BOMBING

And its Place in Modern War

SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography

By Jacob Deschin

Vol. 161

No. 6

DECEMBER
1939

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a Copy

IT HELPED MAKE DREAM CARS COME TRUE

. . . *tetraethyl lead!*

● Have you seen the 1940 cars yet? Each one is a dream car come true. For the men of the automobile industry have been working these many months to translate their dreams, ideas and paper plans into steel and glass and paint . . . to solve the many intricate problems that the "birth" of these wondrous new models involved.

But there was one vital problem that was solved *before* they started. They *knew* that there would be fuels to run the cars they planned. They did not hesitate to design high-compression engines —engines that deliver more power and miles with less weight—because they knew that the high anti-knock gasoline these modern engines require is available at every roadside.

Today, the world over, oil companies improve the anti-knock quality of motor fuels by adding *tetraethyl lead* . . . a powerful, volatile liquid that completely mixes with gasoline and acts to prevent the power-wasting "knock" or "ping" that once threatened the development of the high-compression principle.

The petroleum industry this year—as in previous years—has worked hand-in-hand with the automobile industry by keeping pace with the need for better motor fuels. Through its extensive use of anti-knock fluids containing tetraethyl lead to improve gasoline it has helped make the dream cars of the automobile designer come true. It has helped make them the practical machines that you and thousands of other motorists will thrill to drive in 1940.

THIS MONDAY NIGHT . . . Tune in **"Tune-Up Time,"** featuring Andre Kostelanetz. Tony Martin, Kay Thompson, Columbia Broadcasting System, 8 P.M., E.S.T.; 7 P.M., C.S.T.—10 P.M., M.S.T.; 9 P.M., P.S.T.

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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

NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

CONTENTS • DECEMBER • 1939

NO one needs to be reminded of the important part played in modern warfare by the airplane; newspaper stories are a constant reminder. The other side of the question, that of defense against the frightfulness of air raids, is equally important. It is vital to every nation that anti-aircraft guns be provided in efficient types and large numbers. The United States is, therefore, rapidly adding to its stores of guns, such as the one shown on our cover this month, for defense against attacks from the skies by a possible future enemy. Rapid and accurate fire characterize this deadly weapon for defense.

SCIENTIFIC AMERICAN, December, 1939. Vol. No. 161, No. 6, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Orange, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

Personalities in Industry

BYRON C. FOY

THE automobile business has made the most amazing progress of any industry in the past two decades—and the least known part of it—the human side—is one of the most fascinating stories in American business. For the automobile industry is literally a self-made business. Perhaps a very good reason for this is because it has been built—and is being operated today—by self-made men, of whom Byron C. Foy is a good example.

Mr. Foy is president of the De Soto Motor Corporation, vice-president of the Chrysler Corporation, and secretary of the Automobile Manufacturers Association. And he started at the bottom—but he's never forgotten the things he learned about people when he was out on the firing line as an automobile salesman in the days when you not only had to sell a man a car, but also sell him the idea of why he ought to own a car at all!

As far back as college days, Byron Foy was what you might call an "automobile nut." He had a little four-cylinder car and he loved it. In fact, he liked cars so well that when he graduated he went to work as an automobile salesman in a Dallas factory branch, but he didn't wait around the sales floor for people to come in. He went out and made calls. Lots of them.

When the company announced a nation-wide sales contest, Foy decided he would have to sell in volume, if he was to compete against salesmen in the larger cities. Thus he went out after fleet business—large corporations and the city itself. Like the rising young man in the popular Alger novels of the day, Byron Foy won a coveted prize in that contest.

Then the factory sent him east as a traveling representative. His eastern dealers said they couldn't sell cars in winter. "We can't make country deliveries in the snow," his men complained. "Why not deliver the cars on sleds?" Foy suggested. And they were delivered, right to the farmers' front door. Sales increased.

Still later, Foy went to the Pacific Coast and subsequently became president of the Reo Motor Company of California. Later he returned east as a partner in the New York Chrysler distributorship.

Here he came to the attention of Walter Chrysler, noted for his encouragement of young blood in his organization. Walter Chrysler recognized Foy's promotional instincts and sound business judgment, and brought him to staff headquarters. Under Foy's leadership, De Soto has become a potent factor in Chrysler Corporation sales, and when you talk with Byron Foy, you'll know just why. The fact that he knows people—the things they want and the motives that make them buy—is reflected in his talk, as well as his products, his advertising, and his relations with his men and his dealers.

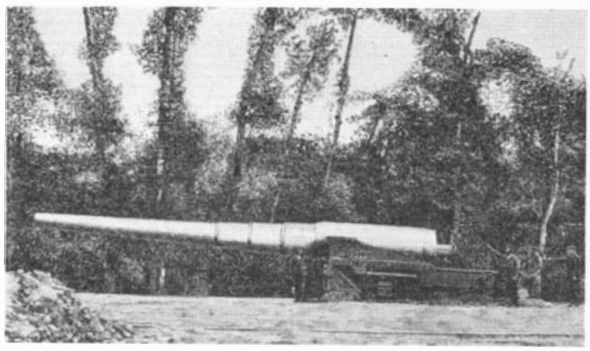
There's nothing fancy about Byron Foy's office, or about Byron Foy. The office is simply furnished. Papers never stay on his desk very long. Foy is a bear for detail—but he goes straight to the most important tasks first. Foy talks easily, and he is easy to talk to. He believes in giving his executives complete confidence and responsibilities. Thus he not only surrounded himself with a strong staff, but the way in which he operates has helped make them strong. Byron Foy is married, and has two children. Besides his family, his main hobby is still motor cars. Though for sheer exercise he rides horseback, the wheel is still his first love. De Soto salesmen in New York know that they can always "call Mr. Foy's office" when a little extra help is needed to make a De Soto sale to one of Foy's many friends. For Byron Foy, automobile company president, is still a great automobile salesman who gets a kick out of "closing a deal."

50 Years Ago in . . .

Scientific American

(Condensed From Issues of December, 1889)

CANNON—"The Spanish government, determined to emancipate the country from its dependence upon foreign nations for its munitions of war, has of late years displayed great enterprise in the establishment of works for the building of war ships and cannon. Among the guns lately turned out at Trubia are four which form part of the armament of the new Spanish steel cruiser Pelayo. Of these two are 49 ton 13 in. guns and two are 11 in. One of the 49 ton guns, shown in our engraving, was lately proved. The projectile used was of steel, weighing 960 lbs., fired with a charge of 440 lbs. prismatic powder, which gave an initial velocity of about 2000 ft. per second and a pressure near 20,000 lbs. per square inch. The penetrating power at short range is 32 in. of wrought iron. Length of gun about 40 ft."



TRANSATLANTIC—"The steamer City of Rome, on her last trip out, made the port of Milford Haven instead of Liverpool, the magnificent system of docks, long under construction at that port, having been at last completed. The substitution of Milford Haven for Liverpool as a terminus saves the delay in steaming up St. George's Channel and up the Mersey, and, more important yet, avoids the dangers of the channel fogs and the annoying delays off the Mersey Bar. To London from Milford Haven *via* the Severn tunnel is 285 miles, against 201 from Liverpool, it being 1½ hours longer by rail."

COAL DUST—"Heretofore about one-seventh of the product of the coal mines has been lost in dust. It is now intended to utilize the dust by making it into bricks that will burn like hard coal, except that there are no clinkers, as the bricks burn to ashes."

FOREST GIANTS—"Plying on Puget Sound is a boat 122 feet long. The timbers of which the hull is built run from stem to stern, and not one is spliced. As a specimen product a Washington lumberman sent to San Francisco last year a beam 24 inches thick and 152 feet long."

PHEASANT—"The Mongolian Pheasant, a valuable addition to our native game birds, was imported from China a few years ago. It has increased with surprising rapidity in western Oregon, Washington, and in the northwestern corner of California, under effective legislative protection. The plumage of the male is extremely brilliant and attractive. As a table dish it equals the partridge and prairie chicken of the East."

LUMINOUS FOUNTAINS—"Among the most wonderful displays, electric and visual, at the recent French exposition were those pertaining to the luminous fountains, which were arranged on a grand scale. The chameleon-like changes of color in the fountain waters were something astonishing to behold. It was not accomplished by the mere throwing of colored lights upon the exterior of a spouting jet, but was due to an interior electric illumination of the water; the beams of light being, so to speak, thrown into and imprisoned within the crystal walls of the water and then carried along with it, becoming visible by interior reflection during the discharge of the water."

PHONOGRAPH INSTRUCTION—"Edison's phonograph has scarcely, as yet, passed the period of "novelty and curiosity," but many practical applications of the instrument have already been suggested, and have in some cases been actually carried out. There is one application, however, that we have so far not heard mentioned, and that is the instruction in the pronunciation of foreign languages. In the future the publishers of manuals of instruction in foreign languages will find it, most likely, a paying undertaking to publish a phonographic key of the various exercises, thus enabling the learner to acquire the correct intonation and pronunciation by causing the phonograph to repeat the word or sentence until it has been perfectly imitated by himself."

LABOR SAVING—"Some people denounce labor-saving machines as an evil. They notice that a few individuals are put out of work for a time by the introduction of some device, but they ignore the greater benefits which the whole community obtains."

LIGHTHOUSES—"The Lighthouse Board has submitted its report for the fiscal year ending June 30, 1889, to the Secretary of the Treasury. At the close of the year there were under control of the board 1021 lighthouses and lighted beacons, 1328 lights on Western rivers, and 4284 buoys of various kinds. In the maintenance of these there are employed 1934 light keepers and a number of miscellaneous employees."

WAVES—"The height of sea waves has long been the subject of controversy. In the recent British scientific expedition some instructive data were gathered by a sensitive aneroid barometer capable of recording its extreme rise and fall by an automatic register. 'With a sea not subjected to an atmosphere of unusual violence, it indicated an elevation of 40 feet from the wave's base to crest.'"

ARMOR-PIERCING—"The new British steel cruiser Blake is to be armed with handy rapid-firing guns that can penetrate 12 or 15 inches of armor plate."

FOOT-WARMER—"One of the latest applications of electricity is the making of a floor mat that throws out heat—an electric heater, in fact, in the form of a mat. An excellent device for warming the toes."

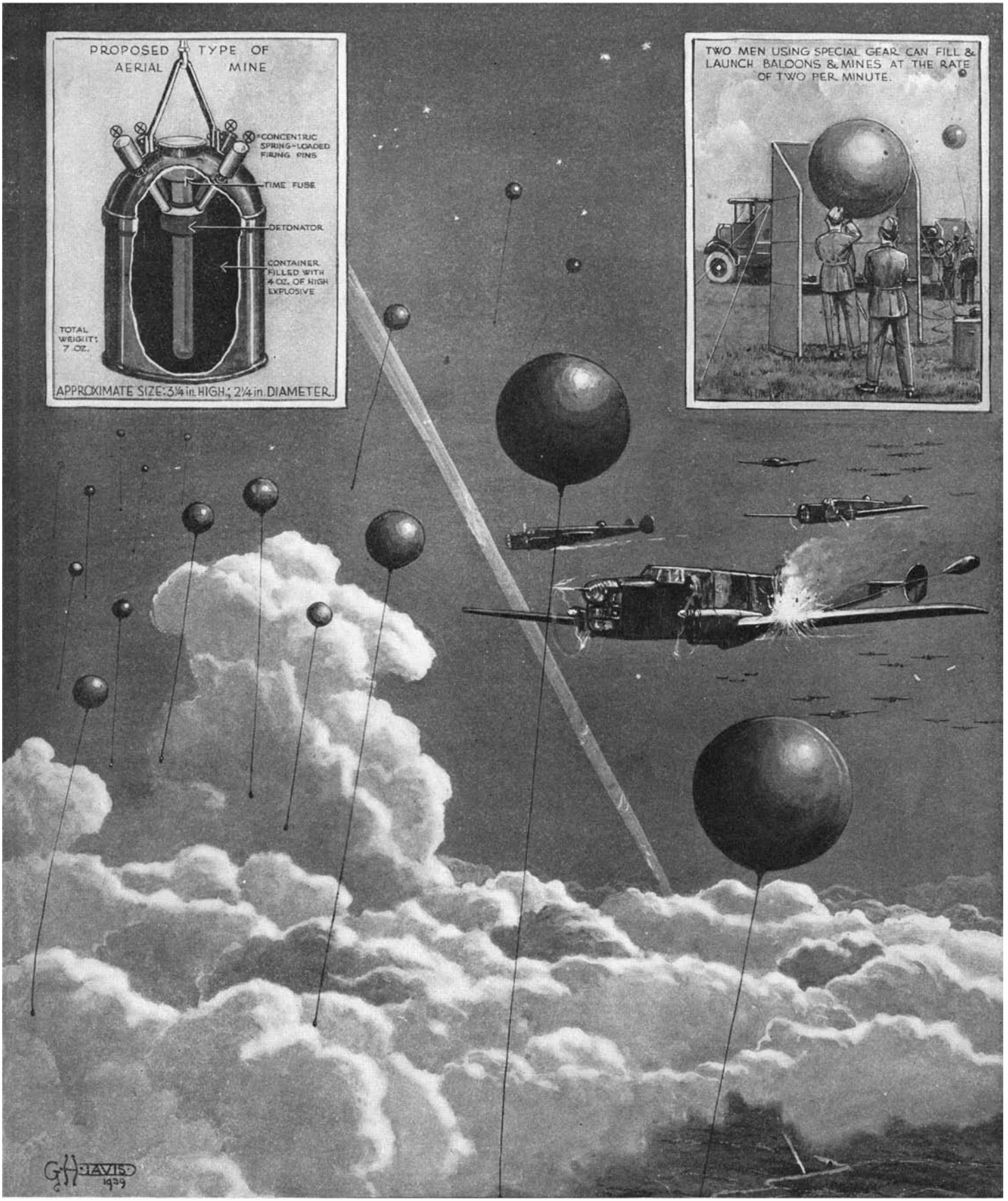
AND NOW FOR THE FUTURE

¶Was Shakespeare Shakespeare? New Findings of Science—by X Rays and Infra-Red Photographs of Paintings—Give Startling Evidence. By Charles Wisner Barrell.

¶New Express Highway in Pennsylvania Follows Old Railroad Grade.

¶Will a Race of Super Men Eventually Evolve? By Henry M. Lewis, Jr.

¶Research in Noise Sheds New Light on a Number of Everyday Problems. By James A. Baubie.



BALLOON MINES TO PUT THE AIR OUT OF ACTION

IF German bombers appear over London some dark night, they may find above, below, and around them an inescapable aerial mine field consisting of myriads of small, free balloons sent to a predetermined height and drifting with the wind. Each would support a cannister of high explosive on 40 feet of fine steel wire. Enemy planes would, therefore, face the double danger of fouling their propellers with wire and contacting the bomb itself. If a wire should catch on a wing, the bomb would be whipped backward to explode against the plane. A time fuse on the bomb allows it to become "alive" only after safe launching and puts it out of action after a given time. This aerial mine has certain disadvantages, but it affords, according to H. G. Wells, "the possibility of putting the air out of action whenever we wish it." Invented by Major H. J. Muir, it would have an enormous effect on the morale of enemy raiders. Drawing courtesy *The Illustrated London News*.

Loading bombs in a U. S. bombing plane during recent maneuvers

Will Bombs Dominate?

Aerial Bomber Has Become Super-Type of Long-Range Heavy Artillery . . . How Bombs Differ in Their Penetrating and Explosive Action

By ARTHUR E. OXLEY, M.A., D.Sc.
Major, Royal Air Force

AERIAL bombing has become a naval and military science of dominant importance in offensive warfare. This is attributable mainly to development in aircraft in regard to range, speed, and carrying capacity. Until near the end of the World War in 1918, aerial bombing was a very secondary means of offense compared with aerial machine gunning, which was organized for inter-aerial combat and occasionally used against troops deploying in the open. The airplane, at this time, was not a high-caliber offensive weapon. Today, the aerial bomber has become a super-type of long-range heavy artillery and a significant challenge is now being made to establish its efficiency not only against the strongest land fortifications but also against fleet battle-units and submarines. Recent events indicate that the command of the seas may to some degree be passing over to the nation which can hold command of the air. Should such power emerge, the aerial bomber will have become a primary offensive weapon in general warfare.

Multiple-engined heavy bombers, numbered internationally by thousands, can now carry projectiles, each weighing a ton or more, over land and sea defenses which are far out of range of the most powerful military or naval guns. Such projectiles are equipped with armor-piercing devices for hurling on ships and fortified positions; they explode with a delayed action after penetrating the objective. Other projectiles are equipped so as to produce a "scatter" effect over the widest range possible; they are designed to cause the greatest devastation in troop concentrations deploying in the open or on unsheltered civilian populations. Such projectiles explode instantaneously on contact with the objective.

High-explosive bombs may be classified in two general groups according to their penetrating and delayed explosive actions or their non-penetrating and instantaneous explosive actions. The first has a relatively thin shell and a penetrating nose-cap of solid steel; the second has a thick shell for more devastating fragmentation effect and a blunter nose to counteract penetration. There are many types of bomb in each classification and those illustrated diagrammatically in Figures 1 and 2 are intended merely as examples to indicate the general difference in the two classes.

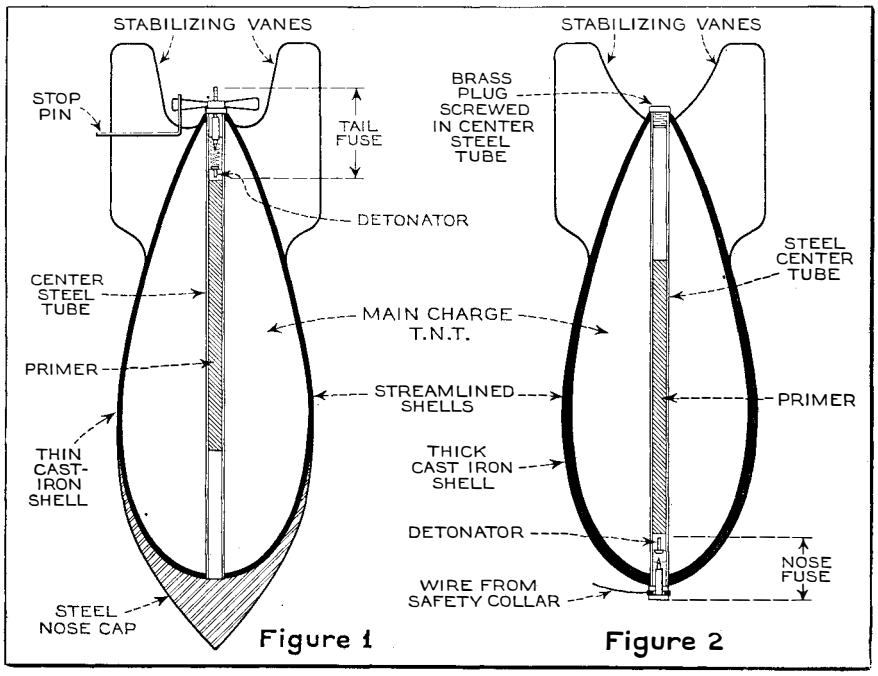


Figure 1 **shows general details of a penetrating type of bomb, in which the fuse action is delayed.** *Figure 2* **illustrates a nose fuse type for instantaneous action**

The type of fuse used in the bomb shown in Figure 1 is a delay fuse inserted in the tail of the bomb; that in Figure 2 is an instantaneous fuse fitted into the the nose of the bomb. (A delay fuse may also be fitted into the nose of a bomb but its construction must be different from the type shown.)

THE delayed-action bomb penetrates and is used in attacks on ships or on towns where the structures are several stories high and are more or less strongly reinforced. Such a bomb, if dropped from a height of 10,000 feet, strikes the object at about 800 feet per second—more than 500 miles an hour. On striking, the bomb does not explode immediately. It penetrates the roof and may pass through three or four floors before the fuse explodes it. The reason for this delayed action is shown in Figure 3, a diagram of one type of tail-fuse. The bomb can explode only when the striker-pin punctures the detonator cap. When the bomb is fused, the striker pin is held away from the cap by a collar to which is attached a pair of vanes. While the bomb is in its carrier on the airplane, these vanes are prevented from rotating by a stop pin fixed to the carrier (Figure 1). As soon as the bomb is released, the vanes rotate, owing to the rush of air past the bomb. After the bomb has fallen about 100 feet below the plane, the vanes fly off the screw-spindle. To prevent the striker-pin from prematurely piercing the detonator while the bomb is in the air, the striker rides on a coiled spring as the bomb falls. On impact, the bomb is slowed considerably while the plunger carrying the striker has nothing to stop it but the resistance of the spring. The inertia of the striker therefore compresses the spring and, in a small fraction of a second after impact of the bomb, the pin pierces detonator and the bomb explodes. This small delayed action is sufficient, however, to allow the bomb, because of its terrific speed and penetrating cap, to pass 20 to 50 feet inside a building, according to the nature of its construction, before explosion takes place. Thus the structure collapses from the pressure of the confined blast.

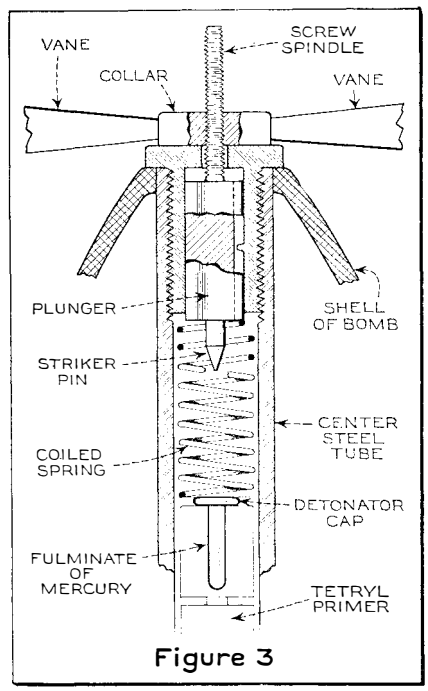
In addition to the objectives already cited, deep trenches and air-raid shelters may be successfully attacked by bombs so fused.

The instantaneous fuse used in the bomb shown in Figure 2 is designed to cause the greatest possible spread of the bomb fragments, by the explosive blast, over the surface of the terrain attacked. The thick shell is shattered into chunks of metal which sweep over a wide area as the high-explosive is detonated. A type of nose fuse used for such a purpose is shown in Figure 4. The instantaneous explosion resulting is far more devastating to exposed personnel than would be the delayed explosion described above.

The nose fuse shown has no spring. Instead, a plunger is held securely in position by a copper pin, about 1/8 of an inch thick, which passes through the plunger and the walls of the fuse. While the bomb is in its carrier on the airplane, the fuse is kept "dead" by a safety collar which is slotted and inserted between the body of the fuse and a pressure plate. This collar is attached to the bomb carrier (see Figure 2) and is a secure protection against premature detonation even should the bomber crash on taking off. As the bomb is released, the safety collar is withdrawn. On impact, the pressure plate is arrested. The shock which it thus receives can be transferred to the detonator only through breakage of the copper pin which is incapable of withstanding the tremendous momentum of the whole bomb. The result is that the copper pin is instantaneously sheared off and within less than a hundredth of a second the striker pin pierces the detonator which causes explosion. Owing to the almost instantaneous action of this fuse, the explosion makes only a very small crater—perhaps one to two feet deep on average ground for a bomb weighing 100 pounds. Under similar conditions the same bomb, fitted with a tail fuse, would make a crater about five to six feet deep. Figures 5 and 6 show this difference. With a tail fuse, the bomb is almost buried in the ground on explosion and the blast is localized. With a nose fuse, the bomb is almost entirely above ground and its blast is wide-spread.

WHEN bombing from low altitudes, as was done over the countryside in Poland, an additional slow time-fuse must be inserted between the striker mechanism and the detonator. On release the bomb travels forward with the same velocity as the airplane and the additional delay of at least several seconds, given by the time fuse, allows the bomber to get clear of the danger zone before detonation takes place.

The main filling charge of modern high-explosive bombs is relatively insensitive. Tri-nitro-toluene (T.N.T.) and various mixtures of this with ammonium nitrate, itself an explosive, are the usual fillers. The mixtures are known as "amatol". Sometimes a small

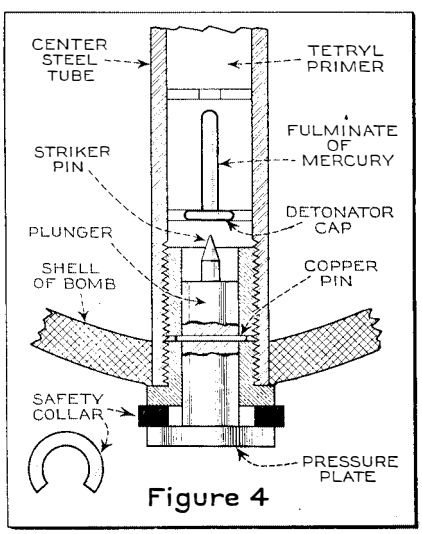


Details of a tail fuse

percentage of powdered aluminum is included in a filler called "ammonal" which has a higher temperature of detonation. Without the use of a detonator none of these explosives will function even on impact of the bomb from several thousand feet. Even the detonator, containing a few grains of fulminate of mercury, which explodes violently on shock, is not a certain guarantee of detonating the main filling charge. It is customary, therefore, to employ a primer consisting of an explosive more sensitive than T.N.T. but less so than fulminate of mercury, to boost the detonator and effect the complete detonation of the filler. In aerial bombs, this primer is charged with "tetryl" (tetra-nitro-methyl-aniline), which, like T.N.T., is a dye-works by-product. The general manner of assembly of detonator, primer, and filler is shown in Figures 1 and 2.

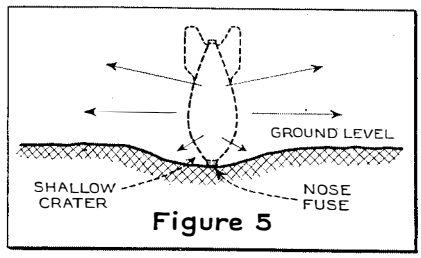
FOR modern incendiary bombs, a most effective filler is thermit. This consists of a mixture of powdered aluminum and magnetic oxide of iron, and is commonly used in welding. When it is fired through a magnesium primer which in turn is ignited by a phosphorus coated friction strip, a temperature of from 2300 to 2500 degrees, centigrade, results—a temperature which easily melts steel. Thermit does not depend upon a surrounding atmosphere of air for its action—the oxygen in the iron oxide provides this, uniting rapidly with the aluminum and causing the tremendous rise in temperature. The mixture will burn under water, boiling it fiercely. Water is useless to extinguish the white-hot slag—it merely passes into scalding steam. Sand is best for localizing the incendiary action.

Modern incendiary bombs are very small: about six inches long and three-quarters of an inch in diameter. They are provided with heavy penetrating iron nose caps and small fixed tail vanes. Containers, each filled with several hundred bombs, are discharged as units. On their downward flight they scatter, since they are poorly streamlined, and cover a wide area of the objective. Hundreds of fierce small fires are thereby started, and any attempts to control the general conflagration are made extremely difficult owing to the numerous scattered outbreaks. If such an incendiary raid is immediately followed up by a raid with high-explosive bombs, and possibly also a gas attack, no fire personnel or equipment can cope with the situation.



Details of a nose fuse

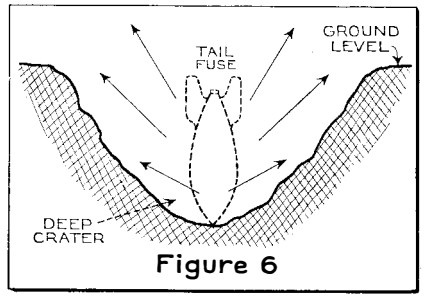
Among bombs used in gas attacks, the most effective are those filled with "mustard gas," which is a liquid. When burst by a small powder charge, the heavy liquid diffuses into the ground and, for days after the attack, is dangerous to anyone in the locality. Where the temperature rises locally, unexpected vapors emerge and may descend into the deepest dugouts and shelters. This vapor acts slowly on the eyes and lungs. It has practically no smell and long after a raid unsuspecting persons who



A bomb fused at the nose explodes on contact, spreading a wide blast

chance to remove their gas-masks—as they must do sooner or later, either for nourishment or comfort—may be attacked without warning. Some hours later blurred eyes, limp bodies, and severely blistered skins show the results. This gas causes only a low mortality but it is highly efficient in putting personnel out of action.

As the war develops, it is possible to make only a guess as to the limits to which chemistry and physics will be applied as aids to aerial "frightfulness." Rumors of the use of super-high-explosives spread 'round the world during the later aerial bombardments in northern Spain. Liquid oxygen was suspected as the component. Cylinders of cellulosic material when dipped in liquid oxygen become virtually packages of dynamite and when freshly prepared have enormous detonating power. But other attendant circumstances, particularly those relating to the high vulnerability of such explosives to shell and even bullet fire and to the evanescent power of the charge—due to continuous and unpreventable evaporation of the liquid oxygen—would seem to lessen the likelihood that such liquid-oxygen matrices could be of real military effectiveness. True may be the report



Penetrating deeply, the blast of a tail-fused bomb is more localized

that the explosive used was "obtained from the air"—but so are the ammonia ingredients used in "amatol" and "ammonal" high explosives obtained by the nitrogen fixation process.

There is also the possibility that concentrated effort is being made to seek a practical application of what has been called the greatest scientific discovery of the year—the detonation of atomic energy as exemplified in the self-catalyzing fission of uranium and other substances by neutron bombardment.

LAST, we cannot completely ignore the possibilities of biology. Reports are available that much experimental work has been done on the possibility of employing bacteria as a novel kind of "ammunition." In this connection, Wickham Steed has called attention to the activities of the aerial offense section reported in *Luft-Gas-Angriff* of the Berlin War Office. In 1938, General Chu Teh reported to the League of Nations that the Japanese had used bacteria in four central China provinces. These try-outs may have shown either the present impracticability or the dangers which attend such desperate means, but modern civilization cannot entirely shut its eyes to the possibilities of future research in this field. The biological view indicates that the effective dissemination of a bacteriological fog of typhoid, anthrax, spotted fever, or plague would have to be carefully synchronized with exacting conditions of temperature and humidity to insure survival of the germs. The bacterial "bomb" apparently consists of a glass container filled with a prescribed culture which is floated by parachute control over areas far in the rear of enemy lines, a mechanical release being employed to release the contents either in the air or on ground contact. The available reports also indicate the "conscription" of infected vermin.

If such monstrous methods should ever become practicable it appears that the only means of defense both for the attacker and attacked would be an elaborate organization of all resources of prophylaxis. Probably a mere knowledge of the power of retaliatory measures, even should such attacks prove practicable, will be an adequate deterrent against such attempts.

All For One and One For All

Research in Motor Industry . . . Co-operation and Exchange of Ideas, Findings . . . Has Resulted In Numerous Significant Developments

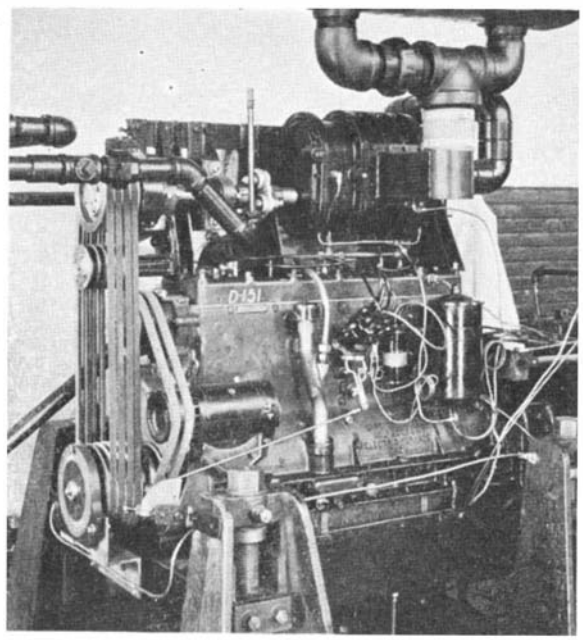
By J. J. FREY
Engineer in Charge of Technical Sales Division,
Ethyl Engineering Laboratory, Detroit

IT is customary to think of that large group of companies which provides motor transportation for America. and for much of the rest of the world, as units in a number of industries—automotive, aviation, oil, tires, parts and accessories, and so on. Actually, this entire group is one inter-related, interdependent industry, the problems and progress of which are inseparably linked. Nothing illustrates this so well as their co-operative research activities. It is doubtful whether anything in American industrial life during the past ten years has been more significant than the freedom with which research men in this group have exchanged ideas and co-operated in experimental projects.

