many kinds of planting and landscape devices to meet all the varying conditions of roadsides. Some sections require rows of trees, other sections groves or groups of trees, still other sections shrubbery and vines and sometimes all that is necessary is to preserve existing trees.

Experimental work has been started in the prevention of erosion by planting shrubs along steep embankments or cuts made in highway construction and it would appear that with the good beginning already achieved the work of highway beautification will gradually become more extensive, especially in view of the definitely favorable public opinion back of the idea.

Rand Gold Mines Salted

THE gold mines on the Rand, South Africa, are being salted but not in the old way, which was to mislead a possible purchaser. Salt prevents the hatching of hookworm eggs and kills the larvae.

Some 200,000 blacks and 20,000 whites had become afflicted with hookworm. The damp, warm soil of the mines was a perfect laboratory for the breeding of this tiny worm. The authorities first tried all the old and much thought of disinfectants, such as ill-smelling coal tar. Then somebody remembered that Dr. W. O. Fischer had rediscovered the fact that salt solution, if not below 20 percent, would kill the larvae and the eggs of hookworms. Soon all the corridors, buckets, cages and banisters were scoured with salt solution, and all exposed earth and waste was covered with a layer of salt about an inch thick. This layer in dissolving kills all the larvae and eggs beneath it. Salt also has the advantage of being cheap, odorless and in no way injurious to the health of the workers. Since salt has been used the hookworm count has diminished to a point where the disease is no longer a financial drain on the owners or a physical handicap to the workers.—*Science Service.*

Electrolytic Cell Makes War-Time Antiseptic

DAKIN'S solution, war-time antiseptic for treating infected wounds, may now be easily and satisfactorily made by an electrolytic cell. The apparatus was designed by Dr. O. R. Sweeney of Iowa State College and has been developed for practical use in hospitals by Paul A. Frank of Akron, Ohio.

Dakin's solution, invented by Drs. H. D. Dakin and M. Daufresne during the early days of the World War, is a solution of sodium hypochlorite. Since the War its use in civilian hospitals has been limited by its poor keeping qualities and the fact that it requires considerable skill in its preparation. If it is not strong enough it will not destroy the germs in the wound, and if too strong it will injure the tissues of the body. The difference between too strong and not strong enough is very small.

To overcome the technical difficulties in preparing this solution, Dr. Sweeney designed a simple, practically foolproof apparatus which is now called the antiseptic cell. An electric current controls the chemical reaction so that the resulting solution is of just the right strength. The hospital technician has only to put into the apparatus a measured amount of sodium chloride, distilled water and sodium bicarbonate, and turn on a switch. Fresh hypochlorite solution is then automatically produced at the rate of about an ounce a minute.—*Science Service.*

Rodents Beware

STRANGE uses of oxy-acetylene welding equipment and supplies have been brought to attention from time to time, but it is believed that the following will be hard to beat for a weird use of calcium carbide.

A garage proprietor in the southwest discovered that a handful of carbide put in a prairie dog hole, followed by a gallon of water, is an effective way of cleaning out a prairie dog colony. The owner of the garage possesses several hundred acres of grazing land and says that the rodents infest his country by the thousands. He is going to treat all of his property with carbide as he claims that it has proved successful and cheap, and is superior to any other method he has tried. People in other localities have already heard of this and are planning to try out the method.

A similar situation exists in many western and southwestern golf courses, where the gopher and his ilk are responsible for a large portion of lost golf balls. Undoubtedly the fairways committee will find that a few cans of calcium carbide judiciously distributed by the handful and followed up by a plentiful deluge of water will go a long way toward cleaning up this nuisance and removing one source of frayed nerves for the golfer.

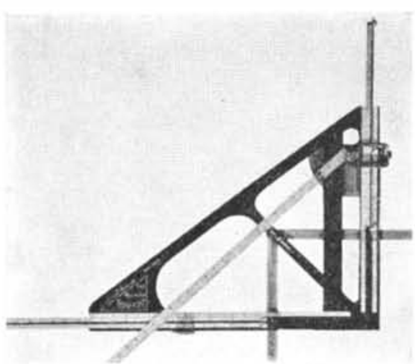
Other reports mention that not a few ants have been destroyed by the same method.

