PRIZE PHOTOGRAPHS: Contest Awards Announced In This Issue

SCIENTIFIC AMERICAN

September · 1936

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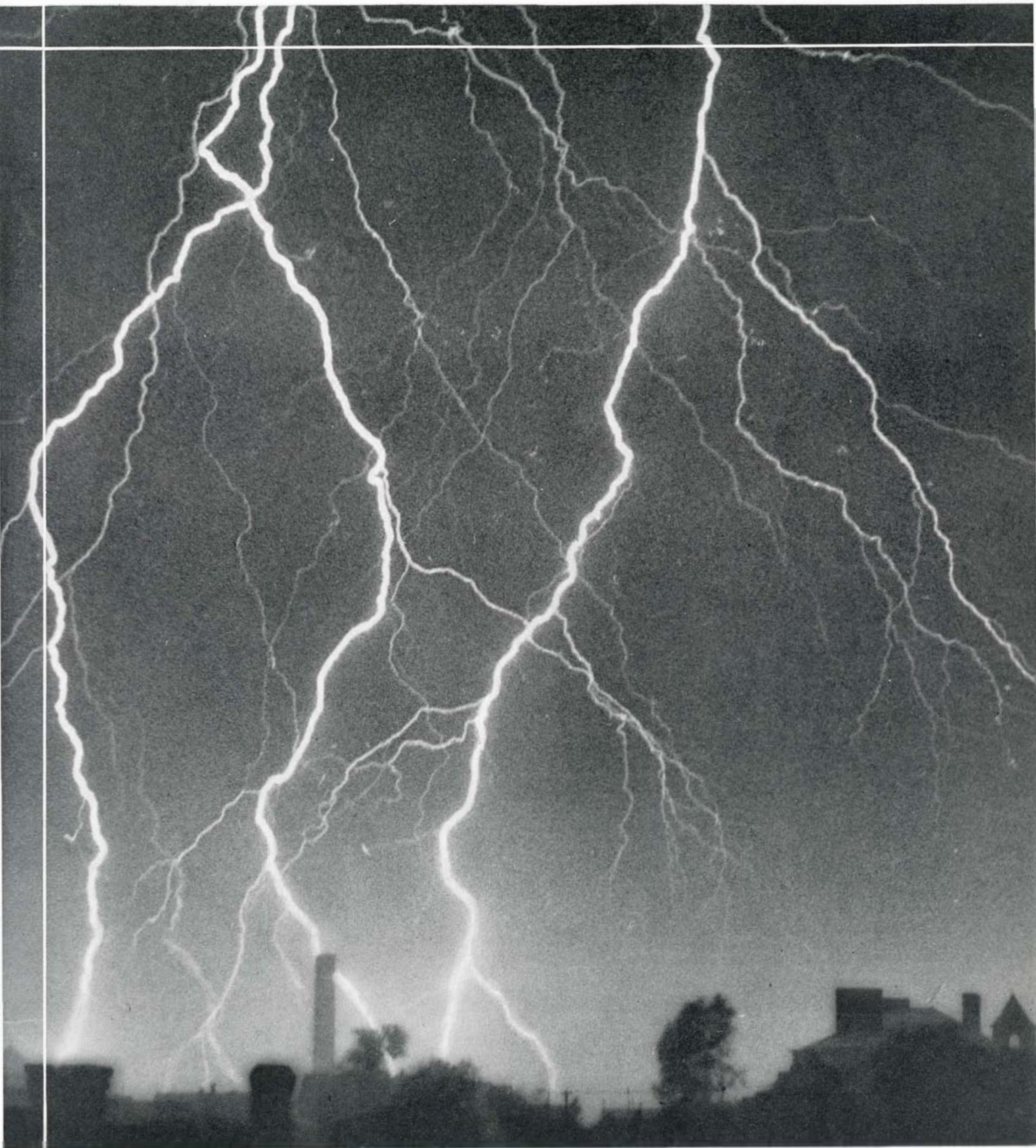

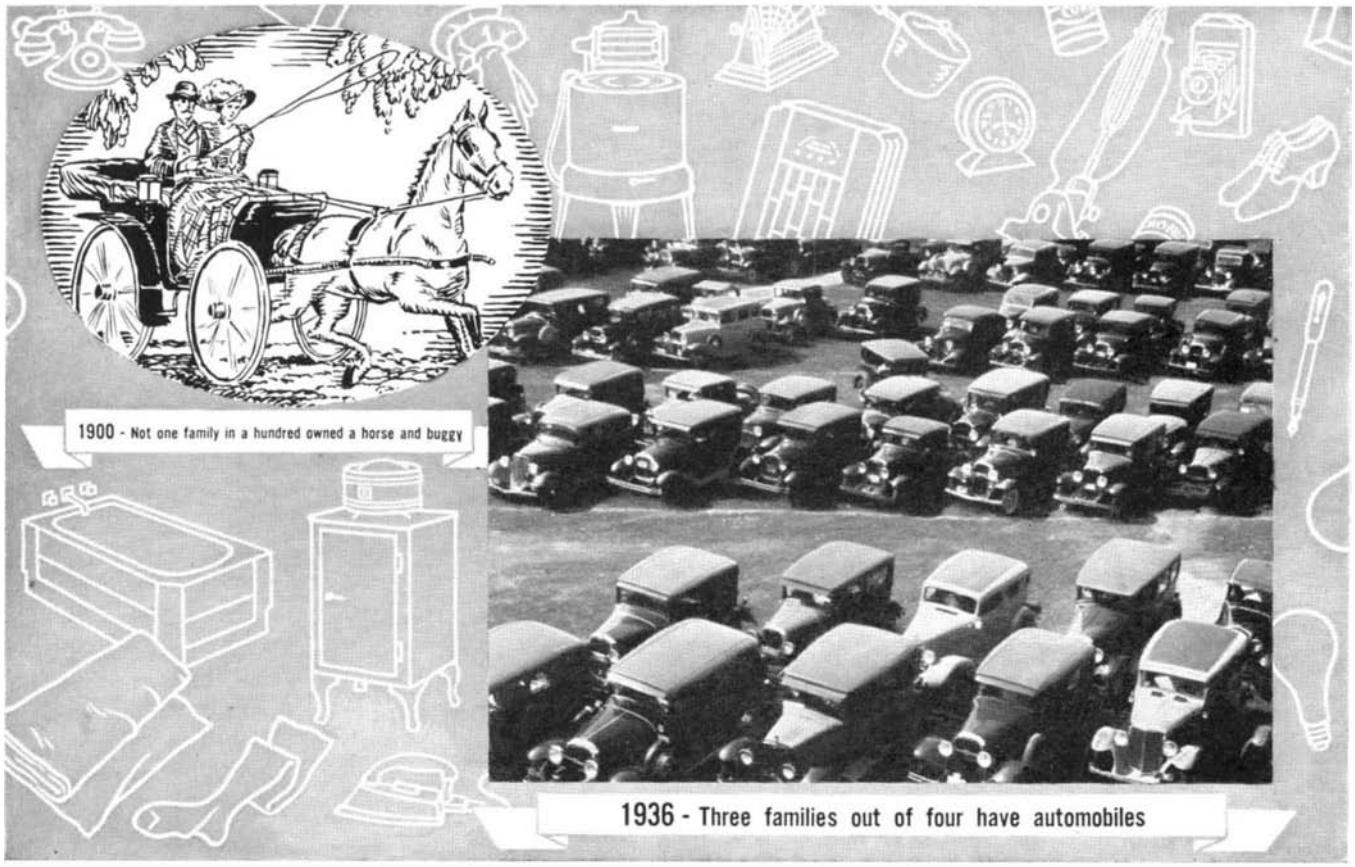

More Goods for More People

IN 1900, not one family in a hundred owned a horse and buggy; today, three out of four have cars. One family in thirteen had a telephone; now, one family in two. In 1900, modern plumbing and central heating were luxuries—less than 500,000 homes had electricity—radio and electric refrigeration were unknown. Today, 21 million homes are wired; 7 million families own electric refrigerators; 22 million have radio receivers.

In 1921, a MAZDA lamp cost 45 cents; it now costs 15 cents. You receive 80 per cent more light for your dollar because of greatly increased lamp efficiency and a lower average electric rate for the home. General Electric research developed these lower-cost lamps, helped devise more economical ways of generating and distributing electricity—to bring better light to more people at less cost.

Today, electricity is vital to industry, for the manufacture of most goods—from bathtubs to textiles, foods to furnaces—to meet the increasing needs and the purses of millions. In this progress, G-E research and engineering have ever been in the forefront. And still, in the Research Laboratory, in Schenectady, General Electric scientists continue the search for new knowledge—from which come savings, new industries, increased employment, more goods for more people.

G-E research has saved the public from ten to one hundred dollars for every dollar it has earned for General Electric

GENERAL ELECTRIC

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

CONTENTS • SEPTEMBER • 1936

THIS month's cover is a striking example of amateur photography under adverse conditions. There have been hundreds of negatives exposed in an attempt to capture the beauty of lightning; but this one, by J. M. Stofan, winner of the Third Prize in our Photographic Contest announced on page 136, is certainly the finest we have ever seen.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of September, 1886)

SODA LOCOMOTIVES—"At the Baldwin Locomotive Works there are in course of construction four locomotives, which are designed to be run by soda, which takes the place of fire under the boiler. . . . The boiler is of copper, 84½ in. in diameter and 15 ft. long, having tubes running through it as in steam boilers. Inside the boiler will be placed five tons of soda, which, upon being dampened by a jet of steam, produces an intense heat."

RAMESES II.—"One of the most remarkable and interesting events pertaining to Egyptology was the recent unrolling of the mummy of the ancient monarch, Rameses II., under whose reign the flight of the Jews led by Moses occurred. . . . The legs and thighs are fleshless; the feet are long, slender, somewhat flat soled, and dyed, like the hands, with henna. The corpse is that of an old man, but of a vigorous and robust old man. We know, indeed, that Rameses II. reigned for 67 years, and that he must have been nearly 100 years old when he died."

INCLINED RAILWAY—"Messrs. D. H. & G. Haggie, Wearmouth Rope Works, Sunderland, are manufacturing two long ropes for a tramway which is in course of construction at Hong Kong, from the town up to 'The Peak.' . . . The incline where the ropes have to work is 4,800 feet long, laid with 35 lb. steel rails on steel sleepers, the line being partly single and partly double; the gradients varying between 1 in 2 and 1 in 10, following closely the natural contour of the ground. The total height the carriages have to be raised is 1,300 feet. The ropes run on separate sets of friction rollers, the one a working rope and the other a safety rope."

MEXICAN RAILROADS—"The expenses of railroading in this hot climate are great. Wooden ties have but a short life, cracking in the dry season, and rotting during the rainy months; bridge timbers and piles also wear out rapidly. Freight cars must be painted frequently to prevent drying and cracking, and even the substantial Pullman cars shrivel under this exposure."

IRON SHIPS—"The opening of the new line of mail steamers by the North German Lloyds, of Berlin, has attracted much attention. . . . The first of the three larger vessels . . . was launched with much ceremony on July 10, and was christened *Preussen*. . . . Length at the water line, about 388 ft.; beam, 44 ft.; and depth from keel to the side of the upper deck, about 33 ft.; cubic contents, 4,000 tons; draught, 20 ft.; and speed 14 knots, or 16 miles an hour. The engine is a three-cylinder expansion engine of 3,500 horse power. . . . The hull of the vessel is made of Martin steel."

UNDERGROUND CABLES—"At the recent convention of the National Electric Light Association, no little time was occupied in a discussion of the expediency of burying the wires. The sense of the convention was decidedly opposed to the project at the present time. Continued experiment and study, while they have done much to remove obstacles, have not yet resulted in finding a solution."

ELECTRIC BOAT—"The *Spark*, which has recently been launched at the Royal Gunpowder Factory, Waltham Abbey, is an electric boat about 25 ft. long and 5 ft. beam. It was designed by the superintendent, Col. W. H. Noble, R. A., mainly as a means of lighting some of the powder houses in the factory, which are at a considerable distance from the dynamos used for general electric lighting purposes."

SALT MOUNTAIN—"Palestine possesses a remarkable salt mountain situated at the south end of the Dead Sea. The length of this ridge is six miles, with an average width of three-quarters of a mile, and the height is not far from 600 feet. There are places where the overlying earthy deposits are many feet in thickness, but the mass of the mountain is composed of solid rock salt, some of which is as clear as crystal."

UMBRELLAS—"Umbrellas, when wet, should be placed with the handle downward to drain. The moisture thus concentrates at the tips and falls from the edge, instead of gathering into the folds of the umbrella, and thus dries quicker and the fabric is better preserved."

RACING YACHTS—"The International Queen's Cup, won thirty-five years ago by the schooner yacht *America*, has again, after so long a sojourn in this country, become a subject of contest. The *Galatea*, an English keel boat, having had her challenge of 1885 extended so as to allow of her racing under it this year, has met the American centerboard yacht *Mayflower* for a series of inside and outside course races to decide the future holding of the trophy. . . . In the *Galatea's* model will be recognized the convex lines of the conventional cutter. Her sheer is quite pronounced, an end elevation of the hull showing a sharp rise in the bow that is missing in the *Mayflower*."

BLONDES—"The use of peroxide of hydrogen, commonly called oxygenated water, is extending for bleaching purposes. It will be remembered that some years ago the fair sex rendered this product somewhat popular by partially bleaching their hair with it, but the product has now emerged from this fashionable employment into the more common and perhaps more useful application for industrial purposes, being now employed for the bleaching of feathers and also of tussah silks, for which it is admirably adapted."

TREE GRAVES—"Mr. John J. Campbell, of Rockville, Ind., has succeeded in the very original work of tracing the course of a cyclone which must have passed over that portion of the country more than 300 years ago. The course of the storm was traced by means of what he calls 'tree graves'—that is, the little mounds which a tree makes when it is uprooted and allowed to decay upon the spot upon which it fell. The earth thus turned up by the roots, with the decayed root itself, will form quite a large mound."

Personalities in Science

FRANK RATTRAY LILLIE

AT its most recent meeting, held in its own splendid headquarters near the Lincoln Memorial in Washington, the National Academy of Sciences, premier body of American men of science, chose as its president for the next four years Dr. Frank R. Lillie of the University of Chicago. The National Academy of Sciences—a name which many a newspaper proofreader with the best of intentions has changed to an incorrect form, The National Academy of Science—is the "Royal Society" of American science, its members being chosen with great care by the Academy members themselves because of definite eminence and accomplishments in some one of the several sciences. In turn, only pre-eminent scientific men have been chosen president of this carefully selected body of less than 300 members: Joseph Henry the great physicist, Agassiz the naturalist and geologist, Remsen the chemist, Welch the pathologist, Walcott the paleontologist, Michelson the physicist, Morgan the geneticist, Campbell the astronomer, the last-named of whom Dr. Lillie succeeds.

Dr. Lillie was born in Toronto and educated at the University of Toronto, Clark University, and the University of Chicago. At the University of Chicago he is professor of embryology and dean of the division of biology. He is also managing editor of the *Biological Bulletin* and editor of the *Journal of Experimental Zoology*. He specializes in such research as the early history and fertilization of the ovum, the physiology of development, heredity, and the biology of sex.

Recent comment on Dr. Lillie's career, written by Dr. Frank Thone, biological staff member of *Science Service*, throws it into clear relief:

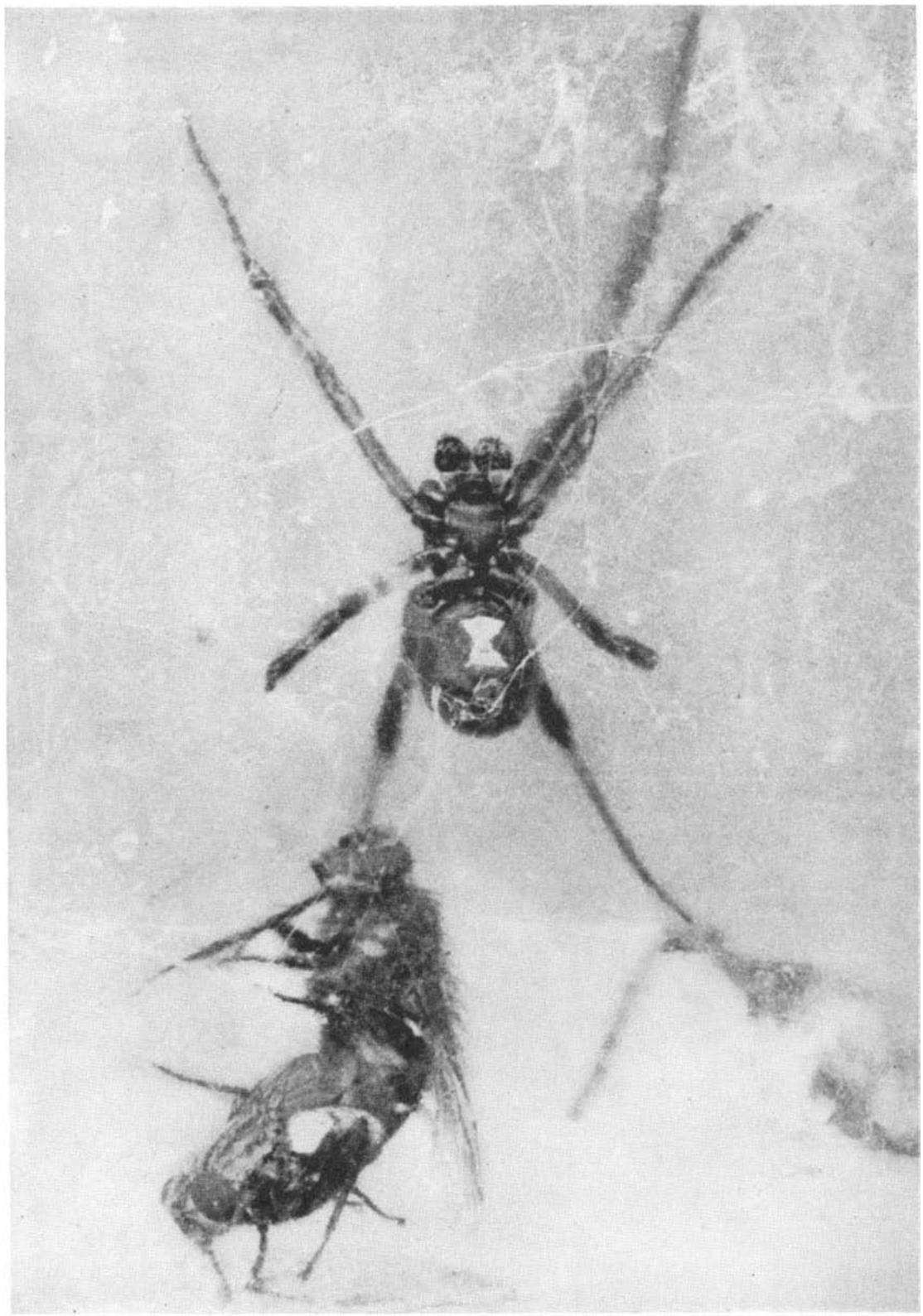
"Modern educational and research institutions are run by professors. Professors are often referred to as impractical dreamers, incapable of handling anything with real money involved. But size up a marine biological laboratory, or even a single teaching and research department in a first-class American university, and you find yourself face to face with the equivalent of a million-dollar corporation, with executive responsibilities as exacting and administrative problems even more complex. A man who can run one of those things need not take a back seat to any so-called captain of industry.

"Such a captain of science is Dr. Frank Rattray Lillie, who holds down two jobs either of which might easily floor many a man who patronizes professors. He is dean of the division of biological sciences at the University of Chicago, which also involves being chairman of the department of zoology and professor of embryology; he has held the latter chair since 1907. He is also president of the Marine Biological Laboratory at Woods Hole, Massachusetts, and of the associated organization, the Woods Hole Oceanographic Institution.

"But being executive head of these knowledge-factories has not stopped him from working at his trade. He has been able, all these years, to go out into the shop and do a lot of straight, solid creditable bench work. His researches in the biology of reproduction have brought him especial fame.

"Added to all this, he has been able to carry on scientific publication notable in its extent. Papers and books based on his own research almost beyond counting, and editorship of two important biological journals are the records of his activity in this field.

"His work has received its due recognition, in memberships and offices in the leading American and foreign science societies, notably The National Academy of Sciences."



THE BLACK WIDOW'S MATE IS INSIGNIFICANT

THE Black Widow spider, after the male has served his purpose, is soon a widow in truth, *his* life being relatively short. Here he is shown in comparison with an ordinary house fly. But the female spreads over as much as two inches, with a jet black body three- to five-eighths inch long. The characteristic hour glass pattern of both sexes shows plainly on the abdomen. These spiders are not new, the Indians having known them and called them "pokomoo," but they are clearly increasing in numbers at present.

A large female Black Widow shown slightly over double size. The hind legs carry a kind of "comb" with which silk in almost liquid state is thrown as a lasso on the victims. Two of the Widow's eight eyes show silvery in the photograph. In the June number of *The Quarterly Review of Biology* there was a detailed, 37-page article on the Black Widow, by D'Amour, Becker and Van Riper of the University of Denver. Squibb and Sons are developing serum

CALLING ON THE WIDOW

Our Most Poisonous Spider . . . Incredible Speed . . . Throws Her Lasso . . . The Death Blow . . . But the Male Doesn't Amount to Much . . . Antitoxic Serums

By NELSON WM. BAKER
Santa Barbara, California

THE beam from my flashlamp cut into a dark corner of the woodshed, exposing an unlovely network of spider web, crossed and criss-crossed from splinter to splinter, and converging around the miniature cavern of a knot hole. So this was the dreaded lady's den—the home of our most poisonous spider, the Black Widow, scientifically speaking, *Latrodectus mactans.* I had caught a brief glimpse of her shiny-black, button-like body disappearing into the knot hole that afternoon when I went for wood, and now I had come to make a formal call.

Her ladyship was nowhere in sight, but, as I had every reason to believe that she was at home, I reached forward and "knocked" gently by lightly vibrating a strand of her web with my finger. After repeating this several times, I was rewarded by the appearance of two spindly, black legs protruding from the knot hole. As the web-shaking continued, the Widow crept farther and farther from her lair, until soon she was in full view, her black abdomen reflecting, mirror-like, the light from my flashlamp.

She descended to my very finger tip, swung sharply about and, with her long, hind legs, lashed out thick, glistening shreds of webbing, which clung to my finger like glue. Evidently feeling certain that she had ensnared whatever luckless creature had wandered into her net, she turned abruptly to nip the victim and stop its struggles with her powerful potion. At this point I jerked my finger away, tearing both the web and its occupant away with it. Soon thereafter I carried the captured spider to my desk in a glass jar.

THIS was a very different home from the one she had been accustomed to. She crawled for a while around the circular glass wall, feeling here and there with her delicate palpae, and trying to find a place to hide away from the glare. Her silvery sparks of eyes caught the light occasionally, and made me feel that she was staring at me—although I knew she could barely see at all. Soon she began to attach little web-anchors about the bottom of the jar, drawing a silken strand from one spot to another until she had spun a soft carpet that protected her body from the cold glass. Then, after many attempts, she anchored a cable up on the side of the jar, and from then on she busied herself manufacturing a crude web that extended halfway to the top of her prison. This new web was fresh and shining, although of the same crazy, criss-cross design as the coarse, dirty web she had swung on in the woodshed. Many times, as she was spinning, I got a good view of her characteristic marking—a crimson "hour-glass" on the under part of the abdomen. (Opposite page.)

Experimenting, I placed a book beside the jar, in such a position as to shut out most of the light. Apparently able to see better, she cleaned and moistened her feet by putting each one to her mouth and nibbling at it, then went over her spinning work carefully, finding and mending all flaws. Repairing done, she began endless attempts to extend her web to the top of the jar.

In the morning I found the spider in the lid of the jar, evidently waiting for breakfast. I captured a lively Jerusalem cricket and dropped it into her web. His powerful, armored legs tore the strands, almost pulling the Widow from her perch. She seemed little excited, however, and just moved her long, fore legs sharply. The cricket, in his wild dashes around the jar, vibrated the web more and more, until the Widow suddenly began to move a little

in his direction. When the bulky insect caught a leg in a mass of tangled webbing and jerked mightily, the spider rushed to the scene of disturbance, but arrived too late, for the cricket had escaped. It seemed that she could not locate the cricket by sight, but only by the "feel" of her web, for she could easily have intercepted the insect many times had she been able to see it. Each time she arrived at a spot where the cricket had been momentarily caught, she spun about and lashed out webbing frantically, endeavoring to secure the intruder. However sluggish *Latrodectus* is reputed to be, she can move with incredible speed when aroused—short, jerky rushes, which must be very confusing to pursued insects.

During one of these rushes the spider turned and, purely by accident, I believe, threw strands of her viscous web over the cricket's fore legs. Struggle as he would, he could not break that gummy mass of strong cables, and each second of delay on his part was proving his undoing, for the spider was rapidly entwining him.

When she had finished her job, the cricket could barely move. She rested a moment before the "death blow," which was merely a nip or two from her diminutive, needle-sharp fangs. A few minutes after these "injections" the cricket ceased to move, except for what appeared to be convulsive gasps for breath.

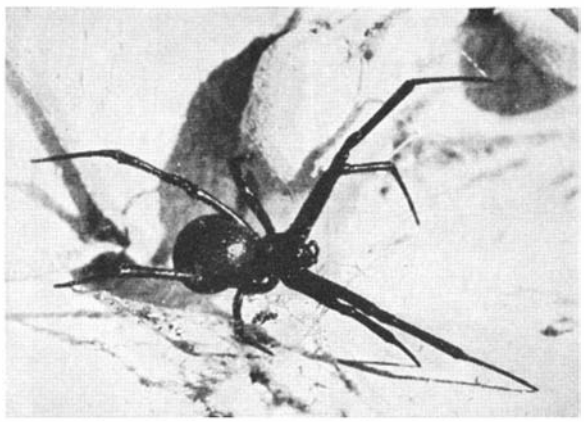
If I dropped an insect into the jar at night when the light was very dim, she would go at once to the victim and deliberately wrap it with webbing. If the prey did not become entangled, and walked about the bottom of the jar, the spider would follow with short, jerky movements until she was within reach, when she would whirl about and, with deadly accuracy, throw her lasso.

ON one occasion I dropped a dozen large flies into the jar at once. The result was more or less amusing, as far as the spider was concerned. She rushed from one fly to another, spinning about and hurling her silken lariat in their general direction. No sooner had she caught one, and was preparing to give it her attention, than another would cause lively commotion elsewhere. She couldn't resist these distractions, and would hurry from one to another, apparently consumed by the greatest anxiety lest the insect she had just left should escape. Before long she had captured and nipped all the buzzing pests. I tried to check as nearly as possible the time, from the moment each fly was bitten until it ceased to move, and found it to vary from 40 seconds to two minutes—a fast worker.

The tiny, white poison gland that lies along each side of the Black Widow's combined head and thorax secretes an extremely powerful, neurotoxic poison, which is considered more potent, drop for drop, than the venom of any of the world's most deadly reptiles. If you take into account the fact that the venom of the great king cobra of India is said to have killed elephants, it is small wonder, then, that the bite of the Black Widow has violent effects on man. Should this diminutive spider inject the same quantity of poison as the cobra it would doubtless mean almost instant death to the victim.

Black Widow venom seems rapidly to paralyze the rear legs and abdomen of bitten insects. Innumerable small moths that I pricked with a very sharp needle dipped in the solution from crushed Black Widow poison-sacs and then released, flew about for a few moments, dropped to the floor, and ran about dragging their rearmost legs. Naturally, my crude apparatus was not nearly so effective as the spider's, and the amount of venom introduced much less, but in nearly all instances the moths died in varying lengths of time. Rats and mice die in convulsions shortly after being bitten, showing marked symptoms of paralysis of the abdomen, lower extremities, and respiratory organs.

The effects of the poison on man seem to vary slightly. From the persons I have talked with, who have been victims of Black Widow bite, I have received two different stories as to the "feel" of the bite itself. Some say they felt no immediate pain at the time; others seem to shudder at the recollection of the electrifying sharpness of the pain they experienced when bitten. There is no doubt, however, as to the seriousness of the symptoms, for all were in deadly earnest when they told of the various stages of suffering that followed the bite. These may be summed up briefly as: muscle pain, general weakness, numbness, and profuse perspiration; high blood pressure, slow, weak pulse, paralysis of the lower extremities, and rapid, labored breathing. The protein poison of *Latrodectus* seems quickly to attack the peripheral nerves and nerve ends, and to travel through them to the lymphatic glands and thence over the entire nervous system. The effects of the venom on the phrenic nerve sometimes cause almost complete paralysis of the respiratory organs, and if this persists, death is often the result.



A female Black Widow spider guarding her two egg sacs, which show above and to the right of her

A FISHERMAN, who was recently bitten by a spider while in fishing camp on Santa Cruz Island, ended up in a Santa Barbara hospital, where he was kept for five days, while efforts were made to check his pain and convulsions. One side of his body was completely paralyzed, and he had to gasp in order to get his breath. On talking with him after the ordeal, I learned that he had received the bite just as he was preparing to "bunk in" beside his camp-fire. The spider, which he afterward killed, bit him just below the knee, and he told me it felt as if some one had poured gasoline or alcohol on his leg. He said there was first a cold, then a burning sensation, which spread rapidly, causing him great pain in groin and abdomen within 15 or 20 minutes. The following two or three hours he thought were his last, but he managed to get some relief by applying heated stones to his abdomen and drinking hot, salt water. The rest of the party were finally able to get him to the boat and start for the mainland, where he was immediately rushed to a hospital. As I was leaving him after our talk, he added with great fervor, "—and, boy, I'd rather do anything than go through that again."

It has been only within the last year or two that scientists have really taken much interest in the Black Widow. Since 1921 the Los Angeles General Hospital has, however, made the most of its *Latrodectus* bite cases by requesting the convalescing patient to return in a week or so to give up some of his infected blood, from which the chemists extracted the solids and made an apparently effective antitoxic serum. For some time this was the only serum available, and but little of it was to be had, as Black Widow bite victims were few—at least those that had hospital treatment.

Lately, several new and more effective methods of fighting the ravages of this little, black spider's poison have been discovered. Dr. F. E. D'Amour, a Denver physiological chemist, has developed an anti-toxic serum from the blood of rats which have been immunized by repeated injections of minute doses of *Latrodectus* venom. As little as

two drops of this serum is said to counteract eight times as much poison. Other treatments successfully used are intravenous injections of magnesium sulfate, or calcium glucinate.

In the last few years climatic conditions in certain parts of the country have so favored the Black Widow that it has become a definite hazard. It is safe to say that, during the months of May, June, July, and August, anywhere from one to 20 of these spiders could be found around the garages and outbuildings of almost any dwelling in southern California—while I have captured as many as 25 about numerous houses, my own included. Throughout the entire South and Southwest, *Latrodectus* was found in teeming numbers. The spider breeds more prolifically in warmer climates, but this seems to be no criterion, as general reports indicate that it is more or less abundant in almost every state in the Union.

A BREEDING ground was discovered in San Diego in January, 1935, when workers, preparing a new parade ground with a grading machine, uncovered thousands of baby spiders, which had just been hatched from eggs. Navy recruits were called from the training station to go over the ground with blow torches and burn out every possible hiding place. The county agricultural department reported that the "nest" was the largest ever recorded. No doubt there are others throughout the section that will continue to send forth promising young Widows unless they are unearthed.

Since the female *Latrodectae* often spin their webs close together in some particularly favorable spot during the regular egg-laying seasons of April, May, June, and July, the proximity of the cocoons at the time of hatching probably accounts for these so-called "breeding-nests." When you consider that each female spider spins from one to seven cocoons in a season, and that each cocoon contains between 200 and 300 eggs, you can begin to imagine the incredible numbers of these arachnids hatched into the world in such a breeding section. Not all the little spiders reach the outside world, however, as the weaker are devoured inside the cocoon, and only the strongest remain to bite their way through the egg-sac. Soon after their chitin-covered bodies have become toughened by the outer atmosphere, the baby *Latrodectae* start spinning webbing which, when caught by the breezes, carries them aloft and distributes them over the countryside.

The egg laying process is very interesting, and is a sight seldom witnessed by human eyes. The female, swollen to large proportions by the fertilized and developed eggs, hangs in a perpendicular position, head and fore legs upward, and begins a peculiar, swaying motion by pulling the body forward with the legs. As this continues, the genital flap in the abdomen starts to open and close. When the muscular exertion is at the proper pitch, the tiny, butter-colored eggs are forced out in clusters, the last of which requires such effort that the spider's abdomen is greatly wrinkled and contracted, having shrunk to less than half its former size.

As soon as the mass of eggs is deposited in the web, the spider commences the long task of covering it with

An appropriate place for a Black Widow home. In fatal cases death will occur in from 18 to 36 hours

her viscous webbing. In order to do this, she takes a position before the eggs and carries the strands of wet webbing from her spinnerets under and over the cluster with her long rear legs, working around and around, until the sac is complete. When fresh, the cocoon is pure, silky white, but as it dries, the surface becomes tan or yellowish and is extremely tough. It has been said that the fluid from the crushed eggs is as poisonous as the venom of the adult spider.

The time required for the young spiders to develop and hatch seems to vary, according to my observation, with changes in atmospheric temperatures. If they are kept in a warm place, and a few drops of water are placed in the jar, the time of hatching is hastened. When the baby spiders finally make an appearance they are white, with two or three rows of black dots running down the back. The outline of the "hour-glass" is also visible, but for quite a while after they have started to grow this remains white, and when the body begins to darken, the hour-glass commences to take on its reddish hue.

The male *Lactrodectus* is not often encountered. He is a meager individual, easily recognized by the conspicuous bulbs on the ends of his palpae, as well as by the stripes on his sides and back. The hour-glass is generally present on the underside of the abdomen, but is a dirty white or yellowish color, instead of the bright crimson of the female. Mr. Black Widow gets short shrift from the "Mrs.," who pursues him with grim determination during the mating season, often only to devour the luckless fellow after her eggs are fertilized.

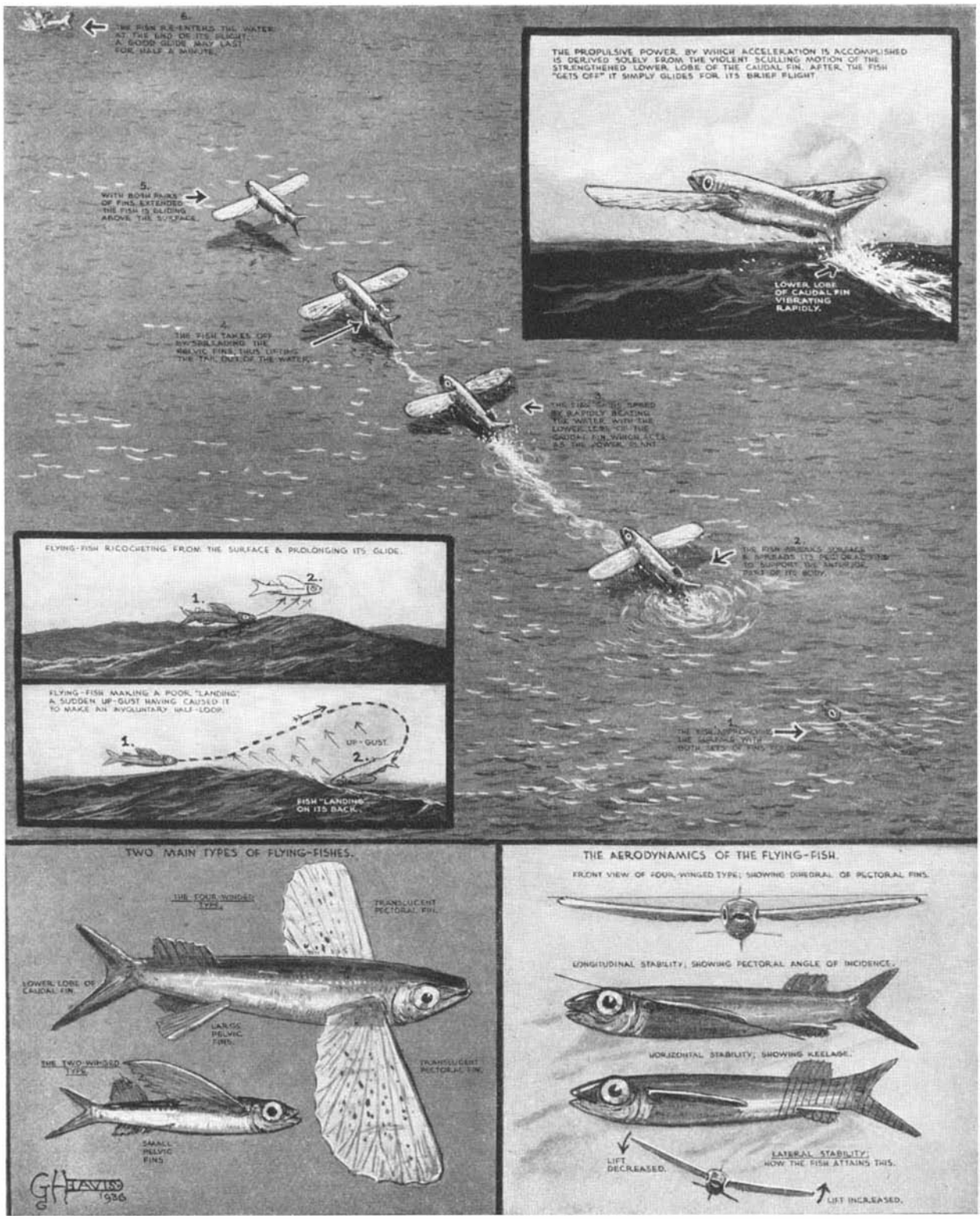
The Black Widow family, as well as other spider families, is often the prey of large hunting wasps and certain parasitic flies. The former enemies paralyze the spiders with the numbing poison from their stings and carry them off to be stored in their nests as food for the wasp larvae. The mud-dauber wasps, whose nests one often washes from the sides of the house or garage with the hose, are said to be particularly Black Widow minded, as far as their diet is concerned, but so far I have failed to find any spiders of this species in a good many mud-dauber nests I have examined.