The fruits of this research have had a far-reaching effect. Better cars at lower prices, better gasolines at lower prices, better tires, airplanes, trucks, tractors, stationary engines, motorboats, and other products made by these companies have been in such demand in America that this closely associated group has grown to a point where it now employs the full-time services of between six and seven million people; furnishes bread and butter for a sixth of the nation directly, and a considerably larger percentage if all those indirectly employed are considered. Almost every person, young and old, has benefited to a greater or lesser degree through faster, safer, more comfortable transportation.

Much has been written about modern research methods, but most of it remains incomprehensible to the average layman. When John Q. Public makes what he imagines is a fuel economy test, he tries out three or four brands of gasoline and, on the basis of the most casual driving, decides that one is better than the others. Of course, such a "test" has no scientific basis. When research men tackle such a problem, they eliminate or take into account every variable, such as the air pressure and diameter of each tire; humidity, temperature, and barometer readings for the day; the condition of the road; the velocity and angle of the wind; and the manner of acceleration and deceleration.

Even one variable, the manner of driving, can make as much as 100 percent difference in miles per gallon. In a recent experiment in Detroit, two cars of the same make and model, both just off the production line, were driven in city traffic over the same route. One driver was told to "step on it" at green lights and to drive as fast as the law allowed until he had to put on his brakes for the next stop light. The other was told to accelerate and decelerate gradually, to make as little use of the brakes as possible. The first car used twice as much gasoline as the second in covering the same distance!



After this laboratory test of an engine, on which is mounted a V-belt driven supercharger, the engine will be installed in a truck for extensive road tests

Let us look, then, as an example, at how one group of research engineers made a fuel economy test. First, they searched for an absolutely level place where they could run cars at steady speeds and at pre-determined varying speeds without interference. This they found in the middle of the Mojave Desert in California—the table-flat bed of a dry lake. Next they devised an instrument which would measure and record the velocity and direction of the wind at all times; a fifth wheel, which would overcome the variable of tire slippage, was installed and attached to a recording device to show exactly the distance traveled over land as compared with the distance traveled through air, as measured by an anemometer. Fuel was fed into the carbureter through graduated gages which measured the gasoline in cubic centimeters. Humidity and temperature records were calculated at all times. The tests were run over and over in order to average the errors which the engineers knew would still creep into the calculations. Altogether, the work covered a period of months and cost several thousand dollars.

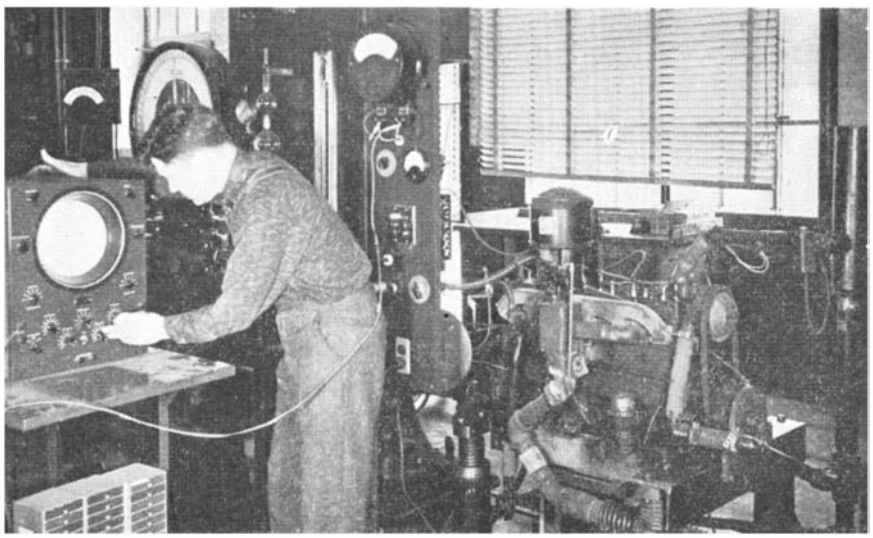
YOU may well ask who went to all this trouble and what did it prove. The answer goes to the very heart and spirit of the group which furnishes the vehicles, the tires, the gasolines, the parts and accessories, right down to the last gadget used in motor transportation. Fuel economy is the concern of many groups and literally hundreds of companies. The company which made this economy test manufactures tetraethyl lead, which is used by oil companies to improve anti-knock quality of their gasolines. But the data obtained were of interest to dozens of companies, showing, as they did, pertinent figures for what engineers call optimum compression ratios, carbureter settings and fuel anti-knock requirements of particular types of engines.

Although several companies often take part in one co-operative research program, I must, for obvious reasons, confine examples to the part of such projects about which I have personal knowledge and which concern, as above, the research activities of a company that manufactures anti-knock compounds for gasoline.

Some of the most interesting, and at

times, most difficult parts of research projects are the development of devices for making accurate tests and the development of instruments to measure pertinent variables. No laboratory can function without instruments and, strange as it may seem, very few of the important ones required can be purchased. When such instruments are needed, there is usually only one way to solve the problem—invent them. A few examples will suffice to show why.

In one of our research projects, we wished to measure the air-fuel ratio in each of the individual cylinders of an engine. No instrument for such measurement existed, or if it did, we could not find it. So our engineers devised a set-up which enabled us to trap a sample of the combustion products of each cylinder and analyze them. In the same project we wished to find out the exact instant when each cylinder fired. The instrument finally worked out recorded the ignition timing on cinema film. Sometimes a research project becomes so involved that the engine being studied is converted, for all intents and purposes, into an "instrument." Such an "instrument" looks like an ordinary heavy-duty truck until you get into the cab or lift the hood. The average truck driver would find gages, dials and gadgets he had never seen before. Under the hood he would find that each set of three cylinders had its own fuel system, and many other modifications. This "instrument" took several months to assemble and build and cost over $10,000, but it proved immensely valuable in tests where it was necessary to eliminate the variables that always must occur when the performance of one truck engine is compared with another.



Cathode-ray oscillograph for testing ignition system characteristics, and apparatus to determine spark plug insulator resistance and minimum firing current

WITH proper instruments, technically able and intelligently farsighted research workers, given sufficient time and resources, accomplish feats that in the aggregate become gigantic. For example, 15 years ago, the engine of the average American automobile had a displacement of 252 cubic inches and could develop 59 horsepower. The average 1940 automobile engine has a displacement of 255 cubic inches, almost identical with the engine of 15 years ago, but it can develop 106 horsepower. Thus we see that in the short space of time that anti-knock compounds for gasoline have been available, the horsepower developed by the average American automobile has been increased over 80 percent, while its weight has remained approximately the same. A large part of the increase in power has been gained by increasing the pressure on the gasoline vapor in the cylinders before it is burned, which, in effect, squeezes more power out of each drop of gasoline. This is where the anti-knock quality of gasoline becomes important, for higher anti-knock quality is required if gasoline is to burn smoothly under the stress of great heat and pressure inside a cylinder.

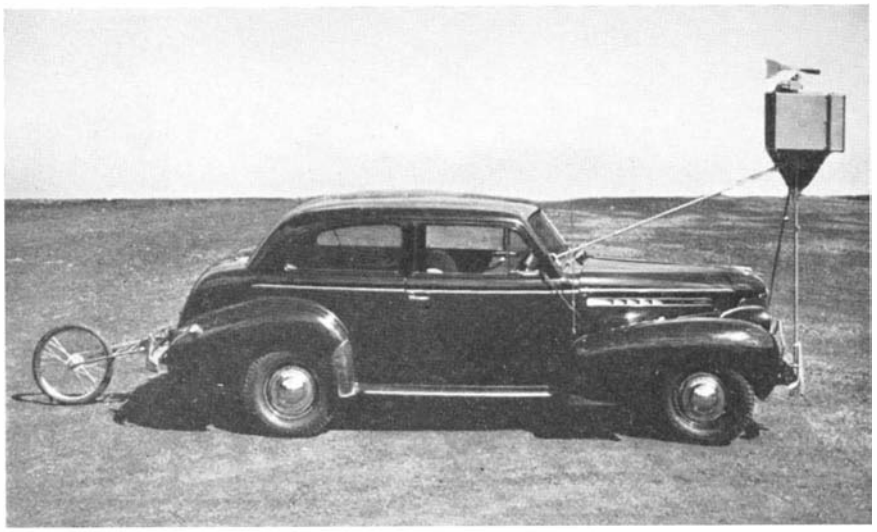
Seems to be a simple matter, doesn't it? Use gasoline of higher anti-knock quality, squeeze it a little tighter in the combustion chamber by increasing the compression ratio and, presto, you get more power and better economy. Unfortunately, it was not as easy as that. A multitude of problems had to be solved before this happy result was achieved. It is more or less a truism in research that when a change is introduced to solve one problem, five or six other problems may be created. That was what happened when compression ratios were moved up. Research and experience showed that the compression ratio which may be used with a given fuel is influenced by many variables including engine design, cylinder size, materials of construction, carbonization, rusting and liming, engine speed, jacket temperature, mixture ratio, mixture temperature, volumetric efficiency, and ignition timing.

Engineers spent years studying these variables as well as the relation of compression ratio to bearing pressures, valves, spark plugs, and so on. Hundreds of tests were run on high, medium, and low compression engines, both in the laboratory and on the road. Literally thousands of adjustments and re-adjustments were made.

All this work eventually led to the universal utilization of higher compression pressures and higher compression ratios in passenger car engines. The average compression pressure in the 1931 automobile was between 90 and 100 pounds per square inch. Today the average is between 140 and 150 pounds. Average compression ratio in passenger automobiles in 1925 was 4.5 to 1. By 1931 the average had risen to 5.25 to 1. Today it is 6.28 to 1. Optional compression ratios run considerably higher. One manufacturer has available a cylinder head giving 7.45 to 1 ratio. And tests have been run in the laboratory on engines with compression ratios as high as 11 to 1. The net result, as pointed out above, has been more power and better economy with very little increase in engine weight—briefly, a better automobile for your money and the promise of a still better one in the future.

BUT such results would not have been possible had not the oil companies kept in step with the march of progress by improving the anti-knock quality of gasolines year after year. Better cracking processes, polymerization, selection of crudes, blending, and the addition of tetraethyl lead have provided the fine fuels at low cost which have justified car manufacturers in designing popular-priced cars which reach ever higher plateaus in engine efficiency.

And this parade of progress has not stopped. Supercharging for the average car may be the next step which automotive engineers take to squeeze more power out of better gasolines, and so our research workers for the past several years have been experimenting with the possibilities and problems of supercharging. In one test, a stock eight-doubled its power output after being cylinder passenger car engine almost supercharged. The engine had an original compression ratio of approximately 5½ to 1 and developed 82 horsepower at 4000 r.p.m. using fuel with an anti-knock quality of 78 octane number. After it was supercharged with an intake manifold pressure equal to 10 inches of mercury, it developed 160 horsepower, using gasoline with an anti-knock quality of 90 octane number. To carry this test further and to determine what advantage supercharging could give to this



Car with anemometer and fifth wheel speedometer. The former determines wind direction, velocity; the latter gives an accurate speed reading. *At right:* Instruments within the car for use in conjunction with those shown above

engine without requiring a fuel of greater octane number than that originally used, the compression ratio was lowered to 4.25 to 1. Using 78 octane fuel again, but supercharged to 10 inches of mercury, the engine developed 63 percent more horsepower than it had with the higher compression ratio on the same fuel.

Thus supercharging, which simply means forcing more air and fuel vapor into the engine by putting greater-than-atmospheric pressure on the intake manifold, seems to promise more of the same kind of improvement that was effected by increasing compression ratios. But there are still a number of problems for research workers to solve before all of the hoped-for gains in efficiency can be realized. For example, in the tests in our laboratories we could put any pressure we wished on the intake manifold at any speed because the engine was on a stationary mounting, taking its air from a tank where constant pressure could be maintained. The problem of achieving equal control with a blower driven by the engine being supercharged is quite another matter. Other laboratories in the research departments of automobile companies, and manufacturers of superchargers, are working on this problem now. We are co-operating with them, giving them the results of our work and they giving us the results of theirs.

But what will be the effect of such great increases in power on other parts of the engine? Will present engine steels stand the gaff? Take valve steels, for example. Fifteen years ago, cast iron was used for exhaust valve heads in many engines. Increasing the engine's output through increases in compression pressure and more revolutions per minute made it obsolete. Silchrome steel became the standard. Today, with still further demands, Stellite-faced valves have come into prominence, and with all the heat and pressure of modern high-speed operation they will open and close (and make a tight seal) 10 to 20 times a second for hours on end while you buzz merrily along without ever a thought of 1,300,000 jobs each valve is assigned to do in your engine every thousand miles.

What about spark plugs? Will supercharged engines call for still further improvements here? A spark plug that was satisfactory in the car of 1925 would not last 15 minutes in a 1940 car running at wide open throttle. Years of experimentation and testing have given the answer to the question of how to make them satisfactory for today's car. What about tomorrow? Only research, trial and error, and trial again can supply the answer.

WITH this past experience in mind, it is easier to understand why super-charging is today of interest to many companies and many research workers and why they swap knowledge and conserve time and money by co-operative work. When you start changing the character of America's gasoline engine, or start changing the character of its gasoline, you interest everyone in a group of industries employing literally billions of dollars.

Even when the finished product is in the hands of the ultimate consumer, many organizations in the vast automotive transport group lend a willing hand in solving problems in operation that may arise. A typical example with which I am familiar was a bad case of what the trade calls "tail pipe halitosis" experienced by a large city bus company. The situation reached a climax in November, 1936, when civic organizations descended on the company and demanded that something be done to stop the fumes of acrid smoke pouring from the exhaust. One of our service engineers, a veteran of innumerable tussles with bus and truck problems, offered his services.

The bus company furnished him an engine of the same model used in the buses and it was set up in our Detroit laboratory. After several weeks of experiments and tests, he worked out a procedure for correcting the trouble and presented it to the bus company. The officials tried it out on ten buses, found that it worked and eventually changed over their entire fleet. His recommendations—increased intake manifold temperatures, changes in carbureter characteristics, including leaner idle mixtures—have been adopted by other bus companies and today are standard practice in meeting the condition known as "tail pipe halitosis."

Another field in which the continuing efforts of research have led to tangible results is power farming. Five years ago, all tractors were equipped with "compromise" engines—that is, they were designed with low-compression motors to burn kerosene, distillate, or gasoline. But farmers who burned gasoline in their tractors got only part of the potential power in the fuel. Why not build tractors with high compression, automobile-type engines capable of using gasoline efficiently. This would give the farmer something he wanted. Tractor engineers who held this belief found ready assistance in our engineering laboratories. The advantages of high-compression tractors were determined by the laboratories and explained to the farmers and tractor dealers. Today nearly all tractor manufacturers make high-compression tractors.

As the new 1940 cars go on the market there are improvements and refinements not available on cars of previous years. These changes represent a cumulative total of thousands of hours of research labor in a hundred different laboratories.

The same impelling force and relentless research which have given us today's engines and vehicles will push on to discover and utilize better principles and materials for the motor transportation of the future.

OUR POINT OF VIEW

No Vigilantes

TIMES of national stress always bring with them curious and often dangerous personal reactions. Mass hysteria, fostered by ill-founded rumors and frequently by malicious gossip, was the cause of many a vicious outburst during World War I. Spy scares set neighbor against neighbor, created suspicions that often had no more foundation in fact than a foreign-sounding name.

With present unsettled conditions pointing toward a future that cannot be predicted, it is comforting to know that our national security has been placed in the capable hands of the Federal Bureau of Investigation. This organization, with the co-operation of all law-enforcing agencies throughout the nation, should certainly be able to cope quickly and effectively with internal affairs that might have disastrous effects if permitted to get out of hand.

Speaking of this latest job of the F. B. I., Director J. Edgar Hoover recently sounded a warning that, heeded, will assist greatly in keeping the United States on a level keel during troublous times. "In the wave of patriotism that is rising in the country," said Mr. Hoover, "there lies the danger of overzealous groups or individuals engaging in acts which are distinctly un-American in method, no matter how patriotic in aim. We need no vigilantes in this situation. The vigilante method is distinctly contrary to American ideals of justice. The Federal Bureau of Investigation has been called upon to investigate all matters relating to espionage, sabotage, and violations of the Neutrality Regulations. In turn, the Federal Bureau of Investigation has requested co-operation of all law enforcement officers in the United States.

"This combined attack by Federal and State forces should be sufficient so far as investigation and prosecution are concerned," Mr. Hoover continued. "Beyond the efforts of these law enforcement agencies there is a need, of course, for the individual co-operation of all sincere and earnest Americans. This co-operation should be limited, however, to passing on to the proper officials all questionable facts or rumors which may come one's way. An alert public is the best defense against traitorous or inimical conduct. Let us be realistic and practical . . . but always calm in our judgment between the real and unreal."

Thus each individual citizen is squarely faced with his own share of the problem of controlling traitorous acts, yet adequately warned against actions that might not only hamper the wheels of justice but even render them momentarily ineffective.—*A. P. P.*

Modern Pioneers

NOT so many years ago this nation celebrated 150 years of existence by the Sesqui-Centennial Exposition. Next year it would be fitting if we should have another sesqui-centennial celebration, one that would mark one of the few extremely significant milestones in our history: the founding of the American patent system. Our progress has been keyed largely to that system and the incentive which it has given to individuals to originate, develop, and improve those brain-children that have made this country the greatest industrial nation on earth. Had it not been for the granting of patents and the profits therefrom, our people would not now have the most advanced civilization ever known, nor enjoy the greatest number of conveniences, comforts, and luxuries; we would labor longer hours and have much less leisure time. Our patent system has been, indeed, an important stimulus to invention, research, and industrial progress.

It was with the thought that the American people should understand clearly the dependence of the nation on a sound patent system—one that is not being changed constantly at the whim of would-be economists, reformers, and malcontents—that this important anniversary is to be observed in 1940. The Modern Pioneers plan to mark the year by several interesting programs, the principal one of which will be the presentation of a number of awards to outstanding inventors and research workers. Manufacturers and responsible executives or members of trade associations and scientific and engineering organizations are being invited to enter nominees for these honors. (Entry blanks may be obtained from Modern Pioneers, 14 West 49th Street, New York. Closing date: December 1, 1939.) Local dinners will honor selected local Modern Pioneers, and some time in February a national dinner, broadcast over a national radio hook-up, will honor a number of the country's outstanding Modern Pioneers.

That the whole program will succeed in its purpose seems asured by consideration of the Award Committee. It is composed of: Karl T. Compton, of M.I.T., Chairman; Forest R. Moulton, of the A.A.A.S.; George B. Pegram, of Columbia University; John T. Tate of the University of Minnesota; Edward R. Weidlein, of Mellon Institute; and Frank C. Whitmore, of Pennsylvania State College.

We wish the organization the great success it richly deserves.—*O. D. M.*

Not Poison

"THEY who get spanked" might well have been the title of a brief item lost to the general reader by its inclusion on our Legal High-Lights page last month. It is here resurrected for the same non-legal reader because of its vital import.

It seems that the Federal Trade Commission has taken cognizance of rumors (circulating "from time to time") as to the injurious effects resulting from the use of aluminum cooking utensils, and has filed a complaint against the publisher of the rumor "tracts," charging that he deceives the public. To us this is a masterpiece of understatement.

This bare-faced campaign to instill an awful fear in the mind of the public has been going on for many years—not just from time to time. It has been fanatic. Why, no one knows. It has been insidious, powerful in its effect. It has offered such a specious brand of "proof" that food cooked in aluminum acts as a slow poison or causes cancer or both that believers have carried on the evil work by word of mouth. And the believers have not all been unintelligent; simply unwise. A cultured lady once told this writer of a trained nurse in a great city hospital (of all places!) who was suffering from a serious case of aluminum-cooking-utensil poisoning!

The fight against this foul campaign of fear has also gone on for years. Scientific American has been in the thick of this fight, has patiently explained over and over that aluminum cooking utensils can have *no injurious effects* on those eating food cooked in them. In unequivocal terms, this magazine has branded rumors to the contrary as malicious and entirely without foundation. We repeat the accusation. The American Medical Association, Mellon Institute, Government bureaus, and others have all done their share of the fighting against the rumor, have done their utmost to scotch it. Yet even now, with the Federal Trade Commission lined up against the fanatics, some people will probably keep talking of the dangers of aluminum-cooked food. But then, they're probably born pessimists and think they have every ailment ever mentioned by Sister Sue and Grandpap and Aunt Het, anyway!—*F. D. M.*

What's Inside The Stars?

Most of Our Present Knowledge of the Composition of the Stars Concerns Only their Atmospheres . . . Now the Analytical Boring Machine Digs Deeper

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.

THE recent Colloquium on Astrophysics, at Paris, under the auspices of the Foundation Singer-Polignac, at which the writer had the good fortune to be present, will have a place in the memory of its participants something like that of the great international conference of the Solar Union at Bonn in 1913—shining the more brightly by contrast with the tragic days which followed. Unlike the earlier meeting, this was a small affair with only 16 regular delegates, and a scant dozen of other invited guests; but it was truly international. Seven countries were represented among the delegates, counting by present residence—France, Belgium, Denmark, Sweden. England, Canada, and the United States. Counting by country of birth, four more are to be added—Holland, Germany, Russia, and India — represented by astronomers of distinction, all of whom are now living in the United States!

The sessions—held in an excellent room provided by the Collège de France—gave much more time for the consideration of individual topics than is practicable at the larger congresses. One, or at most, two of the invited papers were presented at a session; the speaker had 40 minutes or so to present his conclusions; and almost as much time was often spent in animated and profitable discussion.

The problem of language—always more or less difficult at a truly international gathering—was very successfully solved. All the speakers found it easy to present their views either in English or French, and their remarks were translated into the other language, sentence by sentence, as they went along, by a very competent secretary. After a few minutes' experience, this proved remarkably simple; and, though of course it took time, it did not interfere with the free flow of thought and expression, even in active discussion (and the discussions were active)—as many as ten members sometimes commenting on a single paper. The scheme worked so well, indeed, that it may be commended in other cases where the language problem has to be met.

The Colloquium confined itself to two subjects, more closely related than appears at first mention; namely, the novae and the white dwarfs. All the delegates spoke with authority in one or another part of this fairly extensive field.

Lundmark discussed the parallaxes and absolute brightness of the novae; Stratton, the evolution of absorption bands in their spectra; Edlen, the identification of previously unknown lines, and Mrs. Gaposchkin a spectrophotometric study of the bright bands and continuous background.

Beals considered the relations of novae to Wolf-Rayet stars, P Cygni stars, and stars with spectra like Alpha Cygni, and Gaposchkin their relations to the SS Cygni variables.

Swings spoke of the physical problems of the atmospheres of novae and similar stars, Strömgren of theories of their internal constitution, and Baade of the amazingly luminous supernovae.

Turning from the hugest of the stars to the tiniest, Kuiper described the white dwarfs and other abnormally faint stars, announcing the discovery of many new ones and discussing their physical conditions; and both Eddington and Chandrasekhar discussed the internal structure of the white dwarfs, and their bearing on stellar evolution.

OUR less technical readers may be asked to excuse this condensed list of papers. Every one of them contained things which can be presented in non-technical language, and are of general interest. To describe them all would fill many pages like these. At present, it may be well to follow a long-established rule of these columns, and speak of work which has already been published, in part at least, in professional journals.

The question of the composition of the great internal mass of a star might be supposed to be inherently unanswerable. The spectroscope gives us a wealth of information about the atmospheres of the stars, and has established convincing evidence that they are, in general, very similar among themselves in composition (though not in temperature or pressure) and much like the Earth, except for a vastly greater abundance of hydrogen and helium.

But the atmosphere of a star—which forms less than the outermost billionth part of its mass—may not be a fair sample of the whole. We can only "get deeper" (to use Eddington's phrase) by an "analytical boring machine." For an ordinary star, the process is in outline as follows:

The central temperature of a star depends on its mass and radius, on the average weight of one of the free particles in its interior (atoms, electrons. and so on) and on the "model" on which it is built—that is, the way in which the density increases toward the center. The latter effect is found to be remarkably small—it takes an increase of density at the center to more than a hundred times the general average to get a central temperature twice that for a star of uniform density. The average "molecular" weight is more important, for the temperature is proportional to it. At the center of a star the atoms are knocked all to pieces. Hydrogen (weight 1) goes into two pieces (with an average weight of 1/2); helium, weight 4, into three (average 1 1/3); oxygen divides a weight of 16 among 9 pieces; iron one of 56 among 27 fragments (or under actual conditions a few less). For all sorts of atoms, except hydrogen and helium, the average weight of one of the dissociated particles comes out close to 2 (on the chemists' familiar scale); for helium it is two thirds as great as this and for hydrogen only a quarter.

Hence, the more hydrogen there is inside a star of a given mass, size, and build, the cooler the star will be inside. The rate at which heat leaks out to the surface will be correspondingly smaller, and the star will shine less brightly. Helium has a similar effect, but to a much smaller degree.

The analytical theory has been fully worked out—first by Eddington, and in more detail by Strömgren—and it is found that a star containing no hydrogen should be about 300 times as bright as one of the same size, mass, and model, but containing about 80 percent of hydrogen by weight. (For almost pure hydrogen the true theoretical brightness rises again; but this does not concern us here.) The brightness of a star with a given hydrogen content can be calculated from pure theory—assuming a good average "model"—and it is found

that such stars as Sirius, Capella, and the Sun are all much fainter than calculated for no hydrogen. Theory and observation agree for a hydrogen content of about 35 percent for all three stars. (This is by weight; by number, the light hydrogen atoms form a large majority.)

Reasonable change in the assumed density-model might alter the calculated abundance of hydrogen by a few percent but would not greatly modify it.

Most of the stars for which the calculations can be made come out of about the same composition. There are a few exceptions. For example, Zeta Herculis has very nearly the Sun's mass, twice its diameter, and four times its brightness —which indicates a hydrogen content of about 15 percent.

This method, applicable to ordinary stars, fails entirely for the white dwarfs. But, strangely enough, the hydrogen percentage in these can be found in an entirely different way. In a white dwarf the free electrons are degenerate—they are jammed together as closly as the fundamental quantum laws permit. Under these conditions, the pressure varies as the 5/3 power of the number of electrons per cubic centimeter. Given this law, and the average mass of matter per free electron, we can work out all the properties of the body, if we know the total mass, finding its radius, density and so on. The actual white dwarfs, being visible, and therefore hot on the surface, cannot be entirely degenerate, but there are good reasons for concluding that they are actually bigger than this theoretical limit by only a small percentage.

NOW for the companion of Sirius—the most famous of the white dwarfs—observations have been made of the "Einstein shift" of the spectral lines predicted by the general theory of relativity. For any star, this shift is proportional to M/R (where M is the mass and R the radius). According to the theory just described, the shift, E, is given by the equation $E = C\,M^{4/3}m^{5/3}$ where m is the average mass per free electron, and C is a constant which can be accurately calculated. Now for a hydrogen atom $m = 1$, there being one proton per electron. For helium $m = 2$ (mass 4, 2 electrons) and for heavier atoms it is nearly the same. For a white dwarf star of a given mass, and composed entirely of hydrogen, the Einstein shift should be less than one third as great as for one made up exclusively of heavier atoms.

For the companion of Sirius, the observed shift is intermediate between the calculated values for these two cases, and indicates a hydrogen content of about 35 percent.

There is unfortunately no other white dwarf for which our present data permit a similar test. There is one (40 Eridani B) for which we know the mass, but the Einstein shift has not been measured, and estimates of the radius from the spectral type are precarious.

At this point a complication must be mentioned. The question, what equations are to be used for a degenerate gas when the velocities of the electrons become comparable with that of light, is still vigorously under debate. Sir Arthur Eddington maintains that the same formula should be employed; almost all other physicists agree in adopting a different one. The discussion, which is intensely technical, leads to the very frontiers of fundamental theory, and neither party has yet convinced the other.

Atop the physics building at the University of Minnesota this 12-ton dome for a 10½-inch telescope is insulated against temperature changes by two-inch slabs of Celotex laid between T-section members

Fortunately for our present interests, Chandrasekhar, who has worked out the consequences of the alternative theory with great analytical skill, finds that it, too, when applied to the companion of Sirius, leads to a considerable abundance of hydrogen. This conclusion appears therefore to be independent of the theoretical controversy.

But, if there is still about as much hydrogen in Sirius B (the faint companion) as in Sirius A (bright) the astrophysical consequences are important.

According to Bethe's theory, the stars derive their energy by converting hydrogen into helium, and it is only after the hydrogen is almost absolutely exhausted that they have any chance of contracting into the white-dwarf state. The existence of a single white dwarf containing abundant hydrogen appears therefore to be a grave objection to the theory.

Eddington has, however, suggested a way out. In Bethe's theory hydrogen is turned into helium, not directly, but by the action of catalysts—carbon and nitrogen—which are regenerated at the end of the cycle, and so used over and over again.

Suppose, however, that in each cycle a small portion of the catalysts is used up. Then, though the process would be repeated many times, it could not continue indefinitely. The catalysts might be used up before the hydrogen; the formation of helium, and the liberation of sub-atomic energy, would substantially cease; and the star might shrink into a white dwarf with a good deal of its hydrogen left—plenty of fuel, but nothing to burn it with.

Those who have followed our recent presentation of Bethe's theory, will realize that only a very small change in it is required. He concludes that the N^{15} nucleus may meet two fates: $N^{15} + H^1 = C^{12} + He^4$ and $N^{15} + H^1 = O^{16} + h\nu$. In the first case, carbon is regenerated; in the second, the very stable nucleus of common oxygen is formed, while the energy $h\nu$ is liberated. Now neither of these reactions has yet been observed in the laboratory (at least, when the writer last had access to scientific literature). Bethe, from rather general considerations, concludes that the first is many thousands of times more likely to happen than the second—in which case a small amount of carbon would catalyze the transformation of a very large amount of hydrogen. But, if the second reaction had a probability a few percent as great as the first, the carbon and nitrogen might be used up before the hydrogen.

UNTIL more is known, by observation or by the advance of nuclear theory, about these questions, the stellar problem must remain open.

One difficulty, however, vanishes. It was *very* hard to see how Sirius B, which shines feebly and is working at a low rate, could have used up its hydrogen before Sirius A, which is working far faster. The present answer appears to be simple: it hasn't.

There are other possibilities: Eddington calculates that, in the intermediate stage of contraction between an ordinary star and a white dwarf, a star would reach its greatest luminosity and its highest central temperature when it had shrunk to only about twice its final radius. Such a star would appear intensely blue-white, and have a central temperature of 150,000,000 degrees or more, and a very high density. Whether, under such extreme conditions, some of the heavier elements could be built up, is another problem for the nuclear physicist.—*Bordeaux, France, September 11.*

Is Light Slowing Down?

Some Physicists Suspect that Changes Occur in the Velocity of Light . . . Difficult to Prove . . . On the Whole, the Question Remains Wide Open

By DOUGLAS W. F. MAYER

THE third letter of the alphabet, *c*, is harmless enough in the normal course of things, but in the hands of scientists it has become a hook on which can be said to hang the whole of modern physical science. For scientists have chosen this little letter to represent one of the most important constants of the universe—the velocity of light.

