# SCIENTIFIC AMERICAN

AUGUST • 1941

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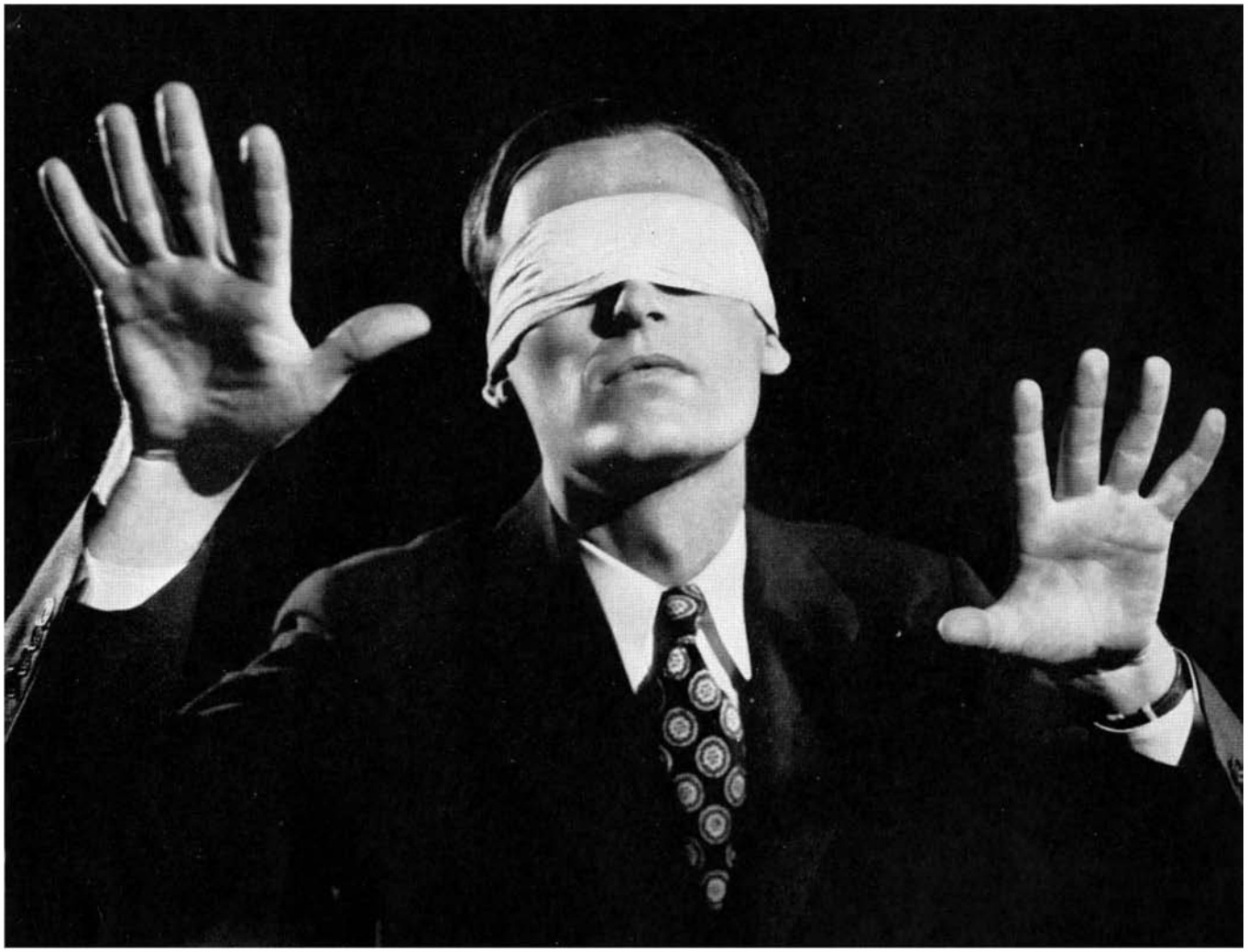
Power for Our Nation's Wings

FOR NATIONAL DEFENSE—

## Keep Our Transport Planes



# WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

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AIRLINES and air transport planes form a backbone of high-speed transportation essential to the United States in defense preparations. In time of actual emergency it would be even more important to the nation. Yet we are facing a danger, sponsored by an emotion which does not consider all the facts of the case. See article, page 53.




# SCIENTIFIC AMERICAN

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## AUGUST • 1941





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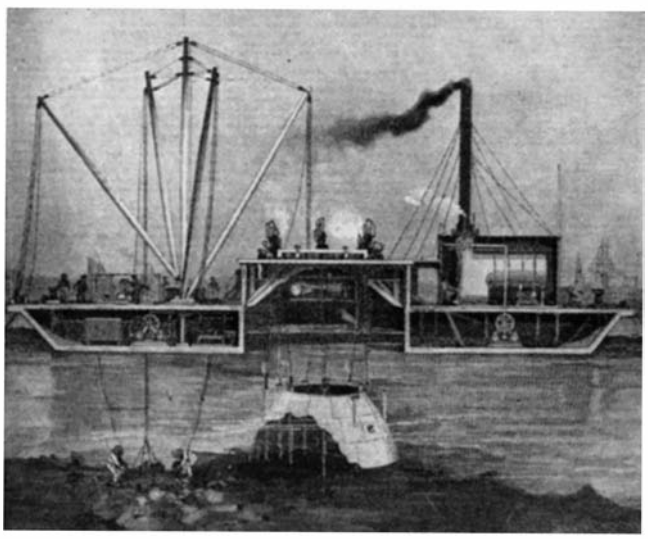
# 50 Years Ago in . . .

