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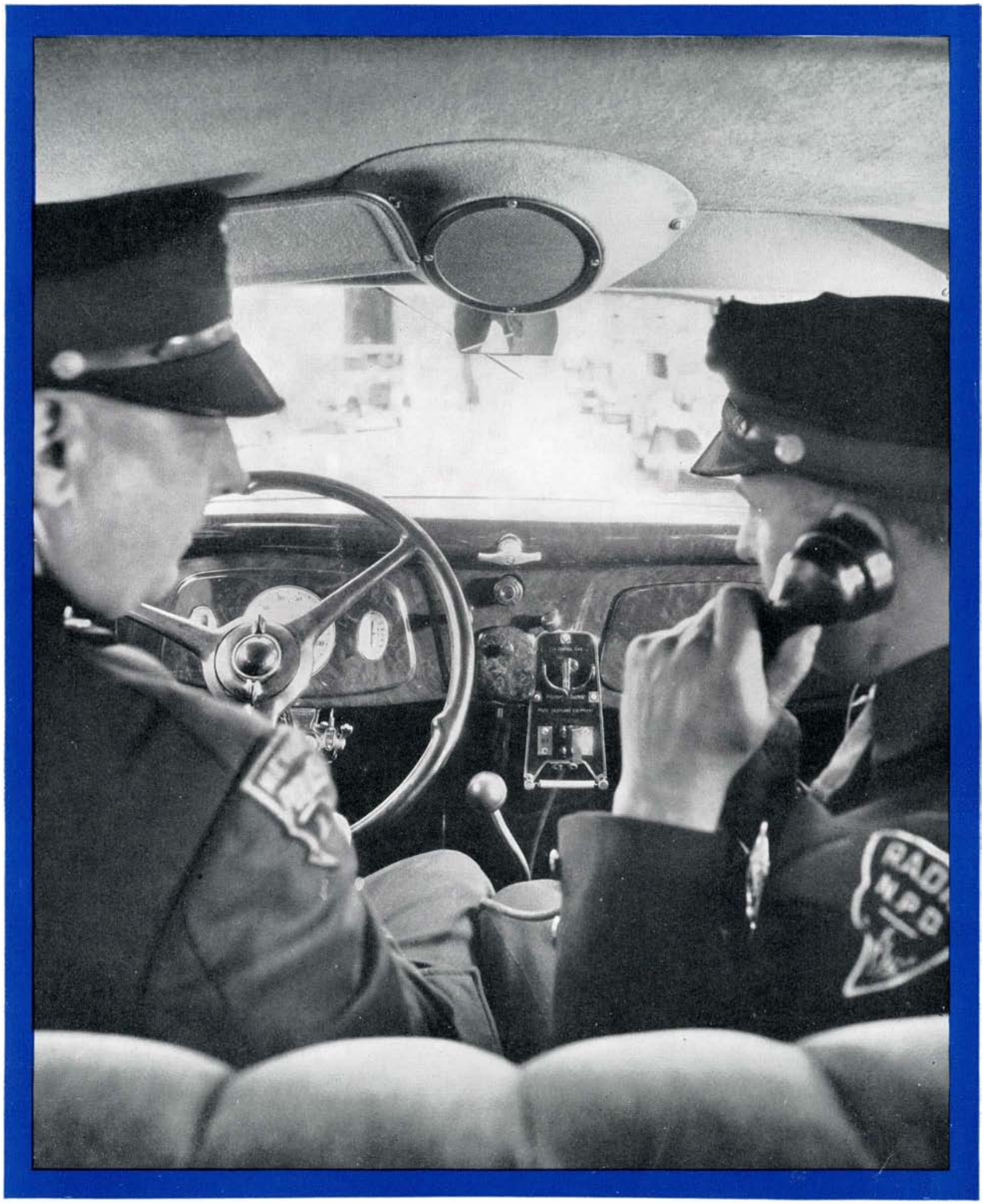


The Latest in Police Radio (See page 77)

VOLUME 153
•
NUMBER 2

SNAKE BITES

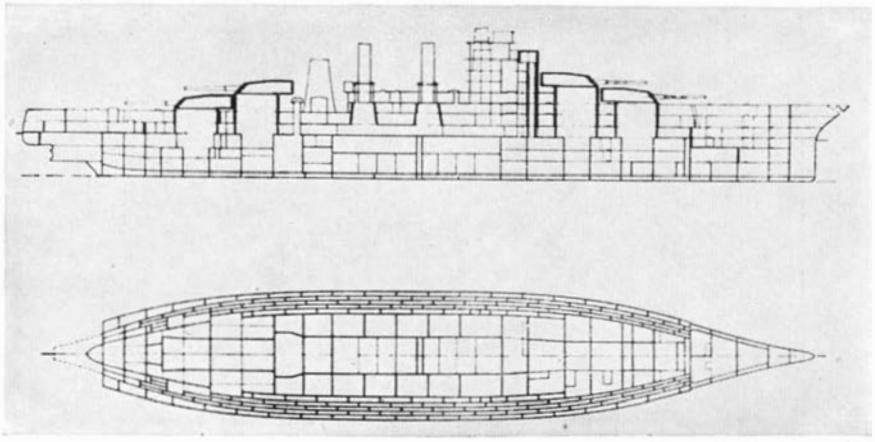
By W. A. Bevan

AUGUST 1935
•
35c A COPY

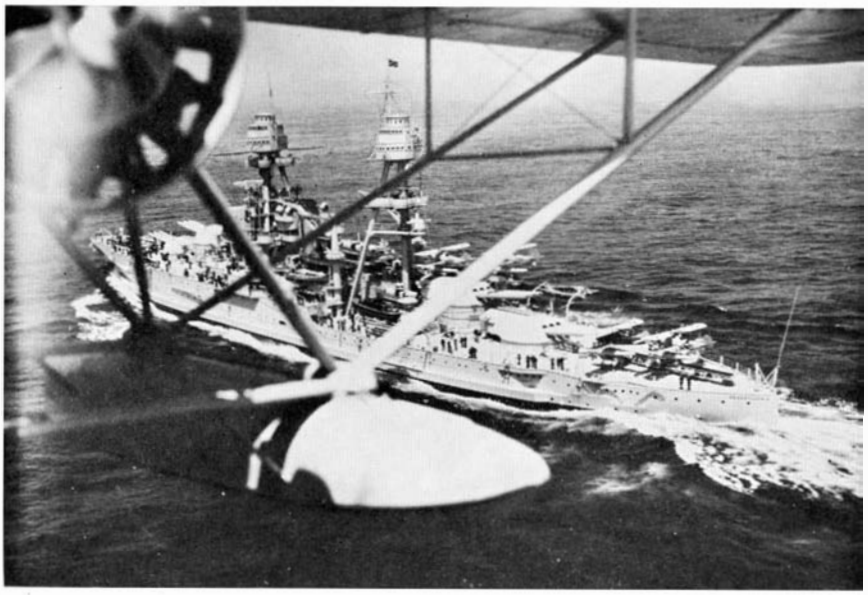
Dear Editor—Give Us More NAVY INFORMATION

For years SCIENTIFIC AMERICAN readers have depended on us for authentic information on scientific developments of naval defense. We are always in close touch with the situation. Often public policy prevents release of news, of which we are kept fully informed, but regular readers know that whatever can be told will be found in SCIENTIFIC AMERICAN first.

EVERY business day the postman brings letters in large numbers to the desks of the Editors of SCIENTIFIC AMERICAN. The range and diversity of the inquiries on every phase and subject of Science and Invention are a revelation of far-reaching influence and a startling testimonial of the confidence of the readers in the Research and Service facilities which are made available by SCIENTIFIC AMERICAN.



Underwater compartmentation of a recent battleship



The U. S. S. *Pennsylvania*, flagship of the United States Fleet. This aerial photograph shows four planes and two catapults, also the hull's blister protection

IN HARMONY with the new American spirit SCIENTIFIC AMERICAN is marching steadily forward, enriching the lives of an ever-increasing number of worthwhile people in their vocations and avocations.

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SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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ACROSS THE EDITOR'S DESK

"THE long dispute over the nature of cosmic rays is perhaps at last coming to a conclusion. The study of this penetrating radiation from outer space has for years been a battlefield on which two opposing schools of thought struggled for supremacy. Dr. Robert A. Millikan of the California Institute of Technology was the leader of the older school, which maintained that the rays were made up of photons or light quanta. The exponents of the newer theory, led by Dr. Arthur Holly Compton of the University of Chicago, are diametrically opposed to this view. They believe that the rays are streams of electrically charged particles, including positive and negative electrons, with possibly some protons and alpha particles." Thus is introduced an article entitled "The Cosmic Ray Puzzle," by Jean Harrington, scheduled for publication next month. Miss Harrington goes on to describe the dispute and its various ramifications and concludes as follows: "But cosmic rays may not remain a mystery for long. Science is busy, finding and fitting together pieces of the puzzle, making clear, bit by bit, its intricate design, and approaching gradually the completion of the picture."

●

PURSUING still further the subject of modern housing, Philip H. Smith, author of the article "Ready-Made Houses" which starts on page 66 of this issue, will present next month a story of modern materials and how they have radically changed home construction. The developments of science are constantly reacting to the benefit of the average man, and in no phase of existence is this more true than in the construction of homes.

●

WHENEVER engineers set out to conquer some phase of nature, problems are always sure to arise which call for new and unusual solutions. Thus, while a bridge may be considered merely as a bridge, the actual construction of it almost invariably involves some new method of getting around seemingly insurmountable obstacles. A bridge recently completed and opened to traffic in Denmark is no exception. This structure, for combined railway and highway use, spans a deep and rapidly flowing link to the sea which separates the peninsula of Jutland from the Island of Fünen. This bridge, aside from its unusual structural features, has an important economic significance. It will greatly speed up transportation, replacing as it does a ferry service which has been continuously active since 1872. While in favorable weather the ferries were able to make the run in about 15 minutes, fog and snow frequently upset train schedules and caused serious delays. The story of the construction of this Danish bridge will be told by R. G. Skerrett in an article scheduled for publication next month.

COMING

¶ "The Cosmic Ray Puzzle," by Jean Harrington

¶ R. G. Skerrett, on the Construction of an Unusual Bridge in Denmark

¶ "In Defense of Insects," by Albert Dickman, Ph.D.

¶ A Two-Page Drawing of the Dewey Class of Destroyers

¶ Philip H. Smith on the Materials Used in Modern Houses

¶ The Significance of Aviation Records, by Reginald M. Cleveland

●

WITH moths and beetles attacking clothing, furniture, and stored foods, several varieties of insects destroying food crops to the extent of millions of dollars annually, houseflies spreading disease, and other insects doing untold damage in various fields, it is small wonder that insects as a group are roundly condemned by many people. When, however, you read the article entitled "In Defense of Insects," by Albert Dickman, Ph.D., to be published soon, you will find that the denunciation of insects cannot be carried very far. Man's convicted enemies in the insect world amount to only about 300 species. When we realize that over 500,000 species of insects have been classified, with thousands more awaiting classification, it becomes apparent that we cannot condemn the whole class for a small number of disreputable members. Dr. Dickman cites many interesting examples of the beneficial work of insects and points out that many of them are absolutely essential to human welfare. Although after reading this article you will still continue to spray insecticides, you will have gained a greater appreciation of how some insects contribute to your daily welfare.

●

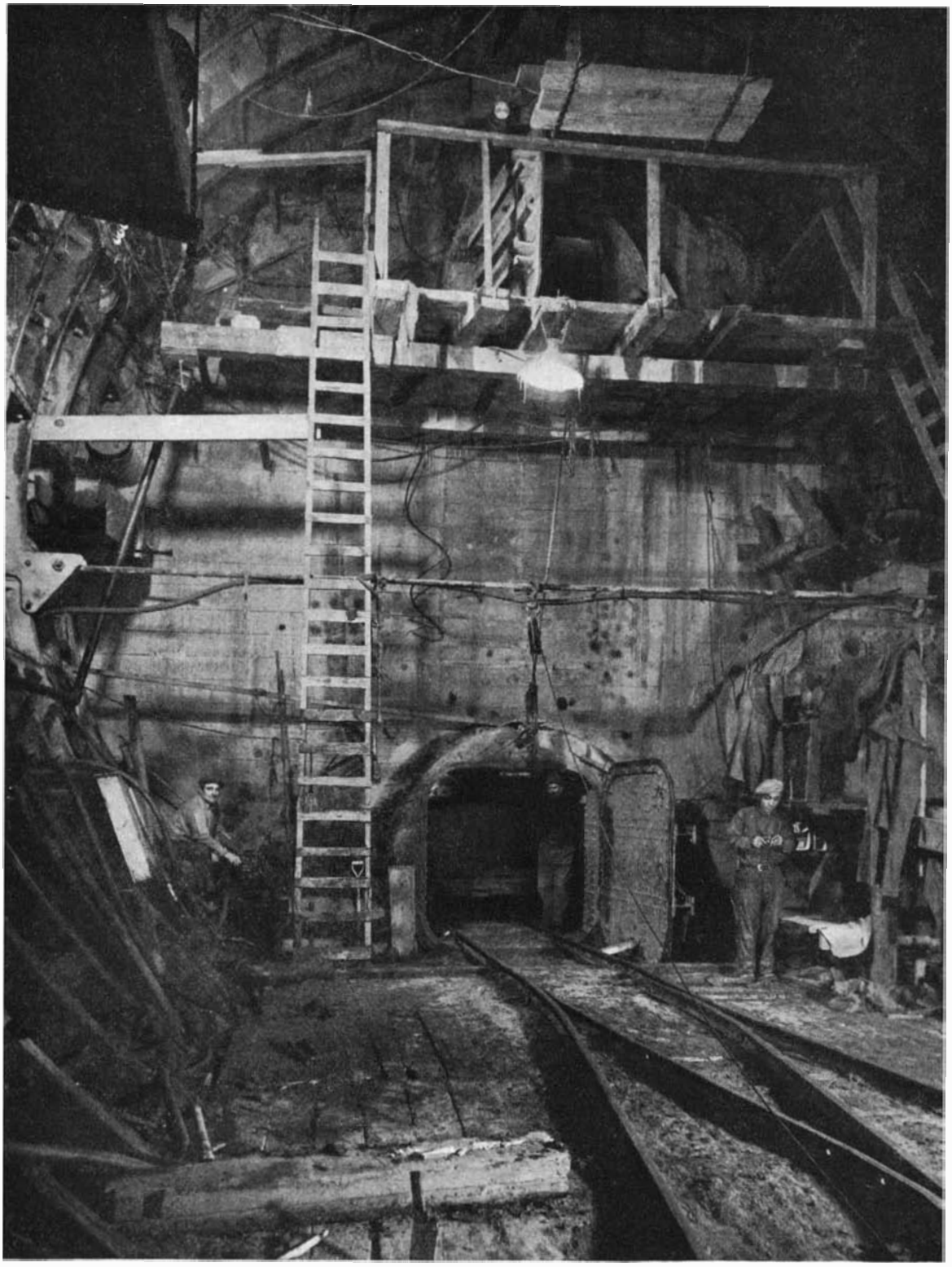
NEXT month we will present a double page illustration, drawn especially for SCIENTIFIC AMERICAN, showing the details of the Dewey class of destroyers. This new type of vessel, the first designed by the United States Navy since 1921, is also the first of its class equipped to combat airplanes effectively. The destroyers each mount five five-inch guns of the so-called "mystery" type which was so designed as to permit a range of fire from the horizontal to the vertical. These new destroyers are reputed to have a speed of from 32 to 35 knots although in some quarters the top speed is said to exceed these figures. An additional feature of vessels of the Dewey class is that particular attention has been paid to the design of living quarters for the crew, giving the men all comforts possible on a vessel of small size. The drawing which we will publish is exceedingly attractive and undoubtedly many readers will wish to preserve it for future reference. It will be so printed on two facing pages that it can be removed from the magazine and framed for display.

●

WHEN the newspapers announce that a new record has been set by an airplane for altitude, distance, economy of operation, or some other phase of flight, the general reaction is all too frequently: "What of it?" In an article to be published soon, Reginald M. Cleveland, well known to our readers for his articles on aviation, will tell of the significance of these air records, why they are so eagerly fought for and what they mean to the aviation industry in general.

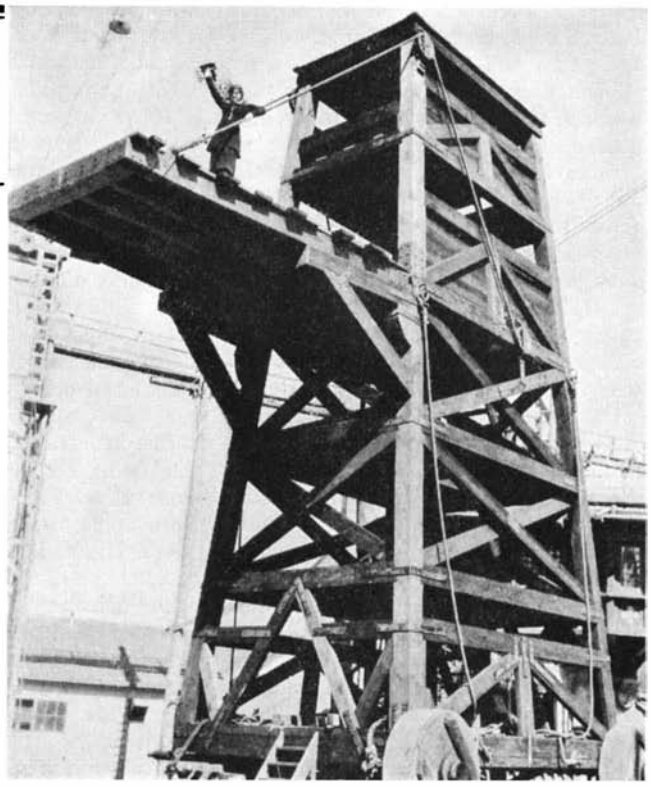
Orson D. Munn

Editor and Publisher



TEN FEET OF CONCRETE PROTECT TUNNEL WORKMEN

THIS 10-foot-thick concrete bulkhead in the new Midtown Hudson Tunnel, New York, holds air pressure in a compressed-air section of the tunnel where men are working. Through this wall pass a material-lock (center), a man-lock (right), and an emergency-lock (top). These locks permit exit from the tunnel to the outer air, pressure being equalized in them. The man at the left is operating an electric hoist used to pull work cars. A short section of track at the material-lock door is removable so that the door may be closed after a loaded car has entered the lock chamber in the concrete bulkhead.



Standing 50 feet high and weighing 15 tons, this siege tower—replica of the great war machine employed by the Crusaders at the battle of Acre—is one of the largest movie "properties" ever constructed in a Hollywood studio

ANCIENT BATTLES IN THE MOVIES

Catapults . . . Battering Rams . . . "Tanks" . . . Armor . . . Swords . . . Shields . . . Historical Accuracy Assured By Research . . . Tricks Used

By ANDREW R. BOONE

TWO hundred Crusaders stood at ease before the wall of Acre. Scores of Saracens looked down on the cameras from the high parapet. Nearby stood a gigantic siege tower, while from a position midway between its two forward columns protruded a battering ram swinging lazily from heavy chains. At one side an 11-ton wooden catapult, capable of tossing a huge rock over the 50-foot wall, was ready to aid in the assault.

Two-score cross-bowmen in dulled medieval armor stood behind wooden mantlets—large wooden shields on wheels, replicas of the first "tanks" ever to appear in battle—awaiting orders from the director, who now addressed them.

"Mantlets will advance to the moat," boomed the loudspeakers. "There you cross-bowmen will cover the advance of the siege tower. Bowmen on the tower direct your arrows at defenders on the wall. The catapult will lay a heavy barrage. Foot soldiers shove the siege tower into place. You men on the wall—return the attack of arrows. Resist the besiegers. Roll rocks and timbers from the wall.

"Everybody ready for the battle? Okay. Roll 'em."

Under the brilliant lights flooding an outdoor set on a Hollywood movie lot began the historic siege of Acre—fought 748 years ago, long before the advent of fire-arms.

JUST as the Christian horde assailed the walls of Acre, less than 100 miles from Jerusalem, these play-soldiers of Hollywood moved the creaking tower forward. The long wooden arm of the stone-caster shot upward to deliver its lethal load among the defenders, but to a point where the missiles would land without harm to actors. Long bows and cross-bows snapped forth their short arrows. Slowly the huge siege tower, 15 tons of timbers standing 50 feet high on iron-rimmed wooden wheels weighing a ton apiece, rumbled forward.

Shouts of attackers and besieged filled the air. Actors in medieval mail, some wearing heavy metal helmets, grouped about the machines of war. Dust settled over the scene. Swordsmen armed with gleaming blades, long metal shields on their arms, walked along the advancing lines, urging the men on. Here was a page from ancient history, coming to life for the screen!

Thousands of properties, from chain mail to the siege tower, make the filming of historic spectacles possible. For nine months before the camera filmed the first scene of "The Crusades," story of Christendom's two-century movement against Islam, Cecil B. De Mille searched famous museums for descriptions and sketches of instruments of war, armor, costumes, and customs—everything that would contribute to the accuracy of the picture.

He found data on the largest siege tower ever built—and reconstructed it, complete with battering ram, which bore the likeness of a ram's head.

He found sketches of the powerful catapults; secrets of ancient Greek fire, forerunner of modern flame-throwing and poison gas; mantlets which, in a crude yet effective way, were the first "tanks"; trenches and tunnels, where trench warfare was waged; incendiary bombs; deadly battle pikes, with which a foot soldier could pierce the armor of a cavalryman, pull him from his horse, or crush his head. All these highly effective weapons and war developments were in use before the Dark Ages had passed into history.

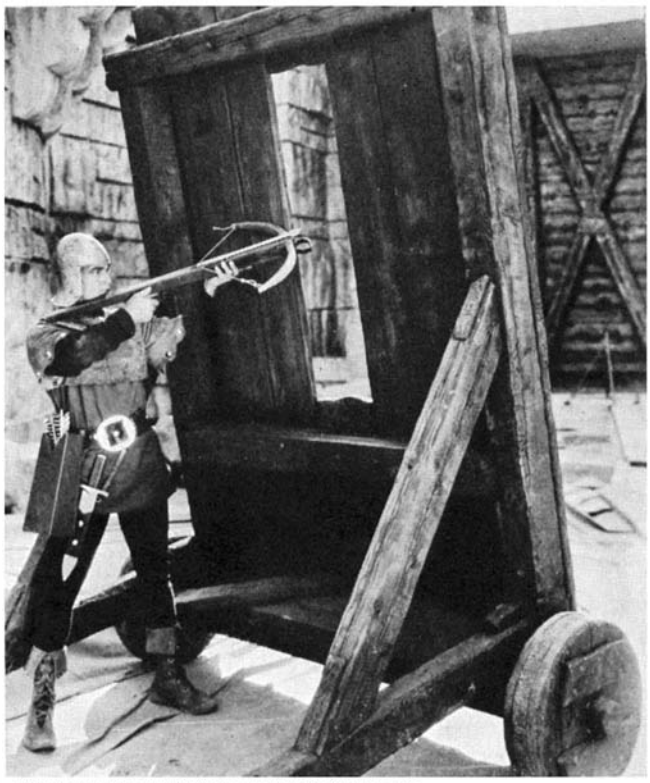
The siege tower which I saw advance to the wall of Acre was square, tapering to the top, and included five decks, connected by ladders. Open at sides and rear, the upper front was protected by a drawbridge, lashed tightly to the tim-

bers until it reached the moat. Wet skins covered the lower part, giving protection against fire and arrows.

Each deck served a particular purpose. From the top platform archers poured a barrage of arrows into the defenders of the town. Soldiers on the fourth level lowered the drawbridge across the moat and onto the wall. On lower floors were massed dozens of soldiers, ready to ascend and cross the drawbridge. On the lowest platform husky warriors manned the battering ram, ready to crush the strongest masonry.

Only one tower was used in the movie assault, though three had been employed in the siege of Acre. During a lull in activities, while perspiring actors rested from their arduous work, De Mille told me an illuminating story about them.

"During the siege," the director explained, "the defenders of the city threw clay bombs onto the towers. These burst on impact, but since the crusaders suffered no harm they became amused. After many bombs had been thrown, flaming torches were cast about. Two towers and all the men on them were consumed by flames. Little did they realize the towers had been soaked by an inflammable liquid contained in the bombs."



A movie cross-bowman of the Crusaders' legions is protected by a wooden mantlet, first "tank" ever to be used in battle

The horrors of flame as a weapon were known to the Arabs and Byzantines as early as the 7th Century, but not until the Christians poured into Eastern Europe and Asia nearly four centuries later did the Crusaders face fire on the battlefield and in the trenches. And so in a corner of a metal-walled shop I saw an expert in chemistry and fire reproducing with benzine, sulfur, carbon, nitre, and cotton waste the flaming oil torches and liquid flame which brought terror to ancient fighting men.

It was with such weapons the first trench raiders were repulsed. As I stood in a trench at the foot of Acre's wall, Harold Lamb, technical expert, told me how the Normans started to tunnel under the wall of a Byzantine city, and the defenders dug a counter-tunnel at right angles to the approach. Sentries stationed along the counter-tunnel sent a detachment of flame throwers to the threatened point where they heard digging. They opened up a small hole and thrust in flame projectors, spraying the enemy diggers with fire from pine resin and sulfur. Thus was trench warfare, born underground seven centuries ago, recreated in a battle of make-believe.

Although of short range as compared with modern artillery, the catapult sounded and looked like a deadly weapon as the mimic battle raged. It was, in reality, a great cross-bow having the power of thousands of its little brothers.

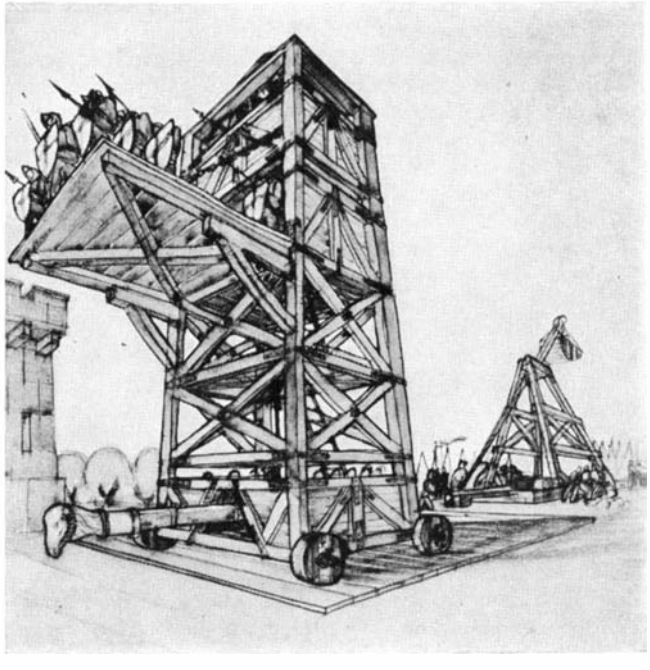
The long arm, fitted with a bucket-like container at the outer end, was pulled down to a horizontal position, until the steel-stripped plywood layers of the bow seemed ready to split. Soldiers charged the weapon by placing a rock in the iron cradle. On signal, they released the trigger, and the bent bow fixed to the head frame snapped the arm forward and upward with a thud which threatened to pull the machine to pieces, casting its heavy charge forward in a graceful arc.

As the assault on the tower went forward amid the thud of the battering ram and the clashing of swords, the sounds of steel striking steel reaching me above the shouts of the combined forces below were very realistic.

SWORDS and shields, I learned, were in fact made of tempered steel, while men's helmets were pounded out of brass or, in the case of combatants, constructed from 16-gage iron, for the microphone soon revealed that only iron gave out the true sound of metal on metal when an aluminum battle mace cracked down on a helmeted head. Whenever a noble sank to his knees from a head blow, often of sufficient force to crack his skull, a football helmet saved him from injury, while a paper container of red blood-like liquid, smashed by the impact, poured down over his face.

As bowmen discharged their shafts from the walls of Acre or attacked defenders from the topmost platform of the powerful siege tower, real arrows, metal tipped, plunged into breasts with the force of bullets—not the rubber-tipped arrows shown leaving the bows wielded by extras, but shafts flying from other bows in the hands of expert archers who aimed them straight at the breast. Arrows flew true, struck, quivered. But they harmed no man, for each actor struck down by an arrow wore a breast shield of cotton cloth and metal.

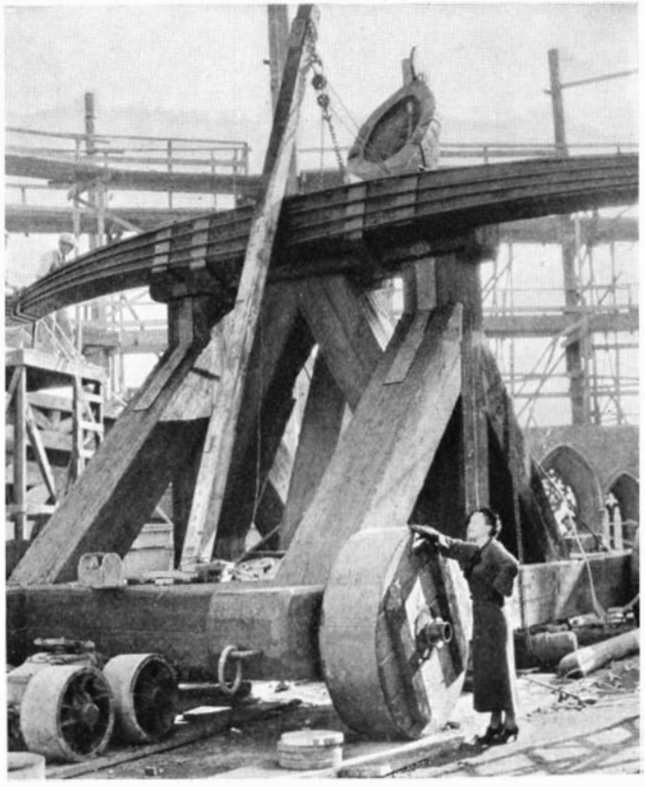
Movie soldiers could not wear the



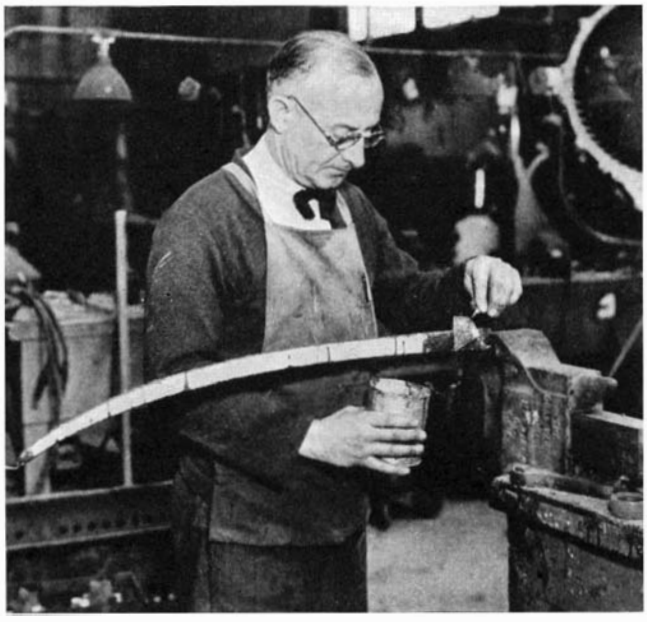
Drawing of siege tower (see preceding page) and catapult, from which architects designed the machines used in the film battle

gleaming armor boasted by the crusading knights. Highly polished steel and brass reflected too many rays from lights and the sun. Paraffin and rubber paint killed the glow. Modern knitted aluminum mail replaced the steel mesh of old, both because of cost and weight. To give it just the right touch of antiquity, workmen painted the chain mail with silver lacquer and flattened it between machine rollers.

In order to accustom the horses to the additional weight as well as to these strange costumes, actors rode their mounts daily for six weeks before appearing in the first scene. They rode at first in customary riding clothes. After a few days they changed saddles, using now high-backed saddles of double weight which provided a needed back rest when thrusting lances.



An 11-ton catapult made for the movies. The great crossbow, built of plywood and steel, can throw a one-ton rock over a high wall. See the text



Workman making the trick sword which severed a silken scarf by burning through it

One by one the various pieces were added to the equipment—a shield on the left arm, then a sword, next the face piece on the horse, now a lance set in its special stirrup—until at last each horse carried an extra hundred pounds, and actors were galloping around the hills of Hollywood in full armor.

For nearly a year before the cameras filmed the first scene, technical experts prepared weapons, armor, decorations for warriors and horses—everything that might bear on the Crusades. Workmen in New York and Hollywood forged swords of tempered steel, cast battle maces of aluminum, pounded out iron helmets. Jewelers created thousands of make-believe pearls, some large as oysters, and fashioned semi-precious stones into glittering crown ornaments.

Thousands of lances, battle maces, pikes, swords, neck and face shields for horses, metal-clad blankets, chain mail for knights, shields for shoulders, arms, hands, chins, and knees for riders and cross-bowmen—each was made after the manner of its counterpart worn seven centuries ago, many offering more actual protection than those worn during the Crusades.

NOT only the incidents portrayed in an historical picture but also all properties and sets must be true to recorded accounts, else some who view the completed play, in the United States or abroad, will challenge its authenticity. Novel methods are employed to recreate some of these episodes and scenes.

Long before the large Acre set was created, artists created sketches from reproductions found in historic works. After several sketches were made, complete in detail, draftsmen made drawings, showing all parts accurately.

To build high, thick walls of solid stone not only would prove too costly, but the producer could not afford to waste valuable time for striking and rebuilding the set. Accordingly he had skilled workers take plaster moulds of rocks forming the breakwater which extends two miles into the sea at the entrance to Los Angeles harbor. A few days later rocks cast in plaster rose to form the protecting wall of Acre, while painters, working with blow torches, paint, and oil stain "antiqued" wooden towers and the larger tools of war.

Finally, De Mille desired to film the storied scene wherein King Richard and Saladin the Infidel were bragging over the merits of their respective swords. Richard cut through a heavy iron mace with his sword. Saladin replied by tossing a silk scarf into the air and cleaving it in two. This Richard could not do, for his iron blade was no match for the razor-sharp Damascus steel wielded by Saladin.

How Saladin should cut the scarf for the picture was the problem. No sword could be found in Hollywood that would do the trick. A workman in the studio's machine shop solved the problem. He cut two flat pieces of wood fibre and curved them to resemble a sword. Along the thickened back edge he fitted a length of copper wire. Over the two pieces of fibre, pressed tightly together, he fitted a length of asbestos tubing. Next, he painted the asbestos with retort cement, which will withstand a heat of 2500 degrees, Fahrenheit, before breaking down. Finally, he ran a resistance wire along the cutting edge. In a matter of seconds the resistance wire reached a white heat when electricity was applied, and the actor, rather than cutting the scarf, literally burned a path through the cloth.

Thus do the movies strive for accuracy in portraying historical scenes. When "tricks" are employed, the reason is usually to expedite the filming operations, or, frequently, because the "trick" shot will appear more real than reality itself.