In almost every fundamental physical equation, whether it be concerned with the structure of the atom or the rate of expansion of the universe, whether it deals with the energy of X rays or the mass of a rapidly moving body, the letter *c* will occur. Way back in the middle of the last century, James Clerk Maxwell showed by a brilliant piece of mathematical analysis that all electromagnetic waves — X rays, ultra-violet rays, infra-red rays, radio waves—would travel in a vacuum with the velocity of light, and that this velocity was equal to the ratio of an electric charge measured on the electromagnetic system of units to the value of the same charge measured on the electrostatic system.

Figure 1

Name of Observer	Method	Length of Base in Yards	Year	Velocity
Cornu and Helmert	Wheel	25,055	1874.8	299,990 ± 200
Michelson (I)	Mirror	665	1879.5	299,910 ± 50
Newcomb	Mirror	4,070	1882.7	299,860 ± 30
Michelson (II)	Mirror	683	1882.8	299,853 ± 60
Perrotin	Mirror	50,256	1902.4	299.901 ± 84
Michelson (III)	Mirror	38,700	1924.6	299,802 ± 30
Michelson (IV)	Mirror	38,700	1926.0	299,796 ± 4

Near the beginning of the present century, Albert Einstein, in his theory of relativity, indicated that the velocity of light was the maximum possible velocity attainable in the universe, and that the velocity of light in a vacuum would be the same for all observers. This velocity was no mere ordinary physical constant, like the velocity of sound, the viscosity of water or the density of lead. It was a constant which it was imperative for science to determine with great accuracy. Römer, a Dane, had been the first to do this successfully. Previously, in the 17th Century, Galileo had tried to measure the velocity by means of distant observers who uncovered lanterns but, naturally, his method was far too crude for him to obtain any results. Römer used the diameter of the Earth's orbit round the Sun as the distance to be covered by the light, while the required signals were provided in the eclipse by the planet Jupiter of his satellites. Römer's method was only roughly accurate, and during the 19th Century mechanical methods were devised and scientists in all parts of the world spent years in making observations and obtaining as accurate results as possible.

Nearly all methods used were modifications of two basic methods—the Fizeau toothed wheel and the Foucault revolving mirror. In the former system, light is passed between two teeth of a rotating gear wheel and reflected back from a mirror at the distant end of the base-line. The observer adjusts the speed of the wheel so that, by the time the light has been reflected back, a tooth has moved round and cuts off the light. Knowing the length of the base-line, the speed of the wheel and the number of teeth on the circumference, the velocity of light can easily be calculated. In the second or revolving mirror method, light is reflected from a revolving mirror along the base-line to a distant reflector and back again to the revolving mirror. By the time it gets back, the mirror will have turned through a small angle. This will cause the light to be deviated. By measuring the angle of deviation with a graduated eyepiece, and knowing the speed of rotation of the mirror and the length of the base-line, the velocity of light may again be easily calculated.

BY the beginning of the present century, a large number of results of similar tests had been published, and these gave the velocity of light with varying degrees of accuracy. These results were copied from the papers originally published, but often the copying was done inaccurately, and reappeared in textbooks and scientific journals. It was again copied inaccurately for later publications. Incidentally, these usually ignored the stated degree of accuracy (explained below) of the initial result.

In 1927, therefore, M. E. J. Gheury de Bray, a London scientist, undertook the praiseworthy task of looking up and summarizing all the original reports of the measurements of the velocity. He published a list of these, but pointed out how inaccurate a good many of them were, and how many of the investigators had failed to apply important corrections. A strong test of the accuracy of a scientific experiment is for the observer to take a large number of readings, and to see whether these show any great deviation from the mean. The observer then states his result as, let us say, 100±2. In this case, the value 2 is the "probable error" calculated from statististical theory, and the result implies that the measured quantity is probably 100, but that the method is only sufficiently accurate to indicate that it lies between 98 and 102.

After carefully studying the subject, de Bray came to the conclusion that, up to 1926, only seven really accurate determinations of the value of *c* had been made. He tabulated these as in Figure 1, in which the second column gives the basic principle of the method used, whether toothed wheel or revolving mirror, while the final column gives the determined value in kilometers per second, with the degree of accuracy.

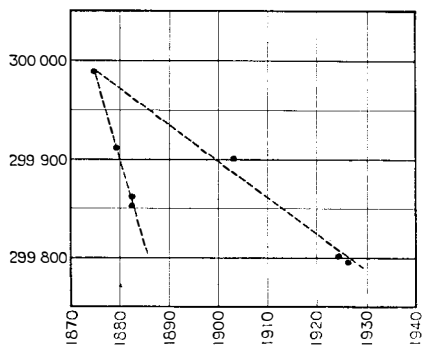


Figure 2: De Bray seeks explanation

De Bray was struck by the fact that here was a "constant" that was by no means constant, since its value seemed to vary from a maximum of 299,990 to a minimum of 299,796 kilometers per second—quite an important variation considering that *c* was supposed to be one of the fundamental constants of the universe. He accordingly decided to depict his results graphically, and obtained the series of dots shown in Figure 2. In this diagram the vertical scale represents the velocity of light in kilometers per second, and the horizontal scale the year in which the velocity was determined. Had the velocity of light

been constant, the dots should all have lain in a horizontal line. Actually, they appeared to lie on two oblique lines, as shown in the diagram. De Bray pointed out that the three on the left had been measured over relatively short base lines, while the three on the right had been measured over longer bases. Cornu and Helmert's reading seemed to fit in with both groups.

De Bray reluctantly came to the conclusion that those measured over short bases were probably less accurate than

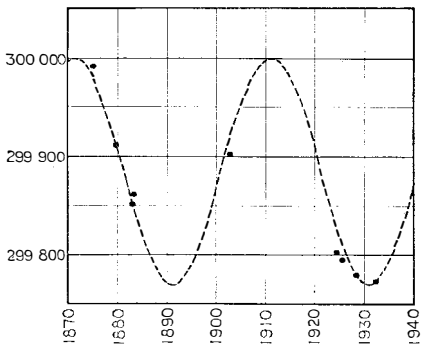


Figure 3: Edmonson's graph of 1934

those measured over long bases, and decided, for the time being, to ignore these readings. The other four readings seemed to show clearly that light was steadily slowing down at the rate of just under 4 kilometers per second per year. De Bray suggested this tentatively to the world of science, then decided to await further measurements.

In 1928, Karolus and Mittelstaedt reported a determination of the velocity which gave a result of 299,778±20 kilometers per second and, in 1933, Pease and Pearson, continuing work Michelson had started at the Mt. Wilson Observatory, obtained a value of 299,774±11 kilometers per second. This seemed to indicate clearly that the velocity of light was still decreasing, but the problem of the three "short-base" readings had yet to be solved.

Then, in May, 1934, Frank K. Edmondson, of Lowell Observatory, Arizona, suggested that the velocity of light may not be decreasing steadily, but might be subject to a periodic fluctuation. He suggested that a period of 40 years, with a maximum variation of 115 kilometers per second above and below a norm of 299,885 kilometers per second, might fit the facts. Represented mathematically, this gives the formula

$$c = 299{,}885 + 115 \sin 2\pi/40\,(T-1901)$$

where c is the velocity of light and T the date of the year. Represented graphically, the equation gives the simple "sine curve" shown in Figure 3. The nine dots on this diagram represent the nine accurate values then known, and the diagram shows how well they fit the suggested curve. At the same time, Edmondson pointed out that his theory could not be properly proved until about 1938. If light were steadily decreasing in velocity, the value of c, in 1938, should be about 299,760 kilometers per second, while if the velocity were fluctuating, as he suggested, in 1938 it would be about 299,835 kilometers per second.

The idea that the velocity of light might fluctuate slightly was borne out by the experiments of Pease and Pearson. In 1929, Prof. Albert A. Michelson, undoubtedly the world's champion timekeeper of light, worried by the fact that atmospheric irregularities (the astronomer's "bad seeing") interfered with his measurements, using long base-lines, embarked on the heroic task of constructing a mile-long vacuum tube. The dead-straight, air-tight metal tube, three feet in diameter, and evacuated to a pressure of 1/250 of an atmosphere, was laid down at the Irvine Ranch, Santa Ana, California. Measurements undertaken by the United States Coast and Geodetic Survey revealed that the tube was 5230.76509 feet long, while, by means of mirrors, the light was reflected back and forth along the tube eight times, giving a base line of about eight miles. Three months after the tube was put into operation, on May 9th, 1931. Professor Michelson died and the work was continued by Dr. Francis G. Pease, of Mt. Wilson Observatory, and Fred Pearson, of Chicago University.

A SERIES of 233 sets of measurements was made over a period of two years, the results being tabulated in Figure 4. The final result was stated to be 299,774±11 kilometers per second. At the same time, it was stated that the readings showed two periodic fluctuations in the velocity of light. One fluctuation had a period of 14¾ days, the other of one year. In both cases the velocity varied by about 20 kilometers per second. The shorter period fluctuation nearly vanished during December 1932 and January 1933, reappearing in February 1933. It was suggested that this fluctuation might be due to some influence of the Moon, though how such an influence might work is not at all clear. Reluctant to believe that the actual velocity of light was changing, the observers also suggested that the variation might be due to instrumental changes, such as a possible change in the length of the light path, ground disturbances, errors in the timing mechanism, or a possible effect of refractive index in the path of light. Whatever their causes, the existence of these minor fluctuations gave a certain amount of justification to Edmondson's theory of a long-period variation.

De Bray pointed out that the earth's magnetic field, which is known to fluctuate, might have some effect on the velocity of light. Accordingly, experiments were made to see whether the velocity underwent any change in a transverse magnetic field. The field used was 100,000 times more powerful than that of the earth, and the sensitive apparatus would have detected a change in velocity of one part in 20,000,000. No such change was detected. The suggestion that the refractive index of air might be changing was ruled out after referring to accurate determinations of this value made during the past 20 years.

At the beginning of 1937, there came the news of another determination of c, made by Wilmer C. Anderson in the Physics Research Laboratory of Harvard University. The method he used was to subject a light-beam to high-frequency modulations by passing it through a Kerr cell. The light beam was then divided into two portions by means of a half-silvered mirror, and the two parts were sent over different optical paths. They were recombined and focused on a photo-electric cell. The difference in length of the two paths was adjusted until the photo-electric cell gave a minimum reading, indicating that the two halves of the beam were out of phase. Knowing this path difference, and the frequency of the modulation, the velocity of light was easily obtained.

Between June 22 and December 5, 1936, 651 measurements were made, and showed no short-period fluctuation which could not be attributed directly to physical sources. The mean result was 299,764±15 kilometers per second. Later, in 1938, Dr. R. A. Houstoun of Glasgow University, Scotland, measured the velocity, using a piezo-electric crystal as an oscillator, and a base line only a few yards long. Initial tests gave a result of 299,761 kilometers per second.

These two determinations seemed to strike a death blow at Edmondson's fluctuation theory, so de Bray, deciding

Figure 4

Series	*Year*	*Dates*	*Number of Observations*	*Velocity*
1— 54	1931	Feb. 19—July 14	493	299,770 ± 12
55—110	1932	Mar. 3—May 13	753.5	299,780 ± 11
111—158	1932	May 14—Aug. 4	742	299,771 ± 9
159—233	1932-3	Dec. 3—Feb. 27	897	299,775 ± 11
1—233			2885.5	299,774 ± 11

again to neglect the early short-base readings, advanced a formula

$$c = 299{,}900 - 3.855\,(T-1900)$$

to account for the diminution of c. This gives a decrease in c of 3.855 kilometers per second per year, and produces a straight line on the graph, as shown in Figure 5, which also shows the readings now known — excluding, of course, the three short-base readings.

So much for the experimental results. Meanwhile, what had the theoreticians been doing?

As was to be expected, the casting of doubt on something so fundamental as the velocity of light produced a veritable plague of theories, most of which were sooner or later proved either

to be untenable or to give a theoretical decrease in velocity of much less than 3 kilometers per second per year. Most of the theories revolved around the supposed expansion of the universe. De Bray suggested that, if the universe were expanding, and if the ether were really material—a view still held by a few physicists—then the ether would gradually be decreasing in density, and the slowing down of light would follow as a matter of course. Calculations of the magnitude of such a decrease showed that it would be negligible compared with the decrease of 3.855 kilometers per second per year indicated by experiment. A similar theory was advanced by Edmondson, who suggested that doubling of the radius of the universe would cause the *measured* velocity to be halved. According to experimental results, however, the velocity of light should be halved in 60,000 years, whereas the universe is believed to double itself only every 1,300,000,000 years. From relativity considerations, Tokio Takéuchi, a Japanese scientist, deduced that the velocity of light will be decreasing, due to the redistribution of matter and radiation throughout the universe, but, again, the calculated decrease was far smaller than that suggested by de Bray.

OTHER scientists have been bolder. They realize that the only real evidence for an expanding universe is the shifting of lines in the spectra of distant nebulae toward the red end of the spectrum—the "red shift". Assuming that the velocity of light is constant, the red shift is explainable only by the theory that the sources of the light—the nebulae—are apparently receding from the Earth with enormous velocities. It has been found that the velocity of recession is proportional to the distance away of the nebula, which gives rise to the picture of an expanding universe. The magnitude is such that nebulae at a distance of one megaparsec (3.26 million light-years) are receding with a velocity of about 500 kilometers per second.

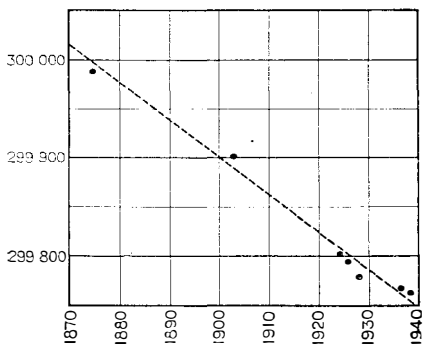


Figure 5: De Bray's graph of 1939

The bolder scientists point out that if the red shift can be accounted for by some other theory, then the nebulae need not be receding and the universe may not be expanding. Most of the theories advanced imply a change in the property of the light as it travels from the nebulae to the Earth, and several of these theories fit in with the idea of a decrease in the velocity of light.

One group of theories suggests that the energies of single packets of light—or "photons", as they are called—may gradually decrease during their journey through space, due to such causes as gravitational interaction, interaction with ionized gases which may exist in space, or simply by a gradual diminution of energy with time. Such a diminution of energy would imply a diminution in frequency and, if the wavelength of the light were assumed constant, a diminution in velocity. H. J. Gramatzki has extended Maxwell's theory of light to allow for either a decrease of velocity with time or a change of dielectric constant with time. In both cases he showed that there would be a decrease in frequency (that is, a red shift), and also in velocity, but again the effect would be negligible compared with that of de Bray.

Zwicky has suggested that differences might be detected between properties of terrestrial light and light from distant nebulae. According to Pierre Salet, the velocity of light coming from stars is about 1.008 times greater than that of ordinary terrestrial light. Zwicky has also suggested that the velocity of light may depend on its frequency, and that such a dependency would account for puzzling features about the spectra of certain novae. Experimental tests, however, seem to refute this.

In turn, de Bray himself recently came forward with a suggestion that the frequency and velocity of light may decrease with time, and claims that observed red shifts can be explained by a decrease given by the equations

$$c = 299{,}774 - 173T$$
$$f = 762.2 - .4T$$

where c is the velocity in kilometers per second, f the frequency in mega-megacycles, and T the time in millions of years. This represents a decrease in velocity of only one six-thousandth of a kilometer per second per year—which, of course, is much less than de Bray's former suggestion of 3.855 kilometers per second per year to fit the observed measurements.

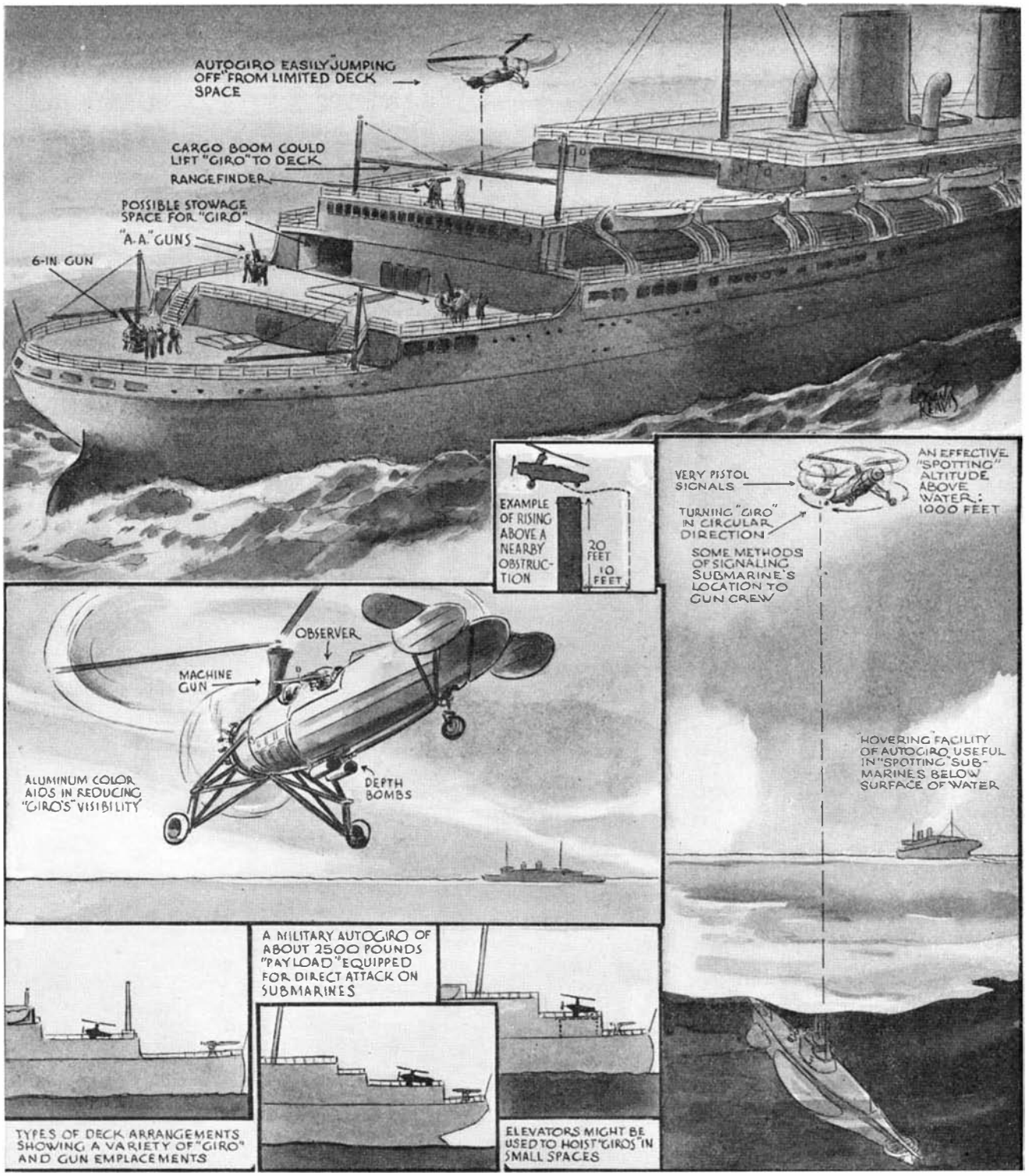
Meanwhile, other scientists hold that changes in the measured velocity of light have no connection whatever with the expansion of the universe, or with alterations of certain fundamental constants. They believe that the variation is due to some undetected phenomenon which influences the apparatus in some way or another. They stress the discrepancies between observations over short bases and over long bases, and also point out that the velocity of light can be measured indirectly, with compact electrical apparatus, by finding the ratio between the electromagnetic and electrostatic system of units. This has been done with great accuracy on several occasions, and the results show no marked variation, the value of c in each case being close on 299,781 kilometers per second.

Other observers claim that, if light were slowing down or its frequency altering, such alterations could easily be detected by sensitive interferometers. All such experiments to detect any alteration have given negative results.

What could possibly cause the variation in the measured velocity of light other than fundamental changes? The answer is: nobody knows. Apparatus more sensitive than that already used will have to be designed and constructed in order to investigate the matter. De Bray has stressed the point that, in the case of the revolving mirror method, it is assumed that the laws of reflection of stationary mirrors still hold good, and that the laws of reflection of a pencil of light, from a real or virtual source which may have a transverse velocity approaching that of light, are assumed to be the same as if the source were at rest. These assumptions, he suggests, may ultimately be shown to be inaccurate.

AT present, however, science stands at the crossroads. Experimental observations, on which the whole of science is said to rest, have presented it with a problem. Some changes have been detected in the measured velocity of light. One road leads to the type of solution involving extremely fundamental changes, the other to the theory that some new type of correction must be sought and applied. Both roads lead into unexplored territory. Which road will science follow? We can only watch and wait for the traffic lights to change.

While the author of the accompanying article, a young English physicist, does not anywhere state that a varying velocity of light has been proved, and that the remaining problem is to determine its amount, it is feared that an occasional hurried reader may run away with these beliefs. If questioned, many physicists might say something like this: "The chances are that there have been errors in some of the experiments, and that the velocity of light is a fixed constant. But, of course, we can't simply shut our eyes to the possibility that it is not fixed, even though this is more pleasant." This article will provide background for accounts of future experiments.—*The Editor.*



Ships Can Carry Autogiros to Spot Submarines

MERCHANT vessels need to be warned of the proximity of submarines if they are to elude or successfully fight them. Submarines can be spotted most effectively from the air, but ships cannot carry ordinary planes (plus catapults) and cannot stop, once a submarine is sighted, to hoist a plane aboard after its water landing. Use of warships to convoy liners or freighters subtracts striking power from the fleets themselves.

The autogiro, carried on individual ships and taking off from cleared present decks or built up ones, would largely solve this problem, believe Scientific American editors. The idea, conceived in our offices over two years ago by F. D. McHugh, has been called eminently practical by experts.

Much experimentation is necessary, of course, but the 'giro has possibilities, as shown in our drawing. It can "jump off" 20 feet straight up and swing hard over to clear ships' superstructures. It can land with a run of about 10 feet. It can hover. It can carry machine guns to drive a submarine's gun crew below decks, and depth bombs to drop accurately while it hovers over the dark blob of a submerged submarine. To the ship's gun crew, it can signal a sub's location and spot shell splashes by flares, Very pistol shots, or acrobatics. Finally, the autogiro can constantly patrol many miles around its mother ship.

Deep Piers Built In Stiff Tides

As the new bridge will look when completed. Note "lookout point"

New Suspension Bridge Near Tacoma . . . Two Deep-Water Piers . . . Enormous Tidal Current Pressure Forces Unique Anchored Caisson Construction

By CHARLES F. A. MANN

OUTSTANDING of all the large bridge projects under way as a result of the past year's Federal RFC-PWA program, is the Tacoma Narrows suspension bridge across the narrow channel lying on the westerly side of the Tacoma Peninsula, Tacoma, Washington.

Two features of this bridge are of particular interest to engineers. One is the fact that its central span of 2800 feet is the third largest such span in the world, only those of the George Washington Bridge in New York and the Golden Gate Bridge in San Francisco being longer. The other is the manner in which the engineers solved the problem of sinking two large piers to a depth of 175 and 200 feet respectively, against the enormous pressure of tidal currents double those at the Golden Gate Bridge.

For more than 20 years, local people have dreamed of a huge suspension bridge across the Narrows to replace the ferries. Always two factors stymied the idea. One was the extreme depth of the tidal current, the velocity of which, changing every six hours, reaches nearly nine knots. The second was the costliness of such a span in view of the semi-pioneer status of the section it would serve—a vast area larger than Switzerland, Holland, and Belgium combined.

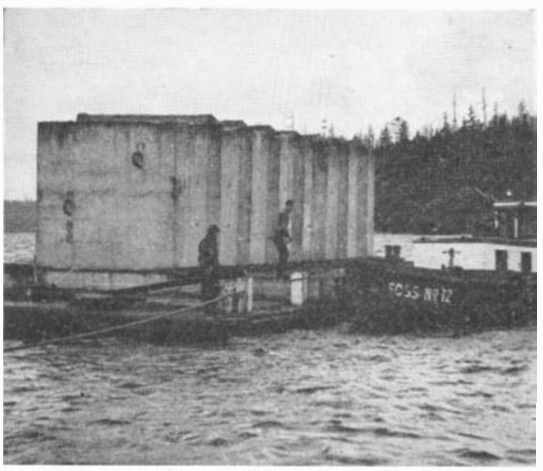
A number of things brought the idea into a more favorable economic position in 1937. They were: the opening of the Olympic wonderland to tourists; the rapid growth of the pulp and paper industry; and the migration of hundreds of settlers from the midwest dustbowl to these cheap, well-watered lands—all insuring greater travel. There was also the fact that the great Bremerton Navy Yard is rapidly becoming one of Uncle Sam's greatest naval bases, indicating a need for good highways and a fast Narrows crossing. Thus it was felt that a Federally supported project could easily liquidate about $4,500,000 of its cost in 40 years.

The chief task confronting the builders was that of sinking the caissons and constructing the piers. The east pier of the Tacoma structure went down 200 feet below water level and the west pier 175 feet, as contrasted to the deeper pier of the two at the Golden Gate Bridge, which went down only 100 feet. Hence it was decided to employ open-well type caissons with a wooden form built around the first part of each caisson to permit floating it into position and lining it up before it was lowered to the bottom. The two main caissons were 118 feet 11 inches long, and 65 feet 11 inches wide, with boat-bow points. These two units were fabricated in Seattle and towed through the Lake Washington Ship Canal to the bridge site in Tacoma.

AFTER the sites for the two piers were located in the Narrows, 24 concrete anchor blocks, each weighing 600 tons, were dumped in a huge double circle around each pier site. These blocks were later anchored by cables to the floating steel caissons to hold them in place against the terrific tidal strain. The blocks were cast on huge barges and were corrugated in such a way that they could grip the bottom mud.

Having provided the anchorage, the two floating steel skeleton forms, which were covered with heavy timbering with caulked seams, were towed into place and anchored to the blocks by cable. These floating caisson sections were spotted accurately by the use of short-wave radio and transits with telescopic sites.

The caissons were partitioned into 24 spaces, each having dimensions of 11

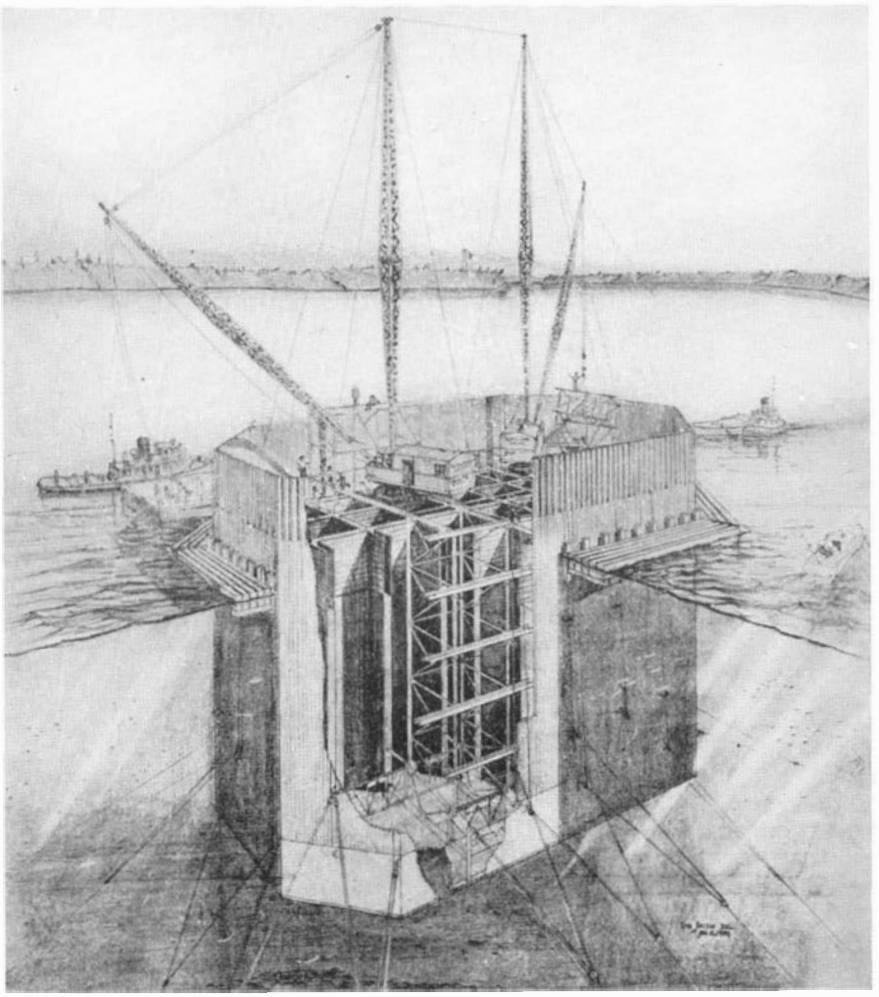


One of the monster 600-ton concrete anchors, sharply corrugated, that were cast on barges

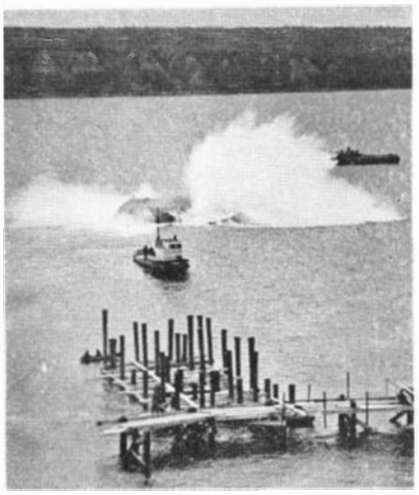
feet 10 inches by 13 feet, all open at the bottom. Concrete was poured into the dividing walls of these sections to form a series of concrete and steel cells. As the added weight lowered the caissons a predetermined distance in the water, the anchor cables were adjusted to take up the slack, and the forms were raised so that another course of concrete might be poured. This was repeated over and over until the lower edge of the caissons struck bottom. Clam-shell buckets then excavated through these cells until the entire caissons dropped through the muck to hard gravel. Concrete plugs were then poured at both the top and the bottom, leaving the cells permanently flooded with salt water.

The Tacoma structure has a total length of 5939 feet. Towers cover an area 19 by 63 feet at the bottom and 13 by 52 feet at the top, and carry two cables 17¼ inches in diameter. Each tower weighs 1875 tons and the two cables 3817 tons. Each cable anchoring consists of a steel and concrete mass of 25,000 cubic yards, weighing 52,000 tons, lodged in the hillsides above the Narrows. Each anchorage will form part of the main roadway. The bridge will have a 26-foot roadway and two five-foot sidewalks.