THE University of California recently announced their discovery of two kinds of wasps that lay their eggs in the cocoons of the Black Widow. The larvae that hatch out are said to devour the baby spiders. If enough of these wasps could be raised and released in spider-infested areas, it would doubtless do much toward keeping the ever-increasing numbers of Black Widows under control.

As I glance up from my writing at the row of jars on my desk before me, I see a formidable array of *Latrodectae*. In one jar on the very end is a forlorn little male—"Mr. Black Widow." What a harem he has! He is minus a front leg—doubtless the result of the violent attentions he has received from a buxom Widow. My latest captive is contentedly dining on a huge, green fly, and perhaps trying to watch me with three or four of her silvery eyes as I write.

●

EDITOR'S NOTE: *As the author has just stated, some wasps, notably the blue mud dauber, attack the Black Widow spider, and it is believed that the field mouse and other small mammals also dispose of many, as do chickens with impunity. However, not too optimistic a dependence is to be placed upon expectations of this kind. Newspaper accounts without end have told us how this or that parasitic insect, bred to attack other insects, was soon to wipe them off the earth; by the time the extermination was supposed to have been accomplished, most of us have forgotten all about the matter. Nature has her own balances that usually prevent such ideal outcomes.*



NATURE'S SEAPLANES—THE FLYING FISH

JUST how flying fish conduct their flight is a matter of some question or at least some argument, many observers having reported slightly different opinions. In the Annual Report of the Smithsonian Institution, Professor Carl L. Hubbs, Curator of Fishes in the Museum of Zoology at the University of Michigan, gives his explanation and from this *The Illustrated London News* commissioned the artist, G. H. Davis, to make the drawings shown above, reproduced by courtesy.

"From very prolonged observation," *The Illustrated London News* notes, "Mr. Carl L. Hubbs states that the fish get up the necessary impetus to fly by a rapid sculling movement of the strengthened lower lobe of the caudal fin or tail. The lobe makes 50 to 70 complete double vibrations per second. When the fish are in the air the pectoral fins are not flapped' like the wings of a bird, but are simply used as supporting surfaces, like the planes of an aircraft. The fish, when clear of the water, glides, its flights being of quite short duration." When beneath the surface the wings are folded.

OUR POINT OF VIEW

Little Science

EVER with us are those who criticize science for its hypotheses and theories, for its abstractions and its apparently non-utilitarian findings, who characterize men of science as cloistered and smug. Some there are who say that science is too far ahead of ordinary mortals and so should declare a holiday. The little things in science, the abstractions, the accidents are scoffed at as of no earthly use. Yet an accumulation of those little things often makes one big, important one; indeed, one abstract finding of a dreamy-eyed scientist, or one accident may later be of such enormous value to civilization as to justify, almost alone, the entire scientific scheme.

Forty years ago a Washington biologist made a chance discovery. Dr. Paul Bartsch, now curator of mollusks of the Smithsonian Institution, was then collecting every variety of snails around the District of Columbia. He was puzzled to find that those from the Potomac differed considerably from those in brooks running into the river. There was no physical barrier to keep the species apart, so he looked further for the reason and found it. The Potomac is slightly alkaline; tributary brooks slightly acid. Some kinds of snails live only in an alkaline environment; others only in an acid one. This was an interesting abstract finding but of "no earthly use" so Dr. Bartsch simply recorded it in his notebook.

The scene changes: 200,000,000 people in China, Japan, Formosa, the Philippines suffer from a strange malady, often fatal. Long study showed that this disease, schistosomiasis, was caused by a tiny worm, or blood fluke, which bored into the body and swam in the blood stream. Where it came from no one knew until Japanese investigators turned up another "little thing." They discovered that the larva of this blood fluke invariably lives in a certain kind of snail while undergoing metamorphosis into a form ready to attack people and certain animals. Bare-legged workers in rice paddies could hardly escape; few did. Cures afforded relief only until re-infection.

Now to the accumulation of abstractions was added the fact that the host for this blood fluke larva is an "acid" snail. Dr. Bartsch's "interesting observation" then showed how these snails could all be killed and, with them, the larvae of the scourge of the Orient. Acid waters were made alkaline by dumping quantities of crushed limestone along the water's edge!

Simple? Yes; every "little thing" in this entire chain! Yet if you ask any one of many millions of orientals who have suffered and seen thousands about them suffer—and many die—from this terrible disease, he'd probably do his equivalent of crossing himself and say: "Yes; simple as any miracle."

Sky Sailing

THE feeling, apparently rather widespread in some quarters, that American exponents of the art and science of gliding are amateurs, taking a back seat when foreign pilots perform, received a rather vigorous set-back at the recent glider meet at Elmira, New York. Among other notable flights at that congress was one that terminated at a point 146.6 miles from the start and that consumed five hours and forty minutes in the air. Another motorless ship reached an altitude of 6516 feet.

The study and engineering skill that have gone into the construction of these frail but sturdy ships, the aptitude for this type of navigation shown by the pilots, and the public interest aroused by the meet have culminated in a decision by the Soaring Society of America to make next year's meet international in character. It is reported that at least 10,000 dollars in cash prizes will be available by that time to induce foreign glider pilots to make the trip and compete with the Americans.

Gliding has long been a prominent part of aviation in Europe; many spectacular flights have been made and a large number of trained and experienced pilots are available. If enthusiasm counts for anything, the American pilots will make a creditable showing next year. The outcome of the meet will be watched with interest, from a sporting as well as a scientific point of view.

Patent Centennial

ON July 4, 1836—a fitting day—a "right" was granted by Act of Congress to American citizens. That Act set up a system which has since been enormously influential in the technical and industrial progress of the United States, for it inaugurated our present patent system, under which all rights to an invention are granted to the inventor. Patent No. 1 of the present series was issued July 13, 1836, to John Ruggles of Thomaston, Maine. Since then over 2,045,000 have been granted.

Retrospection, on this hundredth anniversary, must give us pause. Marvels of applied science, of ingenuity, and of accidental discovery have followed patent No. 1 through the Patent Office. When it was granted, electricity still was to be harnessed; the incandescent electric lamp was still far below the horizon; the phonograph, moving pictures, automobiles, radio, airplanes, and numerous other devices and machines on which great industries have been built were still in the offing. Indeed, many important inventions had not even been envisioned.

Patents were granted by the Colonies as early as 1641, while the first patent law of the Federal government was passed in 1790. At the time each patent was signed by the president, the secretary of state, and the attorney general, but the secretary of war also sat on the patent-granting committee. Control was so rigid in those days that in the first year only three patents were granted, and in three years only 57. Popular demand caused a revision to the other extreme. People then patented almost anything and everything new or old. Since this was so loose a system and afforded no real protection, the same John Ruggles mentioned above worked for and succeeded in having the present system established by law. Without precedent in history, the new law made a patent grant a prima facie standard of validity.

While American patent practice has been revised under the impulse of changing conditions, it is, basically, the same as our forefathers planned it 100 years ago. Under it the government secures the right of the inventor. In our system, he has an inherent *right* whereas in England, for example, the Crown grants a *privilege* for a sort of monopolistic concession.

In 100 years under our patent system, we have traveled far. Most people give it credit for our world leadership in industry for, despite its admitted defects, it has proved to be eminently practical. Revisions may be necessary—indeed, have recently been suggested by a Science Advisory Board committee—but when they come they must be based upon common sense and understanding. They will be predicated upon the need for adjustments to evolutionary changes; the country will countenance interference for no other reason.

Archeology From the Air

The Archeologist Standing on the Earth's Surface is "Too Close to the Trees to See the Woods" but Air Photography Reveals a New Crop of Discoveries

By STANLEY CASSON, M.A., F.S.A.
Author of "The Progress of Archeology"

As modern methods of excavation develop, much more about archeology is found out. Many sites such as Troy and Mycenæ, originally dug by the more rapid and less scrutinising methods of two generations ago, have had to be re-excavated in order to find facts which had either passed unnoticed or which can only be detected as a result of the increased knowledge of today. British excavations at Mycenæ shortly after the war, and the present extensive American campaign at Troy, are some contribution towards the correction of the errors of the earlier excavations and the discovery of evidence obviously missed or ignored by the first excavators.

Chief among the external aids which the modern archeologist has called to his assistance is air photography. At present its use is confined mainly to those countries where aviation is popular and where sufficient funds are forthcoming to subsidize its use in archeology.

The application of air observation to excavation was a product of the World War. Pioneer work was carried out by the Germans in the Sinai peninsula, and an archeological commission working with the German army in Palestine was under the command of an archeological professor, Dr. Wiegand. Here, for the first time, in a volume published after the War, it was possible to see direct photographs of almost unknown cities, ruined and forgotten, in the wilderness of Sinai. The same region was mapped and examined from the ground by Colonel Lawrence just before the outbreak of hostilities. It is interesting to compare Lawrence's ground researches with those carried out by air.

About the same time that these researches were being conducted, British aviators were able to record unknown sites in Mesopotamia. It is thus uncertain to which nation must be given the credit of instituting archeological research on these lines. The German undertaking seems to have been greater and more detailed, the British a study of a more important region.

The archeologist on the ground is to a large extent heavily handicapped when it comes to an exploration of a wide area in the search for sites to dig. He is in the position of a man who sees a half-tone illustration only through a strong magnifying glass. The illustration is largely an unmeaning mass of dots which only extreme ingenuity can piece into the proper pattern. But a long-distance view at once makes the pattern clear. The aviator can take precisely this long-distance view over large areas of land.

The identification of ancient city sites in deserted regions that are difficult to explore on foot is a simple enough task for the aerial observer at a great height. It is when he comes lower that he can help even more. What he detects is not so much the unevennesses of the soil as the changes in color of the soil itself and of the vegetation on it. Soil once turned is never the same again and the vegetation that grows on it indicates the parts of the soil that have undergone artificial handling. One of the most convincing of recent aerial photographs shows how even the tallest trees reflect in their topmost foliage what has gone on about their roots. A view taken of the forest surface in the wild jungle lands of Yucatan shows how the absolutely straight roads cut through the forest by the Maya of a millenium and a half ago, now survive as long straight channels in the level surface of the forest. This can be detected only in an oblique and very high altitude view. It is almost certain that this system of roads would never have been discovered by ground observation alone.

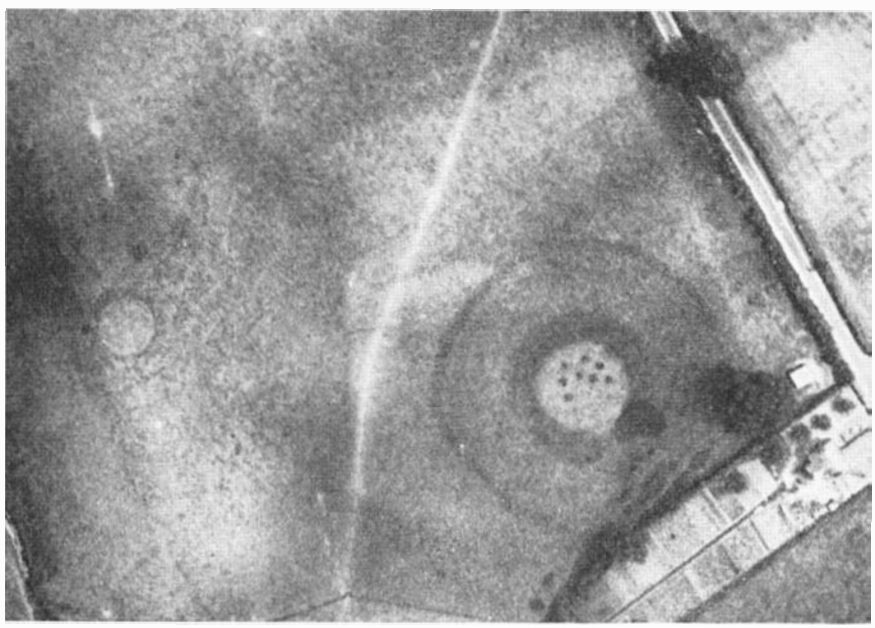


Figure 1: **An air photograph of the site of a prehistoric wooden circle near Norwich, Norfolk, England. For centuries people have tramped over these evidences but the ability to see them from above, as a whole, came only with the airplane**

In mud desert lands like Mesopotamia the air view is of superlative value, for the slightest changes in color of crops and herbage are at once seen from the air. In rocky lands like Greece land surveys by air will reveal very little. In western Europe, on the other hand, the grassy soil and frequent occurrence of chalk downs is peculiarly susceptible to aerial survey. Chalk areas in particular reveal from a height the outlines of every furrow and every ditch or encampment ever made, even if they have been plowed level with the surface long ago.

The full use of air photography in excavation is now in operation in England, where it took root first in 1922. It is

not merely a question of taking a photograph of a site not otherwise known, and then having that site excavated. The aviator now co-operates with the excavators, taking photographs before, during, and after the excavations, so that the excavators shall make no mistake and miss nothing.

The air photograph often reveals, not what is otherwise invisible to the ordinary eye, but rather what would normally pass unnoticed. Just as the skeleton never vanishes, so the changes wrought by human agency on the surface of the earth can never be removed and obliterated. It has been rightly said that the one thing which you can never destroy or obliterate is a hole in the ground. Fill it up, stamp on it, cover it up as you will, always it will emerge like Eugene Aram's victim. And there lies the clue to the value of air photography. Photographs taken from a vertical point of view will reveal all the markings left on the soil by man's agency. Photographs taken obliquely in a slanting sun will show, even in the growing crops, the outlines of long-vanished foundations and the darker patches left by disturbances of the soil. For, once you alter the settled stratifications of the natural soil that Nature has laid down, you can never put them back again in the way in which Nature did it herself.

FOR nearly a generation now, archeologists have been in the habit of plotting out the plans of long-vanished wooden buildings solely by the aid of the holes left in the soil by the posts and beams of the building. These holes, under excavation, appear as deposits of darker earth, unstratified and loose in the solid matrix of the natural soil. Recently air photographs taken in England have revealed whole structures of this kind. The post-holes show up as dark points on the surface, whether it be turf or grain.

A notable discovery of the first order was made, in this way, of a prehistoric circle similar to Stonehenge and only two miles distant from it. But this other circle was originally composed of wooden uprights of massive oak instead of stone pillars as at Stonehenge. Perhaps it was the predecessor in type of Stonehenge. The airplane photograph enabled the excavators to draw the plan of the circle; subsequent excavation showed the plan to be correct, and every detail of the photograph could then be examined on the earth. So emerged one of the most important monuments of British prehistory. The discovery led to further search and other circles were found, thus adding a whole new chapter to British archeology. Figure 1 shows one of the latest to be discovered. To the right of the center of the picture is seen a double circle. The inner circle is actually more like a horseshoe, and in type follows closely on the lines of the inner circle of Stonehenge. The actual circle is near the city of Norwich in Norfolk. Within the horseshoe circle is faintly seen a smaller circle of small dots. These are the marks left by the holes in which immense wooden posts were set up when the shrine was first made, some 4000 years ago.

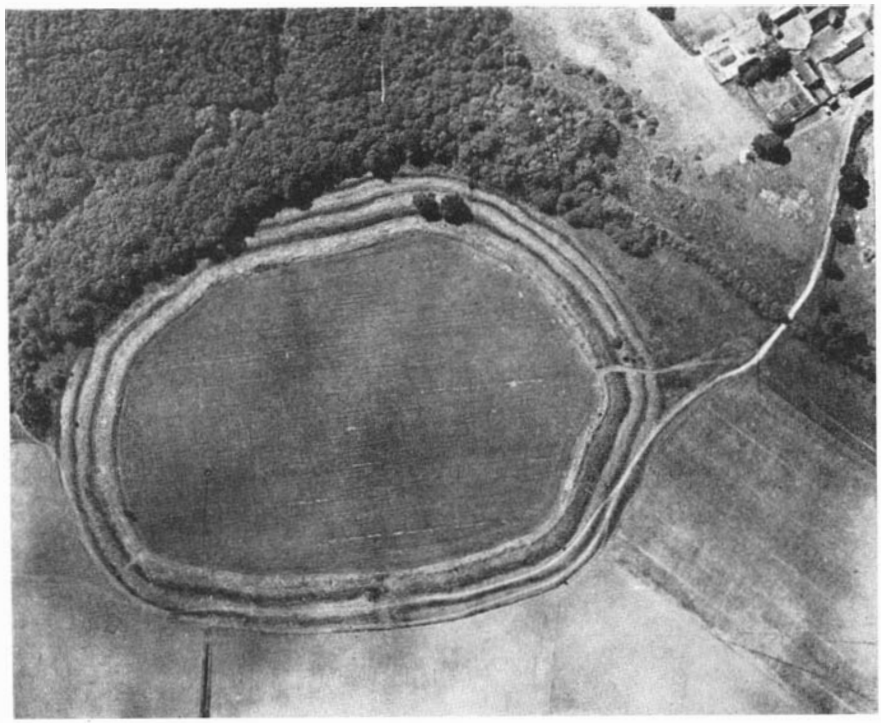


Figure 2: **A British hill-top fort of the early Bronze Age, as yet unexcavated. The earthworks are plainly visible from ground level—still more so from above**

All these circular markings are seen on a turf surface and are almost invisible from the ground level. The darkness of the circles is due solely to the more luxuriant growth of grass on a basis of disturbed soil, and the circles represent ditches that surrounded the central wooden shrine. To the left of the twin circle is a small circle in the middle of a field. This is the site of a burial mound, long since plowed level with the soil but surviving in the color of the grass.

Since this photograph was taken excavations have been carried out and everything indicated on the photographs was found. The ditches were found cut into the natural soil and filled with disturbed earth; the deep holes for the posts of wood were found exactly as shown and it was even possible to discover, from traces on the soil, that all the tree-trunks employed were dragged down the slopes of a neighboring hill to be put into this position.

Photographs taken vertically of prehistoric camps reveal admirably the full details of these astonishing fortresses that top almost every large hill in the south of England. Figure 2 is almost oval and, unlike most camps, has no proper gateway. Figure 3 shows the largest earthwork in England, Maiden Castle near Dorchester in Dorset, which, since the photograph was taken, has also been excavated. The white arrow points to a spot in the mighty ramparts where there is a curious kink. Across the flat turf surface of the interior is seen an irregular line. The photographs suggested that this was the outline of a first fort, smaller and more compact than the fort in its final state. This was verified later by excavation, and the remains of an old rampart were found running across from the arrow point to the opposite ditch.

FIGURE 4 shows an excavation in progress in Ireland, where an expedition from Harvard University is excavating an early Irish settlement of the Christian era. Here the wooden piles of a building, once on a lake edge, are seen, with a dugout boat intact, found where it had finally sunk in its quay when the settlement was abandoned. Only careful and meticulous excavation has made it possible to preserve the outlines of this settlement and its contents.

One aspect of air photography remains to be developed. Hitherto it has not been employed, partly because the regions where it would be most useful are not well endowed with money or with aircraft, partly because the use of aircraft in archeology is by no means universal even in regions where archeological research is intensive. This new venture for air photography I will term "air-marine research". It concerns the Mediterranean more than any other region—perhaps exclusively. By its means air observation can be applied to the

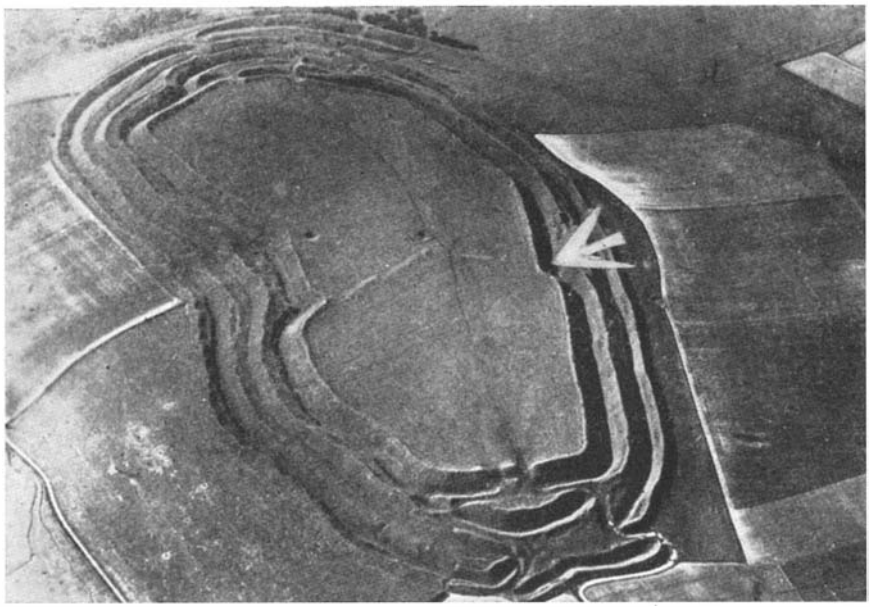


Figure 3: **Ancient earthwork at Maiden Castle, Dorsetshire. There is no written record of the people who built these great forts of earth on hill-tops in Britain**

examination and discovery of objects of antiquity now under water on the seabed. These fall into two classes: (1) towns or buildings which have been submerged under the sea by land-subsidence and (2) remains of ships wrecked in antiquity. Archeologists are now seeking both the means and the opportunity for such research. The results are certain to be of the highest importance. Let me give examples of cases in each class.

In class (1) can be placed a complete Greek city of later Hellenistic date in South Russia on the Crimean coast. Russian archeologists have recently identified it by means of marine telescope observation and divers. But their knowledge of it is only approximate. The city is recorded by a Greek historian as having been finally abandoned when the area became uninhabitable. Apparently in the course of 200 years or so, geologic disturbances forced the level of the city below or just into the sea. Subsequent centuries have completed its submergence.

ANOTHER case is found in the buildings of Roman date in the Bay of Baiæ, near Naples, which are now under the sea. Photographs from the air at a low level would enable accurate plans to be made and divers could then locate details of the site and explore its remains. There could, of course, be no question of scientific excavation, except at prohibitive cost.

In case (2) wrecks of ancient ships which bore as cargoes works of art have been recorded from the coast of Africa, off the island of Cerigo in the Ægean and, in 1930, off Cape Artemisium near Eubœa in central Greece. In each case the wreck was found by chance by sponge fishers and the works of art fished up were recovered more by accident than by design. But the wealth of works of art so found has been enormous. In one African wreck a large number of marble statues were recovered. In the Cerigo wreck one complete bronze statue and about ten marble statues were found, together with a unique example of a Roman astrolabe, which had been one of the ship's instruments of navigation. In the Artemisium wreck what is perhaps the finest of all known Greek works of art was found, the now famous Zeus in bronze at Athens, dating to about 460 B.C., a masterpiece of the first order, in perfect preservation.[1] Sea water tends to ruin stone and to preserve marble, the converse of what happens in the earth.

A systematic examination of all these promontories and straits where wrecks are frequent at all times, carried out as a survey by airplanes, would certainly reveal on clear days traces of wrecks which might then be profitably examined by divers. The addition to our knowledge of Greek and Roman art might well be great. Roman art dealers from 100 B.C. to 400 A.D. looted Greece of its works of art in order to adorn the cities of Rome and Constantinople. By fixing the ancient routes from Greece to Rome and from Greece to Constantinople, and by carrying out such a systematic inquiry, other wrecks beyond those found by mere chance would be discovered. The African coast, even better for aerial observation, would be also worth investigation, for to the new African cities the Romans seem to have brought the works of art of Sicily, which were in the main also Greek. Scholars are now at last beginning to consider this particular and as yet untried form of air research. It should prove fruitful.

[1] Two other works of art in bronze were also found in this wreck, the forepart of a galloping horse, and the quite perfect figure of its rider, a work of the 3rd Century B.C. A few weeks ago the bulk of the body of the horse and its hind legs were found by sponge fishers. No exhaustive examination of the site of this wreck has yet been carried out by divers and it is uncertain at present whether other works of art remain to be discovered there. In any case this wreck has proved the most productive of any so far found. The site of the wreck is a well-known danger spot and there may be other similar wrecks in the sea sand.

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Interested readers may find in the British journal, Antiquity, *a number of accounts of air-photography investigations of sites. For example: "Air Photography in Northern Ireland," Dec. 1930; "Hill Forts," March 1931; "Cerdic and the Cloven Way," Dec. 1931; "Balloon Photography and Archeological Excavation," June 1932; "Some Recent Air Discoveries," Sept. 1933; "The Celtic Field System in South Britain," Dec. 1935. Available in large libraries.*

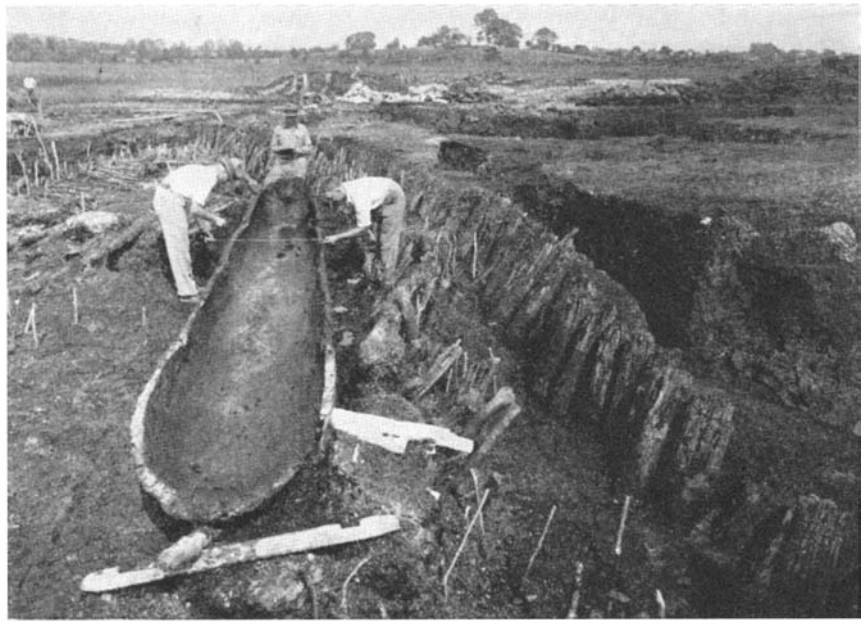


Figure 4: **An expedition from Harvard University excavating an early Irish settlement of the Christian era. The site was formerly at the edge of a lake, now dry**

WHO'S A GOOD DRIVER?

Opinions Differ . . . Tests Tell . . . The Human Equation Must Be Solved . . . Egotism Solved by Training . . . Privileges for Superior Drivers?

By PHILIP H. SMITH

THE deep-seated conviction of almost every red-blooded American motorist that other drivers are less competent can now be exploded. Scientific study of driving skill has reached the point where facts rather than fancy will decide who is competent and who not.

This is a great step forward in the concerted movement to make the highways safe. Efforts to better road construction and to make automobiles themselves safer is all to the good, but in the last analysis the human equation has to be solved. Roads and vehicles are important factors, but they are used by human beings—mis-used or properly used.

Recent studies, and many have been made in various parts of the country, have brought to light several unexpected facts about the man at the wheel, and perhaps the most important of these is that the majority of drivers are unaware of their own limitations. Confidence in your own ability may mean only that you are ignorant of your defects. You may cite with pride the fact that you have had no accidents; it may mean merely that you have been lucky thus far in your motor-car career.

Conviction of personal excellence in driving is hard to deflate, but if excellence does not exist, the highway has a potential hazard until the deflationary job is done and done well. When a driver learns of his limitations, he is the better for it and can be trained to overcome them. The instruments which have been developed to do the revealing are convincing—and strikingly ingenious.

THE Bureau of Street Traffic Research at Harvard University, under the direction of Dr. Miller McClintock, has a most comprehensive group of instruments and tests. Critical examination of these will give the best possible idea of the progress made in measuring driving ability, because the objectives sought are representative of present day scientific effort. So far, seven tests have been developed and these are generally credited with making possible the grading of drivers in a practical way.

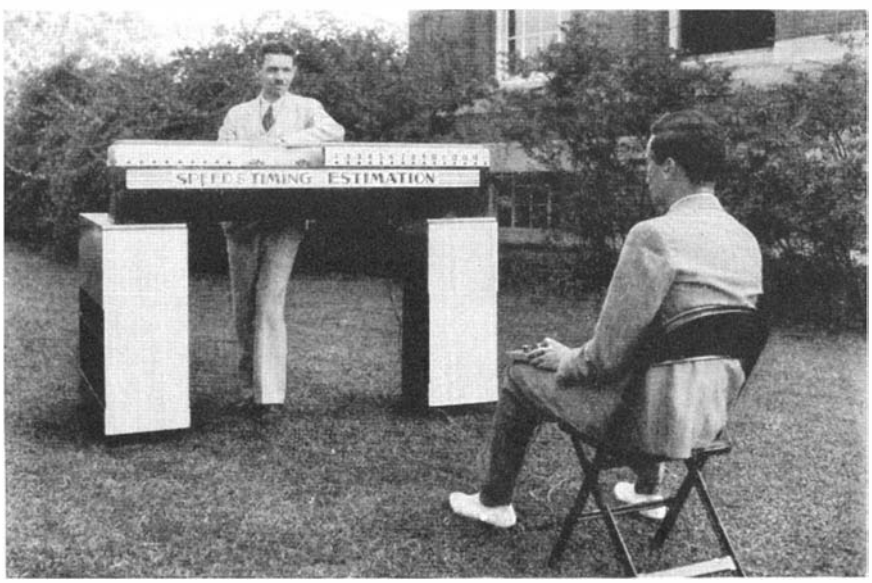
The first and simplest test is for braking reaction. If your reaction time is better than 0.44 second, you are above average. This timing means the interval between taking your foot off the accelerator and applying the brakes when a light in front of you changes from green to red, or when you face an emergency.

Steering skill test. Subject must manipulate the steering wheel to hold the miniature "road"

Steering skill is measured by seating the subject in a chair, facing a road scene which unrolls before him and is so arranged that steering is required to "hold the road." There has been found to be a close correlation between steering skill and driving experience. Other discoveries have been that women learn to steer more slowly than men but improve over a longer period; that the highest scores are made between the ages of 17 and 21, and that driving coordination wanes after 55.

The driver who would overtake and pass a car while another car approaches him must have ability to judge both speed and time, and this constitutes the third test. Two model cars are used and caused to move at right angles to the subject. The instrument itself resembles an elongated box, with the center cut away and the remaining surfaces clearly scaled. In operation, the first model emerges from the enclosure and travels across the cut-away area, promptly pursued by the second model traveling at a higher speed. When both models have disappeared, the subject is asked to estimate where, on the scaled surface, the pursuing car will catch up with the other.

Visual tests, of which several types have been developed, are of prime im-



A test subject, foreground, judging speed and time. Two model cars pass the opening in the box; subject must judge where they will meet, under cover

portance. They endeavor to measure glare-blindness, depth perception, "tunnel" vision, visual acuity, and color-blindness. Apparatus to test for the first simulates road conditions in miniature. The subject looks into a closed box where he perceives the oncoming headlights of an automobile. At the right of this road is a cardboard "pedestrian." The subject has his own set of headlights, the intensity of which he must increase until he can see the pedestrian. Scoring, or the measure of blindness, is based on the increased brightness needed to do this.

DEPTH perception and "tunnel" vision are both of great significance on the highway. If a driver lacks the first he is handicapped in passing; if possessed of tunnel vision he sees straight ahead and misses entirely a quick perception of cars coming from the side. Depth perception can be measured with an apparatus comprising two vertical rods, one fixed, the other movable forward and backward at the will of the subject. The test involves lining up the rods side by side from a distance of 20 feet.

Tunnel vision is being tested by means of a perimeter. The subject looks straight ahead at his own image in a mirror while the operator moves a light box to right or left of the center until it passes from vision. If the subject's vision is restricted to less than 60 degrees on either side his visual condition is declared hazardous.

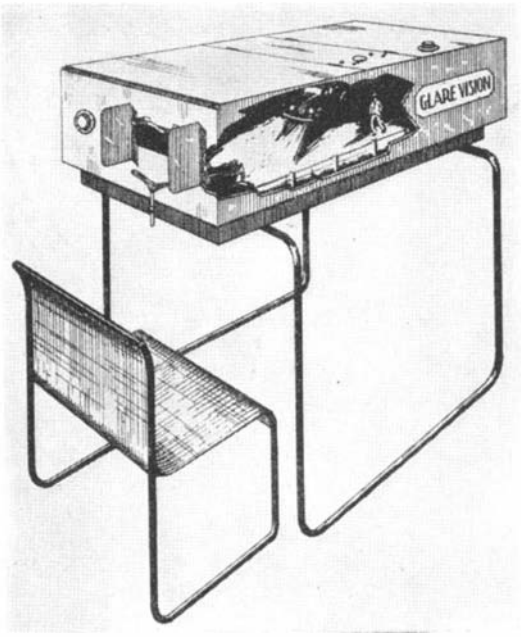
A ring test serves to measure visual acuity. The subject views a series of increasingly smaller rings, each having a gap, until the gap is no longer visible. Color-blindness is measured by an equally simple device. Here the subject simply states the color seen through a hole in a box and guessing is precluded by presentation of colors without regular sequence. A test for hearing completes the tests of individual abilities and there is no special apparatus required for this because auditory testing devices have been available for many years.

If the tests as outlined constituted all there is to the measuring of driving skill, we would have to admit that few advances of a practical nature had been made. The tests would leave still undetermined a driver's capacity to perform a number of operations simultaneously or in rapid sequence as required in actual highway driving. They would leave untested a driver's judgment when faced with a complex situation. What they do achieve is the uncovering of weaknesses of which the driver may be wholly unaware and which would make him prone to accidents.

Workers in the accident-prevention field have seen the need for devising tests which simulate more accurately actual driving conditions, if a real determination of skill is to be obtained. At Harvard the need is met with a miniature highway apparatus; at Iowa State College an outdoor driving field has been developed. Both serve to put the driver under observation while reacting to a series of highway situations.

The miniature highway apparatus comprises the control compartment of a standard automobile and an endless belt highway upon which car models are mounted. The road is seen through a small window to give the illusion of looking through a windshield and the vision is a normal one of oncoming cars and cars traveling ahead. The belt is so arranged that it begins to move when the subject goes through the operation of getting a car under way; the models move faster as the gears are shifted, and further acceleration is given by the throttle. Steering is also linked to the belt. Thus a turn of the wheel moves the belt to one side or the other to create the illusion that the subject's car has moved to the right or left of the highway.

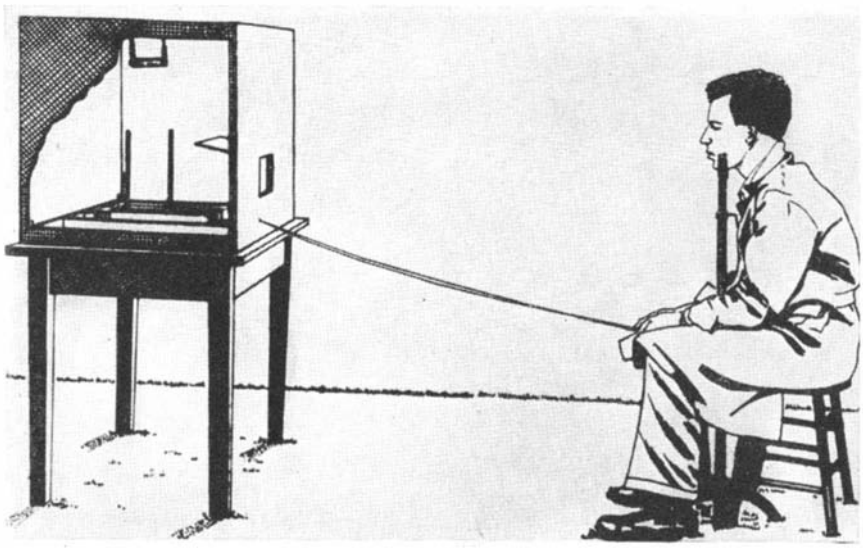
Manipulation of the car controls enables the subject to speed up, pass cars, slow down, stop, and so forth. He must judge distances, speeds, timing, and in short, behave as he would behind the wheel of his own car. In the course of about three minutes he encounters as many hazards as he would normally meet in about one year on the road and his performance can be observed and recorded.



The subject adjusts his "headlights" until he can just discern the cardboard "pedestrian"

The Iowa State driving field likewise simulates actual road conditions. The subject taking his car through the field must obey all signs and rules of the road and react promptly to all instructions. It tests his ability to steer, brake, park, obey signs, not to mention noticing and reading them. In addition to testing, this field can be used for training.