DIGGERS IN THE FIELD

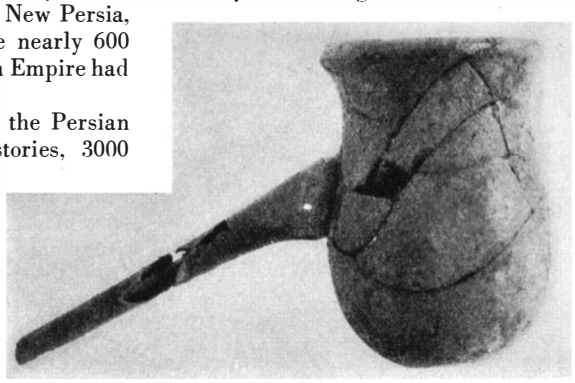
Archeologists Dig Up Ancient Utensils Very Much Like Our Own . . . One of Them a Mystery

By ALBERT G. INGALLS

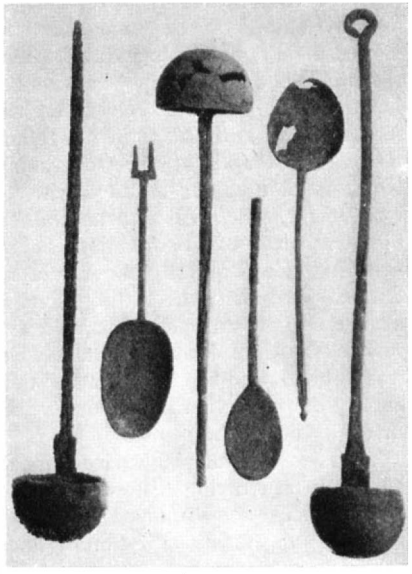
THE artifacts shown on this page were found near Shiraz, in Persia, by an expedition of the Metropolitan Museum of Art, New York, which dug on the slope of a hill once occupied by a fortress and a town, and uncovered pottery, gold jewelry, glass dolls, bronze candlesticks, and other objects of archeological interest. They are from the Sassanian period of Persian history, which dates from 226 A.D. to the conquest of Persia by the Saracens in 644 A.D. Thus they do not pertain to the earlier Persian period made most famous by military exploits—the one which is generally meant by "the" Persian Empire—but to a less widely known Second Persian Empire, or New Persia, a revival which took place nearly 600 years after the First Persian Empire had been wiped out.

Most readers will recall the Persian Empire of the school histories, 3000 miles long and 1000 miles broad (the size of the United States), which was peopled with racial stock closely related to the Caucasian stock of modern Europe, often miscalled Aryan. That empire rose in 539 B.C. under Cyrus. The story of its attempts 50 years later to overwhelm Greece at Marathon and elsewhere is familiar to all. Some 200 years still later, however, that same empire was itself overwhelmed and abruptly ended by Alexander the Great.

Then came centuries of Roman greatness—though Persia did not fall to Rome but to the neighboring Parthians and stayed out of the picture for six whole centuries. But in 226 A.D. Persia had a new inning under a patriotic Persian family, the Sassanians, who threw off the Parthian yoke and brought their country to a brilliant comeback which actually lasted longer than the first empire. Though it was a smaller empire it was a more enlightened one, and Rome, by that time falling to pieces, was willing and glad to ape the customs of the New Persia. (In Rome the state had recently become hitlerized and the people, living on the dole, had lost their sense of public responsibility. Taxes to support the dole crushed them. They soon lost their freedom. These lessons of history are readily available today.)

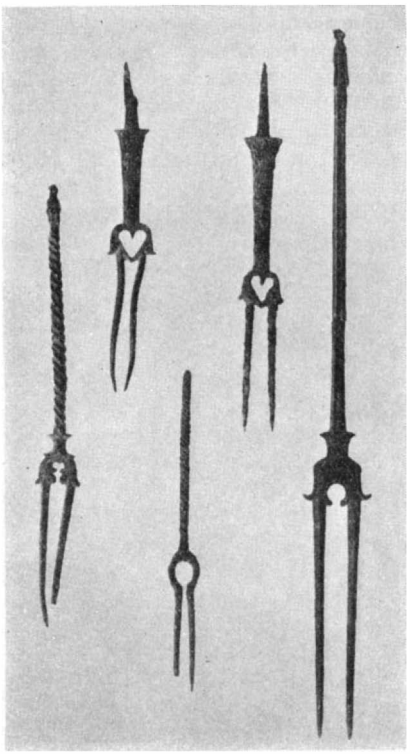


The "eye-dropper" object whose real purpose remains undetermined



Bronze spoons and ladles. Scale about 1:3. Note combination tool

The objects shown in the accompanying photographs pertain to this brilliant New Persian period of history—the one which decadent Rome was glad to ape—and they practically explain themselves. Forks, spoons, ladles, and so on, were not then dissimilar from those we use in 1935. The forks perhaps look odd to us but they would not have looked odd to our own great-grandfathers, since



Bronze or copper forks. Some of these were perhaps for serving

four-tined forks are a comparatively recent innovation.

THE peculiar object in the center picture was called, for lack of a better term, an "eye-dropper" by the archeologists in the field, but its real purpose remains unexplained. In some ways it resembles something in common use comparatively recently but as fully forgotten in 1935 as flint and tinder, Model T Fords, or the art of bundling; that is, the "pap boats" or baby feeding vessels used until a century ago for stuffing our infant great-great-grandparents with pap. Breadcrumbs boiled in water, often served in wine or beer from a vessel having a spout for the baby's mouth—that was pap. Some have suggested that the unidentified object might have been a pipe for smoking. They forget that tobacco was a New World plant not yet discovered. The whole Persian, as well as the Roman and other empires of antiquity, rose, flourished, and declined without a single citizen thereof enjoying a smoke.

If the object in question was not a pap pot, and was not a pipe, what was it? Perhaps some of our readers can suggest what it was.

OUR POINT OF VIEW

Youthful Engineers

THE problem of guiding the youthful student in his choice of engineering as a profession has long harried the minds of educators and has puzzled parents; the lack of adequate guidance has left the student bewildered. Often high-school boys have turned to us for information to help them make the fateful decision, yet we could help but little in giving such long-distance advice; it must be understood that only those close to the student can best evaluate his strictly personal aptitudes and abilities.

Into this problem the engineering profession has long put a great deal of study and has finally evolved a nation-wide system of student guidance, according to an announcement by the Engineering Foundation. Direct contact will be established with students, parents, and teachers through local engineering groups to provide continual counsel for boys who plan to adopt engineering as a career. Dean R. L. Sackett of Pennsylvania State College has been appointed Chairman of the committee on student selection and guidance which will shape the new educational activity. The task of this committee will be to discover the engineering type of mind and to interpret engineering as "a career and as a culture." Local units of the participating engineering societies will be called upon to form in each locality a sympathetic, understanding committee, and engineering schools everywhere are being asked to co-operate.

It is the intent of this new program to give much-needed occupational information to the high-school and prep-school student so that he may understand the demands made on him in preparing for various fields of usefulness, the nature of the service performed and the character of the opportunities afforded. Engineering will be presented in a broad sense with more emphasis upon its functional aspects than upon its technical sub-divisions. That is, such activities as construction, design, operation, management, service, sales, analysis, research, development, production, evaluation will form the real basis of the boys' consideration for or against the engineering profession.

We believe that this plan for student guidance, backed as it is by the Engineering Foundation and member societies and carried forward by some of the ablest educators of the country, is a workable and most promising one for the future. There is one point, however, which was not stressed in the original announcement and which is highly important. This is the question of difficulties that lie ahead for the youthful student. We have seen cases in the past where youngsters have had painted for them glowing pictures of the opportunities in engineering only to find after getting a degree that personal aptitudes were not taken fully into consideration. It therefore seems to us that the study of students' aptitudes is the primary key to the whole problem and it is to be hoped that the Engineering Foundation, in developing their nation-wide program, will observe this fact carefully and devote to it considerable study.

Pan-American Business

WHILE many nations, including ourselves, have been frantically endeavoring to assure outlets for their products through reciprocal trade agreements—horse trading, as it were—a movement of surprising, and gratifying, magnitude has been quietly taking place in Pan-America. The "Colossus of the North," as the United States has often been called with unkind intent, seems to be recapturing the South American market with a vengeance. In 1934, while our imports from that continent increased 13 percent, our sales to South America increased over 41 percent. The result was that we took the lead as an exporter to these markets, displacing Great Britain who showed a gain in 1934 of only 12 percent.

Our gains as compared with world gains, as a whole, are typified by the following examples, *in percentages:*

	Total Imports Gain	Gain in Imports from U. S.
Argentina	5.5	23.
Uruguay	1.5	70.
Ecuador	73.	113.
Chile	33.	70.

To many people, this showing is a portent not only of world recovery but also of future more friendly relations between ourselves and our southern neighbors. Too often have they distrusted our motives, called us grasping, imperialistic. We should like to disabuse their minds of such ideas. An increasing trade between us will help, for it will necessitate a wider contact of representatives, trade commissions, and the like. It will not work miracles, however. Even before the depression, the United States was the leading exporter to South America. And it might be said that some countries will buy regardless of personal feelings simply for economic or quality reasons.

Nevertheless, there is now an entirely new outlook. We have evacuated Nicaragua and Haiti—for the occupation of which we have been so bitterly assailed—and our present "hands-off" doctrine in pan-American politics should inspire greater confidence in us among our southern friends. We hope the time will come when they will look upon us as a big brother whose highest aim is to build up and maintain a feeling of good will in this hemisphere. Ay, 'tis a consummation devoutly to be wished!

Anglo-American

SPEAKING of international relations: Many Americans were pleased with the recent remarks of Mr. Stanley Baldwin and Captain Anthony Eden anent the desirability of closer co-operation between Britain and the United States. It *is* an interesting proposal, but before committing ourselves, we will await development of concrete plans.

False Prophets

EXPOUNDERS of false doctrines are abroad in the land. They seek to gain political profit or power over the masses, or both, by deluding an already befuddled public with half-truths, by citing distorted figures, and by sowing the seed of class-hatred. Lest, therefore, we fall too surely under the influence of one modern Mesmer of the radio who claims that prior to 1930 there had been a steady, devastating decrease in employment and in wages, let's look at some figures.

From the post-war boom year 1920 to the year 1930 (after the crash), the number of American workmen gainfully employed rose from 41,614,288 to 48,829,920—*U. S. Census.* The index number of real wages paid to industrial laborers was 112.2 in 1920 and 136.4 in 1929—*U. S. Bureau of Labor Statistics.* Total volume of wages paid was 29,540,000,000 dollars in 1920 and 34,485,000,000 dollars in 1929—*Brookings Institution, Washington.*

There seems no way of stopping the false prophets who maltreat the truth of these figures via the air waves, so we suggest turning the dial to the program of some clown who makes no pretense of seriousness.

READY-MADE HOUSES

Houses from Catalogs . . . Pre-Fabricated Steel . . . Pre-Cast Concrete . . . Several Types . . . More than Mere Novelty . . . Basic Accomplishments

By PHILIP H. SMITH

IT may sound like fiction, but you can acquire a full-size, life-long home simply by ordering from a catalog and telling the dealer where to erect it. When you take possession a month later, the refrigerator will be making ice cubes; the heating plant will be throwing cool, conditioned air through the rooms; and, as likely as not, the radio will be playing. All you have to supply is something to sit on, something to sleep on, and whatever other furniture you think necessary.

This is the pre-fabricated house about which you have been hearing from coast to coast. Several types are on the market, all essentially the same in being more or less complete, factory-made products, modern in thought, construction technique, and execution. They symbolize the combined genius of manufacturer, architect, chemist, construction expert, and, of course, the visionary.

All the noise and bustle stems from the work of some 50 pre-fabricators, less than a dozen of whom have actually sold a house. Small wonder then that the public knows not where pre-fabrication stands, whether it is a novelty, running on momentum gained at the Century of Progress and local exhibitions, or is the agent of a new era typified by a house on every lot.

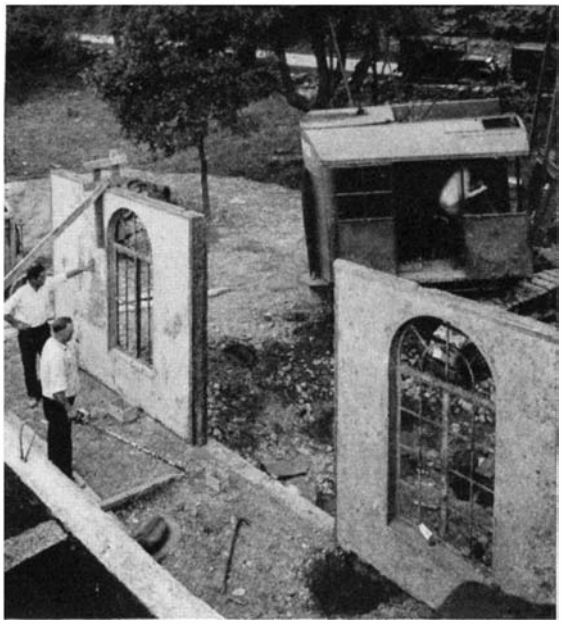
Make no mistake—there is more in pre-fabrication than mere novelty. How much more is hard to discern until sponsor's aims are known, until methods are analyzed, and the basic accomplishment reviewed.

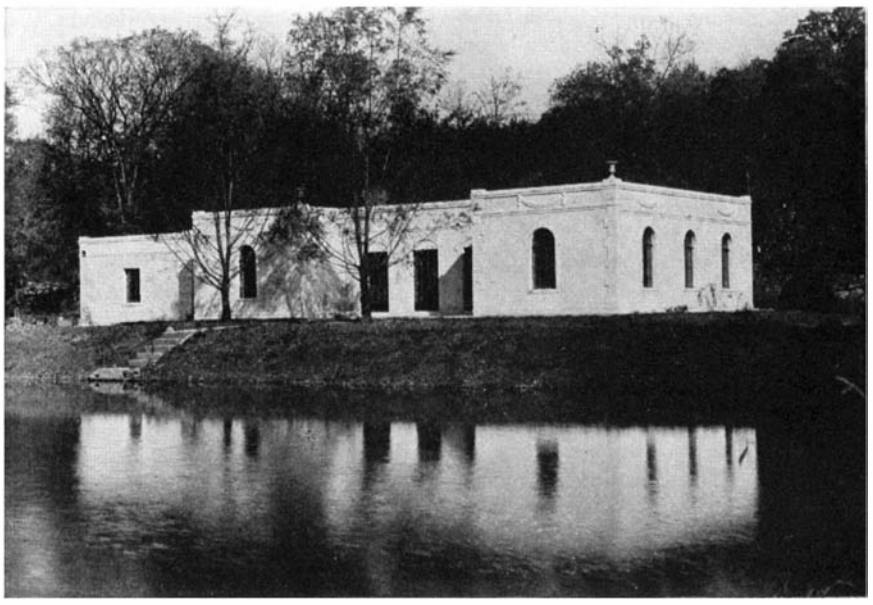
The building fraternity is unanimous in declaring that a restricted buying power is an obstacle athwart the path of home building. The more conservative believe it will revive when economic forces conspire to increase buying power, while the more aggressive and radical elements in the profession hold that the stimulus to building must be given by the industry itself through reduction of costs. Among this latter group are the proponents of pre-fabrication. This is an overly simple statement which should be qualified by noting that there are many progressives who feel that high land values, taxes, and realty speculation (factors which cannot be treated here) create the real blockade.

COSTS do loom large as an obstacle to construction. Compared with any other modern industry of like size and importance, building is far too costly and backward. Methods have changed little in past centuries. Bricks are still laid one by one, lumber is still cut piece by piece, and the finished product differs little from what our forefathers enjoyed. Costly methods still prevail and it is this front upon which the pre-fabricationists make their attack.

The pre-fabricator claims there are four elements to the building problem. There is waste, he says, in small scale operation with a contractor-architect, financer, wholesale supplier, and numerous crafts biting off a little piece from each individual job. Better by far to concentrate functions under a single head to serve many units. This, they say, would make possible purchase of materials in quantity at rock-bottom prices.

Large-scale purchase solves the first of the four elements in the building

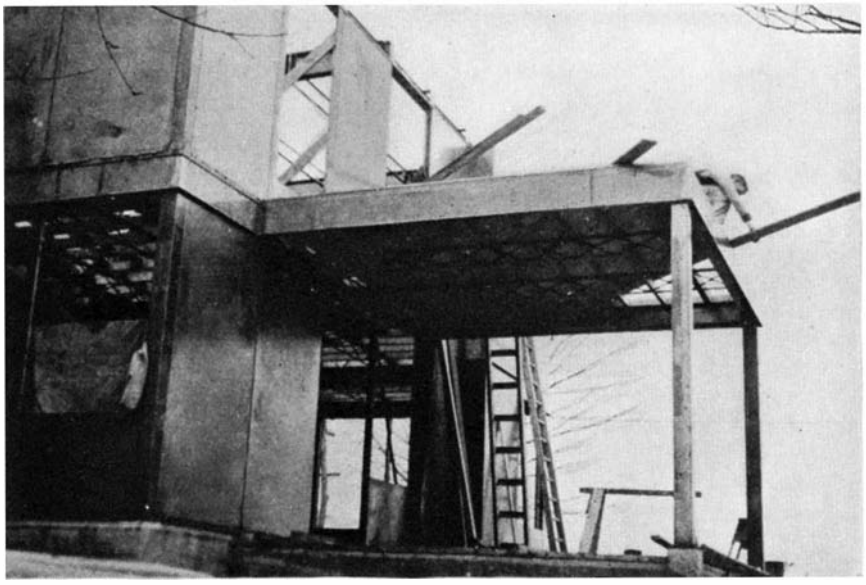




With the foundations in, it is a simple job to set up the pre-cast concrete slabs here shown, that are made according to a new process with imbedded window and door frames. The completed house is shown at right

problem. The second is met by obtaining better materials—better in the sense of being more easily and inexpensively fabricated into form. If this is done, says the pre-fabricator, it would not only reduce fabricating costs, but would contribute to a solution of the third problem which is one of cutting assembly and erection costs on the site. Quite logically, solution to problems two and three transfers the handling of much labor from site to factory where it would be possible to bring about further cost reductions and to give labor more steady employment at a more controllable hourly wage, thus solving the fourth, or variable labor wage, problem.

Pre-fabrication then really means revolutionizing construction to make possible application of our very highly developed machine technology with its inherent cost saving. It involves standardization, integration, and mechanization.



A minimum number of studs and other framing pieces are required in this pre-fabricated modern steel house. *Above:* inserting window frames. *At left:* constructing the porch roof over a steel framework

All this sounds very new, but strange to relate, pre-fabrication is old. Building materials have been factory-made for a very long time. What is attempted now is an increase in scope of factory treatment. Nor is standardization wholly new; the idea is simply carried much further. Portable houses, "ready-cut" structures, the "knock-down" house, all are examples of pre-fabrication and they date back as far as 40 years. It's just that we haven't thought of them as forerunners. Even the pre-cast concrete slab house, about which much is written in the news, isn't new. The writer recalls describing nine years ago a process by which hollow walls of concrete could be factory cast and set up to make houses of many styles at relatively low cost. Such a house was actually erected at that time and still stands in one of the boroughs of New York City—a low cost structure; six slabs forming floor, ceiling, and walls of each room; weatherproof, admirably insulated, and inhabited by a contented pre-fabrication enthusiast.

Early experiments in pre-fabrication made little or no progress. Why? Because the public wasn't ready for it. Factory-made houses required a large market to assure cost savings, and economic pressure was insufficient to force consumer acceptance of the unconventional on a wide scale. But the seeds were sown, experimentation was continued by a few firm believers, and present-day pre-fabrication draws upon years of trial and error in the creation of moderately well-tested products, as is demonstrated by examination of practices.

Steel, concrete, and plywood are the three basic materials with which pre-fabricators are working and there is practically no uniformity of practice. Each producer has his peculiar type of construction and combination of materials, but all strive to obtain a standardization which is practical. Efforts are directed toward contriving a few simple forms which will permit some variation in design while co-ordinating frame construction with standardized exterior and interior panels, doors, and window frames. No matter what the materials used, all components must conform to a definite module so that parts have a maximum interchangeability. The greatest divergence is found in methods of joining, binding, and fitting the pieces and forms of materials together to make a unified structure.

Steel is the most recent material put into commercial use. Structural steel shapes or fabricated light steel strips are being used for frames. For walls, the form is in cells or pans, the former providing a hollow wall which is filled with an insulating material; the latter providing a similar effect when panels or pans are bolted together with an insulating material between. Certain types of steel-panelled structures require no frame, the panels being adequately strong to carry the roof load. Modifications of the all-metal house are found in types using copper and aluminum for walls, or steel covered with a baked enamel finish.[1]

THE proponents of concrete lean heavily to the pre-cast slab, and with very good reason, for enormous strides have been made toward reducing slab weight so that it can be handled without special equipment on the site. Some producers use a wood frame, others steel, and still others have found a way of pre-casting studs, columns, and joists

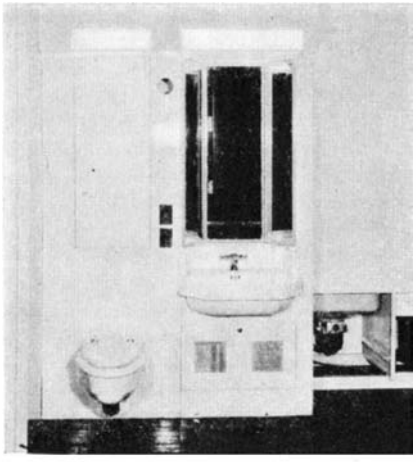
[1] "Fight Corrosion," July *Scientific American.*

so that the entire structure is concrete. Closely allied in character are types of construction which use panels of cement-asbestos with or without insulating material between and held rigidly or merely clamped to permit free movement under stress.

Plywood is only now getting attention as a possible exterior or interior wall material. Development of synthetic resin glues provides a binding substance for the laminations which excludes moisture, fungus, and termites; the finished, compressed panel has great strength. One producer offers a panel strong enough to carry most of the roof load when used in conjunction with light steel I-beams and channels.

LESS prominent construction types, though progressing rapidly, employ steel frames and cork board panels ready for application of any chosen exterior wall surface; light steel frames with ribbed aluminum sheet covering; metal lath wall frame and sand-lime precast slabs, reinforced and braced with steel angles.

The foregoing covers the basic types of pre-fabricated structures. Each type has its advantages and disadvantages, but space does not permit detailed criticism. We can only touch upon merits



and demerits in a broad fashion and steel is the first subject.

On the score of strength, weight, and thickness, there is much to be said for steel. A steel frame is virtually indestructible, and no termite can eat it. Steel panels, properly designed, provide enormous protection, using very little space. There seems to be a tendency to restrict steel to framing inasmuch as the life of a panel is limited by corrosion. Copper-bearing steel[1] gives increased life and so does painting the surface, but painting is a repetitious job. Corrosion can work from the inside, the attack being made from the unpainted inner wall surface. If strong, non-corrosive metals could be had at sufficiently low price, wide use would probably be

[1]Ibid.

Steel construction permits the use of another modern scientific development: arc welding for the joints

made of them by pre-fabricationists.

Steel frames of the light strip type have proved very satisfactory, but as yet costs exceed that of a well-made wood frame. Structural shapes, though satisfactory in service, are much heavier than necessary and excess weight is a factor militating against low cost.

The pre-cast concrete slab house represents enormous strides over earliest models. Two-inch and even one-inch thick slabs of satisfactory strength are now common and this weight reduction permits handling large units without costly equipment. Their lightness, however, is a drawback because they are rather easily damaged in shipment from factory to site.

These drawbacks in construction are by no means insurmountable and they do not detract heavily from the basic achievements toward a solution of the home-building problem. Many of the present houses are admirable from the standpoint of being highly livable. There is no question that design has been unified to the end that operation and upkeep are, in most instances, lower; that what are regarded as necessary comforts are well provided and that the buyer gets his money's worth. But what of first cost? Have the pre-fabricationists achieved their aim of providing homes at lower cost?

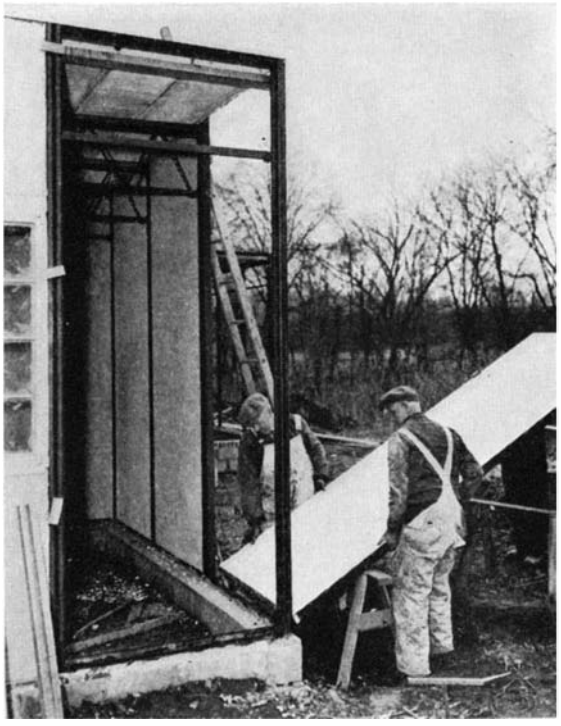
The answer to this question is: Not yet. The proponents of the new building who have not been carried away by enthusiasm for the products of their own genius will admit that the pre-fabricated house can be duplicated in size and general equipment at identical cost by what they term "outmoded methods," but they will add that the buyer gets a better house—that is, better materials—in the pre-fabricated house.

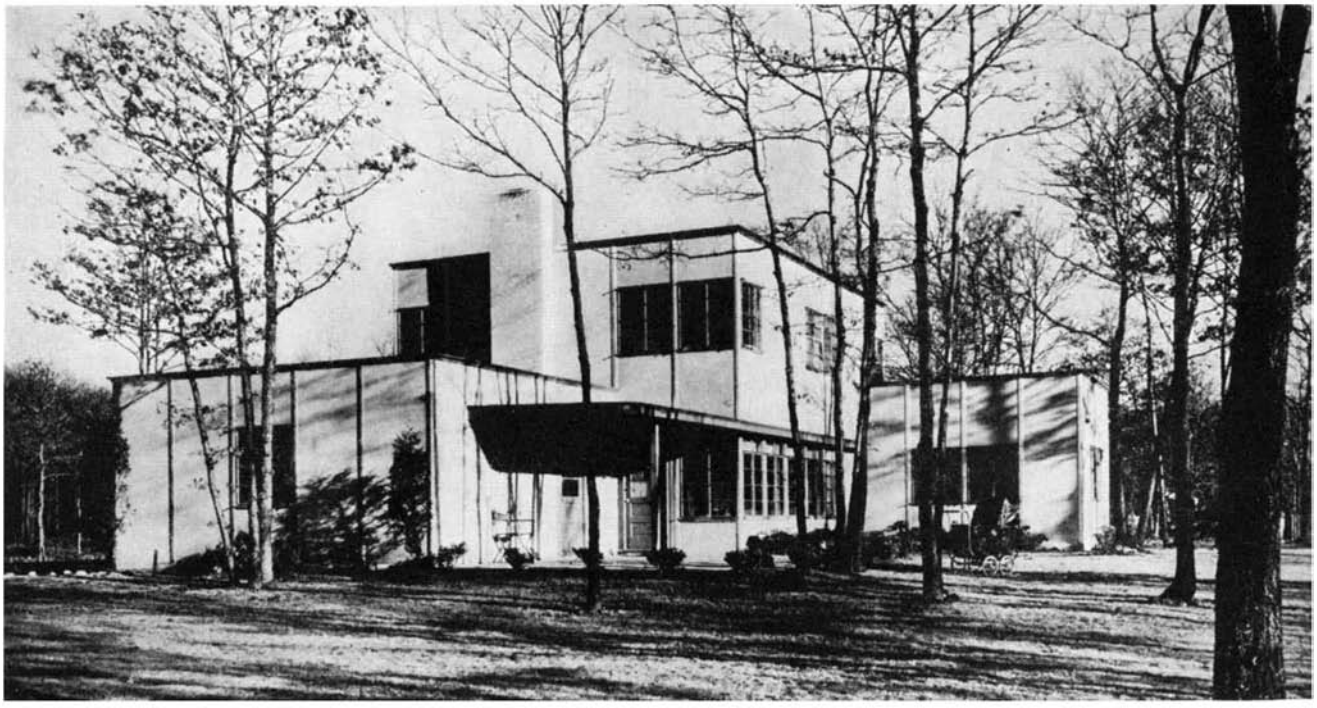
The pre-fabricator has overlooked nothing in his search for means to lower cost, but there are definite limitations in his way. These should be considered here before making a final appraisal.

IT would seem but common sense to get back to fundamentals and ask where the possibilities of savings are. Here we get at something significant. Since most building materials are already factory made, the possible saving is in extension of the factory process in order to reduce the cost of direct labor on the site, and since this approximates 25 percent of the total home cost, here is the place where a dent can be made and *is* being made. Framing a seven-room steel house in 75 man-hours testifies to this. Even so, 15 percent represents about the maximum possible saving in site labor, since there will always be such non-factory items as foundations, sewer connections, sidewalks, and so on.

It is important to note, too, that the use of "better materials" is somewhat dictated by the transfer of labor from site to factory. Materials must lend themselves to machine fabrication if the machine is to contribute to cost saving. Substantial reductions incident to factory treatment depend upon large scale operations, which in turn require a

Partially assembled bathroom side of a new steel unit-house. In this "core" will be all mechanical, plumbing, heating, and electrical devices for the entire home. *At right:* Its steel frame, with wall panels of asbestos and concrete





Research in construction is not enough; research in "liveableness" is every whit as important. The two-story house shown here, constructed as illustrated on the opposite page, has been lived in for over two years and found to be exceptionally comfortable

large market, and that market is not an immediate one though it may be an eventuality.

Aside from cost barriers, there are others militating against the pre-fabricated house. Labor organizations do not relish the oncoming of factory operations which would necessitate a violent readjustment of the many crafts, accompanied by a certain amount of hardship; building codes, fashioned with older methods and time-tried materials in mind, preclude from certain localities these newest products of the pre-fabricator's art. Finally, standardization, so essential to the proper functioning of the entire idea, restricts design variation and thus alienates a large body of potential buyers—the people who now have the money and could purchase at prevailing prices.

In presenting these obstacles and drawbacks to pre-fabrication, nothing has been portrayed but a picture of the moment. Many of the barriers, very real at this writing, are but transitory. Pre-fabricators tell us that transfer of labor from site to factory will give steadier employment and ultimately create new jobs. Eventually the drawback of obsolete building codes will be removed. A code cannot long stand unamended against a demonstrable improvement which means so much to the community. Even standardization, creating a monotonous product, is not a real barrier.

The rock-bottom in possible savings is still in the future. If there is a limit to the reduction of labor costs on the site, there is still an opportunity to work back to cut material costs themselves. Pre-fabricators dream of materials not yet originated which, perhaps, will be made from waste materials or from very cheap bases. They vision improvement in existing materials to give them new qualities, enhancing their utility and value many fold. Recent years have given stainless steel, copper with the strength of steel[1], plastics to form at will[2], more durable paints[3], and concrete which bears little relation to the material which you've seen made up of cement and sand, watered indiscriminately.

THERE is more than supposition in the idea that we are on the eve of startling developments. There are several admirable products in existence now which a change in selling policy would place at the disposal of those seeking low cost building materials—products having low base and production costs when made in volume, but held in the upper brackets until some competition forces cultivation of markets through low price appeal. Even such well-known materials as wood and concrete may be brought to the fore after basic research into their characteristics reveals ways to make them more serviceable. It is to the work of the research chemist, prompted by the pre-fabricators' demands, that we must look for the means to achieve the goal that pre-fabrication has set.

It has been said that home ownership is largely a matter of heart rather than of head. This thought is expressed whenever criticism is made of the somewhat box-like appearance and flat roof of pre-fabricated houses. And it is true. But just the same, it is a wholly functional design, indigenous to the machine age, and the idea supplies the first break with tradition having any force behind it. This presages faster development.

Pre-fabrication gives an opportunity to develop architectural style anew, taking into consideration all modern advances. Its proponents can design, for example, with full appreciation of the freedom oil burners give to utilize basements, and of the new fundamentals involved in air conditioning. They can roam in a field of materials which the architects of traditional design never imagined and they can design for living rather than to perpetuate a design imposed by earlier, sometimes ancient, limitations.

Existing pre-fabricated houses are not to be regarded as the final word. Excellent as they are—superior in many respects to the majority of homes now standing—they are but milestones along a new industrial road. They are the tangible symbols of an idea which has vitalized the thinking of the building industry and drawn to it the creative efforts of a host of contributors. The pre-fabricated house isn't going to run like wild-fire across the country; the immediate market isn't anywhere near as large as many people imagine. But it may easily spur the development of a structural method making possible homes at substantially lower cost. When that happens you will have seen its real potentialities expressed. Meanwhile, pre-fabricated houses are on the way.

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[1]Ibid. [2]"Plastics Come of Age," January *Scientific American*. [3]"Paints in Transition," April *Scientific American*.

Photograph of completed home on page 66 courtesy *The Delineator*. Other photographs courtesy American Houses, Inc.; Connecticut Pre-Cast Buildings Corp.; The Lincoln Electric Co.; The Ultimate Home Corp.

WHAT ARE POSITRONS?

By E. U. CONDON
Associate Professor of Physics, Palmer Physical Laboratory, Princeton University

EVERYONE knows that there are two kinds of electricity, called positive and negative, and that the like kinds repel each other while the unlike kinds attract each other. These amounts of electricity occur in nature in small units of charge which behave more or less like little particles. The smallest unit of charge which ever occurs in physical experiments was accurately measured by Millikan in his famous oil drop experiment, and was found to be so small that 6.3×10^{18} of such charges pass in one second in an electric circuit in which the current is one ampere. Such small units may be positively or negatively charged.

But there is a big qualitative difference between the basic positive units and the basic negative units as they ordinarily occur in nature. Knowing the charge on one of these tiny units, it is possible to measure their inertia by arranging to have them going in a beam which can be deflected by the electric force between the plates of a condenser. This is the idea underlying the cathode ray oscillograph which is beginning to have so many technical applications. The more inertia the particles of the beam have, the less they will be deflected by the same field, other things being equal. In this way it was learned that the negative particles have much less inertia than the smallest positive particle. In fact, such measurements show the inertia of the smallest positive particle to be some 1840 times that of the negative particles. These light and very mobile units of negative electricity are what the physicist calls electrons, and the 1840 times as massive unit of positive electricity is what he calls a proton.

THIS lack of symmetry between positive and negative has always been very puzzling to physicists. All the theories that have been developed so far show no reason why the positive and negative kinds of electricity should behave differently with regard to the inertia of their basic particles. And why, of all numbers, should the ratio of the two inertias be just 1840? I do not ask the question rhetorically, in order to answer it in the next paragraph, for it is one of the outstanding questions in physics today and no one knows the answer.

The foregoing represents the situation as it stood until one night in August, 1932, when Dr. Carl D. Anderson, of the California Institute of Technology, discovered the positron. What, then, is the positron? It is simply the name physicists gave to a new kind of positively charged particle which Anderson discovered, which has the same amount of positive charge as the electron has of negative, *and* has the same small inertia that an electron has, instead of 1840 times as much, as was the case with the least inert form of positively electrified particle hitherto known.

So, perhaps, you may say, the symmetry between positive and negative electricity has been restored; for now we know that both kinds of electricity can occur in particles of the small inertia of the electron. But it is not so simple as that. Why was the positron not discovered until some 35 years after the properties of the electron were first studied? If no one had ever looked for such things you could ascribe it simply to negligence, but physicists have looked for positrons or positive electrons in many ways and in many places. The fact is that negative electrons are exceedingly common. They are a principal constituent of the atoms of all matter, they leak out of hot metals in radio tubes, they bombard the anti-cathode of X-ray tubes in every dentist's X-ray outfit, and so on. Positrons, on the other hand, are a great rarity. Apparently they do not have a permanent existence at all, so that under ordinary circumstances they simply do not exist. If we want to study them we practically have to arrange matters so that we can make them.