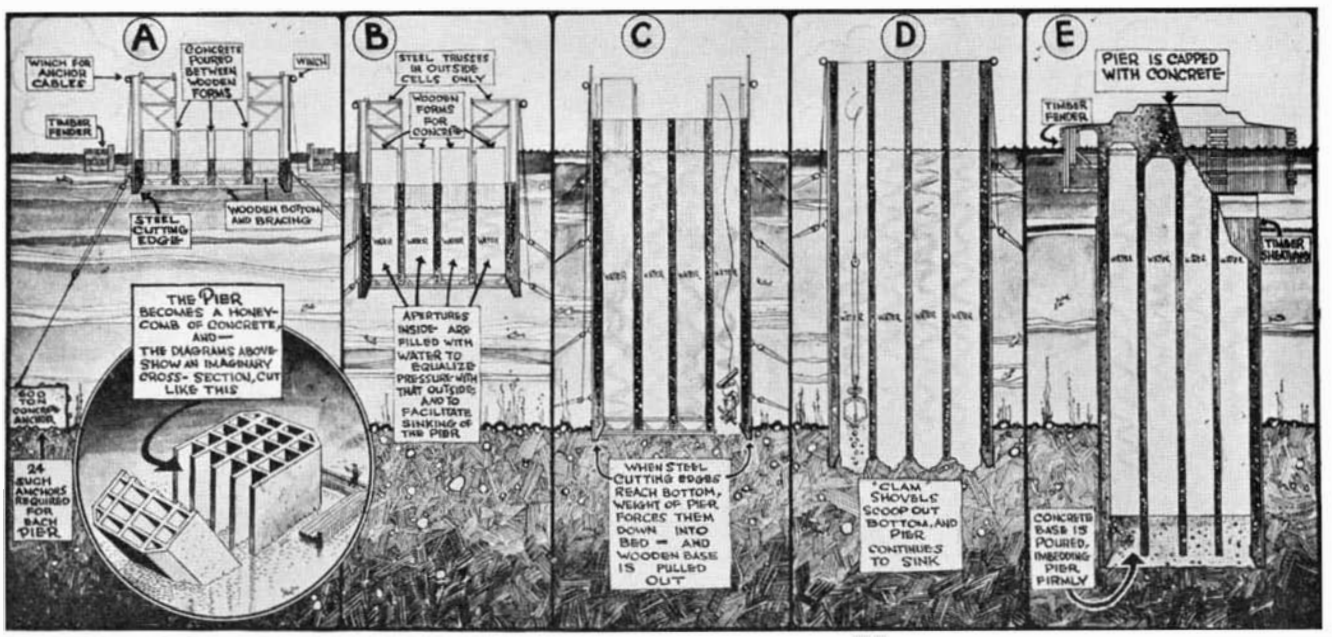
The structure, which will be completed July 1, 1940, will reduce travel time from mainland to peninsula from 40 minutes to 10 and will be the best lighted structure of its kind. Towers and cables will be outlined in lights and the roadway equipped with sodium-vapor fog lights. Airplane beacons will be mounted atop the towers.



A caisson sinks lower in the water but is held rigidly by the anchors



An "anchor" makes a big splash when dumped overboard from a construction barge at a pier site



Step by step, a pier is constructed. Slack in anchor cables is taken up as caisson sinks lower

Answer, Echo, Answer

There are Echoes that Magnify Sound and Others that Change Harsh Discords to Harmony . . . Echoes that Analyze Sound . . . Whispering Galleries

By ALBERT CARR

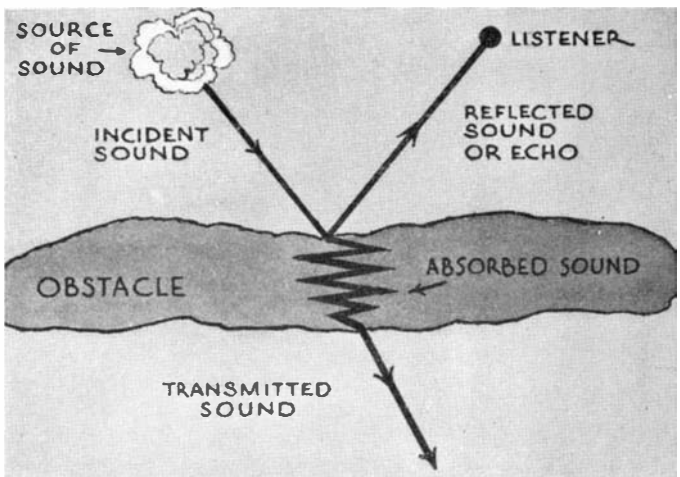
ECHO, according to the Greek myth, was a nymph who pined away for love till only her voice remained. This charming legend makes pleasant folklore, but the science of sonics has given the echo a much firmer basis. Although echoes still possess a poetic, eerie quality, we can now explain *how* they magnify sound, return some voices and ignore others, convert discords into music, carry whispers over long distances, and perform other weird feats which challenge the imagination.

Echoes are sometimes the radio stations of nature; without wires or sending-apparatus, they "step up" sound vibrations and hurl them enormous distances. Some years ago, 28 tons of dynamite exploded in an Alpine railroad tunnel. The terrific blast was heard by Swiss peasants 20 miles away, the apparent limit of the sound. Villages some 25 or 30 miles farther off heard nothing. Then, extraordinary news popped up: 100 miles to the north, across the border in Germany, the noise of the explosion had been distinctly audible. Had the sound of the blast "jumped" over a region 80 miles wide?

"Yes," said the Swiss Meteorological Institute. What had been heard in Germany was not the direct noise of the explosion, but an echo of it. Every echo is, you know, "mirrored" or reflected sound. In this case sound waves, concentrated by the tunnel in which the explosion took place, had traveled upward, reached a heavy cloud formation perhaps 50 miles to the north, which amplified and then reflected the waves to points more than 100 miles from their original source.

Everyone knows that curved or angled mirrors can play curious tricks with an image. Sound-mirrors (another name for echoes) act similarly: they "bounce" sound waves from surface to surface, often altering their volume, pitch, and number of repetitions. Probably no echo has ever achieved the record described by Mark Twain—"you could utter a word and it would talk back at you for 15 minutes." But there is an echo in Oxfordshire, England, which repeats a pistol shot across a valley as many as 20 times, the sound shuttling back and forth between two hills. Like some actors, this echo gives its best performance at night. It has never been heard to score more than 17 repetitions by day; the difference is believed to be due to the more uniform temperature of the air at night.

A unique multiple echo exists at the Menai suspension bridge, in Wales. There, a hammer blow on the main pier is returned in a series of staccato reports from each of the crossbeams, all the way across the river—576 feet. To get an equivalent result with light, you would have to set up a long row of mirrors, equally spaced, and place an object in front of the row, at a wide angle. Then, by standing in the right position, you could see an image of the object in each mirror all the way down the line.



Reflected sound that is clear and definite is an echo

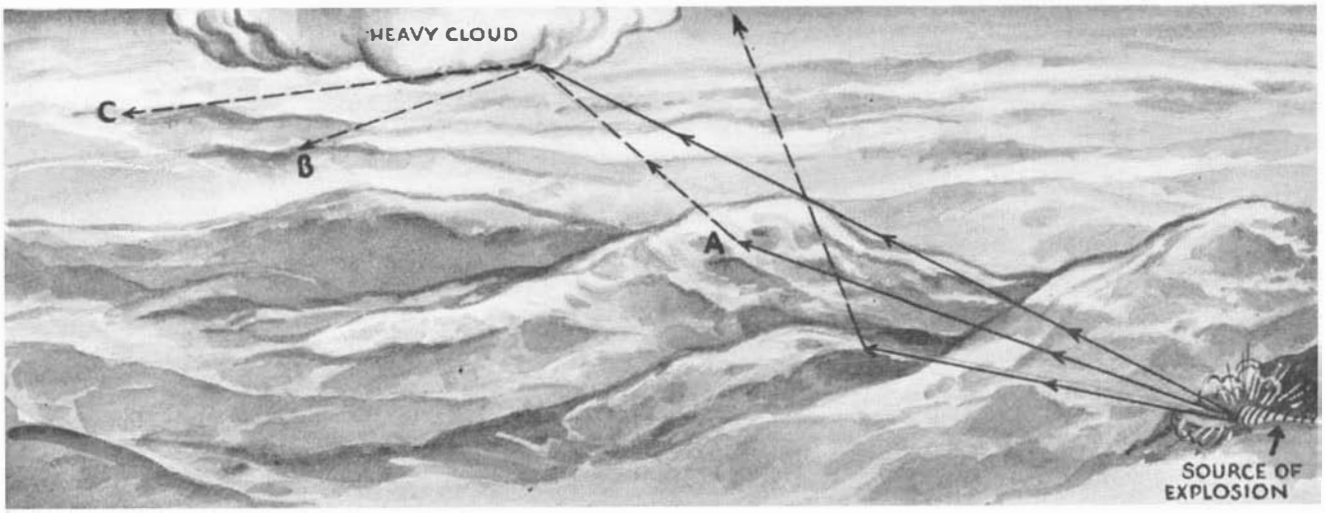
Some echoes disdain mere numerical glory and strive for a single brilliant performance. If, near a certain tomb on the Roman Campagna, you speak an entire hexameter verse, the echo will courteously wait until you have finished, and then repeat it after you. Likewise in the deserted city of Mandu, in Central India, there is a spot where you can utter a long, solid sentence, and have it voyage back presently to your ears, unbroken.

To produce one of these marathon echoes, the sound reflector must be so far away that you have time to speak for several seconds before the waves can make the journey to the reflecting surface and back again. Sound travels a mile in about five seconds; an echo which will repeat a five-second sentence therefore indicates a reflector half a mile away. Only extraordinarily clear acoustic conditions will permit the voice to carry so far; hence the rarity of this type of echo.

As some curved mirrors magnify your image, some echoes magnify your voice. Usually such "megaphone" echoes are heard in caves. At the famous quarried grotto known as the Ear of Dionysius, in Sicily, the crumpling of a piece of Cellophane will make you think a machine gun is at work. Why? Well, when echoes are thrown back simultaneously from many surfaces, their combined volume is louder than that of the original sound heard from a single direction. This phenomenon was once utilized by a troop of Mexican bandits when trapped by a superior force in a mountain pass. Discovering that the crags around them multiplied both the volume and number of their voices, the bandits tried a desperate expedient. Yelling and shooting, they dashed for freedom. The echoes, resounding from all sides, made the enemy believe that a regiment was charging down on them; they fled and the little band escaped. This story, long current south of the Rio Grande, has furnished at least one movie episode for Hollywood.

Mark Twain, veteran echo-fancier, claimed he knew an echo which would speak only German. We may smile at the notion; but there are some echoes which are highly particular about the sounds they will do business with. One English echo has been called "The Suffragette," for, while it will respond to a woman's soprano voice, it pays no attention to a man's.

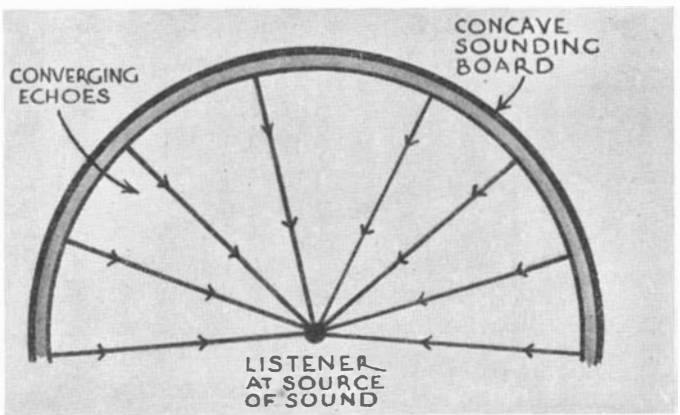
This sex-conscious echo does to sound what a colored mirror does to light. In a polished red vase, for example, you will notice that the reflection of blue objects



Direct sound of a dynamite explosion in the Alps, as the author describes, was heard in the area up to point *A*, but not in the zone of silence from *A* to *B*. The echo from heavy clouds, however, was heard in the distant area from *B* to *C*

in it lose their color. The red light-rays of low frequency are reflected, while the high frequency blue rays are largely absorbed. The "selective" echo acts in the same way, throwing back some sound-waves in greater proportions than others.

The chief factors in this phenomenon, according to authorities on sonics, are the size of the sound reflector, and the variation in the wavelengths which compose a complex sound like that of the human voice. Lord Rayleigh, the famed English physicist, showed that the intensity of sound scattered or reflected by an obstacle is directly proportional to the size of the obstacle, and inversely proportional to the fourth power of the wavelength. (The same law, incidentally, applies to the scattering of light, and is used to explain the blueness of the sky.)



How echoes are magnified. The sound waves, having traveled out from the source in all directions, simultaneously converge back on the shouter from all directions, causing more intense vibration of the eardrum than was made by the original sound. He virtually shouts mouth against ear

When, according to this law, sound waves of various lengths traveling the same plane encounter a small obstacle, the longer waves tend to continue beyond it, much as large water waves pass around a rock and close in again on the other side, without substantial interruption. The shorter sound waves, on the other hand, are scattered, somewhat like small water waves encountering the same rock. Consequently, when the sound reflector is small, the chances of the scattering and reflection of short sound waves are much better than those of long sound waves. Since the shorter waves represent the higher tones of sound, it is these tones which we hear most loudly when a small, distant reflector happens to produce an echo.

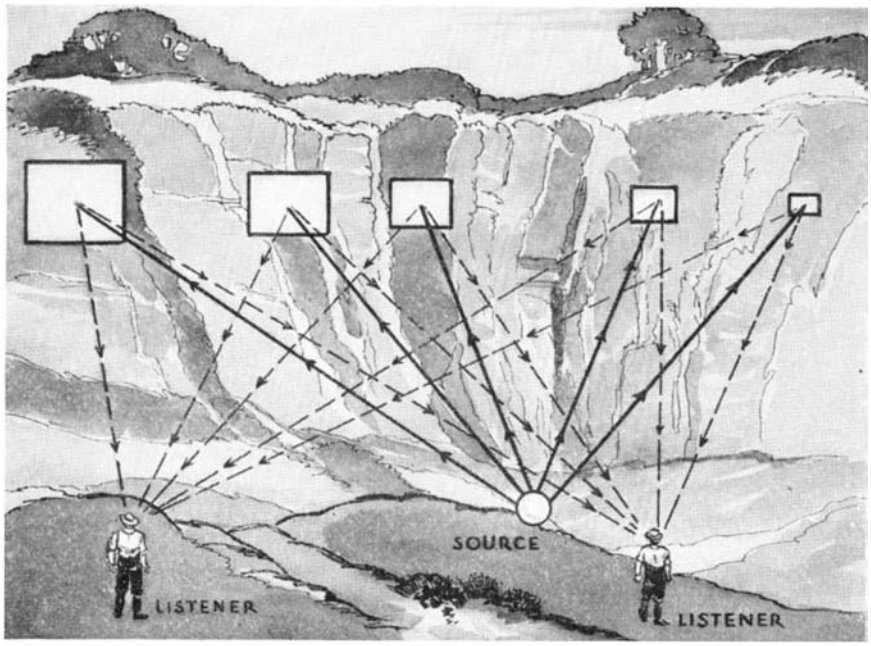
Certain selective or "harmonic" echoes have the curious trick of raising the pitch of sounds. At the Gap of Dunloe, in the lakes of Killarney, it is said that the ghost of a long dead musician will accompany whoever plays a bugle there. It is perfectly true that the echo of each note comes back an octave higher, and that it provides a harmonious accompaniment for a simple bugle call. The principle is that of the selective echo; a small obstacle, such as a clump of trees, will return the first harmonic wavelengths, or octave, of a fundamental tone more efficiently than the tone itself.

Everyone has observed how a prism or spectroscope grating breaks up sunlight into its component colors. Here and there an echo will do the same thing to sound, producing a "sound spectrum." At Bighorn Canyon, in southern Montana, the rushing roar of the river is sometimes echoed from a certain section of the cliffs in a howl like that of a police-car siren, beginning on a high note and sweeping down into the bass clef. Years ago Indians in the neighborhood used to shun the spot for fear of "evil spirits." Today we know that the various wavelengths in the sound of the river are reflected by different parts of the jagged cliff, reaching the ear separately, instead of all at once. If the observer takes another position, he can cause the order of the sounds to be reversed, so that the echo begins with the deep tones, and rises to the treble. Physicists say of echoes of this type that they "analyze" sound.

I remember standing near Eagle Harbor, on the wooded shore of Lake Superior, and hearing what sounded like a celestial hymn, played in slow time by some mysterious organist. For a while I thought I had suffered a hallucination. But similar experiences of others in that region show that what I heard was the noise of the waves of the lake on a pebbly beach, analyzed and echoed harmonically by the forest behind.

The musical echo is certainly the most charming of all the numerous echo family. Its principle seems to be to repay evil with good. On Saddleback Mountain in Maine, the most hideous discords—such as an Indian war-whoop—are returned as a delightful, soft, musical note. Such echoes are generally found only where there are symmetrical rows of trees which "cut out" or absorb certain sound frequencies, and reflect the others in a harmonic relationship.

Perhaps the most dramatic of all echoes are those in which the sound is reflected from deeply curved surfaces. The whispering galleries of the world are all of this type. One of the best known is under the great dome of St. Paul's Cathedral in London. There a whisper will creep across from one side of the dome to the other, to be picked up with astonishing distinctness on the opposite side, 102 feet away. The Ear of Dionysius, already mentioned, is one of the finest of all whispering galleries. At its top is a small passageway where the visitor can distinctly hear the breathing



An abstract diagram of the action of an "analyzing" echo. Large reflecting areas throw back more of the deeper sounds; small ones more of higher sounds. Owing to differing total path lengths these "analyzed" echoes arrive in succession, but from high to low for one listener, low to high for the other

of a man on the floor, 120 feet below. The tyrant, Dionysius of Syracuse, conceived the notion of imprisoning political enemies in the Ear, and by listening at the top, was able to overhear their whispered plots and secrets.

How is it that a whisper which cannot be heard for 20 feet under normal conditions will carry 10 times as far in a whispering gallery? The explanation lies in the fact that the sound is "slanted" off the smooth inner surface of the round dome again and again, traveling in a series of arcs. A helpful analogy is to imagine a billiard ball with "forward spin" as it strikes a cushion at an acute angle. Under the right conditions the ball, instead of being slowed down, "picks up." Similarly, the volume of sound "picks up" in whispering galleries as it travels over the curved reflector.

ECHOES have been used as a method of torture. In the Cave of the Snake, in the wrinkled and lonely hills of the Kaimur Range of India, the least sound is repeated in a low rushing murmur that seems to pervade the doomed chamber. A torture-loving Rajah once conceived the notion of putting his victims, one at a time, in the pitch blackness of the cave, with no company but that of a deadly black cobra. There was no way of telling how soon the cobra would encounter its destined victim, and strike. But every time it moved or hissed the slithering sound would seem to come from all directions. Under the unbearable suspense the prisoner would die a thousand deaths before the fatal moment came.

However, the Rajah felt that in not overhearing the sufferer's torture he was missing the best part of the fun. So he had a small opening made in the sealed entrance. And—as was to be hoped—while he sat with his ear to this opening, the snake crawled up and bit him.

The best known of America's whispering galleries is in the Capitol at Washington, in Statuary Hall, where if you stand in the proper spot you can communicate by whispers with a friend 50 feet away.

Most land echoes seem to have no other purpose than to entertain the curious. But at sea, echoes work for their living, measuring ocean-depths for navigators. The echo depth-finder used by the United States Coast and Geodetic Survey in charting the bottom of the ocean, and carried by practically all important vessels, enables a ship running at full speed to obtain four soundings a second in depths of 600 feet. Sound, be it noted, travels approximately five times as fast in water as in air.

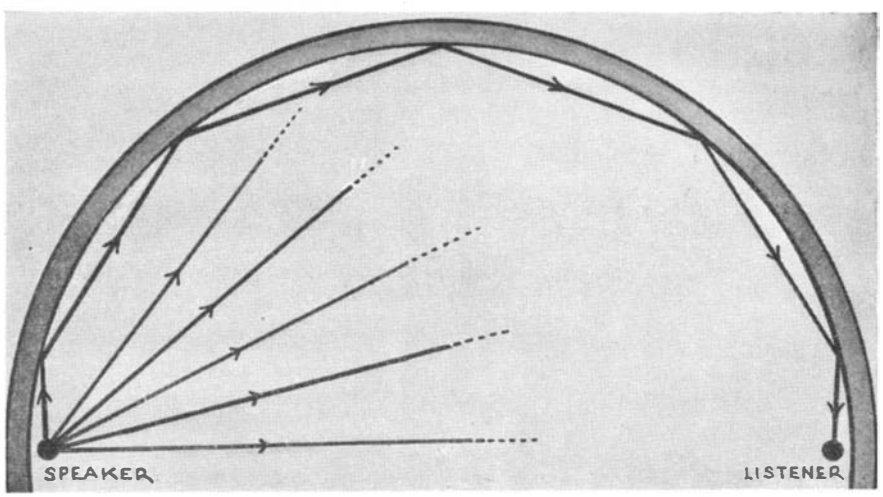
The principle of the instrument is simple enough. Sound waves, produced under water, speed to the ocean bottom, and are reflected upward. An electrical device measures the elapsed time between the transmission of the sound and the return of the echo, and this time interval is recorded in terms of depth. In war time these depth-finders have helped ships to detect the presence of submarines by recording the sound which they make.

The story goes that many years ago, in the cathedral at Girgenti in Sicily, a gentleman was kneeling alone near the high altar, when he suddenly heard a distinct whisper: "Bless me, father, I have sinned. . ."

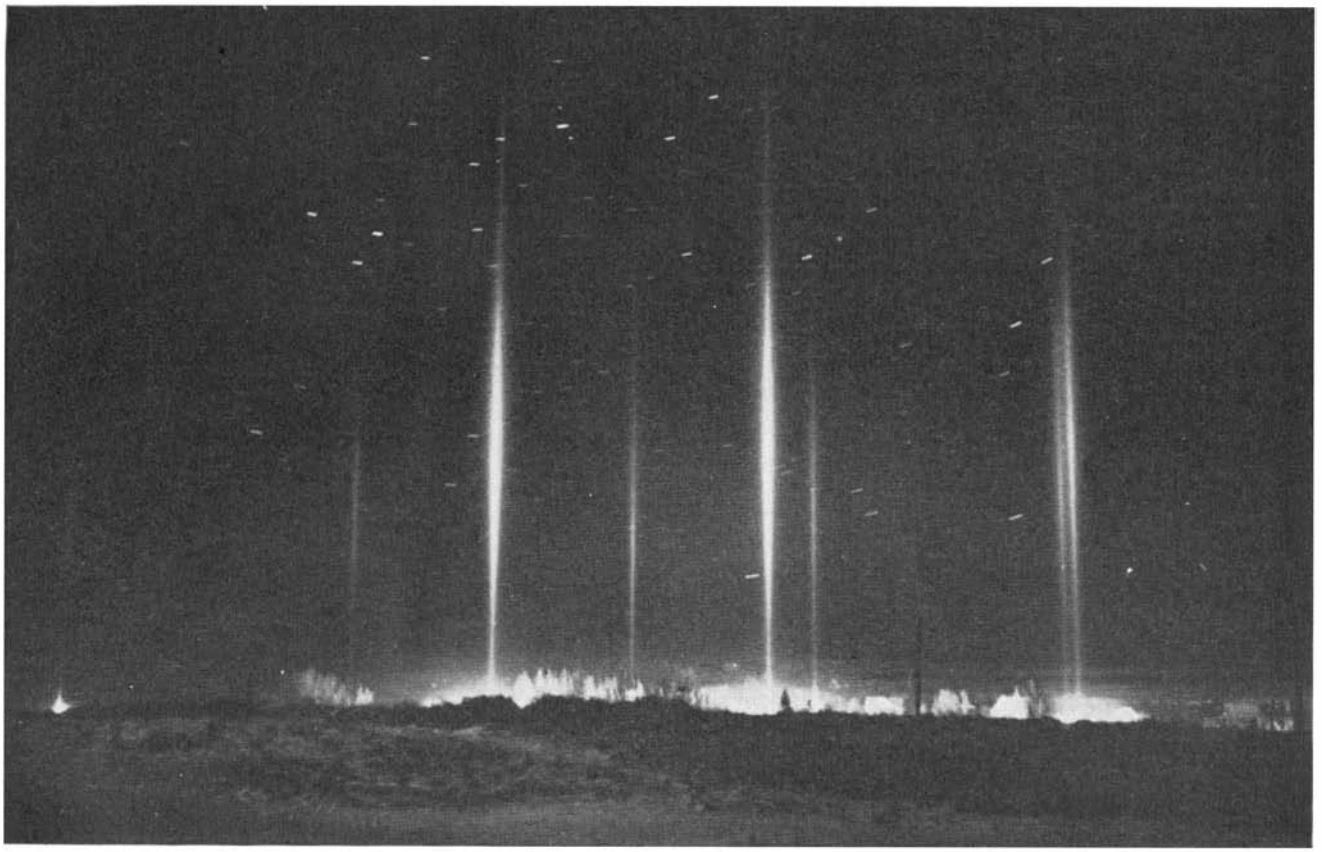
Startled, he looked around. There was no one near him. The whispered confession continued. Amazed, he concluded that it could only come from a confessional booth over 100 feet away. He approached the booth, but at once the whisper ceased. Returning to the original spot, however, he heard the words as clearly as if they were being murmured into his ear.

Unfortunately, he was not content with the discovery of an acoustic phenomenon. Delighted at the prospect of rare entertainment, he invited some of his friends to join him in eavesdropping on the confessions of their neighbors. But, appropriately enough, in the very first confession, he heard the sound of his own wife's voice admitting sins no husband cares to have on his wife's conscience.

AMONG echoes as among people, there is infinite diversity. One finds not only easy-going, good-natured echoes, but grumblers, loud-mouthed bores, wisecrackers, show-offs, temperamental artists, and a few hard workers. But Little Sir Echo always has one advantage over merely human sound-makers. No one expects him to be original.



Sound creeps around the concave wall but soon becomes attenuated elsewhere



Spectacular pillar halos at Wilbur, Washington, photographed at 12:15 A. M. by S. B. Breed. Five-minute exposure at *f*/3.5

Pillar Halos

"EXCITEMENT Caused by Freakish Lights" was a headline in the Wilbur (Washington) Register. "Last Thursday night," the news item beneath it stated, "those of our citizens who were awake witnessed a display of freakish lighting effects that is seldom equalled for beauty. From every outdoor light—street lights, electric signs, and automobile headlights—there arose perpendicularly a shaft of light high into the air. Within these ghost-like beams there flickered and danced millions of particles of frost." On this occasion one Scientific American reader, S. B. Breed, of Wilbur, thought to photograph the odd phenomenon and sent this magazine the illustration shown above, with a request for a scientific explanation.

When readers send this magazine descriptions of odd meteorological or atmospheric phenomena for explanation, the editors turn to W. J. Humphreys' "Physics of the Air," a standard advanced reference work about this particular corner of science; often also, as in this case, to the author himself, Dr. Humphreys, because his lifetime work as Professor of Meteorological Physics at the United States Weather Bureau in Washington, has brought to his attention myriads of meteorological oddities.

"The photograph," he replied, "is of pillar halos and is the best I have seen of that phenomenon. Pillar halos," he continued, "are produced by reflection from the upper and under sides of tabular snow crystals, which tend to fall flatwise." In extension of his comments Professor Humphreys cited an article in the *Monthly Weather Review* of the United States Weather Bureau, by B. W. Currie, Professor of Physics at the University of Saskatchewan, Canada, describing a similar happening, and the following is quoted from that article.

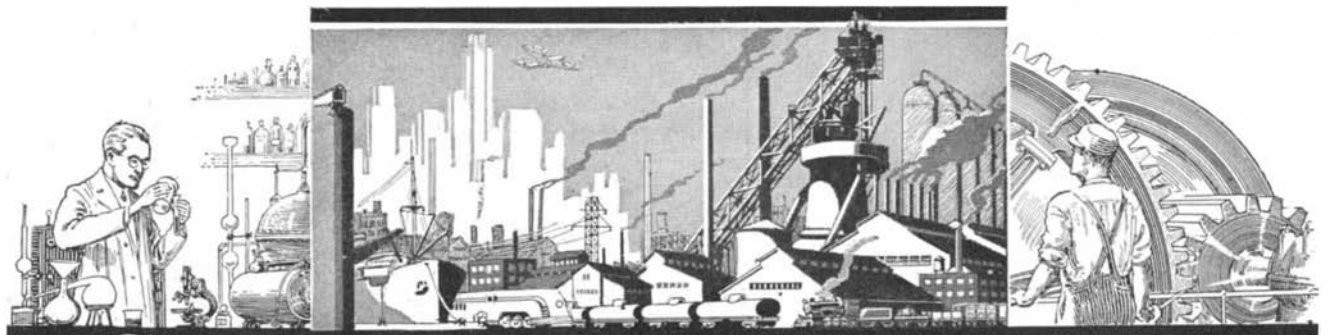
"The color of the light from the pillars, and its state of polarization, show that they are caused by reflection. The color of each pillar is exactly the same as that of the light below it; the red pillars from neon electric signs are particularly noticeable. The apparent height of a pillar increases with the intensity of the light source. Calculations based on known distances to light sources and the measured sizes of the corresponding pillars on photographs often give heights in excess of 1100 feet.

"Two kinds of crystals—thin hexagonal plates and thin broken fragments of snowflakes—cause the pillars. Only the first kind is found on calm nights when the most brilliant displays occur. Both kinds of crystals may be found when the pillars are seen on windy nights.

"Wind velocities less than eight miles per hour seem essential to the formation of bright pillars. If snow is falling, the pillars can be seen only if the wind is strong enough to break the snowflakes. Temperature conditions show no uniformity, partly because the crystals are formed at higher levels and then fall to the surface."

Sometimes pillar halos are similarly seen above the sun or, if the sun is high, below it as well.

Related directly to pillar halos are several phenomena which do not at all resemble them in shape: certain arcs and circles, seen surrounding the sun, often in elaborate complexes like schoolroom exercises in geometry. All have scientific names such as perhelic arcs and circles, anthelic arcs and heliac arcs. But the plot rapidly thickens, for a part of these are caused by reflection, and, to complicate the complexity, there is a third class of ring phenomena due to diffraction: coronas, solar or lunar. Halos are red inside, blue outside, coronas the reverse. Writers often confuse the three classes and who can blame them? Short of close study and perfect memory it is safest not to leave the vicinity of a textbook.



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editor

ALEXANDER KLEMIN

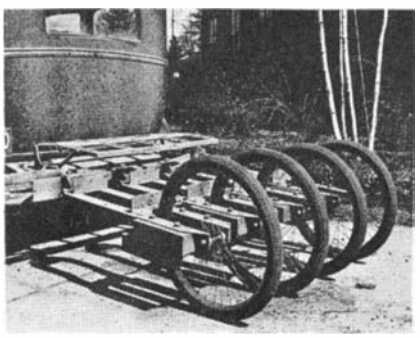
In charge, Daniel Guggenheim School of Aeronautics, New York University

Bike Tires Tested

LIKE its big brother, the automobile tire, the bicycle tire now undergoes actual road tests in addition to laboratory check-ups to insure serviceability.

On a unique machine invented by engineers of the Fisk Tire Company, four bike tires can be tested at one time by means of a trailer arrangement hooked to the rear of an automobile.

The four tires run simultaneously, each under an individual load of 125 pounds. The



Heavily loaded tires under test

automobile pulls them at 25 miles per hour, rain or shine, to simulate actual service conditions.

According to A. E. Benson, Fisk product development manager, the tests provide the following information: Behavior of tire on different types of rims; resistance of carcass to fatigue at different inflation pressures; stability of beads in maintaining a true running tire; resistance of tire to rim cutting; quality of rim strip in resisting indentation of spoke heads; quality of tube in maintenance of air pressure and freedom from excessive growth, and quality of tread stock resistance to wear.

Indoor tests on another machine provide a double check on the same conditions.

Perfected "Rubber Lung"

A SHORT time ago newspapers carried the story of the first use of an artificial lung on a mother during childbirth. The mother was afflicted with paralysis a short time before the child was to be born and had been kept in an iron lung. Delivery was, of course, impossible while she remained in this machine, so a smaller, newly developed lung was borrowed from the family of a paralysis patient, Fred Snite. The delivery was successful.