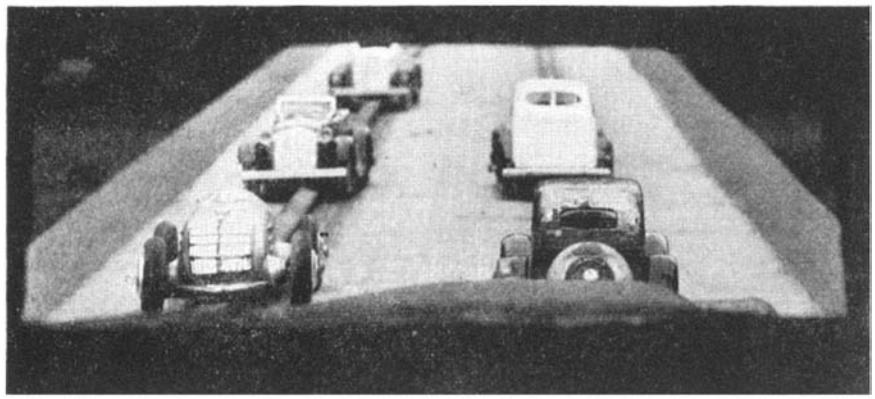
While experimenters agree that driving tests now used by state motor vehicle officials are entirely inadequate to meet the needs of present day driving, they make no pretense that their own tests are infallible. They hold their methods to be more exploratory than conclusive, yet to make a definite contribution to the work of accident prevention. The revelation of driver limitations still leaves the elimination of accidents up to the driver. The best that tests can do is to find the unfit so that they can be

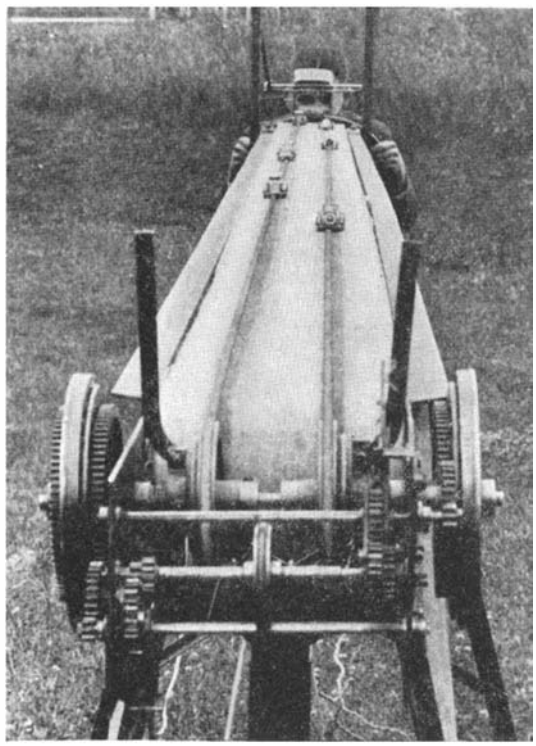


Depth perception of a motor-car driver is determined by checking his ability to align the two vertical rods in the cabinet. One of them is controlled by two strings

eliminated from the highways and show the way to train the rest to become more capable. Certainly the first step in accident avoidance is to know one's limitations.

The purpose of current experimentation is primarily to make better drivers rather than to restrict driving. Tests show that drivers who cannot avoid accidents comprise a group of not more than 5 percent of motorists, while those who have some weakness to make them accident-liable number about 20 percent. This leaves 75 percent of drivers who can benefit from the knowledge that follows from research.





Left: **A miniature highway for testing driving skill under highway driving conditions.** *Above:* **What the subject sees through the windshield of the new testing equipment**

THE weakness of present testing methods are those inherent in most tests of human material. A test is something exceptional and not psychologically identical with the everyday counterpart. The poor driver tries his best, while all persons concentrate on what they are doing to a degree not likely to be exercised on the road. Experimenters realize the need for eliminating this element from tests to get worthwhile results. At Harvard they will make the miniature highway more complex to simulate road conditions more closely, and so operative that results will be recorded mechanically, thus eliminating at least the psychological factor of the observer from all calculations.

If driving tests are ever to be put into operation on a nation-wide scale as a means for determining fitness for the granting of a license, the recording of factual data must be standardized and mechanized so that results depend in no way upon the ability of the tester. This will be done because the value of an established scientific base would be dissipated quickly if so vital a link were left uncontrolled.

While researchers claim that tests will now reveal faults in driving so that the driver can be advised and learn what to do about it, they are not in unanimous agreement that testing principles have been so well established that inferior and superior drivers can be separated, nor are they in complete accord in the opinion that inferior performance *per se* indicates proneness to accidents. With true scientific detachment they view their work as merely a beginning and are working to make their studies more conclusive. They see many physiological reactions yet to be studied and suspect that there may be more factors which go to make up driving skill that have not been discovered and that may be determined only by careful research, assiduously followed.

Driving tests must be checked from all angles to be really scientific and this check is made by correlating with actual highway performance. Two ways are followed—watching the performance of drivers who have been tested, and testing persons who have accident records. The Harvard system of tests is now being applied to Cambridge drivers who have been involved in accidents to see what the correlation may be. Ultimately, for it takes time to build up adequate records, we may know much more about the cause of accidents, for accidents don't just happen; they are usually caused by unthinking or careless drivers.

The immediate value of these tests was made quite apparent recently. Within a few blocks of the examining station a driver passed a red light and ignored a fire engine siren with very sad results. Under normal circumstances the driver might be labeled careless and fined accordingly, but in this case he was tested for driving skill and discovered to be both color-blind and deaf.

It is, of course, possible for a driver to pass strenuous tests and still be a nuisance on the highways; he may still drive as if bent upon turning his car in or turning it over within the year. How then can driving examinations increase safety on the highway? Dr. Alvhh R. Lauer, of Iowa State College, answers this question on six counts. He claims:

First; the type of vehicle best suited to the driver may be adjusted or arranged accordingly.

Second; if drivers know their limitations, they will tend to avoid trouble.

Third; knowledge of the other fellow's weaknesses keeps a driver out of trouble. He makes more allowances.

Fourth; faced with searching examinations, the driver will make more effort to learn the principles of safe driving.

Fifth; a driver will exert more care when made responsible for his weaknesses.

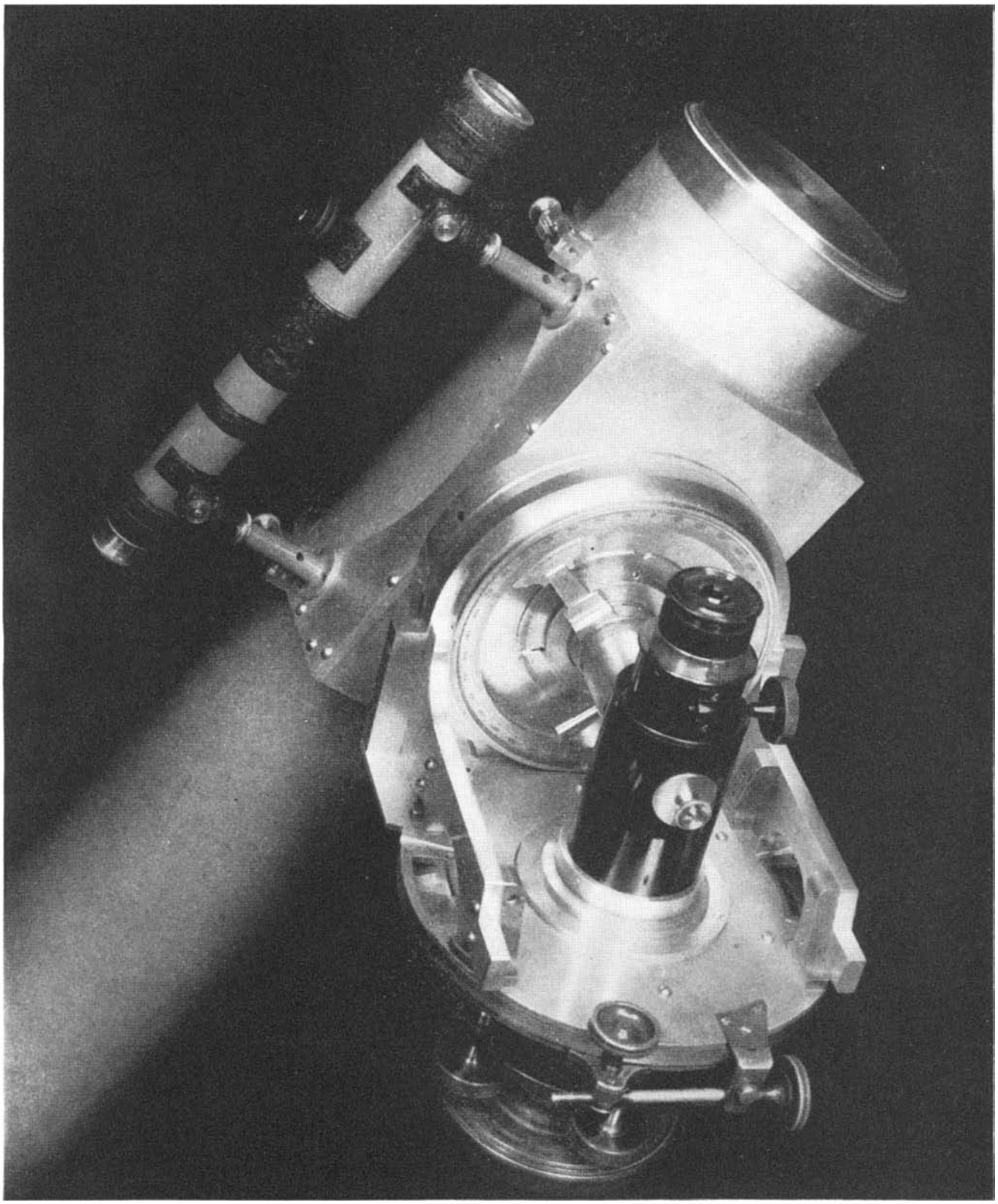
Sixth; proper training can be given because of basing on skill measurements, scientifically obtained.

Dr. H. R. DeSilva of Harvard holds that examining drivers and pointing out their faults to them will go much further toward making the highways safe than repeated admonitions and threats of disbarment from the highway.

CERTAINLY we now have tests that count for something; with the means for grading drivers, the day is not far away when the hopelessly unfit will be taken from behind the wheel, the average driver provided with aids toward increasing his skill, and the superior one perhaps given certain privileges as long as they are respected.

Out of the knowledge that, to avoid accidents, a driver should know his limitations, there can develop the elite of motoring—a group to whose membership all may aspire, for their competence will be factual. Scientific tests point the way to "Know thyself." This is the beginning of driving wisdom.

Photographs courtesy Bureau of Street Traffic Research, Harvard University.



FIRST PRIZE

■

"Springfield Mounting"

By Robert Bushman, 13 State Street, Schenectady, New York. Subject: Springfield mounting for a 4¼ inch amateur reflecting telescope. Taken with a Graflex Series B, Kodak anastigmat lens, 5½ inch, F/4.5. Negative 3¼ by 4¼ Panatomic developed in D-76. Filter, K2. Exposure, 45 seconds at F/22. Printed on Defender Velour Black Glossy. Light, one Photoflood in a reflector. The light source was kept in motion during the entire exposure to prevent heavy shadows and too bright highlights.

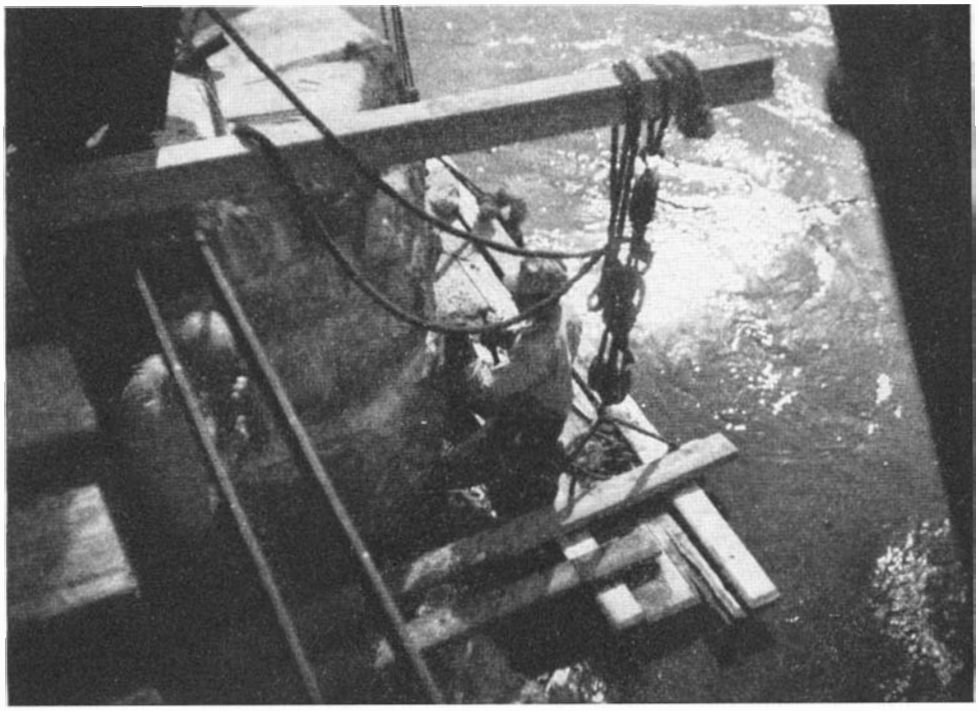
PHOTOGRAPH CONTEST AWARDS

FROM the large number of photographs submitted in the Scientific American Photograph Contest, announced last April, the board of judges has selected the three prize winning pictures reproduced on these two pages. The board consisted of Ivan Dmitri, well-known artist and photographer, Jacob Deschin, conductor of our "Camera Angles" department, and the editorial staff. Announcement of the Honorable Mention awards appears in the "Camera Angles" columns of this issue.

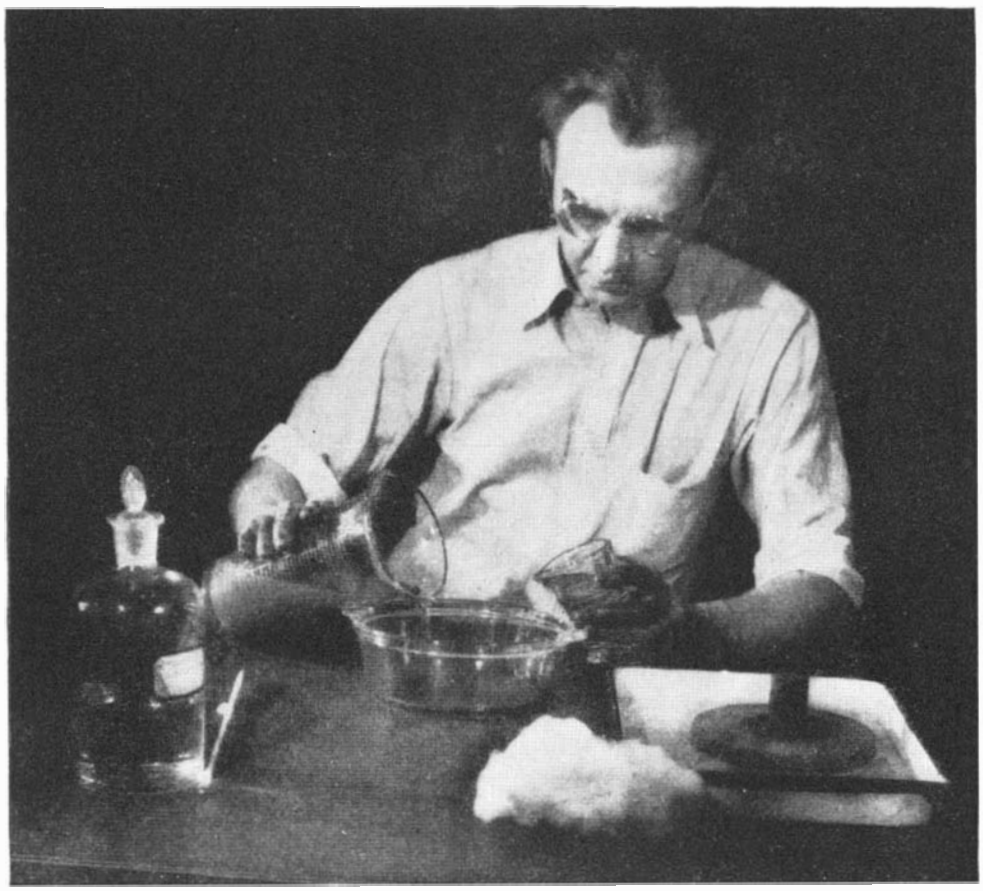
■

SECOND PRIZE

"Bridge Repair"



By Alex Lighter, Glace Bay, N.S., Canada. Korelle K. camera, F/2.8 Trioplan lens. S.S. Pan film, 35 mm. Exposure 1/100 second at F/4.5. Normal contrast P.M.C. No. 1 paper developed in M.Q. tube developer. Negative developed in buffered borax D-76, for ½ hour.



■

THIRD PRIZE

"Silvering Telescope Mirror"

By J. M. Stofan, 95 Grand Street, Garfield, New Jersey. Leica camera, Elmar lens used at aperture of F/9. No filter. Light source, two Photoflood lamps. Printed on #3 paper, developed in D-72. The 35-mm film was developed in D-76.

A bridge that *looked* strong enough, but a light sedan went through it

Horse and Buggy Bridges

Forgotten Bridges . . . Old . . . Weak . . . Not Built For Modern Vehicles . . . Narrow . . . Bottlenecks . . . Hamper Traffic . . . Unsafe . . . Endanger Life

By F. D. McHUGH

A LARGE bus, carrying as passengers a score of carefree, chattering youngsters on their way to school, glides smoothly down a modern concrete road. The driver watches a huge truck preceding them and, guessing its loaded weight at 20 tons, wonders absentmindedly whether that truck can safely cross the old wooden bridge ahead, over a railroad cut, which is posted: "Load limit, 6 tons."

Keeping a safe distance behind, the bus-driver passes a familiar sign: "Warning, Narrow Bridge." He sees the truck ahead rumble off the bridge floor to the concrete beyond, and involuntarily sighs with relief. His bus rides easily on the bridge. He is watching the road ahead and an approaching car for which he must make room. He nears the center when he hears an ominous creaking of old timbers and then—Crash! Floor boards splinter, wooden trusses and stringers buckle, and the bus with its load of happy children dives to the tracks below. A cloud of cindery dust rises for a moment of awful heart-breaking silence. Then, as if by rehearsal, small throats in maimed bodies rend the air with screams that rise to an appalling crescendo. Some voices, chattering but a moment before, will never again be heard.

It is not a pretty sight. Violent death never is; and such slaughter of the innocents is a thing horrendous. Perhaps it has never happened just this way. It could—and may at any time. For someone forgot a bridge!

Bridges, vital highway links, have been forgotten by the thousands. These weak, narrow, and obsolete structures threaten every man, woman, and child in the country. They snatch their toll of lives daily and with every day's depreciation they multiply the death hazard. They void the vaunted safety of the high-speed roads they connect and stand as monuments to the negligence of officials. Authorities who have forgotten these bridges are guilty of flagrant disregard for human life and property. But we, the public, are also culpable.

IT is roads, not bridges, that have been improved. As the use of motor cars has increased at such phenomenal pace during the past two decades, highway departments of town, county, state, and federal government have worked feverishly to provide roads for them. The roads themselves have grown from two lane to three and then four. "Modern roads for modern motor travel" has been the order of the day. As roads were built a new unbalance was created. That Goliath, the transport truck, and creature of a new major industry, highway transportation, demanded highways not only wide and straight, but surfaced to withstand impact.

In rebuilding highways to keep pace with modern transportation needs, engineers often left old bridges in place, allowed the "horse and buggy" bridge to remain, or at best they built for the cars and lighter trucks of other days. Many responsible officials, in common with many laymen, look upon a bridge as a permanent fixture, something to serve until it falls down. As a consequence, one engineer recently told us, "Numerous old bridges in various stages of obsolescence remain to make our highways unsafe despite all sincere attempts to provide new grades, better alignment, and more permanent surfacing." They are, indeed, the weak links in the chain.

Such "weak links"—thousands of them—are everywhere throughout the country. No one has bothered to keep statistics as to the approximate total, but every one who has driven a few miles in the country, particularly on two-lane or secondary roads, can vouch for their existence in numbers. Some will be posted, as is an old masonry bridge near Yonkers, New York: "Steep Hill—Narrow Bridge"; some, as is one we know in West Virginia: "Bad Curve—Narrow Bridge"; while many will frankly confess negligence of responsible persons by some such warning as: "Danger—Load Limit 6 tons."

Some will be of masonry construction, some of old concrete, some of rusted steel, and many of wood. In 1930 there were in use between 450 and 500 old covered bridges (wooden) in 24 states ("A History of the Development of Wooden Bridges," by Robert Fletcher and J. P. Snow, *Proceedings A.S.C.E.*, November, 1932), and many of these—rattly, narrow, and with sharp curve approaches—are doubtless still serving. We know one such on a splendid, new, two-lane, concrete highway in South Carolina.

Accidents, which will be discussed later, have occurred at numbers of these obsolete bridges; they have exacted their toll of lives. All are dangerous despite their warning signs which are continually ignored, and all, even on the secondary roads, are crossed many times by heavily loaded, law-breaking trucks.

"I have a neighbor who makes a living by trucking," says H. E. Colburn, Bridge Engineer of the Allegany County (New York) Department of Highways. "His truck, empty, weighs six tons and he ordinarily hauls a load of eight or ten tons, making a total load of about 15 tons. He cannot get three miles away from his home, with his empty truck, on any road in any direction, except one, without exceeding the posted limits of some bridge, thereby making himself liable to arrest besides taking his life in his hands. On the road which he has the most occasion to travel—a State road—he has to cross one bridge posted for six tons and another posted for four tons in traveling four miles to a gravel plant. Yet he pays the state over 100 dollars license fee every year for the privilege of operating his truck, as well as a substantial additional sum in gasoline taxes.

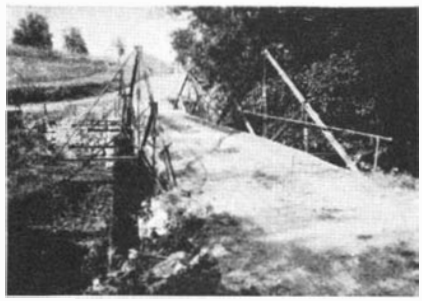
"A few days ago, near here, a gasoline truck weighing 20 tons went through an old bridge posted for four tons. The owner or driver will undoubtedly be prosecuted, fined a nominal sum, and then will proceed to haul heavy loads as usual over weak bridges. Some time ago a chain store truck broke through a bridge on the main route near the village of Belmont. The load greatly exceeded the posted limits of the bridge, so the driver was fined. The fact that there was no other way of reaching the village didn't help any!"

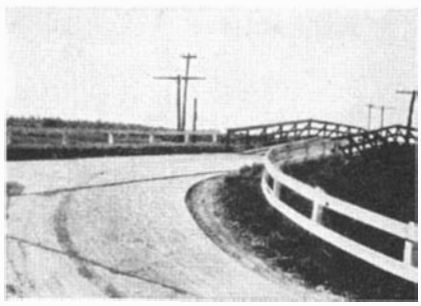
But these were heavy trucks, not buses of school children? True; but Mr. Colburn tells of seeing a bus-load of children, weighing far in excess of three tons, dash at 40 miles an hour over a bridge posted for exactly three tons and a speed of 15 miles an hour! Our introductory scene *can* happen—and will some day. Drawing on his experience, engineer Colburn says that an old structure "may safely carry a 20-ton truck today and collapse with a three-ton load tomorrow"; and cites the case of a steel bridge which fell in while a light coupé was crossing shortly after a heavy bus full of passengers passed over safely.

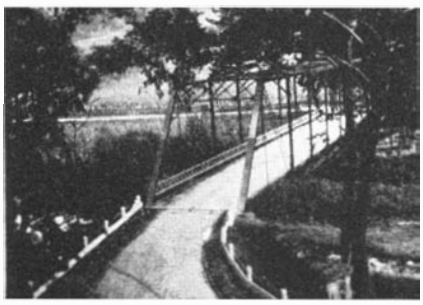
How much study has been given to this question? Little—too little! Mr. H. S. Fairbank of the Bureau of Public Roads, Department of Agriculture, writes: "I regret that there is at present no satisfactory information in this Bureau relative to the number and character of bridges on any of the public roads of the country. Realization of the need for such information is one of the reasons why we are now urging the States, with our aid, to make a thorough-going inventory of the existing rural highway facilities as a part of the state-wide highway-planning surveys, arrangements for which are being made in more than 35 States.

"When these inventories are completed, during the course of the present year, we shall have for the first time a reasonably adequate record of the highway bridges in existence in the States in which the work is done. At present there is no such record in any State, and the nearest approach to it that I know of is in Ohio."

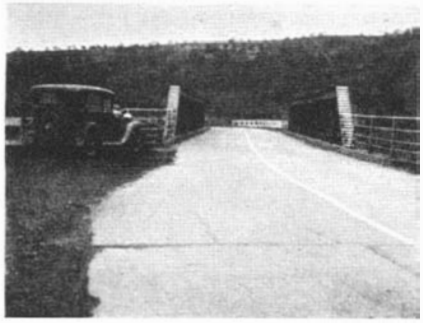
The Highway Research Board, National Research Council, reports: "We regret that we have collected no facts and figures applicable . . ." Four representative state highway departments—those of the progressive states of New York, New Jersey, Illinois, and Connecticut—apparently have no pertinent records available. Connecticut, however, does make some attempt to tabulate highway accident causes. In that state motor vehicle fatalities numbered 439 in 1935; two were at bridge locations.

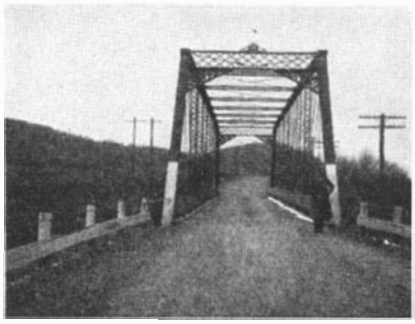






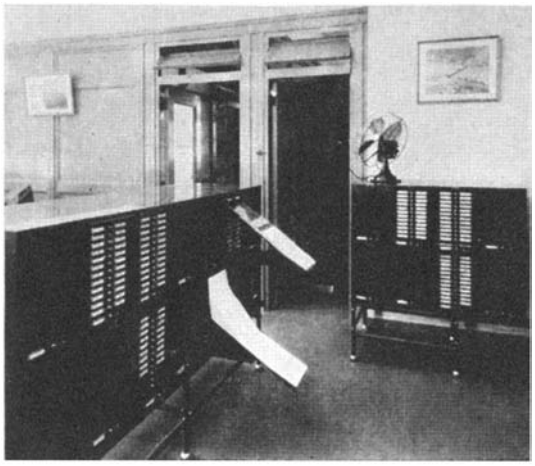
Obsolete, weak, narrow, poorly aligned bridges





Disabilities incurred at bridge locations probably ran much higher because in the country as a whole the ratio of disabilities to fatalities was 32 to 1.

Now, if these four states have so few data to offer, what of other, perhaps less progressive states? Assistant Traffic Engineer Donald S. Berry, of the National Safety Council, Inc., tells us: "We have some general statistics from a few



Visible index system of bridge records, as kept by the Department of Highways of Ohio

of the states that show the relative importance of bridges as a factor in highway accidents. The following statistics from the states of Connecticut and Kansas will serve as examples:

"The annual report of the Motor Vehicle Department of the State of Connecticut shows that there were 439 motor vehicle fatalities in 1935. Of this number, there were 2 fatalities occurring at bridge locations. This seems to indicate that bridges are a small factor, although it must be remembered that the mileage of bridges is very small in comparison with the actual highway mileage."

ADDING to the facts concerning Connecticut, he says that of that state's 15,656 motor vehicle accidents, there were 155 occurring at bridge locations.

"The 1935 report of the Health Department of the state of Kansas," he continues, "shows that there were 52 motor vehicle fatalities occurring at bridges or culverts. The total number of motor vehicle fatalities during 1935 was 522. The statistics also showed that 49 of the 52 fatalities occurred as a result of collisions with fixed objects. This number is considerably higher than that in the Connecticut statistics which is probably due to the fact that the Kansas statistics include culverts with bridges.

"The foregoing statistics, however, do not give any indication of the effect of width or type of bridge upon the accident situation. The accident statistics which we get from the various states and cities do not show the number of accidents occurring on bridges of different widths, and accordingly, we have never been able to make a special study of this subject."

It is interesting to note here that the very complete "Accident Facts, 1936 Edition," published by the National Safety Council, makes no mention of the part played by bridges in the 11 deaths by accident and 1100 non-fatal injuries per hour in the United States during 1935.

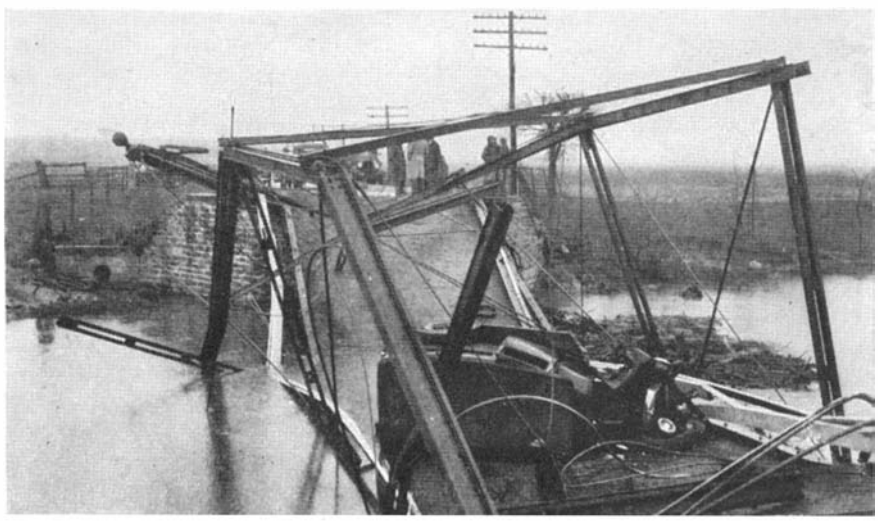
The claim files of The Travelers, Hartford, Connecticut, were equally unproductive of facts on bridge accidents. This was no doubt because their files are not so coded as to surrender their secrets without much research.

So far, we have noted a singular indifference to a problem admittedly significant. Generally speaking, bridges are of secondary importance in highway construction, as is indicated in a paper (Report of Committee on Highway Design) by Albin L. Gemeny, Senior Structural Engineer, U. S. Bureau of Public Roads. He says: "Legal restrictions on the vehicular loads which may be hauled over the public highways have been imposed by the various states of the Union. . . . Most of the regulations are intended to protect the highway pavements, little attention being given to the danger of destruction or serious overloading of bridges." Since his was a paper on design, he failed to mention the possible deaths coincident with bridge destruction!

A clue was given above, however, to one state which has been awake. This is Ohio, as representative and progressive a state as one could expect to find, with its interests in both farm and factory. Ohio has pioneered in making a commendably complete inventory of its bridges, their location, structural details and deficiencies, capacities, and the accidents that have occurred upon them. Mr. J. R. Burkey, Chief Engineer of Bridges of the Ohio Department of Highways, writes that he is fully in sympathy with the theme of this discussion, and has co-operated with us in its preparation, by supplying voluminous notes. For that co-operation, we wish here to express our appreciation as well as our regret that lack of space prevents quotation of as many of his facts as we should like to quote.

THE Ohio State Highway System now consists of 12,176 miles outside of municipalities, out of a total mileage in the state of 85,706. This total is to be increased this year by the addition of 5000 miles. By law, the State Highway Department is responsible for the construction, maintenance, and repair of structures on the system outside municipalities. In order to conduct this work efficiently the Department maintains an elaborate system of records in which the state is divided into 12 highway divisions for administrative purposes. A card index lists every structure on the State Highway System, the cards being filed in a visible index system in the same sequence in which the bridges occur on the road.

"Finger-printing" the highway bridges is what Ohio's card system does. The information is so complete and accessible that it is possible, by a quick glance, to tell what size and weight limits are imposed by structures on any given route. On a card no larger than eight inches by eight inches are shown a bridge's identification number, section, strength or safe load-carrying capacity, roadway width, roadway vertical clearance, type and approximate span of the structure, and numerous other engineering details as to structural fea-



Do old bridges cause accidents? Deaths? Disability for life?

All illustrations courtesy State of Ohio, Department of Highways

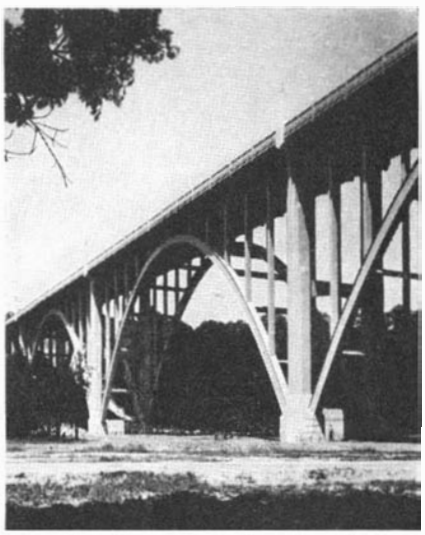
tures and characteristics. Bridges are inspected yearly and additional notes added to the card records.

Of great importance is the Department's classification of these bridges as weak, extremely weak, narrow, narrow and extremely weak, and other terms to show deficiencies.

The Traffic Bureau of the Ohio Highway Department has for several years past been making an extensive and detailed study of accidents on the highways, their causes and means of prevention, something which, as we have seen before, other states have not done in complete fashion—some, not at all. Last year, out of 9314 Ohio accidents reported, 161, or 1.7 percent, occurred on narrow bridges and culverts. Of 583 fatal accidents, 9, or 1.5 percent, occurred on narrow bridges. According to Mr. Burkey, probably many other accidents that did not occur *on a structure* were due to the congestion of traffic caused by a narrow or one-way bridge.

WE have cited the completeness of these records kept by Ohio, simply to point a moral. Other states, neglecting to study the serious menace of old, narrow, or badly aligned bridges, will do well to emulate Ohio's example. That state, in addition to the splendid record-keeping job, has also followed a definite schedule of replacement of obsolete bridges. In 1935, contracts were let for 56 bridges with a total length of 3700 feet, at a cost of approximately 1,000,000 dollars. To July 1st of this year, 47 were contracted for at a cost of more than 1,000,000 dollars. This, indeed, *is* a commendable record, but Mr. Burkey estimates that 35,000,000 dollars will be required to replace all the obsolete bridges on the present system.

This brings up the question of costs. We will turn, therefore, to figures supplied by Mr. A. J. Boase of the Portland Cement Association. He says that a typical 20-foot wide, two-lane highway built for heavy duty on primary state highways comprising the best type of materials and workmanship available today, and including grading, earthwork, and small culvert structures, will cost approximately $2.55 per square yard. "For intermediate construction on secondary roads," he says, "the corresponding cost is around 60 percent of that given for high duty types. For a high quality concrete bridge to carry this road on a span of around 50 feet, for example, the cost, including all incidentals, would be about 35 dollars to 55 dollars per square yard of usable deck surface, 45 dollars being a fairly good average value. This means that the bridge per unit of surface will cost about 17½ times as much as the highway." Thus is explained one reason why old bridges have been neglected: the engineers can show 17½ times as much highway for the same money. The desire has seemed to be to get a surface on all roads as quickly as possible and make them passable the year 'round. Roads have too often been located to make use of old structures, thereby sacrificing proper alignment and grades.



As rapidly as possible, some states are replacing obsolete bridges with structures such as these two in Ohio. Former bridges here were built for horse and buggy days; not for cars

TO quote Mr. Burkey again:

"Necessary bridge and road construction has had to be postponed in the last few years due to the diversion of funds raised for highway purposes—by gasoline taxes, registration fees, and other means—to relief and other governmental activities. (According to *The S. A. E. Journal*, 91,000,000 dollars of the money paid by motorists in special taxes was diverted last year to other than highway purposes.—EDITOR.) The injustice of this procedure is becoming more apparent to the motor vehicle users and the general public and it is hoped that the trend in the immediate future will be to restore these funds to their proper uses.

"The general practice of appropriations being made for highways, including bridges, with no provision made for the amount that shall be expended on bridges, works to the detriment of necessary bridge construction. This is due largely to the fact that the general traveling public quickly notices and complains about road conditions which slow up traffic or make traveling uncomfortable, whereas no complaint will be made about a dangerously weak bridge as long as it does not collapse." We hollered for better highways and got them. We permitted ourselves to be satisfied with new planks or blocks on the bridge floors and ignored what held them up.

One state, then, stands forth alone in this country in the completeness of her highway bridge records, and in her recognition of the fact that hundreds of these bridges constitute a menace to lives and property. Ohio has fought the problem through logically and frankly, confessing her failures, and doing her best to remedy them. Other states, by comparison, have been extremely backward—some criminally negligent! No matter where the fault *apparently* lies. Actually, each entire state as a whole is responsible for forgetting her dangerous bridges. The states themselves—officialdom and public alike—must take the situation in hand, study it through as Ohio has done, and apply the remedy as rapidly as possible. If they do not, there is certain to be a steadily mounting toll of lives as these forgotten bridges grow older, and the economic loss will pile up to enormous totals.

Bridges are not separate entities. They are as much a part of the highways on which they lie as are the road surfaces. They possess no special merit entitling them to discriminatory *laissez-faire* treatment. Indeed, since they are, at best, fixed objects seeming to invite collision, and, at the worst, potential death-traps, perhaps more attention should be paid to them than to adjacent highways. Only when the country realizes the fact that "horse-and-buggy" bridges are not compatible with safety will the road factor in the accident problem be on its way to a final solution.