So the lack of symmetry between positive and negative electricity which has been so puzzling is just as real today as ever, but it bobs up in a different place. There is no longer a lack of symmetry with regard to mass of the least inert particle of each kind of charge, but there is a great lack of symmetry in the natural abundance of the two analogous particles—electrons and positrons. Electrons are everywhere, positrons can be found only under the most exceptional circumstances.

LET us then consider a few of the circumstances under which positrons are found. Their discovery was a by-product of the great cosmic ray research program of the Norman Bridge Laboratory in Pasadena. Anderson, working with Millikan, had arranged a Wilson cloud chamber between the poles of a large electromagnet. A cloud chamber is a device invented by C. T. R. Wilson of England, for rendering visible the paths of high-speed electrified particles as they go through a gas. As the high-speed charged particles go through the gas they knock electrons out of the gas molecules through which they pass. Thus they leave a trail of charged molecules or ions in their track. If the gas is saturated with moisture, in a chamber containing a piston which can be suddenly expanded, then the track of ions is made visible on expansion; for expansion cools the gas and makes the moisture condense out in little droplets. The droplets form most readily on the ions, since the electric charge helps the droplet to form, and thus the path is shown as a fine trace of water droplets which can be photographed.

NO matter for how many years an editor has studied the reader reaction to his own particular publication, and no matter how well defined is the editorial policy of the magazine, the editor must still lean heavily upon the ideas of readers expressed in letters to him. Recently we have received quite a number of letters asking specifically for more articles of the so-called "heavy" type such as the accompanying one. We think those readers who have written are right but we want to be sure. Will you not, therefore, sit down and write us your exact reaction to the accompanying article, which will thus serve as a test of the average reader's wishes? Prior to publication some judges thought this article too stiff for the average non-professional reader, while others believed that the readers do not want lighter articles than this. What is your vote?—*The Editor*.

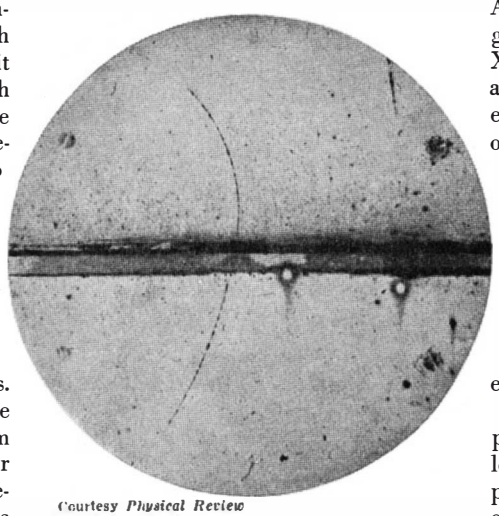
Discovery of a Positively Charged Counterpart to the Negative Electron, That Can Apparently be Created and Destroyed . . . Dirac's Theory . . . All Space Filled With an Infinite Number of Electrons That Can Never be Directly Observed

Anderson's historic photograph, which first revealed the positron, is shown in Figure 1. Hold the page in a vertical plane and imagine yourself looking at the picture through a hole in one pole of the big electromagnet, for that was the location of the camera. The horizontal strip across the middle is the edge of a lead plate located in the cloud chamber. The thing of vital importance is the thin little trail of droplets which is to be seen both above and below the plate, and bent so as to be concave on the left side. That is the path of a high-speed particle somehow associated with the cosmic rays, going so fast that it went right through the quarter-inch lead plate, but not so fast but that the powerful electromagnet was able to deflect it from a straight-line path into the curve shown in the photograph.

The forces which deflect such a particle are of the very same sort that come into play when current (that is, a stream of charged particles) is flowing in the armature of a motor and is acted on by the magnetic field of the fixed or field magnets. There can be no doubt that the particle which made this track was moving from the bottom of the picture to the top, for the fact that the track is less curved below the lead plate shows that it was going faster in the lower half than in the upper, which made it less deflectible by the magnet. The slowing down in going through the lead is due to loss of energy caused by collisions with the electrons and nuclei of the lead atoms. From the direction of the field of the magnet, and the fact that the trails are concave to the left, it can be definitely concluded that the particle which made the trail was positively charged: concavity to the right would be demanded for the case of a negative particle.

NOW how does Anderson know that the trail was not made by the already well-known proton, of 1840 times the mass of the electron? Because a proton which was deflected as much as this particle in the lower half would have to be going much slower, since deflectibility in the magnetic field is measured by the product of inertia and speed. And if it were going that much slower it would not be able to penetrate the lead and still have enough energy to go as nearly straight as it did go in the upper chamber. These are not hypothetical statements about the proton, for the proton is well known and its ability to go through lead for different speeds is known from other experiments.

To be sure, such experiments as this alone do not suffice to measure accurately the inertia or mass of the particle, but they suffice to show that it is about the same as that of an electron. After the discovery, other more exact measurements have been made which show that



Courtesy *Physical Review*

Figure 1: **A high-speed positron, with lowered speed (shorter radius) after passing through lead plate**

the new particle's mass is probably precisely that of the electron.

From the curvature of the paths Anderson could say what was the amount of energy of the positron which produced the track. In this kind of work energy is usually expressed in "electron-volts." An electron-volt is the amount of energy that a particle of charge equal to that of one electron gets when it moves through an electric potential difference of one volt. Thus an electron, in going from the zinc pole to the carbon pole of a common dry cell, gets 1.8 electron volts of energy if 1.8 is the voltage of the dry cell. But it does not get up much speed because it is continually losing this energy in collisions with the atoms of the wire through which it moves. In a vacuum tube, where collisions are rare, the energy accumulates as energy of motion or kinetic energy. In experiments of this sort one electron-volt is a trivial amount of energy—we deal in millions. Measurements show that, before going through the lead, the positron in Figure 1 had an energy of 63,000,000 electron-volts, and emerged with an energy of 23,000,000 volts, the other 40,000,000 having been lost in going through the quarter-inch lead plate.

Since this first picture was taken, large numbers of other pictures of the same sort have been made, which show the association of these positrons with cosmic rays. The first work confirmatory of Anderson's discovery was published in the *Proceedings of the Royal Society*, by Blackett and Occhialini of the Cavendish Laboratory in Cambridge, England. Since then, positrons have been observed in many laboratories, and a large amount of research is now in progress in which their properties are being studied.

SUBSEQUENT research has shown that it is possible to obtain positrons without the aid of cosmic rays. Anderson has shown that when the gamma-rays (high energy form of X-rays) from Thorium C″ (a radioactive substance whose gamma rays are especially penetrating) strike lead or other matter of heavy atomic weight, positrons are ejected. The general experimental arrangements are similar, in that cloud chambers are used to study the tracks of the ejected particles and a magnetic field in order to tell from the kind of curvature both whether the particle is positive or negative and the amount of its energy of motion.

Experiments of this sort show that positrons and electrons come out of the lead in pairs. Coming from a definite place in the lead there are two tracks, one curved as for a positron, one as for an electron. This is the new result. That gamma rays can knock out ordinary electrons by themselves has been known for a long time. All the details that have accumulated would make a story too long to tell here. Suffice it to say that the evidence is that the gamma ray, passing near the nucleus of a lead or other heavy atom, is actually able to create out of nothing a positron and an electron.

It is not quite right to say "out of nothing," for that would be a violation of the principle of conservation of energy, a principle with no exceptions thus far in any part of physics. What appears to be happening here is a conversion of the "non-material" energy of the gamma rays into a material form, the material form being the two charged particles, one positive, one negative. Other experiments have indicated that the reverse process may also take place—that a positron, passing through an atom, may unite with one of the electrons in the atom in such a way that they

are mutually destroyed as material particles. Their energy then appears as a gamma ray. In such experiments we are actually dealing with a conversion of energy into matter and of matter into energy, such as was first postulated in 1905 by Einstein as a consequence of the theory of relativity. (A new derivation of this theorem was presented by Einstein at the Pittsburgh meeting of physicists in December 1934. See SCIENTIFIC AMERICAN cover picture for March 1935, and short note on page 113 of the same number.)

By Einstein's theorem it is easy to calculate that the energy needed simply to create a particle of the mass of an electron or a positron is equal to about half a million electron-volts. So an energy of 1,000,000 electron-volts is needed to produce a pair of particles. Now the energy of the gamma ray from Thorium C″ is known to be equal to 2,620,000 electron-volts. One way in which this is known is by the fact that, when such a gamma ray ejects an ordinary electron from an atom, the ejected electron is found to have this energy by deflecting it in a magnetic field in a cloud chamber.

BUT when the gamma ray of Thorium C″ produces a pair it is found that the energy of motion of the positron, plus that of the electron, amounts to 1,600,000 electron-volts. This indicates pretty plainly that the other million electron-volts was used up in the actual creation of the particles themselves.

In the three years since Anderson's basic discovery many studies of positrons have been made. Important among these is the experimental proof, by Thibaud and Dupre la Tour, that when positrons go through lead, a gamma radiation is emitted of the correct energy to correspond to the converse process to the above—in which an electron and a positron are annihilated, with the mass equivalent to their energy reappearing as two quanta of gamma rays. Positrons also appear in the experiments of Irene Curie and F. Joliot, in which the lighter elements are made artificially radio-active by bombardment with alpha particles.

We still have to consider the question of why the electrons occur abundantly in Nature, and why the positrons are so rare. An ingenious answer to this question is afforded by a theory due to P. A. M. Dirac, the present holder of the professorship in Cambridge, England, which was once held by Sir Isaac Newton. This theory is still in a quite provisional stage, and there are difficult points about it which no one understands, not even Dirac. But it also has many things in its favor, and at any rate it is the theory in terms of which physicists think of the positron at present.

In 1928 Dirac developed a theory for the behavior of the electron, which would both satisfy the requirements of the quantum theory and be consistent with Einstein's theory of relativity. One feature of this theory was that, according to it, electrons could have negative amounts of total energy, just the same as if they had a negative mass. Now negative mass is a rather bizarre concept. Mass is the physicist's measure of inertia, and it measures the amount of force needed to speed up the particle. Using the equations, a particle of negative mass would have such a property

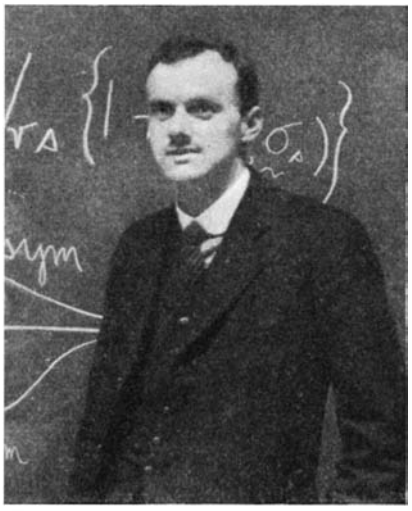


Figure 2: **Dr. P. A. M. Dirac, whose positron theories are receiving support from actual experiment**

that, if you were to push it to make it go in a certain direction, it would actually start moving in the opposite direction, and the harder you pushed it the more it would pick up speed, but always just backward from the normal behavior. When any theory gives such a strange result it is naturally to be viewed with suspicion, for no such peculiar particles have ever been found in Nature. But the theory was so completely satisfactory in so many other respects that it was not to be tossed over lightly.

Another point to notice is this: any system of electrons always tends to radiate light waves, and so to get rid of its energy as much as possible. In Dirac's theory this would mean that ordinary electrons would emit light and go over into the negative energy and negative mass states, unless something were there to stop them. The only thing that could stop them, theoretically, would be if, in so-called empty space, there were already present such a large number of the peculiar type of electrons that there would be no possibility for the ordinary electrons to emit light and go over into the peculiar condition. This implies filling what has hitherto passed for empty space with an infinite number of the peculiar electrons! But that is the postulate which Dirac makes. He says simply that, as they are always there, we do not notice them in our experiments, for experiments only show *changes* in things. It is an absolutely constant feature of our environment which thus escapes attention unless a change in it occurs.

In this great ocean of peculiar unobserved electrons, present everywhere, some special conditions may arise (such as the passage of a gamma ray near a lead atom nucleus) which result in one of the peculiar electrons being knocked up into a state of the usual positive energy and positive mass. If this happens, *two* things become observable. One is the electron that is knocked up into the normal kind of state. The other is that there is now a hole in the otherwise full distribution of electrons of the peculiar sort. This hole, according to Dirac, is the positron. A little thought will show that the hole will behave normally after all. A tiny air bubble or hole in a tank of water will rise. That is because the water is pulled the other way by the earth's attraction. So, likewise, if we have an ocean of electrons of the peculiar sort, with the property that pushing them away makes them come toward you, then a force acting on the ocean will make the hole appear to move in the normal sensible way; namely, it will pick up speed in the same direction as the force acting on it. Also, since at the hole there is one less charge than the normal amount of negative electricity, the hole will count in the equations like a positive charge. (This is just like the case of a man who became so accustomed to being 1000 dollars in debt all the time, that he considered himself to have a dollar when his debt was reduced to 999 dollars!)

OBVIOUSLY, on this view, there is a big distinction between the electron and the positron—just the distinction that is necessary to account for the fact that electrons are abundant and positrons rare. For the positron is just the absence of an electron from the ocean of peculiar electrons. It may be destroyed at any time by having an ordinary electron jump in to fill the hole. But the ordinary electrons have a persistent existence simply because there are enough of them in the world to fill up all the holes in the peculiar states which we ordinarily do not observe, and enough more to provide the ordinary electrons with which physics has long been familiar.

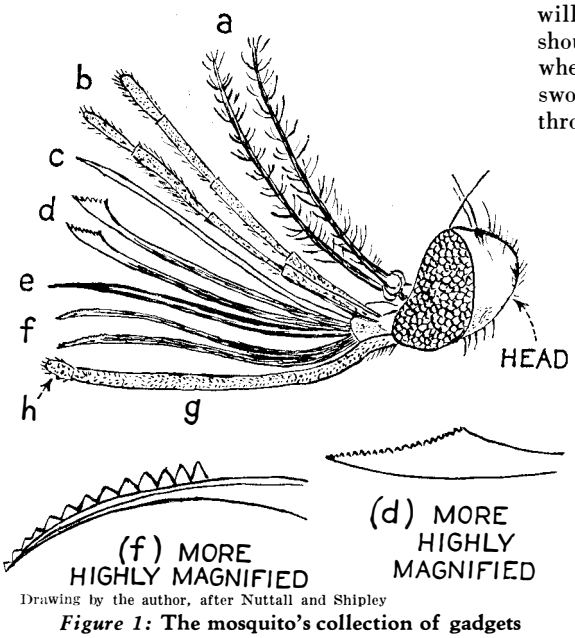
To the plain man such a theory may sound pretty fantastic. I think most physicists themselves find it rather hard to believe. But it does coordinate the experimental observations quite nicely, and no other theory has as yet been proposed which does as well. After all, such a situation is all that ever gives any theory scientific status on a stage of shifting fundamental ideas and ever-increasing array of experimental facts.

THE LADY MOSQUITO AND HER POCKET JACK-KNIFE TOOL KIT

By GEO. A. SKINNER, M.D.

PROBABLY, if you have ever wondered just how mosquitoes bite, you thought they bit by prodding you with a single awl. As a matter of fact, they do not bite at all. Instead, they saw a hole through your skin, then insert a most perfect hypodermic needle and proceed to fill up on good red blood.

If that were all they did it would not be so bad—though bad enough to cause much irritation of the skin, and occasionally some cussing, when the bite is in an especially tender place. And the mosquito has a way of picking out the tender spots, for she feels around and finds one to her liking before starting her carpentry work. It is only the female that bites, for the gentleman mosquito does not live on such coarse food as blood. He seeks the nectar of flowers, and the like.



Drawing by the author, after Nuttall and Shipley

Figure 1: **The mosquito's collection of gadgets**

After the lady mosquito has sawed a hole through your skin she injects through the tube *e*, Figure 1, some of her own saliva, so that your blood will not clot. Incidentally, this is what causes the itching. But in doing this she is likely to inject things that are unfriendly to the human being, such as malarial parasites, tiny worms, called filaria, and the like. We do not have much of this in the north, and most of the mosquitoes north of Missouri are comparatively harmless.

SUPPOSE we look at the tools that Mrs. Mosquito carries. Her kit is admirably designed for the purpose it serves. When we first look, even with a magnifying glass, all that we see is a pair of short, feathery projections and a tiny tube, like the trunk of a very tiny elephant. But this is no ordinary trunk; it is a complete tool kit. Suppose we examine it further.

There are two feathery "feelers" or antennas—Figure 1, *a*—which contain her ears, and seem to play an important part in connection with her too-efficient sense of direction. Then there are what appear to be eight little hair-like projections, which must be "teased" out of their sheath. These look harmless enough, but let's take a stronger glass, so that we may see them more clearly. Now the tools begin to be apparent. First, we see two rather tube-like hairy projections, *b*, that are jointed. Next, there is a beautifully sharpened, long hypodermic needle, *c*. Then two little saws, *d*, on long handles. Next, a sword-shaped blade, *e*. Then two more saw blades, *f*. Then, below them, what is really the case for the tool kit, *g*. This sheath or scabbard, which is really the lower lip, has two little hinged ends, *h*, which are delicate feelers, by means of which the mosquito is able to locate a nice soft place to start operations.

Now look through a still stronger glass at the saws *d*, shown below in the same figure. Each of this pair has some 30 teeth. Each of the other pair, shown more highly magnified at the left, has 13 teeth, all sharp.

We will assume that the mosquito has now alighted on your skin and has prospected around and found a satisfactory place to collect a meal. How does she get it? First, she moves away the two tubes at the top (*b*, Figure 1). Then she starts the two pairs of saws, *d* and *f*, going, and soon she has made a fair sized opening. If you watch her you will see that she weaves her head and shoulders, as does any husky carpenter when sawing. Then she slides in the sword point *e*. This is hollow, and through it she injects her saliva to keep the blood from clotting (also, she may inject various germs). This hypodermic is used only to pass fluids out, as it connects directly with the salivary glands. As she gets further through the skin, the scabbard, or lower lip, *g*, does not enter the wound, but bends back out of the way. (Figure 2.)

NOW she commences to work the other hypodermic syringe, *c*, which is used only to take in food, and the blood is drawn into the stomach by a suction-like action imparted by the little muscles around the head. Watch her commence to swell. In about three minutes she is so full that she can scarcely fly.

When she has all the food that she can carry, she packs up the tool kit and flies away to rest and enjoy the meal—and you have a mosquito bite.

YOU can readily tell whether the mosquitoes at your camp or home are dangerous or not, by watching them when they alight. If they stand with the body parallel to the surface on which they are resting, they are not disease-bearing in northern countries. If, instead, they appear to be standing nearly on their heads, they are dangerous and will convey disease. The eggs of harmless mosquitoes are in rafts or masses.

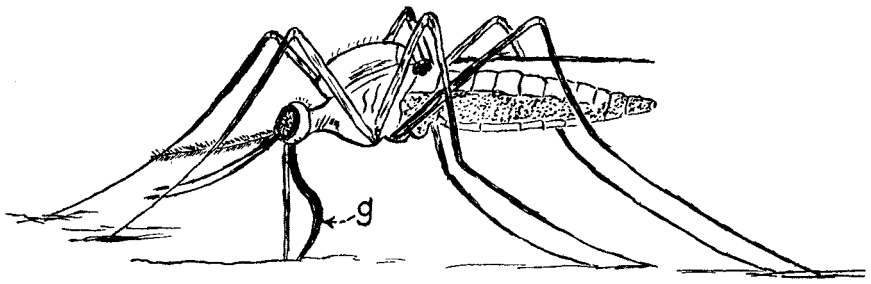


Figure 2: **The sword is in but not the scabbard *g***

When a Snake Bites You

Serum is not Sufficient . . . Prolonged Mechanical Suction is the Basis of the Highly Successful San Antonio Treatment . . . Now Used by U. S. Army

By W. A. BEVAN

IN the treatment of snake bites, it is believed by some that too much emphasis has heretofore been laid on the value of serums, and too little on the value of prolonged mechanical suction for removing the snake's venom physically from the bite. A technique developed largely by a group of men in San Antonio, Texas, particularly by Dr. Dudley Jackson who has probably had a larger personal experience in treating snake bites than anyone in this country, rather reverses these emphases, placing main stress on the removal of the venom, though not denying serums to patients in whom the mechanical treatment has been delayed or ineffective, or in such cases in which the venom enters the general circulation. People at large have probably overestimated the value of serum treatment for snake bites.—*The Editor.*

WIDE publicity has been given to new developments in the treatment of snake bite, but most persons first want to know how to avoid being bitten and what constitutes adequate protection against being bitten. Undoubtedly the best protection against poisonous snakes is a keen eye. With few exceptions, the only dangerous snake is the one you do not see. It is generally the snake under a log or rock, hidden in brush or grass roots and inadvertently touched or stepped on, which strikes. The snake you see a few feet away from you will do no harm, provided you stay away from it.

"But," says the man who goes afield for sport, "I want to think of other things than snakes when I am in the wild. What protection are boots?" Obviously, this question is one of mechanics.

Recently a number of tests were made, by causing poisonous snakes to bite different boot leathers fixed to the tops of venom-collecting glasses in such a manner that the poison could be found if any went through the leather. Those who conducted these experiments, Robert F. Harvey and the author, both of San Antonio, Texas, have been bitten many times by rattlesnakes, water moccasins, and copperheads, and know that snakes bite with even greater force when held by the neck than when they embed their fangs at the end of a well-aimed strike.

IN one experiment a small water moccasin was permitted to bite a piece of thin outer leather used with a heavier leather lining in riding boots. This leather has the same thickness and texture as that used in the uppers of lightweight lace boots. The moccasin bit the leather a number of times, making many scratches, until both of its fangs broke off, but did not puncture the leather. A rattlesnake nearly five feet long bit the same leather, but failed to pass its fangs through. This failure to penetrate the light outer leather makes it unnecessary to experiment with the two thicknesses which make up the leg of a riding boot.

Figure 1 shows a large rattlesnake biting the lightest weight leather used in leather leggings. The large, curved fang, still encased in its skin sheath, can be seen with its point caught in the leather. The venom is evident behind the fang.

As the largest snakes of this country seldom bite above the calf, most of the bites being in the lower third of the leg, substantial boots afford sufficient protection to relieve the wearer of anxiety, provided he can remember to use his eyes before he steps.

Rattlesnakes are abroad on warm nights and the camper should sleep on a raised cot as a precaution. If you can sleep better with a hair rope around your bed, put it there, but don't expect it to make a rattlesnake even hesitate. It is not necessary to place a rattlesnake within a rope circle in order to prove that it will cross the rope; in those circumstances the snake could not go anywhere without crossing the rope. If a hair rope is simply thrown on the ground, any rattlesnake will cross it without any particular inducement or coercion, as did the snake in Figure 3.

In a rattlesnake-infested country wear heavy boots and, if you wear long trousers, wear them outside the boots; for a snake will not stop to figure where the leg itself is, and will bite at what it sees—which will be the trousers.

Within recent years many articles on the treatment of snake bite have appeared in the better magazines, some of them by professional writers who evidently lacked a first-hand knowledge of the subject, and who do not know that serum plays no part today in the treatment of snake bite in the one institution where the snake-bite mortality is lower than anywhere in the world where there are dangerous snakes. The Robert B. Green Hospital in San Antonio, Texas, treats more cases of rattlesnake bite in three months than any other institution in this country treats in as many years.

The highly successful technique used in the Robert B. Green Hospital, and recently accepted for use by the entire United States Army, by direction of the Surgeon-General at Washington, was

All photos by Jack Specht

Figure 1: **This large rattler was unable to puncture the lightest leather used in leather leggings. Note the venom**

developed by Dr. Dudley Jackson, through intensive research started in 1927. Little or nothing could be learned about snake bite from clinical reports—the experience of doctors—because of the great variability of such bites, and the absence of any knowledge of the two factors necessary for the formulation of an opinion. In a given case of snake bite, brought to the doctor, the doctor has no way of ascertaining how much poison the snake injected, nor can he foretell the effect of a given amount of venom upon a patient of a given weight, for the effect cannot be predicted. Patients vary. What, then, would be the truthful answer if we asked the doctor: "Then what would have happened in this case without your treatment?"

Figure 2: **A remarkable action photograph, made *after* it had been ascertained that snakes cannot puncture heavy leather. Note 180-degree opening of jaws, showing how a snake strikes; also rigidity and musculature of the snake's body. The fangs hung for a moment on the trousers**

TO answer some of these questions Dr. Jackson went to work to determine exactly what constitutes a lethal dose of venom for an animal of known weight—and, to shorten the whole long story, every method of treating snake bite was tested under controlled conditions: echinacea, cautery (including gunpowder), ammonia, potassium permanganate, turpentine, kerosene, rattlesnake bile—all were investigated. The only treatment which was uniformly successful was surgical: deep, multiple incisions at and around the site of the bite, and the removal of poisonous fluids by the application of suction cups (Figure 4) at intervals for an extended period, often two days.

The information gained from the first hundred experiments was clinically applied, and the death rate in snake-bite cases immediately dropped. When these experiments were being made, serum was also used and tested, exclusively in a few cases, and later in conjunction with the surgical treatment. Several years later a check was made of all available data on snake-bite cases at the Robert B. Green Hospital, the cases being grouped according to treatment. Of the cases listed as non-specific because they had no adequate treatment, as it is now known, 14 percent died. Only 14 patients were treated with serum alone, and of these two died. Since the incision and suction treatment was instituted, seven years ago, there have been only two deaths, thus giving a mortality of less than 2 percent.

Figure 3: **A Texas diamond back rattler crossing a heavy, rough hair rope. Later, just for the fun of it, the same snake recrossed the rope. Contrary to an ancient tradition or superstition, snakes snap their fingers at hair rope "protection"**

Snake venom is a powerful irritant, setting up a rapid outpouring of lymph from the blood, which causes swelling. In the swollen area there is a mixture of venom and lymph, which is slowly absorbed through the lymph channels. In the San Antonio treatment the absorption of the venomized lymph is retarded by the application of an elastic tube tourniquet, which is not placed tight enough to stop the blood circulation. Incisions in the form of a cross are made through the skin, with a pointed instrument, all over the swollen area and to a depth of a quarter of an inch or more. Suction bulbs are applied to remove the contained fluids. After the first long emergency treatment the bulbs are applied for about 20 minutes out of every hour, as long as there is any lymph to remove. During the intervals between suction periods packs soaked in a hot saturated solution of Epsom salts are applied to the bitten limb.

THOSE who are bitten may receive from the snake anything from no venom in a few cases to several times a lethal dose in others. The majority will recover: with treatment, or with no help, or even in spite of mistreatment. Sometimes a snake's fang strikes a bone, and most of the venom is secreted on the outer skin. Often fangs are embedded and withdrawn so quickly that very little venom is injected, even though it is secreted at high pressure. But in a minority of snake bites the snake embeds its fangs deeply, holds on for a fraction of a second, and injects a killing dose of poison. In a majority of

snake-bite cases, incision and suction, properly carried on, is the only treatment necessary. Salt solution in the veins is used for shock, or as an emergency measure when a patient is markedly toxic, as evidenced by pulse and respiratory changes. In a highly toxic case a blood transfusion from the patient's father, brother, or any suitable donor, is used, and this can well be called a great life saver.

In 1931, in continuation of the earlier research in the treatment of snake bite, as much as 2000 cubic centimeters of serum were tried in experiments. As a result of these tests, The American Medical Association, through its Council on Pharmacy and Chemistry, officially revised its description of snake bite serum to read as follows: "In consideration of the work of Jackson, the Council decided to revise the description of Antivenin (Nearctic crotalidae) to state that 'Recent observations seem to show that there is great advantage in giving the serum in the vicinity of the bite. Use of the anti-toxin should never be allowed to replace first aid measures, especially local incision and suction. Perhaps 50 cubic centimeters of the serum is as small an amount as is likely to prove beneficial.'"

SINCE the American Medical Association regards 50 cubic centimeters as the smallest amount of serum which is likely to be of benefit, we may well question the usefulness of the amount of the present commercial dose, namely, ten cubic centimeters. The government permit to manufacture a product does not constitute an endorsement. It has been demonstrated unquestionably that serum will not neutralize venom in its entirety, when mixed before injection and in the ratio in which the government permit was issued, and you cannot get a snake to mix its venom with serum before it bites.

Figure 4: **Suction cups applied to a twice-bitten leg. Note the normal shape of leg 18 hours after bite**

Serum has not been used at the Robert B. Green Hospital in the past four years. Nevertheless, its use in huge quantities at the site of the bite, the only place where it will do any good, is recommended to those who lack the experimental knowledge and clinical experience to gage the gravity of a snake bite. Huge doses will neutralize a part of the venom. The serum has a definite value, but in no circumstances can it be regarded a cure for snake bite, though it can be a valuable aid.

In 1931 it was learned that many microbic infections are present in all snake venom, the gas gangrene organism, *Bacillus welchi*, being practically always present. This organism has been found in most of the snake bite cases from which bacterial cultures were made to date, but it seldom develops in cases surgically treated. The adequate incision and suction of a snake bite is also the best treatment for the inhibition of the complicating gangrene organism.

Note the normal shape and appearance of the leg of a man, shown in the illustration (Figure 4), who was twice bitten by a large rattlesnake upon which he stepped, following 18 hours of adequate treatment by incision and suction alone in the Robert B. Green Hospital.

A RAZOR blade (Figure 6) is not a good instrument with which to make incisions in snake bite cases, because too long a cut is made before a required depth is reached. A lot of skin can be cut, causing a lot of bleeding, which increases the likelihood of cutting blood vessels, which in turn necessitates plugging the wound, thus defeating the original purpose. A deep incision made immediately following a bite is, of course, certain to bleed, but in this case the loss of blood is compensated for by the natural irrigation. When additional incisions are made on a swollen area the object is to provide an outlet for accumulating lymph. Bleeding should be avoided as much as possible, and the incision should be made short but deep, as diagrammatically illustrated in Figure 7 at the bottom of the column, using a pointed instrument preferably like the one shown in Figures 5 and 7.

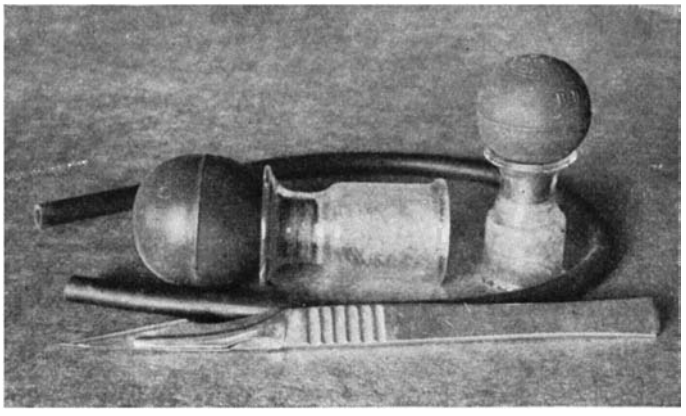
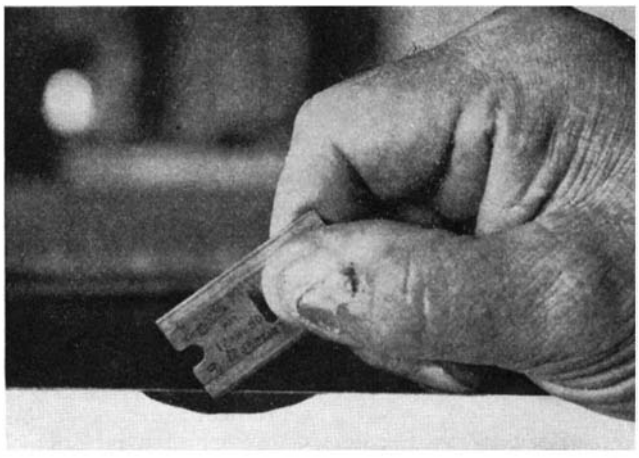
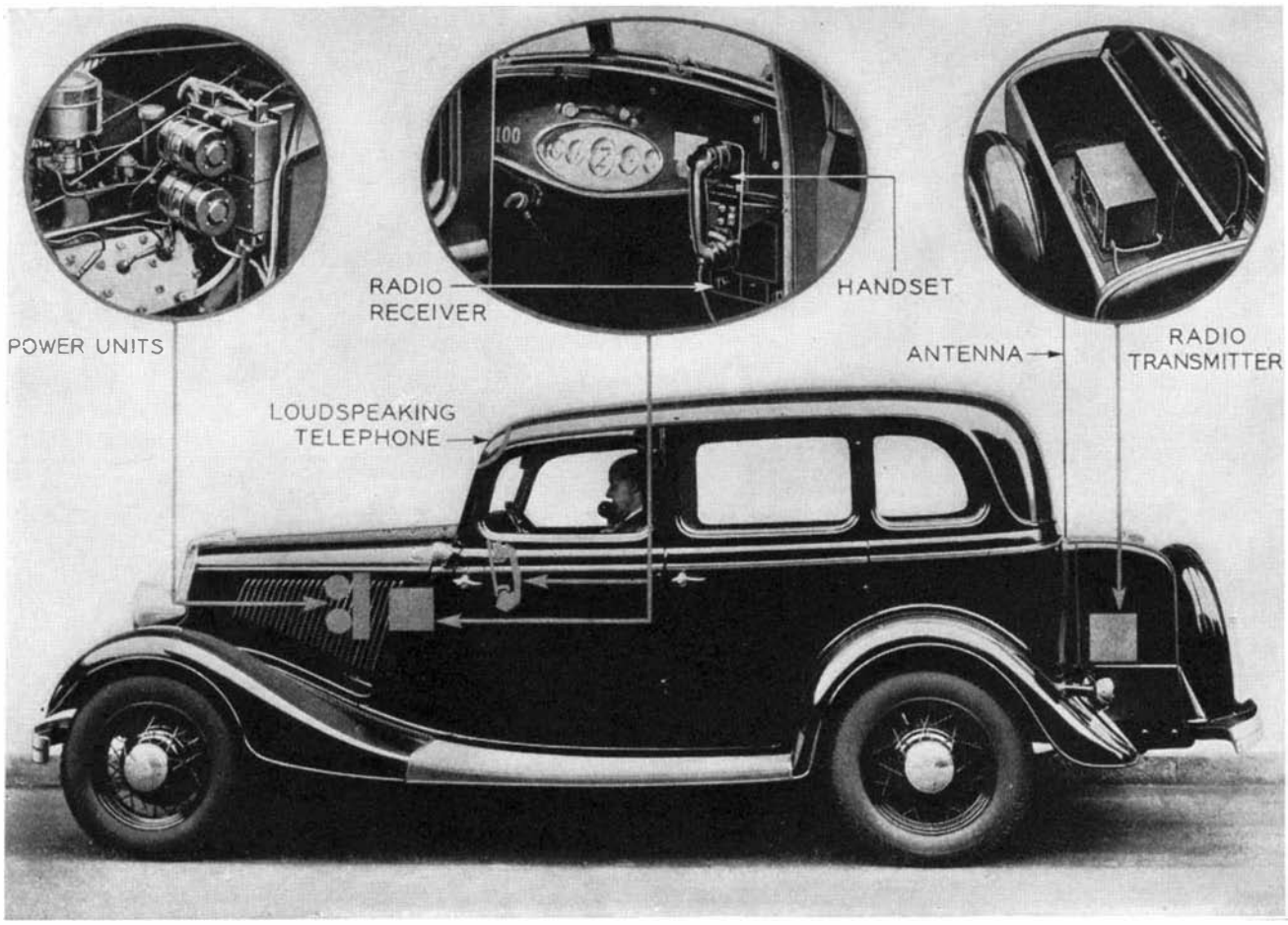


Figure 5: Left: **An elastic tourniquet, suction bulbs, pointed knife—a full kit**

Figure 6: **Darkened area on a white card shows kind of cut razor blade makes. Poor**

Figure 7: **Short but deep incisions are the most satisfactory for treating snake bites. The cutting edge is directed away from the operator. (Note thumb previously damaged by snake)**





Photographs by Western Electric Company

A police car equipped with the latest two-way radio equipment. Insets show close-ups of the important units

The Latest in POLICE RADIO

POLICE radio, now widely used throughout the country, was originally limited to one-way operation; that is, transmission from headquarters to police cars. More recently, advantages have been seen for two-way operation. In addition to receiving orders, the motor patrolman is enabled to report back to headquarters or talk to other cars without leaving his own car. Headquarters, thus in touch with any or all members of its mobile unit, can visualize an entire situation and direct maneuvers with full knowledge of how its forces are distributed.