The small lung which served in this case was one which was discussed in Scientific American about two years ago, and was developed in part by the General Tire and Rubber Company. In an accompanying illustration will be seen the latest perfected model of this lung, which not only provides the patient with a regular rhythmical supply of air but leaves the limbs free for any necessary manipulation or massaging by nurses. It will be noted that an additional feature of this is the transparent plastic cover through which the patient's chest action may be observed. This device, when strapped over the chest, is sealed around the edges by sponge rubber.

This emergency lung, which is called the "General-Collins," is easily transportable, is operated by a ¼ horsepower motor or by a hand pump if electricity is not available, and is so inexpensive that it might be carried as regular equipment in even the smallest hospitals, in police emergency squad cars, fire-fighting units, and by first-aid organizations of all kinds. It has been designed in four sizes to care for patients from infants to large adults.

Bacteria Cause Kerosene Explosion

BRITISH authorities have for months been puzzled by mysterious explosions in gasoline storage tanks holding their wartime fuel. Sabotage was suspected but unproved, for the terrific explosions brought complete catastrophe. Finally a kerosene tank blew up and, after the explosion, bubbles of gas were noticed rising from the layer of water at the tank's bottom on which the kerosene had been floating.

The government's expert on the generation of gases by bacteria, Dr. A. C. Thaysen, examined some of the water and sediment. It was found that they contained a new kind of bacteria which can live in kerosene and ferment it into 10 percent ethane and 90 percent methane. It was undoubtedly

Relief brought by a "rubber lung" wins a happy smile

these explosive gases, generated by the bacteria, which caused the explosion. While Dr. Thaysen has not solved the puzzle of the gasoline explosions, he is virtually certain that a similar action was responsible.—*Science Service.*

BLOOD

THE Japanese are said to have added to the soldier's name on his identification tag, which he wears around his neck, one of the letters: O, A, B, or AB. Precious time is thus saved if the soldier is wounded and needs a blood transfusion, for the letters indicate his blood type, previously determined.

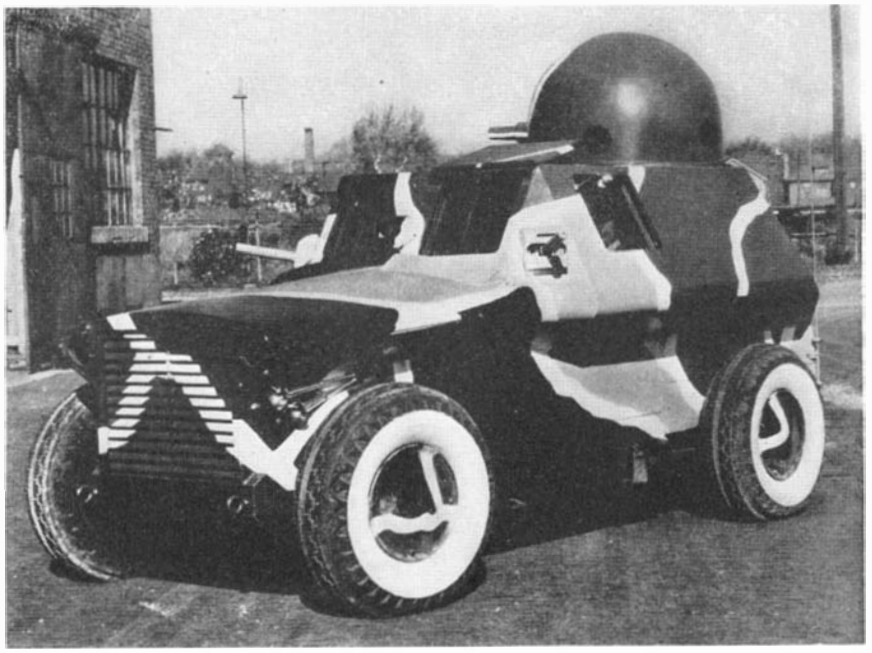
De-Enameling Light Sheets

TO its line of sand-blast guns, Michiana Products Corporation has added a new model which is now being used by makers of vitreous enamel products, such as stoves, refrigerators, cabinets, and sinks, for de-enameling defective sheets or parts which are ordinarily a total loss. This new gun has five outlet nozzles or orifices through which the sand is discharged with a brush-like action, cleaning without peening or distorting sheets 19-gage and lighter. Besides de-enameling, the makers recommend this type gun for cleaning wood, stone, and other materials, the surfaces of which might be damaged by a harsher, single nozzle blast.

Sand blasting for reclamation

Gas-Cooled Compressor Motor

THE world's most powerful air-conditioning compressor unit, with a cooling capacity equal to the melting of 100 tons of ice in 24 hours, has just been announced by Westinghouse Electric & Manufacturing Company. The important feature of this unit is that the new V-16 compressor is hermetically sealed, the motor and compressor both being in the same housing. This permits use of the Freon refrigerating gas, as it returns to the compressor, to cool the motor in passing. Formerly, motors were all air-cooled and required much more space. This new equipment, therefore, has 12 percent more efficiency and its space requirements have been reduced by two thirds—of importance to theaters, restaurants, and the like, where space is at a premium.



For defense against low-flying aircraft

100-Mile-an-Hour Anti-Aircraft Combat Car

EQUIPPED with three machine guns and a cannon; capable of traveling more than 100 miles per hour; built of .50-caliber bullet-proof armor plate and glass; mounted on bullet-proof tires; able to climb grades of 50 percent inclination and travel through mud, sand, and broken ground; having a cruising range of 225 miles at 70 miles per hour; as easy to drive as a motor car—that, in substance, is the newest type of anti-aircraft combat car.

This new mobile unit is a powerful arm of defense against low-flying aircraft on ground-strafing missions. Its armament, speed, maneuverability, and bullet-proof construction make it always ready for instant use.

Designed by Preston Tucker of Tucker Manufacturing Company, this "tank" was made possible by use of the most modern steel construction process—arc welding. Arc-welded construction actually makes the machine bullet-proof. Welding does away with bolts and rivets which become worse than projectiles when driven into the tank by heavy gun fire. While eliminating this hazard, the arc welds are themselves bullet-proof. Welding on the Tucker Tank was done with electrodes and arc welders manufactured by The Lincoln Electric Company.

This tank is equipped with one 37mm full-automatic cannon firing at a rate of 120 shots per minute, and three .30-caliber machine guns. The turret rotates freely, giving complete firing range, and all glass is 2½ inches thick and so placed as to give full visibility.

A speed of 114 miles an hour is possible with a 200 horsepower motor having a seven-speed transmission. In addition, the unit has a 108-inch wheel base and a standard racing-car arrangement in springs and chassis. Tires are apparently sponge rubber "airless" type.

Radio equipment and compass are contained in the interior which is air conditioned for comfort.

TREES

MORE than 6 million trees were planted in windbreaks and shelterbelts last year in a total of 30 states.

Ersatz Rubber

WITH synthetic materials in many instances replacing more expensive and less satisfactory natural products, the question is often raised as to why substitute rubber remains so high in price.

Using the production of Buna, Germany's substitute rubber, as an example, *Plastics* (London) points out that the process is so complicated that certain basic costs cannot be decreased. The works plant is costly, maintenance is much higher than in ordinary plants; the highly inflammable materials need special precautions; continuous testing and research are expensive, but necessary, adjuncts. But the main reason for high cost is the fact that there are so many intermediate processes.

The first step is the manufacture of carbide from lime and coke in an electric furnace using 10,000 volts. This needs a sizable power station to produce the necessary 100 to 200 tons of carbide a day. The carbide is then treated with water to produce acetylene. The acetylene is transformed by catalysis and hydrogenation into the chemical butylene glycol. The yield of these two processes is only 35 percent of the theoretical. Two more steps, another transformation, and a polymerization, yield the rubber substitute. The polymerizing agent is metallic sodium, difficult to handle.

To make one ton of rubber, four tons

of acetylene are required. And to make this quantity of acetylene, at least ten tons of carbide are needed.

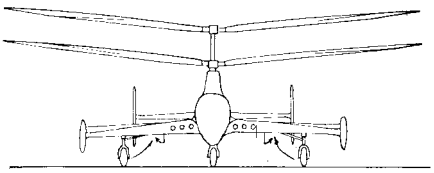
It is interesting to note that, should the cult of self-sufficiency die out, the production would decrease and the price would increase. And, as in the United States, the use of the synthetic material would be restricted to its proper and special uses based on its inherent advantages over the natural material.

Aero-Biology

HAY fever victims will find aviation an aid in their woes if the researches of "aero-biologist" C. C. Durham, of the Abbott Laboratories, are successful. Dr. Durham is a botanist who investigates the distribution of pollen with the aid of a microscope and a kit of Vaseline-covered slides. The slides are fitted into a "sky-hook," and flight investigations of the upper atmosphere have been made with the aid of United Air Lines, Pan-American Airways, and Pennsylvania Central Airlines. Above 6000 feet there is little ragweed or other irritating pollen to be found. Even at ground levels in the Pacific Northwest the air is virtually free of any hay-fever-causing pollens. Flying in the *Yankee Clipper*, Dr. Durham's slides show no spores farther from land than 275 miles. Sufferers from hay fever had better spend their lives flying, particularly flying over the Atlantic!—*A.K.*

The Asboth Helicopter

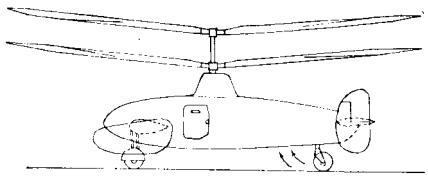
WE have described at some length in these columns the remarkable characteristics of the Focke helicopter, which is of the type where airscrews, turning in contrary directions, are mounted on each side of the fuselage. Now, thanks to the *Aeroplane*, (London) we are able to give a description of the latest Asboth design, which is apparently to be built in England. The Asboth machine, illustrated in the drawings, is known as the A. H. X. With a Gipsy engine of 200 horsepower, a gross weight of 2148 pounds, and a disposable load of 385 pounds, the A. H. X. is estimated as having the following performance: Maximum horizontal speed, 107 miles per hour; ceiling, 11,500 feet; initial rate of climb, 1760 feet per minute; lift, 3260 pounds, giving an excess of lift over weight of 1100 pounds. Speed of vertical descent



End view drawing of the Asboth helicopter. Wheels retract into wing

with the blades auto-rotating is somewhat high, in the neighborhood of 40 feet a second, although the vertical descent speed can be reduced to 16 feet a second by gliding the machine down like an airplane or an autogiro.

The drawings give only a hint of actual construction. Incidence of the blades is varied from hub to tip. If the engine fails, the incidence is automatically changed, so that auto-rotation follows. Without automatic auto-rotation, a helicopter would be a dangerous vehicle when the engine quits. The blades are set rigidly on the hinge and do not flap. There is a "four function" hub. The hub allows the airscrews to be tilted forward to give forward thrust, and permits auto-rotation as previously stated. Control surfaces are carried in the faired beam, which is really a small wing. The landing gear retracts into the wing, and



Side elevation of Asboth helicopter

the now commonly accepted tricycle landing gear is embodied in the design. We admit that this is a sketchy description and hope that more details will shortly be forthcoming. In the present state of the art it is highly desirable that both the superimposed airscrew type of helicopter and the outboard airscrew type should be developed in competition with one another.—*A. K.*

The Future of Flying

DR. H. E. WIMPERIS, former Director of Research of the British Air Ministry, is a man of vast experience in aeronautical matters. His recent address before the British Association for the Advancement of Science, on the future of flying, may therefore be regarded as an authoritative view of things to come.

Speaking of materials, Dr. Wimperis points out the virtues of the high-strength aluminum alloys so generally employed today in the building of aircraft. But aluminum alloy means hundreds of thousands of rivets in a large airplane. Therefore, plastic materials, while no better from a strength point of view, may mean real improvement in production methods.

What is the position regarding speed? Physiologically there is no limit to speed, provided only that high speed is not associated with rapid maneuver. Does not the earth spin around at vast speed without incommoding us in the least? But there are two probable limits to airplane speed. For commercial aircraft this should be around 250 miles per hour, simply because it is uneconomical to fly faster. For military aircraft the limit of speed is likely to be between 500 and 600 miles an hour, because of the "compressibility burble" which occurs near the speed of sound, and which even the best airfoils cannot postpone indefinitely. With compressibility burble, the drag or air resistance increases enormously.

What of the engine? Three thousand horsepower in a single unit is in sight. One great improvement which has entered British but not American practice is the sleeve-valve to replace the conventional poppet valve. The sleeve-valve is no novelty (it has been used in the automobile) and it has only half the component parts of the ordinary poppet valve, permits inlet and exhaust of gases at higher speeds and because it has no local point of overheating avoids detonation at higher compression ratios. Engines today are cooled at much less expense of air drag. In fact, there is some hope of utilizing the heat imparted to the cooling air to produce thrust. In such a case, instead of drag, the cooling system may actually produce forward thrust!

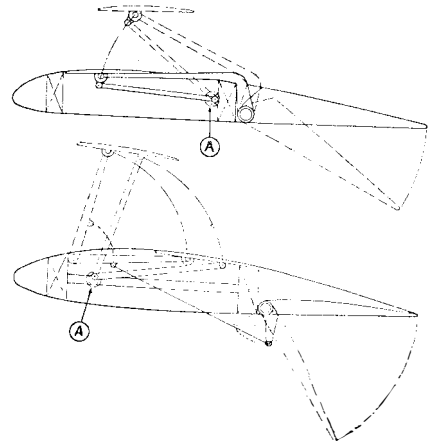
Special wings may be developed which will keep the flow over the surface of the airfoil laminar instead of turbulent, with marked improvement in performance. But then the position of the propeller must be changed. It is not the slightest use to design "laminar flow" wings if the slipstream of the propeller placed at the leading edge of the wing upsets the air flow. Dr. Wimperis therefore argues in favor of the pusher propeller; that is, one placed behind the wing. The pusher propeller introduces problems of its own, such as moving back of the engine and change in trim or balance of the aircraft; the necessity of a long shaft drive from the engine, with attendant vibration troubles; and proximity of the propeller slipstream to the tail surfaces. Nevertheless, the combination of "laminar flow" wings with pusher propellers offers an attractive vista.

The higher the wing loading, the greater the speed and carrying capacity. The Wright brothers carried a loading of 1½ pounds per square foot of wing area. Dr. Wimperis speaks of a stall speed of 100 miles per hour, and wing loadings of 40 pounds per square foot. Particularly in transatlantic flying we may expect tremendous wing loadings to permit non-stop flight across the sea, because the flying boat can use long stretches of water for take-off, and sizes which would appear fantastic today.

These semi-popular, semi-technical views of a well-informed man are helpful to both layman and technician.—*A. K.*

Pushing the Flap Still Farther

THE flap has proved itself highly useful in airplane design, but aeronautical engineers are never satisfied. Therefore, double-flaps, designed by H. B. Irving, are being tested in England. Our own N.A.C.A. is experimenting with a Venetian-blind type of flap with promising aerodynamic results



Two types of the Pidcock combination "slat" and flap for planes

to compensate for mechanical complexity. The *Aeroplane* (London) describes briefly the Pidcock combination of forward "slat" and flap illustrated in two of our drawings. In the Pidcock combination, the effect of the flap in increasing the lift capacity is combined with the lift increase effect of the slat which emerges from the surface of the

wing, and gives a biplane effect. The inclination of the forward slat can be adjusted by the eccentric at the points A on the drawings. There is another reason why the combination of slat and flap is worth considering: The depression of the flap tends to nose the airplane down; such a tendency would be counteracted by the lift force forward of the slat.—*A. K.*

Contrast in Training Planes

TWO of our photographs show a definite contrast in modern training planes. The Stearman PT-13A Army primary training plane is a biplane, powered with an engine of more than 200 horsepower, with a top speed of around 150 miles per hour. The Stearman is a rugged biplane, of short span, so that maneuverability is high and there is ruggedness available for the most violent stunting. The cockpits are open so as to give the "feel of the air" to the pilot.

The Porterfield Model 50 is a decided contrast. It carries only a 50-horsepower Continental engine, of the four cylinder opposed type, and the open cockpit can be converted into a comfortable cabin with plenty of vision. The Porterfield Trainer has been specially designed for the thousands of students who will undertake C. A. A. flight training all over the country. The small ships now being used for such training—the Porterfield, Aeronca, and so on—are remarkably economical, easily handled, of slow landing speed due to their low wing loading (6.5 pounds per square foot on the Porterfield), and safe in students' hands.

Neither the operators who give the instruction nor the students who undertake it have any reason to complain of the equipment at their disposal. Main data on the Porterfield Trainer are: High speed with open cockpit, 95 miles per hour; gross weight 1100 pounds; useful load 436 pounds; length 22 feet 6 inches; wing span, 34 feet 9 inches; wing area 168.8 square feet. The students for whom Uncle Sam is providing flying training are to be envied.—*A. K.*

Two modern training planes with desirable characteristics. *Below:* The Porterfield Trainer, and, *right*, a Stearman primary trainer

Canada to the Rescue

THERE was a beautiful idea propounded in the press that British and French warplanes could fly to Poland's aid and shuttle back and forth, dropping deadly bombs on the German forces. The great distances involved and the destruction of the Polish aerodromes rendered the plan unfeasible. But the scheme of flying bombers across the North Atlantic straight from factories in Canada is much more practical. In fact, the Allies may expect a great deal of help in aerial warfare from Canada. The Society of British Aircraft Constructors tells us in a news letter that 11 major Canadian engineering firms are handling aircraft production work, and that the pulse of production is quickening every week. The network of factories is spread throughout the Dominion, with torpedo planes being built as far west as Vancouver. Our northern neighbor has a great opportunity in military aviation.—*A. K.*

Is the Westwall Invincible?

IF Germany's bristling Westwall proves invincible to attack in the present war, it will be the first great wall in history that has ever completely justified the trust put in it, says *Science Service.*

China's Great Wall, a barrier 1500 miles long, 15 to 30 feet high and reinforced by thousands of towers, was built to shut out barbarians who kept swooping down from the north. Costing thousands of Chinese lives in the construction, one flippant crack later summed up its worth: "The Chinese never got over it, but the Tartars did."

Hadrian's Wall, which crossed Britain from coast to coast, fortified Roman Britain against invasion from tribes of the north. Although the last word in 2nd Century A.D. military construction, the strongly fortified barrier was stormed and broken during more than one conflict.

In Germany itself, Rome's old Limes Line that marked the limit of conquest was not particularly heavy, but the Romans thought it adequate when they had backed it by block-houses and manned it for defense. When internal troubles weakened the empire, however, Franks and other tribes ran over this great wall and swept on in triumph into Gaul.

Truly Versatile

A NUMBER of amazing products of rubber hydrochloride, in a form called Tensolite, were shown us recently by Henry D. Minich. Rubber hydrochloride has been known for a number of years and was introduced in a stabilized form by the Goodyear Tire and Rubber Company in 1934 under the now well-known name Pliofilm. Mr. Minich began working with this product and developed a machine with which he does things to it. From Pliofilm, treated and turned into Tensolite, is made a dental floss, bristles of many kinds, tape in numerous colors, and, even a fiber as fine as cocoon silk. One of the bristles has an abrasive core, so that when made into brushes it will abrade a surface at the same time that it polishes. Sheets have been made that are, in the commercial grade, .0002 of an inch thick, but experimentally they have been made to a thickness of .00008 of an inch. This last sheet puts the word "gossamer" to shame, for it actually floats in air.

Tensolite laminations in different colors are made into attractive striped tapes. Endless belts may be made from it; or colorful sheets for such things as raincoats, each side of a different color. Air-like filaments have made very satisfactory fishing lines and leaders, badminton and tennis racket strings; yarns and threads and tapes have been woven into cloth, belts, trimmings, and baskets.

All Tensolite products are proof against water, oil, grease, acid, alkali, perspiration, mold, and vermin. They stand all normal temperatures, are non-explosive, and can be printed. They have long shelf life and may be cleaned with soap and water or may be dry cleaned. They must not be ironed, but can be pressed readily with weights. While the original Pliofilm supports slow combustion, Tensolite contracts so rapidly in the presence of flame that it actually runs away from the flame.

TAR

THE average smoker lines his lungs with 8 quarts of tobacco tar in a period of ten years, according to the estimate of Dr. Angel H. Roffo, of Buenos Aires, Argentina.

Sulfamic Acid

RECENT development of a practical process for commercial-scale manufacture of sulfamic acid (HSO_3NH_2) has stimulated a wide interest in this new industrial chemical. According to *Industrial and Engineering Chemistry*, a number of industrial uses based on the unique chemical and physical properties of the

With simple equipment amateurs can make sound-on-disk talkies

acid have already been developed. One such use is based on the rapid reaction of sulfamic acid with nitrites to yield nitrogen and sulfuric acid.

A novel industrial application of this reaction is its use for the necessary removal of excess nitrite following one of the steps in dye and lake color manufacture. Sulfamic acid is two to six times more effective than urea which is commonly used for such purposes. Higher concentrations of nitrite may be employed, and the excess nitrite removal in most cases may be shortened from a period of hours to a period of a few minutes. Cleaner shades of color and greater uniformity are thus made possible.

Fluorine Filters of Bone

IN some sections of the country, mottled teeth have become a serious problem because of the fluorine in drinking water. This cause of unsightly teeth, discovered only a few years ago, has set many research scientists working on ways to eliminate it. Dr. H. V. Smith of the University of Arizona, College of Agriculture, reports some success in this direction.

Dr. Smith has invented a small filter cartridge, adaptable to drinking fountains, and made of bone. Another type is larger and suitable for treating the water supply of schools or homes. An electric alarm is set off when the filter in the latter type has absorbed all the fluorine it can and hence needs replacement.

The bone filter is made by treating animal bone with caustic soda, then washing it with water, and finally neutralizing it with a dilute acid.

Arc-Welded Steel River Tunnel

CHICAGO'S new river tunnel, a double tube of steel, 200 feet long, 40 feet wide, and 23 feet high, which is to carry State Street subway cars under the Chicago River, is the most intricate job in Chicago's new subway system. The giant tube will rest in a trench dredged to a 30-foot depth below the river bottom and will be sealed at both ends, towed 15 miles to its site and sunk by pouring concrete on its top.

Different from ordinary procedure in tunnel work, (which involves boring beneath the river bottom), sinking the section as a unit minimizes the depth of earth covering over it—five feet as against 15 with conventional practice. The shallower depth has the added advantage of providing a slighter grade in and out of the tube than would be the case otherwise.

How Effective Is Aluminum Foil Insulation?

RECENT investigation of heat transfer coefficients has shown that a single sheet of aluminum foil placed midway in a horizontal air space with the heat flowing downward is equivalent to approximately three inches of corkboard in insulating value. With three layers of foil in the same space, the heat transmission is reduced to almost half that obtained with one layer.

The investigation also showed that the eye, while a good judge of reflectivity, cannot evaluate aluminum as an insulator. Surface films formed by exposure to laboratory fumes and dust, salt spray, and by normal use as a house insulator are readily visible to the eye, but decrease the insulating value very little.

Amateur Sound Movies

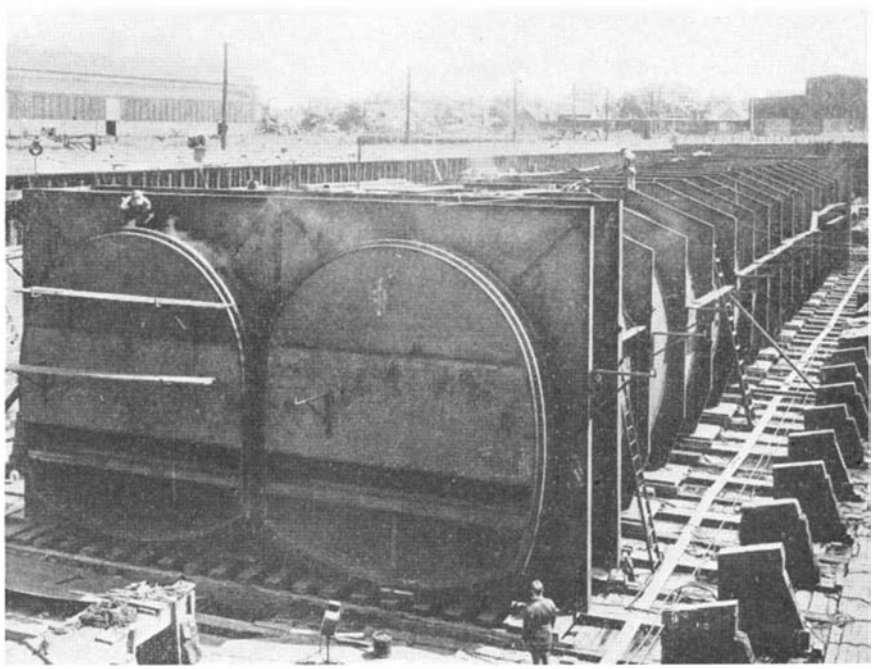
SOUND equipment for amateur movie addicts, available for some years, has made use of the regular film sound track which, of course, necessitates the use of photo-electric cells and auxiliary equipment. Now, for the first time, amateur movies in the 8 and 16mm sizes may be made with dialogue, music, and sound effects—all reproduced as perfectly as sound on film but by the use of a phonograph disk in the Syncrosound System, a product of Presto Recording Corporation.

The entire sound recording and reproducing equipment is contained in a single carrying case that weighs less than 50 pounds. It can readily be carried by one man. The cost of the equipment is about 1/10th as much as the lowest priced sound-on-film equipment. The cost of the sound recordings themselves averages about 20 cents a minute of running time, or one dollar for a five-minute reel. The synchronization is automatic, requiring no supervision or adjustment once the picture is started.

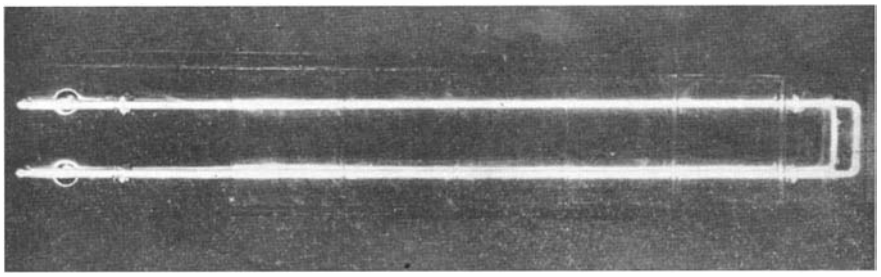
The sound recording and reproducing system can be added to any standard make of silent 8 or 16mm camera and projector. It consists of a portable sound recorder, an electric motor drive for the camera, and a small attachment for the projector. The latter units can be installed for a few dollars and they can be quickly detached if desired to make silent films.

Slow Fuse

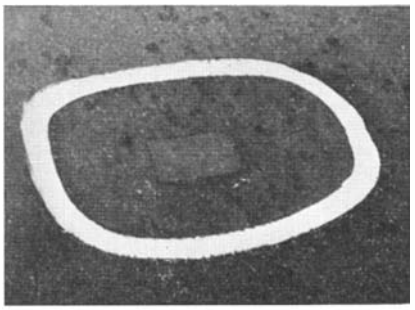
ELECTRIC motors, coils, solenoids, magnets, and relays often have overloads which are not necessarily harmful but which, nevertheless, blow the ordinary type



Welding the double tube of the Chicago River tunnel



Above: One unit of the illuminated traffic marker. *Below:* A plastic test block set in a busy highway



of fuse so that service is interrupted while new fuses are put in place. A new fuse, recently developed by Littelfuse Incorporated, is of unique construction, designed particularly to prevent such interruptions. It has a simple fuse link, a resistor element which provides the heat inertia, or time lag, and a spring.

On severe overloads, the fuse link melts as a convential fuse would do; on prolonged but not severe overloads, the resistor heats up and melts the fusible alloy. The spring serves not only to open the circuit completely after the fusible link has melted, but also takes up the expansion of that link due to repeated heating and cooling.

Should Expectant Mothers Smoke?

SMOKING does not have any good effects on the mother during pregnancy. However, clinical experience would indicate that a moderate use of tobacco is not harmful to the mother or to the baby. When a woman smokes excessively, it is usually suggested that she decrease her smoking during pregnancy and particularly during the nursing period.

Many physicians feel that the nicotine in tobacco may have a deleterious effect on the baby, but there is little scientific evidence to substantiate this view. Nicotine, however, does pass through into the mother's milk, so that excessive smoking may result in toxic amounts of nicotine being absorbed by the child.—*Journal of the American Medical Association.*

Illuminated Traffic Marker Set Into Highway

OF the numerous attempts that have been made to provide safety markers for highways for night driving, one that seems to provide more positive illumination than any other so far devised is that developed by Mr. John H. Greene, President of Illuminated Guide Line, Inc. His invention consists of a neon or other tubular light buried in the roadway under a transparent material. Such lights would be built into roadways at important intersections, turns, or other danger spots, and it is believed that no amount of fog or glare from approaching cars would prevent their being seen by a driver.

When Mr. Greene first conceived this idea he consulted with a number of people regarding a transparent material which would stand traffic wear. Some people told him the scheme was impractical, but he finally found that a transparent plastic would withstand not only the weight but also the surface wearing effect of passing cars and trucks. In accompanying illustrations we show a sample unit of the illuminated guide line and also a picture of a test block of a plastic material made by Monsanto Chemical Company which was set in a busy street of Little Rock, Arkansas, for nine months. At the end of that time, during which an average of 9000 cars per day passed over it, the plastic substance showed no apparent depreciation of the surface and its transparency was as good as when the plastic was new.

Science to the Aid of Beauty

NOT all inventions are made with a definite use in mind. Only too often one may result from a great amount of research and then much more research is necessary to find what it is good for. Polaroid, a material which polarizes light, falls in exactly that class. Originally, it was considered for an important use in the headlights of cars to which it has not as yet been adapted. It had, of course, a definite place from the beginning in scientific work, but practical everyday applications had to be found for it. Work to that end has found for it a place in many industries.

It may, therefore, not be so surprising to learn that this rapidly growing invention has been adapted for the beauty parlor. Because of the ability of this material to dampen light reflections, as we have explained before in these columns, it has been found to be an excellent medium through which to view the skin and see those blemishes which are partly or wholly invisible under ordinary light. Dr. Martin Grabau recently demonstrated in the salon of Helena Rubenstein what is called the "Polaroid Dermascope," which employs this material. With it, it is claimed that an observer can examine layers of skin under the epidermis almost as though the outer skin surface were not there. Then by moving a control lever, he can throw the outer surface into even greater prominence than under ordinary light for the examination of surface blemishes. The assumption is that once the beauty specialist knows of the existence of hitherto unseen blemishes she can adapt her procedure accordingly!

Preserving Paper

A NEW and improved method of protecting documents, developed and patented by Dr. Joseph Broadman, will strengthen paper by means of a protective coating which renders the sheet impermeable to air, moisture, and the like, so that it can be handled and preserved indefinitely. The coating does not increase reading difficulty.

In this process, a page of a newspaper, for example, has affixed to each face a thin sheet of transparent paper, preferably of that type known in the trade as "glassine." These sheets of light-permeable paper are laid on the newspaper with any suitable adhesive, preferably a paste of cold water and wheat flour. They are then allowed to dry at ordinary room temperature. The sheets of transparent paper increase the strength

"Polaroid Dermascope" and, top, skin under ordinary light (left) and polarized light

and tearing resistance of the newspaper, so that it can be handled without crumbling.

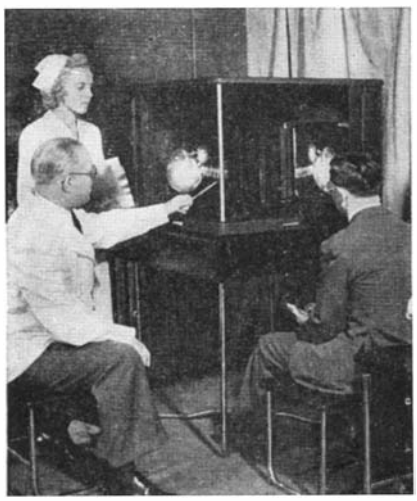
But the transparent paper alone will not protect the page from the effects of air, moisture, and age, so the Broadman Process provides a coating on both faces and the edges of the transparent paper-covered sheet, thus hermetically sealing the printed or written matter against deterioration.