When using carbide as a pest killer don't forget two things: Acetylene gas burns, and when mixed with air in certain proportions it ignites violently, so *don't* try to use it indoors on rats. Secondly, when using the method out-of-doors remember that the carbide residue, if a good deal of water has not been used, may consist both of quicklime as well as slacked lime. So use lots of water, and if cattle, or other domestic animals are about, put it far enough down into the hole so that they can't step into it, or if near the ground surface, cover it with a board. The whole scheme is a grand idea, but use it with intelligence and play safe!—*Oxy-Acetylene Tips.*

The Trianalyst

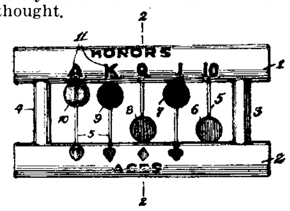
TO solve numerical algebraic equations by some direct method has been the aim of mathematicians through the centuries. Apparently the goal has been reached through the contrivance of a relatively simple mechanism operated on geometrical principles not heretofore brought to general attention.

The working model, with Bakelite base and Celluloid scales, weighs about 12 ounces. Conveniently sized, its dimensions are sufficient to furnish useful approximations of results. This device is the invention of Barrett R. Wellington of the law firm of Van Santvoord and Wellington, Troy, New York. Long interested in the recreation of mathematical explorations, it seems that, on inscribing a square in the right triangle, he happened on several remarkable theorems. It became apparent that they laid the foundation for entirely new methods of graphical analysis and for a mechanical contrivance that may be used to carry them into effect.



The trianalyst solves problems

The outstanding theorem is that the area of the square equals the product of the legs, each diminished by the edge of the square. As each factor may, by the sliding scales, be split into terms, a new means of mechanical multiplication and division is brought into existence, with the accompanying advantage of addition and subtraction in combination. This accomplishment opens up new fields of application, since



many of the most important of the higher equations can be easily factored to bring them within the scope of the instrument. It is interesting to note, as can be seen in the illustration, that the sliding "L", in conjunction with the sliding hypotenuse and other scales, is the key to the main functionings of the invention. It enables the operator to adjust the parts so that there is at once represented a right triangle of any shape with its inscribed square, and the readings of all the component parts.

Ordinarily with little, if any, computation, and on a few settings, roots are obtainable generally for quadratics, cubics, biquadratics and certain forms of simultaneous equations. Not a few of these solutions require long, laborious effort by the prevailing methods of today. The Trianalyst also determines with dispatch certain types of formulas involving multiplication, division, addition, subtraction, and the powers of roots of numbers, all in combination. A detachable protractor, as an incidental feature, furnishes the solutions of trigonometrical problems.

CURRENT BULLETIN BRIEFS

Carnegie Institution of Washington Year Book For 1933. An account of the many and varied researches—astronomical, biological, physical and so on—conducted by America's largest institution of general scientific investigation. *Carnegie Institution of Washington, Washington, D. C. —Paper $1.00 postpaid; cloth bound $1.50.*

Handbook of Goodrich Low-Pressure Tires in Farm Service. The tractor has proved of great value in doing away with horse traction and it has proved more effective when equipped with low-pressure pneumatic tires. Study of this pamphlet will post the agriculturist on a new step towards increased profits in agriculture. *Write for Bulletin 12A. Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Making Cider on the Farm is a circular by Prof. W. F. Walsh. Several new ideas for cider making will, it is believed, give a greatly improved product. Carbonation of the clarified cider is recommended as giving a very pleasing drink. *New York State Agricultural Experiment Station, Geneva, New York.—Gratis.*