## SCIENTIFIC AMERICAN

### (Condensed From Issues of August, 1891)

PANAMA CANAL—"Parts of the canal once excavated at great cost are almost completely filled up again, and in other places the banks have washed in and the channel is obstructed. Nearer Colon, channels that once admitted vessels of 14 feet draught 14 or 15 miles inland are so blocked up in places that a canoe alone could navigate them."

UNDER-WATER—"Upon the discovery of a new Diamond Reef obstruction in the harbor of New York, it was surveyed and found to consist of a massive rock formation. It is only to-day, after twelve months' blasting, that the work of removal is on the verge of completion. The drilling scow used for executing the work is the property of the United States government. . . Through the center of the hull of the scow an octagonal well hole thirty-two feet in diameter is constructed. . . The scow really is used in a four-fold capacity, drilling, hoisting, sounding, and sand pumping. . . Within the hull of the scow is a small machine shop, a blacksmith's shop, and air compressors for the divers, while a complete electric plant is installed for lighting its interior. Experiments have been conducted also with the light under water in the diver's hands."



**The drilling scow, U.S.S. General Newton.**

TRANSATLANTIC—"At 2:30 in the morning, August 5, the White Star steamer Majestic arrived at Sandy Hook lightship, at the entrance of New York harbor, breaking all previous records and achieving the quickest voyage ever made across the Atlantic. She had left Queenstown in the afternoon of July 30, and completed the trip in 5 days 18 hours and 8 minutes."

CONSERVATION—"The establishment of fish hatcheries by the government, the effort to protect the seals of Behring Sea, and the reservation of the Sequoia groves are acts which give promise of a time coming when more serious thought would be given by our nation to the preservation of its heritage."

WELDING—"According to Professor Elihu Thomson, it is not the extra resistance at the break that gives rise to the heating in electric welding. The imperfect contact there no doubt hastens the heating at the joint, but the real cause of the concentration of the heating between the clamps is the relatively greater conductivity of other portions of the welding circuit. . . By keeping the conductors cool their resistance is maintained constant, and there follows an accentuation of heating effect at the joint where the rise in temperature increases the resistance."

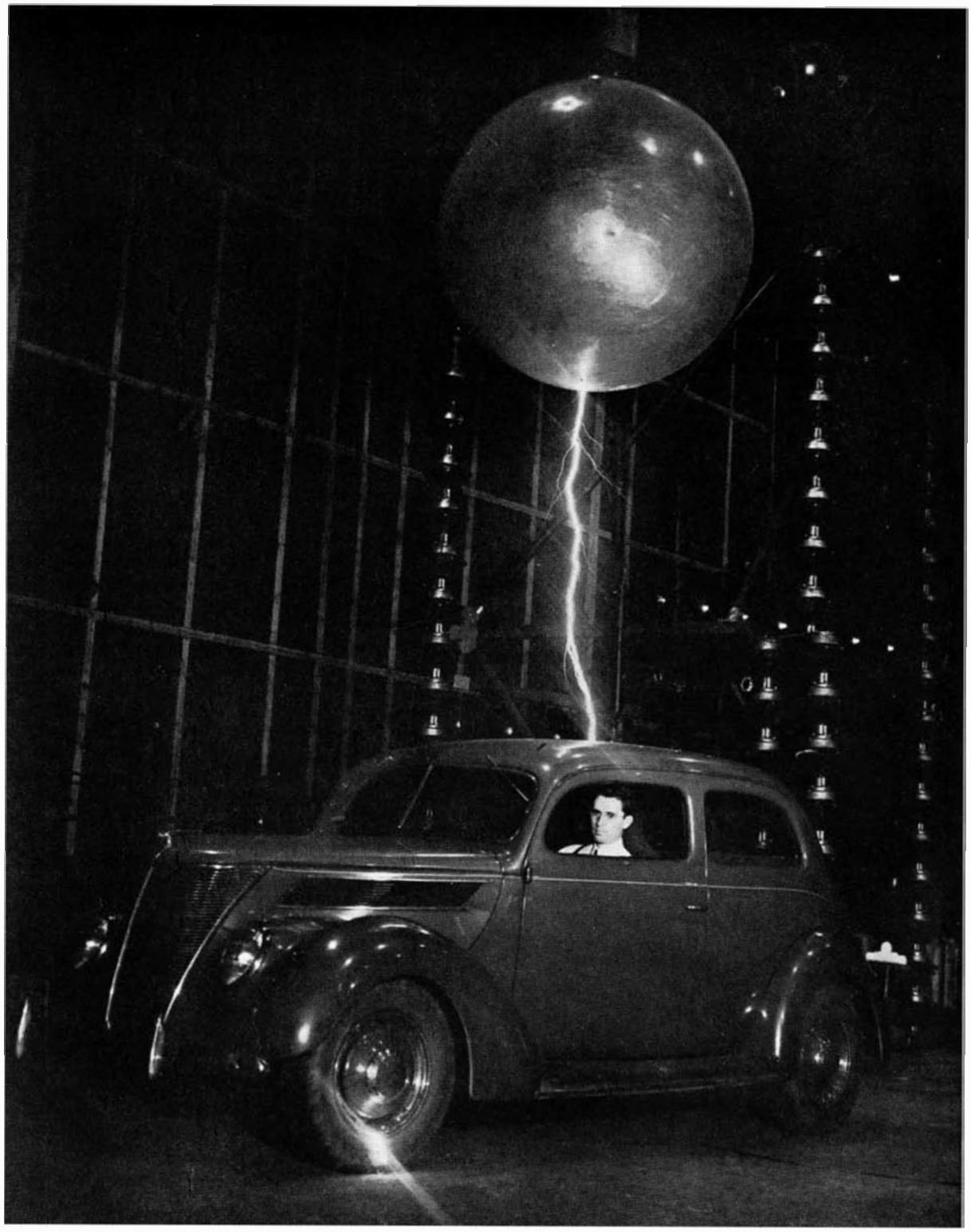
FANS—"One of the necessities of life in Japan consists of the fan, of which there are two kinds, the folding and the non-folding fan. . . The fan is an inseparable part of the Japanese dress. A native is rarely without a fan. It is his shelter from the sun, his notebook, and his plaything. . . . The Japanese gentleman of the old school, who never wears a hat, uses his fan to shield his eyes from the sun. His head, bare from childhood, hardly needs shade, and when it does he spreads an umbrella, and with his fan he directs his servants and saves talking."