The protective coating is a composition consisting of a mixture of 25 parts of Manila gum or Manila copal and 75 parts of ethyl alcohol. East India or Pontianac gums may be substituted in the same proportion. The coating is applied by means of a rigid pad or spreading tool or perforated roller with a cloth covering, causing the formation of a light-permeable, smooth coating.

It has been estimated that about two or three seconds are required to add the "preserving" coating to a coated double page of standard newspaper size, at a cost of 12 cents per sheet. The entire process, including transparent paper and adhesive material, less than doubles the weight and thickness of the page of newspaper.—*Shirley Frank.*

Group Study of X Rays

THE Westinghouse multi-view stereoscope for the first time permits three-dimensional X-ray pictures to be viewed by groups of two to eight persons at a time. Polarized light also is applied to X-ray work for the first time in X-ray history by the multi-view stereoscope. The old-fashioned stereopticon which used to adorn the parlor in the average American home is really the basis for all present-day stereoscope work in medicine and industry. The creation of a picture effect which shows depth depends upon the presentation of two images, taken from slightly different viewpoints. Each eye must inspect only that image intended for it. This is usually accomplished by means of mirrors or prisms. The polarized stereoscope employs two images or transparencies made in the usual manner. The method of illumination and inspection of the images, however, is new, arising from an interesting property of light.



Multi-view stereoscope, in which X rays appear in three dimensions

Two films are placed in illuminator boxes, set at right angles to each other, and fitted with Polaroid screens. One illuminator has its screen arranged to produce vertical polarization; the other, horizontal polarization. A semi-transparent mirror is set on

a diagonal midway between the illuminator boxes. Each observer looks through a pair of polarizing spectacles. Looking into the semi-transparent mirror, the persons at the left see one image reflected in the mirror, the other transmitted through it. Each eye sees only the image intended for it and each with the same brilliance. The new apparatus permits a group to discuss the same image, at the same time that they are viewing it.

Electroplating Plastics

ELECTRO-DEPOSITION of various types of synthetic resinous materials on metals by a new process was described in a recent issue of *Industrial and Engineering Chemistry*. The process involves the solution of the resin in an organic solvent and the subsequent formation of a suspension in mineral oil.

The work to be plated, which may be copper, tin, or brass, is placed in the suspension and direct current applied. Satisfactory results were obtained, using 300 volts for five minutes. After the plating has been applied, the plastic is cured or not, depending on the type. Tests showed that the deposits are satisfactory from the standpoint of electrical insulation. The process has been used experimentally for coating small trimmer condenser plates.

BUNA

GERMANY is equipped to manufacture about 25,000 tons of artificial rubber yearly, as compared with a peace-time need of 100,000 tons of rubber per year.

Refrigeration Affects Flavor

REFRIGERATION of many fruits and vegetables, as housewives have often complained, destroys the rich, delicate flavor for which those products may be noted. This is particularly true of tropical fruits such as bananas, pineapples, mangoes, and avocados. It is also true to some extent for fruits grown in the temperate zones. Some varieties of pears, if held too long at 32 degrees, lose their ability to ripen and "go dead."

To prevent loss of flavor and texture, tropical fruits and pears should not be chilled until immediately before serving.

Circular Seam Welding

AN engineering advance has recently been made by the Chicago Metal Hose Corporation in the attachment of metal end-fittings and end-seals to metallic tubing by means of electric resistance welding. This development, designed principally for use with stainless steel tubing and stainless steel bellows, permits the fabrication of completely sealed vacuum-tight units free from soldered, brazed, or torch welded joints of any kind.

End fittings made from stainless steel have been customarily silver soldered to stainless bellows and tubing where corrosive media or high temperature were to be encountered. However, to meet conditions

where exceptionally high temperatures and actively corrosive elements preclude even the use of silver solder, electric resistance welding has unique application.

Circumference seam welding, made possible through the development of specialized equipment, operates automatically and eliminates entirely the human element present in other welding or soldering procedures.

Extremely thin gages of metal can be handled with ease, and metals of unlike thicknesses or unlike analyses can readily be joined.

Transparent Plastic Heel

A NEW plastic heel is now available in several colors for women's shoes. Besides its transparency, it has the novel feature of a removable lift. As the lift wears down, it may be taken off and a new one snapped into place. The heel is a product of the General Electric Company's plastics division.

The accompanying picture is of a transparent model showing the construction. A

plastic of the polyvinyl methacrylate type is used for the heels. They are waterproof, noninflammable, and give a touch of sparkle to almost any costume.

Some of the heels were "neonized" recently for stage use by the St. Louis Municipal Opera. They produced a striking effect on a darkened stage.

Acid Heals Plant Wounds

WOUNDS in plants are caused to heal by an acid which has been isolated in crystalline form by research workers of the California Institute of Technology. The name "traumatic acid" was proposed for the substance which is identical with the organic acid 1-decene-1,10-dicarboxylic acid. The experimenters, who reported their discovery in *Science* with a promise of a more detailed statement to be published later, induced rapid formation of healing tissue on the cut surfaces of potato tubers by using a solution of the synthetically prepared acid.

Frozen Serum

LIQUID biologicals, those therapeutic agents derived from living sources, have always had a time limit on their original value. This is the reason for the expiration date placed on each market package. A recently announced process, however, en-

ables biologicals to retain their potency long after the time which, until now, had been thought to be their expiration date.

The Lyophile process, as it is called, was developed at Mulford Biological Laboratories and is essentially one of rapid freezing at a temperature far below the freezing point, together with rapid dehydration under high vacuum without melting or fusing the original frozen substance.

The containers are specially designed to maintain the desired vacuum and are so constructed that into the neck of each there may be inserted a tightly fitting rubber stopper. This is done after dehydration is completed and without breaking the vacuum. When the stoppers are in place, the containers are flame sealed, labelled, and are ready for shipment.

The physician who uses the serum finds it a simple matter to restore it to liquid form. After filing and breaking off the neck of the container, a sterile syringe filled with distilled water is inserted through the rubber stopper. The vacuum draws in the water and the material readily dissolves, taking on the original properties which it possessed as a freshly made serum in the liquid state.

The new process brings to the physician, and ultimately to the patient, the original curative value possessed by a freshly prepared substance at the time of its highest potency.

AIR CONDITIONING

IN 1933, there were only about 40 air-conditioned passenger cars on the American railroads, and most of them were diners. Today, the railroads and the Pullman Company operate 11,351 air-conditioned passenger cars.

Big Oil Molecules from Small

SQUADRONS of German fighting and bombing planes now flying in Europe's skies are being lubricated by oils made by treating mineral, vegetable, and animal oils with an electrical discharge process which increases their viscosity. The "voltolized" oils, as they are known, are then blended with ordinary mineral oils to produce what is said to be a superior airplane lubricant which has many of the valuable properties of castor oil.

The action of the electrical discharge appears to produce polymerization of the molecules of the oil (make large molecules out of small ones) and does it without changing the essential properties which make for good lubrication.—*Science Service.*

New Type Big Tree Mover

BIG tree moving is now an established practice in landscaping properties and it is only natural that labor-saving equipment has been devised to keep costs lowered and generally to increase the speed and efficiency with which large specimen trees may be moved and transplanted.

Over a period of the last 10 years, an

efficient type of tree-moving equipment known as the Butts Tree Mover has been developed under extensive field tests. It is compact, requires less hand labor, is readily mobile, and handles trees with speed and safety. Constructed of electrically welded steel and with all fast-moving parts equipped with ball or roller bearings, it should give years of dependable, trouble-free service.

The equipment consists of a complete unit which can be installed on any truck having a minimum of nine inches from rear spring shackles to back of cab. It is so designed that the cradle, in which rests the trunk of the tree to be moved, pivots in two directions; this factor, together with

Cradle end of the unit employed for transporting large live trees

chain suspension, insures proper support for any size or shape of tree. A second cradle, adjustable both in size and in its relation to the trunk cradle, is attached to the rear of the boom, supporting and protecting the ball of earth which may be up to 10 feet in diameter. The boom rolls on its hinges and is lowered to ground for loading. When transporting the tree, the boom is carried up and forward by a power winch driven by a 15,000-pound worm drive. An eyebolt, attached through an adjusting winch to top of boom by cables which pass on each side of the tree, is placed through the ball of earth and affixed to a horizontal plank underneath. The cables in turn are connected to a heavy-duty canvas belt behind the tree trunk to simplify tipping and guiding of the tree.

Carried in a horizontal position with the top forward, the tree rests on saddles at each end of the boom. This latter is operated by roller chain and worm driven sprockets, which control tipping of the boom downward and a leverage, powered by the same roller chains, controls upward tipping of the boom.

The Butts Tree Mover is also used in pulling and loading stumps and is well adapted for use on many kinds of construction jobs.—*C. F. Greeves-Carpenter.*

New Synthetic Solid Produces Unusual Tracing Paper

AN entirely new type of tracing paper combining the transparency of oil treated sheets with the permanence of natural 100-percent rag papers is a recent development of the Keuffel & Esser Company. The new paper is named Albanene. It is made of long-fiber, clean, white rags, and is treated with a new crystal-clear synthetic solid called Albanite, developed in the company's laboratories. Because this new transparentizing agent is free from oil

and wax and is chemically and physically inert, it is claimed that Albanene will not oxidize, turn yellow, become brittle, or lose transparency with age.

It is claimed that the use of this new type transparentizing agent permits a fine toothed, smooth drawing surface that takes strong pencil lines with a minimum wear on the point.

RAILS

BY using a welding process for building up the worn ends of steel rails, the life of these rails is prolonged fully one third.

Protecting Copper Surfaces

THE New York World's Fair, besides being an extraordinary spectacle, proved to be a testing ground to show the lasting qualities of paints, colors, and protecting coatings. Of particular interest is the use of Glyptal, an alkyd resin, which has proved its ability to maintain the luster and characteristic color of copper sheets which it protects. On the exterior of the General Electric Building are thousands of square feet of thin copper sheets, protected with a coating of this material, which have retained their pristine appearance during many months of exposure. This first actual long-term test of Glyptal under such conditions indicates many other possibilities for its use in many industries.

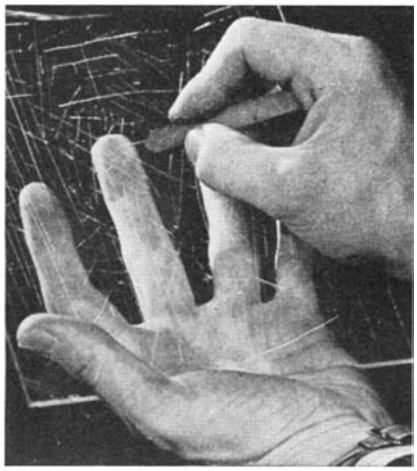
Electric Furnace Uses Blanket of Gas

RESEARCH metallurgists have introduced a new steel-hardening furnace that uses a "blanket" of gas to prevent "singeing" the metal while it is toughened at temperatures as high as 2000 degrees, Fahrenheit.

By means of a delicately balanced atmosphere of pure hydrogen and nitrogen, this automatic electric furnace is able to harden many steels gently without quenching them in oil or water, thus eliminating distortion and formation of scale.

The furnace is approximately seven feet

Removing a block of air-hardened steel from heat-treating furnace



Air-hardened steel scratches glass, approaches the hardness of diamond

long and so designed that a piece of steel passes through it at varying stages of heat, ranging from approximately 1300 degrees to 1750 degrees, Fahrenheit, before it cools in an air-cooled tunnel. Maintenance of an atmosphere of oxygen-free gases inside the furnace prevents any reaction in the steel which would distort or mar the metal. The steel shows no outward evidence of having passed through the fiery ordeal.

Pieces of ordinary steel, polished to a mirror finish, retain their finish after a four-hour hardening treatment in the new apparatus, report Westinghouse engineers. The same steel would burn up if it were subjected to such high temperatures in an ordinary furnace, because of the oxygen in the atmosphere.

The combination of controlled atmosphere and temperature now enables the metallurgist to harden steel pieces in their finished form with a resultant bright finish and without the expense and delay of additional machining.

Increasing the Bearing Capacity of Piles

RECENT investigations for the purpose of economizing pile foundations have developed an interesting method for increasing the bearing capacity of piles by covering them with a thin sheet of aluminum metal and sending an electric current through the soil. Preliminary small-scale tests performed revealed the formation of an entirely new and hardened soil structure in the vicinity of the electrodes. Tests also revealed that the hardening is not simply a drying of soil, but is irreversible since aluminum compounds are precipitated in the soil by the electrical process, cementing the mineral particles of the soil.

With small-scale tests, the bearing capacity after treatment increased up to between 10 and 30 times the original. By pulling the piles, the hardened section around the electrodes can easily be seen. Large-scale tests encouraged a practical application at a bridge foundation. A few timber piles about 60 feet long were covered up to about 25 feet with thin aluminum and driven under similar conditions in the near vicinity of common piles without aluminum. The distance apart of the aluminum piles was between six and seven feet, and electric current was sent through at between 90 and 220 volts. Though the subsoil conditions

were not very favorable for application of this method, the bearing capacity rose from an average of 70 tons to an average of 200 tons after treatment.—*Dr. Leo Casagrande,* in Bulletin No. 11, The Institution of Highway Engineers (England).

AIR

IF air were sold for twelve cents a quart, it would cost each of us over $2000 a day to breathe, and the farmer would have to pay over $13,000,000 a day for the air to raise an acre of wheat.

Aerial Mapping for Highways

THE fastest and cheapest way to secure an inventory of any area is to have it photographed from the air. With highway planning now covering whole states and requiring more and more inventory data, modern methods of mapping based on aerial photography have recently been developed to permit economic methods through the use of simple instruments and devices.

In making topographic maps by stereoscopic methods, the camera used for aerial photographs is of the precision type. Flying is done systematically so that the required overlays, both in the direction of flight and sideways, will be consistent. An aerial photograph does not show any depth, but with two photos partly overlapping and taken from different positions, it is possible to adjust them on the table at a certain distance from the eyes so that there are two images which merge into one having depth in addition to previous characteristics. To aid in viewing, a stereoscope is used.

Where the nature of a contemplated project involves the purchase of land, it is safe to say that the mapping of property by this method on a scale of 1:12,000 is just as accurate as if the surveys were made by transit and tape plotted to this scale.—*Eric Haquinius,* in the *Texas Engineer.*

Trichinae in American Swine

TRICHINAE, the muscle-boring parasites that cause painful and occasionally fatal illness in eaters of inadequately cooked pork, are widely distributed in the United States, reports Dr. Benjamin Schwartz of the U. S. Department of Agriculture. In grain-fed swine, however, they are not nearly as abundant as in those fed on garbage. On the basis of thousands of examinations of slaughtered animals, Dr. Schwartz gave the percentage of trichinae-containing carcasses as less than 1 for grain-fed hogs, whereas it was 5.7 percent in garbage-fed hogs. The greatest bulk of hogs slaughtered in the United States, Dr. Schwartz added, are grain-fed.—*Science Service.*

When Rubber Outlasts Steel

A RUBBER spring can now be made to outlast even a steel spring, it was declared by Dr. S. M. Cadwell, in a paper

Solution to the Problem of the Weights

LAST month the problem offered was one concerning a set of eight weights for use with a beam balance. The weights were to be capable of weighing to the nearest ounce any object up to, and including, 205 pounds. Each could be used on the left scale pan, on the right, or not at all. It was required to find the magnitude of each weight, prove that eight is the least number, and that the eight weights have the least total weight of any set which will fulfill the conditions of the problem.

Solving for the first part we reason that, to weigh one ounce, it is necessary to have a 1 oz. weight. In order to weigh two ounces we may select an additional 1 oz. weight, a 2 oz. weight, or a 3 oz. weight. We choose the 3 oz., because together with the 1 oz. weight it will enable us to weigh not only 2 oz., but 3 oz. and 4 oz. as well. Similarly, in order to weigh 5 ounces, we select a weight equal to two times the sum of the weights already chosen, plus one. For example, (2) (4) + 1 = 9 oz. Reasoning thus, it follows that the eight weights are 1, 3, 9, 27, 81, 243, 729, and 2187 ounces; a total of 3280 ounces, or 205 pounds.

Solving for the second part, we see that since there are three places where the weights may be placed, there will be 3^8 different distributions of them. From this number we subtract one to account for the case where all weights are on the shelf. The remainder is divided by two because for each "out of balance" on the left side there is one on the right. This evaluates to

$$\frac{3^8-1}{2}=\frac{6561-1}{2}=3280$$

It is apparent from the nature of the formula that a number smaller than eight for the exponent of three will give fewer than 3280 weighing combinations, which was a condition of the problem. Eight is therefore the least number of weights.

For the third part of the problem, obviously it requires a minimum of 205 pounds to weigh that much on a beam balance. Since the eight weights add up to only that amount, it follows that they have the least total weight of any set which will meet the conditions of the problem.

presented before a meeting of the American Chemical Society. Dr. Cadwell is director of tire development at the Detroit plant of United States Rubber Company.

This somewhat astonishing conclusion is the result of a series of scientific tests and a research over the past three years in the company's laboratories, Dr. Cadwell reported. The scientist was reserved in his report and comment, but other researchers pointed out that the discovery had possibilities of great importance to industry and transportation.

Dr. Cadwell told the Society his conclusion rested on the remarkable fact that rubber differs from most, if not all, other natural materials in that the "harder rubber is worked the greater its mechanical fatigue life."

"Indeed," he reported, "if rubber is used properly as a spring it can be made even to outlast a steel spring. If metals are to be worked in vibration, all engineers know that the longest life can be expected for a unit in which the metal is under minimum stress or load. For rubber, the opposite is true; the shortest life occurs when the rubber is worked under low loading or low stress conditions."

Low-Temperature Firing For New Ceramic Material

THE high cost and hazard of kiln firing, which often discourage ceramic and pottery work as a hobby, school craft, or small commercial venture, have been banished by the development of a new clay by Ettl Studios, Inc. Ceramite, as this clay is called, requires no treatment other than baking in a kitchen oven for 20 minutes at 250 degrees, Fahrenheit, to produce a product having greater durability than ordinary clay fired at 1800 degrees.

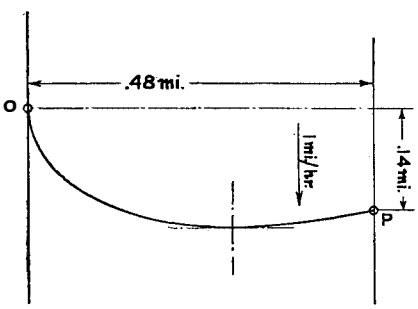
Also available is a full line of color glazes which can be applied with a brush or spray, blended or applied over each other, and rendered permanent by oven baking for 45 minutes at 250 degrees, Fahrenheit.

Problem: The Swimming Dog

FOR the past few months we have been offering our readers a variety of mathematical problems. Judging from the letters received, many people have really enjoyed wrestling with them. There seems to be a sort of esoteric satisfaction in arriving at a solution after an hour or so of brain work.

Can you solve this one?

A man is standing on a river bank; on the opposite bank is his dog. The man whistles and the dog, being well trained and very obedient, jumps into the river and starts swimming, always headed towards his master. The man is represented by "O" in our diagram, and the dog's starting point by



"P." The river is 0.48 miles wide and the dog started from a place 0.14 miles below a point directly opposite the man. (In other words, the man and his dog were a half mile apart.) Now, if the river flows at a rate of one mile per hour and the dog swims at the rate of two miles per hour, how long will it take him to swim the river? Remember that at all times he is swimming towards point "O". The answer is 22.8 minutes and we will publish our solution next month.

As usual, any correspondence relative to this or any of our previous problems should be addressed to Lieutenant-Commander Leonard Kaplan, in care of Scientific American, 24 West 40 St., New York, N. Y., and it will be forwarded unopened.

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; science has so developed them that millions yearly find sport and recreation in their use. Hence this monthly department presenting a wide variety of discussion regarding firearms, their handling, and their accessories. Suggestions from readers will be heartily welcomed.*—The Editor.

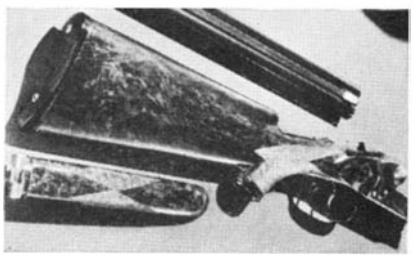
Tenite Stocks

WHETHER or not we've all been aware of it, this stuff called Tenite has been with us in many ways for some time. Both hands have clasped it as we've gripped the steering wheel of the car; we've pounded it in typewriter keys; admired it in radio grille-work and twirled in Europe with Tenite dial knobs. We have yanked it in handle form when we robbed the refrigerator, stirred cocktails with it and even mixed ingredients of said cocktails with a Tenite jigger. But it remained for J. Stevens Arms Company, Division of Savage Arms Corporation, to go almost lock, stock, and barrel in the use of Tenite. Equipped with fore-end, stock, and sight-piece of this plastic, the new Stevens No. 530 M double-barrel shotgun in 12, 16 and 20 gage has caused something of a stir in firearms circles.

Product of Tennessee Eastman Corporation, Tenite is made from Eastman cellulose acetate, is thermoplastic and adaptable to both compression and injection molding. Its attributes for gun stocks are low thermal conductivity, low water absorption, compressive strength of about 10,000 and tensile strength of about 4000 pounds per square inch. In conducting firing tests, a Tenite stocked shotgun was clamped in a shooting jack, shoulder piece resting against a solid block so that the stock received the full gun recoil. After repeated firing, the hard rubber butt-plate crumbled from constant hammering, while the plastic stock showed no fracture or distortion.

Shortly after the Stevens announcement, criticism was leveled at the alleged shrinking tendency of Tenite when exposed to a maintained temperature of 140 degrees, Fahrenheit. It was likewise charged that Tenite would soften and possibly warp in a continuous heat of 160 degrees, Fahrenheit, that acid or alcohol might blemish or soften the smooth, walnut burl-like finish. Although disapprobation was also expressed concerning stock measurements, we're momentarily more interested in the ability of Tenite to "take it" than in gun specifications. However, here's how Stevens lists them: gun is available in 12, 16 and 20 gage with blue forged steel barrels, matted rib, fitted with two white bead Colasta sights, in 28 and 30 inches for 12 gage, 28 inches in 16 and 20 gage. Right barrel is modified and left is full choke, chambered for 2¾-inch shells. It is hammerless; has checkered, full-pistol grip, capped; fluted comb; paneled sides; 14 inch stock; drop at heel of 2¾, at comb 1⅝ inches; positive extraction; and weighs from 6½ pounds in 20 gage to 7½ pounds in 12 gage.

To determine effects of chemicals and reagents on Tenite, Tennessee Eastman Corporation conducted a series of tests in which dried, weighed, and measured samples of the plastic were immersed for 48 hours in 95 different acids, alkalies, salts, alcohols, organic esters, solvents, essential oils, and miscellaneous chemicals of varying solution strengths. From this list we endeavored to select those reagents to which a gun stock might normally be expected to be exposed in the gamut of careless human actions, eliminating such unlikely hazards as hydrochloric acid, sodium hydroxide, and other chemicals not customarily found on the sportsman's person or in his kit. This left us with alcohol (ethanol), gasoline, benzene, turpentine, iodine, mercurochrome, citric acid, and oils of citronella, eucalyptus,



Stock, fore-end, and sight piece of a new shotgun are of Tenite

lemon, pennyroyal, and wintergreen, concerning which Eastman tests showed that benzene produces a "slight blistering," oil of wintergreen a "slightly rough surface," iodine a "brown tint," mercurochrome a "pink tint." Otherwise, "no change" was reported in the surface of Tenite after exposure to these reagents which we selected from the entire 95.

Not doubting the Eastman laboratories, but solely in an effort to test Tenite with both reagents and vicissitudes to which an extremely careless gunner might unintentionally expose his gunstock, we conducted a few "home-made" experiments. We procured samples of the plastic and smacked one piece with a hammer to simulate a hard fall or a blow of the stock against trees and rocks. The result was a much smaller dent than the same force would have made in a piece of walnut. We sacrificed a bit of 90-proof whisky in a 24-hour immersion test without effecting the slightest blemish. Lemon juice, gasoline, iodine, mercurochrome were all negative, save for the expected stains from the latter two reagents. We laid a lighted cigarette on a slab of Tenite and allowed it to burn to the end. The result was exactly what we've been chastised for in the instances of the piano and the drop-leaf table.

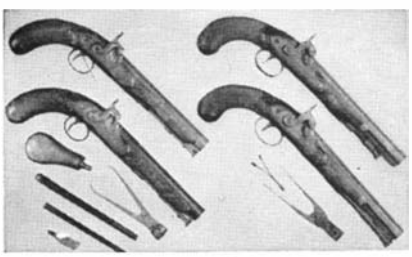
As to the danger of a maintained temperature of 160 degrees, Fahrenheit, Frank T. Green, Assistant Superintendent of the Stevens Company says, " . . . among our laboratory tests, we subjected a stock

molded from this material (Tenite), to a test in a closed electrical oven where temperatures could be maintained constant for a long period of time, and we were able to subject these stocks to a temperature of from 190 to 200 degrees, Fahrenheit, without any apparent distortion." We shudder to think that any person could conceivably do to his gunstock all that was done to Tenite and we rather think that, insofar as its durable qualities are concerned, the results speak for themselves.

For Gun Collectors

IT'S a far cry, indeed, from a Tenite-stocked shotgun of the 20th Century to the Austrian made specimen of wheel-lock "sporting rifle" of 1665 which we recently inspected at the exhibit of the International Studio Art Corporation, formerly a part of the William Randolph Hearst collection, and now being disposed of. Specifications of this rifle, expressed in the modern manner, are: blued, octagonal barrel; fixed leaf rear sight for point blank shooting with adjustable folding leaf for elevation (fancy that—"elevation" in 1665!); rifled with eight, deep, narrow grooves; length, 44 inches; weight, 8 pounds, 5.44 ounces; caliber, .63.

Not to know where or when one may stumble across a really fine specimen of the early gunsmith's art, but to be able to evaluate such a find, and to couple with it all an active imagination, probably constitute the primary component parts of the fascinating hobby of amateur antique gun collecting. Our own imagination certainly needed no urging when, in rummaging through the International Studio's exhibit, we found the pair of dueling pistols which spat lead at each other on Saturday morning, April 28, 1826. For on that date, with those arms, at a secluded spot above Little



Dueling pistols that were used on the field of honor 113 years ago

Falls Bridge, Virginia, John Randolph and Henry Clay respectively sought and defended honor. No one was hurt, honor was vindicated, dueling went the way of the muzzle loader, and now, 113 years later, this fine pair of pistols is looking for a new owner. Meanwhile, our imagination rambles on in the realm of ancient firearms and those who used them.

We've considerable interesting information on tap concerning the inauguration of amateur collections of old firearms and if you're interested in learning how to begin, where and what to look for, we'll be only too glad to pass it on.

European Guns Available

NO one can prophesy what new twists the European war will have taken by the time this appears in print, but we have recently been informed by Abercrombie & Fitch, Francis Bannerman & Sons, and Stoeger Arms Corporation, three of our largest importers of foreign made sportsmen's arms, that the importation of those very excellent Belgian and English shotguns and rifles has not thus far been seriously affected. Save for the German makes, where the situation is, rather naturally, somewhat different, imports are expected to continue in sufficient quantity to maintain the already large stocks of these firearms on hand.

Although all British gun manufacturers are reported to be busily engaged in wartime operations, and although their personnel has been affected by calls to the colors, Messrs. James Purdy & Sons, Boss & Company, E. J. Churchill, Ltd., W. W. Greener, James Woodward & Sons, and others are continuing to make the fine quality guns for which they have so long been famous. There has been no perceptible break in the import of Belgian firearms and save for a momentary lull at the outbreak of the war, British imports have to date proceeded normally. Despite the disruption of German shipping, Abercrombie & Fitch have just reported the receipt of a shipment, via Norway, of Greifelt triple barrel shotguns.

Pot-Shots

AT THINGS NEW

RUST INHIBITING PRODUCTS suggest use of RIG for rifles, pistols, and shotguns to prevent erosion, corrosion, wear from brushes, patches, and abrasives and for protection of the delicate surface of the bore. RIG's use is not limited to guns; it is highly recommended for skates, fishing tackle, and tools, and it goes hand-in-hand with RIO, a rust inhibiting oil.

BOOKS OF THE MOMENT include Ledyard Sands' "The Bird, the Gun, and the Dog" and Bob Nichols' "Skeet And How To Shoot It," reviewed on other pages of this issue.

PRES-TO OILER, product of the Dill Manufacturing Co., looks like a fountain pen, clips into the pocket like one, has a transparent oil reservoir, and applies exactly the right amount of oil in just the spot where you want it. Each press on the steel point releases 1/10 of a drop of oil with no dripping or smearing.

REMINGTON ARMS CO., in attractive three-color trap and skeet catalog, presents complete line of traps, timers, new crimp shells, guns, targets and full dimensional and working plans for skeet field lay-out and traphouses.

IVER JOHNSON'S latest addition to .22 target revolver field is Model 822. Specifications, including proof-testing and sighting, are: single action; adjustable finger rest; blued finish; 8 shots; counter-bored chambers and extractor; six-inch barrel with non-glare rib; Patridge type sights; one-piece walnut checkered grip; highly polished steel hammer and trigger; weight, 28 ounces; over-all length, 10¾ inches. Model 822 shoots .22 caliber long-rifle, long, and short rim fire, is not equipped with "Hammer the Hammer" device.

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

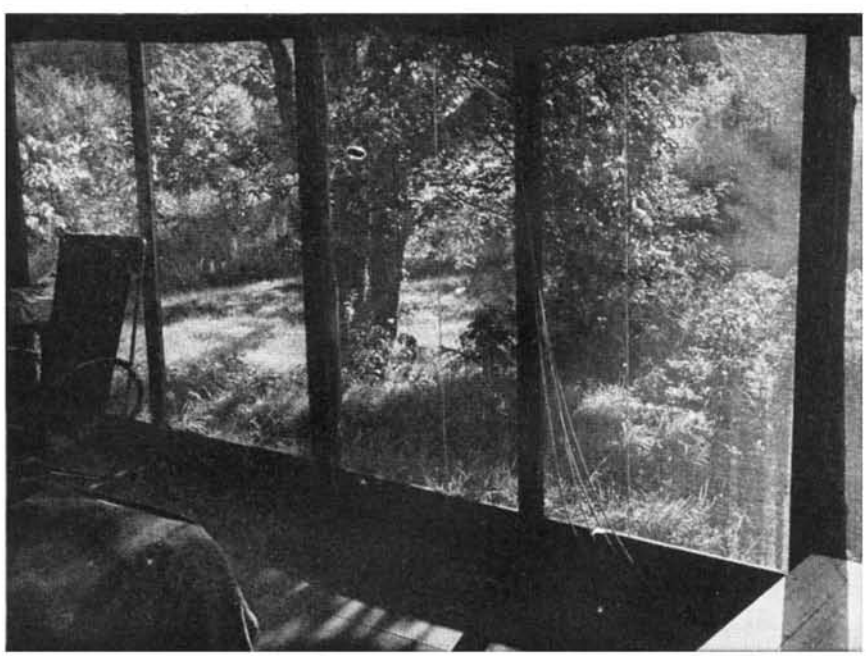
Those Vacation Pictures

THE vacation months are gone but the negatives remain, and with them your responsibility for carefully evaluating the merits of each and discarding those which, from every viewpoint, are of no worth. Among the discards will undoubtedly be sunrises and sunsets, mountain scenes with bald skies, certain landscapes, and so on. Even the best of us, carried away by a peculiar lighting or misled by a touch of color which might have been effective in color but not in black and white, take a number of shots during our vacations and at other times which bring disappointing results when fished out of the developer tank. Such incidents are nuggets of experience which are to be valued rather than deplored. The next time you will be more careful and hold your fire, or try some other angle.