Rock Crushing Machines. Certain industries require the use of massive, heavy-duty machinery. In the past, lubrication may have been given secondary importance in such machinery—now the trend seems to be towards automatic lubrication. The principal types of crushers are illustrated. *Write for Bulletin 12B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Animal Books for Children. This series of four books about animals for children is illustrated with "three-dimensional" pictures of groups in the Field Museum. With the aid of a special colored spectacle the groups appear to stand out. The books relate to "The Lion," "The Bear," "Sheep and Goats," and "The Deer." The text is by H. B. Harte of the Museum staff. *Field Museum of Natural History, Chicago, Ill.—25 cents each plus 3 cents postage. Set $1.00, postage 10 cents extra.*

TEXTILE MACHINERY; IMPROVEMENTS IN DESIGN AND METHODS OF LUBRICATION. Stability in machine performance can be materially influenced by the thought which is given to lubrication when the unit is in the drafting board stage. This is particularly the case with textile machinery which is more or less complicated. *Write for Bulletin 12C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE NEW SCIENCE OF LIGHTING, by Dr. Matthew Luckiesh and Frank K. Moss, presents the results of scientific researches which have extended the viewpoint of lighting and vision into seeing as an activity of human beings operating as seeing-machines. *Write for Bulletin 12D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

GEOLOGIC HISTORY AT A GLANCE, by L. W. and G. L. Richards Jr. Two large charts, in book form, showing in a table, the eras, periods, epochs, and strata of geologic history, with corresponding evolutionary changes in biology. An excellent aid for lecturers since the charts are removable and can be hung on the wall. *Stanford University Press, California.—$1.25.*

FACTORS IN MEASUREMENT OF AIR PERMEABILITY OF PAPER. (Bureau Research Paper No. 682.) A comprehensive definition of air permeability in relation to paper and fiber board. Suggestions are made relative to a standard testing method. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

INSTRUCTIONS AND RULES FOR CONSUMERS IN TRANSPORTING, STORING, AND USING HIGH EXPLOSIVES AND PERMISSIBLE EXPLOSIVES. Much of the folder is taken up by "Don'ts," giving good advice which is very necessary in handling explosives. The directions for priming, tamping, and firing are fully illustrated. *Institute of Makers of Explosives, 103 Park Ave., New York City.—Gratis.*

CLEAN AIR, AN ACHIEVABLE ASSET. (Reprint from the *Journal of the Franklin Institute.*) We had an article on this subject in our February, 1934 issue. This is a subject which is attracting a great deal of interest in municipal sanitation. *Mellon Institute of Industrial Research, Pittsburgh, Pa.—Gratis.*

COMMON WEEDS (Botany Leaflet 17), by Paul C. Standley, gives brief, non-technical accounts of various features of plant life with reference to the botanical exhibits in the Field Museum and to the local flora of the Chicago region. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

SELECTED MOTION PICTURES (SILENT AND SOUND) gives a list of free and rental pictures which are designed to be shown to children and young persons. *The Y.M.C.A. Motion Picture Bureau, 347 Madison Ave., New York; 19 South La Salle St., Chicago, Ill.—Gratis.*

Books SELECTED BY THE EDITORS

THE PROGRESS OF SCIENCE

By J. G. Crowther

IN this, the newest book by the author of "An Outline Of The Universe," "The A B C Of Chemistry," "Science For You," and several other popular scientific books as well as SCIENTIFIC AMERICAN articles, we are given an account of recent fundamental research in physics, chemistry, and biology. We are told of the famous Cavendish Laboratory at Cambridge University and the work on atomic physics that goes on there; of the cosmic rays; of diplogen (heavy water); the chemistry of evolution; heredity; and other things scientific. This book fairly well covers the field of recent scientific advance. The author knows his science accurately. His books are suited best to readers having a pretty fair background in science, yet they are popular in nature.—$3.75 postpaid.—*A. G. I.*

MAKING THINGS FOR FUN

By A. Frederick Collins

THE boy or girl who delights in making his or her own toys will certainly appreciate as a Christmas present a copy of this latest book by Mr. Collins. The author calls this a "how to make" book for boys and girls of all ages. Surely anyone between ten and sixteen years will find much enjoyment in the instructions given for making things from all kinds of material. The instructions range from how to make simple little things from paper to the construction of a miniature stage, a model ship, and a midget radio receiver. Entirely practical in scope, the book will furnish endless entertainment to anyone who likes to see things grow under his own hands.—$2.15 postpaid.—*A. P. P.*