The two-way police car equipment here illustrated has been developed by Bell Telephone Laboratories and operates in the ultra-high frequency band opened up for police use not long ago by the Federal Communications Commission. Among its features are the facts that the receiver is of the superheterodyne type, that the frequency of the mobile transmitter is crystal controlled and its operation automatically controlled by the voice, and that it employs a vertical antenna in the form of a flexible steel rod for both transmitting and receiving.

THE receiver is constantly ready for operation so that messages from headquarters will at all times come in over the loudspeaker. The patrolman's ears and nerves are spared by a special circuit which causes the loudspeaker to remain silent unless the transmitter at headquarters is on the air.

To conserve power, the power supply of the car's transmitter is ordinarily off. To talk from the car, the patrolman merely lifts a handset telephone from its hook on the instrument board, simultaneously flipping a switch which turns on the dynamotor that supplies the transmitter. During the conversation, the sound of his voice automatically puts the car's transmitter on the air; as soon as he ceases talking it automatically switches off.

This is accomplished by two relays. The first is actuated by currents generated by the speaker's voice. It, in turn, actuates a second relay which throws the antenna from the receiver to the transmitter, likewise applying plate power to the transmitter and disconnecting it from the receiver.

These relays are extremely fast and the initial transfer is practically instantaneous. In reverse action, however, the second relay is more slowly timed. Consequently it does not act during the interval between words but only when the speaker pauses at the end of a phrase or sentence. Instead of the automatic voice control, a "grip-switch" in the handset may be used to actuate the second relay.

The crystal, which holds the transmitter to within .025 percent of its assigned frequency, is one of the newly developed type requiring temperature control only below freezing. At this point a heater automatically goes into operation. The transmitter weighs only 20 pounds and is 11 by 7 by 6½ inches.

The system is at present in operation in Evansville, Indiana, and is being installed in Nashville, Tennessee.

THE SEVEN LEAGUE BOOTS

Telephoto Lenses are Versatile . . . Annihilate Space . . . Larger Images . . . Better Portraits

By JACOB DESCHIN

"IF I were only nearer!" is a familiar thought to every camera user who has stood a hundred feet away from a "whopper" and sighed for the power to annihilate the space between. With a telephoto lens, you *are* nearer.

With a telephoto lens you are near an object in the street while stationed in a skyscraper, or near to the top of a skyscraper while stationed in the street; you are near—at distances which would be impractical with a lens of ordinary focal length—to the action at sports events, to what is going on across the street, to distant landscapes, to airplanes and birds winging across the sky, to animals some distance away, that would scamper away if you approached.

Everyone is familiar from childhood with the seven-league boots which magically carried the Puss-in-Boots of the classic fairy tale a full seven leagues forward each time she took a step, but modern telephoto lenses are more convenient still, for the cameraman has but to point his lens and the seven leagues vanish before his very eyes.

Vacation days are great days for the telephoto—in camp, in the mountains, at the seashore. High divers, with their graceful flight through the air from springboard to water, children at play in the sand, bathers splashing about in the surf, mountain climbers making their laborious way toward the heights, the many incidents in camp, are all grist for the telephotographic mill. The special virtue of telephotography in these and similar instances is that while some of the pictures can easily be taken with the ordinary lens, the latter will often include much more than is actually wanted, while the telephoto will more nearly limit the picture area to the subject desired, besides giving a larger image.

The bird is unaware of the photographer who is some distance away, using a telephoto lens

This capacity of the telephoto lens to snuff out space and so give "close-up" images of distant objectives will suggest many possibilities for its use to the worker who has hitherto used only the regular lens on his camera. He can easily recall the many occasions when he

would have given much to have been able to photograph a large image of an objective which he was forced to abandon because of the inability of his lens to do the trick.

How many times, for example, has he longed to take "head and shoulder" portraits and found that he either could not get close enough or when he did that his subject's face was distorted due to poor perspective resulting from a too near view-point? Since in portraiture the face is *the* picture, a negative that shows only the head and the shoulders is often greatly to be preferred to the "three-quarter" or "full-length" picture. Compare a picture in which the face fills the negative with one containing the distractions of the subject's hands, dress,

Two portraits, both made at a distance of six feet. *Above:* With a 50-millimeter lens. *Left:* With a lens of 135-millimeter focal length

and other details, and the advantage of using a telephoto lens in portrait work will instantly become apparent. Facial studies of babies, children, the men and women among one's family and friends, "characters" about town, are always fascinating.

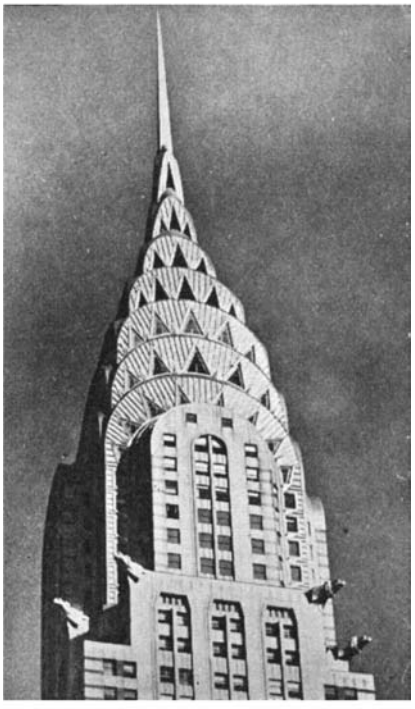
THE photography of distant landscapes is one of the favorite types of telephoto work. Here, except on extremely clear days, the cameraman must take into account the problem of atmospheric haze which is often encountered because of the great expanse of space through which the lens must cut its way to record a picture of the distant scene. In such cases it is necessary to use a yellow or light red filter, although panchromatic film must be used with the latter since orthochromatic film is practically insensitive to red.

Animal and nature photography is another splendid field for the telephoto enthusiast. Squirrels feeding from a child's hand or digging holes to bury their peanut hoard in anticipation of winter; pigeons, swallows, and other birds of the city parks in various amusing situations; swans and ducks pro-

OF PHOTOGRAPHY

ceeding majestically over the smooth waters of the park pond; cats and dogs; the traffic policeman's horse feeding on sugar cubes from a pretty lady's hand; a monkey cavorting in a pet dealer's window—these are but a few of the opportunities open to the telephoto lens, and a search through woodland and forest for interesting plants, inviting paths, and other attractions of nature will provide many more.

Telephoto lenses are available for cameras ranging in size and bulk all the way from the large view cameras down to the miniature type. It is in the latter and the reflex camera classes, however,



that telephoto lenses have found their greatest popularity. The extra lens is carried in a case in one's coat pocket and when the need arises the regular lens of the camera is removed and the telephoto inserted in its place, the lens thereafter being used in the same manner as when employing the regular lens, the only difference being that objects are brought nearer.

Telephoto lenses are made in a variety of focal lengths, so that there is a wide choice varying all the way from a focal length of 3 inches in the case of fast miniature camera lenses, which give a magnification about 50 percent greater than the regularly employed 2-inch lens, to lenses which give a magnification of a dozen times and even much more. One

Photographs of a building, taken from the same distance. *Above:* Ordinary lens. *Left:* Telephoto

telephoto lens which will answer the worker's average needs will be sufficient for the start, but later on he may find that in certain instances this lens gives him a larger image than he wishes or is still too short for some phases of the work he does. For the larger reflex and view cameras there are available lenses which may be adjusted for different magnifications. A worker equipped with two or three telephoto lenses besides his regular lens should be in a position to tackle practically any problem that comes his way.

These extra lenses should individually be given every care, for the lens surface, being softer than that of ordinary glass, is easily scratched. A cap for both front and back of the lens should always be in place when the lens is not being used and each lens should be in its own case. When changing lenses even the most extravagant precautions will not be out of place. Beware of dirt, dust, or sand entering the camera, for these can do untold harm, particularly in their effect on the workings of the focal plane shutter of the miniature camera. Where possible, it is advisable to go indoors to change lenses and thus avoid dust and dirt and in addition effect the exchange of the lenses with more convenience.

While cameras equipped with tele-

Action photographs, otherwise unattainable, are often possible with a long focus telephoto lens

photo lenses are generally placed on tripods or other steady support, there are many occasions when a snapshot while holding the camera in the hand is desirable, as in street or animal photography. When a telephoto-equipped camera is held in the hand, shutter speeds should be not slower than about 1/50th of a second to avoid vibration, which on a telephoto is greatly magnified. Wherever possible assist steadiness by bolstering your back against some firm support, such as a building, telegraph post, a tree or a fence, and, without straining, hold the camera absolutely steady. In miniature camera work, owing to the length and weight of the longer telephoto lenses, the technique is to grasp the camera in one hand and support the lens with the other, somewhat after the manner of holding a rifle. One further precaution: Always use a lens shade.

THE worker who is just acquiring a telephoto lens for the first time will soon discover to his delight that what he really has bought is the equivalent of a second camera, and the many possibilities which his new acquisition will open up to him will in the long run repay him handsomely for the cost of the lens in the pleasures he derives in photographing such distinctly telephotographic subjects as scenic views, portraits, and animals in park, street, and woodland.

The telephoto lens, in a hundred different ways, to which new ones are constantly being added by enthusiastic workers with such equipment, reveals a wonderful versatility and takes an honored place in photography as the cameraman's "open sesame" to the conquest of new photographic worlds.

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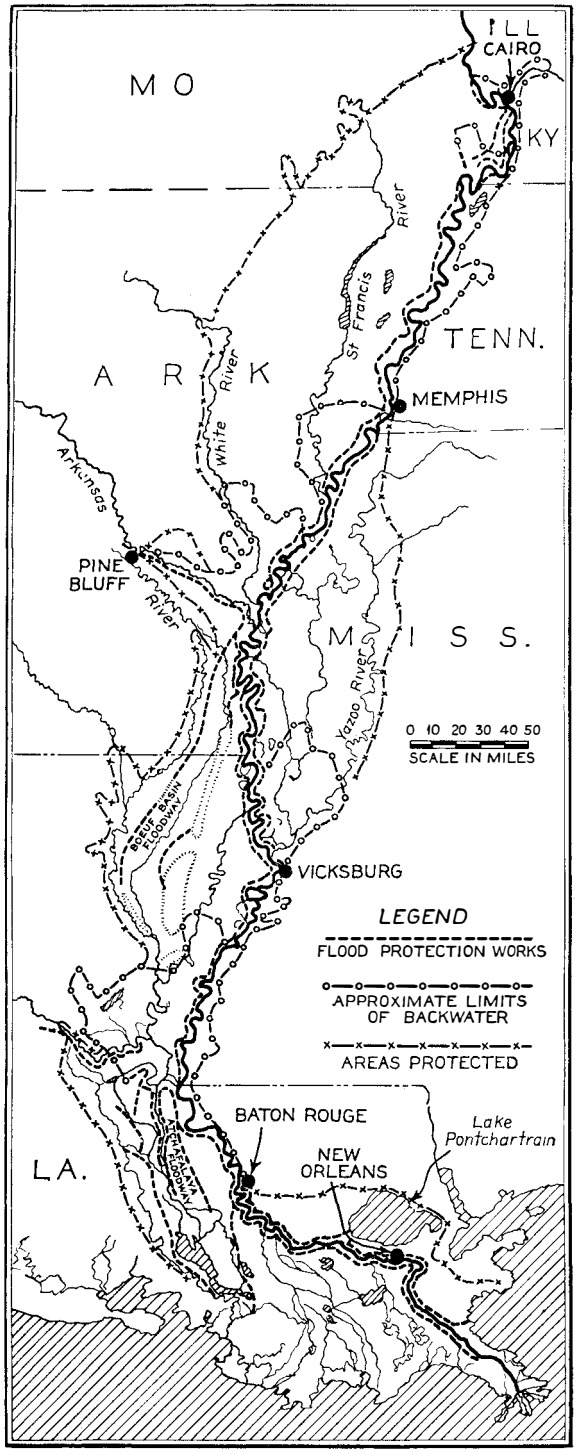
Starting next month: A regular monthly department devoted to all phases of photography of interest to the advanced amateur.

FLOOD CONTROL

By R. G. SKERRETT



Flood control on lower Mississippi as planned and worked out by the United States Army Engineers

FLOOD-CONTROL work that has been going forward rapidly on the lower Mississippi River since 1928 has reached such a present stage that there is every reason to believe that this really stupendous project will be completed sometime in the first half of 1936. When that climax is reached, a total of 650,000,000 cubic yards of earth will have been placed in the defensive levees that have either been heightened or built entirely anew to hold within definite bounds the flood waters of the Mississippi River system seeking an outlet to the sea. This volume of earth is more than twice the amount of earth that had to be excavated in digging the Panama Canal.

To appreciate what has been planned and is being directed by the Corps of Engineers of the United States Army for the greater security of life and property in the region ravaged eight years ago, the general public should know something about the physical conditions contributing to the problem; about the magnitude of the factors that have to be taken into account, in providing a solution; and, finally, be told wherein the flood-control system now under construction differs from that heretofore relied upon throughout that stretch of the river.

WHAT is generally known as the Lower Mississippi River is that part of the "Father of Waters" that has cut a devious and changing course through a great alluvial valley that extends from Cape Girardeau, Missouri, southward to the Gulf of Mexico—an airline distance of about 600 miles. The winding river, however, has a channel-way nearly 1100 miles long within the limits mentioned. The meandering course traced through the alluvial valley bed, the tremendous amount of silt carried by the river, and the large vertical range of surface level between mean low water and mean high water, add immensely to the difficulties that have to be mastered in restraining the river when in flood.

The drainage basin of the Mississippi River system extends from above the Canadian boundary southward to the Gulf of Mexico. Its eastward limit is within 250 miles of the Atlantic seaboard. On the west it reaches to within 500 miles of the Pacific Coast. In short, the Mississippi River and its tributaries draw from a watershed that has a total area of approximately 1,250,000 square miles. The volume of water moving seaward at any time is dependent upon the rainfall throughout this vast expanse as well as upon the season of the year; but, when a large percentage of the runoff is free to flow into the main stem of the system, the discharge into the Gulf of Mexico may be as much as 2,850,000 cubic feet per second! All this water escapes by what is, in effect, the small end of a funnel where the velocity of flow is highest because of the constricted area of the passageway.

Since De Soto's expedition saw the Mississippi in flood close to 400 years ago, when the lower river had a temporary width of 40 leagues, there have been fairly continuous records of the recurrent prevalence of similar stages of overflowing high water; and it is a fact established by these data that severe floods occur in the lower Mississippi on an average of every 2.8 years. It is not necessary for heavy precipitation to occur throughout the whole of the drainage basin in order to bring about a flood of major proportions. The unprecedentedly great flood of 1927 was principally the result of precipitation that was confined to the areas contiguous to the lower river while the season favored the rapid movement of the runoff into the tributary streams.

BEFORE the French founded New Orleans in the first quarter of the 18th Century and built a low levee along the riverside to protect the city from periodical floods, there is no evidence that elsewhere along the lower river earlier man reared any other barriers to hold such waters at bay. Prior to that time, the flood plain of the alluvial valley had an expanse of quite 30,000 square miles; and that basin offered the river a safety valve for the release of its seasonal overabundance as the flood moved in a comparatively leisurely way toward the several outlets by which the water journeyed to the sea. In the 200 and more years between the founding of New Orleans and the flood of 1927, levees were built along the banks of the lower Mississippi system until about 21,000 square miles of the basin became protected in this manner from flood waters—at least, that was the purpose for which those dikes were erected. Therefore man, in his efforts to cultivate and otherwise to utilize the rich soil of that region, shut out the river from the far-flung flood reservoir which it had

ON OL' MAN RIVER

Started 1928 . . . Completion Next Year . . . Levees Raised . . . "Fuse-Plug" Spillways . . . Floodways Provided . . . 650,000,000 Cubic Yards of Earth Moved

used for untold centuries. Just in proportion as the flanking levees interfered with the natural expanding of the river laterally, the volume of the water in any given interval of time rose higher and moved faster in its irresistible descent to the sea. The rushing waters, incidentally, became more destructively erosive as their turbulence and velocity increased. Decade by decade, some of the levees have had to be built higher and higher so that they would not be overtopped by the river at the crest of a flood. The normal range between mean low water and mean high water in sections of the lower river is as much as 40-odd feet. This was not the case when the river was free to occupy 20,000 square miles or more of its ancient flood plain.

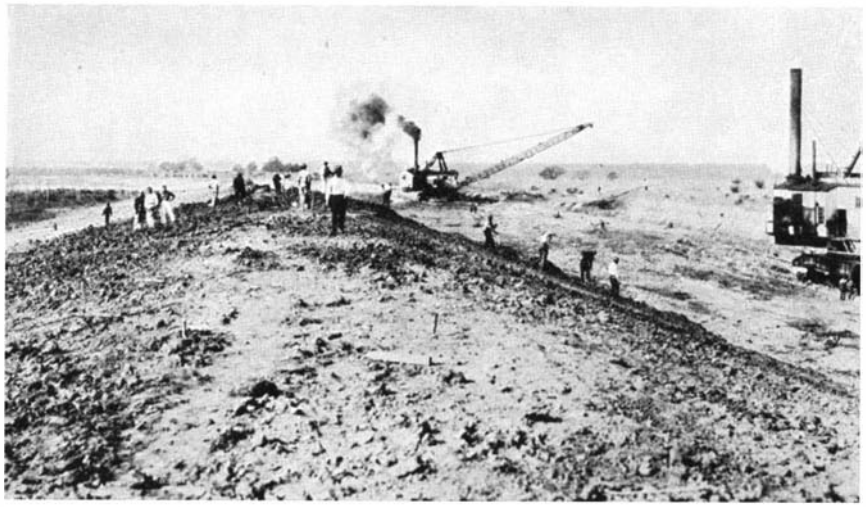
SINCE the creation of the Mississippi River Commission in 1879, the system of levees along the lower Mississippi has been continually extended until it measures approximately 1900 miles—twice what it was in 1880. This method of keeping or trying to keep the river within bounds, for the convenience and safety of dwellers in the region, was adopted by the Government engineers because for fully 4000 years levee systems had proved to be the only means which alone could be used to solve a major flood-control problem. But effective as levees are in many respects, they are not a cure-all for flood evils. Time and again the levees of the lower Mississippi have been breached by flood waters, and extensive areas have been inundated as the river battled for its ancient elbow room. The engineer's answer to each of these irruptions has been either the broadening or strengthening of each damaged levee or raising it to a greater height. In this manner, the system generally has mounted successively, and as each new level was reached, the belief was fostered that the system as a whole was high enough and strong enough to meet any likely maximum flood stage. We know, however, that it failed at critical places when the river rose to the height it did eight years ago. Those facts, combined with a very critical analysis of all available data, led the Army engineers to plan the flood-control works that are now nearing completion—works that are to provide a margin of safety even should the flood waters attain the stupendous flow of 3,000,000 cubic feet a second!

In providing for this possible contingency, the crests of the primary system of levees are being raised three feet higher than they were in 1927; but the responsible experts are no longer placing entire dependence upon levees to hedge in flood waters. Instead, profiting by a lesson that should have been learned long ago, the engineers are offering to the river side channels of relief in the very region the stream occupied freely in centuries gone by. These side channels, or floodways, will detour the excess water above a given flood level, while the main levees will guide the major volume of the total flow safely onward to the sea.

The more capacious of the floodways are to the westward of the customary course of the Mississippi, and only two of the new floodways are on the east side of the river. The western floodways are flanked on their western limits by a secondary line of comparatively low levees that will keep the detoured waters within circumscribed bounds and generally away from the more valuable lands of the region. The floodways west of the river are located in areas where farming is not extensive, and where occasional inundations will entail comparatively moderate crop losses. When flooded, those lands will probably be enriched by the silt deposited upon them. The broad plan of flood protection represents a carefully thought-out compromise that makes certain reasonable concessions to the ancient natural rights of the "Father of Waters" and to the rights that intrusive man has acquired by settling in the region and by developing it for his own ends.

IN prehistoric times, the Mississippi River had numerous outlets to the Gulf of Mexico which were in certain cases safety valves during flood stages, while some of them carried off water more or less continuously. The early explorers and settlers found that the river discharged into various bayous—to the east and west of the present navigable channel—that have since become closed. One such by-pass, on the east, connected with Lake Pontchartrain. The Atchafalaya River, on the west, functioned then as now as an all-stage supplemental channel, and the existing flood-control plan provides for the use of the Atchafalaya and some of the low-lying territory traversed by it for a floodway. The Bonnet Carré spillway, on the east bank of the river about 40 miles above New Orleans and recently completed, will permit flood water, above a given level, to flow into Lake Pontchartrain and thus reach the Gulf of Mexico.

Upstream of Vicksburg, Mississippi, adjacent to the confluence of the Mississippi and the Yazoo Rivers, there is also created a backwater area of floodway which, as a flood subsides, will gradually return the water into the main channel. Three other backwater reservoirs on the west side of the Mississippi system in Arkansas and Louisiana will be able to accommodate temporarily excess flood waters and then feed them back into the



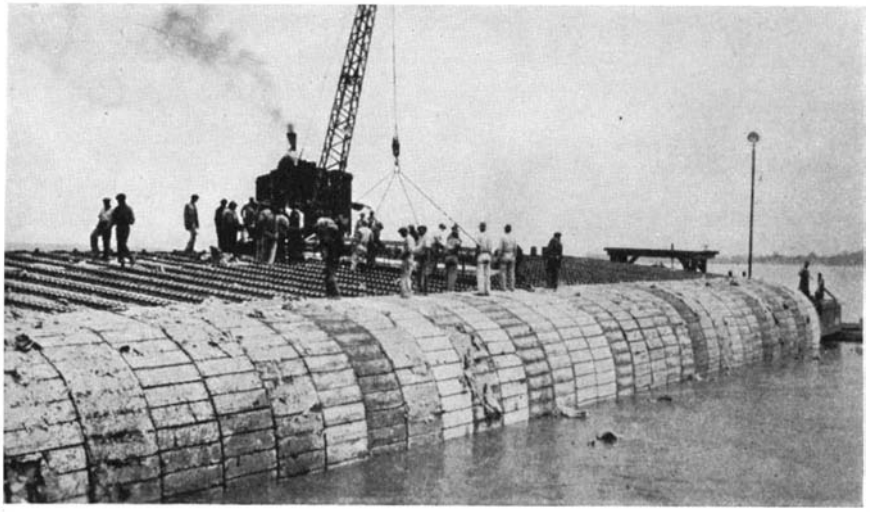
Great dragline excavators digging earth and depositing it on the levee in the center. More than 3,000,000 cubic yards of earth will go into the finished flood barrier in the Atchafalaya section, thus making it an enormous lateral dam

Scarcity of stone and a plentiful supply of sand and gravel along the lower Mississippi have led to the use of cast concrete tetrahedrons for building revetments. Their shape prevents tumbling by swirling waters, so they have proved effective in retarding erosion of the soil

main stream as the flood level drops. The inundation of several of these floodways will be through or over "fuse-plug" levees placed at strategic positions. The crest of each of these spillways is three feet lower than the crest of the adjoining main levee, and the passageway thus offered is broad enough for an enormous volume of water to escape while still leaving the crest of the main levee a full foot higher than the surface of the flood. Should the flood level persist, the escaping waters will wear down or breach the fuse-plug levee and allow still more water to flow into the floodway and thus relieve pressure upon the main levees. The defensive barriers are counted upon to protect 12,000,000 acres from overtopping waters; and the floodways and the backwater areas will, together, provide emergency relief basins having a total expanse of 8,000,000 acres.

The levees range in height from about 20 feet to more than 30 feet, and are massive ridges of earth arranged generally parallel with the riversides, and broad enough in cross section to stand against the pressure exerted upon their river slopes by flood waters. The earth required for their construction is uniformly excavated from borrow pits in the vicinity of the levees, but far enough to the rear not to induce undermining by water moving through the ground upon which the levees are reared. Because of this requirement, especially in low ground near the edges of the river, it is sometimes necessary to go inland several hundred yards to dig the dirt for levees, and the different circumstances of the source of the essential material have called for the development of novel and diversified mechanical means for excavating and transporting the earth. Government experts and the contractors have contributed to this development work, and construction has proceeded uninterruptedly and with such success that the entire project will be finished long before the date originally set.

The Mississippi's swirling, swiftly moving flood waters are highly erosive, undermine river banks, and damage riverside properties. The materials so detached are redeposited where they may change the course of the river and possibly obstruct navigable channels. Therefore, flood control and the maintenance of channels are inter-related activities, and this is especially so in providing protection of the banks against erosion. Again, the responsible officers of the Corps of Engineers have devised numerous forms of revetments either to deflect the river currents or to blanket the banks from above the high-water line on the shore outward for some distance below the surface of the river at low water. In some cases, these mattresses are made up of fagoted masses of willow branches 16 inches thick and laced together to form a unit mattress 150 feet long and 100 feet wide, several of these rectangular sections being spliced together to form a single great mattress 200 feet wide and from 300 to 1000 feet long. The mattress is held in place upon the bank and river bed by rock ballast dumped upon it.



Launching articulated concrete mattresses, a highly satisfactory form of revetment, from a barge on which they are cast continuously

A LATER and more rugged form of revetment is that of slabs or blocks of reinforced concrete linked together by flexible metal bonds. A mattress of this sort is constructed in successive sections on barges equipped for the purpose. The shore end is hauled up as high as desired on the bared bank and then added to, strip by strip, and extended as far as needed underwater toward the center of the stream. The very latest type of mattress consists of a reinforcement fashioned of wire cables and steel mesh embedded in a heavy sheet of asphalt paving. With the floating plant devised for the work, a flexible blanket of this sort three inches thick, 200 feet in width, and more than 500 feet in length can be fabricated at a rate of 30 linear feet an hour. A mattress of this kind, laid upon the bank and bottom of the river, will effectually protect the underlying ground from the erosive sweep of the swift waters; and, because of the enduring character of the asphalt, the mattress will probably last unimpaired for many years.

The estimated ultimate cost of this flood-control work is 325,000,000 dollars; and of this amount 257,000,000 dollars have been either expended or appropriated to carry on the undertaking. This money is being provided by the Federal Government; and local interests have not contributed. In addition to giving protection to the alluvial valley, the project will increase the value of property in the region and promote the welfare and prosperity of everyone living there—incidentally having a beneficial reflex on the nation as a whole. At this time, the undertaking has been carried forward far enough to protect the lower valley against all but the greater floods; and there is every reason to believe that the full program of flood-control work will be finished well within the 10 years originally set in 1928. In its various aspects, the project is an engineering task of truly monumental proportions.

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The author of this article, Mr. Skerrett, has written another interesting engineering article concerning unique construction methods used on a bridge in Denmark. It will be published soon. —The Editor.

Office Efficiency

Increased by Scientific Study . . . Better Light . . . Quiet . . . Comfort . . . How Studied

By DEAN M. WARREN

IT is axiomatic that efficiency in work of any kind is highest when employees have comfortable working conditions. Lighting also is known to play an important part. With these facts in mind, A. H. Stricker and M. W. Ulf of General Electric's Nela Park plant set about to lessen the fatigue of their card punch operators.

The first step was to design and install for each a more convenient shelf to hold the papers from which they transcribed. The second was to add a supplementary lighting system to the one already installed which delivered about 8 footcandles on the working area. These two changes increased operator efficiency. Production increased 30 percent while errors, always low, were decreased 27 percent. Then unnecessary noises were reduced by carpeting the floors and relocating the supervisor's desk. The changes so far had eliminated factors which caused physical tension and bodily fatigue so the investigators began a restudy of earlier changes.

Fatigue of office workers measured by the ophthalmic ergograph

NEXT to be reviewed was the lighting, and here a major improvement was made. The original auxiliary system consisted of a small bowl reflector equipped with a 25-watt lamp and adjustable to any desired position by means of a flexible arm. It had many shortcomings. It gave only a spot of light on the paper and also was objectionable from the standpoint of reflected glare. After much experimenting, and with the consulting assistance of the Engineering Department, a supplementary lighting system that consisted of an adaptation of the Illuminating Engineering Society's study lamp was installed.

In order to discover to what extent the additional footcandles actually reduced fatigue, tests were given the operators by engineers. One day a group of operators would work under the general lighting alone, while another group worked under the supplementary system; the following day they would alternate. Tests were made at the beginning and end of the day by means of a semi-automatic ophthalmic ergograph for measuring ocular fatigue. This instrument consists of a pair of prisms that rotate in opposite directions. The subject places her right eye at the prism, keeping both eyes open, and fixates upon the test object, a small capital E, 14 inches from the observer. When the subject is comfortably positioned, she opens an electrical circuit by means of a key which brings into play a magnetic clutch and rotates the prisms. When the power of the prism overcomes the converging power of the eyes, the image splits into two, one for each eye. At the instant of splitting, the subject depresses the key, returning the prisms to zero position, ready for the next observation. This was repeated twenty times to obtain an average. These tests indicated that the eye muscles were three times as fatigued when the day's work was done under the lower levels of illumination as they were when it was done under the higher levels.

This study in office efficiency is significant because of the fact that there are many thousands of power-driven machines in use throughout the country today on which similar tests could be made in the interests of increased efficiency and greater production.

Below: **The card punch operators working under difficult conditions of lighting and inconvenient work placement**

The improved set-up, with individual lights that do not produce glare. Newly designed brackets hold the sheets

Sun Clocks

Beautiful Garden Ornaments . . . Sun Clocks, Not Sundials . . . Dependable to Within One Minute

By RUSSELL W. PORTER
Associate in Optics and Instrument Design at the California Institute of Technology. Contributing Editor

Illustrations by the author

THE advent of the pendulum clock gave the sundial a knockout blow as a time keeper, for it was independent of the weather, and indicated the passing of the hours whether the sun was shining or not. And of course nowadays, if the old clock runs down, pick up the right time to t second by switching on the radio

However, the sundial is still a charming garden ornament, even if one has to perform a mental calculation to use it—though even then there is an uncertainty of a few minutes, due to the ill-defined shadow cast by the gnomon. Some years ago (August, 1928) the Scientific American published an article of mine in which I attempted to give more precision to the sundial by forming, witl a lens, a sharp image of the s instead of using the shadow abo ferred to. These experiments led me into using the sun's image, in connection with the familiar clock face carrying the hour and minute hands, an advance in dialling originally due to W. E. Cooke, of Australia. Furthermore, to avoid the mental addition or subtraction already mentioned, I have drawn on the properties of the analemma, that odd looking hourglass figure so often seen on globes, with the ultimate object of so tying up the lens, analemma and clock dial, that standard watch time is found directly. No discovery is claimed for using this combination, the general idea having been known for years, but the manner of employing these various elements in beautiful garden ornaments may be found interesting.

The trouble with Old Sol as a steady timekeeper is that he does not arrive due south of us every day exactly at noon (by our watch). Depending on the season, he is either ahead of or behind time. But our clocks will not run fast and slow to accommodate our luminary—they must run at a uniform rate. Moreover, we desire our days to be of the same length—24 hours. And so the astronomers hit upon the device of imagining a fictitious sun that came around to the meridian at 24-hour intervals, and called it the "mean" sun, as distinguished from the real or "apparent" sun which we see. These two "suns" travel across the sky more or less in company, never more than 16 minutes of time apart.

In Figure 1, imagine yourself looking at the framework of the southern heavens—there you stand in the lower left-hand corner. Two examples are shown at random, in November and February. both when the fictitious sun *M* is on the meridian at high noon. But in the first case—November—the sun we actually see is lagging behind his companion *M*, and in the other—February—he has forged ahead. These separations, if plotted for the year, will yield the curved path shown—our analemma—and the interval separating the two suns (indicated by the heavy black lines in the drawing)

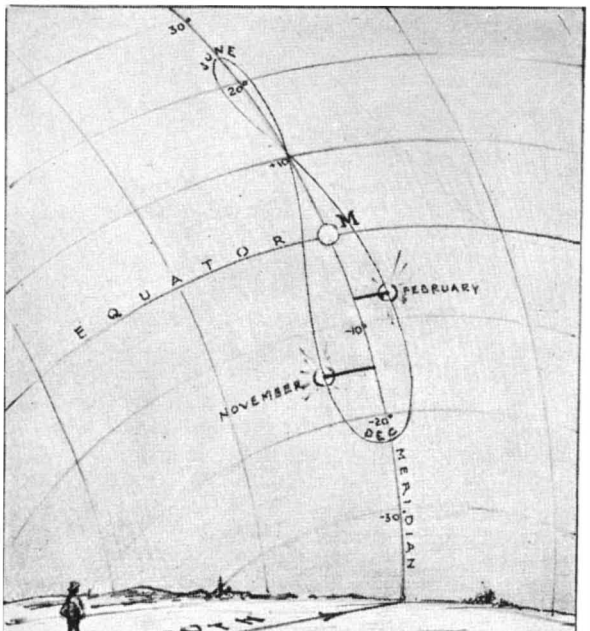


Figure 1: The master analemma is the or traced on the sky by the real sun's cha

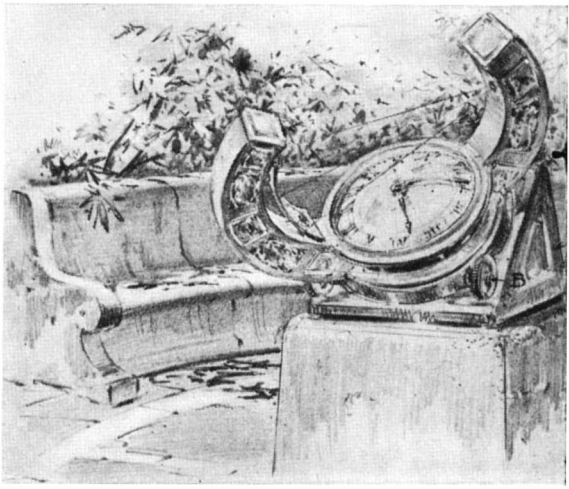


Figure 3: This is similar to Figure 2, except that it different base and is actuated by means of a worm

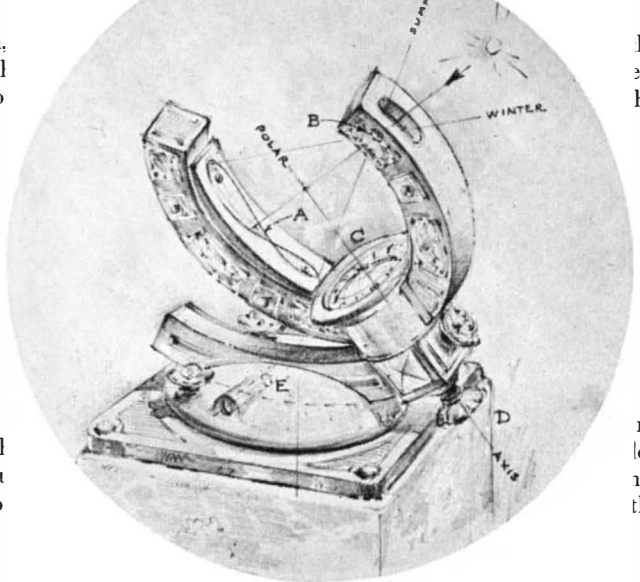


Figure 2 (below): With hands but without works, the sun clock accurately tells the time

wn as the "equation of time." ık it is now fairly obvious why, in clock, we let the sun's image fall he analemma instead of on the eridian. Sketches accompanying his article are a few of those accumulated during the past ten years.