UP TO DATE ON

Efforts to Piece Together the Biggest Present Puzzle of Physical Science Go On . . . Part of the Picture Emerges but Much Remains a Deep Mystery

THE past twelve months and the next to come may well be marked in science texts of the future as the crucial period in the development of cosmic ray theory. Within the last year the controversy over the nature of cosmic rays has resolved itself into a more or less general agreement. What the next will bring remains to be seen; but indications are that at least some of the outstanding mysteries should be cleared up. So much cosmic ray research is being done all over the world that the scientific journals are continually crowded with accounts of new experiments and measurements.

But why so much interest in a phenomenon which is so far lacking in practical applications? These rays go whizzing around and about us with incredible energies, but without any obvious effect or any way, obvious or otherwise, of being harnessed to do work. Well, the answer is partly man's natural-born curiosity to know what makes the wheels go round; and partly that, when we find out all there is to know about cosmic rays, we shall know a great deal more about how the universe behaves, from the stars right down to individual atoms. We might then be able to produce cosmic rays artificially, as we do X rays, and there is no telling what an ingenious scientist might do with so powerful a tool in his hands.

Cosmic rays have the universe for their playground. They pour into the earth's atmosphere from all directions at once, and there is every indication that they pervade all interstellar space. They come apparently from nowhere, and speed along their way, like Sunday drivers, with nowhere in particular to go.

ORDINARILY they travel in straight lines, like light, and indeed, for a long time cosmic rays were thought of as being a high-energy wave or photon radiation similar to light and X rays. But within the last few years experimental evidence has been piling up to show that they cannot be photons at all.

For when a fairly low-energy ray comes within reach of the earth's magnetic field, it departs from its straight line path and curves in toward the earth's magnetic poles (Figure 1). Only rays of very high energy, more than 20 billion electron volts, can go vertically through the atmosphere at the equator. So if we take an instrument to measure the number of rays reaching sea level per minute, we shall find more coming in in the higher latitudes, nearer the earth's magnetic poles, than at the equator. This increase in intensity as one goes north or south from the equator is known as the latitude effect. It was discovered by Clay in 1927, and has since been amply verified by Compton, Millikan, and many others.

The latitude effect at sea level is not very great, but if we took our cosmic ray counters up in an airplane, as Bowen, Millikan and Neher have done, or in a stratosphere balloon, we should find the variation much more pronounced. At the very top of the atmosphere, the polar intensity is probably more than a hundred times greater than the intensity at the equator.

Figure 1: **How the earth's magnetic field deviates arriving particles. From Lemon, "Cosmic Rays Thus Far," courtesy W. W. Norton & Co.**

These facts take some explaining. We know that the rays we measure are deflected by the earth's magnetic field. Such behavior would be inexcusable in a photon, which is able to traverse a magnetic field as if it were not there at all. An electrically charged particle, on the other hand, behaves in a magnetic field just as these rays do, and we must conclude, then, that what we are measuring are streams of charged particles like electrons, positrons, and protons.

But are the rays we measure the real cosmic rays? Suppose for a moment that the original ray is a stream of photons instead of charged particles. Once inside the atmosphere it begins to collide with the molecules and atoms of the air, breaking them up into fragments. These fragments are charged, and they become a secondary cosmic ray.

This theory fits all the facts but one, and that is the rapid increase of the latitude effect with altitude. If the rays we are measuring are entirely secondaries, we should expect to find fewer of them near the top of the atmosphere, where atoms and molecules are few and far between. Here the latitude effect should drop off. Apparently, however, it goes right on increasing as far as the magnetic field is effective.

These are the pieces of the puzzle, and when we fit them together we find we must conclude that at least the greater part of the original cosmic ray consists of charged particles. Photons, neutrons, and any other neutral corpuscles are confined, if indeed they are present at all, to a tiny fraction of the incoming radiation.

HAVING decided this, we can immediately put it to use. The rays are sensitive to all irregularities in the earth's magnetic field, an inconveniently lopsided and unsymmetrical affair. If across a map of the world we draw lines through all the places where equal intensities of cosmic rays occur, we have a series of curves or "isocosms" following almost exactly the lines of equal magnetic force. So in cosmic rays we have a new means of studying the magnetism of our own planet.

The last opponent of the charged particle theory of cosmic rays has fallen by the wayside within the last year, so we can turn now to see what other bones of contention we can unearth. For the discovery that the rays are chiefly charged particles is only half a triumph. We have still to find out what the particles are, what they do, and whence they come.

There is a large class of charged bodies. The lightest of these are the electron and the positron, or positive electron. Then comes the proton, the elementary positive corpuscle which forms the hydrogen nucleus. Next heaviest is the deuteron, the core of heavy hydrogen, with the same charge as the proton but weighing twice as much. Next in line is the helium nucleus or alpha particle, with a charge of two and a mass four times that of the proton. After these come a long series of atomic nuclei or ions, each heavier and bearing more charge than the one before.

Cosmic Rays

By JEAN HARRINGTON

Out of these, which particular particles are pouring into our atmosphere as cosmic rays? In other words, how can we identify and analyse streams of bodies which we cannot see nor feel? Such is one of the most important problems of current research.

Imagine for a moment that we can divide a stream of cosmic rays into several distinct groups: a group of alpha particles, say, another of protons, and so on. Taking one of these groups separately, let us see what happens to it as it approaches the earth in any particular latitude. It has been mentioned before that a particle must have tremendous energy to get through the atmosphere at the equator. It is also true that it must have a certain minimum energy in order to penetrate the atmosphere at all; otherwise it will simply be deflected so much that it retreats off into empty space before it has a chance to reach the air. Now the particles in any group have many different energies, some less, some greater, and some just equal to this minimum or "critical" energy of penetration.

WHAT happens to the particles of critical energy or greater as they hit the air? They crash into atoms and molecules in their way, and at each encounter lose some of their original energy, until finally they come to a standstill and cease to be rays at all. The distance they travel before they lose all their energy is called the range of the particles. Those with the same energies have equal ranges; and those with the lowest possible or critical energy obviously have the shortest ranges. We can calculate what this minimum range should be for any kind of particle with critical energy. The next step is to compare the calculations with the actual experimental facts.

Piccard, Captain Anderson, and others who have made stratosphere balloon flights have brought back from the heights of the atmosphere records of the cosmic ray intensity. We have said that the intensity goes on increasing steadily up to the top of the air, but this is not quite true. For suppose the balloon reaches the heights where one group of particles with critical energy has just reached the end of its range. Here the instruments will record a certain intensity, based on the number of ions produced by the original particles. Then if the balloon goes still higher, there is no increase in intensity, because there are no more of these particular particles of shorter range to give any additional ionization in the instruments. So if a graph is drawn showing how the intensity increases with altitude, there are flat steps in it at the heights where the various minimum ranges belonging to different types of particles come to an end.

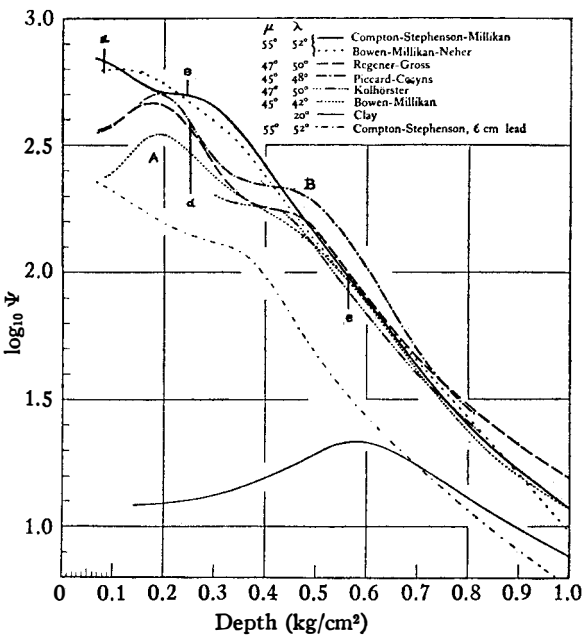


Figure 2: **Humps in vertical intensities of cosmic rays. From** ***The Review of Scientific Instruments***

As a matter of fact, the graphs plotted from actual observations show three such steps, one very high in the atmosphere, one near sea level, and a third falling in between (Figure 2). A beautiful verification of these results was presented at the May meeting of the American Physical Society by Dr. W. F. G. Swann, when he showed the observations made on the historic stratosphere flight last November.

Now, comparing the calculated range of an alpha particle of critical energy with the range indicated by the topmost step, we find that they agree remarkably well. So we conclude that one component of cosmic radiation consists of alpha particles. Similarly we discover that the range of electrons and positrons accounts for the middle step, and that the lowest step is due probably to protons.

There are, then, three chief components of cosmic rays that we can be pretty sure of: alpha particles, found only high in the stratosphere, electrons and positrons which are more penetrating, and protons, the most penetrating of all. We are not justified in saying, however, that these are the only components. For if a stratosphere balloon got beyond the 72,000 feet reached by Captain Anderson in November, it might reveal other steps due to the ranges of particles heavier than the helium nucleus. There may also be neutral particles, like photons or neutrons, with even greater ranges than the proton; but these, if they occur at all, form so small a fraction of the total radiation that they do not show up in the experimental curve. Very probably there are no other charged particles with a minimum range greater than protons, unless there is some very penetrating body still unknown to science.

IT should be noted that, in comparing the observed ranges with those calculated, we must reduce them to the same terms. For a particle with a given energy will travel much farther in the rarefied gas of the stratosphere than it will near sea level where it encounters many more atoms and molecules per centimeter of path. One must compute what depth of stratosphere air is equivalent to a unit volume of air at ordinary pressure in order to make any comparison. There is still a great deal of uncertainty in making these calculations, because it is not known to any degree of exactitude just how or how fast the rays lose energy in going through the air.

An interesting verification of the presence of alpha particles in the upper atmosphere was reported to the American Physical Society recently by T. R. Wilkins of the University of Rochester. His, he claimed, was the simplest equipment to be sent up in the National Geographic-Army Air Corps stratosphere balloon. It consisted only of a set of specially prepared photographic plates attached to the outside of the gondola. Any particle which happened to glance across one of these plates at the right angle would leave its characteristic

track in the emulsion. Although the thorough examination of the plates is a long and tedious operation, those already studied show long, heavy tracks due to high energy alpha particles. No trace of other particles has yet been found.

Electrons and positrons have also been observed in Wilson cloud chamber photographs. But no one, up to the time this paper is being written, has yet succeeded in definitely cornering a cosmic ray proton, by cloud chamber photographs or otherwise. At best we can say that the data gathered so far seem to point to protons as the third chief group of cosmic ray particles; and by the end of the year there may no longer be any uncertainty about it.

One of the many effects of cosmic rays, the most interesting and the least understood, is the production of showers of charged particles. A cloud chamber photograph (Figure 3) of a shower shows a sheaf of dozens of tracks all originating from the same point, and curving in the magnetic field of the chamber, some more than others, some to the left, others to the right. The interpretation of such a photograph is that large numbers of positive and negative electrons of different energies are produced almost simultaneously by a single cosmic ray encounter. The negative electrons are deflected in one direction by the magnetic field, while the positrons are curved in the opposite way. Those of lower energies have the shorter and more curved paths.

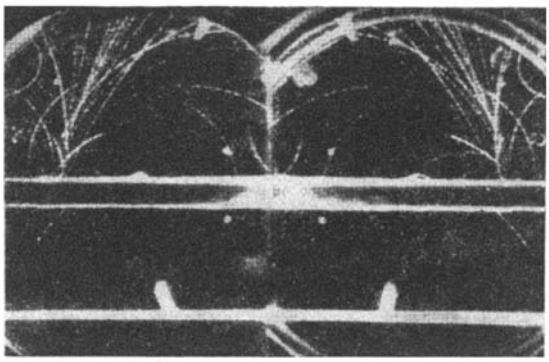


Figure 3: **A cloud chamber photograph by Anderson, showing dozens of cosmic ray tracks curved, as explained in the text, by the magnetic field**

THE particle responsible for these atomic cataclysms is very probably a photon. This seems a bit absurd, as we have already devoted a page or two to proving that photons can have but an inappreciable place in cosmic radiation. True, but we were talking then about those pristine rays which come through space just as they were created. What reaches us and what our instruments record may be only fourth or fifth cousins of the original family. For a whole series of things may happen before the energy in one of those primary rays is dissipated.

We think of an atom as a heavy nucleus surrounded by a number of electrons. Suppose one of the cosmic ray particles runs into such an atom in the atmosphere, as we have pictured it doing several times before. One of two things may happen. It may knock an electron from its place outside the atom, leaving the atom as a charged ion and sending the electron along as a secondary ray. This is the process of direct ionization, and we believe that the proton is most efficient at this type of encounter.

Or the cosmic ray particle may penetrate clear to the nucleus, causing profound energy changes therein, changes resulting in the emission of some nuclear particle or radiation, in turn giving rise to an X-ray photon. Now this photon can lose its energy in producing an electron and positron; these smash into other nuclei to bring forth new photons, which in the course of events create new electron pairs, and so the cycle progresses until the energies involved become too low to be effective. Long and complicated as such a process seems, it occurs practically instantaneously in a region where gas molecules are crowded closely together, as they are in a cloud chamber.

So in this second process of cosmic ray encounters is a possible explanation of the showers. The theory that the photon starting a shower is probably a secondary is supported by the fact that showers follow the same variation in latitude as the original rays; that is, more occur at higher latitudes than near the equator.

One well-established but not too well-explained observation is the rapid increase in the number of showers per minute with increasing altitude. The growing intensity of the original cosmic rays themselves as one goes higher in the atmosphere accounts for a part but not all of the increase. It has been shown experimentally, however, that the shower-producing photons are excited primarily by electrons and positrons, and there is a theory of Bethe and Heitler, based on wave mechanics, to back up the experimental results. We remember that positive and negative electrons are less penetrating than protons, and thus occur in relatively larger numbers high in the atmosphere. If we could prove that the increase in the number of electrons and positrons alone with altitude coincides with the increase in showers, our problem would be solved.

However, Dr. Millikan, the old antagonist of the charged particle theory of cosmic rays, and still partial to his photons, has recently made some shower measurements on the top of Pike's Peak. He found that the increase in showers at that altitude was much larger than the relative increase of electron intensity. On that basis he proposes that some of the showers must be caused by primary rather than secondary cosmic ray photons. This could mean that the fraction of incoming photons must be considerably larger than most scientists are willing to admit. Although Dr. Millikan's results were questioned at the time he made his report, there are many such inconsistencies and uncertainties still to be cleared up.

NOW a word about the energies of cosmic rays. The chief experimental method of determining the energies of charged particles is based on the property we have mentioned many times before; namely, their deflection in a magnetic field. One difficulty with this method lies in deciding which of the particles are primaries and which secondaries; another is that particles with energies higher than four or five billion electron volts are affected so little, even by the strongest magnetic fields that we can produce, that it is impossible to measure the curvature of their tracks accurately. But other considerations, based on the theory of penetration and on measurements of the great depths beneath the surface of the earth which some of the rays manage to reach, indicate energies ranging roughly from a billion to perhaps more than 600 billion electron volts. These are much higher values than were accepted last year, since in the interim scientists have come to agree that the particles of lower than a billion volts energy are, in general, secondaries.

While our knowledge of the laws of absorption of high-energy particles passing through matter is still more qualitative than accurately quantitative, and most of our calculations therefore only approximations, we can say that the energies of the original cosmic rays are so great as to be almost beyond human imagination. But where do these particles acquire such inconceivable speeds? This is a question we must leave for the future. At present the hypotheses concerning the birth of cosmic rays are at best wild guesses. The rays seem to come from beyond the solar system, and from far beyond the island universe of stars and nebulæ in which our own little system lies embedded. Probably the rays have been traveling through empty space for billions of years before they reach us. But where they started from, and why, neither Compton nor Millikan, nor Swann nor any other cosmic ray expert can yet tell you.

Microscopic Big Books

Books, Documents, Drawings, Newspapers on Tiny Film Read in Projector . . . System Saves Handling of Originals . . . Enlarges Libraries . . . Many Uses

By R. G. SKERRETT

THE crowded contents of a large library can now be duplicated on a microscopic scale and yet rendered optically available, when desired, on even a somewhat magnified scale for the greater convenience and comfort of the reader. This has been made possible by cameras of special kinds, by films of superfine grain, and by recently developed reading machines of light and compact forms that enlarge and project the recorded micro-copies. Thus we have a significant advance over the method, first used some years ago, of making a film record of pages of rare books so that the books themselves might suffer less destructive handling.

A monster reference book is reduced to a film sealed in the case (with box) shown at left

The question of space in the library, in the office, and elsewhere is yearly becoming increasingly acute, because suitable space costs more and more and involves complications. By the use of the new method, printed pages, drawings, music, current files, and the like can be reduced to microscopic size and reproduced for reading or examination with a great saving in weight and bulk.

Work in this field has been going forward abroad and in this country for years, but much has been accomplished lately in this country to make the benefits of micro-copying available to the greatest number of people. By means of micro-photography an original full-size page can be reduced from 150 to 400 times, registered well-nigh imperishably on specially treated films, and then encased in sealed cartridges ready to be inserted in a suitable magnifying reading machine. A pound of film will carry micro-copies that are the equivalent of a ton of printed matter in the usual form, altering to that degree the whole problem of storage, handling, and distribution.

Heretofore, micro-copying of books and the like has mainly been utilized by the scientific and the academic world. Now, many more people will be able to benefit by this medium of reproduction. Original volumes and documents, virtually museum pieces, need not be handled by the reader in their original form, and accessibility restrictions will, in effect, be lifted by placing the photographic films at the disposal of any responsible person who would be able to obtain from a library the loan of any ordinary volume. The cultural benefits of the new procedure should be self-evident. Furthermore, should an original be destroyed, after micro-copying, then the film would still remain as a source of information and duplication.

It is now the practice of some newspapers to make film record copies of their daily issues instead of printing special issues on rag paper. A number of universities are using the same method to film rare books and manuscripts to amplify the resources of their libraries. Several government departments are pursuing a similar course to preserve valuable publications and to assist isolated scientific workers, educational institutions, organizations and individuals. This is notably the case with our Department of Agriculture. There are banks that thus record daily all the checks that pass through them. Ordinary industrial and commercial correspondence can be reduced to film file records and save in office space and possibly in rented storage space.

The film's tiny "pages" are projected on the screen of this device

The pioneer inventions of Rear Admiral Bradley A. Fiske, U.S.N., in the field of reading machines and the more recent inventions of Verneur E. Pratt are combined in the apparatus produced in the last few months for making and then projecting micro-copies of all kinds of printed matter. The so-called "filmbook" is a film packed in a cartridge or holder in a manner that does not expose the emulsion side of the film to possible marring. In handling the filmbook, the fingers never touch the film, and the container can never be placed in the reading machine inverted. These arrangements insure long service life of the film. The Teledex is a line-reading model to be used with filmbooks of telephone directories and similar volumes, as well as statistical data and the like; and the Optigraph is a reading machine of unrestricted scope.

A LAWYER, a physician, a patent attorney, an engineer, and so on may have at his disposal in his own office in an extremely compact form an entire library relating to his particular profession. Small towns and schools may be able to house filmbook copies of the entire contents of a large metropolitan library. The filmbook method may be employed in reproducing reference books, dictionaries, encyclopedias, and other generally bulky volumes, and do so for a fraction of what the present editions of such works cost. When not in use, the filmbooks can be tucked away in a very small space. Inventive minds, by these unique uses of the camera and the photographic film, have thus opened the way to still more astonishing applications for the benefit of one and all.

NOVAE AND SUPER-NOVAE

The New Star Recently Discovered Lies in Our Own Galaxy and is a Normal Type . . . Some Seen in Other Galaxies Are Enormous . . . Called Super-Novae

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. President of the American Astronomical Society.

IT is still news as these lines are written—though it will hardly be when they are published—that still another bright temporary star has appeared. This one was discovered on June 18 by L. C. Peltier of Delphos, Ohio, the active amateur who recently detected the comet which is likely to be visible though not conspicuous to the naked eye about August 1. The star was then of the third magnitude.

Good evidence of how close a watch is now kept upon the heavens is found in the fact that the Nova was independently discovered by Nielsen in Denmark, Loreta in Italy, and by four others at Sonneberg and Heidelberg in Germany, Stalinabad in the Soviet Union, and Kalamazoo, Michigan. The only remarkable feature of this is that one of the discoverers, Hoffmeister of Sonneberg, is a professional astronomer! Most professionals are too busy looking through telescopes or, more probably, guiding eyepieces, to gaze upon the sky at large.

There were many professional astronomers and very competent ones in the 19th Century, but the skilled and competent amateurs of today were rare then. This may explain an apparent puzzle. The present Nova is the sixth since 1900 which has become conspicuous to even a casual glance, and the second, Nova Geminorum of 1912, surpassed the fourth magnitude and was easily visible to the naked eye even under poor conditions. That is, we have had a naked-eye Nova every five or six years. Yet only three such objects, none of them very bright, were recorded in the last half of the 19th Century. Is this merely an accident such as well may happen with something that occurs at irregular and unpredictable intervals? Or are the heavens better watched than formerly? We can be certain that no object like Nova Persei, which was at best as bright as Vega, and Nova Aquilae, twice as bright, appeared between 1850 and 1900—unless, indeed, it blazed up in the part of the heavens close to the sun and faded again before the sun had got out of the way. There is one chance in three or four that this would happen. Setting these two aside we have three in 50 years against four in 36, which is no larger a fluctuation than is very likely to come by chance.

So we cannot be sure how much of the present abundance of recorded Novae is to be attributed to the diligence of modern observers and how much to the casual bounty of Nature. We know for certain, however, that the amateur's careful watch has resulted in the discovery of recent Novae at an early stage of their career, and so made it possible to secure observations of great importance which would otherwise have been lost forever.

The new discovery will be known as Nova Lacertae, since an exact determination of its position shows that it lies a fraction of a minute of arc from the boundary between this constellation and Cepheus—to which it was at first accredited. This is a good example of the utility of the exact delimitation of the constellations, which was reported in these columns a few years ago.

OWING to precession, the declination of this star is increasing and if the constellation boundaries were supposed to move with the pole and equinox, it would now be in Cepheus. But the boundaries are fixed in terms of the equinox of 1900, so no such absurdity can arise. Proper motion might really carry the star across the line, and it is lucky that it is not double for we might then have an astronomical analogue of the story of the man whose house was in Massachusetts, but his back yard and garage in Rhode Island, so that he had to pay for car licenses in both states.

The Nova itself appears to be of the normal type like Nova Aquilae. It rose to maximum at magnitude 2.3 on June 20 and has dropped rapidly. Van Beisbroeck reports that it is probably identical with a 15th magnitude star which appears in photographs between 1893 and 1930. Its spectrum just before maximum showed dark lines displaced to the violet, indicating a velocity of 1100 kilometers per second. This is a high velocity even for a Nova, and suggests that the outburst was a great one and that the star is remote. Struve's statement that there are strong interstellar calcium lines confirms this suspicion. A reliable determination of the distance may some day be made if an expanding nebula around the star becomes telescopically observable, but this may require years.

Not long before this conspicuous star absorbed the attention of observers, a faint but really far more remarkable Nova was recorded in a spiral nebula. The appearance of new stars in extragalactic nebulae is by no means unprecedented. A new star appeared in September, 1885, close to the center of the great Andromeda nebula, and rose to magnitude 7.5. Had modern spectroscopic equipment been available a great deal could have been found out, but in those days only visual observations could be made and those were indecisive. A Nova, Z Centauri, appeared later in a southern spiral nebula, and no less than five of these objects were observed in nebulae belonging to the great Virgo cluster between 1909 and 1926. Spectrum photographs of Z Centauri and of one of the others were obtained, but were again hard to interpret conclusively owing to the very small scale.

A watch has been kept at Mount Wilson for similar objects, and was rewarded in January of the present year when a star of magnitude 14.5 was observed by Hubble and Moore in the spiral nebula N.G.C. 4273, where nothing had been visible three weeks before. In a month it had faded to a quarter of its original brightness, confirming the diagnosis of a temporary star.

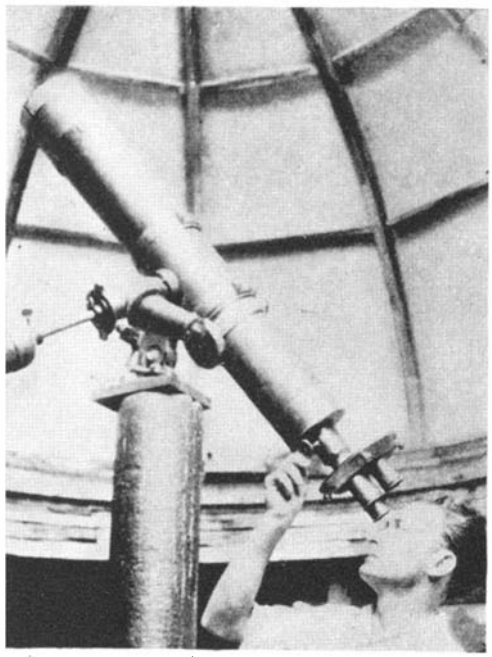
These figures do not appear at first sight to be remarkable, but this nebula is very far away. The distance to the middle of the cluster to which it belongs is estimated by Hubble, on very good evidence, as 7,000,000 light-years. To appear of the 14th magnitude at that distance the Nova must have been 8,000,000 times as bright as the sun! There is good reason for the name "Super-Nova," which is now generally accepted.

The star in the Andromeda nebula must have been brighter still. The distance of this is well determined as 900,000 light-years and the correspond-

ing maximum brightness is 60,000,000 times the sun's. These are amazing figures but there is a direct check on the last and wildest; for large numbers of much fainter Novae have been observed in the same nebula. These are fairly similar in maximum brightness and, with the same assumption regarding the distance, they come out from 5000 to 100,000 times as bright as the sun. These are almost exactly the limits which are found by altogether independent methods for the bright Novae which can be studied in full detail.

THIS is convincing evidence but, nevertheless, how can a single star give out many times as much light as all the stars visible to the naked eye?* Two ways are open: it may be very big or very hot. Without knowledge of the spectrum we could do no more than speculate. But Humason, with the 100-inch reflector and the new and very powerful nebular spectrograph (which gives tiny images but can reach very faint stars), photographed the spectrum of this latest Super-Nova in February, 1936 (when it was of magnitude 15.7!!) and obtained a plate which shows definite details. The spectrum at first sight looks queer enough but, when compared with those of other Novae, it becomes intelligible. The principal features are enormously wide, though not very intense emission bands which may be interpreted as the hydrogen lines Hβ and Hα, and a group of nitrogen lines in the blue (near 4650) all prodigiously expanded to a width of from 150 to 200 angstroms. These are just the lines which are strongest in some typical Novae of the ordinary sort, but to widen them to this extent demands a shell of gas expanding with a velocity of 6000 kilometers a second.

A faint spectrum of a Super-Nova in another nebula, obtained at Mount Wilson by Nicholson in 1926, is strikingly similar, and Mrs. Gaposchkin at Harvard had independently shown that the photographed spectrum of Z Centauri was of the same character. As for S Andromedae, the verbal descriptions of visual observers, which alone are available, are consistent with a spectrum of the same sort. It appears, therefore, that the spectra of Super-Novae differ from those of ordinary Novae mainly by exaggeration of these remarkable features—the bright bands widening so greatly that only the stronger ones are saved from merging into a general confusion. Physically this suggests that the outburst of a Super-Nova differs from the ordinary kind mainly in its intensity. The shell of ejected matter is blown off many times faster. In the same number of days it travels correspondingly further, so we might well expect Super-Novae to be much greater in diameter than ordinary ones at comparable dates. Whether they are brighter per square mile as well is harder to tell, but Mrs. Gaposchkin in a very recent paper points out that the great strength of the blue nitrogen lines in ordinary Novae indicates a relatively moderate degree of atomic excitation which is surpassed in other cases. If, following her lead, we assume that at maximum a Super-Nova shines ten times more brightly per unit of surface than the sun, the surface area of S Andromedae comes out 6,000,000 times the sun's and its diameter about 2500 times the sun's, rather larger than the orbit of Uranus. The recently observed star, on the same assumptions, would be about one third as big, or three times the size of a giant star like Antares.



L. C. Peltier in his home-made observatory. Many notable discoveries have been his

There is nothing absurd about these dimensions, particularly when we recall that they are those of the expanding shell of gas at the time when it begins to become transparent and let through the ultra-violet light from the central core. At 6000 kilometers per second the shell would expand to 750 times the sun's diameter in a single day. It might easily keep on for two or three days before it grows thin, depending on the amount of material which was originally blown off the star. So this hypothesis appears to be quite reasonable.

A Super-Nova must get rid of an enormous amount of energy. If it remains of 60,000,000 times the sun's brightness for a month, it would lose as much visible radiation as the sun does in 5,000,000 years. How much more escapes in the ultra-violet (unobservable through our atmosphere) we do not know—some allowance has already been made for it by overestimating the duration of maximum brightness. Measured in engineering units the amount of energy is great beyond conception. From the cosmogonic standpoint it is not so high. The store of internal energy which the sun possesses in virtue of its huge internal temperature is about three times as great, and a dense massive star would contain much more. It is possible, therefore, to explain even a Super-Nova on Milne's theory that some growing approach to internal instability breaks down with a sudden contraction of the central mass of a star, liberating a tremendous store of heat. It may be, however, that in these vastest of all known energy-transactions a wholesale liberation of sub-atomic energy occurs. We must wait for further data—and perhaps wait a long time—before we can decide.

IF Super-Novae appear in external galaxies, why may they not in our own? It is likely enough that one has actually been seen. Tycho Brahe in 1572 carefully observed a Nova in Cassiopeia which became brighter than Venus and was visible in broad daylight. He observed its position within a fraction of a minute of arc, without the aid of the telescope! There is nothing near this place now which can be connected with the Nova. Had it been an ordinary Nova, it would have had a large parallax. Assuming it to have been a Super-Nova we get a distance of about 2000 light-years, which is reasonable enough.

Stranger perhaps than all else is the thought that in the phenomenon of Super-Nova—which we date naturally by the time at which we see them—we are studying specific transitory events which happened not a few centuries ago in historic times but in the geologic past before the Ice Age had begun and when no intelligent life inhabited our planet.
—*Princeton University Observatory, July 6, 1936.*

●

Few amateur or professional astronomers have ever known the skies better than Leslie C. Peltier, whose vocation is that of a draftsman but who spends the greater part of his free time in the avocation of variable star observing and the search for comets and new stars; in fact few professional astronomers have the opportunity to become thoroughly *familiar with the appearance of each detailed constellation.*—Ed.

*There are about 6000 such stars. If they average 100 times as bright as the sun, their total light is 1 percent of that of S Andromedae, but allowance for very bright stars like Rigel or α Cygni would increase this total.

LIQUID-PROPELLANT ROCKET

Gyroscopic Control... Speeds of 500 and Then 700 Miles per Hour Attained... The Next Step Toward Higher Speeds and Elevations is Weight Reduction

(In Two Parts—Part 2)

ALTHOUGH much of the eastern part of New Mexico appeared to be suitable country for flights because of clear air, few storms, moderate winds, and level terrain, it was decided to locate in Roswell, where power and transportation facilities were available.

A shop 30 by 55 feet was erected in September 1930 (Figures 5 and 6), and the 60-foot tower previously used in Auburn and Fort Devens was erected about 15 miles away (Figure 7). A second tower, 20 feet high (Figure 8), was built near the shop for static tests; that is, those in which the rocket was prevented from rising by heavy weights, so that the lift and general performance could be studied. These static tests may be thought of as "idling" the rocket motor. A cement gas deflector was constructed under each tower, as may be seen in Figures 7 and 8, whereby the gases from the rocket were directed toward the rear, thus avoiding a cloud of dust which might otherwise hide the rocket during a test.

Figure 5: **The shop which was erected in Roswell, New Mexico, in 1930**

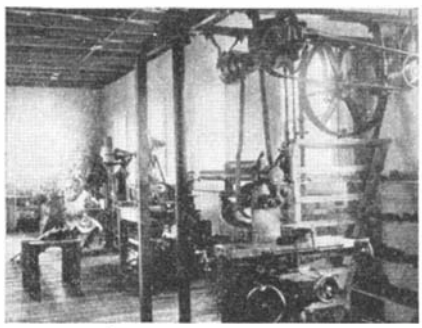


Figure 6: **Interior of the shop at Roswell, with its several machines**

Although, as has been stated, combustion chambers had been constructed at Clark University which operated satisfactorily, it appeared desirable to conduct a series of thorough tests in which the operating conditions were varied, the lift being recorded as a function of the time. Various modifications in the manner of feeding the liquids under pressure to the combustion chamber were tested, as well as variations

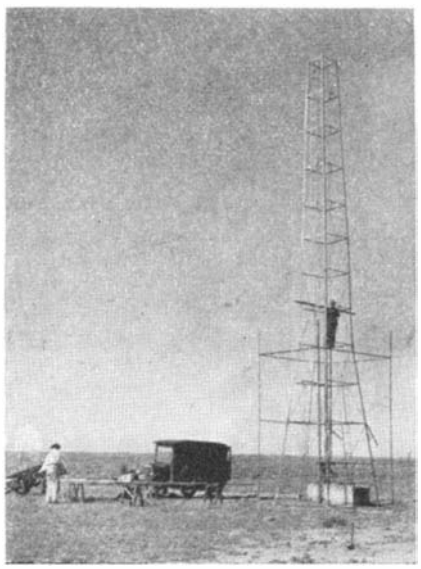


Figure 7: **The 60-foot tower that was previously used in the North**

in the proportions of the liquids, and in the size and shape of the chambers. The chief conclusions reached were that satisfactory operation of the combustion chambers could be obtained with considerable variation of conditions, and that larger chambers afforded better operation than those of smaller size.

As will be seen from Figure 8, the supporting frame for the rocket was held down by four steel barrels containing water. Either two or four barrels could be filled, and in the latter case the total weight was about 2000 pounds. This weight was supported by a strong compression spring, which made possible the recording of the lift on a revolving drum (Figure 9) driven by clockwork.

The combustion chamber finally decided upon for use in flights was 5¾ inches in diameter and weighed five pounds. The maximum lift obtained was 289 pounds, and the period of combustion usually exceeded 20 seconds. The lifting force was found to be very steady, the variation of lift being within 5 percent.

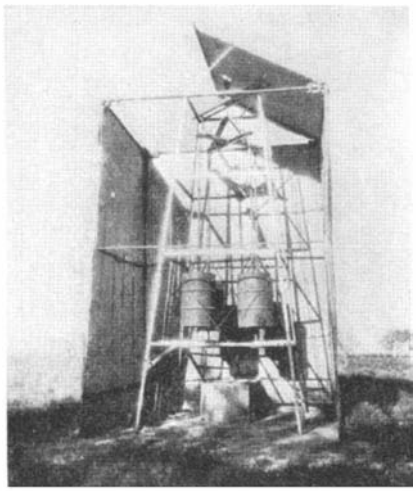


Figure 8: **The 20-foot tower near the shop, used for the static tests**

The masses of liquids used during the lifting period were the quantities most difficult to determine. Using the largest likely value of the total mass of liquids ejected and the integral of the lift-time curve obtained mechanically, the velocity of the ejected gases was estimated to be over 5000 feet per second. This gave for the mechanical horsepower of the jet 1030 hp., and the horsepower per pound of the combustion chamber, considered as a rocket motor, 206 hp. It was found possible to use the chambers repeatedly.

THE results of this part of the development were very important, for a rocket to reach great heights can obviously not be made unless a combustion chamber, or rocket motor, can be constructed that is both extremely light and can be used without danger of burning through or exploding.

The first flight obtained during this period was on December 30, 1930, with a rocket 11 feet long, weighing 33.5 pounds. The height obtained was 2000 feet, and the maximum speed was about 500 miles per hour. A gas pressure tank was used on the rocket to force the liquid oxygen and the gasoline into the combustion chamber.

In further flights pressure was obtained by gas pressure on the rocket,

DEVELOPMENT

By ROBERT H. GODDARD
Director of the Physics Laboratory at Clark University

and also by pumping liquid nitrogen through a vaporizer, the latter means first being employed in a flight on April 19, 1932.

In order to avoid accident, a remote control system was constructed in September 1931, whereby the operator and observers could be stationed 1000 feet from the tower, and the rocket fired and released at will from this point. This arrangement has proved very satisfactory. Figure 10 shows the cable being unwound between the tower and the 1000-foot shelter, the latter being in the far distance, and Figure 11 shows the control keys being operated at the shelter, which is provided with sand bags on the roof as protection against possible accident. Figure 10 shows also the level and open nature of the country.

One observer was stationed 3000 feet from the tower, in the rear of the 1000-foot shelter, with a recording telescope (Figure 12). Two pencils attached to

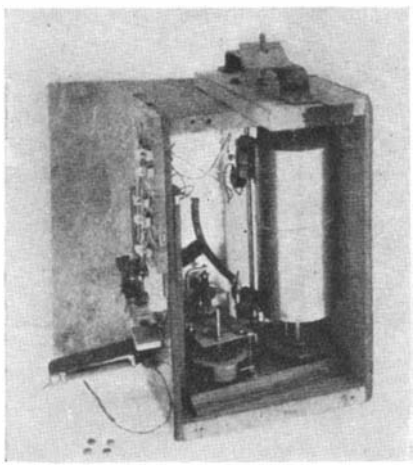


Figure 9: **Revolving drum for recording the lift in the static tests**

this telescope gave a record of the altitude and azimuth, respectively, of the rocket, the records being made on a paper strip, moved at a constant speed by clockwork. The sights at the front and rear of the telescope, similar to those on a rifle, were used in following the rocket when the speed was high. In Figure 13, which shows the clock mechanism in detail, the observer is indicating the altitude trace. This device proved satisfactory except when the trajectory of the rocket was in the plane of the tower and the telescope.