Among your most interesting negatives will be those of people, particularly children. Some of them, because you may possibly have had to work fast and get your subject on the fly or were handicapped in some other way, may not be everything that might be desired as to composition. However, do not give up on this account; there is always the opportunity of taking a piece out of the negative and projecting it at a suitable angle. The "Rural Portrait" illustration did not present any great difficulty with this group of eight children of various ages. The stoop was conveniently handy; the lighting would have been better if the faces were more in the shade, but the squints here and there lend an atmosphere of humor to the picture.

Valued above others will probably be those pictures which illustrate your vacation experiences. An entire series or group of prints may be assembled to illustrate the experiences of living at a farmhouse in the country. One such picture is that of "Sunrise" taken at 6:30 o'clock on a September morning. In composing this picture in the camera, it was thought best to concentrate on the outdoor scene and include only sug-

"Rural Portrait"

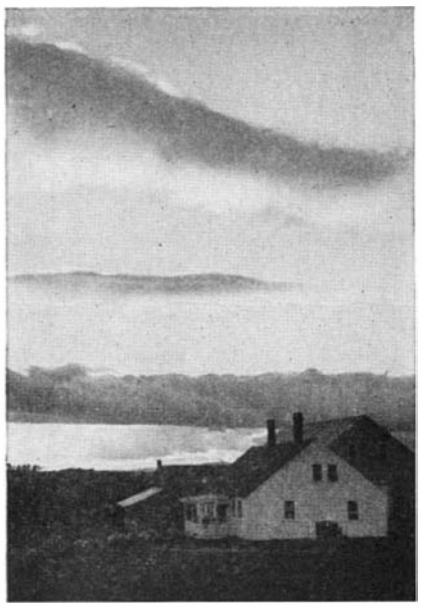


"Sunrise"

gestions of the cot on the left and the wooden bench on the right.

Inevitably, there will be sunset pictures. Two examples that appear to have "come out" with fair success are "Sunset" and "Place's Pond." The former was shot on the way home from a short excursion. It seemed to deserve photographic attention because of the arrangement and shapes of the clouds and the interesting foreground which, of course, had to be shaded somewhat in printing to allow the greater printing exposure required for the clouds. "Place's Pond" was one of a series of shots during a sunset. The quality of the water and the delicacy of the sky made a shot imperative.

"Barn Texture" is an example of the type

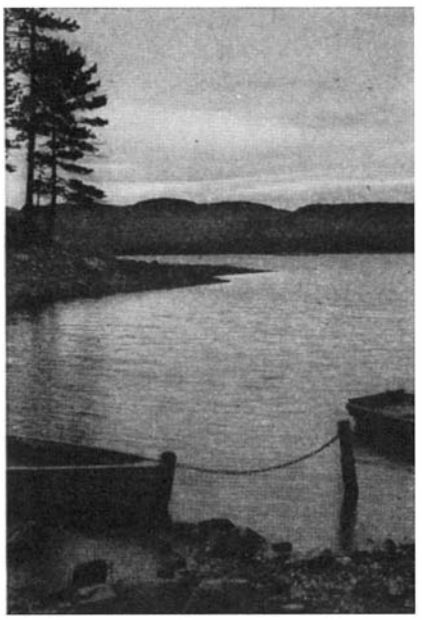


"Sunset"

of shot that may interest both the pictorialist and the antiquarian. This also might be part of a series showing different parts of the barn, exterior as well, possibly, as the interior. The lighting has to be watched carefully, of course, in order that texture may be revealed in the most eloquent way.

In printing your vacation pictures, make a special effort to concentrate on a few negatives each session rather than attempt to work through the night and try, willy-nilly, to finish up the whole batch all at

"Barn Texture"



"Place's Pond"

once. If you print only a few, you will know that your best work went into them because you will not be tired; if you print many, those towards the end of a weary evening are bound to suffer in quality.

When you are through with the negatives, return them immediately to their enclosures which should, of course, be provided when the negative strips are removed from the drying clips and cut up for filing. It is so easy, when many negatives are being printed, to let them lie around after an evening's work, to gather dust and possibly suffer accidental nicks and scratches.

Study your vacation negatives and see where this or that one may have been improved or why this one failed and that one is absolutely hopeless. You will learn much from such careful study that will help you not only during vacation next time but all through the other seasons of the year.

Cleaning Lenses

A PERIODIC cleaning of the camera lens should be one of your regular hobby duties. Carefully remove the lens from the camera and brush all surfaces with a camel's hair brush to remove grit and dirt. Wipe the glass with a sponge moistened in spirit. Make sure the sponge is absolutely clean and free of dirt. Finally, polish the surfaces with chamois. Or breathe on the surface of the glass and polish gently with an old, soft, and well-washed cambric or linen handkerchief.

Lightning Specialist

A FOUR-FOOT lighting rod erected on the tower of New York's Empire State Building provides Bill Eason, General Electric engineer, with unusual picture material of scientific value, according to a story in *The New Yorker*. Mr. Eason's exclusive job during the thunder-shower season, May 15 to October 1, is to come down to New York, watch for lightning and take pictures of the bolts as they strike the Empire State. The pictures plus the data are relayed to the home office.

The equipment includes three high-speed cameras in a room on the 39th floor of the building at 500 Fifth Avenue, at Forty-

second Street; two oscillographs for recording the duration and intensity of lightning strokes, in the Empire State tower; and a fourth camera on the roof of a building at Eighth Avenue and Thirty-fourth Street, which gets the lightning "in profile." The latter camera is operated by remote control from the Fifth Avenue office.

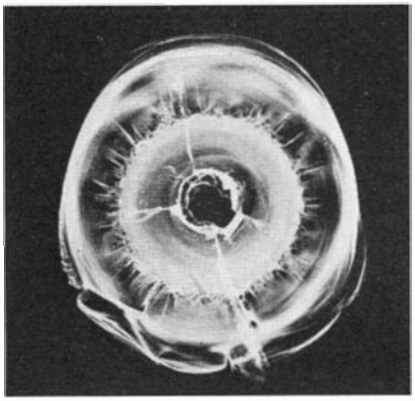
When one of his storm tipsters rings Mr. Eason on the phone, the routine is for Mrs. Eason to taxi from their apartment at 10 Park Avenue to get the cameras ready at 500 Fifth Avenue, while Mr. Eason hurries to the Empire Tower to start the oscillographs, after which he taxis to the Fifth Avenue office ready for action. Work is in total darkness and a time clock is punched to record the instant a picture is taken.

As he works, Mr. Eason talks into a microphone attached to his lapel, a record of his comments being engraved in wax, which Mrs. Eason transcribes the next day for the home office.

The Empire State has been struck by lightning 92 times in the last four years, but no one is ever hurt. Some of the strokes have exceeded 22,000 amperes and have lasted more than a second. It takes about six-tenths of an ampere to light an ordinary 60-watt electric-light bulb.

Glass Pictures Without Negatives

IN a recent letter, E. L. Hettinger, of Reading, Pennsylvania, writes us about his experiences in the making of prints by enlargement in his special field of technical glass studies, and sends us a beautiful example of one of the prints he has made.



Without a negative

"The matter of making enlargements without negatives," Mr. Hettinger writes, "has been an old stunt employed many times in my forty-five years' of experience. There were times when we would take a piece of lace, or a piece of geometric chipped glass, and place it in the enlarger so as to make a border for some of our negatives. Naturally, this all occurred in the old days when things had to be fancy so as to be attractive. Later on, this experience helped me in my work on heat-treated glass. The main problem was to try to get some idea about the harmonic vibration point of glass.

"To break thousands of pieces of glass and make negatives, and then enlarge them was far from satisfactory. Under these circumstances, I tried the old stunt of using the glass in the enlarger without making a negative. I found that little if anything was lost in the print. In the illustration (reproduced here), a steel pellet hit the center of a piece of glass as shown by the inner circle. There was a vibratory motion, and then the energy dissipated from these concentric rings, and showed a fracture which again reverted back to the ring vibrations.

"Without trying this experiment, you would hardly know how much was lost in making a negative and then enlarging it. For this reason, I have adopted this method of making enlargements without making negatives, because it saves a lot of time, and one does not lose any of the minute details that are required for studying the subject."

Just a Detail

THERE is a story going the rounds concerning the folly of being didactic among one's peers. It seems that a member of a camera club requested a fellow member to develop a dozen negatives for him. Presumably wishing to make sure that no mistake would be made in the processing, he gave complete instructions including the wholly unnecessary one of closing the darkroom door before beginning operations. All these instructions, to the very letter, were set down in writing, and were followed without change. However, one very important step was omitted: there was nothing to the effect that the white darkroom light should be turned off before operations were begun. The darkroom worker mischievously went right ahead with all the other instructions, including the removal of the film from its covering in the ruinous light. Of course, the films were hopeless from the start, but he

developed, fixed and dried them, carefully wrapped them up with interleaving between the negatives and handed the finished work, very solemnly and innocently, to the owner. The latter stood aghast at the 12 black negatives but took the incident in good grace when his written instructions, with the fatal omission, was shown to him. Luckily, the pictures could be taken over again without trouble, and were. The next day the didactic member again asked the same favor, but this time he simply said: "Will you please develop these for me?"

Up-Lighting

A SPECIAL effect, full of warmth and glow, is obtained in portrait lighting by having the subject partly illuminated from below, as in the illustration, "Mary Ellen." This type of lighting is usually called "dramatic" but when so employed it

"Mary Ellen"

ordinarily constitutes the main and only light used. However, a softer effect is obtained by having the light come from above, back of the subject and reflected from below by a reflecting screen so placed as to give the effect sought. This was the procedure in the present instance.

Award for Camera Headliner

FOR the best foreign newsreel of the year, A. T. Hull, Jr., of Pathe, says an announcement from the makers of the Leica, was awarded the plaque of the National Headliners Club at a dinner held recently in Atlantic City. The film for which he was given the award showed the terrible holocaust of the bombing of Canton. Like many of the cameramen covering the hostilities in China, Hull was never without his Leica, and he continually used it for making stills, many of which have appeared in *Life* and other national publications.

Spotting Kinks

BLACK lines and black spots on prints, caused by transparent lines and holes in the negative, are usually more difficult to remove than spotting out light defects. One effective way to remove both lines and spots

You Can Win one of 27 PRIZES

Over $1300 in AWARDS

Fourth Annual SCIENTIFIC AMERICAN AMATEUR PHOTOGRAPHY CONTEST —

EVERYONE who owns a camera has a chance of winning a valuable prize. Plan now to enter your prints in this contest. You may enter any or all of the three divisions, but not more than two prints may be entered by one contestant in any one of the divisions.

Specific rules for this contest are published below. Be sure to read them before you submit prints.

RULES of the Contest

- **1.** The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.
- **2.** Prints must not be smaller than 5 by 7 or larger than 11 by 14. Prints need not be mounted, but may be at the contestant's option.
- **3.** Photographs must be packed properly to protect them during transportation.
- **4.** Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.
- **5.** Each entry must have the following data written on the back of the print or mount: Name and address of contestant, type of camera, and film, enlarger and paper used.
- **6.** Contestants may submit no more than two prints in each group, but may enter any or all groups.
- **7.** Prints must be in black and white. Color photographs are not eligible.
- **8.** Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.
- **9.** Scientific American reserves the right to purchase, at regular rates, any non-winning entry.
- **10.** No entries will be considered from professional photographers.
- **11.** All entries in this contest must be in the hands of the judges by December 1, 1939. Results will be announced in our issue dated February 1940.
- **12.** This contest is open to all amateur photographers who are not in the employ of Scientific American.

Prizes for BEST PHOTOGRAPHS in EACH DIVISION follow:

First Prize
One $250 "Lifetime" LONGINES Watch*

Second Prize
One $125 LONGINES Watch*

Third Prize
One FEDERAL No. 636 Variable Projection Printer
(List price $29.50)

Fourth Prize
One FEDERAL No. 120 Enlarger
(List price $17.95)

Five Honorable Mention Awards, each consisting of a one-year subscription to Scientific American

Remember that these prizes are to be given in each division—or a total of six watches and six enlargers plus 15 subscriptions to Scientific American, totaling $1,327.35 in value.

*** First Prize watches are standard men's pocket models. Second Prize winners may choose pocket style or gentleman's or lady's wrist watch.**

Submit Pictures in ANY or ALL Three Divisions:

Division 1. Human—including portraits and other camera studies of people.

Division 2. Landscapes—including all scenic views, close-ups of parts of landscapes, seascapes, and so on.

Division 3. Action—including all types of photography in which action is the predominating feature.

In each division there will be prizes of two Longines watches—"The World's Most Honored Watch"—and two Federal Enlargers, as well as five Honorable Mention Awards.

This Contest Closes Dec. 1, 1939—All Entries Must Then Be in Hands of Judges

Address All Entries to
PHOTOGRAPHY CONTEST EDITOR
SCIENTIFIC AMERICAN
24 W. 40th St., New York City

THE JUDGES:
McClelland Barclay, artist
Ivan Dmitri, artist and photographer
Robert Yarnall Richie, commercial photographer

is through the use of ink eradicator. This should be applied a little at a time, removing the line bit by bit. The black defect cannot be taken out all at once. For removing small black spots, another method is to use a small spotting brush molded to a fine point and tipped with white spotting color. The effect should be judged only after the color has been allowed to penetrate the paper at the treated point. If the result is too light, add a little gray after the first application has dried.

Bathing Beach Idea

THIS suggestion is probably a little late for this year, unless you are on your way south, but it will keep until next time. "Stormy Weather Ahead," a low angle shot suggested by the darkening clouds, is a

"Stormy Weather Ahead"

subject that depends for its effect on the clouds, the nature of the lighting, and an exposure favoring the clouds. In this instance, the clouds covered the sun and an exposure made which was inadequate for the foreground figure, suitably rendered here in practically a silhouette. The shot was made as the subject swung slightly backward from the hips and looked up toward the approaching clouds.

Last Call

THERE is still time to enter the Fourth Annual Scientific American Photography Contest—but hurry, hurry, hurry: Entries must be in the hands of the judges by December 1. Doll up your best prints so that they look their finest, for one of them may bring you a valuable prize.

Full details of the contest appear on this page. Be sure to read the rules carefully so that your prints will be eligible.

Narrow Formats

A PRINT does not necessarily have to fall within the category of the regulation 5 by 7, 8 by 10 or any of the standard paper sizes. If the particular picture you have in hand looks better in a format which is narrower with relation to its length than

the usual ratio, by all means go ahead and print it that way. In the subject illustrating this piece there seemed nothing to do but treat it as you see it reproduced. The grand display of clouds is the principal attraction and their majesty is greatly emphasized by comparison of the towering masses with

"Majesty"

the small boats on the water below. The negative image had to be considerably "trimmed," but the effect and composition were greatly improved as a result.

Identifying Paper Emulsion Side

SOME workers find difficulty while in the darkroom in telling the paper emulsion side from the uncoated side. This is particularly difficult with smooth paper. There are three general ways of telling the coated from the uncoated side. First, there is the familiar one of biting a corner of the paper. The side that sticks to the teeth is the emulsion side. The other telltale signs are that the emulsion side looks more shiny than the other and also that it has a tendency to curve inward, concave fashion.

WHAT'S NEW
In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

PRINCETON EASEL ($12.75): Constant-center type enlarging easel. Masks consist of four strips of heavy-gage formed steel, 1½ inches wide, holding paper firmly and making for clean border line. Each pair of masks operated by single control button. Moving control button simultaneously moves both border strips towards or away from each other. Baseboard of easel provided with set grooves for 4 by 5, 5 by 7, 8 by 10, and 11 by 14-inch paper. Guides always ready for use without adjustment,

but are flush with top of base so that smaller guides do not affect use of larger paper sizes. Surface of baseboard finished in special silver lacquer which provides a focusing surface not easily affected by dust and grime. Frame of heavy metal, designed to provide adequate strength and rigidity in order to insure perfectly square borders and firm paper grip.

ARCUS JIC-A-MAT ($6.75): Resembles ordinary 8 by 10 enlarging easel; top covered by 13 separate and differently shaped mats made of red Bakelite which can be arranged to form almost unlimited montage combinations. Each mat has its number and indicator, so there can be no mistake as to paper areas exposed and those that are still to be exposed.

AGFA TEXTURE SCREENS ($2.50 each; set of four screens with Agfa Border Mask, $10): Available in four types: three fabric textures identified by names Satin, Oxford, and Homespun; fourth, irregular pattern named Ripple. Screens measure 8 by 10 inches; can be used for both contact and projection printing, being placed in immediate contact with photographic paper during exposure. Special precautions in manufacture are claimed to permit use of same contrast grade of photographic paper that is employed when prints are made without texture screen. Agfa Border Mask ($3) is 11 by 14-inch negative designed for use with Texture Screens. Mask provides 7½ by 9½ inch field with etching-edge border.

F-R ROLL-FILM DEVELOPING OUTFIT ($2.95): Contains essentials for fine grain developing, including new F-R "Special" adjustable developing tank (adjustable to roll films of all popular sizes); fine grain developer, X-33; concentrated fixing-hardening solution, Fixol; two spring film clips for hanging film to dry; complete instruction book containing darkroom information.

KODAK MONITORS SIX-16 AND SIX-20 ($30.00 to $48.50): Features: automatic film-wind control and body shutter release which retracts automatically when camera is closed; aluminum alloy bodies and backs; new system of bed braces which provide 10-point support to maintain lens and shutter rigidly in accurate position; mechanism to prevent double exposures; eye-level and waist-level finders; monitor turret with automatic exposure counter, field depth scale, range finder clip, and single push button to control both opening and closing; two tripod sockets, as well as folding supports for leveling camera on table.

MASTERCRAFT; GRANT, SR.; ARNOLD ENLARGERS: Three additions to Sun Ray enlarger line ranging from $16.50 to $75. Mastercraft: takes negatives from Robot size to 2¼ by 3¼ inches; geared trolley focusing unit. Enlarger only, $32.50; with 3½-inch *f*/6.3 Ilex lens, iris diaphragm, $37.50; with 3½-inch *f*/4.5 Wollensak lens, iris diaphragm, $42.50. Grant Sr. Enlarger and Projector: Wollensak 3-inch *f*/4.5 lens; two condensers, precision focusing on geared trolley unit; revolving head for horizontal or vertical negatives; geared post; built-in red light filter, for use on A.C. or D.C. Enlarger only, $42.50; with 3-inch *f*/4.5 Wollensak lens, $52.50. Arnold

Model A, goes to four feet in height; has interchangeable lenses; two 4½-inch removable condensers; No. 211 opal enlarging bulb; extra heavy extension geared poles; special trolley focusing mount; geared sliding compartment for copying, loading, and so on; red filter; through draft ventilation; extra heavy baseboard 20 by 26 inches, completely balanced. Enlarger only, $65; with 3½-inch *f*/4.5 Wollensak lens, iris diaphragm, $75.

UNIVEX ZENITH CAMERA ($15 with built-in Photoflash synchronizer; $12.50 without synchronizer): Made of cast light weight alloy; case leatherette covered, full chromium plated. New type high-speed shutter with speeds of 1/200, 1/100, 1/50, and 1/25 plus Time and Bulb. Iris diaphragm openings *f*/4.5 to *f*/16; new formula *f*/4.5 lens. Lens and shutter mounted in large barrel and focusing done by large diameter ring.

AGFALITE ($25.): Lighting device featuring pantograph mechanism, permitting set up and adjustment at moment's notice. Pantograph anchored to base of steel carrying case and provides extensible support for light sockets and reflectors, permitting light placement at any position up to 94 inches above floor level. Built-in counterpoise spring mechanism fixes pantograph at selected position without fastening. Equipped with two sockets mounted independently on sliding bars at top of pantograph mechanism to permit horizontal adjustment of spacing of two lights. Distance between centers of lamps variable from 11 to 36 inches. Device takes No. 2 flood lamps and is furnished with two adapters to use No. 1 lamps as well. Reflectors of special design to promote even distribution of light. Features include caster supports fitting base of unit, approved Underwriters cord with separate outlet plugs, and diffusion screen. Unit supplied in brown crackle finish with pantograph and caster frames in nickel finish.

PHOTO ART NEGATIVE BRUSH: Designed for eliminating dust and other alien material from negatives. Can also be used for brushing photographic lenses. Soft, flexible hair used safeguards negative or lens from scratching. Brush sufficiently wide for use on films and negatives of every type. Handle consists of flexible leather, perforated for convenience in hanging.

ARGUS VESTPOCKET EXPOSURE METER (25 cents complete with leather case): Celluloid wedge type meter; flat and small. Rotating wedge disk indicates brightness of subject, while sliding rule indicates correct shutter speed and lens aperture to use. Film speeds in Weston.

BEE BEE FILETTE ($1.00): Container for filing, classifying, and indexing negatives. Provided with ruled numerical index, allowing ample room for descriptive data. Contains 100 transparent glassine envelopes. Boxed in hinged container.

LAFAYETTE COMBINATION SUN SHADE AND FILTER MOUNT: Made of duralumin; outside polished natural duralumin fin-

ish, but all inside surfaces are spray coated with black composition to eliminate reflection. Serves both as shade and mount for standard filters. Shade consists of clamping ring which attaches to camera lens barrel. Into this is screwed hood which also serves to clamp filter in position. Recessed seat for filter in clamping ring felt-lined to prevent scratching. Shades available to fit all lens sizes up to 42mm diameter.

PHOTRIX "22" ENLARGER ($69.50, without lens): Features: Cool-working, six-volt illumination operating from house current on built-in transformer; pivoted lamphouse that tilts to correct distortion, turns horizontally for projection of all negatives; dustless, scratchless, all-metal negative holders; micrometer focusing lens-mount; counterbalanced head moves with one-hand operation; built-in spring holds lamphouse at any height; true double-condenser optical system and adjustable light source; two diffusion disks included for special effects and elimination of grain from negatives; takes negatives from 35mm to 2¼ by 2¼ inches; uses lenses 2, 3, or 3½-inch focal length.

ARGUS MODEL C3 CAMERA ($30.00): Synchronized Photoflash Argus model. Complete with battery handle and reflector. Built-in timer synchronizes flash and shutter speeds. As in C2 model, built-in coupled range finder focuses from 3 feet to infinity. Model C3 equipped with f/3.5 Cintar triplet Anastigmat lens, shutter speeds 1/5 to 1/300 the second.

TEXTURITE SALON EXHIBITION MOUNTS: Made of 16-ply standard thickness white pulp board. Obtainable in either white or cream color with or without fine black line around opening; either horizontal or vertical for 8 by 10 or 11 by 14 inch prints.

FOCUSING SPOTLIGHT: For use with Deluxe C Speedgun for 3¼ by 4¼ and 4 by 5 Speed Graphic cameras and for Deluxe C Jr. Speedgun for 2¼ by 3¼ Miniature Speed Graphic. Spotlight plugs into these speedguns, drawing current from speedgun batteries. Light supplied is useful for night flash photography where outside illumination is insufficient to permit normal use of either range finder or ground-glass viewing screen. Also serves as test lamp, visually showing strength of batteries and indicating when replacements should be made.

DILL CAMERA SHOULDER BRACE ($2.75): Enables photographer to hold camera steady during time exposure. Fits all standard cameras. Screws into tripod hole. Length of brace may be varied by telescopic adjustment. Ball joint, which may be locked, provides adjustment to any position. End resting on operator's shoulder equipped with rubber ball that can be removed to provide easy attachment of brace to table tripod for interior exposures. Chrome finish.

GOODSPEED SYNCHRONIZER ($13.50 including case): Synchronizes with all between-the-lens shutters and most focal plane shutters. Batteries contained in reflector unit. Small synchronizer unit (less than half size of a cigarette) attaches to camera like a cable release. Sliding socket to center all bulbs: bulb ejector.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. I have had some trouble with light leaking through the bellows of the camera. What is the proper method of testing for light leaks?—W. J. N.

A. One way is to remove the back of the camera, pull a light-proof cloth over the head and the camera and insert into the bellows a small 4-volt lamp in a holder connected to a pocket lamp battery. Examine the bellows folds, joints and corners. If and when the source of the light leak is discovered, repairs may be made by filling the holes with rubber solution thickened with lamp black powder, or the break or breaks may be covered with small pieces of black court plaster.

Q. How can I obtain the letters A. R. P. S. after my name?—B. W.

A. These letters stand for Associate of the Royal Photographic Society (of Great Britain) and are accorded to members of the Society who have achieved distinction in some field of photography. Membership is open to all photographic workers in all parts of the world. The first step towards the acquisition of the coveted letters is to fill out a regulation form and send it to the Secretary of the Society in London, accompanied with evidences of one's work. Periodically each year these applications are voted upon and if you are turned down once, you can apply again at a later time, with better evidences of your work.

Q. Where and how is distilled water obtainable?—M. J. R.

A. Distilled water may be purchased at the five-and-ten-cent store or at the drug store. Water free of the foreign matter contained in water obtained from taps may be had by catching rain water in a non-metallic container, such as an enameled pail or crock.

Q. I wish to take stereoscopic color transparencies with a 35mm camera. I am acquainted with the Leica equipment for this purpose, but can you tell me of any other equipment for taking and viewing these pictures?—D. E. D.

A. You probably are aware that stereo pictures can be taken with any camera simply by using a still subject and shifting the position of the camera between the two exposures a distance of about 2½ inches, approximately the distance between the two eyes of a human being. As for viewing the resulting stereos, any regular stereo viewer accommodating this size transparency will be suitable. An article on stereo photography appeared in our Camera Angles department in the November 1938 issue.

Q. I have had very little experience in photography and cannot spend much, but I will soon need an apparatus for use in plant-breeding work. Can you advise what type I must get for clear snapshots of plants and also photomicrographs of plant cells and the like?—A. L.

A. The least expensive outfits for your purposes are the Argus and the Mercury, for both of which cameras special apparatus is available in these fields. The service departments of both these organizations will be glad to send you helpful data and suggestions.

Q. What do you think of taking two exposures on a single film without covering half of the lens? Will the pictures be sharp and worth enlarging?—L. D.

A. This is altogether possible and is, in fact, an arrangement in regular use on view-type cameras. A ground glass focusing-type camera is required and the proper negative masks must be provided so that one half of the film is covered while the other half is being exposed, and vice versa. If the focusing is accurately done there is no reason why both pictures on the same film should not be as sharp as one picture made on the whole film.

Q. Can you tell me where I can get a list of picture agencies?—J. C.

A. Editor & Publisher, the newspaperman's organ, has a complete list of syndicates that buy photographs. The list was reprinted some time ago in an issue of Camera Magazine, Philadelphia, Pennsylvania.

Q. Is it possible and practical to make sensitized paper for use in making photostatic copies of printed matter?—L. E. W.

A. Most hand sensitized papers do not have sufficient contrast for photostatic work. Rather, we would suggest the use of some such paper as Novaflex or Outline Special.

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

SCIENCE TODAY AND TOMORROW

By Waldemar Kaempffert

COVERING most of the especially interesting things in the gamut of the scientific and industrial world, Kaempffert, who never has learned how to be dull, entertains and painlessly informs the reader as he goes. The sun; exploding stars; birth and death of the moon; life in the solar system; rocketing through space; explorers of the atmosphere; mystery of the atom; after coal, what?; the chemical revolution; can the laboratory create life?; evolution since Darwin; Carrel; man and his world; artificial lightning; speed; steamships; democracy and the machine—these are the headings under each of which the author, an outstanding interpreter of science, chooses to spill a myriad of significant scientific sidelights. Eminently fine reading for the man who doesn't want to study, yet wants to know what's going on around him. (275 pages, 5 by 8 inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

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By H. Bennett

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By Ledyard Sands

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MODERN PLASTICS, OCTOBER, 1939

A Catalog and Directory by Modern Plastics Magazine

ARTICLES on various phases of plastics manufacture and use, hundreds of pictures of various products molded in plastics, advertisements by the score to cover the entire field, and numerous special features fill this splendid issue of the magazine *Modern Plastics*. It has been bound in an attractive stiff cover, the surface of which is a parquet of wood impregnated with plastics. Color plates abound throughout the volume. It is intended as a permanent reference. (454 pages, 8¾ by 11¾ inches.)—$2.10 postpaid.—*F. D. M.*

FINDING NEW SUBJECTS FOR YOUR CAMERA

By Jacob Deschin

CAMERAS too often repose in closets and bureau drawers because their owners have exhausted their own limited resources of photographic subjects and have tired of repetition. With new vistas opened to them through the ideas suggested by Mr. Deschin, they will find new joys, keen delights, in photographic exploration of hitherto unthought-of fields. The suggestions offered are far too great in number to attempt to list: they cover a wide range from city sidewalks to unusual models, from hobby photography to picture finding in the dark room. The best we can do here is to say that this is one book which the ambitious amateur photographer cannot do without. (240 pages, 6 by 8½ inches, 24 excellent photographic illustrations, most of them full-page size.)—$2.60 postpaid.—*A. P. P.*

SKEET AND HOW TO SHOOT IT

By Bob Nichols

TO the skeet devotee this book will be a friendly, helpful critic in pointing out possible existing faults of form, stance, fit of gun, target lead, and other factors which may have tended to interfere with perfect scores. To the inexperienced skeet shooter it will be a complete and competent guide for the above named integers of the sport, as well as for choice of guns, constructive suggestions and extensive information on eyes and shooting glasses, clothing, field lay-out, and the entire game from station one to station eight. The author writes in clear, graphic style, gained from his own extensive experience in skeet shooting and from his knowledge and background as Arms, Ammunition, and Skeet Editor of *Field and Stream*. (177 pages, 6 by 9¼ inches, 46 illustrations.)—$3.60 postpaid.—*A. D. R., IV.*

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By W. O. Kermack and P. Eggleton

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

AT long last, someone has actually built the spectroscope and spectroheliograph (not to be confused with the spectrohelioscope) described in "ATM," third and fourth editions. For some reason this instrument never has been popular with the crowd. Arnold S. Mountfort, a portrait artist, 2200 Mountain Oak Drive, Hollywood, Calif., is the first maker (Figure 1). "The actual work took about two months of my spare time, mostly in London," Mountfort writes. "The recommended water clock driving mechanism ('ATM,' page 211) was not a success, as it always went in jerks due to the dark-slide's friction. Regarding the cost, about which you inquire, I cannot now state but, with a fair genius for getting material for nothing, the whole, including the coelostat, should not cost more than $10 or $12.

"The most difficult part was cutting and mounting the slits. By fixing the curved one on the end of a long piece of wood pivoted at the other end, I got a good and true edge by rubbing it against a piece of fine Carborundum stone for the male half and reversing them for the female.

"It was all intensely interesting and well worth the trouble. My first photographs were terrible tragedies. The solar spectrum, though clear, was so over-exposed that it came out positive. But if there was nothing to work for it would not be half the fun. I have found no need for the long focusing rods or for a shed, a galvanized cover giving sufficient protection."

Mountfort, at the time he wrote the above, was painting a portrait of R. W. Porter to be contributed to a gallery of astronomers and telescope designers of our time, "in order that those who will be working the 200-inch in 1000 years," as Mountfort puts it, "may know something of the pioneers of this development of today."