Figure 2 will give a good idea of the principle involved. The analemma A is shown on a curved brass plate which has a radius of curvature equal to the focal length of the small lens *B*. The reason why we let the sun's image fall on this "figure eight," as already explained, is that in so loing we automatically get mean ıe instead of apparent time, as the sundial.

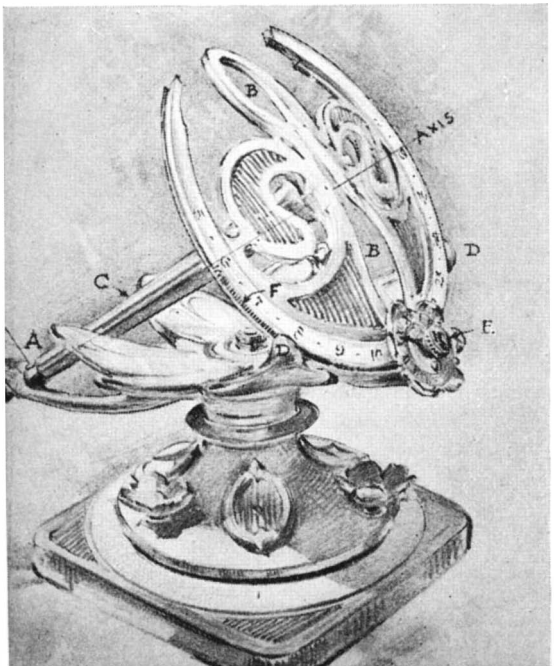
The clock face—there is no clock movement back of it, but just the hand and face—is shown at *C*, and the problem now is to so tie up the rotation of the analemma and lens with the hour and minute hands, by proper gearing, that when the apparatus is turned by hand, using the petal *D*, so that the sun's image from the lens bisects the figure eight, the clock hands will indicate the time. It is done by means of a simple gear train that turns the minute hand 24 times in a day, the hour hand two times a day, and the ring carrying the analemma and lens once a day. These are the three ratios, 24, 2 and 1, and all three of the corresponding parts are driven by turning the lower petal. Of course, you must know which wing of the figure eight to use in bisecting the sun's image, but the months are usually stamped on the analemma (clearly shown in Figure 6). In this design, provision is made for inclining the polar axis to fit the latitude, and clamping with setscrew *E* in Figure 2.

FIGURE 3 is similar to Figure 2, but has a permanent base *A*, and the drive is through the worm shaft *B*.

By introducing an additional reflection, with a right-angle prism, we can radically change the design, and view the sun's image by transmission, drawing the analemma on a piece of curved, translucent celluloid or ground glass. In Figure 4 the prism and lens are at *A*, and the reflected, converging beam is thrown up to the analemma, which covers the opening *B*, *B*. The upper bearing of the polar axle *C* rests on the two leaf pads *D*, *D*, and on the knurled head *E*. This carries the minute hand and has a pinion

as a gear

Figure 4: **Another change rung on the principle shown in Figures 2 and 3**



that engages the bent rack *F*. For careful setting purposes, the bent rack is quite as satisfactory as the more expensive worm wheel in Figure 3. Even when setting by hand, as in the case of the clock shown in Figure 5, the bisection is fairly easily made. But one can always set a division a little ahead of the sun's image and then watch the disk of light creep up until it is certain that the disk is bisected. The uncertainty is never more than a few seconds.

A variant on this arrangement is shown in Figure 5. Here the polar axle, carrying the prism, lens, and analemma, slides in a groove around a fixed hour circle *A*. In these two designs, Figures 4 and 5, the analemma has been fitted into the conventional pattern of the fleur-de-lis.

In all of these attempts to get accurate watch time from the sun, I have experienced the most trouble in properly ad-

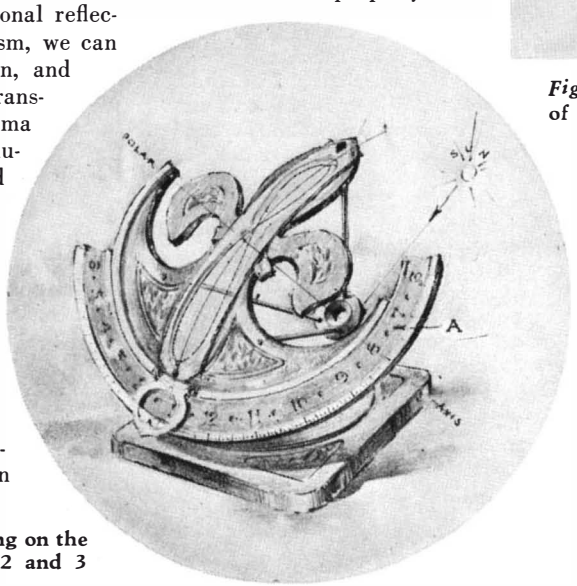


Figure 5: **Still another variation of the basic principles already stated**

justing the polar axis of the instrument parallel with that of the earth. One satisfactory solution was found in the design shown in Figure 6, where the sun clock has been stripped of everything but bare essentials. Unfortunately the clock face is turned down, and has to be viewed through the looking glass *A*. But the instrument can be adjusted and checked on Polaris any clear evening. To do this, the diagonal mirror *B* is removed and an image of Polaris is formed by the lens *C*, on the polished plate carrying the analemma. A line drawn from the center of the lens to any part of the small circle *D*, makes an angle with the polar axis equal to the complement of

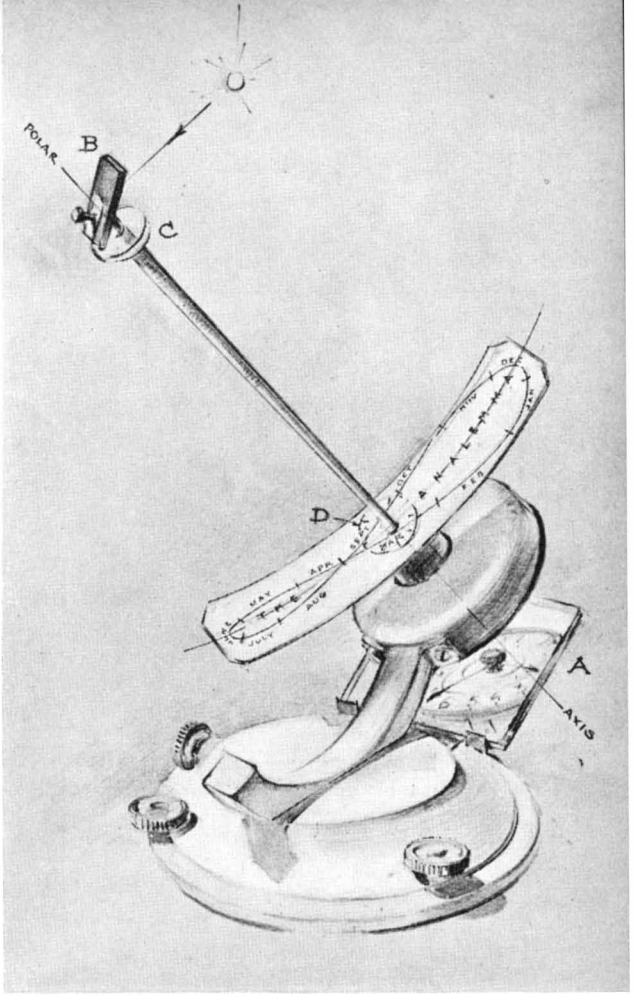


Figure 6: **This design is arranged to facilitate adjustment of the sun clock to parallelism with the axis of the earth**

Polaris' declination, viz. 1° 05′. The image of the star is readily picked up with a magnifying glass, and the adjustment made with proper allowance for hour angle. The diagonal is returned to its seat, and time to well within one minute may be depended upon.

It should be noted that, not only will the sun's image on the analemma give standard time, but it will also give the day of the month.

There is probably nothing to be gained in accuracy by increasing the focal length of the lens beyond eight or ten inches, which gives an image somewhat under an eighth of an inch in diameter. Neither should the lens aperture be over a quarter of an inch (*f* 40). On polished brass the image is very easy on the eyes if filtered through a wafer of red or yellow glass.

All parts of the sun clock should be of non-corrosive metal—brass, statuary bronze, rustless steel, aluminum, or some other.

Well, the sun clock may be little more than a novelty, since we are living in an age when time may be picked out of the ether whenever desired. But it's lots of fun, out here in California where there is almost too much sunshine (I come from New England), to rehabilitate the sundial into an instrument of precision, and to juggle its optics and watch the various forms develop.—*Pasadena, March, 1935.*

THE BLUE CLOUDS OF MARS

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

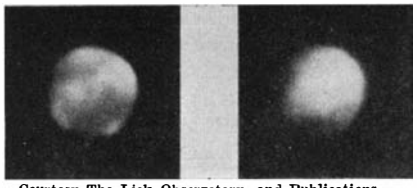
IT is doubtful whether anything else in the skies excites so widespread and general an interest as the planet Mars—unless indeed a total eclipse of the sun is imminent, or a great comet is in sight. There is sound reason for this, for we can find out enough about the planet to be sure that it is more or less similar to our own world, and yet not enough to be sure *how* similar—so that the questions most interesting to the imagination remain unsettled.

A first telescopic view of Mars—even with a large instrument and under good atmospheric conditions—is likely to be very disappointing to the novice; and the more familiar he is with the drawings, or even the photographs, made by professional students of the planet, the worse will be his disillusionment.

There is plenty of detail on the planet's surface, but it lacks contrast—an artist would describe it as being pitched in a very low key. It would not be fair to expect Mars to look like the moon at her quarter, when the jet black shadows and brilliantly lighted peaks make an exceedingly "snappy" picture. The full moon, when there are no shadows to bring out the relief of the surface, and only the tone and color of its materials count, is more fairly comparable. But her spotted face shows more contrast than the planet's, as is evident when the two are compared with such magnifying powers that they appear of the same angular dimensions. At its nearest, Mars appears to be 25″ in diameter. When at opposition, in the part of its orbit remotest from the sun, as it was recently, its apparent diameter is only 14″.

WITH a power of 300—which is moderate for planetary observation in good seeing—Mars, as seen through the telescope at the least favorable opposition, looks more than twice as big as the moon to the naked eye, and under the best conditions nearly four times as big. We might then expect to see as much on Mars with a telescope as on the full moon with a good opera glass, but we do not.

The greater part of the difference arises from atmospheric unsteadiness. To the unaided eye, and even with a good binocular held in a steady clamp, the images of heavenly bodies are steady (except for the sun at the point of setting). But when the disturbances are magnified some hundredfold they become very serious. It would be hard to match them in a naked-eye view, even by artificial means. One might do so by getting the moon directly over a chimney from which heated, though smokeless, gases were pouring, or maybe by lying on the floor and looking through an open window just above a radiator working at its fullest power.



Courtesy The Lick Observatory, and Publications of the Astronomical Society of the Pacific

Photographs of Mars, taken March 14, 1935, with a 12-inch refractor, at the Lick Observatory. In the ultra-violet (*left*) as is the case in the violet, light area at the bottom is the north polar cap (telescope inverts), but the south polar cap is turned away. Large clouds—three light areas (squint the eyes)—are seen between these. In the infra-red (the right-hand photograph) the clouds do not show, just as is the case with thin haze on earth. But two canals, too fine to reproduce, show on the original photograph, extending from the north polar cap into the brighter area. Dark area at bottom is Mare Acidalium

To see just how hard these conditions would have to be to spoil a view of the moon with the naked eye, or with an opera glass, might be an amusing experiment for an amateur astronomer already familiar with telescopic "bad seeing"—as, alas, all who look through telescopes must be.

In photographing Mars, unsteadiness is even a worse obstacle, for the eye can seize the moments when the images are good and the plate cannot. But the "flatness" of the picture can be greatly modified by the choice of suitable color filters. With the filter transmitting the deep red, the contrast of the surface markings is greatly enhanced. Such photographs, especially if printed on contrasty paper, make the details far more conspicuous than they ever appear to the eye. This is not, of course, a defect of the photographs but a great advantage; it brings out things which would otherwise be hardly observable—just as photography of star clusters and nebulae does to a much higher degree. With yellow or green light the gradation is much the same as to the eye. With a screen transmitting the violet only, the surface markings practically disappear—not because they are obscured by anything in front of them, but since the reddish and the greenish areas both photograph equally dark with light of this color.

Even under good visual observing conditions, or when photographing with appropriate color screens, the Martian details are sometimes difficult to make out. There are real seasonal changes: in the early spring of the planet's temperate regions the darker areas show less than the usual contrast, and parts of them may be hard to detect, while in late summer they are, in general, decidedly darker and more conspicuous. Some of the beautiful photographs obtained at the Lowell Observatory show these changes clearly, and afford an objective proof of their reality.

BUT there are more rapid changes in visibility, for which neither the earth's atmosphere nor the Martian seasons can be held responsible. There is at all times a whitish illumination at the planet's edge—called the limb-light—and as the rotation carries the markings into this, they are partly or wholly drowned out. The explanation of this is simple. When we are looking at the center of the disk, our line of sight passes almost squarely down to the surface and through but a small thickness of the planet's atmosphere. Near the apparent edge, the rays strike obliquely and traverse a much greater amount of the gases. Any haziness—even the small effect of scattering by the molecules, which is inevitably present in all gases—will therefore be greatly magnified near the limb and produce an effect of just the observed type.

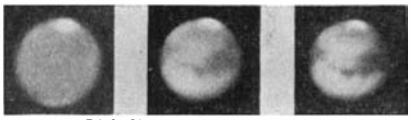
The earth, viewed from without, would undoubtedly show a similar but much more conspicuous effect—as is obvious when one considers the character of the views steeply downward and off toward the horizon, from an airplane or a high mountain peak. At times the markings appear to be veiled over large areas, even near the middle of the disk. These effects usually last but a few days, and it is reasonable to attribute them to temporary fogs or haze. An observer on

the moon or Venus—could one exist there—would undoubtedly have noticed obscuration of this sort, and of remarkable persistence, over the central-western portions of the terrestrial marking which is known to us as North America!

Sometimes—though very much more rarely than on earth—definite clouds appear upon Mars, and completely obscure large areas with a whitish veil. Such formations are just unusual enough to deserve specific mention in astronomical literature. A conspicuous group of clouds which appeared on March 12 of the present year is illustrated on page 86, which shows photographs by Dr. Wright made at the Lick Observatory and reproduced by their courteous permission. These clouds were evidently bluish, for they are not visible on the right-hand photograph taken with infra-red light, but are very strong in the violet and ultra-violet (left-hand photograph)—so much so that they, as well as the polar caps, cause an apparent swelling of the photographic images, giving them their curious lumpy appearance. It is noteworthy that they are much more conspicuous toward the edges of the disk than near the center.

CLOUDS which were conspicuous when the sun rose over the Martian surface often partially fade out near noon. This behavior has often been recorded, and is obviously and simply interpretable. They form before sunrise, dissipate in the warmth of noon, and return in the cool of the evening. This is enough to settle that these markings are produced by some sort of condensation of atmospheric vapors. But they do not appear to be quite like our familiar clouds on earth. Everyone who has attempted cloud photography knows that the first prerequisite is a yellow or red screen. On an ordinary photograph the sky may be very "flat," but in the red the clouds stand out sharply against a dark background. This happens mainly because this background is the clear blue sky, which scatters the violet light powerfully and the red very little. But we would not get the pictures that we do, unless the clouds themselves reflected all colors of light almost equally well (as their whiteness proves to the eye). Clouds as white as ours would undoubtedly show on infra-red pictures—even if taken from above—against the darker background of a planet's surface. Hence these Martian clouds must not be pure white, but bluish—banks of blue haze, rather than dense fog.

Is this reasonable? We may meet the question with another: What are the clouds on Mars made of, anyhow? We can be sure of one thing: it is the same stuff which forms the polar caps. Ever since the regular seasonal changes of the latter were observed, nearly three centuries ago, it has been generally recognized that they must be composed of something snow-like. This melts or evaporates in the spring and summer, "vanishing into the air," and comes down not long afterward in the opposite winter hemisphere, after a long journey which it can only have in the form of invisible vapor. But there are a great many substances which are equally capable of doing this. Water—frozen into snow—will fully meet the conditions. So also would carbon dioxide condensed



Courtesy Lick Observatory

The ordinary (cloudless) photographic appearance of Mars. Taken in 1924. *Left:* In the ultra-violet. Note south polar cap. *Center:* In the yellow. The markings show faintly. *Right:* In the infra-red the dark markings, Syrtis Major at left limb, Sinus Sabaeus in center, Margaritifer Sinus and Indus to the right, show up the best. Many astronomers now agree that these are vegetation, for they exhibit seasonal changes in color and intensity, and that the rest is desert. The center picture is more like the kind of seeing we get visually, being fainter. Unless the observer knows what to look for, he will see little on Mars even if the seeing is good. It is a matter of training, not of the eye but very largely of the brain

into the solid form now familiar to us all as "dry ice"—and so would sulfur dioxide or ammonia.

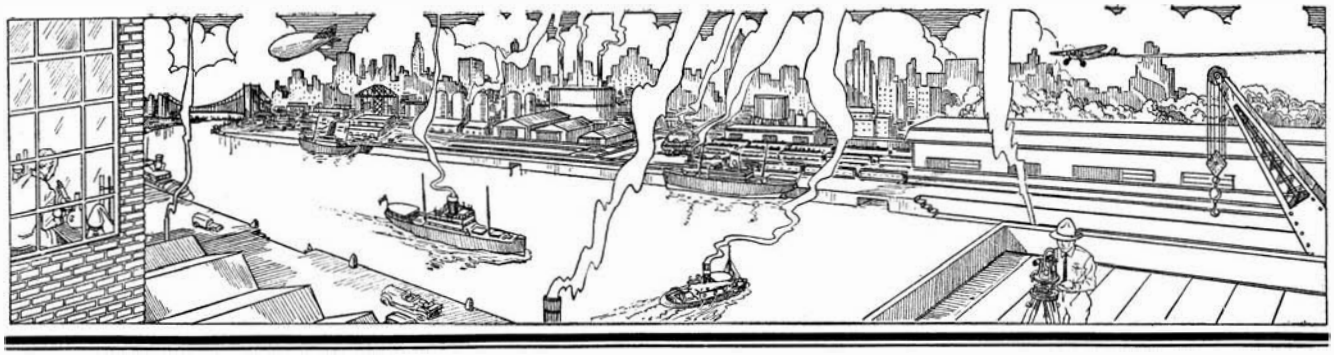
Mere telescopic observation, however careful, cannot distinguish between them. It tells us one thing, however. The retreat of the shrinking caps has been carefully observed, and is found to occur with remarkable regularity, year after year. The date when any particular spot on the surface gets clear (measured in a Martian calendar) shifts but a very few days from one year to another—it is incomparably more regular than that of the first or last snowfall here. Moreover, this date in different latitudes comes always at the time when the returning rays of the sun carry a certain definite amount of heat to the surface. Mars is nearest the sun in the summer of its southern hemisphere—and the time schedule for the shrinking of the southern cap is shifted accordingly, coming earlier in the springtime in the north, but corresponding to the same daily supply of solar heat.

This shows clearly that the polar caps are composed of some one substance which disappears just as soon as the surface reaches a definite temperature. Now this temperature can be calculated, for we know how much heat the surface gets from the sun, and can safely assume that its radiating power is much like that of terrestrial rocks or clays. The results are conclusive. Though the computed temperature is well below the freezing point of water, it is so far above the boiling points of the other substances mentioned (or the temperature of sublimation of carbon dioxide, which at low pressures passes directly from a solid into a gas) that they are quite put out of further consideration, and only water remains.

The caps are of course composed, not of liquid matter, but of some form of snow or hoar-frost. In sufficiently dry air, snow will evaporate and disappear without melting, at a temperature below the freezing point. This has often been observed in the Northwest; indeed, it used to be a commonplace in the old days for a housewife to hang out her washing on the line, only to have the clothes freeze as hard as boards almost before the clothespins were on. After a day or two, with clear freezing weather all the time, the clothes would be perfectly dry. The ice had not been beaten out by flapping in the wind; it had evaporated into the dry air. Something of this sort evidently happens in the polar regions of Mars every spring.

AIR as cold as this is saturated by a very small quantity of water vapor. This suffices to explain what might otherwise be puzzling—that the spectroscopic tests show no definite evidence of water vapor in the atmosphere of Mars. Were the temperature high, and the corresponding tension of water vapor great, we might expect to get observable absorption, despite the difficulties caused by the water vapor in our own atmosphere through which we have to look. But an atmosphere as cold as that near the polar cap must at best be very dry, and the feeble absorption produced within it might easily be masked by the overlying terrestrial lines, even though the most powerful means of separation available to us should be tried.

The equatorial regions of Mars, in which the winds blowing from the poles have been warmed, must be at least as dry, and it is possible that liquid water could hardly exist there at all without immediate evaporation. Condensation into the dense masses of cloud which occur in the moisture-laden atmosphere of the earth would be very unlikely. Under the most favorable conditions we might expect the production of very thin clouds of ice crystals, not of water drops like our own high-level clouds. If the particles were fine enough, such clouds would scatter blue light more powerfully than red, and would appear as bluish haze rather than as dense white masses—and this is very probably the nature of the fugitive markings which have recently been observed.—*Princeton University Observatory, May 8, 1935.*



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

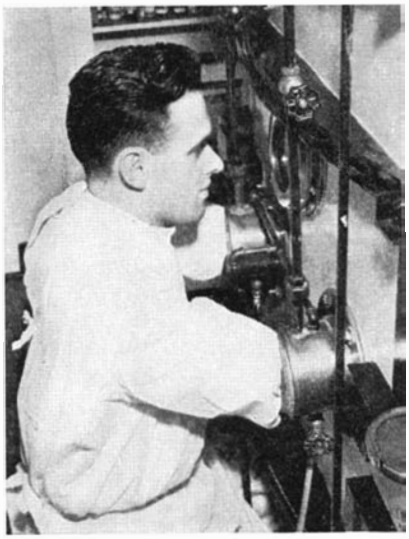
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

Lehigh University

Living Test Tubes

AN important biological experiment, which has puzzled scientists for more than 50 years and may lead eventually to the isolation of the germs which cause colds, influenza, and infantile paralysis, has been successfully completed at the University of Notre Dame. After six years of constant laboratory work, Prof. J. A. Reyniers has succeeded in obtaining absolutely



Professor Reyniers examining his living test tubes through a glass port-hole in the chamber described in the text. His arms are encased in rubber gloves sealed in two ports

germ-free guinea pigs and in raising them without contamination by germ-life of any kind.

The importance of this work lies in the fact that it permits a study of any single germ on a living organism, until now considered impossible. Most scientists hitherto have contended that life in an animal body was impossible without bacteria.

Moreover, it was this presence of many forms of germ life which has interfered seriously with the isolation in the past of the germs which cause many of the most current human ailments and, consequently, no serums or other effective preventives have yet been developed.

The compartment in which the pigs live, and which contains all the attendant apparatus, including the air-conditioning equipment, resembles a square diving bell, with portholes in each side to permit inspection of the germ-free inhabitants.

In addition, there are two ports, containing sterilized rubber gloves, through which Prof. Reyniers can insert his hands to care for his charges, clean the cages, fill the milk and water bottles, and examine the pigs periodically for any sign of contamination.

Longer Life for Silk Stockings

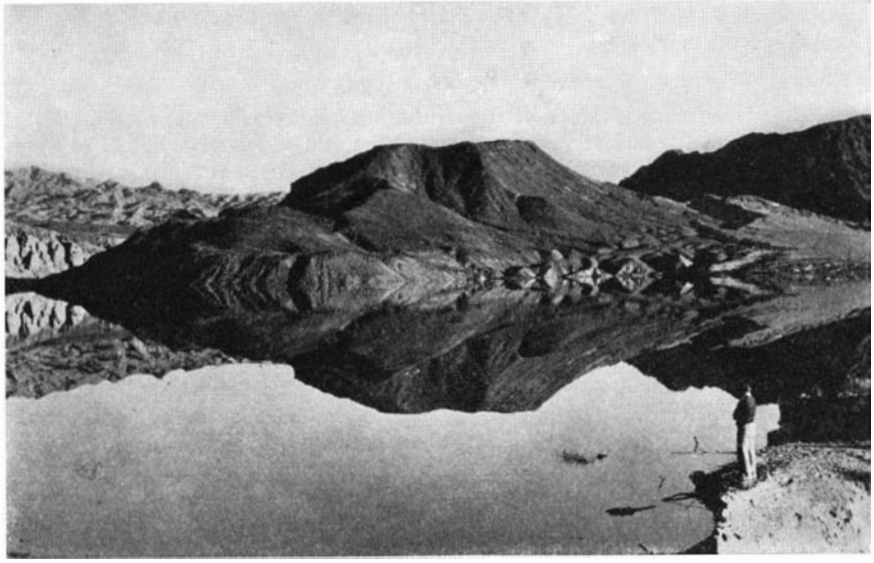
LADIES, here's a practical tip from Uncle Sam on how to make silk stockings last longer! According to chemists at the Bureau of Standards, tests reveal the fact that aluminum sulfate can be used as an excellent preservative for silk stockings. The treatment, which is claimed to considerably increase the strength of the materials, consists of dipping new stockings in a hot solution of about 3 percent aluminum sulfate. After the treatment the stockings should be dried and then washed gently.—*A. E. B.*

U. S. Excels in Wasting Soils

"THE most colossal achievement in soil wastage the world has ever witnessed in as short a time" is the way in which H. H. Bennett, of the Soil Erosion Service, United States Department of Agriculture, characterizes soil erosion losses in this country. "Although three centuries have passed since the first successful colonization, much of our ruined land has known the plow for scarcely more than a generation."

A nation-wide survey by the Soil Erosion Service shows that approximately 50 million acres of once fertile land have been ruined for practical crop use by erosion, with another 50 million acres in almost as bad condition. This 100 million acres is equal to 625,000 farms of 160 acres each.

Another 125 million acres, says Mr. Bennett, most of it still under cultivation, have



Courtesy *The Reclamation Era*

After admiring this photograph of the Arizona hills mirrored in the lake forming above Boulder Dam, do not fail to turn the magazine sidewise (either way) and see the faces, austere and gruesome, that peer at you. These countenances were first called to attention by Dr. William F. Durand, Stanford University, Consulting Engineer of the Bureau of Reclamation, Department of the Interior

lost all or most of the topsoil; on other millions of acres erosion is getting under way, so that good farm land is being destroyed at the rate of more than 100,000 acres a year.

"The world is strewn with ruins of once flourishing civilizations destroyed by erosion, particularly in Syria, Turkey, and China, but these lands were cultivated for thousands of years before abandonment was necessary."

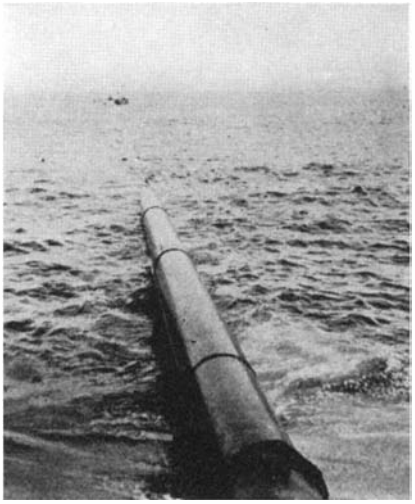
ANCIENT PLASTIC

KING Tut's sarcophagus was varnished with melted amber. This long prized material is giving way in modern days to the synthetic plastics which have become a large industry.

Sewerage Outfall Pipe Pushed Into Sea

THERE have been a number of occasions when it was necessary to carry pipe-lines a half mile or so from shore into the ocean in order to pump oil out to floating loading docks. Such pipe-lines have usually been pulled out from the shore by tugs, the pipe itself first being welded into one long line. One particular job of this sort which we recall, necessitated the building of a small-gage track reaching in a straight line for hundreds of yards back from the shore. The pipe-line was constructed beside this track, rolled onto small carriages and then towed out to sea.

A recent project where it was necessary to extend a sewerage outflow pipe into the ocean was carried out by *pushing* the pipe. The outer or floating end of the pipe was blanked off with a bolted flat head which was later removed by a diver. In the installation, three 60-foot sections were lined up on skids and welded together to make one 180-foot section. This was rolled on to the ways and backed out to sea by donkey engine power. This donkey engine was set up on shore to one side of the inland end of the ways. From the engine, the cables ran to the water's edge, thence through an anchored cable sheave at that point, and back to the rear end of the pipe and parallel to it. When one 180-foot section was pushed out to sea, another one made up of three



A sewer pipe is pushed to sea

PROGRESS In This Age Of Science

As Told to Scientific American

By EDWARD G. BUDD

President,
Edward G. Budd Manufacturing Company

MOST of the work done in this world is in moving things around.

A tree trunk is hauled to the saw mill, planks are moved from the saw mill to the lumber yard, then from the lumber yard to the factory, and from one part of the factory to another part on trucks or elevators. The product is then moved to the furniture store and from the store to the buyer. The capable housekeeper keeps moving it around all the rest of its existence.

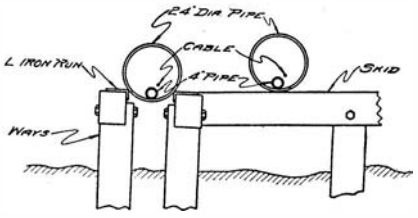
A great part of our life is spent in moving our bodies from one place to another. In most instances, vehicles are employed; usually the vehicle is vastly heavier than the goods moved.

The consumption or waste of human effort and mechanical power has in recent years been much reduced by improved types of motive power and by improved highways. In recent years the dead weight of the vehicle has rather increased than lessened.

There is now before us an era of weight reduction in carriers, whether ships, elevators, automobiles, or railways.

A contribution to the revival of business will be the production of railroad vehicles weighing from one half to one eighth of those now in existence, reducing the cost of carrying the persons or goods by one half to one quarter of the previous practice.

Developed in times of depression, this new art will be a powerful lever in economic rehabilitation.



Sketch showing general arrangement of method of handling the outfall pipe that was pushed to sea

60-foot sections was rolled onto the ways, lined up with the first, and they were welded tightly together with a sleeve-weld, by the oxy-acetylene process. This process was continued until the full length had been pushed out to sea.

A unique feature of this project was the insertion in the 24-inch sewerage pipe of a four-inch pipe which was kept full of water as ballast. This water stabilized the main pipe in the heavy seas, and was necessary because there was no breakwater or other protection against the surge of the surf. When the line was completed, a cable pulled the four-inch pipe out of the main 24-inch line.

British Train Record

WORD from England tells of a new record of 108 miles an hour with a new steam locomotive of the London Northeastern Railroad. Whether significant or not, the locomotive's name is *Papyrus*, after the well-known horse which won the Derby.

As in America, steam-powered railroads are unwilling to admit that the new lightweight type Diesel-powered trains alone can go places in a hurry.

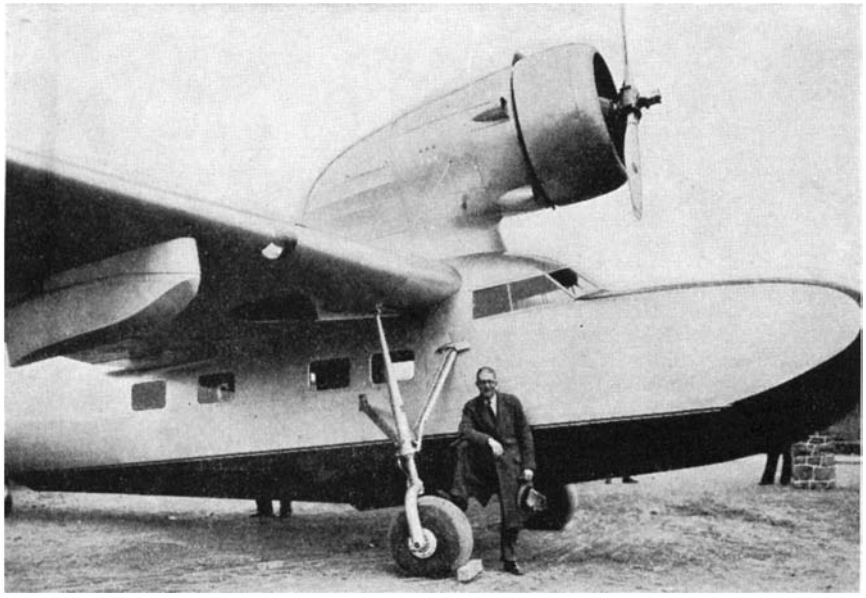
While English circles may regard *Papyrus*' speed as a record, American "old timers" will jog their brains a bit and think back to 1904 when the Philadelphia & Reading put one of its crack trains through its paces and came up with a speed of 115.20 miles an hour; or they recall the run on the Michigan Central in the same by-gone year when 111.90 miles an hour was attained. Even in 1893 the New York Central's Empire State Express sped a measured mile in 32 seconds and thus traveled at the rate of 112.5 miles an hour.

Coming closer to 1935, it is hard to find speed records which eclipse the older marks. The streamlined *Zephyr* of the Chicago, Burlington and Quincy R.R. reached a top speed of 112.5 miles an hour during its long-distance run from Denver to Chicago last year.

And there is the special feat of Franz Krunkenberg's streamlined rail car in Germany which, in 1931, went from Hamburg to Berlin at an average speed of 143 miles an hour.

New Protective Coating Stops Waste

THE usual paint film is composed of organic oils in combination with opaque pigments which give it color. Such a film is subject to breakdown and saponification by the actions of acids and alkalis. The effect of the various acids and caustics has long been known, and much work has been done



Three-quarter front view of the *Baby Clipper*, a single motor amphibian

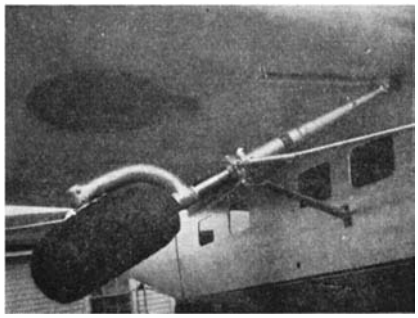
to produce a coating which will withstand these severe reactions. One such coating that holds promise is called Plicote.

In all laboratory tests, Plicote has shown a remarkable resistance to chemicals, and this property has been borne out by actual service tests that have been in progress for more than a year. Tanks coated with Plicote have withstood the action of 50 percent caustic solutions at elevated temperatures. Brine tanks have been coated with unusual success. The activity of fruit and fruit acids in the canning industry has been coped with by Plicote; this product is also tasteless, odorless, and non-toxic.

The New "Baby Clipper"

THE latest Fairchild amphibian, also termed the *Baby Clipper*, is said to be the world's largest and fastest single-engine amphibian transport, and is to be used along river routes in South America operated by Pan American Airways. It is of particular interest because the retraction of landing gear has been carried in this design to the limit of its possibilities, and because the "mechanization" of aircraft controls has also advanced a step further.