Figure 10: **Cable being unwound between the tower and the shelter**

For great heights, short-wave radio direction finders, for following the rocket during the descent, will be preferable to telescopes.

During this period a number of flights were made for the purpose of testing the regulation of the nitrogen gas pressure. A beginning on the problem of automatically stabilized vertical flight was also made, and the first flight with gyroscopically controlled vanes was obtained on April 19, 1932, with the same model that employed the first liquid nitrogen tank. The method of

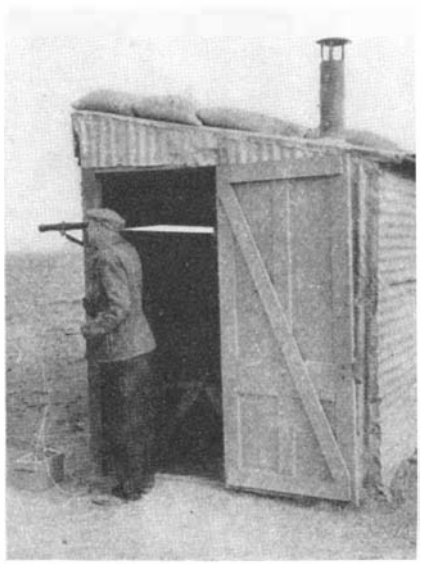


Figure 11: **Control keys being operated at shelter. Note sand bags**

Figure 12: **Observer and recording telescope 3000 feet from the tower**

stabilization consisted in forcing vanes into the blast of the rocket[5] by means of gas pressure, this pressure being controlled by a small gyroscope.

As has been found by later tests, the vanes used in the flight of April 19, 1932, were too small to produce sufficiently rapid correction. Nevertheless, the two vanes which, by entering the rocket blast, should have moved the rocket back to the vertical position were found to be warmer than the others after the rocket landed.

This part of the development work, being for the purpose of obtaining satisfactory and reproducible performance of the rocket in the air, was conducted without any special attempt to secure great lightness, and therefore great altitudes.

IN May 1932 the results that had been obtained were placed before the advisory committee, which voted to recommend the two additional years of the development. Owing to the economic conditions then existing, however, it was found impossible to continue the flights in New Mexico.

A grant from the Smithsonian Institution enabled the writer, who resumed full-time teaching in Clark University in the fall of 1932, to carry out tests that did not require flights, in the physics laboratories of the University during 1932-33, and a grant was received from the Daniel and Florence Guggenheim Foundation which made possible a more extended program of the same nature in 1933-34.

A grant made by the Daniel and Florence Guggenheim Foundation in August 1934, together with leave of absence for the writer granted by the Trustees of Clark University, made it possible to continue the development on a scale permitting actual flights to be made. This was very desirable, as

[5] U. S. Patent, Mechanism for Directing Flight, No. 1,879,187, September 27, 1932.

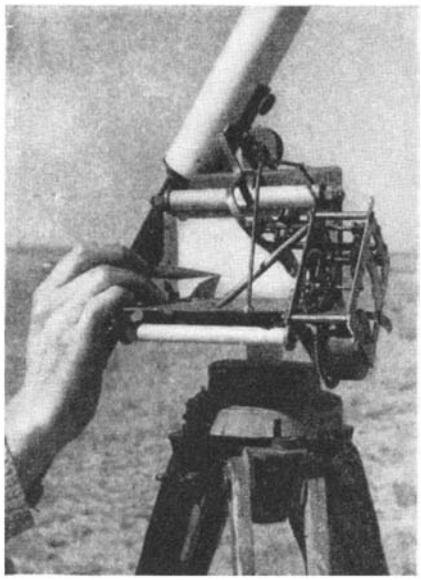


Figure 13: **The recording telescope and the automatic clock mechanism**

further laboratory work could not be carried out effectively without flights in which to test performance under practical conditions.

Work was begun in September 1934, the shop being put in running order and the equipment at the tower for the flights being replaced. The system of remote control previously used was further improved and simplified, and a concrete dugout (Figure 14) was constructed 50 feet from the launching tower in order to make it possible for an observer to watch the launching of the rocket at close range. The relative positions of launching tower, dugout, shelter, and telescope are shown in Figure 15.

It was of the first importance to perfect the means of keeping the rockets in a vertical course automatically, work on which was begun in the preceding series of flights, since a rocket cannot rise vertically to a very great height without a correction being made when it deviates from the vertical course. Such correction is especially important at the time the rocket starts to rise, for a rocket of very great range must be loaded with a maximum amount of propellant and consequently must start with as small an acceleration as possible. At these small initial velocities fixed air vanes, especially those of large size, are worse than useless, as they increase the deviations due to the wind. It should be remarked that fixed air vanes should preferably be small, or dispensed with entirely, if automatic stabilization is employed, to minimize air resistance.

In order to make the construction of the rockets as rapid as possible, combustion chambers were used of the same size as those in the work of 1930-32, together with the simplest means of supplying pressure, namely, the use of a tank of compressed nitrogen gas on the rocket. The rockets were, at the same time, made as nearly streamline as possible without resorting to special means for forming the jacket or casing.

A pendulum stabilizer was used in the first of the new series of flights to test the directing vanes, for the reason that such a stabilizer could be more easily constructed and repaired than a gyroscope stabilizer, and would require very little adjustment. A pendulum stabilizer could correct the flight for the first few hundred feet, where the acceleration is small, but it would not be satisfactory where the acceleration is large, since the axis of the pendulum extends in a direction which is the resultant of the acceleration of the rocket and the acceleration of gravity, and is therefore inclined from the vertical as soon as the rocket ceases to move in a vertical direction. The pendulum stabilizer, as was expected, gave an indication of operating the vanes for the first few hundred feet, but not thereafter. The rocket rose about 1000 feet, continued in a horizontal direction for a time, and finally landed 11,000 feet from the tower, traveling at a velocity of over 700 miles per hour near the end of the period of propulsion, as observed with the recording telescope.

Inasmuch as control by a small gyroscope is the best as well as the lightest means of operating the directing vanes, the action of the gyroscope being independent of the direction and acceleration of the rocket, a gyroscope having the necessary characteristics was developed, after numerous tests.

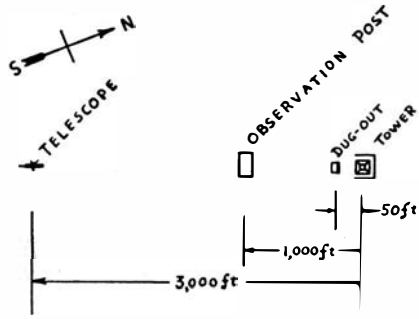


Figure 15: **Showing the relative positions of the several objects named**

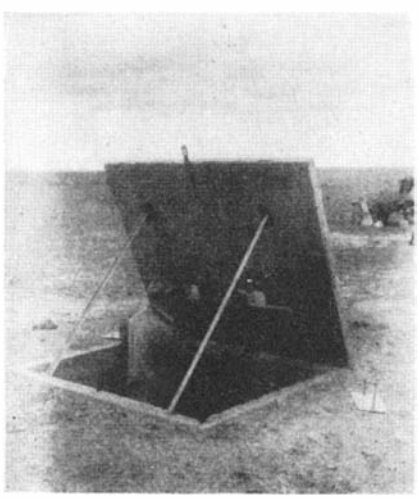


Figure 14: **Concrete dugout permitting observation at close range**

Figure 16: **The author holding in his hands the gyroscopic stabilizer**

The gyroscope, shown in Figure 16, was set to apply controlling force when the axis of the rocket deviated 10 degrees or more from the vertical. In the first flight of the present series of tests with gyroscopic control, on March 28, 1935, the rocket as viewed from the 1000-foot shelter traveled first to the left and then to the right, thereafter describing a smooth and rather flat trajectory. This result was encouraging, as it indicated the presence of an actual stabilizing force of sufficient magnitude to turn the rocket back to a vertical course. The greatest height in this flight was 4800 feet, the horizontal distance 13,000 feet, and the maximum speed 550 miles per hour.

IN subsequent flights, with adjustments and improvements in the stabilizing arrangements, the rockets have been stabilized up to the time propul-

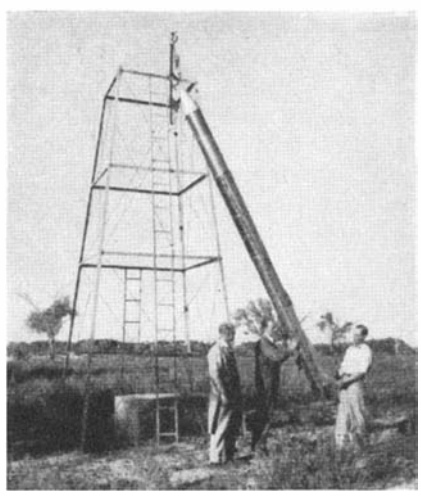


Figure 17: **Testing the gyroscope and directing vanes before flight**

sion ceased, the trajectory being a smooth curve beyond this point. In the rockets so far used, the vanes have moved only during the period of propulsion, but with a continuation of the supply of compressed gas the vanes could evidently act against the slipstream of air as long as the rocket was in motion in air of appreciable density. The oscillations each side of the vertical varied from 10 degrees to 30 degrees and occupied from 1 to 2 seconds. Inasmuch as the rockets started slowly, the first few hundred feet of the flight reminded one of a fish swimming in a vertical direction. The gyroscope and directing vanes were tested carefully before each flight, by inclining and rotating the rocket while it was suspended from the 20-foot tower (Figure 17). The rocket is shown in the launching tower, ready for a flight, in the close-up (Figure 18), and also in Figure 19 which shows the entire tower.

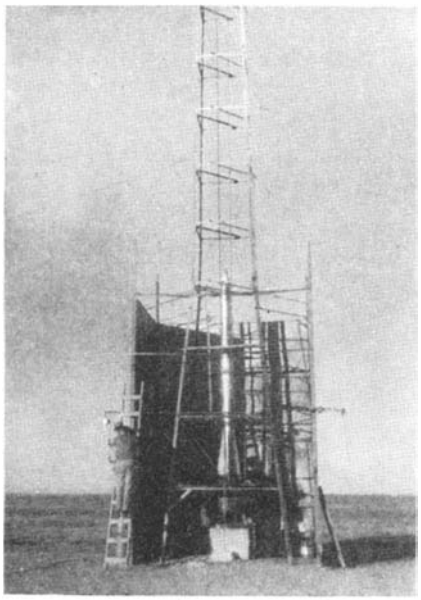


Figure 18: **Close-up of the rocket in launching tower, ready for a flight**

The behavior of the rocket in stabilized flight is shown in Figures 20 and 21, which are reproduced from 16-mm motion picture films of the flights. The time intervals are 1.0 second for the first 5 seconds, and 0.5 second thereafter.

The continually increasing speed of the rockets, with the accompanying steady roar, makes the flights very impressive.

Figure 20 shows the flight of October 14, 1935, in which the rocket rose 4000 feet, and Figure 21 shows the flight of May 31, 1935, in which the rocket rose 7500 feet. The oscillations from side to side, above mentioned, are evident in the two sets of photographs. These photographs also show the slow rise of the rocket from the launching tower, but do not show the very great

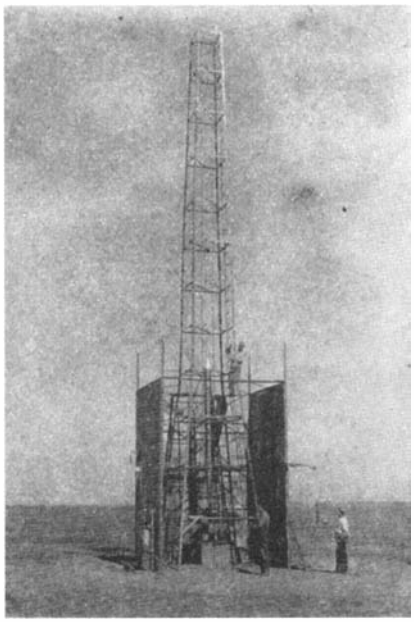


Figure 19: **The same as Figure 18, except that entire tower is shown**

increase in speed that takes place a few seconds after leaving the tower, for the reason that the motion picture camera followed the rockets in flight.

A lengthwise quadrant of the rocket casing was painted red in order to show to what extent rotation about the long axis occurred in flight. Such rotation as was observed was always slow, being at the rate of 20 to 60 seconds for one rotation.

As in the flights of 1930-32 to study rocket performance in the air, no attempt was made in the flights of 1934-35 to reduce the weight of the rockets, which varied from 58 to 85 pounds. A reduction of weight would be useless before a vertical course of the rocket could be maintained automatically. The speed of 700 miles per hour, although high, was not as much as could be obtained by a light rocket, and the heights, also, were much less than could be obtained by a light rocket of the same power.

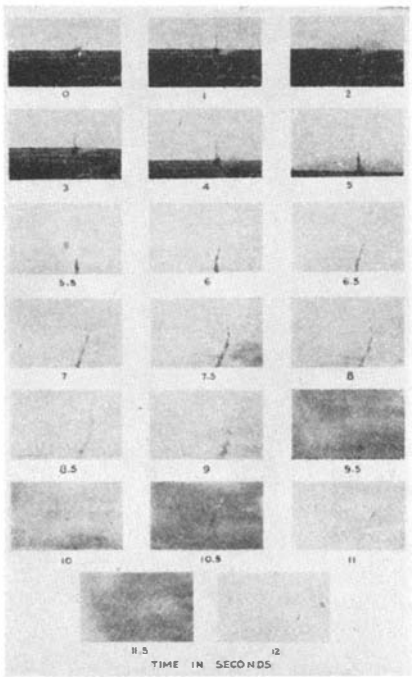


Figure 20: **The flight of Oct. 14, 1935. The rocket rose 4000 feet**

It is worth mentioning that inasmuch as the delicate directional apparatus functioned while the rockets were in flight, it should be possible to carry recording instruments on the rocket without damage or changes in adjustment.

The next step in the development of the liquid-propellant rocket is the reduction of weight to a minimum.

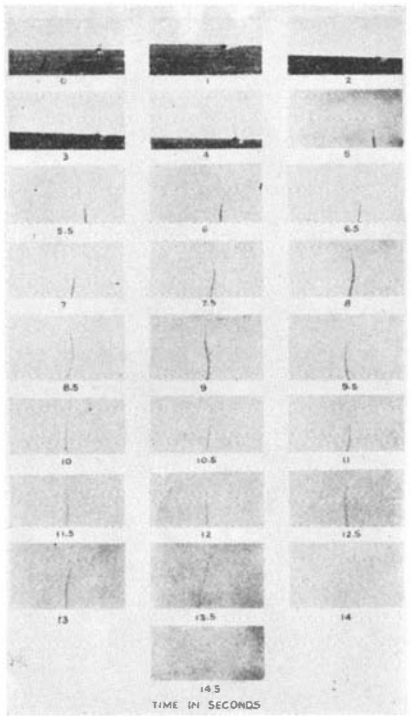


Figure 21: **The flight of May 31, 1935. The rocket rose 7500 feet**

The chief accomplishments to date are the development of a combustion chamber, or rocket motor, that is extremely light and powerful and can be used repeatedly, and of a means of stabilization that operates automatically while the rocket is in flight.

I wish to express my deep appreciation for the grants from Daniel Guggenheim, the Daniel and Florence Guggenheim Foundation, and the Carnegie Institution of Washington, which have made this work possible, and to President Atwood and the Trustees of Clark University for leave of absence. I wish also to express my indebtedness to Dr. John C. Merriam and the members of the advisory committee, especially to Col. Charles A. Lindbergh for his active interest in the work and to Dr. Charles G. Abbot, Secretary of the Smithsonian Institution, for his help in the early stages of the development and his continued interest.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

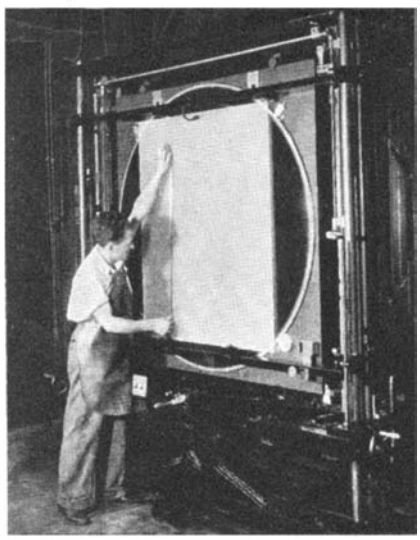
Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

One Million Inches of Fine Ruling on Glass

THE circular halftone screen shown in one of our illustrations is 58 inches in diameter. This screen and two others of the same size are the largest of their kind in existence, and all were made by Max Levy & Company. The screen is shown in place on the plate end of one of the largest color process cameras ever made, in the Chelsea plant of The Forbes Lithograph Company, Boston. It is what is known as a 120-line screen, and is used in making photographic halftone negatives for large lithographic reproductions.



A large half-tone screen—one million inches of fine ruling on glass

The halftone screen is used to produce the dots of various sizes and shapes that can be seen in almost any one-color or multi-color printed reproduction by viewing the reproduction through a magnifying glass. One was used to make the illustrations in this magazine.

In making this huge screen two separate sheets of glass were ruled with parallel lines. These two sheets of ruled glass were then sealed together so that the lines of one sheet were at right angles to the lines of the other. There are over 1,000,000 inches of ruling on these two sheets of glass, and the width of the ruled lines, as well as the distance between them is accurate to 1/40,000 of an inch.

In view of the fact that the halftone reproductions made through this screen contain 14,400 dots to the square inch, and that, in multi-color work, these dots in the various colors have to be located on the printed sheets very accurately to produce the fine clean graduations of color so essential to high grade lithography, it naturally follows that all other equipment—photo-composing, lithographing, and so on—must be accurate and up-to-date in order to match the extreme accuracy of modern photographic equipment.

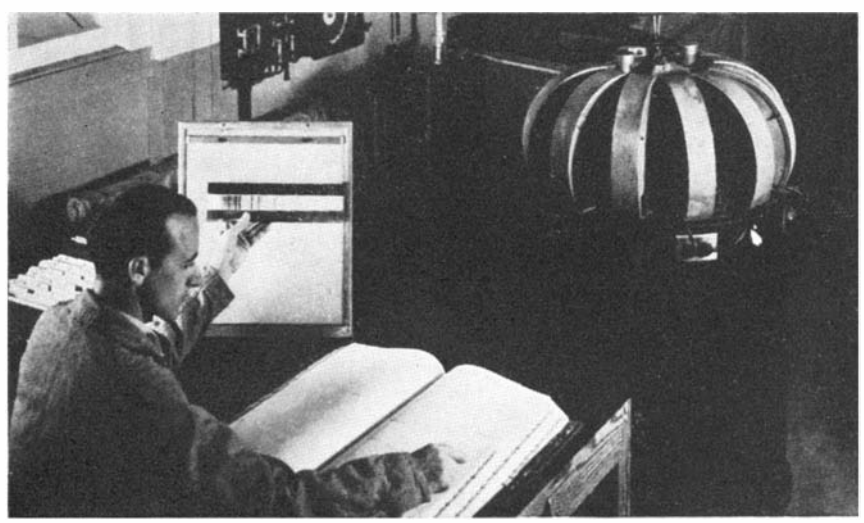
Chemical "Finger-prints"

A UNIQUE method of "finger-printing" chemical substances through the use of X-ray diffraction patterns has been worked out by The Dow Chemical Company.

According to Willard H. Dow, president of the company, the method permits immediate identification of unknowns even though the unknown is a mixture of substances of similar chemical nature. It also permits accurate analysis of particles no larger than the point of a pin. The new method, however, is not applicable to liquids nor to other non-crystalline substances. The company already has acquired a library of 4000 films.

"The taking of X-ray diffraction patterns for the purpose of analysis is not new," said Mr. Dow, "but they formerly proved of little value because they could not be classified. Our chemists have solved the classification problem by taking a leaf from the familiar police system of fingerprinting.

"The molecules of any given compound are arranged in a definite geometrical structure, which is a characteristic of this compound only. Equally characteristic of the given compound is the photographic pattern which results from the interaction of X-rays with this definite geometrical structure. This photographic pattern can be viewed as the 'fingerprint' of the chemical compound. The pattern consists of a sequence of lines of definite positions and intensity. It is these lines which give the key to accurate classification. Just as the lines and whorls of fingerprints permit classification into definite groups with unerring accuracy, so do the positions and intensities of these X-ray diffraction lines.



Chemical "finger-prints" being checked against the record

"We measure the distance from the left edge of the film to A, the heaviest line; to B, the second heaviest line, and to C, the third heaviest. This immediately permits the location of the unknown pattern in the standard classification catalogue. Further examination of the weaker lines quickly gives the final analysis. The system is proving of immense value in experimental work because of its speed and accuracy."

U-V LIGHT AND MOLD

GROWTH of mold on food products, meat, bread and pastry, is prevented by exposing the material to ultra-violet light from special lamps for a period ranging up to several hours.

SMALLPOX MENACE

AMERICANS like to point with pride to achievements resulting from their readiness to make prompt practical application of scientific research. The smallpox situation in the United States provides a distinct blow to any such feeling of pride. Science provided a way to prevent this disease by vaccination against it—as early as the 18th Century. Yet in 1935 there were over 8000 cases of smallpox in the United States.

Instead of decreasing, this preventable disease has been increasing again in the United States, figures collected by the Metropolitan Life Insurance Company show. Half again as many cases were reported last year as in the year 1934.

The black spots on the smallpox map are in the northwestern part of the country. Seven eastern states—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Pennsylvania, and Rhode Island—had no cases during 1935. In the same year, however, eight Western states—Washington, Idaho, Montana, Wyoming, Colorado, South Dakota, Nebraska, and Kansas—had over 5000 cases.—*Science Service.*

"LEAPING LENA"

ONE man operates a new half-ton tamper driven by the explosions from a gasoline engine. This new tamper not only compacts the soil but moves forward as well as upward in its leap. It has been facetiously dubbed "Leaping Lena" though "Powerful Katinka" might do admirably.

Essentially the device is a four-cycle, single-cylinder combustion engine with very simple mechanical features designed to lift the device bodily by utilizing the energy generated in the explosions. It can be operated so that there will be about 50 explosions per minute and can deliver blows at this rate to the surface to be compacted. The truncated cone body of the machine carries a gasoline tank, and has attached two handlebars through which the operator controls and guides it. Dry cells, ignition coils, and other electrical apparatus are carried in a knapsack-like outfit on the operator's back. The explosions are not automatic but are produced separately by a push button contact on the right handlebar. The average height of a jump is about nine inches and the forward movement at each jump about the same.

"Leaping Lena" at rest

This tamper is a product of the Delmag Company of Germany. It is now being used in the work on San Gabriel Dam No. 1 under construction by the Los Angeles County Flood Control District, according to Paul Baumann, Junior Assistant Chief Engineer.

The designer of this unique tamper undoubtedly had a sense of humor, for in arranging the exhaust ports and the air intake, he created an arrangement to give the appearance of a freakish face which has added much to the amusement of observers, particularly in the dark. With the exhaust ports, or eyes, spitting fire, and the air intake, or mouth, opening and closing with each jump, "Leaping Lena" looks like a mean monster to anyone who first becomes acquainted with it.

"Leaping Lena" leaps

RUBBER FOR ROADS

RUBBER roads are being tried out in Queensland, Australia. The raw material is being sent from Papua (New Guinea). So far they have proved too costly, but more latex is now being used with the rubber with better and more economical results. If they are completely successful, the use of rubber will be extended considerably.—*Australian Press Bureau.*

POLARIZING GOGGLES

LIGHT from practically all scenes commonly viewed contains a large proportion of polarized light. Through the use of the new polarizing plate, developed by Alvin M. Marks, research engineer, it is possible for the polarized surface light to be prevented from reaching the eye, whereas the light carrying the underlying detail is not polarized and is readily transmitted to the eye. In other words, the glare reflected from surfaces viewed is eliminated.

These polarizing glasses are available mounted in spectacle frames. They may be obtained either as plano or flat lenses for normal eyes; or through local opticians who will grind the surfaces of the polarizing plate into any lens prescription required.

In reading, especially when the light is ahead, polarized eyeglasses are desirable. Without them, particularly when the print is on glossy paper, indistinct images of the light tend to cause glare and to obscure the contrast between the print and the paper. When polarizing eyeglasses are worn in reading these highlights are eliminated. The blacks seem blacker and the whites whiter, making print and illustrations more legible.

Now that gem-stone cutting has become a hobby for the amateur, motor-driven machines for the work have been designed and built. See Current Bulletin Briefs, page 180

TIRES

A THIN solution of glycerine applied to worn tires will make them shiny and they will have a newer appearance.

WHIRLPOOLS AND VORTICES

AT the Royal Institution in London, Prof. E. N. da C. Andraded recently discussed "Whirlpools and Vortices." The best example of what is ordinarily thought of as a vortex is the whirlpool that is formed where the water runs out of a bathtub or basin. There is a widespread belief that this always spins one way, clockwise or counter-clockwise, and that this is due to the rotation of the earth. Actually, however, if the water is allowed to come to complete rest in a vessel where the hole is accurately in the middle, and if the plug is carefully withdrawn, no whirlpool is formed. The whirlpool that is generally observed is due to some slight rotation given to the water near the edge of the vessel, which, by the laws of fluid motion, becomes very much accentuated where the water runs out. The direction of the spin depends on the direction of this slight motion. If the spin is actually always in the same direction in a particular bath, it is because of some chance influence, such as the position of the taps.

The spin of the earth should actually give rise to a rotation of the water where it runs out, but the effect is far too small to be observed with a bath or basin. Where a large, still, sheet of water runs out through a vertical pipe, as at the intake of a water

turbine, the effect should, however, be large enough to observe. It is, in fact, found that under these conditions whirlpools form, and that the spin of the water is in an opposite direction in the northern and in the southern hemisphere, as it should be.—*Nature* (London).

OIL BURNERS

SHIPMENTS of oil-burning equipment for domestic and commercial use during 1935 increased 38 percent over 1934 shipments, the total number of units moving from manufacturing plants being 138,899, according to the U. S. Bureau of the Census.

Air Conditioning the Airliner

AIR conditioning the transport plane in summer means pre-cooling the interior air before take-off. Once the airplane is at high altitude a natural system of ventilation keeps the passengers comfortably

Pre-cooling the interior of an airliner before it leaves the ground

cool; it is at the airport that artificial cooling must be used.

The conditioner shown in one of our illustrations is eight feet long and is mounted on a standard automobile chassis. It delivers 1200 cubic feet of filtered, cooled, dehumidified air per minute and can reduce cabin temperature from 100 degrees, Fahrenheit, to 39 degrees. The cooling medium is calcium chloride brine, and the pre-cooled air is introduced into the cabin through an insulated metal hose. The weight empty of the conditioner is 2700 pounds; when filled with refrigerant it weighs 5200 pounds.

In winter the process will be reversed, with steam or electric coils warming the air until the engine exhaust-gas heating system takes charge of temperature control.—*A. K.*

Refrigeration on Pacific Airways

THE *Clippers* operated by Pan-American in the Pacific are supported by a stupendous ground organization. A recent issue of *Refrigeration Engineering* gives additional emphasis to the effort exerted. On the tiny islands, Midway, Wake, and Guam—claimed by the United States in 1898 but regarded as unimportant until recently—the landing base is fully equipped with hospital, radio, machine shops, kitchens, and the like. Quite recently 50-room, knock-down hotels were shipped to each of these specks of American territory. To combat the tropical temperature refrigerators have also been provided. These are in the form of huge boxes, constructed of wood with waterproof insulation, and a sheathing of eight layers of aluminum foil in crumpled form, four inches thick altogether. Compressors, methyl chloride in finned coils, all the elements of a modern refrigerating plant are there. Three compartments are available for meat, fish, and fruits and vegetables. The operators of Pan-American are pioneers in true American tradition but they have many more technological resources to back them up than those available to the hardy men in covered wagons.—*A. K.*

New Aviation Fuel

ONE of the main reasons why aircraft engines have increased in specific power and in fuel economy is increased compression ratio. But increased compression ratio and higher powers for a given piston displacement are only possible with fuels of higher "octane rating." Volumes have been written on "octane rating." In the simplest terms we may say that high octane rating means "no-knock" at high compression ratios. High octane ratings have been achieved hitherto by adding tetraethyl lead to gasoline, and blending "iso-octane" with that substance. But iso-octane is very expensive and only available in small quantities.

The Standard Oil Development Company now announces, in a paper read before the Society of Automotive Engineers by H. E. Buc and Major E. E. Aldrin, a new fuel which will give the much desired 100 octane rating, but at a much lower cost than previously. It is available in unlimited quantities.

This new fuel is termed EL-435. In it, tetraethyl lead in the ratio of three cubic centimeters per gallon of gasoline is still included, but the gasoline is blended with isopropyl ether. This compound is derived from propylene, and there is enough of the raw material being produced in the United States to give us 850,000,000 gallons a year of the finished fuel—more than ten times the annual consumption of aircraft gasoline.

Why isopropyl ether has these remarkable properties is a highly technical question, involving chemistry, thermodynamics, combustion technology, which space will not permit us to deal with.

But it is possible to get a conclusive idea of what the new fuel will mean to the aviation industry.

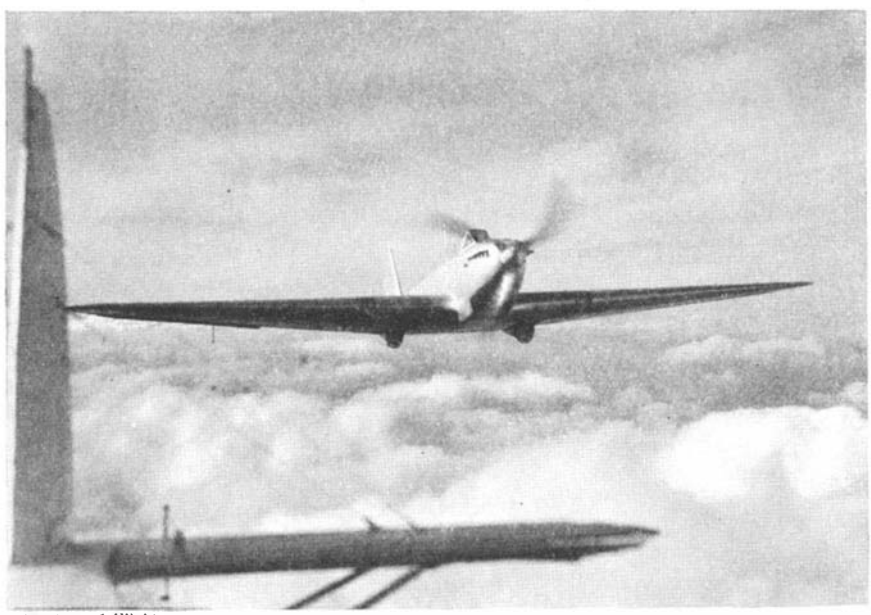
As compared with ordinary aviation gasoline there should be a saving of 15 percent in fuel consumption, with a corresponding increase in possible pay load. Or, alternatively, it will be possible to increase the power some 30 percent without the present prohibitive costs. Hitherto only the Army and Navy Air Services have been rich enough to utilize 100 octane gas. Commercial operators have resorted to the use of 100 octane fuel at take-off or in emergencies, switching over to ordinary gas for steady flying. Now they will dispense with "switching" and be able to use the high octane rating gas in normal flying.

The importance of this new fuel in air transport economics, in long flights, as across the ocean, can hardly be overestimated.—*A. K.*

The Fairey Bomber

THE new Fairey Battle, a light two-seater bomber, has created quite a sensation in Europe. While great secrecy is observed as to its performance figures, the English press proudly states that it is at least 100 miles per hour faster than any French bomber, and that its speed is over 250 miles per hour; gossip has it that the top speed is close to 300 miles per hour, coupled with adequate range and high bombing capacity. The span of the machine is over 54 feet, and the overall length is 42 feet. Yet in spite of its size and powerful fighting equipment, the Battle is reported to have carried out perfect loops, rolls, half-rolls, figures of eight, and so on, with the ease of a single seater pursuit. Thus the British apparently have the combination of a bomber with the maneuvering qualities of a fighter.

This combination of qualities is due to very clean aerodynamic lines, careful control design, retractible chassis, large aspect ratio, and so on, in which practices the British have undoubtedly followed American leadership. Where the British have



Courtesy of *Flight*

The Fairey Battle in flight, with wheels retracted

Courtesy of *Flight*

A side view of the Fairey Battle, showing its clean lines

the "jump" on American constructors is in the engine. This is a liquid-cooled 12-cylinder engine of great power yet very small frontal area. Rumor says that we have a similar engine in the United States, but the British have actually put such an engine into use—so they are a step ahead in this respect.

Take-off and landing with the Battle are helped by the now conventional flaps fitted in the trailing edge of the wing. An automatic pilot is installed for long flights and under conditions of zero visibility. The cockpit is exceptionally roomy, with comfortable seats for pilot and observer, and is totally enclosed by a tunnel-shaped top, made of tough transparent material, which can be opened partly or wholly as the circumstances of aerial combat or bombing attack may demand. The bomb load is carried in special compartments within the structure of the airplane and does not, therefore, detract from the performance.

Now and again we hear of pilots bringing ships down with the landing gear still retracted. In the Fairey Battle careful precautions have been taken against forgetfulness of this sort. As the pilot throttles back the engine, the word "wheels" appears in lights on the dashboard, and an electric horn is sounded. As soon as the pilot releases the undercarriage the horn ceases to blow and the word "wheels" is replaced by a red light which turns to green when the chassis is locked ready for landing. After take-off another red light appears to warn the pilot if the wheels are not fully locked in the "up" position.

Our curiosity is greatly aroused by the hints given as to structure. For example, the fuselage is constructed of long duralumin strips. While the Aluminum Company of America has been successfully experimenting with the welding of high strength aluminum alloys, the process has not yet been fully accepted by the aircraft industry. Therefore it is interesting to read in English descriptions that ". . . these flaps were an excellent example of welding. The stiffeners and outside skin are all fastened together in this way."—*A. K.*

Europe Arms in the Air

THE Aircraft Year Book for 1936, published by the Aeronautical Chamber of Commerce, is as good as ever and covers completely every sphere of aviation activity, manufacture, development, transport, and so on. But in so far as the American scene is concerned, our readers are perhaps already familiar with a good deal of its contents—though it is an invaluable and comprehensive book of reference. What we found most interesting and, in view of the European situation, highly ominous, was Chapter 3, entitled "Other World Air Powers." Here is the table of Combat Airplane Strength, projected into the future, which speaks for itself:

	Jan. 1935	Jan. 1936	Jan. 1937
British Empire	2800	3600	4500
France	3600	3400	4000
Russia	3000	3400	4000
Italy	2300	3300	4000
United States	2060	2800	3000
Japan	1850	1800	2100
Germany	600	1600	2600

Let us quote from this chapter: "The United States, France, and Japan lost in actual numerical strength during 1935."

Here is something else, which is both gratifying and yet a warning signal: "Great Britain, France, Italy, and Germany have spared no expense in perfecting their government laboratories for aeronautical research and experimentation. For years they have watched the work of the National Advisory Committee for Aeronautics in the United States. They know that the superior performance of American commercial and military airplanes must be attributed partly to the knowledge gained from the research in the NACA laboratories at Langley Field. The foreigners are now establishing laboratories in an effort to overcome this American leadership in technical development." We must take note of this.

Russia is frequently held up to us as an example of everything as it should be. Let us quote: "Russia's large fleet can be compared to those of other nations only in numbers. With few exceptions the Russian planes are slower, more cumbersome, and more difficult to keep in repair. That can be attributed to several factors, among them unskilled personnel in the shops, the relatively few capable designers, and the system of state-owned and operated plants."

Great Britain is feverishly working on an expansion program. France is making real efforts. Goering's plan in Germany is for 2600 combat planes by the end of 1936. In Germany the largest production plant is that of Junkers at Dessau. It employs 15,000 men and its capacity production, if devoted to one model, is 1000 completed combat machines a month. "When one realizes that the entire industry in the United States, Great Britain, or France could produce that number of planes only after expanding for seven months under actual wartime mobilization conditions, the significance of the German program becomes apparent."

The moral of this splendidly written chapter is clear. In the air we shall not long hold our technical superiority and we certainly do not have a numerical superiority. Naval treaties and limitations of naval vessels are all very well, but the aircraft program and progress of the United States must be carefully considered by the most pacifistic of our citizens.—*A. K.*

LIGHTNING

ONLY three persons in every million of our population were struck down annually by lightning in the last 10 years. Outdoor workers are in much greater danger than city dwellers, so certain agricultural states have a higher lightning mortality.

Airliner Housekeeping

THE recent redecoration of the entire fleet of planes of United Air Lines was accomplished with the aid of an interior decorator who supplied striking colors and materials. Like a good housekeeper, the transport company wishes to keep all this in the best possible condition. Hence our photograph of an airplane mechanic hard at work going over the upholstery, rugs, and

"Housecleaning" the airliner

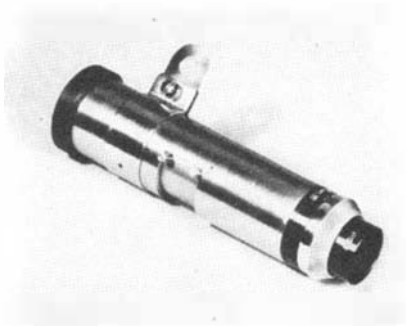
so on, with a powerful portable vacuum cleaner. This may lessen the glamour of being an airplane mechanic for some of our youngsters!—*A. K.*

Instrument Illuminator

EVERY minor improvement in aircraft accessories helps the flying game, and the new Fairchild Instrument Illuminator will be a boon to many a pilot who has to fly in darkness and follow the lights, and yet must be able to consult instruments and

maps. The illuminator shown in the photograph is only 3¾ inches long and has a diameter of ⅞ of an inch. The current is only ¼ of an ampere at 12 volts.