"STAFF"—"Thirty thousand tons, or two thousand carloads, of "staff" will be used in the construction of the main buildings of the Columbian Exposition. . . It is composed chiefly of powdered gypsum, the other constituents being alumina, glycerine and dextrine. These are mixed with water without heat, and cast in moulds. . . The natural color is a murky white, but other colors are produced by external washes, rather than by additional ingredients. . . . The casts are shallow, and about half an inch thick. They may be in any form—in imitation of cut stone, rock-faced stone, mouldings, or the most delicate designs."

INSULATION—"The coffer dams of cruisers 9 and 10, building at the Columbian Iron Works, Baltimore, Md., will be filled with cellulose, which has been adopted by the Navy Department. The living apartments and store rooms of the cruisers are being painted with cork paint, which consists of a heavy coat of white lead and varnish, over which is sprinkled cork. It forms a non-conducting material which keeps the ship dry in warm climates and moist atmospheres."

SIMS-EDISON TORPEDO—"The torpedo is a cigar-shaped copper cylinder about thirty feet long, adapted to carry four or five hundred pounds of a high explosive in its forward end, while about amidships it contains an electric motor and steering device, with a coil of cable to be paid out as the torpedo moves, and keeping it in constant connection with the shore. . . It is evident from trials that the Sims-Edison torpedo is a highly valuable adjunct for harbor defense and also for naval operations in general."

LIGHT—"Professor J. J. Thomson has prepared a number of vacuum tubes in which there are no electrodes, but which are surrounded by coils of insulated conductors connected with batteries of Leyden jars. These tubes contain a little gas, of sorts, remaining after they had been exhausted in the ordinary way, and every time the jars are discharged through the surrounding conductors, the insides of the tubes are filled with light, which varies in color with the kind of gas contained therein."



## WHEN LIGHTNING HITS A MOTOR CAR

THAT modern steel automobile bodies are effective shields against lightning was recently proved in the laboratories of the Westinghouse Electric and Manufacturing Company, where a 3,000,000-volt stroke of man-made lightning was directed against the top of a car. Although the bolt hit the car top within a few inches of the head of an engineer seated within, the only traces of damage were small burn marks on the metal top. The circuit was completed by the charge jumping around one of the tires to ground.

# KEEP OUR TRANSPORT PLANES

## Scheduled Airlines are Essential to National Defense

A. D. RATHBONE, IV

SCHEDULED air transport lines in the United States are playing an important and readily demonstrated role in our national defense program as it exists under present conditions; how much more important their part would be under actual war-time conditions is a picture that can be sketched from data now available as a result of lessons learned in the European theaters of war.

Based on a study of passenger loads and express cargo carried by planes of his company during recent months, an official of one of our major airlines estimates that 60 percent of the passenger traffic today is traveling on some form of defense activity, that fully half of the express shipments transported by the line he represents are related in some way to defense work. Comparable percentages on the other United States airlines indicate that air transportation is furnishing a highly desirable means of speeding up our defense efforts. Add to that the fact that Army and Navy officials have requested that all possible important defense items be moved via the scheduled airlines, and a comprehensive picture begins to shape up.

Due to increased demands for air transportation, passenger travel on the scheduled airlines increased 65.4 percent for the year ending December 31, 1940. For the first six months of that year, the planes carried 492,145 more passengers than in the same period of 1939, and flew 11,838,732 more miles. In view of these increases in the nation's requirements for fast plane service, it is estimated that in 1941 our fleet of domestic airliners will be called upon to transport 1,500,000 more ton-miles of air express, 3,750,000 more ton-miles of air-mail, and thousands more passengers than in 1940 in order to keep pace with the stepped-up tempo of the national defense program. As the web of this defense production expands and affects every city and hamlet in the land, as the cry for speed, speed, and more speed crescendos during the present emergency, the demands on the scheduled airlines will increase rather than diminish.