The *Baby Clipper*, designed by A. A. Gassner, carries two pilots, eight passengers, and 1000 pounds of mail and express, at a cruising speed of 158 miles per hour with a range of 750 miles. The high speed is 179 miles. The spacious cabin is 16 feet long and six feet high, and has two compartments each accommodating four persons in comfortable lounge chairs. Large windows and the position of the lifting surface afford an exceptional range of view. The mid-wing is mounted approximately half-way between the top and bottom of the hull. The construction is metal throughout. The semi-monocoque hull has six compartments altogether, which are separated by water-tight doors and bulkheads so that the hull will remain afloat even with two adjacent compartments flooded. The single engine is mounted in a highly streamlined nacelle above the wing, and is a Pratt & Whitney Hornet developing 650 horsepower at 2050 revolutions per minute. The specifications are as follows: Span, 56 feet; length, 46 feet; wing area, 485 square feet; weight empty, 5500 pounds; payload, 2445 pounds; gross weight, 9600 pounds; service ceiling, 18,000 feet; and landing speed, 58 miles per hour.



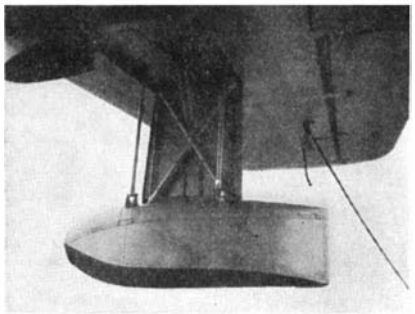
One of the landing wheels of the *Baby Clipper* partially retracted

As stated above, the main special interest of the *Baby Clipper* lies in its retraction features. In this design, the engineers made it possible for the pilot to do the following with smoothness and dispatch:

1. Lower flaps to reduce landing speed and landing run.
2. Pull up the main wheels and the tail wheel simultaneously for water work.
3. Retract the tip floats so as to eliminate resistance in flight still more.

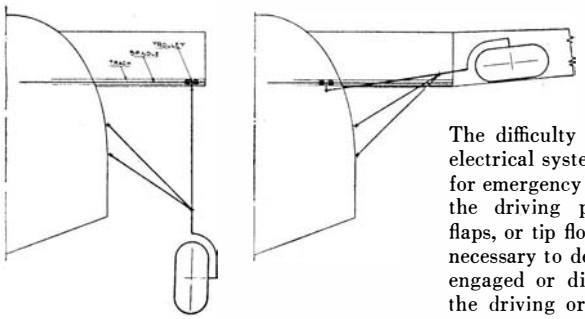
Generally speaking, aircraft designers are apt to be secretive as regards the precise mechanism they employ in retracting gears. The Fairchild Company is most generous in its disclosures, which are illustrated by our diagrams. The landing gear structure is so designed that the wheels fold rearward and upward, rotating slightly around the shock strut axis during the retraction. They are flush with the underside of the wing when fully drawn in. The operation is accomplished by turning a spindle (installed inside the front spar flange) which in turn operates a trunnion on the wheel trolley causing the trolley to move inboard or outboard as required. The side brace struts are attached to the main shock strut by a universal joint. The tail wheel, which retracts simultaneously with the landing gear, is drawn into a well on the underside of the hull behind the second step.

The wing-tip floats retract against the underside of the wing by a parallelogram arrangement of struts, with spindles and trunnions employed here also.



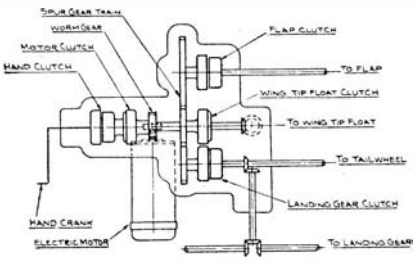
Wing-tip floats on the *Baby Clipper* amphibian are retracted by means of a sturdy parallelogram of struts

The problem was how to operate these three retraction systems at a distance. Hydraulic operation was ruled out, as being somewhat complicated and unreliable. There was the further difficulty that the three systems had to be operated separately.



***Left:* Diagrams of *Baby Clipper* landing gear in its two extreme positions**

The difficulty was solved by the use of an electrical system with only one hand crank for emergency use, and a gear box to divert the driving power to the landing gear, flaps, or tip floats as required. It was found necessary to devise clutches which could be engaged or disengaged at any position of the driving or the driven members in the gear box, and a suitable electrical hook-up had to be developed.



Simplified drawing of the gear box used in the retracting landing gear of the *Baby Clipper*, described here

The drive system for the landing gear consists of the spindle with the trunnions already mentioned, to which the retracting trolley was attached. The spindle is turned through a drive-shaft system from the respective gear in the master gear box, and is engaged by operation of a clutch selector lever. When the electric motor is switched on, the drive shaft and spindles turn, and

the trunnion moves the shock strut trolley. When the trolley reaches a point close to the extreme position, it engages a limit switch, the electric current is interrupted, and the spindle and trolley stop.

The designers are to be congratulated on the mechanical and electrical ingenuity they have displayed.—*A. K.*

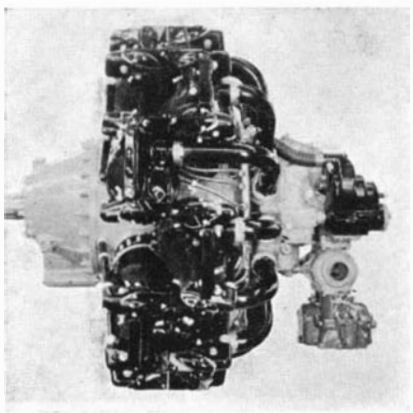
A Remedy for Airsickness

MEDICAL men say that airsickness is often caused by a condition known as "hyperventilation" in which the patient exhales carbon dioxide in excessive quantities. The remedy is to supply the sufferer with carbon dioxide, and the simplest method of insuring this supply is to breathe into a paper bag. Carbon dioxide accumulates in the bag, the patient inhales the gas and his airsickness disappears! Holding the breath for 15 seconds or so is also helpful. This sounds more promising than some of the remedies for airsickness which people sometimes advocate.—*A. K.*

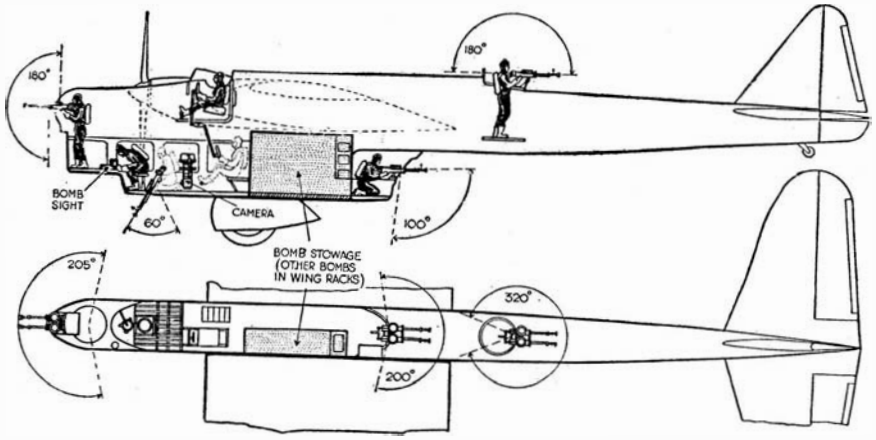
Double-Row Aircraft Engines

DOUBLE-ROW aircraft engines are by no means new. They were used by Anzani, a French company, before the war, and by Armstrong-Siddeley in England soon after the war. In 1928 Curtiss Aeroplane and Motor Corporation employed this principle quite successfully in a six-cylinder radial engine of moderate power. But it is only within the last two years that the two-row radial has become generally available in the United States as an airplane power plant of high power output. Its development has been largely due to Pratt and Whitney, Wright, and the Bureau of Aeronautics in the Navy Department.

Mr. C. H. Chatfield of Pratt and Whitney has recently published an authoritative paper on the subject of two-row engines, and points out their many advantages. One of these advantages lies in greater smoothness and freedom from vibration which follow from an increase in the number of cylinders. Again, as compared with the single-row type, the two-row has more and smaller cylinders. This means a reduction of the stresses introduced in the propeller by explosion impulses. As these stresses are often the critical ones in determining the size of propeller parts, the result is that, for a given engine power and propeller



Side view of the twin Wasp

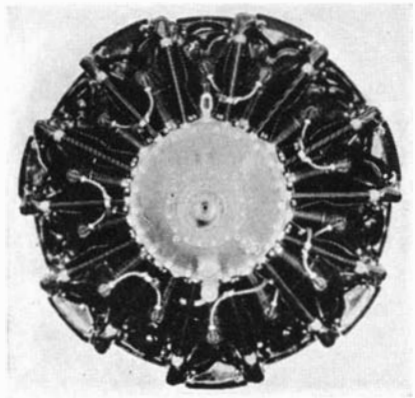


Two drawings that show how armament is placed on the formidable Amiot *143M*

speed, the weight of the air screw for the two-row engine may be safely made less than that for the single-row motor. Still another advantage, due to the smaller cylinders and the greater number of them, is reduction of noise effects. The individual exhaust impulse is less powerful, and the higher frequency of the exhaust noise makes it less objectionable. Longer life and greater reliability are a natural corollary of the above characteristics.

Of course the two-row engines are somewhat more expensive to build and maintain.

When the development of two-row engines was first undertaken, it was feared



Front of a double-row engine

that it might prove very difficult to cool the rear cylinders adequately. But contemporaneously with the development of the two-row there has come the use of pressure baffles which guide the air to the cylinder fins, and reduce the amount of cooling air required. As a result, it has become relatively easy to insure to the rear cylinders an adequate flow of air that has not been heated by contact with the front cylinders. The controllable cowl, recently introduced, is also a help in securing adequate but controlled cooling. Cooling is also more likely to be satisfactory in a two-row because the cylinders are smaller; the volume of the combustion chamber then becomes smaller in relation to the cooling surface of the cylinder.

Although the over-all length of the two-row is greater than that of the single-row, this disadvantage is more than offset by the reduction in over-all engine diameter. In a typical case, there is a reduction in frontal area of 35 percent. Reduction in frontal area means, of course, reduction of air resistance.

Also, with a smaller engine behind it, the propeller suffers less from interference and gives greater propulsive efficiency.

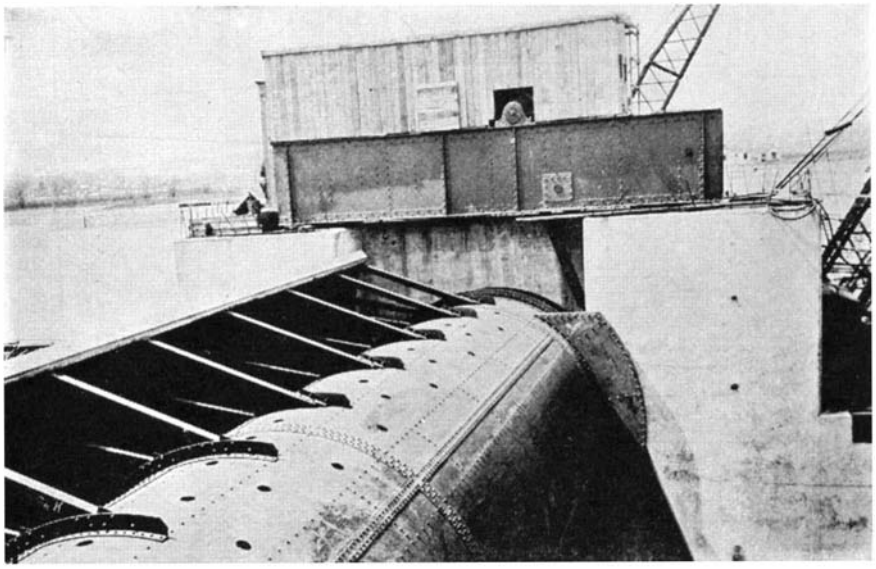
Mr. Chatfield's theoretical analysis is fully borne out by the facts. Thus, the twin Wasp Junior is substantially equal in power to the single-row Hornet, although the piston displacement of the latter is some 10 percent greater.—*A. K.*

Formidable Fighting Aircraft

IN the single-seater fighting airplane, the tradition has been to provide one, or at most two, light machine guns synchronized with and shooting through the propeller. Now the fashion is to carry four guns instead of two. The two machine guns firing through the propeller are still there, but on top of the wings light *cannon* of 20 millimeter caliber are mounted and operated by remote electric control. At the same time, in order to keep up the performance, 14-cylinder double-row engines of 900 horsepower are mounted in some of these single seaters. Certainly these speedy and well armed fighters are formidable weapons of offense.

On the multi-place fighters and bombers, even more powerful guns are mounted, and there are rumors that a French bomber has actually been equipped with one of the famous 75's. This is a far cry from the first early days of the World War, when rival airmen took a crack at one another with revolvers!

While single-seater fighters and two-seater fighters are still found in large numbers in all the air services of the world, there are also many "multi-place decombat" as the French call them. The accompanying diagram gives an excellent idea of the formidable and comprehensive armament of the Amiot *143M*, one of the outstanding French examples of this type of fighting airplane. At the very nose of the ship there is a sheltered gun turret, with two guns. In the open air a man had to be very strong indeed to swing two guns, but when the "sheltered turret" is well worked out, no such difficulty is found. Another gun is mounted also in a sheltered position, on top of the fuselage behind the wing. Below the fuselage there is a hanging car with bomber, camera man and a rear lower gunner at work. Bombs cannot always be placed in the small fuselages, so they are frequently hung below the body just as in the Amiot *143M*. With such an arrange-



Roller gate and concrete pier sill of the electrically heated dam

ment of guns the bomber-fighter can give a very good account of itself in combat, and as will be clearly seen from the sketch it has an almost universal range of fire, front and rear, above and below. Should war really come, it may be expected that aircraft will become even more vicious and formidable.—*A. K.*

An Electrically Heated Dam

IN much the same way as water is heated on an electric range, the Mississippi River—or at least a small part of it—will be heated by giant Calrod-type electric heating units now being manufactured by the General Electric Company, the purpose of which will be to facilitate the operation of the gates of a dam near Canton, Missouri, during freezing weather next winter and spring.

The reason for this apparently unusual use of electric heat is that the government is building a new roller-gate type of dam at Canton, representative of the latest American engineering practice. The main gates will consist of huge rollers or drums, some of which will be 109 feet long and 20 feet in diameter, placed horizontally across the stream. The ends of the drums will rest on sills built into the concrete piers and will be so arranged that each drum can be partially rotated and raised to vary the flow of water or allow ice to pass during the spring thaw.

In order to permit year-round operation it will be necessary that the ends of the drums be kept free from ice. The giant heating units will be installed in the drum ends and pier sills to prevent freezing. Some of these heating units are as much as 27 feet in length, but, despite their huge size, the power required for heating one end of a roller will be only 18 kilowatts.

Boric Acid Ice Protects Fish in Shipment

FREEZING fish in a film of boric acid solution has proved a boon to Canadian shippers of finny foodstuff. When frozen fish are shipped in an unprotected state, they lose moisture rapidly and the flavor of the fish is impaired. For some time it has been the practice to seal the fish up in a film of ice, in order to keep the natural moisture in the flesh. This layer of "glaze" is easily broken in handling, so the method has not been entirely satisfactory. Now chemists at the Canadian Fisheries Experimental Station at Prince Rupert, B. C., have discovered that a tough "glaze" can be formed over the fish by freezing a solution of boric acid on them. This boric acid ice does not crack easily, and a chip may be broken out of it without injuring the surrounding surface. Very little of the acid penetrates into the fish. The acid also serves to keep down the bacteria which cause reddening of the fish. The method is proving very satisfactory.—*A. E. B.*

LATEX

THE amount of liquid latex used in 1934, according to the Goodrich Rubber Company, would equal in volume a five-minute flow of water over Niagara Falls.

Fever Treatment In Arthritis

A PATIENT suffering from one type of arthritis, that due to the gonococcus "germ," has an 80 percent chance of being promptly cured by a few sessions of fever treatment, according to Dr. Philip S. Hench of the Mayo Clinic. Dr. Hench showed pictures of some patients afflicted with gonorrheal arthritis or rheumatism hobbling around painfully on crutches one day and walking briskly about 24 to 48 hours later. Early and efficient treatment is necessary to obtain the best results.

"Unfortunately germs supposed by many to cause the common forms of rheumatism (chronic deforming arthritis) are usually resistant to heat and apparently are not killed by the amount of fever which it is safe to induce in human beings," Dr. Hench said. "While fever therapy in the hands of specially trained physicians and assistants is essentially a safe procedure," he continued, "the reactions must be carefully controlled at all times by attendants. Such treatments cannot therefore yet be said to be cheap, and the day when anyone can turn on his own electric apparatus and cook away his disease in the fires of fever has certainly not arrived, probably never will."

Dr. Hench described the effect of the fever treatment as follows: "A whirlpool of physical and chemical reactions occurs during the induction of such a 'friendly-fever' in human beings. Blood vessels change their size; the blood, kidney excretion, and sweat are altered in their content, and it would seem that the immunity mechanism of the patient is enhanced. The most important discovery is that the germs of gonorrhea and syphilis can actually be killed if enough fever can be generated in the patient."—*Science Service.*

Britain to Build New Non-Magnetic Ship

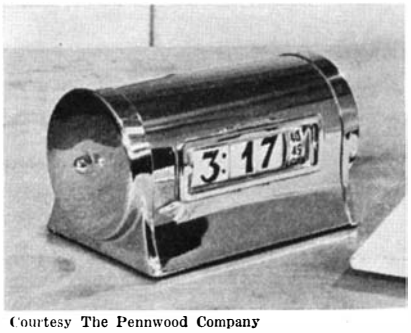
BUILT almost wholly without iron or steel, a new non-magnetic ship is planned by Britain to replace the lost *Carnegie*, formerly operated as a cruising laboratory by the Carnegie Institution of Washington. The *Carnegie* was destroyed by explosion and fire while refueling in the harbor of Apia, Samoa, November 29, 1929.

A non-magnetic ship has tremendous practical importance as well as great scientific value. The deviation of the compass from true north varies from place to place on the earth, and changes with time. Hence if navigation charts are to be made and kept accurate, exact compass determinations have to be made periodically.

Paradoxically, although compass accuracy is more important at sea than on land, it is easier to achieve on land than at sea. This is because ordinary ships, even wooden ones, contain so much iron that they disturb the delicate instruments and falsify their readings.

Because of this, the Carnegie Institution of Washington built the non-magnetic yacht *Carnegie*, replacing practically all iron and steel fittings and machinery with bronze and other non-ferrous metals. Even the two internal-combustion engines she carried were almost wholly bronze, the only iron in them being the linings of the cylinders. So small a matter as the iron in the "tin" cans of her stores was a cause of concern to the scientific command.

After the loss of their ship, the Carnegie Institution of Washington decided not to replace her. The British Admiralty, in view



Courtesy The Pennwood Company

One of the latest self-starting electric clocks on the American market offers an added attraction of "automatic" time telling. Four dials show the time to the second. All moving parts are enclosed with a permanent supply of lubrication; the motor is supported in alignment by a one-piece metal chassis

of the Empire's great maritime interests, has, therefore, undertaken the construction of a non-magnetic ship of their own. Parliament has just authorized the expenditure of 10,023 pounds sterling as first installment of her cost. Details of the plans are not yet public, but it is probable that the new ship will be larger than the *Carnegie*.—*Science Service.*

ASBESTOS

THE ancients recognized the non-inflammability of asbestos, for, according to Westinghouse, the lamp wick of the sacred fire of the goddess Vesta, attended by the Vestal Virgins in Roman times, was made of this rock fiber.

Remaking Geography

SCHOOL children of the immediate post-war years were bewildered and seriously hampered in their studies not only of geography but of the history of Europe because of the many changed boundary lines and new countries. If the present fad for changing well known place names and country names holds, the student will be more than ever bewildered because, as new maps are drawn, the map makers do not take into consideration the fact that students ought to have, in addition to new names, the older, more familiar ones.

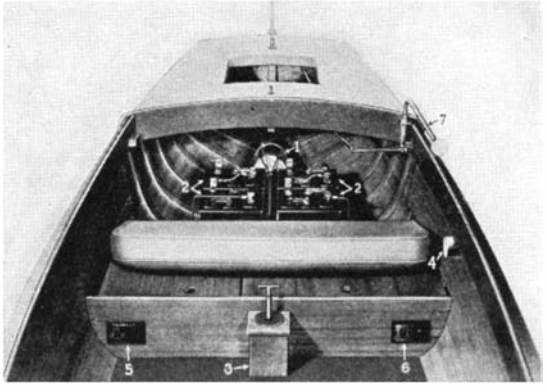
Passing quickly over Russia which, because of a changed social system, feels called upon to change old names without rhyme or reason, we find more stable countries taking new names or re-adopting old ones and insisting that they be used throughout the world. It has been difficult enough for everyone to become familiar with Chosen as the Japanese name for Korea; now Persia insists upon world use of its ancient name Iran, and Abyssinia wishes to be called Ethiopia. Some other requested usages are listed below with the older, more familiar designation following:

Oslo—Christiania
Istanbul—Constantinople
Peiping—Peking
Marseille—Marseilles
Warszawa—Warsaw
s'Gravenhage—The Hague
Firenze—Florence
Praha—Prague

Electric Boats

HEAVY-DUTY storage batteries provide the motive power for a new line of boats developed by Electri-Craft Corporation. It is stated that one charge of the storage batteries for one of their models makes possible 40 hours of cruising, permitting travel totalling 195 miles. The cost of operation is, therefore, said to be from two to five cents per hour depending upon the size of the boat and the rate per kilowatt hour. The major advantages are quietness, lack of vibration, and extreme simplicity of operation. Batteries are charged while the boat is docked.

Because of the quiet operation of these boats and the freedom from oil and grease, they are permitted in waters generally prohibited to power boats.



Left: **Power unit in standard model of the electric boats described in these columns. 1 is the motor; 2 the storage batteries; 3 the speed control switch; 4 the directional control switch; 5 charging switch; 6 combination light and charger switch; 7 steering control**

Science Service

The Triborough Bridge, linking the boroughs of Manhattan, Queens, and Bronx, New York City, takes shape. This view shows the workers' cat-walks over the famous Hell Gate. One of the ingenious features of this bridge is the ramp system at the western end, where the traffic will be divided without undue congestion

"One-Way Paint"

THE development of paints with a "valve-like" action which would allow one-way passage of moisture, is predicted for the near future by Dr. H. A. Gardner, Director of the Institute of Paint and Varnish Research.

Speaking before a regional meeting of the American Society for Testing Materials, Dr. Gardner foresaw the use of a paint which would permit moisture to escape from the inside surface but prevent its entrance from the outside. The attempt of moisture in the wood to get out through a paint film is a frequent cause of paint blisters. This tendency is apt to become more of a problem as our homes and factories are provided with dry air by the general use of air conditioning.

Dr. Gardner said that this new type of paint might be made by the use of "pigment aggregates having specially shaped particles."—*A. E. B.*

Sound Meter Aids Deaf

A DEVICE expected to be of considerable aid in instructing the deaf to speak with normal intonation of the voice has been designed at the Cruft Laboratory at Harvard University by Frederick V. Hunt, instructor in physics and communication engineering. The apparatus is essentially a refinement of instruments already in use for measuring sound frequency or pitch.

Minute voice fluctuations are translated by the apparatus into electrical impulses, as in the telephone, and are instantaneously registered on a small dial. A deaf person using the device watches his voice fluctuations on the dial, modulating his voice until he obtains a reading similar to that of a normal person speaking in ordinary tones. —*Science Service.*

America's First Submarine Cable

WE have just run into a most interesting situation. A Canadian subscriber wrote us recently that a tablet had been placed on a building at Charlottetown, Prince Edward Island, with the following inscription: "First Submarine Telegraph in America. Commemorating the laying of the first submarine telegraph cable in America. It extended from Carleton Head, Prince Edward Island to Cape Tormentine, New Brunswick.

Laid by Frederick Newton Gosborne, Monday, November 22, 1852." Our subscriber was inclined to doubt priority of this installation and asked that we check our early files to see whether we could find record of a previous installation. We found it.

In our September 18, 1858, issue a letter discussed the laying of a submarine cable in July, 1848, at the bottom of the Hudson River between New York and Jersey City. It read in part: ". . . In the autumn of 1846-7, two lines of wire were thus insulated with a compound of india rubber and sulfur for Mr. Hugh Downing, the President of the House Telegraph Company, for connecting this city and Philadelphia by telegraph; and in the months of April, May, and June, 1848, a large amount of small iron and copper were insulated and covered with gutta percha by Mr. Reynolds, for persons connected with the Morse lines; and in July of that year four miles of No. 9 iron wire were insulated with a double coating of gutta percha by the same gentleman, a part of which cable was placed at the bottom of the river between New York and Jersey City. . . ."

Clean Air Electrically

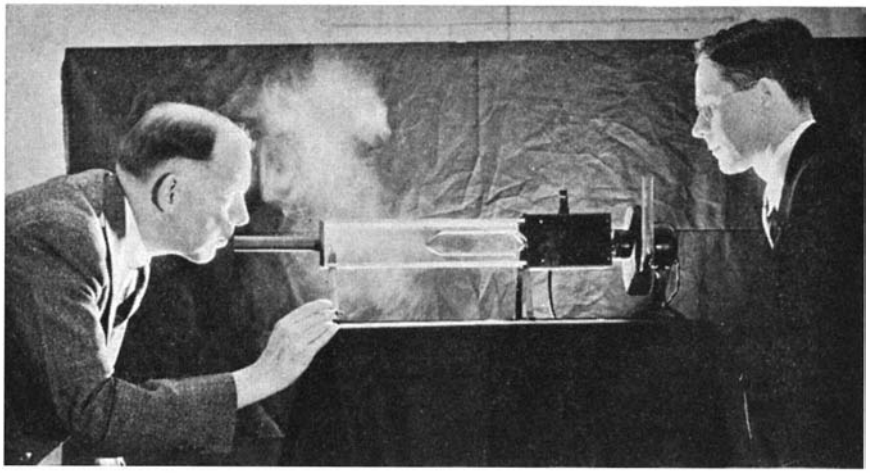
DEVELOPMENT of an electrical unit to remove dust, soot, pollen or other solid and liquid particles in air has progressed to the point where engineers of the Westinghouse Electric & Manufacturing Company now have several experimental models installed in homes and offices of the Pittsburgh district.

Data is also being gathered by physicians who are using the units in their treatment of patients afflicted with any of the numerous types of asthma or pollen fevers.

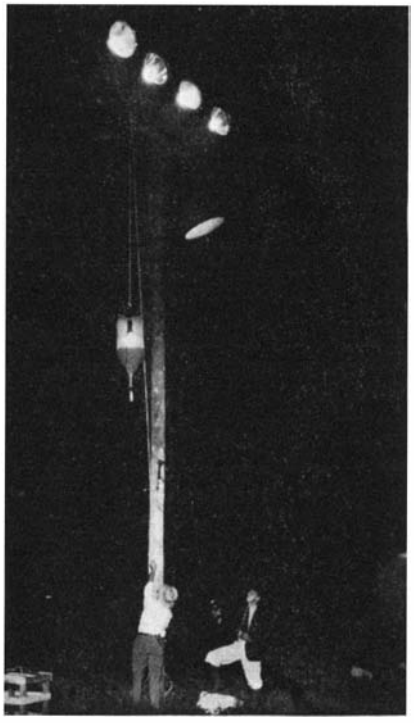
Electrically, the unit is a comparatively simple device. It is so arranged that it draws particle-filled air past two small wires, suspended horizontally. Connected to a power pack, which raises their voltage, these wires "charge" all air particles in their vicinity. This act is termed ionizing the air. Next the ionized particles are drawn through a series of plates which are also charged. The plates have opposite polarity, with the result that just as a needle jumps over to a magnet, so do these air particles move and cling to the plate. Thus the air is made to clean itself. In addition, a film of oil covers each plate to make certain that the particles, after being attracted, stick to the plates. The air, freed of particles, is then sent on into the room by means of a fan. The unit requires only about 50 watts to operate. After the plates fill up, they may be cleaned in running water.

In certain sections of Pittsburgh, 97 percent of the impurities collected was in the form of soot. In outlying sections, the larger percentage of particles consisted of various irritating pollens.

Hay fever victims who have used the cleaner have stated that relief came to them within fifteen minutes after they had been in a room where the air had been electrostatically cleaned.



An experimental model of the device for cleaning air electrically



Huge insect traps, using mercury-vapor glow lamps as "bait," have been found effective in capturing the Asiatic garden beetle. In the West, specially colored lamps serve as "bait" for trapping fruit flies

Chemistry Speeds Linen Manufacture

AMERICA may take a position of leadership in the production of linen textiles if the hopes of Howard D. Salins of Chicago prove well founded. This chemist has worked out a process for treating the flax which, if successful, will greatly facilitate and cheapen linen manufacture. The inventor claims that his process, details of which have not been made public, makes possible the removal in two hours of the gummy substance that holds the fibers of flax together, whereas it takes two months under the dew-retting process in general use in Europe and Canada.—*A. E. B.*

Bones Not Rigid And Unchanging

BONE is not the hard, stiff, unyielding, almost stony stuff we get used to thinking it is from examining it when dead and dry. So long as it is a part of the living body it is plastic and accommodating, readily making way for changes that take place in living organs of softer tissue located in or on it. So Dr. Charles B. Davenport of the Carnegie Institution of Washington recently told the American Association of Physical Anthropologists.

Dr. Davenport based his assertion on X-ray studies of a certain cavity in the base of the skull, photographed at one-year intervals in a considerable number of individuals. He found that this cavity increases in size with age. Other bone studies gave additional support to his thesis of the relative plasticity of living bone.—*Science Service.*

Baltic Sea Highway

AN automobile highway, encircling the Baltic Sea, and running through eight countries, is planned by the Joint Scandinavian Tourist Committee which reports that the new route will be ready as soon as the Norwegian State Highway is completed.

In the future, therefore, international tourists will be able to start from Hamburg to Copenhagen, Helsingör, Helsinborg, and proceed through the Swedish chateau country and the beautiful lake regions of central Sweden to Stockholm. From Stockholm the road will go to Oslo, or farther north through Sweden, and then along the Norwegian State Highway to Petsamo, on the northern coast of Finland, at the Polar Sea. From Petsamo the route will continue southward through Finland to Helsingfors, Leningrad, Tallinn in Estonia, and Riga in Latvia, and thence via the Polish Corridor to Berlin. The route will offer an extensive variety of scenery, ranging from fertile plains and virgin forests to majestic mountain scenes, and enable tourists to visit eight capitals.

Plastic Stove and Furnace Lining

DOMESTIC stoves, ranges, furnaces, and boilers now may have their efficiency raised through the use of a new plastic refractory material which is distributed under the name of Fireline. The manufacturer claims this new lining will give industrial combustion efficiency to home heating plants and burners, that it will raise the combustion temperature, reduce soot, smoke, and ashes, and increase the heat capacity of any domestic plant burning solid fuel.

Fireline comes in plastic form and, it is reported, can be properly installed by anyone with a mechanical bent. It is said to

make firepots gas-tight, to resist shock and erosion, to be non-cracking, and to have sufficient strength to repair cracked, broken, or burned-out firepots permanently. It comes in 2½, 5, 10, 50, and 100 pound cans and is applied from one to two inches thick over firepot wall from grates to fuel line. It is guaranteed to withstand temperatures to 3000 degrees, Fahrenheit, without cracking, fusing, or spalling.

BOOTLEGGERS

COAL bootlegging is now estimated to total 40,000,000 to 50,000,000 dollars a year and employ 100,000 people. Miners no longer able to salvage coal from dumps, because of better sorting machinery, started mining their own in small exposed seams and gradually expanded this work until it is quite a business, the work mostly being done at night.

A PHOTOGRAPHIC STUDIO IN MINIATURE

THERE is a fascination in making photographs full natural size or larger which ordinary photography does not possess. The one reason that it is not practiced more commonly is the difficulty encountered in maintaining the proper relationship between camera and object. When working with sizes larger than natural, the slightest movement will destroy the focus and will probably displace the position of the image.

The use of an optical bench will overcome the difficulties mentioned, but it is usually somewhat difficult to alter the usual optical bench accessories to make them suitable for this purpose.

An optical bench has now been introduced which is designed for photographic work of the kind described, and is intended for amateur as well as more serious use. The bed of the bench is like that of a well-known optical bench, but saddles and accessories have been made especially for photography. A camera head permits the camera to tilt in a vertical arc, to swing horizontally through a complete circle, and to be raised or lowered.

Two vee troughs serve to support lens extension tubes of 20 inches in length or even more. The most elaborate accessory is the stage itself. This measures five by eight inches. It has five-inch uprights at the back which are grooved to take backgrounds of transparent, translucent, or opaque material of any color.

The stage moves in a direction parallel to the bed by micrometer screw control. This is operated from the camera position by means of a flexible cable adjustment. This permits the finest adjustment of focus to be made *by changing the distance between the lens and the object*, from the operating position behind the camera. The entire stage with its controls may be raised or lowered in coarse adjustment by a friction post and in fine adjustment by a micrometer screw adjustment.

Lighting of any kind may be obtained by using one or both of the lamps which are attached to the stage by means of swinging arms. Shades are provided to keep glare from the lens.

The entire bench is designed to make possible assured results in the fascinating field of photomacrography, that field which lies midway between ordinary photography and photomicrography.

"Enduro," an 18-and-8 stainless steel, now makes its contribution to music. Guitars, said to have excellent tonal qualities, are being made of this alloy, which contains 18 percent of chromium and 8 percent of nickel

Courtesy *Nickel Steel Topics*

RAYON IN BETTER TIRES

ARTIFICIAL silk as strong as structural steel is the latest remarkable product of synthetic chemistry, according to Lammot duPont. This high-strength rayon was developed especially for use in the manufacture of cord tires and it has been appropriately named Cordura.

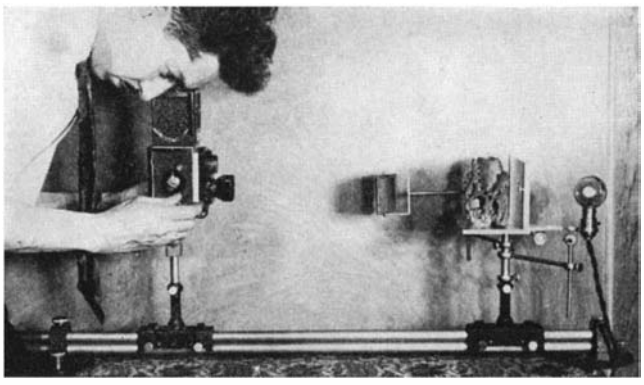
Although considerable progress has been made in the construction of cord fabric for automobile tires, most of the recent improvements in tires have been directed along the lines of improved rubber accelerators, anti-oxidants, and the conditions of vulcanizing. The development of Cordura is expected to prolong still further the life of tires. Indeed, it promises to double and triple the mileage of heavy duty truck and bus tires.