The illuminator comprises a metal shell fitted at its forward end with a knurled ring to adjust a diaphragm through which the light is projected. The light bulb is



Aircraft instrument illuminator that uses a special optical system

mounted on a socket fitting into the rear end of the shell and is instantly removable.

In the side of the shell is a sliding shutter which may be opened to light the cabin for reading maps or general illumination. Between the bulb and the diaphragm is a light-collecting lens; another lens at the forward end confines the beam to a definite area.

With this optical system, the shape of the beam on the instrument panel is fully controlled. The beam may be confined to a few instruments or to a special group by the insertion of a mask at the projecting lens.

The most effective location for the device is above the head of the pilot on the center line of the airplane with the forward end aimed at the instrument panel. When the illuminator is thus located the usual reflection from the instrument panel is reflected downwards and therefore away from the pilot's eyes.—*A. K.*

CORN—SOLVENTS

IN applying nitrocellulose lacquer to the average automobile, the solvents consumed are equivalent to the quantity that can be made from nearly two bushels of corn, according to Charles L. Gabriel of Commercial Solvents Corporation.

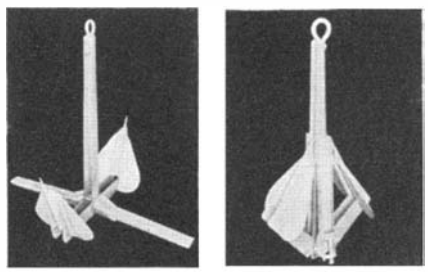
AIRCRAFT ANCHOR

LANDLUBBERS know that anchors are used to moor ships at sea, but very little else—at least the landlubber writing this note pleads such ignorance. Yet centuries of experience have gone into the development of the anchor, and there is a good deal more to it than just "plain anchor."

The mooring line is fastened to an eye at the top of the "shank." The length of the line should be at least four and preferably six times the depth of the anchorage to provide maximum holding power. At the bottom of the shank are arms which carry the curved "flukes" with which we are all familiar, however rarely we may go to sea.

The holding power of the conventional anchor as used by the Navy is only 12 or at most 15 times the weight of the anchor. Hence the huge weight and size of Navy anchors.

In sea-going vessels, the weight of the anchor is of little importance. In flying boats, however, weight reduction is a vital element. It was therefore quite natural that John K. Northrop, the noted aircraft designer, should turn his attention to the design of an anchor which, for a given weight, should have maximum holding power. As a result, the Northill anchor was developed by Mr. Northrop in conjunction with Pan American and other seaplane operators. In one of the two accompanying photographs the anchor is shown ready for use. Its first distinctive feature is the novel "fluke" which was developed after innumerable "digging in" tests. This fluke with its pointed tip has enormous penetrating power and consequently great holding power. At the same time, the fluke is so shaped that if a pull is exerted directly upwards on the eye, the fluke immediately cuts its way out from the bottom of the sea. The "stock" or cross member rests on the bottom of the water when the fluke is embedded and also adds to the drag or holding power. The Northill anchor is stated to have a holding ratio of 60 to 1 as compared with the 15 mentioned above for conventional designs. The anchor is generally made of stainless steel, which is somewhat more expensive



Aircraft anchor, open and folded

than galvanized iron but also less troublesome from a corrosion point of view.

On the Sikorsky *S-38* amphibians, the old 65-pound anchor has now been replaced by a 12-pound Northill. Since space also is at a premium in aircraft work, the fluke and stock arms can be folded or hinged together as shown.—*A. K.*

IHRIGIZING

BY the use of its inventor's name, this process title succeeds in hiding its essential nature. To the chemist or engineer, however, the much more prosaic explanation will suffice that silicon is the key to the situation. For "Ihrigizing" is a method of driving silicon into steels or ferrous articles to form a protective case of almost any desired thickness. This case is, in technical parlance, "ferro-silicon," or approximately 14 percent of silicon itself.

Ihrigized parts are rendered somewhat surface-brittle, says the *Industrial Bulletin* of Arthur D. Little, Inc., so that they must be ground to shape instead of being machined. Bolts and nuts, chemical and machine parts are cased after the thread-cutting operation has been done. The treatment is said to increase the size of the original article by not more than one to three thousandths of an inch, and may actually decrease the weight slightly with no distortion.

In resistance to chemical attack by hot concentrated acids, such as muriatic and sulfuric, Ihrigized steels display remarkable properties, enduring for months where the base metal alone would last only a few days. Wet chlorine and salt spray are also successfully withstood. These chemicals, though less publicized than acids, do more damage in aggregate dollars and cents. The resistance to heat and wear is also greater than that of many types of treated steel, and may lead to wider adoption for special uses. Unusual electrical and thermal properties are shown by wires made of Ihrigized steel. Sheets to be processed, however, must not be too thin, as the active element, silicon, penetrates rapidly, and may produce a case that extends all the way through the material. One positive requirement for Ihrigizing is that the sulfur content of the base metal be low.

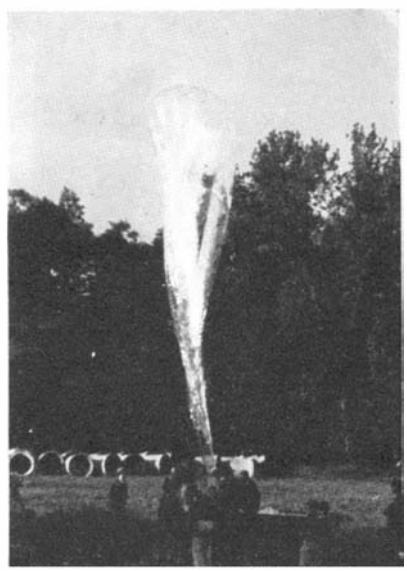
At present small machine parts are being commercially treated, with important work under way in Ihrigizing long tubes. As to cost, there is considerable latitude for a process which endows a cheap base metal with acid-resistant qualities of the much more highly-priced stainless steel, or the effectiveness of very high silicon irons.

BALLOONS FOR COSMIC RAY RESEARCH

WE are indebted to Dr. Thomas H. Johnson of the Bartol Research Foundation of the Franklin Institute for first-hand information on the high altitude balloons recently employed in cosmic ray research.

The balloons are 16 feet in diameter, and are pear shaped, consisting of a sphere surmounting a 30-degree cone. Fully inflated they are 26 feet in height. "Orange peel" sectors are cut from transparent Cellophane, 0.0008 inches thick, and cemented together with Scotch tape. There are 16 such sectors, which are widest at the equator. At the top the sectors are brought together to a point.

Just above the load ring on the inside, the appendix—three feet long by five inches in diameter—broadens out conically and is cemented to the neck of the balloon. Hydrogen is introduced through this appendix, which also acts as a valve, preventing the air from entering but allowing the hydrogen to escape when the balloon is



Cellophane stratosphere balloon ready to carry instruments aloft

fully inflated. The bag has a capacity of 1800 cubic feet, but is inflated on the ground to only 500 cubic feet, giving a gross lift of 28 pounds. The great difference between the inflation at ground level and the inflation at altitude is the key to the altitude possibilities of the balloon. The comparatively low lift of 28 pounds explains why Cellophane and other extremely light elements of construction and equipment are employed. Thus the bag weighs only six pounds and the ballast bag and release mechanism only ½ of a pound. The remaining lift is balanced at the start of a flight with sand. The ballast release mechanism operates by means of a wind cup in such a way as to release sand when the balloon ceases to rise at a predetermined speed of two meters per second.

At the start the balloon is held by a string so that sand is released until the balloon begins to lift the parachute and the radio apparatus, which weighs seven pounds. The balloon is still held by the string until five pounds more of sand have been discharged. At that instant the string is released and the craft rises at the rate of two meters as previously mentioned. Then the rise shuts off the sand valve and there is steady ascent, with automatic ballast and gas control until an altitude of 13 miles is reached.

A constant record of the height of the balloon is transmitted to a radio receiving station on the ground. For this purpose a mercury barometer is used and the height of the mercury column governs the frequency of the transmission of "dots." These dots vary in frequency from one per second at ground level to ten per second at the highest altitudes. Cosmic ray intensities will also be recorded by a system of dots from the radio transmitter. The signals are recorded in the laboratory by converting the dots into deflections of a small mirror attached to an oscillograph. This causes a beam of light to flicker across a slit, making a photographic record on a film.

The advantage of the system from the standpoint of cosmic ray measurements is that it enables the scientists to obtain cosmic ray intensities in sparsely inhabited regions where self-recording equipment sent up in free balloons might not be recovered. Manned balloon ascensions to similar heights present enormous difficulties.—*A. K.*

Improvements in Dry Cleaning

BY using new types of solvents which reduce the danger of fire in dry cleaning, this widespread industry is developing into new fields with new economies in keeping our clothes clean. Formerly, when highly flammable naphtha was the solvent used, the constant danger of fire required the isolation of dry cleaning plants away from dwelling and thickly populated areas. The first step toward greater safety was the introduction of non-flammable solvents containing chlorine, carbon tetra-chloride, trichloro-ethylene, perchloro-ethylene, and others produced by chemical synthesis. At about the same time, steps were taken by the National Association of Cleaners and Dyers in co-operation with the Bureau of Standards to develop a less dangerous petroleum naphtha which would be cheaper than the synthetic materials. This research developed the so-called Stoddard Safety Solvent, which is very similar to the petro-

leum naphthas formerly used except that it is much less flammable. Still safer petroleum solvents have been developed to fit revised methods of operation.

The result of this movement to make dry cleaning plants safer from fire has been to permit the spread of the industry and the introduction of dry cleaning plants into laundries. An educational program to instruct dry cleaners in better methods of operation has improved the quality of work done at the same time that its cost has been reduced.—*D.H.K.*

Germicidal Rays

A NEW low-wattage gaseous conductor device which produces radiations germicidal to mold spores in the air and known as the Sterilamp is announced by the Westinghouse Lamp Company. Annual food spoilage, which runs into millions of dollars and which is one indirect cause of high food prices, is largely the result of mold spores. Baked goods, treated with these germicidal rays, remain mold-free for long periods and can be completely consumed in the home before they spoil.

Permeating the air of refrigerator storage rooms with these germicidal rays kills mold spores and spoilage bacteria, makes it possible to tenderize, or "age," meat at higher temperatures without danger of spoilage from mold or putrefaction. The process is speedier and promises considerable savings in refrigeration costs and reduced trimming losses.

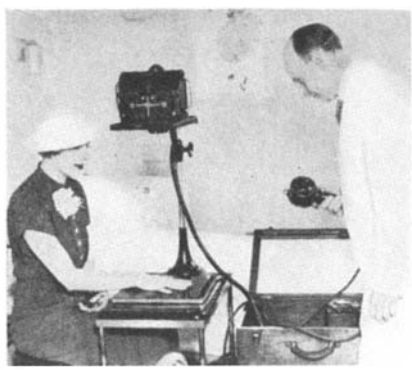
For years scientists have known that certain radiations outside the spectrum of visible light possessed germicidal characteristics, but they have never been able to devise means of producing them economically and practically. The new germicidal lamp produces these rays efficiently and effectively. It is a slender glass tube containing a small quantity of special gas. Electricity sent through the gas produces the germicidal rays.

Tests indicate that the lamp can also be used to sterilize conditioned air.

"The only trimming necessary when meat is aged under these radiations," says Dr. Robert F. James, "is the removal of a dark surface film. Loss of weight is largely eliminated by maintaining 90 percent or higher humidity which is made possible by use of these devices. In present commercial practices, weight losses amount to about 30 percent from slaughterhouse to table. Using these germicidal rays for artificial aging can reduce this loss to about half.

"So great is the waste on high-hung beef that only diners at high class hotels and restaurants can afford to eat it."

Other advantages in the packing industry are the vast savings in refrigeration costs. Meat can be aged at 10 to 15 degrees higher temperature and in about one third the time, thus reducing the amount of storage space required. The possibility of "tenderizing" meat while in transit from Chicago to New York is not inconceivable in the future, in the opinion of Dr. James.



X-Ray Equipment on the "Queen Mary"

PASSENGERS who require medical attention aboard the new superliner *Queen Mary* are cared for in a modern, completely equipped hospital. The General Electric X-Ray Corporation furnished the X-ray equipment shown in our illustration. The device not only takes radiographs, but may also be used fluoroscopically if the medical officer wishes to examine the patient visually.

Platinum Helps the Farmer

THE average farmer would no doubt be amazed to learn that such an aristocratic metal as platinum is one of his best friends. Such is the case, however, for the cost of fertilizer enters into the cost of the crop, and platinum has reduced the cost of fertilizer.

This is done by the use of platinum as a catalyst for synthetically producing nitric acid, one of the most important fertilizer bases. These catalysts are made of an alloy of platinum and its sister metal rhodium, usually in the form of gauze. Practically all the world's nitric acid is produced with such catalysts, and nations which, like the United States, lack natural deposits of nitrates, no longer fear the possibility of being without this valuable substance.

Toxicity of Rotenone

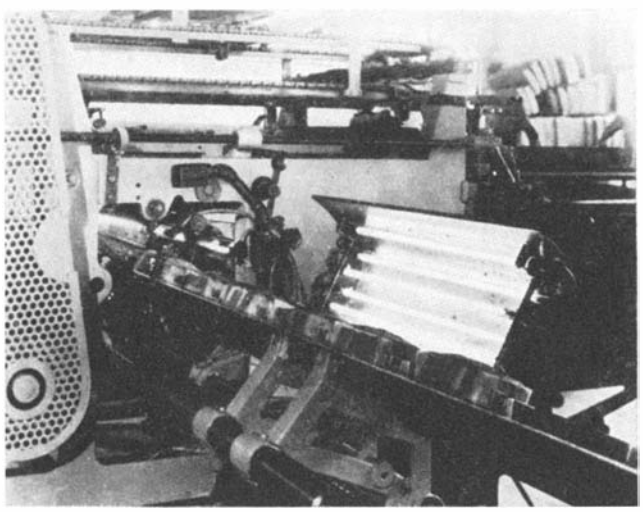
EXTRACTS of derris and cube and of rotenone, the active principal of these roots, have been widely heralded as fatal poisons to insects but quite innocuous to warm-blooded animals. Experience has shown that this desirable characteristic is only partly true—if at all. Recent investigations by scientists at the U. S. Department of Agriculture have shown that laboratory animals can be poisoned by any of the three and that the extracts of the natural products are more toxic to animals than the purified rotenone. The toxicity of these insecticides to animals varies over a wide range depending both on the method of preparation and on the form in which they are administered. Apparently belief that rotenone and substances containing it are non-toxic were based on the very slow absorption of the poisons when administered by mouth. Solutions of any of them in olive oil are definitely toxic.—*D. H. K.*

Odd Cheese Curing Rooms

A NEW use for an old coal-mine shaft in Pennsylvania has been found. It makes an excellent curing room for domestic Roquefort cheese, says Dr. L. A. Rogers, of the Bureau of Dairy Industry of the United States Department of Agriculture. The shaft has been whitewashed and partitioned, and dampers have been installed. The air forced through the wet shaft by the mine fan maintains this room at 46 degrees to 48 degrees, Fahrenheit, with humidity near saturation.

There are other Roquefort projects in this country using unusual local facilities. In the damp sandstone bluffs of the Mississippi at St. Paul, caves have been cut and are used as curing rooms for Roquefort cheese made from cow's milk.

For a number of years a mountain farmer on the Pacific coast has been making a good Roquefort from goat's milk. He ripens the cheese in a room literally built in a large spring of very cold water. The water



Cakes and meat being subjected to the germicidal rays discussed above

not only flows under and around the room, but onto the roof so that it pours over the wall and turns a fan to circulate the air inside.

The Department has been interested for a long time in the production of domestic Roquefort cheese from cow's milk. It has established the fact that the special flavor, appearance, and texture of this cheese depend in a large measure on the control of the growth of molds and bacteria, and not on climatic conditions or peculiar herbage in the pastures, or even on the use of sheep's milk or goat's milk exclusively. The Department has carried on most of its Roquefort-cheese experiments with cow's milk.

The process of making Roquefort cheese includes inoculating the curd with a mold grown in loaves of bread. The bread finally becomes a mass of mold in the spore stage. This is dried, ground to a powder, and sprinkled over the curds as they drain.

SOLAR ENERGY

IF all the sunshine in the United States could be converted into usable energy, there would be available 7000 trillion horsepower.

WORLD'S STEEPEST INCLINED RAILROAD

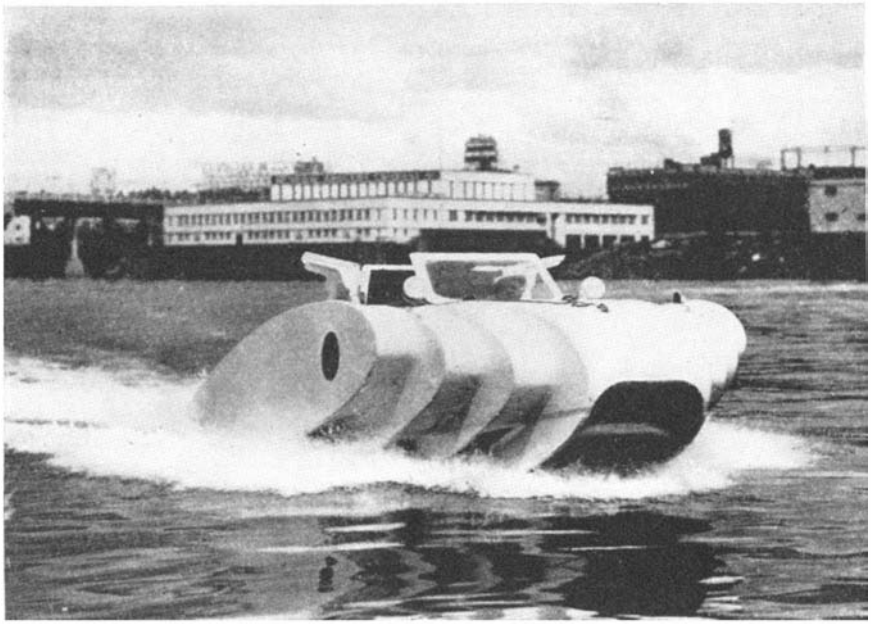
WHAT is believed to be the world's steepest standard-gage railroad is located near Ripple, Oregon. It is 3421 feet in length, starting up on a 28 percent grade, continuing on a 79 percent and cutting down to 50 percent as it nears the top of the incline.

The railroad brings logs from a 300,000,000-foot stand of timber lying on the high mountain ridges and delivers them at the foot of the canyon. The fine stand of Douglas fir and west coast hemlock to be cut is very valuable, covering a great area, so the matter of its removal is an important one, involving as it did the lowering of logs 1500 to 2500 feet down the narrow and precipitous side of the canyon of the Salmonberry River and getting them to the railroad at a convenient point.

Engineers decided that an ordinary railroad was out of the question, according to *Science Service*. Owing to the nature of the country, about 15 miles of mainline would have been required, the cost and construction of which would have been prohibitive. An incline was decided to be the most economical solution and the site was chosen. This lay on the "nose" of a sharp ridge, allowing grading to be cut to a minimum and permitting easy removal of material.

The incline is a double-track counterbalanced one, lowering one loaded car at a time and at the same time bringing up an empty one. Cars used on both straightaway and incline are those ordinarily used in northwest logging, weighing 14 tons when empty. With 28-ton loads of logs, their descending weight is 42 tons. An average car load is 9000 feet of timber and under ordinary hauling conditions about 250,000 feet of timber can be hauled in a day.

The approximate cost of the grade was about 6500 dollars, whereas a standard logging railroad built between the ends of the



Efficiency and comfort are claimed for this unusual watercraft

incline would necessitate an expense estimated at 25,000 dollars.

"Inclines are not the most desirable method of handling logs," says Mr. Bollons, the designing engineer, "but as the remaining stands of timber are in more or less isolated regions, requiring long and expensive railroads, these inclines are going to come into more general use in the future."

ETHYLENE RIPENING SAFE

ETHYLENE, used to hasten the coloring of fruit and the ripening of walnuts, produces no changes which will not occur naturally in a longer time, according to Chace and Sorber, chemists in the United States Department of Agriculture.

Aerodynamic Watercraft

A NEW and unusual type of watercraft, said to have a hull efficiency more than one third greater than any motor boat of previous design, has been successfully tested by a Portland, Oregon, inventor. Known as the Strode Aerohydrocraft, the boat is unique in that it incorporates for the first time both aerodynamic and hydrodynamic principles in design.

The hull of the craft is similar in construction to the wing of an airplane and has, extending from its sides, a wing-like structure composed of airtight compartments. These wings serve to give "lift" to the boat when it is in operation.

V. W. Strode of Portland is the inventor and holds basic patents on his development. Powered with a stock Ford V-8 engine, experiments with the craft were worked out in co-operation with the marine engineers of the General Petroleum Division of the Socony-Vacuum Oil Company whose marine lubricants and fuel were used in all tests.

The top service speed of the new craft is at present 40 miles per hour, although further development is expected to make for even greater speed. The aerodynamic features are said to give it an unusual riding ease.

Complete and scientific streamlining of the boat serves further to augment its efficiency.

In addition to being more efficient in operation, the hull of the new type craft is non-sinkable and non-capsizeable. Following tests, the boat was taken over by the city of Portland, where it is being used as an ambulance and first-aid boat on the Willamette River.

Stomach Periscope

AN instrument that might be called a stomach periscope may be the means of preventing many cases of stomach cancer. The instrument, a flexible tube called a gastroscope, for looking inside the stomach, was designed by Dr. Rudolph Schindler of Chicago and his colleagues Drs. Marie Ortmayer and John F. Renshaw, states *Science Service*.

The flexibility of the instrument gives it a tremendous advantage over the earlier style of rigid gastroscope. Made of flexible metal, covered with rubber, it contains 46 lenses on the inside. At the end of the two and a half foot tube is a small light. The tube is no larger around than one's finger.

Because of its flexibility it can be bent backward and to the side or in any direction, thus enabling the physician to see every part of the stomach. This was not possible with the old model rigid gastroscope. Dr. Schindler, in showing it to physicians, held a book at one end and turned the tube in all directions, but the person looking through the tube could read the printed page no matter how the tube was bent.

The patient experiences no discomfort and there is no danger of injury with this instrument. The patient's throat is anesthetized, the tube is passed down it, and the examination of the stomach is made in a minute or two. This can be done in the doctor's office and the patient is able afterwards to go on to his work. One patient had the tube passed into his stomach 65 times.

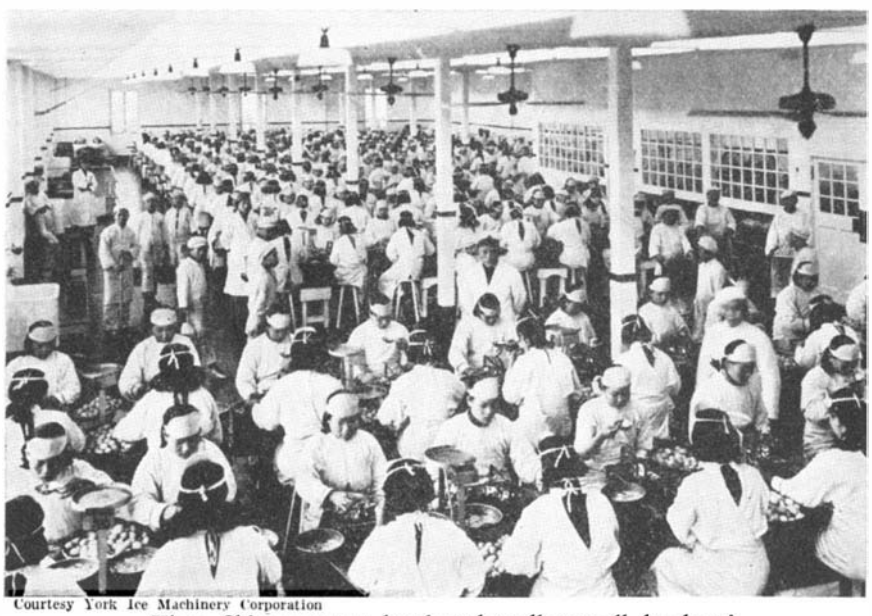
This instrument gives far more accurate information about the condition of the stomach than even the X ray. With it the physician will be able to detect not only the presence of cancer, but the amount of cancer present and whether it is an operable type.

Breaking and Smelling 5,000,000 Eggs a Day!

THE delicate art of egg-smelling—the ability to detect one bad egg among a million good eggs by the sense of smell—has probably been developed to a higher degree of efficiency in Shanghai, China, than anywhere else in the world. This highly specialized job of egg-breaking and egg-smelling furnishes steady employment to hundreds of Chinese girls, as a part of China's vast frozen egg industry—the largest industry in China which uses mechanical refrigeration.

Much of this refrigerating machinery and freezing equipment has been furnished and installed by York, Shipley, Fed. Inc., the Shanghai branch office of the York Ice Machinery Corporation.

Methods of handling, inspecting, freezing, and processing eggs have been developed on an extensive scale with the



Courtesy York Ice Machinery Corporation

These Chinese women break and smell eggs all day long!

introduction of modern refrigeration. Today, there are some half dozen establishments devoted to egg-handling and processing in Shanghai, center of the egg-freezing industry, and each of these large plants requires 1,000,000 or more eggs per day.

Chicken raising on a large scale is unknown in China. In fact, there are practically no commercial chicken farms in China, but this vast production of eggs comes from small individual "farms" where the average number of chickens does not exceed 100. Boats sail down the Yangtze River every day to collect eggs from the various concentration points along the banks, and deliver them finally to the egg-breaking establishments in Shanghai.

One of the largest of these establishments, known as the Henningsen Produce Company, at Shanghai, employs in its breaking room some 600 girls, and they break approximately 1,000,000 eggs a day. With the present improved methods of egg handling and rigid inspection, it is practically impossible for a bad egg to escape detection by the keen noses of these trained girls.

Each egg is broken and smelled, and, if properly "fresh," is dumped from the small cup in front of each girl into a large container beside her. At each row of benches there is a supervisor, whose sense of smell is keener than the average. Each of these larger cans of eggs must be personally smelled by the supervisor before being passed on to a larger tank, whence a pump delivers the product to a central separating or mixing tank. The "chief smeller" of each establishment must approve the contents of each larger container before it is permitted to enter the mixing tank. It is said that the sense of smell has been so highly developed that many of these "chief smellers" can detect the presence of one bad egg in an entire tank of egg mixture.

Certain portions of the egg yolks are dried by patented processes, and certain portions of the egg albumen are dried for special uses. Large quantities of eggs, still in the shell, are frozen for shipment in crates, forming the bulk of China's egg exports. Eggs packed and frozen in China compare favorably in bacterial count with eggs produced in America, Europe, or in South America, since rules as to food inspection are rigidly enforced at Shanghai.

Pure Corn Sugar in Crystals

DEXTROSE, the sugar produced from corn, is proving of important industrial value since it has been made available in pure crystalline form. Long an important food staple, corn sirup, the form in which dextrose is first produced, has baffled attempts to obtain the sugar from it in perfectly pure crystalline form. The solution of the problem was finally reached as a result of a careful study of its habits of crystallization. The fragility of the crystals was overcome by conducting the crystallization at a temperature high enough to insure that the sugar would crystallize alone without water. By careful control of temperature and concentration of the solution as it crystallizes, commercial production of pure dextrose has been made to yield a product cheap enough for many new applications.

The possibilities of use of the new pure dextrose include, in addition to food uses,

the synthesis of new organic acids, alcohols similar to but supplementing glycerol, insecticides and disinfectants, wetting and dispersing agents for use in rubber and textiles, and a long list of the important glucosides of value in medicine.—*D. H. K.*

Comfort for a Hotel

INSTALLATION of what is declared to be the largest hotel air conditioning system of its kind in the country was completed recently for the Hotel Statler, St. Louis.

The new installation provides air conditioning for all of the lower section of the

One of the individual room controls in a hotel air-conditioning system

hotel, including lobbies, restaurants, private dining rooms, cocktail lounge, bar, barber shop, meeting and function rooms, as well as 300 bedrooms.

The Hotel Statler is the first hotel in the country to use air conditioning on such an extensive scale. For over a year, the Statler system has operated a number of types of installations of various manufacture. After considerable research in the field, officials of the hotel selected a system of individual Airtemp room conditioners which cool through the circulation of cold water.

The new system includes many newly improved features which, according to Airtemp engineers, mark a definite forward step in air conditioning development.

Chief among the new features is the Statler-Airtemp Regulator by means of which guests may control the extent of cooling and circulation of air within their rooms, according to their personal desires. The new instrument contains, in addition to thermometers which register both outside and inside temperatures, a control mechanism which permits the guests to regulate the degree of cooling and dehumidification as well as amount of fresh air coming into the room.

The Sourdough Goes Modern

IT is a far cry from the picturesque old sourdough prospector of 1849, who sought gold in the wastelands of the West with his meager supplies packed on burros, to the modern, scientific prospector of 1936, who seeks any and every kind of precious mineral with every known piece of equipment stored aboard a streamlined, powerful truck.

TAXES

THE automobile operator pays taxes of from 3½ mills to a little over 8 mills per mile, according to the differentials applied in his particular state.

The old sourdough sought only gold. When he found a deposit he believed to be gold, he had to stake a claim and rush to the nearest settlement or town to have his find assayed, and then had to spend long months determining whether his strike was valuable.

But today the modern, scientific prospector carries complete equipment on a motor truck and trailer, with sufficient supplies to let him live in comfort for several years, if need be, in desert or mountain. He is not only a prospector, but a minerologist, geologist, miner, and assayer. He is equipped with an assay furnace, diamond drills, scales, acids, and every modern instrument necessary to discover the worth of the mineral, the size of the deposit, and the kind of metal in the deposit.

And the modern prospector seeks not only gold, but silver, beryllium, colemanite (borax), tungsten, oil, and every known precious metal in the deserts and mountains of the western United States.

Ernest A. Moross of Mosherville, Michigan, and R. B. Dennis of Cleveland, Ohio, are two such scientific prospectors. They believed prospecting scientifically would result in many "strikes" like those of other years. They dreamed and planned for many months of starting on a scientific expedition into California, Arizona, and the other western states where the country's great mineral strikes have been made.

Moross knew the success or failure of the trip depended on his transportation so he chose one of the new streamlined 1½-2 ton White trucks.

The truck was specially built to meet Moross' specifications. The extra equipment included a four-wheel drive; underdrive, 8-speed transmission giving 48 percent grade climbing ability; a 50-ampere generator; PPL booster for braking on mountain roads; air brakes; one-cylinder air-pump for inflating tires in the desert; No. 4-OB oil bath for protection in sand storms; puncture-proof tires and tubes; oil Purolator; a power take-off to run the generator from the engine to furnish electricity for the assay furnace, cooking, and refrigerating; 12 wheels—dual on front in emergency; special high traction differential gears in tandem axle; special four-shoe cable brake; five gasoline tanks with 140-gallon capacity; and six 50-gallon water tanks.

All of the above equipment is on and in the truck. The all-steel, streamlined body was built by Ernest Schaefer, custom body builder of Cleveland. The trailer is an all-steel Kabin-Koach built in Detroit. It has beds, refrigerator, plumbing, dinette,

The assay furnace and water tanks in the modern sourdoughs' truck

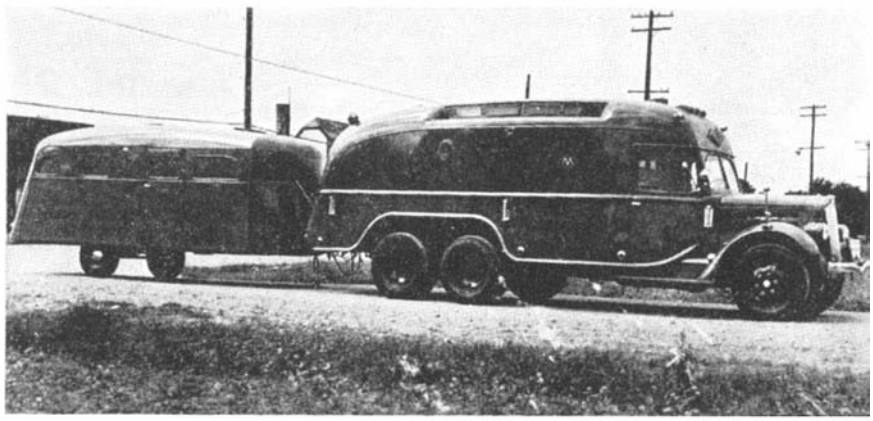
toilet, and storage space. The beds can be turned into soft-cushioned seats for daytime travel.

The final piece of equipment was a large tarpaulin which will be stretched over the truck, making a large tent under which the assaying and testing can be done, with the prospectors well protected from the sun and sand.

Wood to Yeast

UTILIZING the sugars produced in the process of converting spruce wood into paper pulp by the sulfite process, a plant recently put into operation in Nova Scotia produces baker's yeast as an important and valuable by-product from a material heretofore wasted. In the process of making pulp from wood, chips are cooked at high temperature with a solution of calcium and magnesium sulfites to dissolve out all those constituents of the original wood which are not cellulose. The resulting waste sulfite liquor from the pulping process contains lignin, proteins, resins, fats, and carbohydrates dissolved from the wood or formed during the cooking operation. For many years this waste has not only had little value but has actually been an expense to the paper maker who has had to dispose of it. The new method of utilizing sulfite waste liquor for the growth of yeast not only assists in the disposal of this waste but at the same time yields a profit.

The carbohydrates (sugars) in the waste liquor as produced amount to some 30 percent of the weight of the pulp produced



A streamlined truck and trailer equipped for modern prospecting

and about three fourths of this sugar content is fermentable. The process consists in neutralizing the liquor as produced with lime and soda, adding nutrients, and seeding with a pure culture of the desired yeast. After the yeast has attained its growth it is filtered from the solution, washed and dried. The quality of yeast produced is reported to be very high as compared with that made by other methods because of the fact that the sulfite liquor used is completely sterilized in the paper making operation, and hence contains no wild yeast to contaminate the product. The process was developed by G. Heijkenskjold, a Swedish engineer, and has been successfully employed abroad.—*D. H. K.*

Glass Again! It Erases

GLASS in many forms has found many new uses recently. It has now been given the job of erasing. Fibers of glass inserted in a holder as are the bristles of a brush provide numerous minute pin points which will erase India Ink, typewriting, paint, printer's ink, and is useful for polishing metal. It is made in a molded plastic holder which operates like an automatic pencil to propel the brush through the tip. It uses refills.

Erasing with glass

This device is more efficient than old ones of the same type as the fibers of glass are specially treated by a process to make them more flexible and bind them together slightly to eliminate much of the breakage. The brush is said to be softer and less likely to wear a hole through thin paper.

The Coldest Cold

NO one has yet reached the absolute zero of temperature, but by using liquid helium and the cooling effect of demagnetization at the low temperature which this produces, investigators have approached to within about one sixth of a degree of the lowest possible temperature. W. F. Giauque (pronounced Joke), of the University of California, described the method used and some of its results when he was recently awarded the Chandler Medal for his researches in the field of very low temperatures.

Using liquid air to cool liquid hydrogen and liquid hydrogen to cool liquid helium which in turn cools a cell containing a solenoid surrounding the material which is to be finally cooled, Dr. Giauque sets up a very strong magnetic field in the sample by means of the solenoid. When the heat of magnetization has been absorbed by the

(*Please turn to page* 176)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

EACH month, as we sit down to write up this department and run through a drawerful of materials sent in for publication, it is a question what to serve up; no wonder the ladies get tired of "thinking up meals." For several years we gave our readers a pretty steady diet of telescope descriptions, attempting at that time to

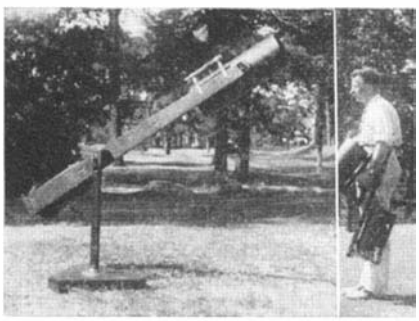


Figure 1: **Seely, folding scope**

publish all that came in, since we had included in "Amateur Telescope Making" an invitation to send them to us. In more recent years their numbers swamped us and we gave up this intention, regretfully removing the invitation from "A.T.M." and selecting especially outstanding telescopes for description. This, however, somewhat leads to the discouragement of the new recruit to the hobby, who is not likely to branch out into fancy work on his first telescope and who may not care, for that reason, to be high-hatted by seeing only Rolls-Royce class jobs described. We hope our following will continue to send in photographs of those telescopes which have original features of merit, whether they are big telescopes or little, beautifully finished or rough, for the features themselves are the essence of it, provided there are any.

Speaking of photographs, here are a few notes on the practical end of making them for publication, as checked over by our layout and make-up editor, who often groans about some of the art (editorial lingo for illustrations) we hand him with the request that he do a miracle in reproducing it.