**NATIONAL DEFENSE**

**● The air transport system of the United States must be kept intact. Our transport planes must be retained in this country where they are doing outstanding work in speeding national defense and aid to Britain, and where they would be of incalculable value to us in case of war. To these statements Scientific American subscribes whole-heartedly. Even though, as the accompanying article points out, Britain would like to acquire a large part of our commercial planes, analysis of the problem indicates that to grant such a request would be as much a dis-service to Britain as to our own country. To take these planes from their present work would be as foolish as to tear up our railroad rails to furnish steel to our British friends. Here is no question of refusing aid to a troubled nation, but rather one of preserving the facilities with which we can give them the greatest possible assistance.**—*The Editor* ●

And yet, despite these facts, it was recently reported that, in answer to England's insistent requisitions, 20 of our passenger transport planes—almost priceless in the face of present manufacturing emphasis on military airplanes and the consequent reduced production of passenger ships—have been transferred to the British for use as aerial troop transports. Furthermore, public announcement has been made of the British request for as many as 200 of our fleet of passenger planes, and privately it has been rumored that England would like to have the entire fleet.

THERE is no question here of refusing aid to embattled Britain. Rather, it is a problem of how we can continue to accelerate our production pace of war material in order to comply with England's and our own defense requirements —if we deny ourselves the only means available for rapid transportation of technicians, scientists, workers, executives, blue prints, specifications, vital tools, parts, and so on, to and from our national defense centers and our territorial outposts. And the solution to that problem gives no thought to the part our scheduled airlines might be called upon to play in actual protection of the United States should a war-time necessity make M-Day plans a reality over-night. It has been stated on good authority that approximately 350 passenger transport planes operated by the 18 scheduled airline companies in the United States—the only air transport fleet of this size in the world, outside of Germany, capable of potentially important military use—comprise the nucleus of an emergency aviation program under the Army's M-Day plans.

Despite the aerial movement of German soldiery in the Norway campaign of over a year ago, it apparently took the recent Nazi air-borne invasion of Crete and


**The emergency has increased air tonnage**

the aerial transportation of German troops and supplies to northern Africa to bring into sharp focus British consideration of the need for large planes, capable of mass transportation of troops and munitions. As a spur to this evident awakening, it has been claimed that in all movements of German army forces by air, there has been utilized a total of not over 400 transport ships. With these two factors in mind, it is not surprising that England should look longingly at our highly developed flying services, for nowhere in the world is there another comparable fleet of transport type airplanes save those now occupied 24 hours a day in maintaining our established passenger, airmail, and air-express services.

However badly our big flying ships may be needed elsewhere, their removal now from our scheduled services would, in the light of existing demands for expanded flying operations, seriously cripple defense preparation facilities and tend toward reversion to the slower pace of such activities as they existed in 1917 and 1918. A comparison between potential possibilities for enhancing speed of preparedness in those times and today leaves no room for doubt as to the value of our airline system.

With memories of difficulties attendant on troop and munition movements during World War I still vivid in many minds, contemplation of the present co-ordinated networks of expanded and improved rail, highway, water, and air transportation and the respective efforts of these utilities to provide all-out co-operation in this emergency should be gratifying. The accompanying map, showing regular routes of our scheduled airlines, for example, clearly depicts the possibilities of speedy communication between the nation's most important centers of defense production and between primary plants and factories and their subsidiaries, all of which must be continuously inspected and controlled by technical experts and executives entrusted with key positions in the present emergency.

Officials of defense industries are called to Washington for vital spur-of-the-moment conferences, the decisions from which must be immediately explained and described to meetings of draftsmen, engineers, superintendents. Government mediators in labor difficulties receive instructions at the nation's capitol and, by plane, can be on the Pacific Coast the following morning in their efforts to save loss of time and stoppage of production. Recently, the supply of aluminum in a Los Angeles manufacturing plant engaged in defense work ran dangerously low, threatening a cessation of activities. A shipment was on the way, but might not reach the factory in time. Two of our large airliners were stripped of seats, flown to Pittsburgh, received capacity loads of aluminum, and transported the metal to the plant in time to prevent a shutdown. Such incidents are typical of our needs for uncurtailed and speedy air transport in these days.

REGARDLESS of these facts, misconception has arisen in some quarters concerning the number of planes actually in use over these routes. The contention has been made that certain of these lines are dispensable, that more ships than are actually needed are operating between such major points as New York and Washington, New York and Chicago, New York and California. Proponents of this argument maintain that "surplus" transport planes may be removed from some routes and sent to Britain's aid without seriously disrupting either our rapid transit flying system of freight, mail, and passengers, or the M-Day plans for civil aviation. It is not, however, alone the number of ships flying between New York and Washington, for example, that enables the airlines to hold a schedule of 49 flights daily. It is the constant use of only a fraction of that number of planes—some of which are constantly off-duty for complete maintenance and safety check-up—operating on a round-trip basis under different crews, and each averaging 1000 miles every day, that makes this service possible. Passenger and freight records show that even this frequent schedule is heavily taxed many times. That similar conditions exist elsewhere throughout the country is borne out by the defense freight and passenger figures quoted earlier.