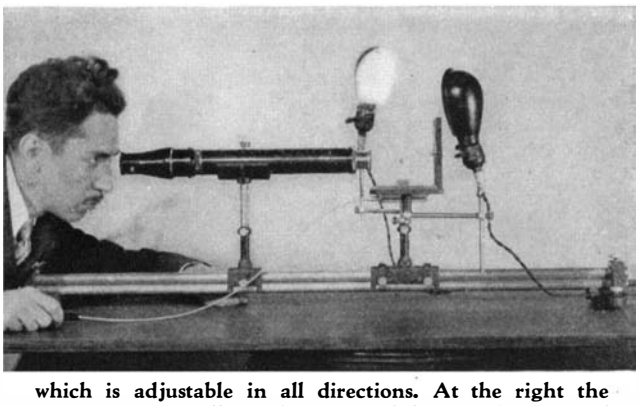
The rayon manufactured for this purpose is produced under special conditions of manufacture. It is said to be as strong as structural steel of the same cross-section. It also has low elongation and a very harsh and unpleasant feel as compared with the rayon manufactured for fabrics. It possesses, however, unparalleled resistance to heat degradation.—*A. E. B.*

FUSED COLLARED SHIRTS

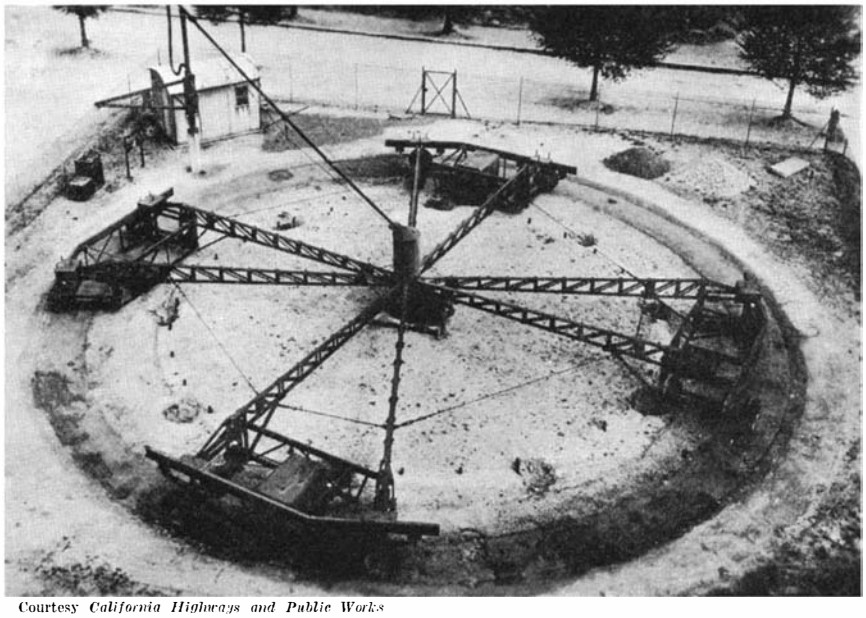
WHEN the first splashy advertising of the new wiltless collared shirts appeared in newspapers recently, there was some bewilderment as to how this development had come about. When it is explained that these collars are fused by the Trubenizing process, the question begins to clear up. As a matter of fact, the outside cloth is fused, or perhaps it might be better to say glued, to the lining cloth. Dr. Benjamin Liebowitz, an engineer, is credited with the development.

The Trubenizing invention employs an arrangement of threads of cellulose ester as both a stiffening medium and a binder for uniting the lining with the outer and inner plies of collars, cuffs, or other textiles. The different layers of cloth are laid with the lining threads of cellulose between them and spaced about every fifth thread. This spacing is necessary to prevent filming over or closing when the finished cloth





A photo-optical bench that permits the amateur photographer to conduct serious experimental work in the field of photomacrography is now available. At the left above the bench is shown in use with a camera firmly fixed to a head which is adjustable in all directions. At the right the operator is controlling adjustment of the stage by means of a flexible cable, at the same time focusing for an enlarged image. The extension lens tube is held in a vee trough



Courtesy *California Highways and Public Works*

Road materials are tested under conditions closely approximating actual traffic use in this test track set up by a German highway laboratory. The track is about 70 feet in diameter and permits the testing of a strip of road material from 6 to 10 feet wide. The loaded wheels that constantly grind away on the surface can be shifted sidewise to cover the entire width of the experimental roadway

is treated with a solvent. A preferred method of solving the artificial threads is to place the collars between two pads, wet with acetone, and then to apply pressure. Heat and further pressure are applied, as a result of which the solvent is driven off. The cellulose ester remains behind no longer as a fabric, but as a checkered structure partly dispersed into the adjoining fabric plies, which checkered structure adhesively binds the plies together and stiffens them.

SHIP POWER

ONLY two vessels on the sea today have greater rated horsepower than the new French Liner *Normandie*. Her electrical power plant is rated at 160,000 horsepower while both the aircraft carriers *Lexington* and *Saratoga* have 180,000 horsepower.

Poison Ivy, Poison Sumac

VACATIONISTS as a rule dread nothing more than "getting a dose of poison ivy." The unsightly blisters, the unendurable itching, the frequently prostrating allergy or "shock effect," can combine to ruin a holiday as hardly any other woodland plague is able to do.

The best prevention is to keep away from it. To do so, you must know it when you see it. That is not difficult. Poison ivy is either a slender low shrub or a vine that clings tightly to trees and stone walls with thousands of little roots. Its distinguishing mark is the triple leaf: "Leaflets three, let it be!" states the old rule-of-thumb. Its flowers are a loose cluster of inconspicuous greenish bloom; its fruits (frequently persistent from the previous winter) are pallid waxy berries. Don't touch it, and you won't get "bit." The notion that ivy can poison at a distance is simply superstition.

If you find you have touched it, wash your hands at once, and very thoroughly. Strong laundry soap is best; the alkali helps to kill the poison. A more thorough remedy, for cases that actually develop, is a 5 percent solution of potassium permanganate. This stains the skin brown, but the stain can be removed later with a weak solution of oxalic acid, or just by thorough washing.

To prevent ivy poisoning, wet exposed parts of the skin with a 5 percent solution of ferric chloride in a half-and-half mixture of water and alcohol. Don't wipe off the solution; let it dry on the skin. This will neutralize the poison.

Some persons are apparently quite immune to poison ivy, and can handle it with no more harm than if it were lettuce. But such immunity is not a certain thing. It can be lost without warning, and once lost seemingly never returns.

Poison ivy is found in all moderately moist open woodlands in the East, and its Pacific Coast twin, poison oak, grows in similar habitats. Even more virulent than these two, though affecting fewer people, is poison sumac, a close botanical relative. This grows only in acid-water bogs or on their margins, so the average person who likes to keep his feet dry is not likely to get into it.

Poison sumac looks like ordinary sumac, except that its bark is a rather pale gray, and its fruits are in loose, drooping bunches of white berries instead of erect, stiff clusters of red-brown fuzzy "seeds." The remedies for poison ivy are good also against poison sumac.—*Science Service.*

Rustproofing With Alternating Current

AN entirely new method of depositing zinc for rustproofing which, for the first time in the history of electro-chemistry, utilizes alternating current in the process, has been perfected by the Ford Motor Company and is now being used in its entire production of head and tail lamps at the Ford lamp plant at Flat Rock, Michigan.

The new process requires less room than other methods of rustproofing, and provides a surface which is ready for painting as it comes from the rustproofing machine. The only attention required before painting is to wipe off the surfaces to be painted with a clean cloth.

The efficiency of the rustproofing may be gaged from the fact that a minimum resistance to rust of 300 hours under salt spray is required by the Ford Motor Company for these parts. In actual laboratory tests complete resistance to rust after 1000 hours of salt spray is being obtained. This is equivalent to years of ordinary use.

The rustproofing machines are entirely automatic. The burnished lamp shell, which has been coated with an oily film, is hung on a conveyor which carries it into the bath, where it stays for 4½ minutes. The bath is kept at 155 degrees, Fahrenheit, and an alternating current of 20 volts, pulling from 35 to 50 amperes at 60 cycles, alternately makes the article to be rustproofed an anode and a cathode.

The effect of this current, it is believed, is not to make the process one of electroplating, but the electricity prevents the formation of hydrogen on the article being treated, and eliminates polarization. The result is that the steel is able to take a coating of zinc by chemical action without interference.

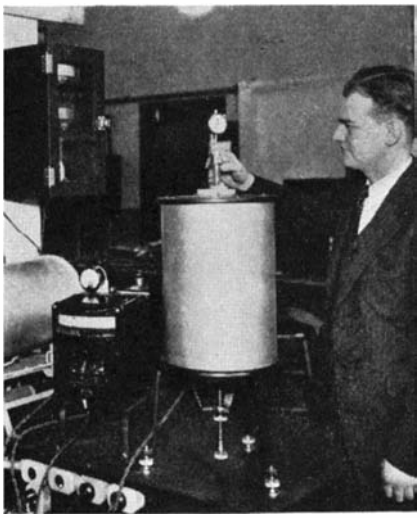
After 4½ minutes in the bath the conveyor takes the rustproofed articles to a hot water spray rinse and dip rinse, and then carries them to the paint booth, where they are dip painted at once after being wiped off with a clean cloth.

If the alternating current were not used, it is stated the deposition of zinc would be very thin and too crystalline, and a great deal of iron would be removed by chemical action and go into the solution.

A feature of the process is that the proportion of metallic zinc in the bath can vary widely and still permit of satisfactory results. It is allowed to vary from 0.9 percent to 0.2 percent.

Measuring Expansion of Metals

A DILATOMETER is an instrument which measures and records, in ten-thousandths of an inch, the expansion and



The dilatometer for measuring accurately the expansion of metals

Portable photo-cell color matchers

contraction of metals as they are heated and cooled. Such a device has been built from specifications of the United States Bureau of Standards for use by the General Electric Company in its investigations regarding metals, and is not a device that the company is marketing.

The dilatometer consists of a small cylindrical furnace surrounding a quartz tube—the quartz withstanding high temperatures and having a minimum of expansion when heated. A round core, about the size of a thick pencil, and made of the metal to be tested, is placed within the tube, which is then electrically heated up to 1800 degrees, Fahrenheit. On top of the specimen is placed another smaller quartz tube, sealed at both ends, to transmit the dilation of the specimen to a dial gage. The gage is connected by an Invar clamp to the outside quartz tube, and can be read to 0.0001 of an inch.

Metals do not expand in an even, gradual way as the temperature is increased, investigations have shown. Instead, they react in an irregular fashion, expanding in spurts. Such irregularities can be determined accurately with the dilatometer. In welding, brazing, or heat treating, information on the reaction of metals to heating and cooling is very valuable. In welding, for example, where one metal is being joined to a different one, the two should cool at approximately the same rate or be heated in a manner to compensate for difference in cooling rate. If one of the metals should cool faster than the other, it would shrink away from the weld and either crack or weaken the joint.

By testing various alloys of different compositions with the dilatometer, it is possible to tell how individual elements are affected by heat variations. After this has been determined it is possible to raise, lower, or even eliminate the critical points of a steel compound, for instance, by adding certain elements. In this way, a compound can be created with nearly any characteristics of expansion and contraction that may be required.—*A. E. B.*

Portable Colorimeter

A PORTABLE colorimeter which can be operated from any 110 to 115 volt light socket has been developed by the M-R-H Laboratories. This new color matching instrument, about the size of an ordinary electrical meter, furnishes its own illumination and gives identical comparison either by day or by night without any effect from outside light sources. It consumes but 50 watts of energy and can be furnished as a six volt battery unit when necessary.

This unit operates much the same as does the one mentioned in our June issue. Light reflected from the samples that are to be color-matched falls upon sensitive photo-electric cells and the vernier scale permits highly accurate matching. The manufacturer claims that it covers such a wide band of color that it goes both into the infra-red and ultra-violet fields of the spectrum.

This new color matcher requires a sample only two inches square in order to make a complete test and sells for a moderate sum.

IMAGES WERE KISSED

IMAGES of the Holy Virgin were much kissed by devout Christians in the 17th and 18th centuries. This caused so much wear of the images that they were finally glazed with mica as a protection.

World's Longest-Span Concrete-Arch Bridge

THE double-track railroad line between Zamora, Orense, and La Coruña, in Spain, will be carried across the Esla River on a concrete-arch bridge, 1545 feet long, which has been in course of construction since August, 1934. This bridge, described by A. O. de Retana in *Cemento* of February, 1935, is to have a central arch of 627 feet clear span, which makes it the longest reinforced-concrete arch in the world. The main arches of the Traneberg bridge in Sweden and of the Plougastel bridge in France, which have held the length record so far, have clear spans of 586 feet and 566 feet, respectively.

The curve of the arch is a parabola of the fourth degree with a rise of 205 feet. As seen from the architectural drawing, the arch carries ten sets of spandrel columns, up to 127 feet in height, supporting the two-track roadway. The arch is a hollow structure divided into three longitudinal compartments, throughout its length, varying in height from 12.1 feet, at the crown, to 19.7 feet at the springing line. The total width of the arch box varies similarly from 25.9 at the crown to 29.7 feet near the abutment. The longitudinal partitions have a uniform thickness of 2.3 feet, while the back and the soffit slabs vary in thickness from 2.95 feet at the crown to 4.35 feet at the abutments.

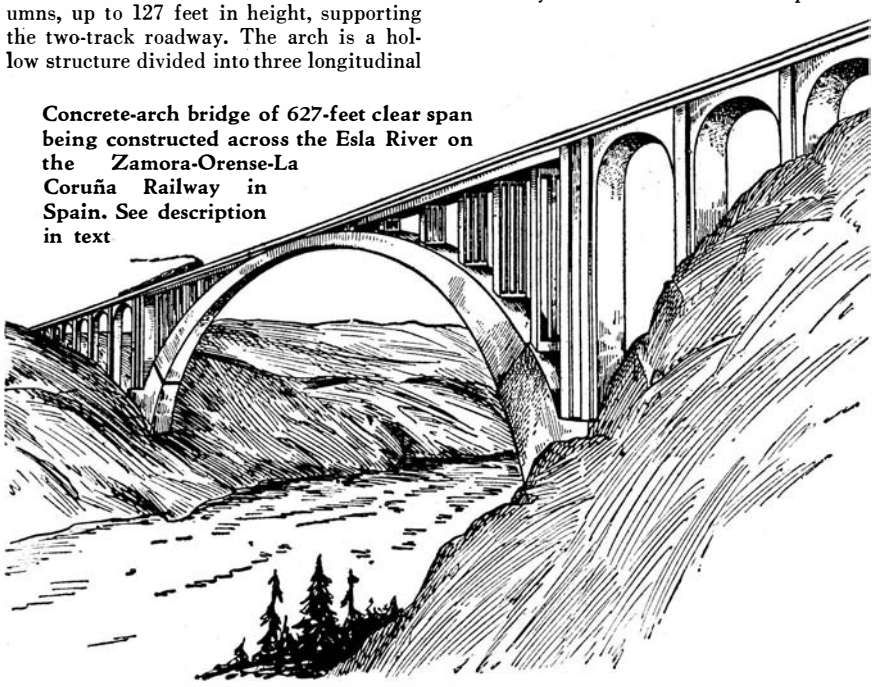
The arch is designed to satisfy the following conditions: (1) skewbacks submerged, or above water; (2) temperature variation of ± 18 degrees, Fahrenheit; (3) wind pressure up to about 28 pounds per square foot. The maximum stresses will be 1182 pounds per square inch at the crown and 1223 pounds per square inch at the abutments. These stresses are only about 28 percent of the 90-day strength of the concrete, which will be proportioned with 590 pounds of Portland cement per cubic yard. The job will require a total of 39,200 cubic yards of concrete and 1100 tons of steel.

The arch centering will consist principally of ten arched-truss ribs forming a system of uniform cross-section 31.2 feet wide and 11.5 feet high. The removal of the centering and the adjustment of the neutral axis of the arch will be carried out in accordance with the Freyssinet system, which proved highly successful in the construction of the Plougastel bridge. Thirty-six hydraulic jacks will produce a positive bending movement of 20,300,000 foot-pounds at the crown, and 1,530,000 foot-pounds at the abutments. The keystone gap will be 6.3 inches wide at the extrados and 5.4 inches at the intrados.—*Engineering News-Record.*

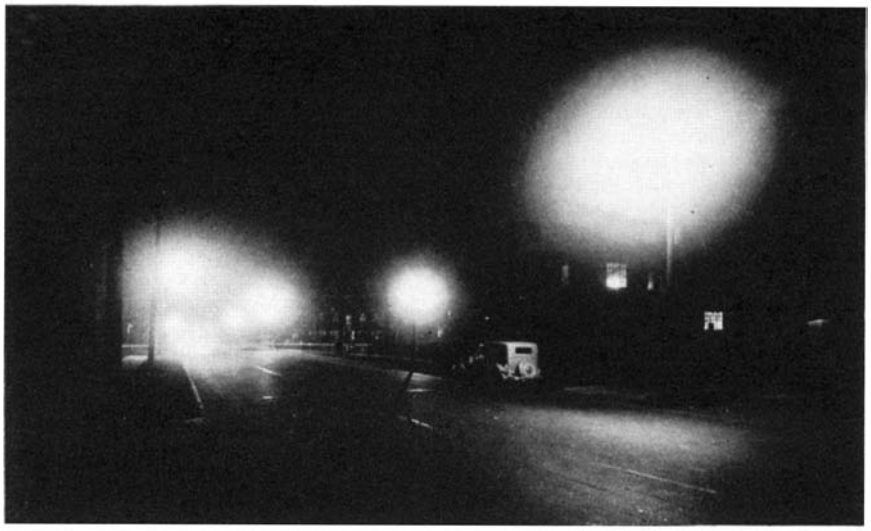
Rheumatism Cured By Vitamin D

RICKETS-PREVENTING vitamin D is of great benefit in the treatment of arthritis, or rheumatism as it is sometimes called, Dr. C. I. Reed of the University of Illinois College of Medicine recently told members of the American Physiological Society.

Seventy out of 100 arthritis patients



Concrete-arch bridge of 627-feet clear span being constructed across the Esla River on the Zamora-Orense-La Coruña Railway in Spain. See description in text



Left: **A street in Detroit illuminated with 300-watt tungsten filament lamps that produce 6000 lumens. An experimental set-up of Westinghouse high-intensity mercury vapor lamps, consuming approximately 400 watts produced 14,000 lumens—an increase of 8000 lumens per lamp for an increase in power of only 100 watts. The photograph below shows how sharply the details of objects are defined when illuminated by vapor lamps**

treated this way by Dr. Reed and his associates, Drs. M. L. Hathaway and H. C. Struck, were definitely helped and some apparently cured.

The vitamin was given in the form of concentrated viosterol and enormous doses were used. While 3000 units is the standard dose for rickets treatment, Dr. Reed used 1,000,000 units and in some cases 3,000,000 to treat the arthritis patients. All kinds of arthritis except that due to gonorrhea were helped.—*Copyright, 1935, Science Service.*

BRITISH LENSES

ABOUT 80 per cent of the movies now produced in Great Britain and the United States are photographed with lenses produced at Leicester, England, according to a British publication.

Rubber Protective Coatings

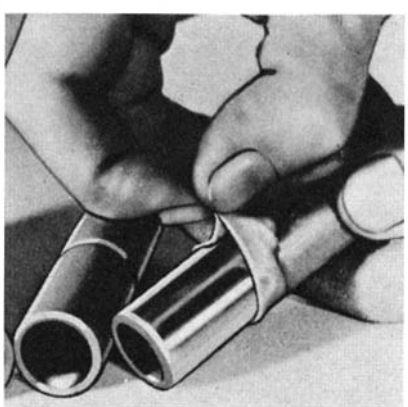
A NEW process which makes possible the use of rubber protective coatings applied in liquid form, has just been developed, according to an announcement by Kelsan Products. For industrial applications, the development opens up new possibilities in many directions. It is reported, for example, that one manufacturer has been experimenting with the possibility of coating a complete automobile body with Kelsanite, leaving it on while the body goes over the final assembly line.

Consideration has been given, furthermore, to leaving the coating on during road test, shipment, or drive-away, removing it only just before delivery of the car to the final purchaser. In this way the body finish would be protected until the car is delivered. Removal of the coating is quite simple, involving merely the loosening of an edge, and then pulling the whole coating off in one sheet, like a Cellophane wrapper.

The cost of providing this protective coating is said to be only nominal and insignificant. Kelsanite is also useful in the masking of automobiles for lacquering.

Another important application of Kelsanite is in the protection of finished parts and equipment for shipment or storage. Parts can be sprayed or brushed with, or dipped in Kelsanite, thereby sealing the surface against air and moisture.

As a rust preventer in storage of metal parts, Kelsanite coated parts have been subjected to over 150 hours of salt-spray tests without showing any signs of corrosion. Kelsanite, it is said, also acts as a cleaning compound, absorbing any dirt or moisture on the surface being coated. When removed it thus leaves the surface clean and dry. In the plating of metal parts Kelsanite has a definite field as a masking compound to prevent deposition of metal except where desired. Following the plating operation, the coating is then readily stripped off.



Rubber protective coatings (Kelsanite) are easily stripped off

High-Speed Army Tank

READERS of these pages have followed in recent years certain of the more important developments in Army tanks and have noted particularly the design of Mr. J. Walter Christie of a powerful tank which would run at high speed on wheels when used on the road and on an articulated track in cross-country runs. The Army has, however, desired a tank of its own design which would also embody most of the good features of others that have gone before. The following paragraphs from *Army Ordnance* give characteristics of such a tank developed by Army engineers:

During the past several years the Army has attempted experimental mechanization. A critical element of the mechanization was the ability to make strategic marches of several hundred miles and then launch an attack. With the full track vehicles having sustained speeds of only 14 or 15 miles per hour, this was not satisfactorily obtained, and the vehicles designed by Mr. Christie filled the gap, permitting strategic marches at speeds of 40 to 50 miles per hour, and then conversion to a track-laying vehicle for use in an attack.

The new tank which has been demonstrated during the past few days to high officials of the Army was designed by Ordnance personnel in the Office of the Chief of Ordnance, Maj. Gen. W. H. Tschappat. This work was greatly facilitated by the enthusiastic support of Maj. Gen. Edward Croft, Chief of Infantry, and personnel of his office. The tank is a full-track vehicle, and is capable of speeds greater than 50 miles per hour and a sustained speed of 30 to 40 miles per hour. The development of this tank is an outstanding automotive development applied to military uses during the past ten years.

After construction at Rock Island Arsenal, this light tank was tested for 2400 miles over irregular terrain and on various types of roads. This test was conducted at the Arsenal. The tank was driven overland by Capt. T. H. Nixon and Mr. Joseph Proske, leaving Rock Island Arsenal on November 14 and arriving in Washington on November 17. During this run all existing records for non-convertible track-laying vehicles were broken. The entire trip of approximately 900 miles was made at an average speed of 30 miles per hour. This included the time necessary in passing through the various cities en route. During one day the tank covered 336 miles in eleven hours.

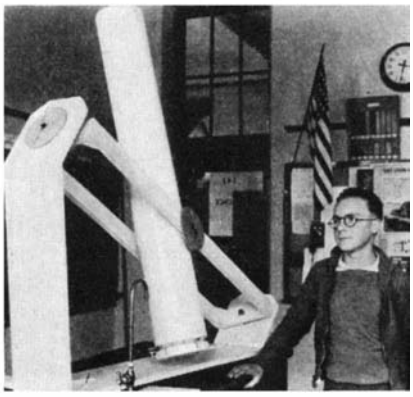
The general characteristics of this light tank are: Length—12¾ feet; height—6½ feet; width—7 feet; weight—fully equipped

(*Please turn to page* 103)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

EVERYBODY who reads this is hereby automatically invited to attend the tenth annual get-together of amateur telescope makers, to be held Saturday, August 3, at *Stellafane*, near Springfield, Vermont. These annual pow-wows run about as follows: People begin arriving Saturday noon,



mostly by motor. The afternoon is spent in "talking it over" with other hobbyists. At six there is a picnic feed (about one simoleon), at seven an hour's oratory, and the rest of the evening is spent pow-wowing and observing—some go to bed, some sit up late, some return home that evening. Many bring tents to sleep in but there is a hotel in Springfield. Early Sunday morning there is another feed and, as the day wears on, the remaining people drift away. The party offers an interesting 6, 12, or 24 hours of hobnobbing, whichever length you prefer to make it. Bring along your telescope—others will want to see what you've done. About 200 usually attend these corroborees.

WE receive a steady stream of inquiries from amateurs who want to coat their own mirrors by the evaporation process, and our usual reply is: If you have previously dealt with high vacuums, or if you are prepared to do some months of preliminary wrestling with the process, also if you have something under 100 dollars to spend, go to it—you will have a lot of fun or at least "experience." But don't run away with the idea that you can do the job as simply as some seem to believe, or anything like as simply, as the ordinary silvering job. On the other hand, the technique does not seem to be a big obstacle to a man who has had the advantage of a general physical laboratory background. Here is a letter from Gerald E. Kron, 405 La Follet, Adams Hall, Madison, Wisconsin, whose connection with the University of Wisconsin provided him with that advantage.

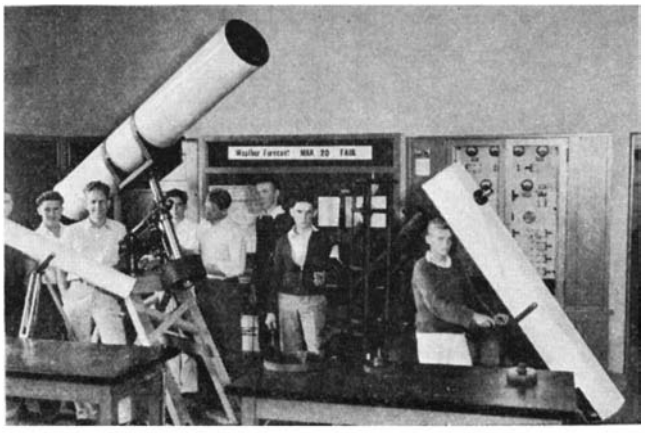
Photos by Oscar S. Marshall

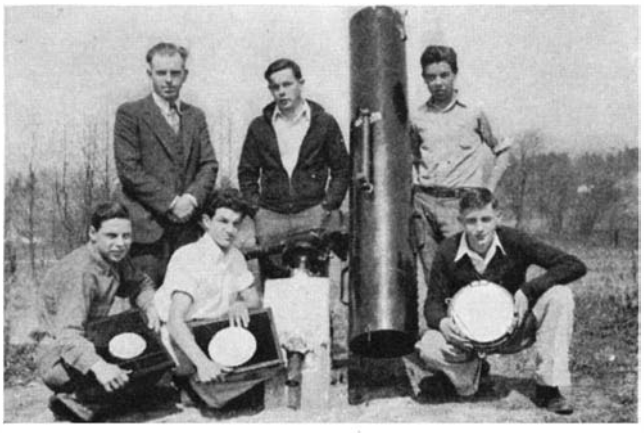
***Left:* They start young in California—Richard Cale of Pasadena and his telescope. *Right:* The Pasadena Amateur Astronomers' Club at John Marshall High School, Pasadena**

"Your letter gives me the impression that the amateur telescopists consider evaporating metals quite a difficult piece of work. In a sense this is true, but if one has all of the equipment available, as I did, the evaporation of silver, at least, is quite simple. I built the evaporating outfit and got a coat of silver all in the space of two weeks. But it must be held in mind that I had all of the means of a large university at my disposal, in addition to the advice of several people who had done evaporating before.

"The most important condition for evaporation of metals is to have a high enough vacuum. I believe that any trouble experienced by people who have failed was caused by having too poor a vacuum. It is necessary to have a pressure at least as low as 10^{-5} mm. of mercury, and a very good coat will be obtained if the pressure can be reduced to 10^{-6} mm. [About 1/75,000,000 atmospheric pressure.—*Ed.*] Aluminum is very difficult to evaporate at any pressure higher than the second named above, because it tends to burn up, or acts as a 'getter.' Silver is *by far* the easiest of all the materials that I tried, and I would advise anybody experimenting with the process to start out with it, by all means.

"I produced my vacuum by first pumping down as far as I could with a Cenco [Central Scientific Co., 456 E. Ohio St., Chicago.—*Ed.*] Hi-vac fore pump (about 10^{-3} mm. of mercury). Then the final high vacuum was produced by surrounding a charcoal trap fastened to the apparatus with a dewar flask full of liquid air. The amount of air and other contaminating material that such a trap will absorb (or adsorb) is almost unbelievable. It will reduce the pressure from fore-pump pressure to such a low point that an electrical discharge will not pass through. I used this as a test of my vacuum. It is crude, but quite convenient, and after one learns something about the character of discharges through different pressures,





While telescope making is definitely not a hobby for little children, and has been followed almost wholly by adults, lads of high-school age, particularly after they have studied geometry, can handle the work without difficulty, and it is being used, more and more, by science teachers as "project" work for science classes. Here are two pictures of this kind. *Left:* The Burbank Telescope Club at the Burbank High School, Burbank, Calif., composed of physics students who together made the 12⅜-inch reflector shown, and individually made other telescopes. *Right:* Telescope making members of the Astronomy Club at the Snohomish High School, Snohomish, Wash., with 6-, 8-, and 10-inch mirrors. Science teachers are urged to consider using this work next term. Pupils will retain what they learn, long after they have forgotten mv^2, etc. Wood-working shop, machine shop and laboratory work are involved, and the work is strongly motivated—the romance of astronomy

he can estimate his pressure with a fair degree of accuracy.

"By far the greatest difficulty encountered was to eliminate all leaks from the system. I believe that the only person in the world who really learns something about leaks is the man working with high vacuum. I know that any of the men working at Wisconsin University will agree with me, and there is a great deal of high vacuum work going on there. The character of the apparatus made it very susceptible to leaks, the apparatus being composed of a large bell jar over a very heavy vacuum plate in which were sealed the necessary electrodes and tubes. Bell jars for such purposes are usually sealed down with a wax of some sort, but I used common Plasticine, a type of modeling clay which never hardens. It makes an excellent seal which is very easy to apply and remove. [J. L. Hammet Co., Cambridge, Mass.—*Ed.*]

"The material to be evaporated is melted with a heavy tungsten filament supported by large electrodes sealed into the vacuum plate. It is difficult to find a material with which to seal these electrodes against the vacuum, and still have them insulated from the metal plate. One of the research men made a glyptol resin for me which is just about the acme of perfection for the above purpose. If anyone you know of would like some of this stuff, I shall be glad to tell him how to make it. It can be melted in place, and yet it is proof against the intense radiation from the filament.

"Many materials can be deposited by evaporation: silver, copper, aluminum, gold, platinum, chromium, quartz, and fluorite. I tried chromium and quartz, but I was not able to get them to a high enough temperature. I have found out, since, that chromium does not give a very bright surface, anyway. Quartz is useful, because it can be deposited over a surface like silver, giving it almost perfect protection. As a whole, aluminum does not seem to stick as well as silver. The latter must be removed from the inside of the bell jar after a run, with an acid or an abrasive powder.

"If anyone you know of would like some help with this evaporating, I shall be glad to answer any questions that I am able to."

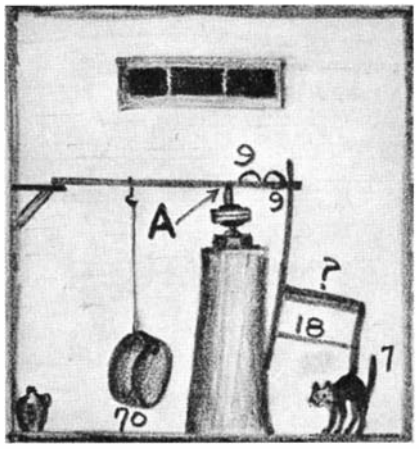
The advantage of aluminum over silver is, of course, that it automatically coats itself with oxide which, being corundum, has the hardness of sapphire. Still, anyone who intends to play with the evaporation game probably would pick up valuable experience from the experiments with plain silver suggested above, later trying aluminum.

A LOT of people are having trouble with pitch for laps. Joseph A. McCarroll, an architect, 521 Palisade Ave., Teaneck, N. J., had so much of it that he got mad and made an investigation of pitch from all angles and, as a result, has decided that the best pitch is not the pine pitch most of us use but coal tar pitch. Only after he had done a lot of experimenting with coal tar pitch did it become known that Ellison now uses that kind. Here is what McCarroll writes:

"Many mirror makers may think that, because there seems to be little or no reference in print to the use of coal tar pitch as a base for polishing, this material is therefore not suitable for that purpose. It will come as a surprise to many to learn

that it is not only suitable, but that in many respects it offers some definite advantages.

"The material to use is *coal tar* pitch. It is a by-product of the manufacture of illuminating gas. The tar is usually sold by the gas companies to concerns that distill it to obtain its many very valuable derivatives so useful in the arts and commerce. Pitch is what is left of the tar after distillation. Coal tar pitch should be distinguished from 'water-gas' tar pitch, which is not nearly so useful to the mirror maker.



With apologies to Rube Goldberg

"Among the advantages of coal tar pitch is a rubbery smoothness of the surface texture of the material when formed in the lap. This probably accounts for the excellent polishing effects obtainable. It seems to work faster and with more positive effect than pine pitch, especially in figuring. It seems that the tendency to cause scratches is less. This may be due to the absolute purity of the material. It is said by the makers that the ordinary run of the pitch, as manufactured, is entirely free from grit or any other foreign substance. It is not necessary to strain it, provided it is packed in clean containers.

"In melting coal tar pitch it is advisable to watch it constantly, especially where the melting point is high. There seems to be a point during the heating when it may suddenly froth up and run over the container and become ignited by the flame. The danger from fire should be carefully guarded against. Water-gas pitch is particularly bad in this respect and should not in any circumstances be used for tempering purposes.

"In making the polishing lap the technique will be found to be quite similar to that used for pine pitch. There will be a marked difference, however, when it comes to cutting facets, as coal tar pitch is much less subject to chipping under the knife. This is a tremendous relief and this one quality alone should commend it highly.

"Such materials as wax, turpentine and rosin cannot be used to advantage for mixing with coal tar pitch for modifying its hardness or other properties, for this kind of pitch is entirely different in chemical composition from pine pitch and, in fact, in making mixtures of either of these materials only such as are of an allied nature should be used. It is true, the two differing varieties of pitch can be mixed, after a fashion, but the smoothness of texture of the coal tar pitch is then lost and gas bubbles will be found to be one of the troubles. Instead, pitch having a higher melting point should be used to harden a similar pitch of low melting point, or vice versa. Creosote oil (common variety) may be used for softening the pitch, although it is better to mix pitch with pitch; if for no other reason, so that one can exactly determine the melting points of the components. For example, equal quantities having melting points at 150° and 200° Fahrenheit will yield a mixture having a melting point of 175°. The range of grades which should be kept on hand for all year round use should run in about 10° intervals from M.P. 140° to 180°. The extremes are useful chiefly for mixing purposes since, if used straight, they would be too soft and too hard, respectively. A melting point of between 155° and 160° will be found to be most generally useful for polishing at room temperatures around 70°. The determination of the melting point of pitch is accomplished by the use of very special testing devices which the amateur would not likely want to bother about. He should get his pitch already graded for melting point.

"The melting point is a very definite property of the pitch, which must be known for basic tempering purposes, but for determining the probable behavior of pitch on the lap under any given room temperature it is necessary to have some other test, such as the penetration test, which will show the specific hardness under existing conditions. This distinction will be apparent when it is realized that a pitch with a melting point of, say, 150°, used in a room at quite low temperature, might have exactly the same specific hardness as a pitch of 170° M.P. in a room of higher temperature.

"Unfortunately the writer, at the present moment, is unable to give very definite suggestions regarding available sources of supply of coal tar pitch in small quantities. It is commonly sold by the ton and in drums containing several hundred pounds. Almost any local roofing concern will have a supply of it, but when using material from such sources straining will be necessary and considerable experimenting with mixing and tempering will undoubtedly be required.