WITH the most thoughtful intentions many persons break our partly Scottish heart by going to the added expense of having enlargements made from photographic negatives which they make of telescopes and so on, because the ordinary size prints do not seem to be sharply in focus. Wasted money! If the original negative is not sharp, enlargement only makes matters worse—the fuzziness is enlarged with the rest. Then, when we have half-tones made for reproduction from these fuzzy enlargements, they have to be reduced—possibly to the original negative size—and we are right back where we started, only a little worse off. There is always some loss of definition in a half-tone reproduction. Hence, if we have to start with a fuzzy print, the reproduction will be proportionately worse than from a clear sharp print.

The game can't be beaten by enlarging fuzzy negatives. But fine half-tone reproductions can be made from sharp contact prints of almost any ordinary size. Of course, if you use 35-mm or "half vest-pocket" film in your camera, it is preferable to enlarge to 3 by 4 inches—a photographic enlarging camera usually seems to do a better job than the engraver can do when making a half-tone negative. If, however, your camera takes negatives 2¼ by 3¼ or larger, concentrate on getting sharp negatives and send us contact prints on glossy paper. "Spend the difference between the cost of contacts and the cost of enlargements on a drink—ice cream soda, of course." So our layout editor suggests, and, he adds, "While we are on the subject of photos: When 'mugging' your telescope or whatever, look to the background as well as the subject. A telescope, for example, photographed against a background of trees or buildings of approximately the same general tones as the scope will be quite successfully camouflaged. If possible, set up a background of neutral tone—an old bed sheet is

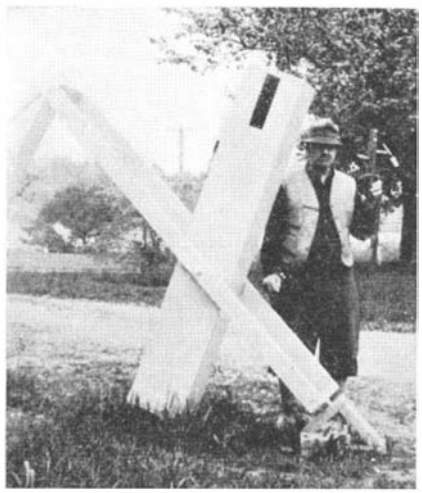


Figure 2: **Bartlett, wooden tube**

fine—or try shooting against the sky. The subject will then stand out like a sore thumb, without distracting or camouflaging objects in the background."

GETTING back to telescopes, Figure 1 shows a simple one of conventional 6" beginner's size but it has a feature: it jackknifes. Roy A. Seely, 3818 Spuyten Duyvel Parkway, New York, N. Y., who lives in an apartment house where every cubic foot of space is expected to store two cubic feet of something, is the maker. The "spinal colyum" is hinged amidships and folds when the owner decides that Jersey mosquitoes have made the New York park uninhabitable and wants to go home. Unfortunately the little picture at the right was trimmed, involving the upper half of the telescope, but it still shows the folded telescope feature. The short end tubes exclude stray city light, and rubber base pads shunt off city vibration, for New York trembles at all times: subway trains and heavy trucks.

FIGURE 2 is a 9" wooden tube reflector made by Clifton W. A. Bartlett, Pembroke, Maine. In fact, he says, the whole rig is wooden, with the exception of one bolt. He points out the eyepiece end feature: "I cut two slots, one on either side, into which the eyepiece assembly slides, with a blank in the other slot. Thus you don't have to break your neck observing." This feature also permits taking the eyepiece and diagonal indoors without complication. The double yoke type of mounting is a neat, clean-looking type, especially rigid, easy to build, and inexpensive. We urge the construction of more of them. A relatively small drawback is that a little patch of sky around the Pole is out of reach.

AMATEURS in Indianapolis, Indiana, are incorporated into the "Indianapolis Amateur Astronomer's Association," Victor E. Maier, 1306 Parker Avenue, being the energetic secretary and he wants the world to know that Indianapolis is in, of, and on it. He writes: "Our group is constantly growing, the number in good standing now totaling 93. Better telescopes all the time.

"One of our members, Dr. L. F. Smith (D.D.S.) has finished an 8" Springfield of superlative design and workmanship. I enclose his photo (Figure 3). Some of the machining on this job required real hocus-pocus. The machine work was done by our ace machinist Harry Jordan. This particular instrument has several innovations. In order to get his necessary portability the entire assembly is made of aluminum, with the exception, of course, of the detachable counterweight and braced arm and the gears. The 'friction drive' is very accurate, such that the telescope can be pointed in any direction quickly, and the slow motions used immediately without loosening or locking. The offset hand wheel in R.A. gets away from limitations in driving when west of the meridian. The cast-iron worm gears

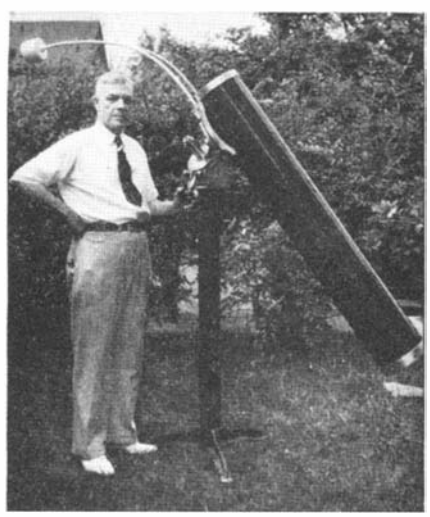


Figure 3: **Smith, Springfield type**

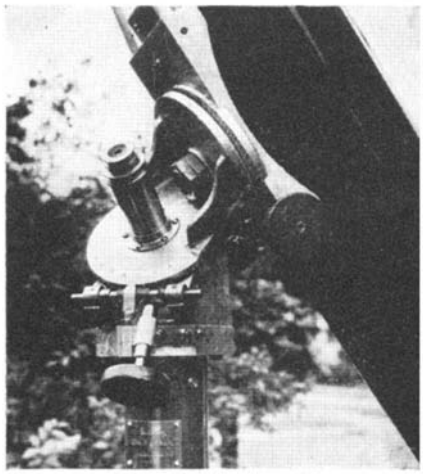


Figure 4: Smith's hand drive

and steel worms were cut by Mr. Jordan. They can be driven in a complete circle. The diagonal holders and focusing device are of the 'Jordan design' and permit easy, accurate adjustment. The Pyrex mirror, which Dr. Smith finished, possesses one of those rare 'lifesaver,' smooth figures, with the 'crest' at the proper place. All told, we believe this to be a very outstanding instrument. In the close-up (Figure 4), note the offset hand drive for R.A. It allows much greater degree of rotation. Fiber friction disks sandwiched between the gears (home made) and aluminum castings do away with locking devices."

SHOP NOTE: When, in polishing and figuring, it seems impossible to get a sphere, try abandoning the very short strokes recommended elsewhere and substitute long, firm, fearless ones. We discovered this accidentally when we got mad and didn't longer care what happened, and since then two others have tried it and likewise found it did business. *But*, it requires good hard lap—no mush (Everest scale one pound pressure, finger nail, ¼" mark, 20 seconds or more), and this in turn requires rouge that hasn't scratched yet. We found it possible with this to extend the strokes to equal full diameter of mirror in their total sweep, without turning the edge. Avast, then, with fiddling, timid little one-inch strokes to get spheres. Instead,

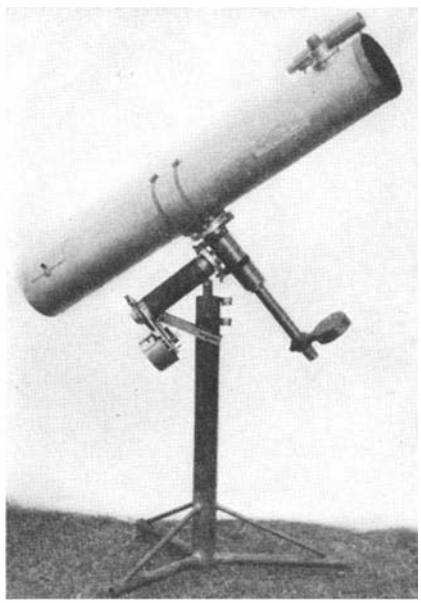


Figure 5: Prescott's portable

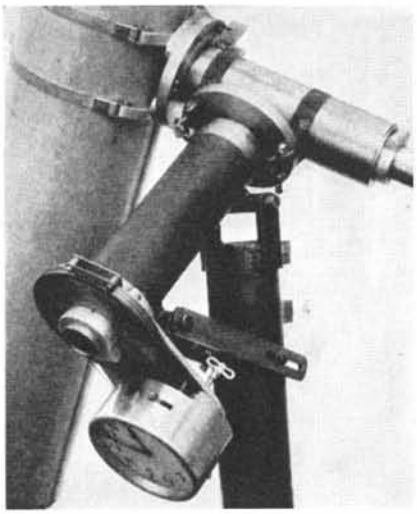


Figure 6: **Prescott's clock drive**

get mad at 'em. Try it at *your* risk, and please report findings, since it might have been our own bad language, and not the long strokes, that did it.

THE 6″ portable telescope with welded pipe stand, shown in Figures 5 and 6 and made by Fred L. Prescott, 3111 Brooks St., Dayton, Ohio, deserves commendation on the score of its declination axis, which is large enough at the bottleneck, and the same strength is carried through to the tube. Too often mountings which have a sufficiently large declination axis at the bottleneck, have this same large axis shaft attached to a light plate on the tube—thus wiping out the gain in rigidity conferred by the large axis shaft. Here, however, the design is consistent, straight through. The wing nuts that show on the flange near the polar axis are attached to the ends of metal bands passing around that axis; the end of the polar axis does not quite touch the declination axis (hidden, in the photos shown here).

Outside of the simple yet rigid latitude adjustment, also with wing nuts, the chief item is the clock drive, about which the maker writes: "The polar axis turns in a tube with suitable bushings, which in turn rotates in the polar axis housing. This tube has a 5″ drum at the lower end, over which a stranded wire cable (airplane control cable) passes, making 1½ complete turns. The clock, an old alarm clock, has the spring removed and a 1¼″ drum fitted, with the cable passing around it several turns and fastened to the drum. On the other side the cable winds up on a ⅞″ drum to which an 8-day spring is connected. The spring thus draws the cable in, turning the polar axis bearings in sidereal time, the clock escapement regulating the speed. The 4:1 ratio is just right, since the key of the clock makes four complete turns in 24 hours. The diameters given are "pitch diameters"—to the center of the cable.

"To the 5″ drum is attached an index reading against the hour circle, and thus, once set on some known star, right ascensions are read without correction for local time throughout the evening, as in 'A.T.M.' p. 145. The upper polar axis bushing must incorporate the flange against which the thrust comes, otherwise the telescope will not run positively with the tube and bearings. No lock is required, the telescope being turned freely to an object which it follows until moved to another."

Mr. Prescott also describes a hard lap which he has used: "A smooth piece of cotton cloth is stretched over the tool. Bits of beeswax are laid over the lap and the whole slowly warmed in the oven until the wax melts and saturates the cloth. The excess wax is removed with a piece of cloth. The edges are notched about ⅜″ deep, about 1″ apart, all around, to guard against turned edge. This lap works from the edge inward, because the radius of curvature of the lap is about .005″ to .010″ greater than that of the mirror. With good rouge, this lap is fast and about as free of scratching as HCF. It has the advantage that its radius does not change during the polishing, and it works very smoothly." Mr. Prescott sends along two ronchigrams indicating very good workmanship. We have not tried out this lap but see no reason to doubt its value.

With regard to notching the circumference of a lap to guard against turned edge, this is a common expedient though, properly speaking, it is a sort of makeshift and compromise. The notching out is likely to make a transition zone, being mighty hard to do just right. However, we confess doing this same stunt, even though it is a frank confession of something or other suspiciously like not knowing our trade or not having much pride in it. A good hard lap ought not to turn an edge, even when not notched out. All this advice is cribbed from the most expert mirror maker we know, Wally Everest; it was he who first gave us Hell for using notched out edges on laps.

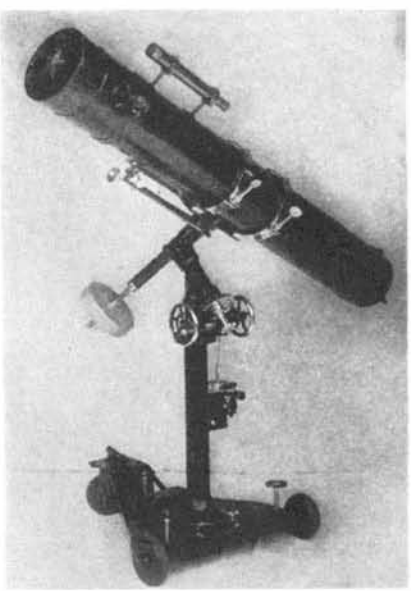


Figure 7: **The Duxbury model**

A THIRD portable or semi-portable telescope—an 8″—which is very finished in appearance but embodies something of the type of attachment plate at the tube, which was mentioned above, is shown in Figures 7, 8, and 9. Figure 7 was published some months ago but without any detailed information. The maker is Dr. M. N. Duxbury (another D.D.S.), 805 Bellin Building, Green Bay, Wis. Dr. Duxbury sent several large, detailed blueprints, but these could not be reproduced here; besides, we are still stubbornly "sot agin" the blueprint idea. If any wish to copy this telescope they may obtain blueprints direct from the

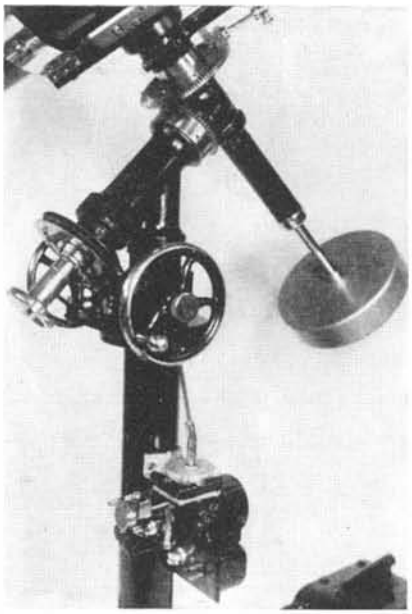


Figure 8: Duxbury detail

maker. The telescope is one of the most finished in outward appearance we know of.

The truck (Figure 7) has three leveling screws used in connection with level vials. It has a removable tongue. Quite a few amateurs are so situated that their telescopes must be taken out of doors, and a truck mounting of this type is almost the only solution where a fairly heavy telescope is desired.

Figure 8 shows the clock motor, made by the United Air Cleaner Corp, Chicago; it is a United Phonograph Motor, Blue Flyer Model. The gear box contains two worm gears, a gear, and pinion, and the maker has the patterns, which he states may be rented. The hand wheels are sewing machine fly wheels.

The controls are all within a short radius immediately beneath the eyepiece. The details of the declination and R.A. slow motion controls shown in Figure 9 are of much interest and warrant close study.

Another interesting feature is the tube, which will rotate without a wrestle, as there are roller bearings between it and its retaining bands.

The truck assembly was made by the Green Bay Vocational School, under the direction of Mr. Edward McMonagle, the tube by the same school under the direction of Mr. Thorpe. The eyepieces, mirror, and diagonal were made by Mr. C. T. Elias, and the silvering was done by Dr. Stephen F. Darling, both of Appleton, Wis.

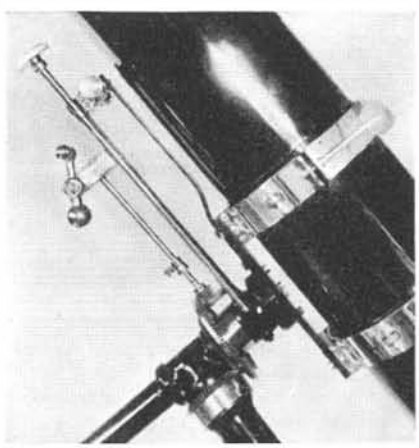


Figure 9: Duxbury slow motions

CAMERA ANGLES

Conducted by JACOB DESCHIN

Keeping Solutions Cool

ONE of the principal difficulties encountered by the darkroom worker, particularly during the summer months, is the problem of keeping his developing solutions at approximately the desirable 65 degrees, Fahrenheit. During really warm days, the temperature of the solution, as it stands on a shelf, may reach as high as 75 degrees or more, and anyone who has tried it knows what a job it is to bring this down to 65 degrees by running cold water over the bottle. A good way to avoid this trouble is to purchase or make a so-called "nursery" or "automobile" icebox and keep the bottled solutions in that. A 10-cent piece of ice will last from a day to a day and a half and may be purchased only when anticipating darkroom activities.

"Minicams" Grow In Favor

THE growing legion of miniature camera users among newsmen was recently augmented by the Associated Press' purchase of ten F:1.5 Contax units. The Contax and Leica distributors have had quite a job on their hands breaking down the "sales resistance" of the newscameramen with regard to using the miniature camera on their regular assignments to cover subjects difficult or impossible to tackle with their regular 4 by 5 cameras. But success now seems assured, for these tiny outfits have demonstrated their worth time and again, especially on indoor night assignments where the bulk of the larger outfit is too cumbersome to handle in tight situations.

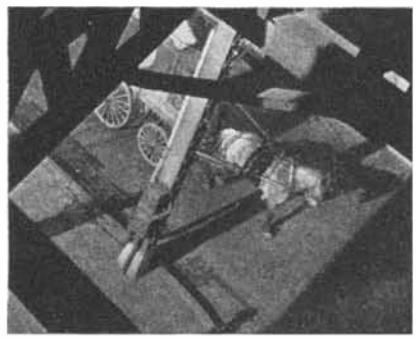
From the same source it was learned that a considerable number of Leica cameras have been bought by a group of explorers equipping themselves for a long journey and to whom the pictorial record of their findings will be the most valuable "game" they plan to bring back with them.

Fighting Superstition With Cameras

AN interesting sidelight of the recent eclipse which drew to Siberia many scientists from distant lands to witness and study the great solar event was the sale of several hundred thousand low-priced cameras to the masses to enable them to make individual recordings of the phenomenon. The cameras sold for a few rubles each and their distribution was in line with the Soviet Union's fight on superstition. In addition to the cameras, millions of pamphlets printed in the many languages spoken by the different nationalities comprising the Soviet Union were handed out and hundreds of university lecturers traveled throughout the country explaining the eclipse to the people.

A Word for the Horse

THE city horse, dragging out a burdensome existence pulling delivery and fruit-peddlers' wagons from dawn to dusk, is worth occasional photographic attention.



. . . The Horse

In the main, he makes a rather unattractive subject, but now and then he may be seen, as in the above illustration, in a characteristic situation worth recording. The picture was made in New York City from the platform of the elevated railway.

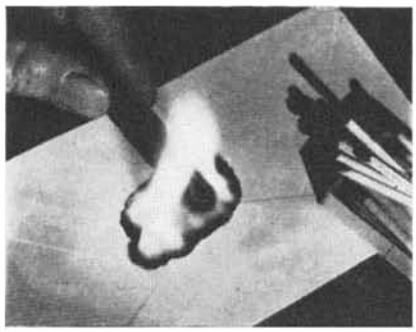
Photographing the Abstract

THE photography of intangible ideas offers the serious hobbyist, eager to try "something different," one of the most interesting, albeit one of the most difficult, phases of camera activity. Both stimulating and challenging to inventiveness, it calls for imagination and the ability to state photographically—that is, in material, visible form—that which exists only as an abstraction. The commercial photographer assigned to create an advertising photograph for one of the "service" type of companies, that will express some such idea as reliability, strength or dignity, draws on all his resources to turn out a job fitting the occasion. How well he succeeds depends, to a great extent, on how much time he can give to thinking about it.

Thought, then, in terms of symbols, is the main thing. You know what you want to say. But how to say it? You look about your home, stare into shop windows, watch children at play, realizing that you do not know exactly what you seek but that when it appears you will recognize it. You will sit musing at the dinner table, toying with sugar cubes, tooth picks. It may prove

discouraging work but it should not be pursued doggedly; rather, if allowed to develop subconsciously, an unexpected moment may produce the answer.

The idea finally decided upon must be simply expressed, direct, so that it will be easy to understand. Simplicity, however, is difficult to achieve, whether in writing or photography, so that much reliance must be placed on the lucky inspiration. But inspiration springs from thought, so the more



"Finality"

we think about a subject the greater the chance of the inspired "spark." Developing a sense of observing symbols in ordinary human gestures, in humdrum, daily routine, will do much to make facile the invention of palpable subject-matter capable of signifying an abstract idea.

The two examples illustrating this discussion may clarify things to some extent. "Finality," for instance, depicting the burning end of a stick of sealing wax as it is being applied to the flap of the envelope, symbolizes an irrevocable act. For better or worse, right or wrong, wise or foolish—doubt, indecision is over. The deed is conclusive; it is finished, final. "Leisure" attempts to carry out the idea in the curtained window, the soft illumination of the curtains, the assorted accessories on the table, and the man reading a newspaper. The picture might have been merely a study of a man reading a newspaper; as it is, however, the man is but part of the whole, indispensable though he is to the full expression of the idea of leisure. He is absorbed in his reading and is apparently in no hurry to finish with it. There are many hours ahead and no work until the morrow.

The idea must come naturally, without straining, for a labored device will in most cases carry with it the serious stigma of heavy-handedness, therefore abstruseness. Beware of overlooking the obvious. Be alert for the ready-to-hand subject that calls for no more preparation than the aiming of the camera. If you have to "set up" your subject, use the fewest accessories necessary to get your idea across and use light in the most effective manner to give due emphasis to the most "telling" feature of the composition. Shadows are very forceful in this type of picture and a simple object, made to throw a long shadow, will sometimes serve better than a more elaborate setting.

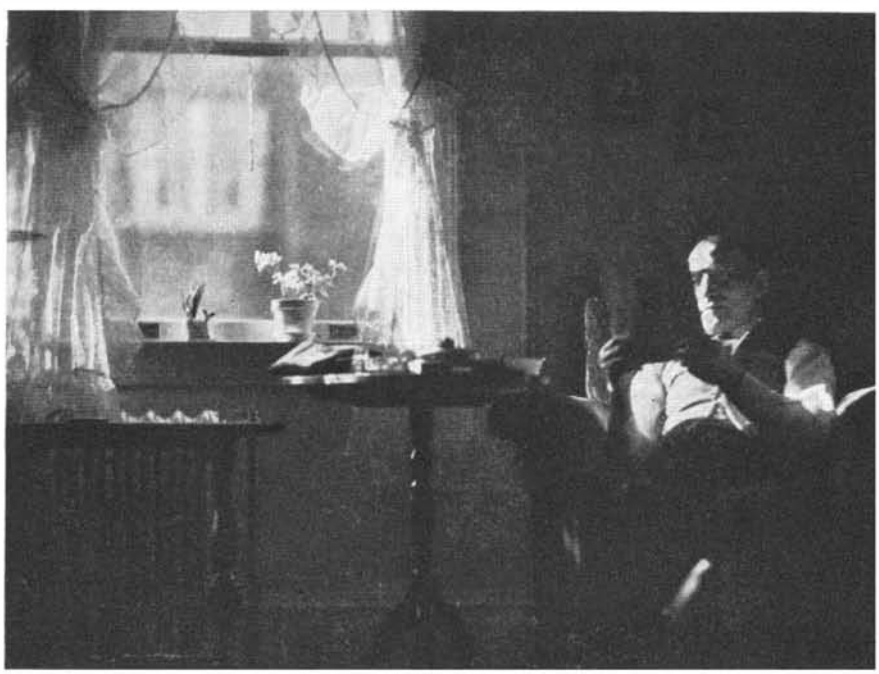
There is much real satisfaction to be gained in devising photographic abstractions for the worker who sees in his hobby something more than a means of recording the run-of-the-mill subjects.

New Photoflood Size

A NEW Photoflood bulb size producing twice as much light as the present Mazda Photoflood bulb and with triple the life of the latter is announced by the General Electric Company. Like its less powerful predecessor, the new bulb, which consumes 500 watts and resembles the standard 150-watt inside-frosted Mazda lamp both in bulb size and appearance, is used on the ordinary house circuit. While the new Photoflood was developed for the use of the commercial and portrait photographer, it will be found very useful to the amateur photographer.

Compact Lighting Outfit

AN inexpensive portable lighting outfit, capable of furnishing proper and generous illumination for a great many types of subjects is being offered by the Testrite Instrument Company. "The Ideal Studio and Home Outfit," as it is called, fits into a carrying case and includes the following

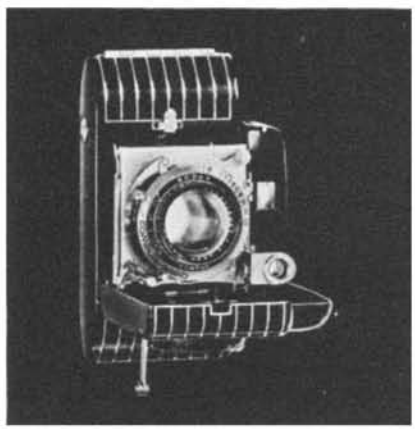


"Leisure"

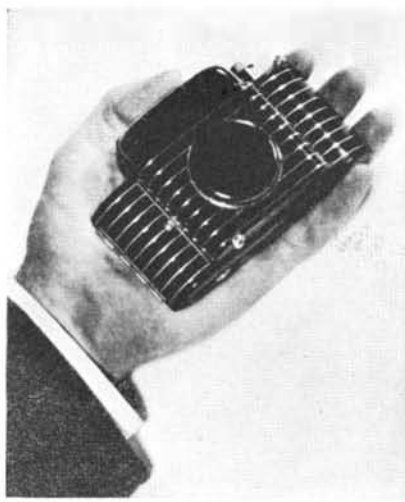
equipment: Four 2-socket 10-inch reflectors and two 3-section folding stands rising to a height of more than 8 feet and with adjustable swivels on the cross bars to permit directing the lights at any desired angle; four diffusing cloths and clips; and a 25-foot extension cord. With the four reflectors accommodating a maximum of eight Photoflood bulbs, this fund of lighting should be sufficient to take indoor snapshots even with the slower lenses or with the faster lenses considerably stopped down for depth when this is found desirable or necessary. The advantage of the carrying case arrangement is the easy portability of the entire lighting outfit.

Another Miniature

INTRODUCING a new Eastman lens—the Ektar F:2—the Rochester company has put on the market the latest miniature camera—the Kodak Bantam Special. Featured by a built-in, synchronized range finder of



Open and closed views of the new Bantam Special miniature with F:2 lens and a built-in range finder



the military split-field type, the camera weighs but 16 ounces and is enclosed in a die-cast and machined aluminum case shaped for convenient handling and finished in a new-type baked enamel of unusual toughness. When closed, the case provides complete protection for the lens, shutter and front elements of the view-finder and the range-finder.

The Ektar F:2 is an anastigmat of 45 mm. focal length, the range of the diaphragm openings being from F:2 to F:16, with the depth of focus at 10 feet and the smallest opening so steep that all is in focus

from 4½ feet to infinity. The closest focusing distance is three feet. The Compur-Rapid type of shutter with which the camera is equipped has nine speeds, from 1 second to 1/500th of a second, as well as time and bulb action.

The film locks automatically in centered position for each exposure and a specially designed film pressure plate gives uniform film register. The camera is 4⅞ inches long, 3⅛ inches wide, and 1 1/16 inches thick; it uses eight-exposure roll film of two types, Panatomic—F828—which is a medium speed panchromatic film, or Super X—X828—high speed panchromatic.

AFTER THE RAIN

A GREY rain-soaked scene comes suddenly to life as the sun peers momentarily through a rift in the clouds. The main highlight in one of the "strong" positions,

"After the Rain"

the varied direction of diagonal lines, the soft highlights on the automobile tops, the resumption of natural movement after the downpour, the bootblacks once more in their places—all is adequately rendered to reproduce the mood of the moment.

NEW SPEED GRAPHIC SIZE

THE newscameraman's 4 by 5 Speed Graphic, some time ago made available for amateur workers in the 3¼ by 4¼ size, has recently been placed on the market in the 5 by 7 size. This size is quite popular with pictorial workers who like to use the view camera type, which the Speed Graphic resembles in some respects.

EXPRESS "CHROME" FILM

A FINE-grain orthochromatic film possessing such speed that pictures may be taken with it even in weak light and on dull days is the new Gevaert Express Superchrome Rollfilm, which is also available in filmpack and 35 mm. "miniature" sizes. To help users of their film in attaining a fair percentage of correct exposures, the manufacturers offer the following convenient exposure table:

	U.S. No.32 F:22	U.S. No.16 F:16	U.S. No.8 F:11	U.S. No.4 F:8
Bright Sun	1/25	1/50	1/100	1/200
Faint Sun	1/10	1/25	1/50	1/100
Bright Cloudy	1/5	1/10	1/25	1/50
Dull Cloudy	1/2	1/5	1/10	1/25
Rainy	1	1/2	1/5	1/10

It is suggested that a tripod be used for all exposures made at speeds below 1/25th of a second.

You will notice that each larger opening for any given condition of light is, of course,

exposed for half the time of the preceding smaller opening, so it will be a simple thing to estimate the proper readings for diaphragm openings on your camera other than those appearing in the above table. You will notice, too, that the various speeds for the different light brightnesses "double up" on each other as the illumination becomes weaker.

Bottle Washing

SOME of our readers may have thought of this already, but if you have not, you will find the use of a spray attachment for the faucet a very useful tool for washing out the insides of bottles. A dime buys a good one. Bottles should be thoroughly rinsed out after being emptied and before they are re-filled; the spray offers an effective means of doing this. Trays may also be rinsed this way after each processing session and again just before they are filled with developer and fixing solutions; they are bound to gather some dust between periods of use.

"Miniature" Depth

THE extreme depth of focus of the 2-inch "miniature" lenses is illustrated in the accompanying photograph. This was made at F:12.5, 1/20th second, on "superpan" film, from a crouching position below

Depth with a miniature

the canopy framework. The advantage of getting all planes practically equally sharp at so short a distance—about 15 feet—from the nearest plane makes the "candid" type of camera useful in many instances where other equipment would fail miserably.

Buy or Build?

THE question is frequently asked whether it is not cheaper to buy one's photographic accessories than to build them. Such a statement cannot be answered with a blanket reply of "yes" or "no" because several factors are involved. What, for instance, is meant by expense? Money or time? From the dollars and cents viewpoint, it may be cheaper to "make it yourself" but it will, of course, involve time—in some cases, a great deal of time. It is taken for granted, of course, that the home-made article will be made so well that it will work as effectively as the purchased one.

Another point to consider is the "make-up" of the builder himself. There are some self-sufficient people, sometimes known as the "handy-man" type, who will never buy an article that they can possibly make themselves. With such persons, the expense of time will be offset by the satisfaction derived from making the desired gadget.

Then there is the factor of whether the accessory in question is available on the market. Certain photographic problems are so peculiar and unusual that nothing remains for the worker to do but to make the required tool himself or to go without it.

For Limp Prints

THE bugaboo of curled prints is being shooed away by some workers through the use of a glycerine bath between the washing and the drying. The bath gives to the prints brilliance and the requisite limpness for easy handling and mounting. The prints are immersed in the following bath for one minute and then dried in the usual way:

Glycerine	1 part
Water	19 parts

Miniature Printer

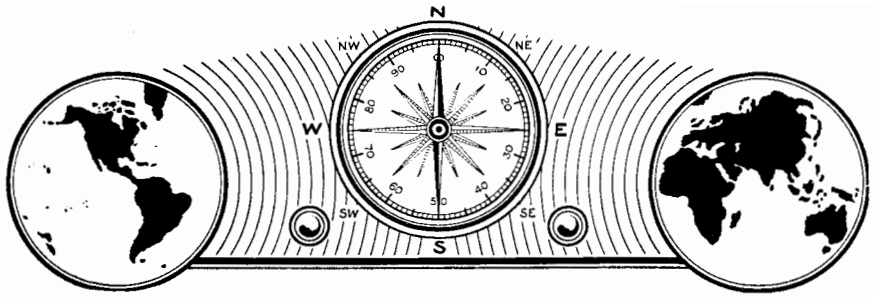
A PRINTING box furnished with an adjustable mask for printing negatives varying in size from 2¼ by 3¼ inches down to the 35 mm. size is now on the market, in which negatives may be used either in strips or cut into individual exposures and held securely under the masks while the paper is adjusted into place. The Miniature Printer is an adaptation for miniature camera workers of the larger professional printers.

Honorable Mention

IN addition to the three prize winners in the SCIENTIFIC AMERICAN photograph contest, announced on page 136 of this issue, ten honorable mention prizes, each a one-year subscription to SCIENTIFIC AMERICAN, were awarded to the following:

Stephen S. Slaughter, New York City; Al S. Oliger, Seattle, Washington; Wm. Edwin Booth, Richmond, Virginia; C. H. Freeman, Ottawa, Ontario, Canada; John D. Briggs, Ridgewood, New Jersey; Bory Osso, New York City; A. W. Prasse, St. Louis, Missouri; Walter Krauss, Clifton, New Jersey; Irving Herman, Manchester, New York; Tom Recker, Penysburg, Ohio.

Other examples of excellent work, selected from among the many photographs entered in the contest, were submitted by: Wm. Beardsley, Newport, Rhode Island; Celia Spalter, New York City; C. N. Joyner, Tientsin, China; Harold Robert Stamm, West Allis, Wisconsin; Geo. A. Hilbert, Ridgewood, New Jersey; M. L. Pool, Columbus, Ohio; Harland L. Swift, Santa Monica, California; G. Frank Zimmerman, Cranford, New Jersey; John B. Lurvey, Manchester, New Hampshire; C. C. Balke, Highland Park, Illinois; Thomas F. Mulry, Shelton, Connecticut; Edward C. Day, San Anselmo, California; Charles Dowell, Hoquiam, Washington; Mrs. Dorothy E. Calder, Harvard, Massachusetts; Werner von Bergen, Clifton, New Jersey; Ted White, St. Petersburg, Florida; Edward Eaton Kimball, Farmington, Maine; S. A. Meloslavin, Chuquicamata, Chile, S. A.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

"VERIES"

THE hobby of all-wave DXing has more to it than just the reception of conversations and programs from distant 'phone and broadcast stations. Indeed, to many listeners, a very real interest lies in collecting verification cards.

Verification cards—"veries" for short—are obtainable from most of the domestic and foreign standard and short-wave broadcast stations. Such a card is not only an acknowledgment of a reception report, but is a documentary proof of your reception of a program from the station providing the card. It is clear from this that stations send verification cards only when they are satisfied that you have actually intercepted one of their programs. Proof of reception is therefore required.

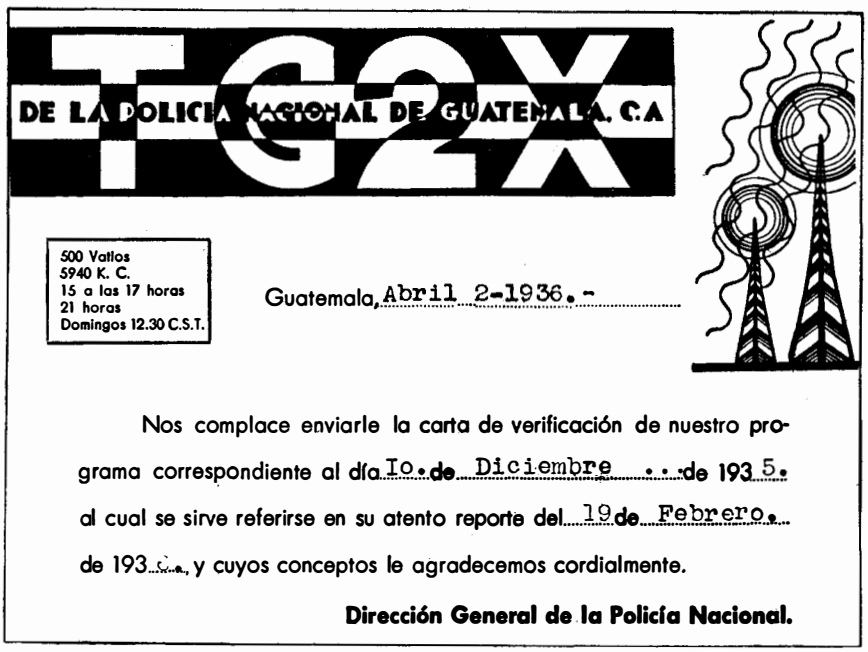
If you caught a fish "this big," or made a hole in one, you require evidence or your friends will accept your remarks with more than a grain of salt. But if you pick up VK2ME, in Australia, or JVM, in Japan, or most any other distant station, you can obtain the evidence right from the stations in the form of verification cards addressed to you.

Some of the cards are very attractive, and some are very rare, though none have monetary value. Nevertheless, there is as much of a thrill in collecting veries as there is in collecting stamps—and it costs much less.

How do you get hold of them? Well, suppose you pick up an orchestra playing, let us say, "The Blue Danube," and later, say, "Swamp Fire," and finally you hear the station announcer refer to VK2ME. It's a pretty good shot, then, that you have listened to Australia, and the orchestra pieces together with any other selections or remarks you heard constitute proof.

The thing to do, then, is to write to the station, giving as many details as possible regarding the reception. This should include the date and time heard, the station call letters, the frequency or wavelength on which the station was received, whether there was interference from another station (give the call if you know it), whether the program was interrupted by natural static, whether the signals faded, whether periodic distortion was noticeable, whether the general quality of reception was good, and the signal strength. The last should be stated in "R" units, which are as follows: R1—just audible; R2—very weak; R3—weak but understandable; R4—fair; R5—fairly strong; R6—strong; R7—very good signal; R8—very strong; R9—extremely strong.