WHEN the all-out defense program was declared in effect, there were approximately 110 commercial passenger ships of all kinds on order in the airplane factories. Immediate demands for war

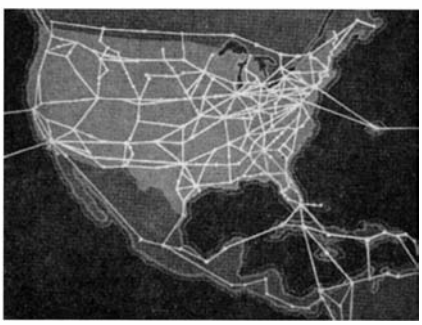
**Constant check-ups for maximum safety**


**A Stratoliner, typifying American leadership in scheduled commercial airlines**

planes relegated this construction program into the dim back-ground to such an extent that production for 1941 is estimated at not more than 50 commercial ships, barely enough for replacement of obsolete and worn-out models, and a minimum of expansion of service in normal times. With requirements for scheduled airway use increasing 65 percent last year over 1939, and an additional 40 percent increase thus far in 1941, it can readily be seen that further emasculation of our present scheduled airline facilities would place us in an unenviable position so far as national rapid transit in our defense program is concerned, and in a positively dangerous position should our air-transport system be needed for actual defense of our country.

AT THE very second that this is being read, according to data from the Civil Aeronautics Authority, and during every other second of each 24 hours, 225 common-carrier transport planes under the United States flag have on board more than 1500 passengers and 18 tons of this country's mail and express. It is, therefore, easy to see what a two-thirds reduction of our air-carrying power would do to an American sky service which, to most of us, has become as common as breakfast. As to replacement of the 200 transport ships which have been asked for by England, it would, as already noted, require nearly four years under the 1941 production pace assigned to this type of ship.

And what about defense of the United States, should such action ever be necessary, and if we should now grant a majority of our air-



**America's web of airlines: vital links in our defense plans**

liners to Britain? While the intimate and extensive ramifications of the M-Day plans are not publicly known, it is safe to assume that each of our 350 airliners has been carefully evaluated as to maximum cruising range, troop or munitions capacity, flying speed, and other factors. The 1857 airports of the United States, graded 1st, 2nd, 3rd, and 4th class by the Civil Aeronautics Authority, have come in for close scrutiny, as have all physical properties of our scheduled airways system.

To a man—or a woman—every member of the extensive personnel of the airlines is a trained specialist. The pilots, in view of their intensive training and broad experience, would prove invaluable as members of our military flying forces. American aviation mechanics cannot be surpassed. In 1940, for every 21 passengers on domestic planes there were in aeronautical service two pilots, one steward or stewardess, and 40 persons engaged in various kinds of ground work.

The potential strength and value of these flying assets in time of an all-out emergency can hardly be over-estimated. Our transport planes are essential to high-speed production of materials of war—both for the help of England in present-day fighting, and for this country in building up its defenses. It would indeed be a grave error to transfer two-thirds or more of our largest airplanes to a courageously fighting ally whose needs cannot be minimized, but who must appreciate that her own—and our—ends will best be served by leaving these same ships right where they are today.

As has been hinted, the airlines of the United States, valuable as

they are under conditions of defense preparations, would be of even greater value to us if this country should face the crisis of actual warfare. From the giant Boeings, with a 33-passenger capacity, to the Lockheeds, which carry a load of from 14 to 16 persons, the average plane of the scheduled airlines would transport a minimum of 14 infantrymen, equipped with full packs. Therefore, approximately 5000 troops could be speedily moved by the entire air fleet in a few hours from one part of the country to another. As for mobilization of the planes themselves for any such purpose, the exact location of every ship is known every minute of the day or night, and it is estimated that a "calling all planes" order would bring all 350 of them to any given series of fields within a few hours.

In the event heavy troop concentrations were deemed advisable, the ensuing shuttling process would provide our military forces with a mobility impossible through use of any other form of transportation. Such rapid flexibility of movement of men and munitions, now recognized as one of the keys to Nazi military successes, would be utterly impossible without an adequate fleet of flying transports co-operating with the land, sea, and air forces of this country.

●

*Just prior to going to press, newspapers reported a new Federal government levy on the airlines of 24 more large transports for transfer to England by August 1. We believe this must be stopped. Furthermore, it is unnecessary. On authoritative reports, there are in this country more than 100 Lockheed-Hudson bombers — ordered for England — now complete and awaiting delivery. Exact prototypes of the Lockheed Lodestar transport plane, these could be quickly converted into troop transports at small cost, thereby reserving our own airliners for the vital part they must play in our own defense.*—The Editor.

● ● ●

# Will Bacteria Be Used In War?

## Insurmountable Difficulties Stand in the Way of Employing Disease-Causing Organisms

J. J. KERSHAW

BACTERIAL warfare is the substance of the most recent tale of frightfulness that is being syndicated in the flaming sheets of the Sunday press from coast to coast. According to the diabolical schemes outlined, not only hostile armies but also the entire enemy population will be infected with bacilli in order to produce decimating epidemics at the front as well as behind the lines. Thus, annihilation of the enemy of the future by wholesale extermination will supposedly proceed much more rapidly and far more effectively than by other contemporary mechanical and chemical means. Presumably, bacterial warfare is to surpass chemical warfare in frightfulness; it seems that the engineer, and the chemist, and the biologist, too, will be given their chance to mobilize their secret bag of tricks containing disease breeders and organic poisons as weapons of attack. The horrors of medieval warfare are supposedly to be resurrected!