FIRST big hurdle to jump when undertaking a Schmidt astronomical camera has been the deep curve; otherwise a lot more Schmidts would be made by amateurs. The Lowers used 25 pounds of Carbo and played wet nurse to their grinding machine for 98 hours, in 1935, when roughing a deep *f*/1 curve out of a 12-inch Pyrex disk for a Schmidt. Today they use a Borium tool on a large lathe and do the job (to within ¼ inch of ultimate depth—as far as is safe) in one day. This is excellent—provided you have a Borium tool and a large lathe. The alternative—hand work—would require "less than a month," working union hours, Harold Lower states.

Fred Ferson, Biloxi, Mississippi, therefore suggested some months ago that an attempt he made to wangle the Corning Glass Works, Corning, N. Y., makers of Pyrex baby bottles and 200-inch mirrors, into casting a batch of Schmidt blanks with approximate curve. Approached, Corning showed a co-operative spirit. "What size, what curve, would you like?" they asked. Offhand, one might reply casually, "Oh, all sizes, all curves." But this would make the disks cost real money, for the sale will not—cannot—be large. Ferson therefore suggested 12½ inches, 32-inch radius, as a mean—or, rather, mode. Lower agreed. So did others.

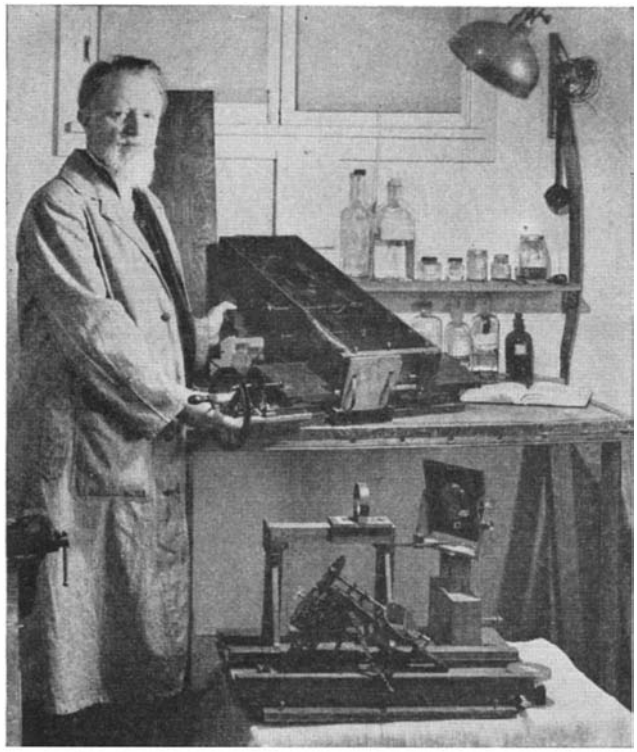


Figure 1: **Mountfort and spectroheliograph**

Advised, Corning stated that the most economical way for them to make these would be to rough grind the cavity rather than cast it in, as the molds are expensive; also, for some technical reason, to make the radius 36 inches. They found they could supply these at a little more than double the price of ordinary Pyrex disks of the same size.

Before announcing this fact it was thought best, however, to put these disks to actual test, so Corning sent Ferson a disk, 12½ inches, 36-inch radius, and he spit on his hands and went to bat with it. Final report: He spent 12 hours and used two pounds of Carbo in deepening the curve from 36 inches to 32 inches and truing it. Used convex tool of full diameter, which he cast from type metal. The soft metal ground away as fast as the glass: hence, no concave mate was needed. Metal tool also gave shallower pits, smoother surface, he states. In sum, he reported, it is now possible to grind and polish a primary for an *f*/2 Schmidt, or an *f*/3 Wright, by hand, in about the time required for a mirror of like size but common focal length. For this, we may thank Ferson and Corning.

LAST month in this department it was hinted that James G. Baker, of the Harvard College Observatory, had designed a family of flat-field cameras (Figure 2) equivalent in performance to the Schmidt. The following is his description of them:

"Many years ago Schwarzschild set out to find the most useful system of two mirrors possible. He found that, although there exists a system that is aplanatic and anastigmatic on a flat field, it is of no practical use because of the total silhouetting of one mirror by another. As a consequence, Schwarzschild reintroduced astigmatism and solved for the parametric equations of a family of aplanats with flat field. The best-known member of the family is a system of two concave mirrors, the secondary being half the diameter of the primary. Astigmatism in the system limits the available field of this reflector.

"Improvements in the image quality of reflectors were of a minor nature until Schmidt introduced the idea that small deformations in an otherwise weak lens could be most effective in helping to eliminate the image defects of coma and spherical aberration. Wright has generalized the original Schmidt camera into an entire family of Schmidt cameras and has shown that astigmatism cannot be eliminated on a flat field by correcting plate and one mirror alone. Wright's work in turn can be generalized to show that astigmatism cannot be eliminated on a flat field, even when several correcting plates are employed, all separated, so long as the total powers of these correcting plates are of the second order with respect to the mirror.

"Three mirrors with aspherical surfaces can be designed to give excellent performance mathematically, but the silhouetting in such a system is hopeless. Thus, only one more possibility remains, and that is a system of one correcting plate and two mirrors. This combination produces a two-parameter family of telescopes with flat field. The two parameters remaining after all third order aberrations have been satisfied, are the distance of the correcting plate from the primary mirror and the distance of the photographic plate from the secondary mirror. When the correcting plate is placed immediately before the secondary, the tube length becomes extremely short compared with the focal length. For example, one combination produces a tube one sixth the length of the tube for a Schmidt of the same focal length and performance. For such a short tube length all three of the curved optical surfaces are aspherical. The two

aspherical mirror surfaces fortunately possess no inflection points.

"If the tube length be of no serious consideration, the two-parameter family includes a remarkable one-parameter family, with tube length about ¾ that of the Schmidt of the same focal length, such that the two mirror surfaces depart inappreciably from spherical surfaces. The curve of the correcting plate becomes much more shallow, and is not much deeper than for the Schmidt of same focal length and aperture.

"The reasons for the existence of the two-parameter family can be seen from consideration of the Schmidt and Schwarzschild systems. Then, too, one can deduce the family from the Schmidt system. One starts by considering the usual Schmidt camera with an additional plane mirror secondary, untilted, so that the curved focal surface is inverted and near the primary. By keeping the radial and tangential astigmatic surfaces coincident, and by variation of all the curves and separations, the curvature of field can be continuously reduced to the flat field here considered.

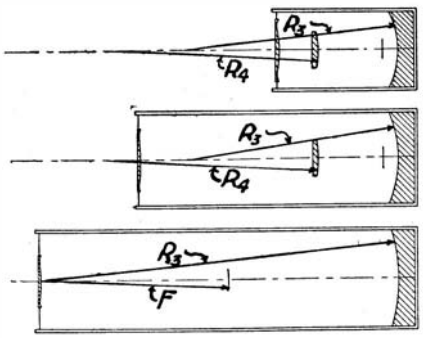


Figure 2: The Schmidt system compared with the two-mirror systems

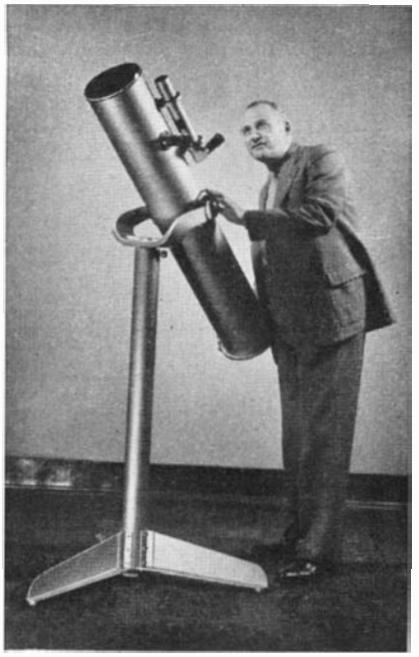
"Figure 2 shows an *f*/3 camera of short tube length with an 8 degree unvignetted field, also the corresponding camera of longer tube length and spherical mirror surfaces. Moreover, for comparison purposes a Schmidt camera of exactly the same light-gathering power, focal length, and unvignetted field is shown. The apertures of the two-mirror systems have been adjusted to compensate for the additional silhouetting and extra surface, absent in the Schmidt.

"The advantages that can be pointed out for the two-mirror system are the extremely short tube length possible, with consequent saving in space and material, convenience in loading the plate holder, and the existence of a large, flat, unvignetted field. To give an idea of the importance of the field, if the customary large paraboloidal reflector were converted into this type in the same tube, the number of square degrees photographed per night would equal the number of square degrees photographed by the paraboloidal form per month, the definition at the edge of the useful field being the same, from a very conservative calculation. Fortunately, the two mirrors and plate-holder are close together in what is usually the stiffest part of the tube."

In Figure 2 the spherical surfaces, tangent to the true surfaces of the mirrors in the shortest type, are shown dashed. The mirror curves are exaggerated to twice their true depths, the correcting plate surface many times, and the focal surface of the Schmidt twice.

THE BEGINNER'S CORNER

THE experienced telescope user is often less inclined to belittle the alt-azimuth type of mounting than is the beginner. With the equatorial type, because one axis is cocked over parallel to that of the Earth, it is necessary to keep moving the telescope tube in only one direction as the Earth rotates. In the alt-azimuth, having the same axis perpendicular to the Earth's surface—that is, at some angle to the Earth's axis—it is constantly necessary to move the tube in two: for example, over a bit (azimuth) and up a bit (altitude). In practice this isn't nearly so much of a bother as it sounds; while the mounting is simpler to build. The clean, trim alt-azimuth shown was built by J. L. Wagoner of Pittsburgh, Pa. It has a 6″ mirror and a 7″ aluminum tube. The pillar is a piece of 4″ brass tubing and the base and yoke castings are of aluminum.



TELESCOPTICS

(Continued from preceding page)

IN the *Journal of Scientific Instruments* (London), August 1939, H. W. Cox, 47 Upper Green, Mitcham, Surrey, England, an amateur whose first Schmidts were described in the February number, describes in a six-page article his technic of making Schmidts. He sent us an extra copy of the article, which will be lent to those seriously doing Schmidt work who wish to ask for it, provided they will promise to return it promptly so that it may be passed on to others. Cox will also send copies to genuine Schmidt workers, if asked. The paper would mean little or nothing to others, as the methods are in no way applicable to work on ordinary telescopes; Schmidts being advanced work.

ONCE a year a "nova" breaks out among telescope makers: verses. Most recent poet is the proprietor of the Apex Monument Works (gravestones!), 6815 West 27th Ave., Edgewater (Denver suburb), Colo., who offers the following outburst (novae are due to an overproduction of energy):

The Amateur Mirror Maker

By Anton Bohm

He walks at night, around a keg; on top a disk of glass.
He pushes forth and pulls it back—another piece of glass.
For months and months he's kept it up, his patience still intact.
One hundred miles he's surely walked around that circular track.

He counts the minutes and the strokes, ellipitical and straight.
He fights against a turned down edge and spheroids much oblate.
Paraboloid, hyperboloid, A.T.M.A., T.E.—
Are words and terms that he can use with ultrafluency.

And every now and then he takes his pretty, shiny disk—
With loving care he handles it, indeed he takes no risk—
And puts it on a testing stand to see what he can see,
And squints along a razor blade and then he shouts with glee:

"At last! I see what seems to be a doughnut fat and round!"
But though the shape is there alright, the depth is too profound.
The distance from the inner zone, compared with from the rim,
Is much too far away as yet. So it appears to him.

Again the weary grind begins. It surely is no cinch.
The surface must be right within one millionth of an inch.
One millionth of an inch is small, and you will promptly ask:
"How does he know when he is done with his gigantic task?"

His pinhole lamp and razor blade—they will reveal to him
The mirror in its perfect shape, correct from rim to rim.
But if you knew the grief he has with rings depressed and raised,
With turned-down edge and edge turned up, you'd surely be amazed.

But that is not the only grief—experience he must gain.
It's finding scratches, sleeks and pits that causes him much pain.
Dust is a thing that he abhors—he flies into a tantrum
When finding on his polished disk a grain of Carborundum.

"Oh Wifey! Did you sweep the floor?" he hollers from his shop.
"If you insist on cleaning up, I'll surely buy a lock."
"Indeed you'll not," replies his spouse, "I never yet have seen
A place so gory, it's a fright—I'll never get it clean.

"Rouge over every thing I see. It surely is a mess.
Rouge on my towels, yes on the walls. It's even on my dress."
But all hard tasks come to an end. Some night the Foucault test
Will throw upon his speculum the shadow he loves best.

The shape is there—the depth is right, at last the thing is done.
He heaves a sigh of deep relief—some people call it fun.
And so will you, I dare predict. Some day you'll see it—but
You never will, till you've become a Telescoptic Nut.

FORKS, if made by casting from carefully shaped patterns, may be made very pleasing to the eye but, if not, they sometimes fail to satisfy the telescope maker's feeling for beauty. A kind of fork that can be made with a lathe alone, yet which is pleasing to the eye, is shown in Figure 3. Otto C. Rasmussen, 57 Brunswick Ave., Troy, N. Y., designed this fork, in which he used 1½″ steel shafting, a circular plate of ¼″ steel and underneath it, two rollers. The telescope, a 6″ of 50″ f. l., is equipped with a motor drive mounted on its triangular baseplate. The latter is of angle iron with a ⅛″ steel deck. On

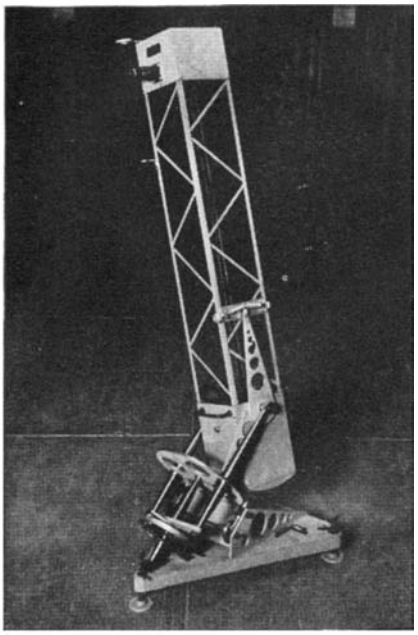


Figure 3: Rasmussen's neat fork

this deck are two double glasses and at the apices three leveling screws with locknuts. The hour circle is of the floating type. The square tube is made of ½" x ½" x ⅛" angle iron with diagonals of ⅜" x ⅛" strip steel.

Rasmussen also made a nocturnal or horometer (Figure 4) for giving sidereal time. The handle is held perpendicularly, Polaris is sighted through the central hole and the straightedge is turned to line up on Beta Ursa Minoris. The pointer then shows sidereal time within about 5 minutes.

BOTH "ATM" and "ATMA" recently underwent minor operations when exhaustion of stocks led to reprintings (note: *not* new editions). Misprints were corrected and in "ATM" a few changes made. Old note on p. 333 discouraged refractor work, new one encourages it—things have progressed. Note on p. 458 was replaced by one telling why photographic lens making is highly advanced work, because numerous novices seem to get the idea that making a photographic lens would be a "simple introduction" to telescoptics! Hallucination.

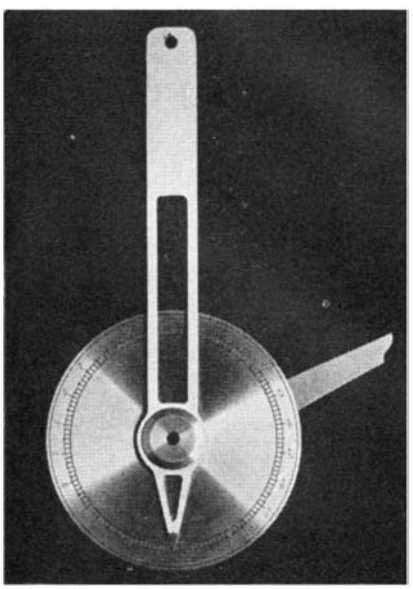


Figure 4: Rasmussen's horometer

CURRENT BULLETIN BRIEFS

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

ENGINEERING: A PROFESSION, edited by J. Anderson Ashburn, is a 28-page booklet dealing specifically with the functional aspects of engineering. It should be of great assistance to students who, having decided to follow engineering as a life work, are still at a loss as to what particular branch of engineering would be their wisest selection. *The Michigan Technic, College of Engineering, University of Michigan.—25 cents.*

THE SHOOTER'S BIBLE, 1940 edition, is a 512-page catalog that illustrates and describes 16,000 items covering guns, accessories, gun tools, ammunition, and all the other gadgets dear to the heart of the gun hobbyist. This one book might almost be called the equivalent of a whole gun library since it can serve as a guide to practically everything in which the reader would be interested. *Stoeger Arms Corporation, 507 Fifth Avenue at 42nd Street, New York, New York.—$1.00.*

KODACHROME, PHOTOGRAPHY IN COLOR, is a 52-page booklet which discusses Kodachrome film, and gives data on its use for full-color filming. Exposure technique both in daylight and artificial light is treated, and advice on using a photoelectric exposure meter is included. A number of the illustrations are in color. *Eastman Kodak Company, Rochester, New York.—25 cents.*

THE BROWNING PRESELECTOR AND VISUAL FREQUENCY MONITOR is a single page leaflet, Bulletin 103-A, which describes two instruments of great value to the serious amateur radio operator. The preselector described has a general coverage of 5 to 185 meters, with electrical band spread, and gives 25 to 70 DB gain on all bands. The visual frequency monitor insures precise frequency measurement on the amateur bands. *Browning Laboratories Incorporated, Winchester, Massachusetts.—Gratis.*

STATISTICS OF RAILWAYS OF CLASS I, is a 12 sheet folded bulletin based on the official summaries of the Interstate Commerce Commission from 1926 to 1938. It covers—among other phases—investment and income, fixed charges and dividends, traffic averages, equipment and service, taxes, and so on. *Association of American Railways, Bureau of Railway Economics, Washington, D. C.—Gratis as long as limited supply lasts.*

AO PEOPLE is a 26-page booklet which gives a comprehensive picture of the world's oldest and largest optical institution and of the people who work for it. Well-illustrated, the booklet was created by American Optical Company for distribution to prospective employees, company visitors, editors, professional men, and the general public. Although the booklet can be read in a few minutes, the reader will nevertheless get an accurate idea of the tradition behind the optical concern and its workers and also an understanding of the intricate technical problems involved in the manufacture of optical equipment of all kinds. The booklet can be considered a valuable contribution to the art of establishing cordial relationships between industry and the public and as such may well be worth studying. *American Optical Company, Southbridge, Mass.—Gratis.*

LEITZ BOOKLET No. 7838 describes the Leitz Gnome II home projector for two by two-inch slides and gives complete information on the projector and accessories. *E. Leitz, Inc., 730 Fifth Avenue, New York, N. Y.—Gratis.*

SOME CERAMIC MANUFACTURING DEVELOPMENTS OF THE WESTERN ELECTRIC COMPANY, by A. G. Johnson and L. I. Shaw, is a 25-page illustrated report which gives a general picture of the development work involved in the introduction of manufacturing processes for various ceramics as used in telephone apparatus. The work reported here should be of interest to many other industrial fields. *Bell Telephone Laboratories, 463 West Street, New York City.—Limited free distribution.*

BLASTING DITCHES WITH EXPLOSIVES is a 62-page illustrated booklet designed to give its readers a working knowledge of the use of dynamite for this particular purpose. The information applies specifically to drainage as required for farm land, highway construction, and for other purposes where economy and efficiency are necessary features. Besides the detailed instructions, the book describes blasting tools, accessories, safety rules and practices, and so on. *E. I. du Pont de Nemours & Company, Incorporated, Wilmington, Delaware.—Gratis.*

ALLIS-CHALMERS TEXROPE DRIVES AND LO-MAINTENANCE MOTORS is a 28-page illustrated catalog that shows various types of industrial drives and gives data on how a drive should be selected for a particular purpose. It also lists various types of electric motors which are particularly adaptable to varying operating conditions. *Allis-Chalmers, Milwaukee, Wisconsin.—Gratis.*

EARLY FIRE-MAKING METHODS AND DEVICES, by Warren N. Watson, B.S., A.M., is an interesting book of 71 pages plus an index which gives a running story of the whole history of fire-making from the most primitive implements of early man and more modern but uncivilized races down to the present day match. Illustrated and described are fire drills of various types, percussion methods of striking fire, and physical methods, including the fire piston. *Warren N. Watson, Fairfax, Virginia.—$1.50 cloth, $1.00 paper.*

KODAK FILMS is a 56-page booklet on Kodak roll films, filmpacks, miniature and sheet films. Photographic characteristics of the films, such as speed, contrast, and the like, are described, and the sensitometric terms are explained. Of especial value is the "Specifications" section, which provides full information as to the photographic and physical characteristics, the uses and processing of each film. *Eastman Kodak Company, Rochester, New York.—15 cents.*

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.
New York Bar
Editor, Scientific American

UNDRAMATIC

A SET of rules is not a dramatic theme that is subject to protection as such under the copyright laws. This principle is illustrated by a suit for copyright infringement, brought by the author of a book relating to sales arguments, against a prominent automobile manufacturer. It was charged by the author that the copyright on his book was infringed by a moving picture used by the automobile manufacturer for demonstrating proper sales technique to its salesmen. The portion of the book which was alleged to be infringed contained a list of six principles or rules of persuasion to be followed in presenting a sales argument. The accused moving picture film depicted three salesmen, two of whom expounded and demonstrated faulty sales arguments. The third salesman expounded and illustrated the proper sales approach and correct sales arguments. In the course of his portrayal the salesman listed certain rules or principles to be followed in presenting a sales argument and the rules thus expounded in the moving picture were similar both in content and in sequence to the six rules listed in the book. In illustrating the proper sales approach the third salesman carried out or followed the rules which he expounded. It was contended by the author of the book that because of the listing of the rules or principles of salesmanship as set forth above and because of their portrayal in the manner described, the moving picture constituted a dramatization of the book and accordingly was an infringement of the copyright thereon.

The Court rejected this contention, pointing out first of all that "a set of rules is not a dramatic theme" and that accordingly the moving picture could not be considered a dramatization of the book.

SELLER BEWARE

THE seller of a patent should beware that he does not infringe it because in a suit for infringement of the patent he cannot defend on the grounds that the patent is invalid. In a recent suit for patent infringement the inventor of a box for paper rolls had been an officer of the plaintiff corporation and while in its employ had assigned his patent to the corporation. Subsequently, he severed his connection with the plaintiff corporation and organized the defendant corporation for the purpose of manufacturing and selling boxes for paper rolls. Thereafter the plaintiff corporation sued both the inventor and the defendant corporation, charging patent infringement and one of the defenses raised was that the patent was invalid. The Court ruled that the defense of invalidity could not be raised because of the previous relationship between the inventor and the plaintiff corporation and because of the intimate connection between the inventor and the defendant corporation. This suit not only expresses the established principle that the assignor of a patent cannot subsequently question the validity of the patent in a suit brought by the assignee but also carries it one step further and holds that a corporation organized and controlled by the assignor cannot question the validity of the patent.

LACQUER

A PATENT on lacquer consisting of a combination of nitrocellulose and a particular synthetic resin was held valid and infringed in a recent suit for patent infringement which illustrates that the substitution of one ingredient for another may amount to invention. The particular synthetic resin which was mixed with the nitrocellulose was described in the patent as a solution of a glycerol ester of a resin and organic carboxylic acid selected from the group consisting of phthalic, maleic, fumaric, malic, and succinic acids. The Court found that prior to the patent in suit lacquers had been made by mixing nitrocellulose with other types of resin. The Court also found that the particular resin described above was known and had been used for other purposes prior to the patent in suit. It was argued by the defendant that the mere substitution of one resin for another did not amount to invention but was within the range of routine laboratory work and represented mere mechanical skill. On the basis of the evidence introduced in the case, however, the Court concluded that the results obtainable by mixing resins with nitrocellulose could not be predicted, that the production of the lacquer covered by the patent in suit resulted from considerable experiment, and that the lacquer was superior to the lacquers of the prior art. As a result the Court held the patent to be valid.

WEATHER STRIPPING

A PATENT for an all-metal weather stripping which is applied to the window without the use of nails, screws, or other extraneous fastening means was held to be valid and infringed in a recent suit before the federal courts. The patent in suit disclosed a weather stripping formed of a unitary metal clamping portion adapted to clamp to either the sash or the frame and a resilient metal weather closing strip attached to the clamping portion. The defendant manufactured and sold a weather stripping having a metal clamping portion and a resilient weather closing strip. However, the defendant's weather stripping differed from the weather stripping shown in the patent in several respects and it was contended by the defendant that because of these differences his stripping did not infringe the patent. Thus, in the stripping shown in the patent the clamp was formed with an arcuate hooked portion which was not embodied in the defendant's structure. The Court found that plaintiff's weather stripping was new and represented a substantial advance in the art. As a result it concluded that the differences referred to by the defendant were not important and did not avoid infringment.

OUTSMARTED

A RECENT case in the New York State Supreme Court involved a rather novel application of the so-called Fair Trade Act. The Fair Trade Act which has been passed in substantially the same form in most of the states of the Union permits a manufacturer to enter into contracts with his customers, fixing the retail prices at which they may sell commodities bearing his trade mark, name, or brand and provides that knowingly selling commodities beneath the price thus fixed constitutes unfair competition.

In the case in question a silk manufacturer entered into a contract with a dress manufacturer confining the sale of silk bearing the trade mark "Pussy Willow" in the cutting trade to the dress manufacturer who in turn agreed that the retail price of the dresses made from the "Pussy Willow" fabric should not be less than $12.95. A prominent New York department store attempted to purchase dresses made from the "Pussy Willow" fabric from the dress manufacturer but since the department store would not agree to refrain from selling the dresses for less than $12.95 each, the dress manufacturer refused to sell the dresses to the department store. Thereafter, the department store obtained dresses from another and unauthorized source but which were nevertheless manufactured from genuine "Pussy Willow" fabric and they proceeded to sell the dresses for less than $12.95 each. The silk and dress manufacturers then sought to obtain an injunction against the department store on the grounds that the sale of the dresses for less than $12.95 each was in violation of the Fair Trade Act and constituted unfair competition.

The Court refused to grant the injunction, pointing out that the dress was manufactured by some other source and was not a product of the dress manufacturer nor did it bear his trade mark, name, or brand. The Court also pointed out that, while the silk was undoubtedly the product of the silk manufacturer, the dress did not constitute a "commodity" produced or owned by the silk manufacturer. The Court, concluding that every act of "outsmarting" does not constitute unfair competition, made the following statement:

"Obviously, the defendant outsmarted the plaintiffs. But the law does not essay to reach every case of outsmarting; nor does every case of outsmarting constitute unfair competition. I recognize the plaintiff's embarrassment and possible loss. But I am unable to perceive that the law here invoked affords them relief."

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December · 1939

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Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

Vol. 161, No. 6, 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid.

Printed in the U. S. A. Press of the Wilson H. Lee Co., Orange, Conn.

For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

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

The older man will sit quiet a moment and then in a tone of infinite pathos:

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

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

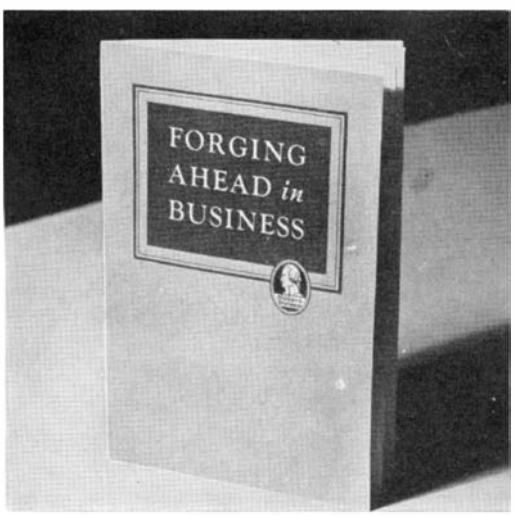
"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime'* the other class have convinced themselves that they can do it within the next few days. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

This booklet costs you nothing—and for a good reason. It is worth only what you make it worth. It explains how for more than thirty years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.



"FORGING AHEAD IN BUSINESS" is an interesting, helpful booklet. It is yours for the asking. Send for it. Measure yourself by it. Look clearly, for a few moments, into *your* next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

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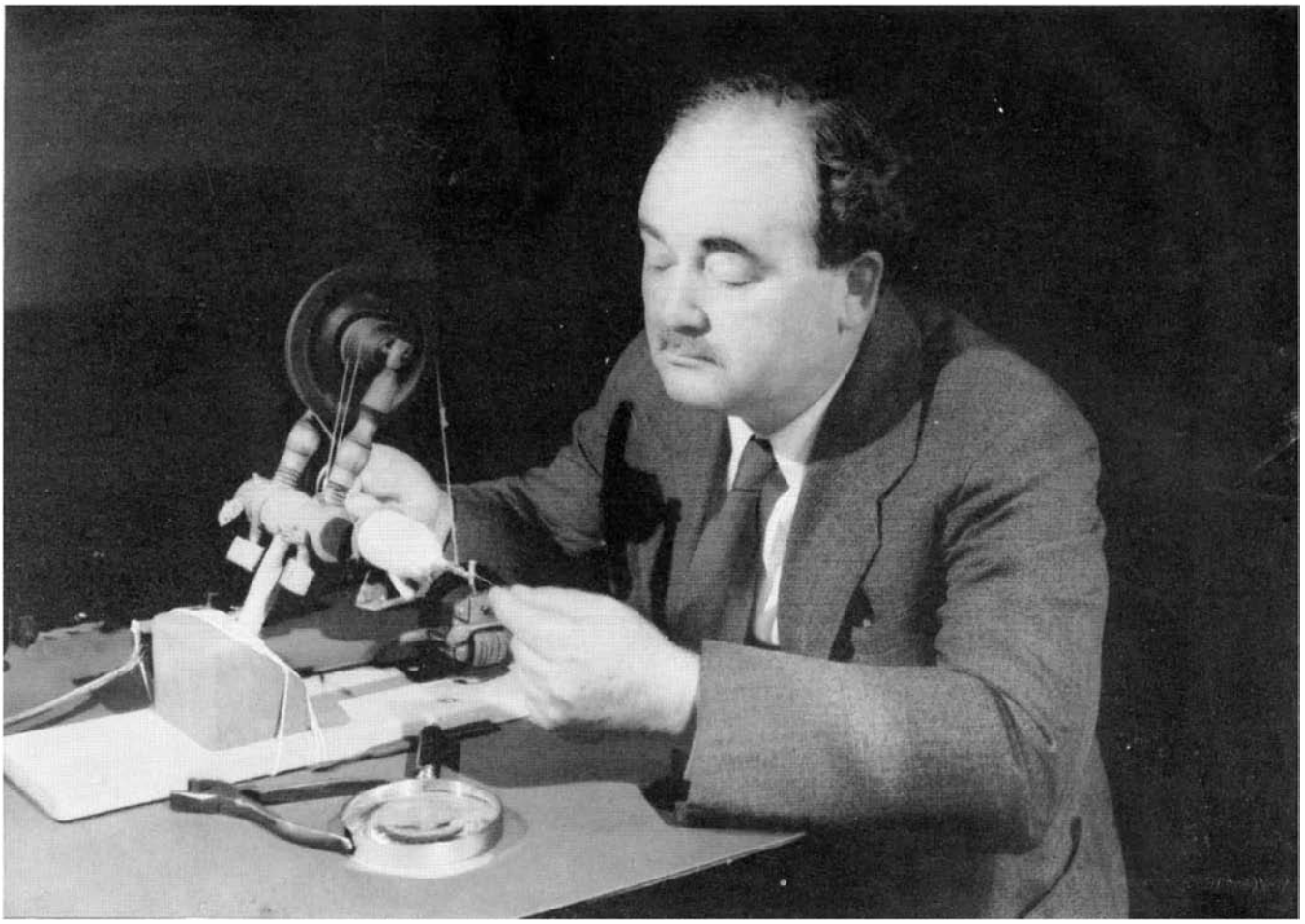

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