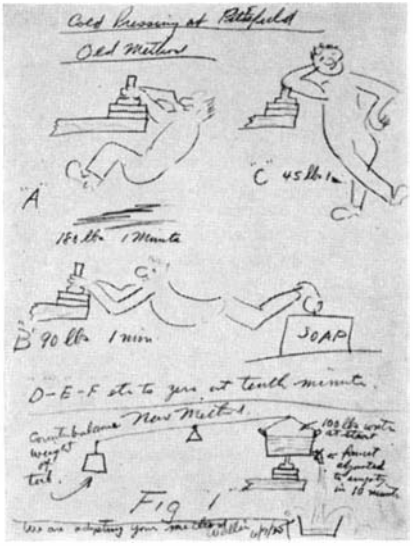
"The writer has been using coal tar pitch for quite a time, under the impression that he was, perhaps, something of a pioneer. Word has recently come, however, that Ellison is using it and favors it for figuring. This should definitely put the stamp of approval on its use."

We intended to reserve this paper for inclusion in the "A.T.M. Supplement," but thought it perhaps better to publish it here first, hoping that other experimenters will report their findings on this kind of pitch before it is set up permanently in that book. In the meantime a source of supply may turn up.

Until we receive a reply from Ellison, all that we can say about his use of coal tar pitch is contained in the following sentence from his last letter. "Coal tar pitch—the very stuff that the paviors use for setting the street blocks—is the best of all for figuring." We have a sample of the pitch he was apparently using in 1928, when we visited his shop, and this appears to be pine pitch; hence he must have taken to using coal tar pitch since that date. Just as we read proof on these pages a rumor that Fecker uses it turns up. Mr. McCarroll at the same time (latest minute) believes he has located a source of supply from which the prepared product may be obtained, but this is as yet too indefinite to state here. Although he is busy, we have urged him to be the dealer himself, because he understands the requirements from the point of view of the amateur telescope maker. Whether he will consent or not, we cannot say, but may have more to say later.

SOME who have written to individuals mentioned in this department, also in the instruction book "Amateur Telescope Making," have evidently ascribed their delayed replies to unwillingness to answer. It is seldom or never that. It will be evident that, when a man's name and address is given here, a flock of letters will converge on him from all directions, and if only one out of a dozen of these includes a stamped return envelope, that one fellow stands to be out quite a bit for postage alone, and his delay may be understandable. Also make it easy for him—tell him to scribble his answer on the margins and back of your letter; why be conventional among fellow hobbyists?

RECENTLY, when writing to Wallie Everest, your old scribe included a sketch of his wonderful, patented, standardized cold pressing equipment, and Wallie returned it with a sketch exhibiting various scientific methods employed in Pittsfield. Both sketches are reproduced on this page. In our own sketch, note tree-



Eurythmic postures in Pittsfield

trunk pedestal; also lever across top, one end bearing on a shelf and shiftable endwise in order to get variation in pressure when single hanging weight is used, and the other end bearing on the handle dingbat shown in A.T.M., page 288, through pivot point *A*, an alley stolen from Scribe, Jr. Two nine-pound hemispheres of lead and an 18-pound chair may be added for heavy pressing, also "Skow," the cat, though she won't often stay put in the chair. (Contrary critters—cats.) Like Topsy and A.T.M., this remarkable outfit "just grew," but we will bet it is no worse than some which the rest of you readers are using, and not so bad as some—and it works. When using heavy weights, rapid unloading may cause deformation of the mirror, hence inventor Everest suggests a washtub which may, if preferred, be filled with champagne, and this weight siphoned off, at the end, into the sink—or elsewhere.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 98)

and with personnel ready to fight—16,000 lbs.; maximum speed—50 miles per hour; sustained speed—30 to 40 miles per hour; engine—260 h. p. radial, air-cooled; track and suspension—special Ordnance design. The tank is equipped with one or two turrets. In every case it carries two caliber .30 machine guns, one caliber .50 machine gun, together with Thompson submachine guns. A crew of four operates the vehicle. A radio with an 80-mile range is provided.

High ranking officials of the Army, and numerous others, were much impressed with the flexibility of control, the easy riding qualities, and simplicity for war-time manufacture of this weapon.

DIAMOND DUST

SOME tropical woods are so dense and hard that a saw with extremely hard teeth is necessary to cut them. The difficulty of sharpening the teeth has been solved by the use of diamond dust.

CELLULOSE FROM SUGAR CANE BAGASSE

EVERY year at our sugar mills there are collected large quantities of bagasse, the fibrous residue which remains after extracting sugar from the sugar cane. In continental United States, chiefly Louisiana, the annual tonnage of bagasse reaches about 500,000, and in Puerto Rico and the Territory of Hawaii there are 2,000,000 additional tons annually. Bagasse is not wholly a waste product. It has some value as a fuel, and it is customary to burn it under the boilers in the sugar mills. As a fuel, one ton of the green bagasse is equivalent to about one barrel of oil. With fuel oil selling at $1.00 to $1.25 a barrel, the fuel value of this material is not high. Some bagasse is used in the manufacture of structural insulation board, but this industry has never absorbed over 20 to 25 percent of the continental supply.

The comparatively high cellulose content of bagasse has suggested its use as a source for paper pulp. Some attempts at producing paper pulp from bagasse were unsuccessful. The value of pulp in paper making depends on its felting quality, which in turn is dependent on the length of the fiber. Some of the bagasse fibers are long, but a large proportion of them are short. There is some demand for short fiber pulp, but it must be mixed with some long fiber pulp to produce acceptable paper.

During the last 15 years, there has been an enormous growth in the demand for cellulose for other uses than paper. In that time we have witnessed the growth of the rayon, staple fiber, and transparent sheet cellulose (Cellophane) industries. Little rayon was produced in the United States in 1920, but in 1934, 208,000,000 pounds were manufactured in this country, and the world production for 1934 was

Publishers: G. E. STECHERT & Co., New York - DAVID NUTT, London - NICOLA ZANICHELLI, Bologna - FELIX ALCAN, Paris - AKADEMISCHE VERLAGSGESELLSCHAFT, m. b. H., Leipzig - RUIZ HERMANOS, Madrid - F. MACHADO & C.ia, Porto THE MARUZEN COMPANY, Tokyo.

735,000,000 pounds. The other two developments are of a later date, and no one acquainted in these fields will hazard a guess on the yearly amount of these materials the world will require.

Experimental study in the Bureau of Chemistry and Soils showed that the pulping of bagasse could best be accomplished with dilute nitric acid. The availability of cheap nitric acid, due to the low price of ammonia, indicated commercial possibilities along this line. An experimental pulping method using dilute nitric acid was developed during this research. Interest in the work was evidenced by some concerns having large quantities of bagasse at their disposal, and the Bureau is co-operating with some of these companies in the commercial development of this process, with encouraging results. From this farm by-product, which is a waste to the cane sugar planter, high-grade industrial alpha cellulose has been prepared which compares favorably with any industrial alpha cellulose purchased by the rayon mills, and at a price to compete with standard grade of industrial alpha cellulose. Bagasse is, therefore, a potential source of one half a million tons of industrial alpha cellulose for the continually expanding high-grade cellulose industries.

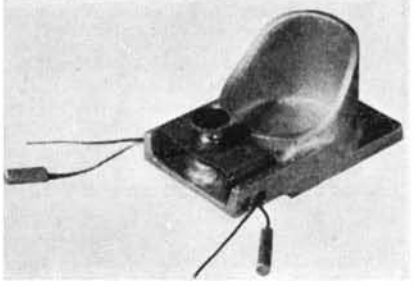
Black Concrete

CARBON black is an important constituent of automobile tires; now it is also being used in the concrete roads over which those tires roll. Introduced into the concrete in order to produce a dark color which cuts down road glare and to afford more contrast between traffic lanes, it has been found to improve the strength of the concrete as much as 25 percent. The colloidal black, besides coloring the concrete, improves the bond between the hydrated cement and aggregate, thereby increasing the strength of the concrete. It seems quite probable that these aqueous dispersions of carbon black will have a considerable use, not only for darkening, but also for increasing the strength of many compositions, such as concrete, mortars, and artificial stone.—*A. E. B.*

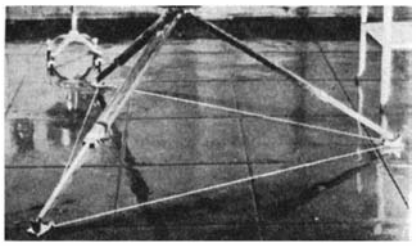
Immovable Tripod Base

ACCOMPANYING photographs show a type of tripod base which should be very useful to surveyors, photographers, or others who use tripods on hard or slippery surfaces. This device consists of three cast aluminum "sockets," on the bottom of each of which there is a rubber pad; the three sockets are tied together, when spread by tripod legs, by a tough adjustable cord.

With this device it is possible to adjust each leg separately or to slide the three legs as one unit into any position without altering their relative positions. This tripod base is light in weight and takes little space when not in use.



One of the metal sockets that are used in the immovable tripod base



Metal sockets linked together form a satisfactory base for any tripod

Peppermint After Heavy Meal

THE popular custom of offering guests peppermint candy or peppermint cordials after a heavy meal has scientific support in the findings of four Chicago physicians, Drs. H. I. Sapoznik, R. A. Arens, Jacob Meyer, and Heinrich Necheles, who reported on their investigation in the *Journal of the American Medical Association.*

Tests made both on dogs and on human beings showed that the oil of peppermint that is present in peppermint candy has a decided motor action on the stomach. Digestion is speeded up, and the stomach empties an hour faster. The peppermint is particularly useful after a meal with a high fat content, making the person's stomach feel less full and distended.—*Science Service.*

Belt Drives for Aircraft

IN the design of flying boats and amphibians, there is always some difficulty in locating the engine. To provide the necessary propeller clearance above the hull, the engine must be placed rather high up. Hence it is usually located above the wing (as, for example, in the Fairchild *Baby Clipper*) where it is not readily accessible and where it creates air resistance.

A more practical arrangement would be to have the engine in the hull and the propeller above the wing. But then there arises the problem of transmitting power through shafting and gearing. That means noise and weight, two of the enemies of the aircraft designer. Accordingly, considerable interest is attached to an experiment being tried by the Casey Jones School of Aeronautics, in which the engine is to be placed inside the hull, and a belt drive will transmit power to the propeller. A few years back such an experiment would have been unthinkable. Now engineers have made so much progress in increasing the life and smoothness of operation of belting, that they are perfectly confident of giving the aircraft industry a new and satisfactory transmission system.—*A. K.*

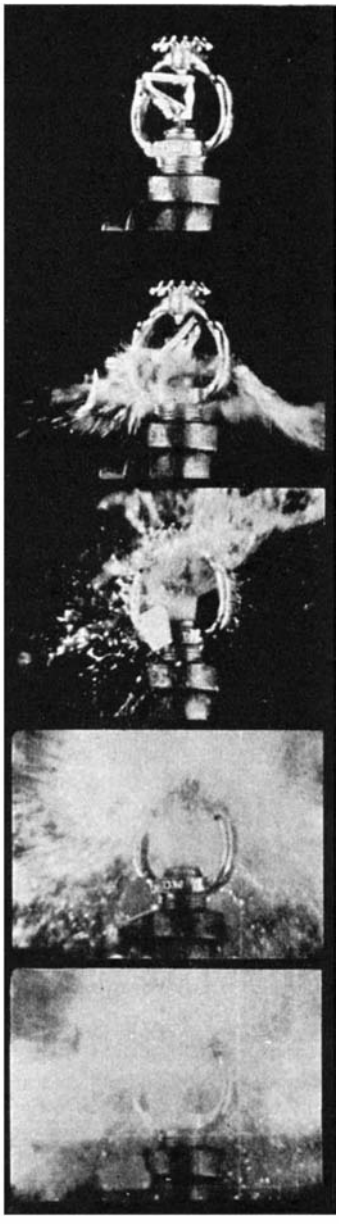
Sprinkler Head Split-Second Operation

ONE tenth of a second after the heat struck the solder, water deluged the fire in sufficient quantities to extinguish it

—45 gallons per minute. Such was the remarkable automatic action of the Rockwood Type "D" Sprinkler Head recorded for the first time in history of the sprinkler industry by a high-speed movie camera in the laboratories of the Rockwood Sprinkler Company, at Worcester, Massachusetts.

Despite the excellent field service record of this head as a fire extinguishing device, and many laboratory tests made by insurance underwriters and themselves, the company engineers determined to make use of the high-speed movie technique that has only recently been developed, to establish a picture study of an operation that is too quick for the eye to follow.

Taken at the rate of 192 frames per second, these films showed that it required only one tenth of a second for the sprinkler head to operate from the time heat of the proper degree struck the solder until water was deluged upon the fire. Besides showing the extreme speed of the sprinkler head, these films also furnished an excellent study showing the actual movement of parts and the distribution of water. In the various picture frames the flying parts of the head actually appear to float in the air; the acceleration due to gravity, increased by the snap action of the figure-4 linkage having comparatively little motion from one frame to the next.



High-speed movies show that a sprinkler works in 1/10th second

Slower United States Recovery

LIGHT is thrown on world recovery in a recent issue of the *Business Bulletin* published by the Cleveland Trust Company and edited by Colonel Leonard P. Ayres.

"In June of 1933," according to the Bulletin, "when the Recovery Act went into effect, the volume of industrial production, as measured by the index of the Federal Reserve Board, was 92. This means that it was 92 percent as great as the average of production during the three years 1923, 1924, and 1925. Since that time there have been three periods of recovery, and three of decline, the latest of which is now under way."

The Bulletin then carries a tabulation compiled from statistical reports of the League of Nations to show the percentage recovery of a number of countries of the world from June 1933 to the spring of 1935. This tabulation follows:

Sweden	+41	Canada	+17
Hungary	+33	Finland	+14
Italy	+31	Austria	+10
Germany	+26	Poland	+ 8
Chile	+24	Czechoslovakia	+ 8
United Kingdom	+20	Netherlands	0
Russia	+19	Norway	— 1
Roumania	+19	Belgium	— 3
Japan	+17	United States	— 9
Greece	+17	France	—16

The very low position in this scale of the United States is symbolized by, among other things, the production of steel. "In the United States the output in 1934 was 51 percent of that in 1928, but in the rest of the world it was 97 percent. . . . Figures for pig iron are available to show in 1934 a recovery here to 43 percent and abroad to 93 percent."

Thumb-Sucking Dangers Are Illusory

IF your child develops badly shaped jawbones, and in consequence has not the facial beauty you would desire for him, do not blame the thumb-sucking habit, if that is one of his faults. Thumb-sucking is not necessarily connected with deformities of the dental arches, Dr. Weston A. Price, Cleveland dental surgeon, recently stated at a meeting of the American Association of Physical Anthropologists. He studied primitive peoples from all over the world—Eskimos, Canadian Indians, Gaels of the outermost islands off the coast of Scotland—and found that, so long as they remained on their native diets, their children all had normal development of teeth and jaws, even though they did suck their fingers. But after contact with the outer world and the introduction of "store food," jaw and tooth troubles began.—*Science Service.*

Sponge Rubber Tires

SPONGE rubber is gradually being adapted to more and more uses. First it was introduced in rubber balls for children. Later excellent bath sponges, chair cushions, window channel guides, and so on, were developed. Now we find it in a dozen different places in automobile interiors such

as in arm rests, straps, seat cushions, and other places.

One of the latest developments is the use of sponge rubber fillers in place of inner tubes in heavy duty tires for army trucks. A tire so assembled deflects the same as an inner tube and is of course absolutely puncture proof. Exhaustive tests in which the tire has been shot through with machine gun bullets were very satisfactory. On the basis of these tests, army trucks are now being equipped with sponge rubber fillers in place of inner tubes.

Anti Ants

According to Prof. F. Z. Hartzell, entomologist at the New York State Agricultural Experiment Station at Geneva, extermination of ants in lawns can best be accomplished by gassing the insect with carbon bisulfide. The best way to get the fumes of the carbon bisulfide into the ant colonies is to make small holes about 8 to 12 inches deep and 6 to 8 inches apart around and through the infested area in the lawn. In each of these openings, place one tablespoonful of carbon bisulfide and cover it immediately with soil. The treatment is made more effective by placing a wet blanket over the infested area for about four hours to confine the gas. Carbon bisulfide gas is heavier than air and will replace the air in the tunnels occupied by the adult ants and the immature stages of the insects, thus affecting a quick death. One treatment usually suffices as most of the adults will be killed, and the young, if not killed outright, cannot survive without the care of the adults.

It is not necessary to purchase highly refined carbon bisulfide, which is often quite expensive, the so-called "technical" grade being entirely satisfactory for the purpose. Carbon bisulfide is highly inflammable and should be handled and stored with just as much care as would be exercised with a similar amount of gasoline. Also, special precautions should be taken while working with this material to avoid close contact with a lighted pipe, cigarette, or cigar.

Detects Spurious Gems with Dry-Ice

If you're thinking of buying a diamond or pearl, take along a piece of dry-ice when you go to make the purchase. According to M. D. Walker, writing in *Nature*, genuine stones emit a rattle or squeak when touched with a piece of solid carbon dioxide. Counterfeits make no noise. In the same way, says the author, a quartz lens may be distinguished from a glass one.

2,000,000 Patents

Just 99 years ago, in 1836, the United States Patent Office began its present series of patents with the issuance of patent number 1. On April 30, 1935, patent number 2,000,000 was issued. Mr. Joseph Ledwinka, chief engineer of the Edward G. Budd Manufacturing Company, was the patentee and his patent covered a pneumatic tire for railroad cars.

Mr. Ledwinka's own experience with patents serves to indicate the remarkable growth in the number of patents issued yearly. In all, he has been granted 248 patents. His first, in 1899, was number 638,643. Thus 63 years were required to issue less than three quarters of a million U. S. patents while during the past 36 years more than one million and a quarter have been issued.

Novel Refrigerant

Boron trichloride is receiving attention as a refrigerant in compression refrigerating machines. Added to its advantages of non-combustibility, non-toxicity, and absence of corrosion effects, is the further advantage that leaks in the refrigeration system may be detected immediately because the substance forms a mist when it comes in contact with moist air.—*A. E. B.*

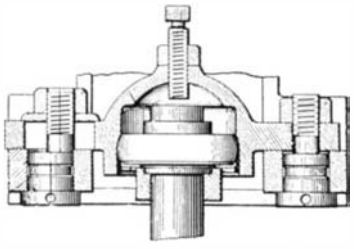
Variable Coupling Air-Tuned Radio Transformers

A new unit for superheterodyne radio receivers consists of a variable coupling air-tuned intermediate frequency transformer which provides a continuous range of variation from one-third critical coupling to over three times critical coupling. Continuous variation between these limits may be controlled from the receiver panel by means of an ingenious mechanical arrangement developed by Hammarlund. Where continuous variation is not necessary, the coupling may be adjusted to the desired value and locked at that point by means of a collar and set screw provided for that purpose.

Both the primary and secondary are thoroughly impregnated three-pie Litz windings. The tuning condensers are the familiar midget air-dielectric type and are located on the sides of the shielding can at top and bottom. The transformers may be used with any screen grid tubes normally used as I. F. amplifiers. Both tuning adjustments are on one side of an aluminum shield.

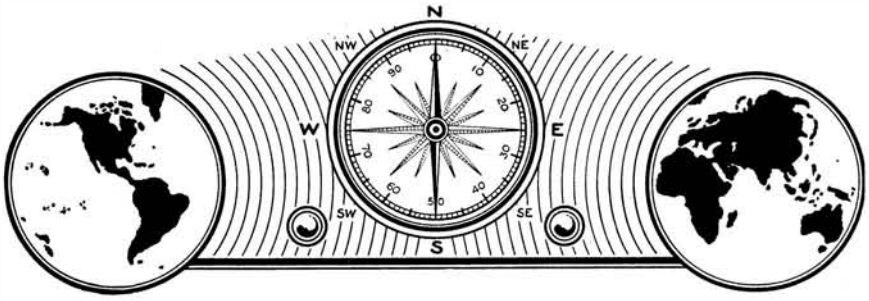
New Adjustable Bearing Box

A patent for a newly invented bearing box which is universally adjustable has just been granted to Mr. William T. Harding of North Carolina. It is adaptable to certain cotton mill machinery for which it was particularly developed. The new bearing is capable of compensatory action when



New universally adjustable bearing

making certain vertical, horizontal, or longitudinal adjustments and is self-aligning. The saw cylinder of a saw gin using this bearing, for example, may be adjusted in all directions in respect to the grate and circular brushes with which it co-operates. Although more particularly adapted to cotton gins, it is applicable to any mechanical construction wherein the necessity of adjustment of one part to another arises.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Receiver Noise Reduction

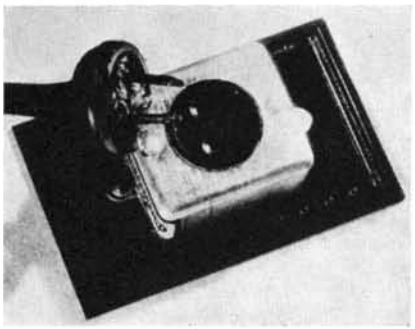
ANY type of radio receiver is subject to two distinct types of noise interference; natural static, which is a basic atmospheric disturbance, and "man-made" interference, produced by various forms of electrical machinery.

There is no cure for natural static, but, fortunately, this form of interference to radio reception is severe only during electrical storms and, in southern climates, during intervals of intense atmospheric changes. In any event, the effect of natural static on radio reception in general has been reduced to an almost imperceptible degree by the expedient of increasing the power of broadcast transmitting stations. The result is that the broadcast signals are of sufficient strength to "over-ride" the natural static and thereby create an impression of low static disturbance.

In the quest for radio programs free from natural disturbances, keep in mind the fact that the many small contrivances sold as "static eliminators" neither eliminate natural static nor reduce it to any degree without also reducing the strength of the received signal. The recent announcements with regard to a method devised by Major Edwin H. Armstrong of eliminating natural static had reference to a new *system* of transmitting and receiving radio waves, and therefore has no bearing on the foregoing statement.

Man-made interference, created by vacuum cleaners, electric fans, heating pads, leaky electric power lines, automobile ignition systems, and so on, may be reduced or completely eliminated, depending upon the method of attack. The noise may be eliminated at its source, or reduced to a negligible quantity at the radio receiver. Attacking the noise at its source is not always practical; firstly, the offending machine may be the property of a neighbor not disposed toward co-operation or, secondly, it may be difficult to trace. Moreover, it may prove expensive to treat all the electrical equipment in one's own home. Under ordinary circumstances, it is more practical to quench the noise of the arch offenders, such as oil burners and electric pumps, and disregard the small fry, such as sewing machines and vacuum cleaners.

In order to correct noise difficulties, it is necessary to have some understanding of the character of the interference. Natural static produces crackling, rustling, crashing, or grinding sounds, and is sporadic. Man-made interference more often than not has a sound characteristic of the machine producing it. Therefore, it is seldom sporadic and has some definite rhythmic tempo, and in instances where it is produced by some form of electric motor, may well have a decided musical pitch. As examples: A vacuum cleaner produces a sound in the radio receiver quite similar to the mechanical sound of the cleaner; a sewing machine produces a high-pitched and non-too-steady whirr; a dial telephone reproduces a series of equally-spaced clicks, the number of them corresponding to the digit dialed; the ignition system of an automobile is somewhat similar in sound to that of a dial phone except that the clicks are continuous and vary in their number per second with a variation in the speed of the motor. Moreover, the amplitude of the sound first increases and then diminishes as the car passes by.



Courtesy Aerovox Corp.

Figure 1: **Radio noise filter**

The noise from any stationary electrical device may reach the radio receiver by one or both of two paths — either directly through the electric light wires, or by radiation through space, in which case the noise is collected by the radio antenna in the same way that the signals from a broadcast station are collected. There is the possibility, therefore, that the radio receiver will have to be protected against noise from two directions. If the receiver is of modern construction, more than likely the power-plug end is protected by a static screen against any noise that would ordinarily reach the set through the electric light wires. Receivers of earlier design may require a noise filter. One such device is illustrated in Figure 1. It is attached directly to the wall outlet and has a receptacle of its own for accommodating the power plug of the radio receiver. Oddly enough, the same sort of device, but with

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

a slightly different mechanical form, is used for the purpose of eliminating noise at its source. These devices are so constructed that they may be easily attached to vacuum cleaners and other household electrical equipment. Either type may be purchased from any radio dealer, or installed by a radio serviceman.

The task of eliminating man-made noise produced by oil burners, electric pumps,

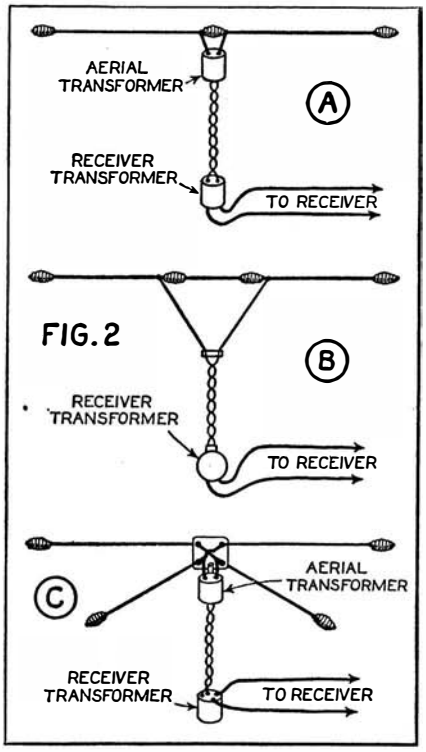


Figure 2: **Noise reducing aerials**

and other similar types of power machinery, should be left to a competent radio technician or an engineer from the local electric light company. These men have special equipment for tracing noise and can readily judge the size and complexity of the filter required on power machinery.

Stopping noise at its source is the most effective means of obtaining radio reception free of interference. Nevertheless, remarkable relief may be obtained by the use of a noise-reducing antenna system. This type of antenna is particularly effective when used in conjunction with a short-wave or an all-wave receiver. As a matter of fact, it is folly to expect satisfactory results from these receivers with an ordinary aerial.

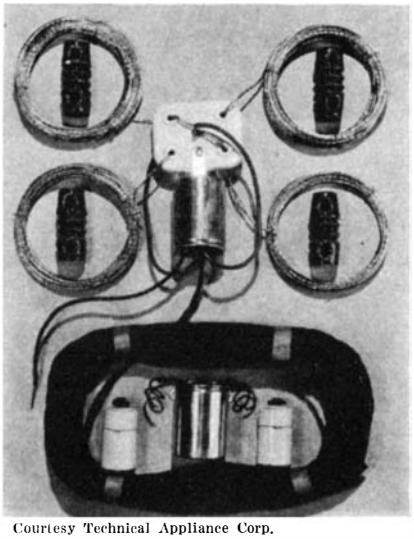
There are two basic types of noise-reducing antenna systems; one for use with a standard broadcast receiver and the other for use with a short-wave or all-wave receiver. The two types are not interchangeable, although the all-wave type may be used with a standard broadcast-band receiver since it is designed to operate effectively in all bands. It is just as well to use this type, for in that event, a perfect antenna system is available for an all-wave receiver when one is purchased.

There are as many all-wave, noise-reducing antenna systems as there are makes of radio receivers. Basically, they are all alike, and one make should function as well as another, provided it is the product of a reliable manufacturer.

The mechanical features of the various types are shown in Figure 2. The aerial shown at A is known as a "doublet" and consists of two horizontal wires of equal length insulated from each other at the center. Here there are attached two lead-in wires twisted together. At each end of the lead-in wires are connected "transformers." The upper or aerial transformer matches the electrical characteristics of the aerial to that of the lead-in; the lower or receiver transformer matches the electrical characteristics of the lead-in to those of the radio receiver input.

At B in Figure 2 is shown a similar type of antenna, but minus the aerial transformer. Matching in this case is obtained by fanning out the upper ends of the two lead-in wires. This type is equally as good as that shown at A. The only difference lies in the manner of obtaining what is known as the "impedance match."

At C in Figure 2 is shown a "double-doublet" antenna system. This is the most advanced type of all-wave, noise-reducing aerial, and is the most desirable form to use. The mechanical shape is not always exactly as shown in the illustration, but, in any case, there are *two* sets of wires rather than one set. The wires of the additional set are of equal length, but shorter than the horizontal set. The longer wires are effective at the longer wavelengths and the shorter wires at the shorter wavelengths. The dimensions of both sets of wires are such that almost equal response is obtained at all the wavelengths covered by the average all-wave receiver. It should be mentioned here that the type of antenna system shown at B in Figure 2 is



Courtesy Technical Appliance Corp.

Figure 3: **"Double-doublet" kit**

also of the "double-doublet" type. The fanned-out lead-in wires serve as the second and smaller doublet.

A typical "double-doublet" antenna kit is shown in Figure 3. The uppermost coils of wire are the long, horizontal doublets; the lower coils are the shorter doublets which are usually erected at an angle with the horizontal. At the center of the coils of wire is shown the dividing insulator and, attached to it, the aerial transformer. The large coil of wire at the bottom of the illustration is the twisted pair lead-in. In the center of this coil is shown the receiver transformer.

Any of these all-wave, noise-reducing antenna systems may be installed from directions obtained with the kits. Here

again, however, it is best to have the installation made by a competent radio technician. There are a number of technical factors which must be taken into consideration. The mere erection of such an aerial system in what may appear the most suitable space is no guarantee that the aerial will function properly. But, if you wish to handle the installation yourself, here are a few pointers:

Normally, man-made interference hugs the ground. Therefore, the higher the aerial, the less will be the noise pickup.

In the case of apartment buildings, and other structures having steel beams and a large amount of metal piping, the "ground" is the roof of the building. Therefore, erect the aerial at least 20 feet above the roof or—if possible—string the aerial from the edge of the roof to a nearby tree, pole, or the roof of another house.

Do not erect the aerial near any metal structures. Metal roofs, metal pipes, steel beams, light and telephone wires, and so on, will pick up noise from electrical machinery and *re-radiate* it. Thus, if the aerial wire is near any such metal object, it may pick up noise originating in the cellar of the building or in the house next door.

Do not permit the aerial wires to run parallel to electric light or power lines. Place the aerial at right angles to such lines, or as near a right angle as possible.

Do not fasten one end of the aerial to the top of an elevator shaft. These shafts are a prolific source of interference. If necessary, add rope to the end insulator so that the aerial wire itself is at least 20 feet from the shaft.

Do not worry about the lead-in wire. This may be run directly through a noise area. Any noise picked up by the lead-in is balanced out before it reaches the radio receiver.

Doublet and double-doublet antenna systems have slight directional characteristics. They receive best from directions at right angles to the horizontal stretch. Therefore, if the ends of the wire point north and south, best reception will be obtained from the east and west. Likewise, if the ends point toward noise sources, the interference will be minimized.

CURRENT BULLETIN BRIEFS

A GUIDE TO BETTER ALL-WAVE RECEPTION includes descriptions of the latest forms of double-doublet and single-doublet all-wave noiseless antenna systems. Other helps to the all-wave reception fan are also described. *Write for Bulletin 835A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WORLD SHORT-WAVE RADIOPHONE TRANSMITTERS, compiled from official and unofficial listings by Lawrence D. Batson. The preparation of a comprehensive list of short-wave transmitters of the world is a large undertaking, complicated by the fact that stations are constantly being constructed and rebuilt. This listing, however, is one of the most complete available and is to be recommended to all short-wave enthusiasts. It includes several valuable charts, a world time map, and lists stations both geographically and by wavelength. Contains other pertinent information. *Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.—25 cents (coin).*

S. A. E. STANDARDIZATION ACTIVITIES: A REPORT TO THE PRESIDENT AND COUNCIL, by C. W. Spicer. An important work for industry is being done by the Standards Committee of the Society of Automotive Engineers. The present pamphlet outlines the general policy and procedure of the Standards Committee and contains an index giving references to specific recommendations for standard practices. *Society of Automotive Engineers, Inc., 29 West 39th Street, New York City.—Gratis.*

FROM THE ROUGE TO THE ROAD is a remarkable little booklet, thoroughly illustrated with unusual photographs, which tells a running story of the huge multi-angle industry which has been built up around the production of motor cars. The booklet is printed in two colors and will be of interest to anyone who drives an automobile. *Write for Bulletin 835B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

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PER CAPITA COSTS IN CITY SCHOOLS, 1933-34, Pamphlet No. 61, by Lula Mae Comstock. This publication is the result of a carefully conducted survey of various groups of city schools. It includes a tabulation of the cities surveyed, listing population, daily current expense, yearly current expense, and other pertinent data. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

A NEW CROCODILE FROM THE PHILIPPINE ISLANDS, by Karl P. Schmidt, is a four-page pamphlet that is Volume XX, No. 8 of a zoological series. The leaflet describes a salt-water crocodile, *Crocodylus porosus*, which is found in most sections of the East Indies. Illustrated with two drawings showing palatal views of skulls of crocodiles. *Field Museum of Natural History, Chicago, Illinois.—10 cents.*

Books SELECTED BY THE EDITORS

THE SEARCH FOR TRUTH

By Eric Temple Bell

WHAT is truth? What is straight, sane thinking? Both are rarely attained, most of our thinking being of the wishful kind—unconsciously we believe what we wish were true. This book centers around the rules of thinking employed in man's search for truth—rules which underlie all scientific theories. A difficulty in the way of radical advances in thinking is our inability, the author says, to throw off traditional patterns of reasoning which we have acquired through years of hard work at school. But this book is no dry discussion about logic; it is bright, witty, often ironical and sarcastic, and has been received with amused approval by many scientists. The author is a well-known mathematician and his book shows the mathematical (logical) type of mind at work, but it is not in the least mathematical. He analyzes scientific theories, picks on half-baked thinking and especially on mystics. (If you are a mystic this book will spoil your digestion, but if you are a realist it will cure dyspepsia.) He has "a trenchant style, a caustic pen and a rich sense of humor."—R. W. Porter. He places sharp tacks in the seats of the mighty of the scientific world, respects no sacred cows, and reveals plentiful cat-holes, even in Euclid's and Aristotle's "watertight" logic, likewise some modern mystics', including Eddington's and Jeans'. A few topics: Toward Cloudcoocooland; Monkeying with Time; Science and Religiosity; False Gods; The Fourth Dimension; The Priesthood of Science. All persons interested in scientific theories should read this outstanding work.—$2.65 postpaid.—*A. G. I.*

A HISTORY OF THE GREAT WAR

By C. R. M. F. Cruttwell

A LARGE part of the books about the World War have been partisan—if not pro-Ally or pro-German, then at least pro-some-statesman-or-other, or pro some general, or warped in some single direction. But no book about the War has received so much praise on one score—its objectivity—from reviewers and critics as this one, written by an Englishman. Without heat or spleen he dispassionately points out both the faults and merits of either side, yet his account makes fascinating reading, like a narrative—which it mainly is. It leans rather more toward the technical military side—in other words it is not superficial—but any non-military reader would find it easy to follow.—$5.70 postpaid.—*A. G. I.*

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WHY THE WEATHER?

By Charles F. Brooks, Professor of Meteorology, Harvard

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MODERN GAS AND ELECTRIC REFRIGERATION

By A. D. Althouse, B.S., and Carl H. Turnquist

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THE FUNDAMENTALS OF RADIO

By R. R. Ramsey, Ph. D., Professor of Physics, Indiana University

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By Erwin Schrödinger

THE notable Austrian physicist who developed de Broglie's electron wave theory into a famous theory of wave mechanics, and possibly replaced the law of cause and effect with a statistical law, is the author of this book. The attempt by Schrödinger and others to smash the law of causality has provided a loophole for the mystics to escape from a strict cause and effect world, yet retain their scientific outlook, also to attempt a reconciliation of religion with science. Indeed, the ranks of science have provided some of the same mystics, notably Eddington and Jeans. All this leads away from realism, for the last building stones of the universe are thus reduced—so this book says—to "a spiritual throb" and are nothing but pure thought.

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By S. O. Rawling, D. Sc., F.R.P.S.

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