IN ANCIENT times the furies of war scourges accompanied Mars into the field of battle. Epidemics decimated the ranks far more thoroughly than the most terrible enemy. Whole armies were wiped out by contagious diseases. In the course of time, however, medical treatment and sanitation succeeded in harnessing epidemics. While during the wars of the 18th Century losses from diseases were nearly six times those caused by actual combat, this ratio dropped, in 1850, with the French troops during the Crimean War, to 3.2 to 1, and during the Franco-Prussian War, on the German side, to 1 to 0.6. During World War I the horrors of epidemics were practically eliminated, and it was only toward the end of that struggle that communicable diseases began to come to the forefront.

And now it is reported that military scourges are to be artificially loosed, that science is to be enlisted in converting these communicable diseases into effective weapons of warfare. That this question may be considered of especial importance is obvious from the fact that the use of disease organisms as an instrument of warfare was considered by the Conference on the Limitation of Armaments, held in Washington in 1922. An international commission, appointed at that time, reported as follows: 1. The effect of bacterial injury cannot be limited or localized. 2. Modern water purification methods protect against the organisms of typhoid and cholera. 3. Plague is a disease that would be as dangerous for the force using the organisms, as for those attacked. 4. The danger from typhus has been exaggerated. 5. Modern sanitary methods are effective in controlling communicable diseases.

Then the question of bacterial warfare suffered a lapse of interest, but during the past few years there has been a marked revival of interest in this supposed bugbear of bacterial warfare. Possibly this is only part of the effort of professional pacifists to add all the imaginary frightfulness they can picture to the known and very real horrors of war.

THE space and thought that have been given by feature writers have not been without effect, and many people now believe that bacterial warfare represents a real threat and problem for future generations.

War history through the ages clearly demonstrates that the moral aspect has nothing whatever to do with the acceptance of implements of warfare, and it would, therefore, be useless to preach morals. In the same manner as "outlawing of future wars" will not assure universal peace, disarmament conferences and national alliances will be unable to regulate future warfare, regardless of alleged brutality or of "being against the laws of Nature." After all, it is not sentiment but effectiveness alone that decides the application of new implements of warfare. The history of war weapons has taught us that the employment of a new, appar-

ently inhuman weapon, or of a very cruel implement of warfare, will be abandoned only when this weapon, through the development of combative or protective weapons, has lost its importance or has been rendered useless by the development of a more effective weapon.

WHEN in prehistoric times a certain warrior conceived the idea of employing a sling-shot instead of "*natural* weapons," such as his fists, claws, or teeth, and tossed a stone at his opponent, he loosened a storm of protest from his enemies. The use of stones in honest combat was then considered inhuman, brutal, cowardly. Nevertheless, the next time his opponent, too, did not hesitate to employ this "cowardly" method of fighting and to throw stones; presumably he picked the most jagged rocks he could find!

The same thing happened during the subsequent evolution of the sword, the lance, black powder, the firing-pin rifle, the machine-gun, the U-boat, explosive bombs, and chemical warfare. Every time somebody tried new and "inhuman" instruments of annihilation, the disgusted adversary, "forced into it," improved upon and intensified the despicable method of fighting.

The same will probably happen with biologic warfare. If ways and means are found to decimate the enemy's ranks by communicable diseases or by deadly poisons, carried into the enemy's territory, this "cruel" and "inhuman" method of fighting will be generally adopted, despite all sentimental objections. The mere fact that the eminent peace workers at the Disarmament Conference in 1923 at Geneva considered bacterial warfare seriously enough to prohibit its use, along with chemical and incendiary warfare, justifies us in considering this agency. Fortunately for the human race, the situation is such that exaggerated fears of the devastating effects of bacterial warfare are without foundation, unless an author's imagination should become a reality, and some sort of superbacillus could be cultivated. The poor prospects of successful biologic warfare may best be judged from a few typical examples.

Let us consider, first of all, the group of communicable diseases such as cholera, typhoid, and dysentery, that attack humans by way of the alimentary canal. Formerly, these diseases appeared as epidemics in time of war and peace, though nowadays typhoid and dysentery are rare and limited to narrowly confined areas; there is probably hardly an American physician who has seen, much less treated, a cholera case. But the bacilli for these diseases may be artificially cultivated, and cases may be visualized where water and foodstuffs have been contaminated with these disease germs. But would this really bring about an epidemic? By no means, for it would be suppressed at once; the remedy is quite simple. Aristotle already knew it, and gave his friend, Alexander the Great, the good advice to "boil his water and bury his dung." In those days precautionary measures were considered effeminate and ridiculous; nowadays sewer and water systems protect us from the dangers of contamination. In a civilized country, epidemics such as cholera, dysentery, and typhoid, even if artificially propagated, may be eradicated at the source.