Thus, a report might run as follows: "Your station VK2ME was heard by me on July 1st between the hours of 8 and 9 A.M., E.S.T. on a frequency of 9590 kilo-



Verification card from the police radio station TG2X, Guatemala

cycles. No station or static interference noticeable. Signal fading varied between R7 and R9. Average signal R8. Distortion noted during signal fades. Quality (clarity) excellent. I employ a Model 000 Blank All-Wave Superheterodyne with a doublet antenna running north and south. . . ."

The above should be followed by at least a partial list of what was heard, such as musical selections, talks, and so on, and concluded with a request for a verification.

It is very important that you list some of the things you heard. Some people attempt to obtain verifications by copying the programs printed in newspapers, or by merely stating that they heard the station at a specified time. This has made it necessary for the stations to exercise care in issuing verifications, and you are not apt to get one if it appears that there is a possibility you never heard the station at all.

It is also advisable that the technical data be accurate, and not colored by your desire to sound pleasing. If the signal is poor, or weak, or fades badly, by all means say so . . . this is just what the station engineers want to know, and it is only through such data that they are able to improve services. That's the reason they want such information.

The letter should be addressed to the station. Usually the station call, the city, and the country are sufficient, but if you want to be on the safe side, consult the lists of station addresses published in radio magazines.

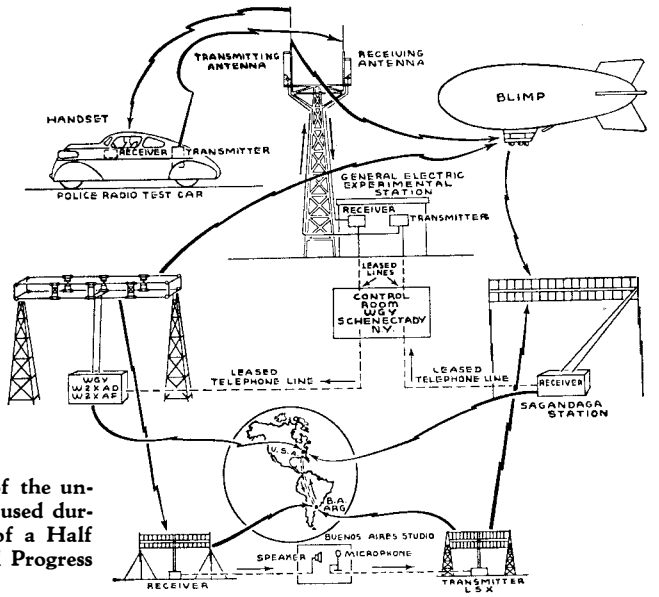
Each request should be accompanied by an International Reply Coupon. These can be purchased at any post office—at nine cents each. They are acceptable in most countries, but they need not be sent with a request addressed to any station in the U.S.S.R.

Veries—called "QSL cards" by radio amateurs—can also be obtained from amateurs in this and foreign countries. However, the radio amateur is not apt to send a verification unless your request for one is accompanied by a detailed report regarding your reception of his signals. It is neither necessary nor advisable to include a statement of what you heard, other than the call of the station with which he was communicating, but it is only fair that you give him a report to compensate him for his trouble in mailing you a card. The report is as valuable to him as it is to the broadcast station engineer, for by such reports the amateur can determine his field pattern, and correct it if it is not to his liking.

In requesting verifications, keep in mind that no one is compelled to provide them. It is a courtesy, and an expensive one for most stations.

Novel Radio Hook-Up

DURING the celebration of Schenectady's Half Century of Electrical Progress, a novel radio hook-up was employed to provide two-way conversation between the Goodyear blimp *Resolute* and a General Electric police radio test car roving the streets. Theodore Van Deventer and Ernest J. Berggren, two Edison Pioneers who were early co-workers of the great inventor, discussed the work done by Edison in 1875 on wireless telegraphy, and afterwards talked with station LSX in Buenos Aires, a distance of more than 6000 miles.



Simplified drawing of the unusual radio hook-up used during the celebration of a Half Century of Electrical Progress

The accompanying sketch shows how this was done. The mobile radio equipment used in the blimp and car operated on ultra-short waves. Signals transmitted from the blimp were intercepted at the Sagandaga station and fed to the control room of WGY by land line. The signal was then transmitted from the General Electric experimental station to the police radio test car. The signals transmitted from the police car were intercepted at the experimental station and relayed to the blimp through transmitting station W2XAD. This same signal was intercepted at the receiving station at Buenos Aires and re-transmitted to the Sagandaga station through the LSX transmitter. By this means a complete circuit was made available.

New Soviet Station

A NEW short-wave broadcasting station has been placed in operation in Moscow. The call is RAN. This station is being heard well on the east coast on a frequency of 9520 kilocycles (31.51 meters). There are daily transmissions, broadcasts in English being from 7 to 7:30 P.M., Eastern Standard Time.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 163)

liquid helium, the space surrounding the sample is evacuated to make it a heat insulator and the magnetic field is removed. In demagnetizing, the sample cools itself still farther. In this way the lowest temperatures yet attained are reached. The material cooled is one ordinarily considered non-magnetic.

Absolute zero of temperature is 273.13 degrees below zero, Centigrade (−459.4 degrees, Fahrenheit), and at that point heat ceases to exist and all motion of molecules stops, according to present theory. As a result of attempts to reach this coldest cold, the possibility of separating different kinds of atoms of the elements (hydrogen and oxygen, particularly) was first shown and the subsequent isolation of these isotopes has given us heavy water. One of the remarkable effects of these low temperatures is that the electrical resistances of the common metals become vanishingly small.—*D.H.K.*

MILK

MILK will not boil over if a little glycerine is rubbed around the rim of the saucepan.

WOOD WITHSTANDS TERRIFIC FIRE

IN a spectacular demonstration staged before officials and members of The American Building Officials Conference, a small frame building of chemically treated wood withstood in an amazing manner, according to Phillips A. Hayward, Chief of the Forest Products Division of the Department of Commerce, a most severe fire test. Tests were conducted at the plant of the Protexol Corporation, manufacturers of the chemicals with which the wood was fire-proofed.

The small building, approximating 10 feet by 12 feet in size, was of ordinary frame construction with a wood shingle roof. One outside wall was also shingled, the other three being sheathed only. All wood, including sash and doors, had been chemically treated, though the slab door had been treated some 30 years previously and had served in a now dismantled New York Hotel.

A large flat steel tray of ten inch depth placed inside the building on the ground was first filled with cotton waste. A tank truck then pumped over this waste a layer of highly inflammable liquid. The roof and outside walls of the building were likewise sprayed with the oil and ignited.

As soon as the inflammable liquid had been burned off the roof and sides of the structure, the flames quickly died down. It was then necessary to open the front door and throw in a flame to start the interior fire.

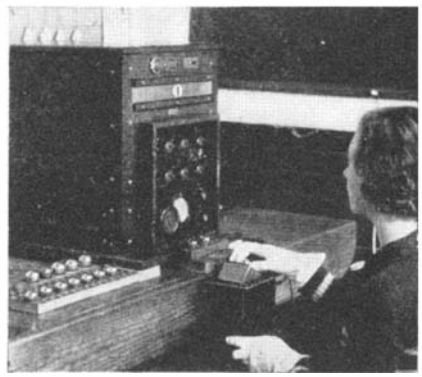
The raging inferno on the inside of the structure was permitted to burn for 40 minutes at a temperature exceeding 1800 degrees. By the end of 20 minutes the continued intense heat inside the structure had eaten through the end-wall peaks and the roof. The windows had of course gone out earlier. Not an ember was thrown and not a piece of wood went down flaming.

While chemists and wood experts have long known that wood and shingles could be chemically treated against fire, this is believed to be the most spectacular demonstration of the fact ever held.

UNIFORM BEARING BALLS

ADDED uniformity in ball bearing manufacture has recently been made possible by a unique electrical testing unit which reveals internal defects and gives an indication of the micro-structure of the steel without injury to the surface of the ball itself. The equipment is shown in our photograph in operation at the plant of The Fafnir Bearing Company, for whom it was developed.

Balls to be tested are simply rotated on two small electrical contacts in the V-shaped notch in front of the operator, and a light beam moving over a ground-glass scale reveals whether or not they come within previously determined standards.



Electrical testing of bearing balls

A balance of inductances between three known values and the ball to be tested, similar in principle to the balance of resistances obtained with a Wheatstone bridge, provides the basis of the test. Since the balls have been previously checked for size to within limits of .00005 to .0001 of an inch, settings are made on the basis of constant mass for each size of ball.

Experiments have shown that internal flaws, soft centers, excessive decarburization, and other variations in micro-structure all result in definite changes in the readings obtained. Since hardness also depends upon micro-structure, the measurement gives an indirect check on this factor as well. Correlation of the results obtained with metallographic examination, hardness tests, and the like provides standards for production tests. At present, all balls of one-inch diameter and larger, where variations due to heat treatment are more likely to occur, are tested on this equipment. Smaller sizes, down to ½ inch, may also be tested as a check on other inspection methods.

SHOT POISON DUCKS

WILD ducks often escape hunters' gunfire only to be poisoned fatally by lead shot which they eat in dabbling for food in marshy areas. Waterfowl losses from lead poisoning are common, and many ducks die from eating only four or five lead pellets.

The slow, toxic action of the lead first causes ducks to lose their power of flight,

and then their ability to swim or walk. In this helpless condition, even should they survive the ravages of the poison, the birds are likely to become victims of the elements or of predators. The Bureau of Biological Survey called attention to this waterfowl menace in 1919 and pointed out the hopelessness of any remedial measures.

"All that can be done," said the Bureau then, "is to call attention to the prevalence of lead poisoning and to describe the cause and symptoms, so that persons finding affected birds may understand."

But the outlook for preventing lead poisoning of waterfowl is somewhat brighter now. By mixing lead and magnesium, scientists of the University of Minnesota and of the Biological Survey have developed an alloy that disintegrates in water, or, if it is eaten by waterfowl, breaks up rapidly in the gizzard and passes through the intestinal tract before a fatal dose of lead can be absorbed by the bird's body. Ordinary lead shot when eaten by waterfowl are trapped in the gizzard and gradually are ground away. This finely divided lead absorbed by the duck's body as it passes through the intestine produces the poisoning. When the new alloy has been developed to the point where its use by shot manufacturers will be practicable, the scientists believe the dangers of lead poisoning will be greatly decreased.

POWER

MUSCLE power of man and animals used in all of man's activities totals 110 billion horsepower per year, it is estimated.

Energetic Jets

FEW materials have ever appeared so unpromising from a utilitarian standpoint as the recently discovered element deuterium, better known as heavy hydrogen. So much like ordinary hydrogen that refined experiments are required to show any difference, and costing even now 13,000 dollars a pound (to be compared with nine cents a pound for hydrogen), it seemed destined to remain a laboratory curiosity, yet an important use has been developed for it.

It has been found possible to produce jets of deuterium gas of such high velocity, reports the *Industrial Bulletin* of Arthur D. Little, Inc., that the energy available due to speed alone in one pound of the gas is equal to that obtainable from the combustion of 2500 tons of coal. The apparatus for producing the jets resembles a short-wave radio transmitter operating between the poles of a powerful electromagnet. When the jets impinge on various substances, profound changes occur and artificially radioactive bodies are produced. In particular, samples of common salt have been so far converted as to have a radioactivity half as intense as that of pure radium, and to give off more penetrating gamma rays (short X rays) than any naturally occurring radioactive substance. The great difference between the radioactive salt and radium is that the activity of the salt decays rapidly and becomes unappreciable after a few weeks, while that of radium continues practically undiminished for centuries. When radium

decays it leaves a residue of radioactive substances, but radioactive salt decays to common salt with a little harmless magnesium chloride.

These properties of radioactive salt lead to the possibility of an important medical application. It is very dangerous to introduce radium compounds into the blood for relief of suffering, as there is no good way of getting rid of radium afterward, and prolonged exposure to radioactivity is dangerous. By this new development, however, it may prove possible to give radioactive salt by mouth or injection and obtain the beneficial effects of radium without the dangers.

"Liquid" Coal

TO amplify the supply of liquid fuel required for oil burning furnaces and even for Diesel engines, large quantities of coal in an extremely fine state of subdivision are incorporated into fuel oil used in Great Britain. The method consists of grinding the coal to extreme fineness in the oil and adding a material which will prevent it from settling out. Many substances have been used to hold the coal in suspension but the most common one is a lime-rosin soap dissolved in the oil. By using such mixtures made with petroleum or coal tar oils, a substantial saving in the quantity of imported oil required for fuel is realized.—*D. H. K.*

Glass Fish Line

ZANE GREY, and all those other dwellers of the upper-crust of Famous Fishing Feats, will please take their hats off to a 10-year-old boy. He has just accomplished one of those Ripley rarities—the landing of a fish with a line made of glass! He is Bob Crandall, of Ashaway, Rhode Island, son of J. T. Crandall, well known Eastern sportsman and veteran manufacturer of fish lines.

The youngster's achievement came as the result of the first actual test of a line made of fibrous glass, which has fascinating possibilities in the textile field as a result of the recent discovery of a revolutionary process to produce glass in fibrous form.

Bob's father took him to Thompson's Camps at Naples, Maine, for the test and the thrilled youngster landed a three-pound salmon in Sebago Lake, at the mouth of the Songo River, giving him the distinction of being the first person in the world ever to catch a fish with line made of pure glass thread. Bob caught his fish trolling a Black Ghost Fly.

Flux for Aluminum Solder

OF interest to solder and flux users is the new flux developed by the Alumaweld Company of America. This new flux, used in conjunction with a special, high strength solder, does a job heretofore considered impossible.

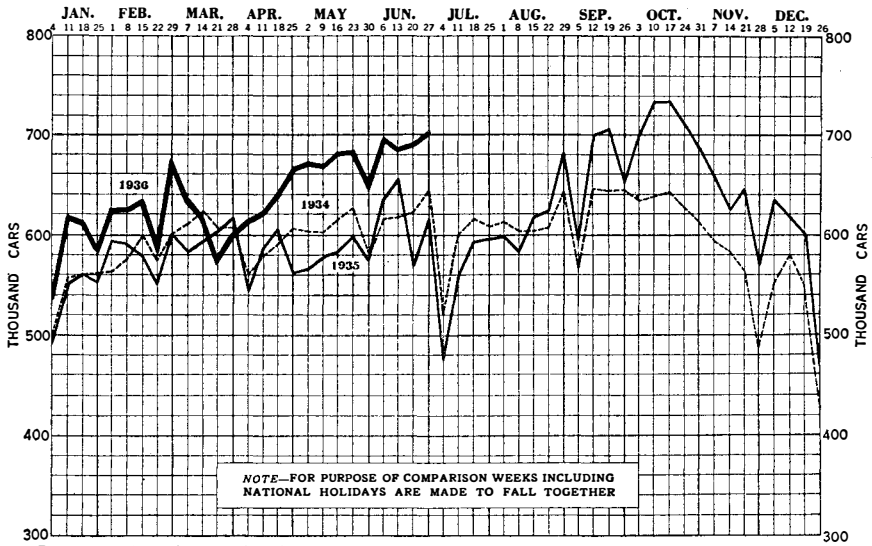
With Alumaweld flux it is now possible to make high-strength, permanent repairs on joints of any metals. It makes soldering easy because both solder and flux are applied with an ordinary soldering iron or blow torch. The soldering job is done at a low temperature but has the advantage of requiring high temperatures to melt it a second time. It works equally well on aluminum, stainless steel, die-cast pot metals, cast iron, copper, brass, and so on, which makes it easy to join any two different metals if desired. Alumaweld flux works with any type of solder.

Alumaweld solder has a tensile strength of 12,000 pounds, which is ten times that of ordinary solder. The finished joint can be worked or machined and takes a polish over which chromium or any other plating can be applied.

No Bedbugs on Swallows or Bats

SWALLOWS and bats are often killed because they are thought to spread bedbugs. This is a mistake, says W. L. McAtee, of the Bureau of Biological Survey. Both swallows and bats are sometimes attacked by insects that do in fact resemble the despised and detested bedbug, but these insects are definite and distinct. One variety preys on swallows and another on bats, but neither attacks men nor has the same habits of life as the bedbug.

Swallows as a group are good friends of farmers. They are insect hunters, and work from daylight to dark gathering food for themselves and their young. In the course of a season each swallow accounts



Revenue freight car loadings through the week of June 27. This "barometer of business conditions" continues to show very marked improvement over last year

for a quantity of insects that would otherwise make trouble in fields, gardens, and orchards.

Swallows are to be encouraged as working partners of the farmer and, as beneficial birds, are protected by state and federal laws.

Value from Farm Waste

HULLS removed from oats in making them useful for food were formerly a waste product burned under boilers but now as the raw material for the manufacture of furfural they have become industrially important in the refining of petroleum lubricating oils and in purifying rosin. The success story of furfural began shortly after the end of the World War when it was still a rare chemical laboriously produced by the ounce principally as a curiosity. Investigation of its value was undertaken in the belief that if use for it could be found the production of furfural from farm wastes would assist in solving the problem of disposing profitably of these by-products of agriculture.

Furfural was found to be valuable to the synthetic chemist in making a number of important compounds and resins but its peculiar value as a solvent has become more important than any of its other applications. In refining petroleum lubricating oils, the problem is to separate undesired materials from the oily part of the lubricant. Furfural was found to have the ability to dissolve the unwanted impurities in the lubricating oil and now is used in huge quantities for supplying better oils for industry.

In the refining of rosin, it was found that furfural would dissolve the greater part of the colored compounds which lowered the grade of rosin and would leave the clear rosin in solution in gasoline. This application has added importantly to the value produced by our naval stores industry. Thus the waste of the rolled oats industry has not only been profitably utilized but at the same time the material produced from it has increased the value of products of other industries.—*D. H. K.*

Are You an Alpha Omega?

YOU—anybody—can be a member of Alpha Omega, an honor society not yet founded, but proposed by President Max Mason of the Rockefeller Foundation before the recent semi-centennial celebration of the scientists' particular society, Sigma Xi. You do not need to be devoted to a life of science, as are the members of Sigma Xi. All that is required of the Alpha Omega "pledge," according to *Science Service*, is that he (or she) shall be dedicated to the scientific way of living.

That means that you will have to give up your pet superstitions, your carefully cherished predilections, your wavering but still stubborn belief in shadowy borderline quasi-sciences—until cold, hard, bomb-proof factual demonstration can be produced in their support. The password of Alpha Omega, Dr. Mason proposed, shall be "How do you know it?" and the answer, "What of it?" It will be distinctly a fraternity of the hard-boiled.

Such an attitude of scientific skepticism is needed especially in these days to probe and test the ground where structures of mass action are to be built, Dr. Mason intimated.

"Our civilization can advance as the art of living is enriched by the application of knowledge won through the sciences," he said. "But scientific and technical knowledge can be used to retard and even to destroy the things most valuable in our lives, if their use be distorted by prejudice, passion, or individual and group selfishness. The safeguard is to be found in proper emotional education, both formal and informal, for the attainment of self-control, and the acquirement of the objective attitude."

The Alpha Omegas are not universally popular, Dr. Mason warned, for they take an aggressive attitude to some of the foibles of their friends. "They do this because they believe that little things add together to make large things, and that mental attitudes are contagious. They continually see small and apparently harmless examples of belief and action that remind them of the burning of witches, of lynchings, of cruel intolerance, of the K.K.K., of the Black Legion, of mass murder in the name of patriotism. And so they do not keep their passwords secret—they use them every day."

Greek Shorthand

"STENOGS," wrinkling their pretty foreheads over notes that have "got cold" since the boss dictated them yesterday, just don't know how tough a transcription job really can be.

How would you like to try to decipher a shorthand notebook that somebody else wrote about 2000 years ago—in Greek?

That is the job which scientists of the British Museum have set for themselves. A chance to decipher ancient Greek shorthand now appears possible, according to *Science Service*, through the discovery, in the archives of the Museum, of a papyrus manuscript bearing many shorthand signs and in parallel columns the equivalent words in ordinary Greek characters. If you can read Greek really fluently, you might be able to puzzle out some of the stenographic notes.

This ancient shorthand is made up of about the same kinds of strokes that one finds in present-day Gregg, but there are surrounding flocks of "ticks" that are rather reminiscent of Pitman. The important "key" specimen in the British Museum appears to have been written by an expert, for the characters are smoothly and beautifully formed.

Considerable quantities of shorthand manuscript have survived from ancient Greek times, but until now nobody has been able to read them. The British Museum specimen is expected to unlock this stenographic literature, as the famous Rosetta Stone, found in Egypt over a century ago, unlocked the until-then mysterious hieroglyphic writing of the old Nilotic obelisks and temples.

Greeks of early Christian times, as well as of the classic days, had their shorthand-writing secretaries—who, incidentally, appear always to have been young men. The famous Church Father, Origen, is said to have kept seven stenographers busy with his rapid-fire dictation. Their notes were read by other scribes—frequently young women—who transcribed them in Greek

longhand. Origen would doubtless have rejoiced, had he been able to get hold of typewriters—for he was a quantity-production author.

Shorthand appears to have been a required subject in some Greek school curricula. There is extant the parting warning of a Greek schoolmaster, just before vacation: "Now boys, don't forget everything I've taught you, during the holidays. When you come back next fall, if you don't remember both your arithmetic and your shorthand, I'll certainly make my cane dance on your backsides!"

Art in Nickel Silver

WHAT is practically a lost art is preserved by manufacturers of buttons for the dress uniforms of officers in a number of British Army regiments. These buttons, which are made of nickel silver, are hand-worked with designs cut out with fine jewelers' saws. The filagrees and designs are said to be comparable with those worked on precious metals. Some of the saw blades are so fine that they are practically invisible.

Baby Oil

FOR centuries, it has been a custom to anoint very young babies with oil, in lieu of water-washing. This all-over oiling procedure is usually followed for only a few weeks, but oiling following a soap-and-water washing may continue for a long time. Finally, a little oil is applied locally just to inflamed areas. Normally, the oil used has been the olive oil of southern Europe, for which cotton-seed oil and corn oil became widely substituted in this country. Recently there has appeared a strong trend toward specially-prepared oils for this purpose, with properties other than mere oiliness, says the *Industrial Bulletin* of Arthur D. Little, Inc.

The modern baby oil, besides being blended from several kinds of oils to secure the right spreading and coating properties, contains preservatives which keep it from becoming rancid and hence irritating; what is more important, it is made antiseptic toward the types of bacteria found on the skin. In addition, it is pleasantly perfumed.

The earlier attempts at surface antisepsis were made by rubbing mercury compounds on the skin, with or without oiling, a drastic procedure not entirely free from chance of irritation and of poisoning, and only partially effective at best in preventing or curing skin diseases. Antiseptic oils avoid the use of mercury, using instead the newer synthetic germicides. The effectiveness of antiseptic oil has been so demonstrable that it has been adopted by a number of maternity and babies' hospitals. Indeed, some superintendents have become so enthusiastic over its record in the prevention of impetigo and other highly contagious skin diseases that they have made its use a feature of their treatment and recommended it for continuation in the home, often up to the age of six months or more.

Several manufacturers have watched with wonder and chagrin as the market for packaged talcum powder has shrunk with rapidity, while baby oil has become an article of commerce with its volume already reaching sizeable proportions.

More Profit in Woodland If Only Big Trees Are Cut

THERE is a great deal more profit in lumber from farm woodlands when only the large, mature trees are cut and the small trees left to grow into another crop. The United States Forest Service has found that maple trees less than 12 to 14 inches in diameter actually do not pay their way through a band sawmill.

There is about 19 times as much lumber in a tree 26 inches in diameter as in a nine-inch tree. But since the lumber in the larger tree is worth about twice as much per foot, the total value is approximately 36 times as great.

Selective cutting removes the greatest value with the least volume. It leaves small trees as a windbreak and allows them to grow faster because they no longer need to compete with big trees for moisture, sunlight, and space to spread their crowns.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

A New and Fascinating Machine. Catalog description of a machine for cutting and polishing gem stones, also containing useful data for those who are interested in amateur gem cutting as a hobby. *Write for Bulletin 936A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Soil, the Nation's Basic Heritage tells the story of the restoration of natural water control through soil conservation and improvement, with particular reference to the work being done in the Tennessee Valley. *Tennessee Valley Authority, Washington, D. C.—Gratis.*

The Western Range. A report to the Secretary of Agriculture, on the original and present condition of the range resource, factors which have led to the present condition, and the social and economic importance of the range and its conservation. *Government Printing Office, Washington, D. C.—Gratis.*

Diesel, the Modern Power, describes in simple and non-technical language the development of the Diesel engine from the beginning to its present form. Beautifully illustrated with drawings and photographs, it tells the whole story and touches upon the future possibilities. *Technical Data Department, Research Laboratories Section, General Motors Corporation, Detroit, Michigan.—Gratis.*

Perspective and Optical Illusions of Depth, by Theodore M. Edison, deals with gages of depth and includes several striking optical illusions. A technical chap-

ter is devoted to the production of correct perspective and to the use of mechanical, optical, and photographic perspective drawing aids. *Request Calibron Notebook No. 3, Calibron Products, Inc., West Orange, New Jersey.—Single copies 50 cents; additional copies (in same package) 30 cents each.*

PROGRESS IN AIR CONDITIONING IN THE LAST QUARTER CENTURY, by Willis H. Carrier, reviews developments in this comparatively new industry and illustrates much of the equipment used in large installations. *Write for Bulletin 936B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MANUAL ON PRESERVATIVE TREATMENT OF WOOD BY PRESSURE brings this subject completely up-to-date and outlines the characteristics of both woods and preservatives as they affect treatment. The book contains 50 working charts and tables. *Request Department of Agriculture Miscellaneous Publication No. 224, Superintendent of Documents, Government Printing Office, Washington, D. C.—15 cents (coin).*

THE NEW AND REVOLUTIONARY THINGS BEING DONE IN RAYON is a 16-page pamphlet dealing with all the phases of rayon manufacturing and use. *Write for Bulletin 936C to Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE NEW WAR ON ACCIDENTS deals in a concise manner with the problem of traffic congestion. It answers the all-important question: "What can I do about it?" The answer should be heeded by everyone. *National Safety Council, 20 North Wacker Drive, Chicago, Illinois.—Gratis.*

THE NATIONAL PHYSICAL LABORATORY, REPORT FOR THE YEAR 1935. A 249-page account of the investigations in physics, electricity, radio, metrology, engineering metallurgy, and aerodynamics at Britain's "Bureau of Standards." *His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.—12 shillings, net.*

FINE WIRES is a 14-page pamphlet describing various forms of resistance wires, metallic ribbons, and thin foils for electrical purposes. *Write for Bulletin 936D to Scientific American, 24 West 40th Street, New York City.—3 cents.*

SOIL SURVEYS FOR HIGHWAYS, Engineering Experiment Station, Circular No. 33. This 36-page booklet gives a brief summary of highway construction and a comprehensive review of present day methods. *Engineering Experiment Station, The Ohio State University, Columbus, Ohio.—Gratis.*

DATA CONCERNING PLATINUM describes metals in the platinum family together with their uses in industry. It also illustrates many of the different standard products made of these metals. A series of tables gives pertinent facts. *Write for Bulletin 936F to Scientific American, 24 West 40th Street, New York City.—3 cents.*

MODERNIZING THE KANSAS HOME, by H. E. Wichers, tells the story, mainly in pictures and short text, of how various types of homes in Kansas have been modernized. The remarks, of course, would pertain as well to homes in other sections of the country. An excellent bibliography is included. Bulletin No. 32, *Engineering Experiment Station, Kansas State College, Manhattan, Kansas.—Gratis.*

ADDITIONAL INFORMATION ON THE FOLSOM COMPLEX, by Frank H. Roberts, Jr. Report on the second season's investigations of the Lindenmaier site in northern Colorado, where evidences, 12,000 to 13,000 years old, of Folsom man's handiwork were found. *The Smithsonian Institution, Washington, D. C.—30 cents.*

LOWER-COST MANUFACTURING BY SHIELDED ARC WELDING shows some of the cost-cutting possibilities of this particular type of welding. *Write for Bulletin 936G to Scientific American, 24 West 40th Street, New York City.—3 cents.*

HOME FIRE HAZARDS is essentially a handbook of warning, putting forth as it does many of the reasons for fire in the home. *Research Department, American Fire Insurance and Indemnity Group, 80 Maiden Lane, New York City.—Gratis.*

THE FUTURE OF RADIO is a reprint of a statement by David Sarnoff before the Federal Communications Commission. It outlines the public interest in radio, the convenience value of radio communication, and, particularly, the developments which may be expected in television and other uses of the ultra high frequencies in the near future. *Radio Corporation of America, 30 Rockefeller Plaza, New York City.—Gratis.*

POINT DISCHARGE IN THE ELECTRIC FIELD OF THE EARTH. By F. J. W. Whiple and F. J. Scrase. An analysis of continuous records of the discharge current between the earth and the atmosphere. *His Majesty's Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.—One shilling sixpence, net.*

RHODANIZE describes in a non-technical manner a process for protecting the surface of any silver object from atmospheric and other causes of tarnish. *Write for Bulletin 936E to Scientific American, 24 West 40th Street, New York City.—3 cents.*

PAINT AND VARNISH by Joseph H. Koffolt and James R. Withrow. This 20-page pamphlet sets out to prove that paint does not cost—it pays. It tells briefly and concisely of the protective value of paint and varnish and of the selection and use of these materials. It also deals with the application of paint and varnish—how and when they should be used. Circular No. 32, *Engineering Experiment Station, Ohio State University, Columbus, Ohio.—Gratis.*

THE DEPENDENCE OF TERRESTRIAL TEMPERATURES ON THE VARIATIONS OF THE SUN'S RADIATION. By G. C. Abbot, Secretary, Smithsonian Institution. The results of five more years of solar study with regard to long-range weather forecasting, giving affirmative answer to the question "Does the variation of the sun's radiation sensibly affect the course of temperature in terrestrial weather?" *The Smithsonian Institution, Washington, D. C.—10 cents.*

Books SELECTED BY THE EDITORS

INVENTION AND THE LAW

By Harry Aubrey Toulmin, Jr.

THIS book, in which the author discusses under appropriate headings the meaning of the word "invention" as used in the law of patents, and presents a learned treatise on the "Background of Invention," will no doubt prove of interest to the lawyer in general practice and a welcome addition to the library of those lawyers specializing in the practice of the law of patents. It should also be of interest to inventors for it will inform them concerning that thin line separating the field of invention from that of mechanical skill. It is noted that this dividing line is not a fixed straight line but one forming capes and promontories projecting from one field into the other; this is the reason why so many writers and judges have found that it is quite impossible to lay down a fixed rule for determining what is and what is not a patentable invention.—$5.25 postpaid.—*O. D. M.*

A MANUAL OF PHOTO-ELASTICITY FOR ENGINEERS

By L. N. G. Filon

MATHEMATICS abound in this volume covering the relatively new field of study which has become so significant to engineering progress during the past few years. It is a practical handbook, brief and yet sufficiently explicit to enable an investigator to understand the fundamental problems involved, to set up his apparatus, and to use it in the best possible manner.—$1.65 postpaid.—*F. D. M.*

HOW ANIMALS DEVELOP

By C. H. Waddington

THIS short account of the science of embryology is the first book in English to provide a simple outline of the whole of this important subject. It shows that the study of development is perhaps the best method of approach to the most fundamental of all biological problems, the problem of how all the diverse activities of an animal are integrated so as to make up a complete individual organism. The book gives a sketch of the general pattern on which all animals are built, and in this connection discusses fully the most recent work, particularly that centering in the discovery of "organizers." It is simply written and should enable the general reader to understand recent revolutionary advances which have been made in this subject. It should also be useful to medical students and students of zoology who want a reliable and up-to-date survey to supplement their more particular studies. Illustrated.—$2.15 postpaid.

WITH PLANE, BOAT AND CAMERA IN GREENLAND

By Ernst Sorge

A SCIENTIFIC man with experience as an explorer in Greenland, together with other practical expedition men, was employed to pilot a troupe of moving picture actors on an easy summer expedition in Greenland (described in the book as a "polar" expedition) and the mixture produced some odd results. Needing polar bears for the pictures, they took some to Greenland from a zoo in Germany! Despite these amusing aspects of the "polar expedition," the author—who is the expedition scientist—gives really valuable accounts of the stupendously impressive calving of a huge glacier, which sets up waves higher than any in mid-ocean, as well as other scientific matters pertaining to glaciology. Good reading.—$5.20 postpaid.—*A. G. I.*

ASTRONOMY FOR THE LAYMAN

By Frank Reh

THE poems of astronomy form the main element in this unique book. The author has ransacked the realm of poetry to find fitting verses to illustrate each detail in a discussion of the earth, moon, and stars. The result is a real anthology of astronomical verse, with a dash of simple astronomy thrown in.—$3.15 postpaid.—*A. G. I.*

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By E. J. Salisbury, D. Sc., F.R.S.

A BOOK for the gardener with an inquisitive mind, who wants to know the hows and whys of the soil and its composition, the effect on plants of sunlight and shade and of frost and fog. Good chapters on root growth, propagation by cuttings, and on seeds and their germination. 320 pages, illustrated mainly by line drawings. Index.—$3.15 postpaid.—*F. B. I.*

TWENTY YEARS UNDER THE SEA

By J. E. Williamson

POSSIBLY no living man has spent more time investigating the mysteries of the depth of the ocean than the author of this book. For 20 years he has, with the assistance of the "photosphere," photographed under-sea scenes for educational and scientific purposes. The present book, beautifully illustrated with numerous under-sea photographs in full page size, tells of his work and of the results obtained. Written from the standpoint of general interest, it is an outstanding book of its type. The photographs alone are well worth the price of the book.—$2.65 postpaid.—*A. P. P.*

SHIPS AND THE SEA

Compiled and Edited by Pay-Lieut. E. C. Talbot-Booth, R. N. R.

PART of the enjoyment of an ocean voyage lies in having a knowledge of some of the mysteries of the seas and of the ships that sail them. For the person who studies each passing ship with more than a casual interest, this volume is truly what its publishers

claim: "A Cruising Companion." Containing over 700 pages, it is still of pocket dimensions. Starting with a long chapter on seamanship and navigation, it discusses many of the technical aspects of ship operation; it gives also various tables of distances, code signals, and communications; it answers such common questions as "why a ship remains afloat"; it has a chapter on yachts and yachting and another on sailing ships, as well as a discussion of seaports, the fishing industry, navies, and, in fact, practically every subject pertaining to the sea. It is profusely illustrated with silhouettes of well-known merchant vessels of all nations, which may be used for identification purposes; with colored folded inserts showing the merchant marine flags of all nations, the house flags of many lines of Britain, the Netherlands, United States, and other countries; and silhouettes of warships of a number of nations. Many enjoyable and profitable hours may be spent in a deck chair with this handy volume.—$3.20 postpaid.—*F. D. M.*

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For MEN
who want to become independent in the NEXT TEN YEARS

IN the Fall of 1946 two business men will be sitting in a down-town restaurant. "I wonder what's going to happen next year," one of them will say. "Business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

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He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

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"I wish I had those ten years back," he will say.

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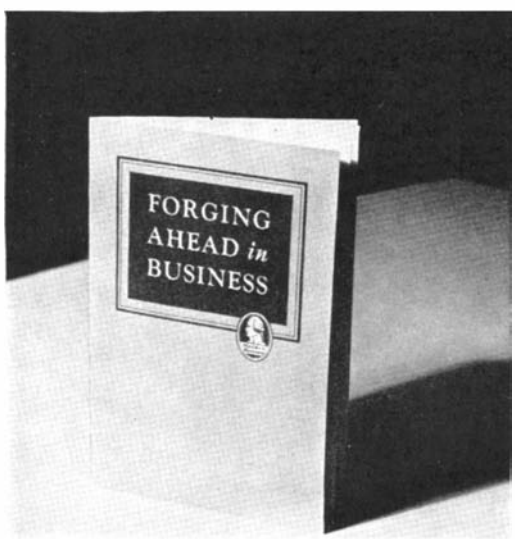

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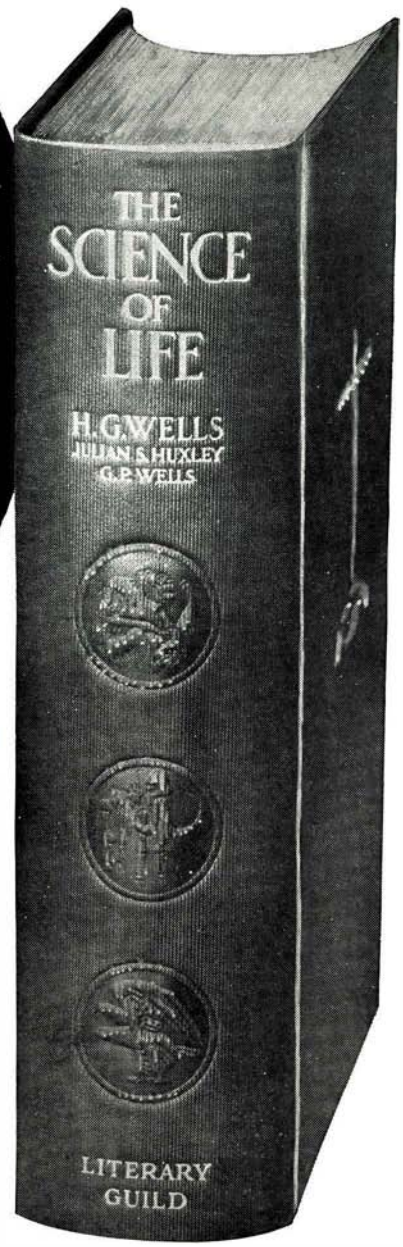

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