EDISON, HIS LIFE, HIS WORK, HIS GENIUS

By William Adams Simonds

IT is now possible to look back upon the life-time work of Thomas Alva Edison and view it in a perspective which makes possible a more true evaluation of the labors of a man who contributed vastly to our present industrial and social developments. The present author has gone further than usual in books of this type, tracing the history of Edison back to the great grandparents, and giving an historical background which makes possible a highly desirable evaluation. Then comes the story of Edison himself, and many of the myths which have been built up around this great figure are exploded by what appears to be irrefutable documentary evidence. The reader is then led through

The hands of genius; from "Edison, His Life, His Work, His Genius"

trials and tribulations of Edison and his various inventions, the story ending with an account of "Light's Golden Jubilee," and the last work of Edison just before his death. Several pages in the back of the book are devoted to notations regarding the foregoing text and a bibliography which should prove of great interest to anyone desiring to know more of this great American inventor and his work.—$3.70 postpaid.—*A. P. P.*

LANGE'S HANDBOOK OF CHEMISTRY

By Norbert Adolph Lange, Ph.D.

THIS book is the result of a number of years' experience in the compiling and editing of data useful to chemists. It is one of the most usable reference books on the subject we have ever seen. There are 1540 pages of closely condensed matter. There is also an appendix of mathematical tables and formulas contributed by Richard Stevens Burington, Ph.D., which adds materially to the value of the book. Such useful things as a table of chemical journals from 1880 save the researcher infinite time. The services of 70 collaborators are noted and we join with the author in the hope that this book will be of the same usefulness to the worker in science as is the dictionary to the worker in literature, and that its resting place will be on the desk rather than on the book shelf.—$6.25 postpaid.—*A. A. H.*

WIDE ROAD AHEAD!

By Henry B. Lent

WHILE this book was prepared primarily for the youngster who is interested in knowing what makes the wheels go 'round, it will also be read and enjoyed by grown-ups who would like to have a superficial knowledge of the automobile and its manufacture. The text makes no pretense of being technical but rather it tells a readable story of the inception of the automobile, its present development, the assembly line method of manufacture, and the uses of the final product. The entire running story is told in 102 pages of easily read text, supplemented by a series of black and white drawings which are striking in their explanatory simplicity.—$2.15 postpaid.—*A. P. P.*

CITY EDITOR

By Stanley Walker, City Editor, The New York Herald-Tribune

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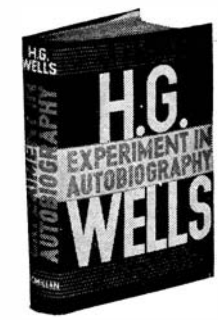

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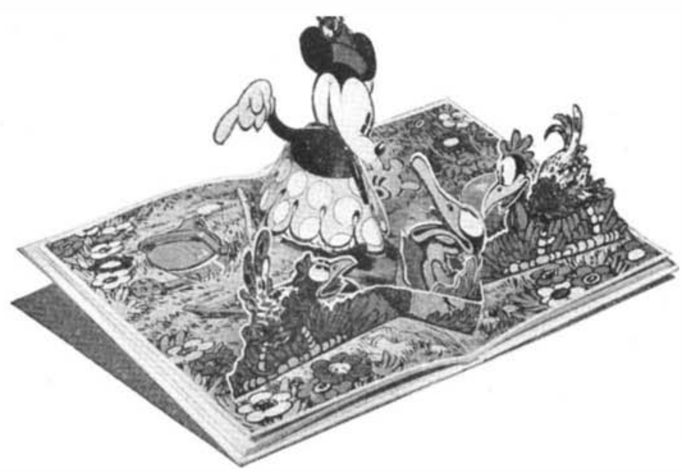

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