A second group of maladies that could be serious enough to prove effective as a war weapon, provided ways of using them properly could be devised, are the communicable respiratory diseases, such as influenza, pneumonia, and the common cold. Although the latter is no real disease, it might nevertheless produce great numbers of non-effectives. It is not improbable that infected dust might be strewn by airplanes and thus find its way into the respiratory organs. But what would be accomplished by that? Practically nothing, for we do not normally inhale air that is free from bacilli, and during an epidemic of "la grippe" not *all* people become infected. Consequently, the bacilli alone do not cause an epidemic; certain secondary factors make human beings susceptible to infection. These supplementary factors so far are little known, and as long as the actual causes of epidemics are unknown, no epidemic can be artificially generated.

THE most dreaded diseases of past wars, the bubonic plague and the typhus epidemic, which even during the World War I infested particularly the Russian ranks, are transmitted by insect bites, infected fleas, and body lice. Of course, one could imagine recently innoculated rats being dropped in cages by means of parachutes from enemy airplanes. The cages open, and the rats crawl into basements and loft buildings, the infected fleas jump about, bite humans, and, within a short time the bubonic plague is rampant throughout the land. But even in this case the devil is not so black as painted. During an epidemic of "Black Death" in the Punjab in 1924, which killed hundreds of thousands of Indians, barely six white persons died among the British troops and other Europeans within the infected area. Somehow the plague seems to halt before civilized peoples; cleanliness is the best protection.

In order to produce a typhus epidemic, lice would have to be implanted within the clothing. That this trick could be accomplished successfully may not be expected of even the most resourceful spies. Moreover, there are now means of destroying lice in a very simple manner, and louse infestation is, therefore, not to be feared in modern warfare. Consequently, epidemics of typhoid, too, are eliminated from the possibilities of bacterial warfare.

VERY dangerous organisms, on the other hand, which might be mobilized for bacterial warfare, are the spore-forming invaders of tetanus, of gas gangrene, and of anthrax. All of these agents have been mentioned as possible war weapons. It is well known that wounds infected with these bacilli cause much terrible suffering, even for the slightly wounded. But, fortunately, even this system would remain an experiment with unsuitable means. In the first place, the diseases are not communicable. In the second place, shells would have to be used as carriers of the infective agents, and these are, as is well known, naturally disinfected; no living organism can withstand the temperature generated by an exploding shell.

Last, but not least, the warfare biologists mention the possible use of toxic products derived from bacteria. The toxin of the bacillus botulinus is so powerful that instances have been recorded where .005 milligram would kill a small guinea pig. For a human being, one half milligram is equally deadly, whether consumed with food, injected into tissue, or even dropped upon the mucous membrane or conjunctiva. And a spoonful would be enough to poison the whole population of a large city. A single airplane could carry enough botulinus toxin to destroy the world's

entire population. But, although these figures are mathematically correct, it is not so simple in practice. While it would not be difficult to produce the necessary amount of botulin and to transport it, the real problem involved is how it should be administered.

THERE were over 100 billion bullets manufactured during World War 1, enough to kill the entire population 50 times; but a few of us are still alive. So it is with botulin. The disease symptoms, caused by botulin, are similar to those of typhus and of cholera, and the means of defense are similar, too. As little as we have to fear from an artificial cholera epidemic in future warfare, we need not be unduly alarmed about secret botulin poisoning at the enemy's hand. Bacterial toxins are readily destroyed by the simple expedient of heating. Therefore, like bacteria, they are unsuited for transmission in shells.

Even this brief résumé shows that biologic or bacterial warfare is a phantom of the future which, while it may scare some timid souls, cannot equal in effectiveness the implements of destruction already known. After all, human beings come in daily contact with innumerable bacilli, and there is no reason to believe that they could do much more injury to civilized peoples in time of war. Admittedly, bacterial warefare would probably cause difficulties, but it would be easier to deal with than chemical gas warfare.

The important factor in the development of implements of warfare has been, and still is, effectiveness. It is, therefore, apparent that the question of whether bacterial warfare will be used or not, will depend very largely on practicability rather than on the sentimental reactions of pacifists.

Certainly, at the present time, seemingly insurmountable technical difficulties prevent the use of biologic agents as effective weapons of warfare.

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## MEDIUM TANK

### Weighs 28 Tons; Speed 25 Miles Per Hour

GENERAL specifications of the Army's M-3 Medium Tank were recently revealed by Lt.-Col. H. W. Rehm, commanding officer, Detroit Ordnance Plant. This tank is being produced at the new Chrysler-operated tank arsenal and is also being built by the Baldwin Locomotive Co.

Weighing about 28 tons, powered by a 400-horsepower Wright radial aircooled engine, the M-3 has a maximum speed of 25 miles per hour, Col. Rehm stated. Its dimensions are approximately 9 feet high, 9 feet wide, and 22 feet long. The turret and certain of the front-end parts, he said, are of cast steel weighing a total of about 6½ tons, and another 6½ tons of rolled armor plate is distributed according to the vulnerability of various locations. A single filling of the gasoline tank takes 175 gallons, which gives a cruising radius of about 350 miles at approximately two miles per gallon. The armament, Col. Rehm revealed, consists of one 75-mm gun having a 30-degree traverse and a 45-degree elevation; one 37-mm gun with a 60-degree elevation; three 30-caliber machine guns; one 30-caliber machine gun with an elevation of 65 degrees, and several light hand machine guns. The crew, he said, consists of seven men, six of whom are seated while the loader of the 75-mm gun must stand while at work.

The M-3 is a rear-engine job with disk clutches immediately ahead of the power-plant, and in front of them a synchromesh five-speed forward and one-speed reverse transmission. The drive is through the front end where the Cletac method of steering is provided. In this steering method the power is always applied to both tracks, but the inner track may be slowed to one-sixth of the speed of the outer track. In describing the tracks, Col. Rehm said that they are made up of 79 shoes, with rubber covering on the contacting surfaces, and are hinged together with rubber bushings so that there is no metal-to-metal contact. They are guaranteed for 2000 miles and last considerably longer, he stated. The bogie wheels and idler at the rear are also rubber tired, so that the only steel contact is with the driving sprocket at the front.

Col. Rehm noted that the armor plate is the latest design which does not shatter when punctured by a projectile. The only danger to the crew, he said, would be from the projectile itself or the slug of armor plate pierced out, rather than from the splinters of armor which are present when normal armor plate is punctured.—*S. A. E. Journal.*

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**UTILITY: A tank moves over seven times as far per dollar as a cavalry unit and can hurl from five to seven times as many pounds of bullets at the enemy per man employed—Army Ordnance, May-June 1941, page 604.**

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## BOMBPROOF

### Concrete Roof on Aircraft Plant

ENGINEERS for the $21,000,000 Ford Motor Co.'s aircraft engine plant, now under construction at Dearborn, Michigan, have provided a bombproof roof of reinforced concrete to protect the vital first floor from air attack damage, reports *Engineering News-Record.*

Overhead protection will be 22 inches of reinforced concrete, while service tunnels carrying electrical conduits—"lifelines" of the plant—will be buried underground beneath a 12-inch layer of steel and concrete.

It is understood that studies made in England show that bombs now in use cannot penetrate such protection. Ford engineers estimate that the first floor should be secure against critical damage from any but the most prolonged air attack.

## Reversed "Blackout"

### Glaring Lights May Be Effective Protection

A CANOPY of glaring light over a city in danger of invasion would afford better protection than a blackout, in the opinion of A. F. Dickerson, head of General Electric's illuminating laboratory.

This canopy, created by a huge battery of small but powerful searchlights pointed upward from the tops of buildings, would tend to prevent enemy flyers from locating vulnerable targets.

An added advantage of the canopy of light would be that enemy bombers, silhouetted against it, would become easier prey to defending fighter planes flying at higher altitudes. The lights would also assist anti-aircraft defense.

# When Bores Must Be Hardened

## Electro-Magnetic Induction Process Provides a Means of Improving Wearing Surfaces

A. P. PECK

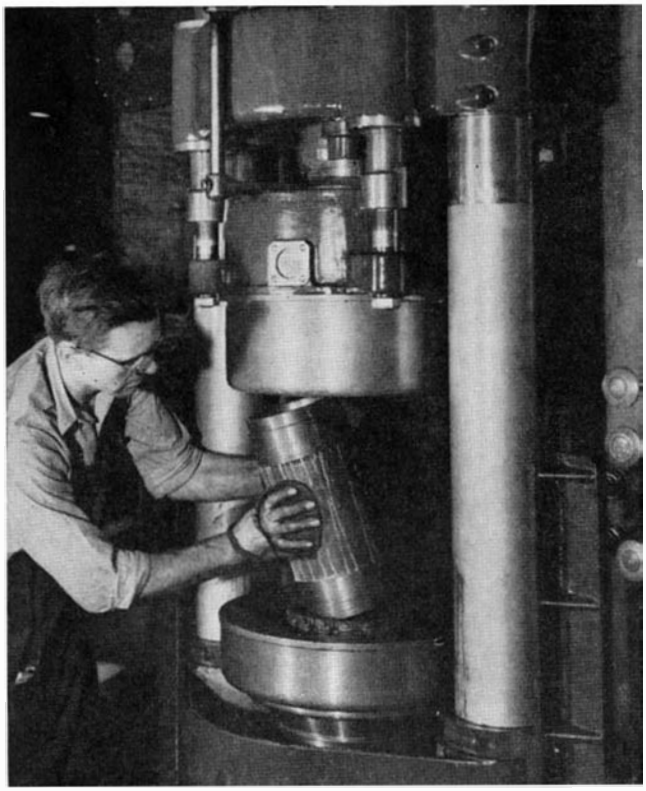
AN ELECTRO-MAGNETIC heat-treatment process which holds promise of creating improvements in nearly every ferrous product containing bores which must withstand wear or stress has already been developed into a practical production-line unit. It has long been recognized that if the bore of a cylindrical object could be hardened while the remainder of the part was held in an undisturbed condition, the entire manufacturing operation could be simplified. Existing methods of hardening, however, did not meet design and production requirements, until the induction method of heat treatment was developed by Budd Induction Heating, Inc.

The objective of the development of this system was to achieve the improved physical characteristics which would naturally result from the production of a hard bore on the interior surface of a cylinder without disturbing the metallurgical condition of the remainder of the unit. It was also hoped that a wider range of metals, including alloyed as well as non-alloyed ferrous metals, could be satisfactorily surface-hardened under production conditions. All of these desirable features have been realized and, furthermore, are being achieved in coördination with a control system which operates automatically. Thus is assured uniformity of hardness throughout the treated area, uniformity of area treated, and uniform depth throughout the area which has been hardened.

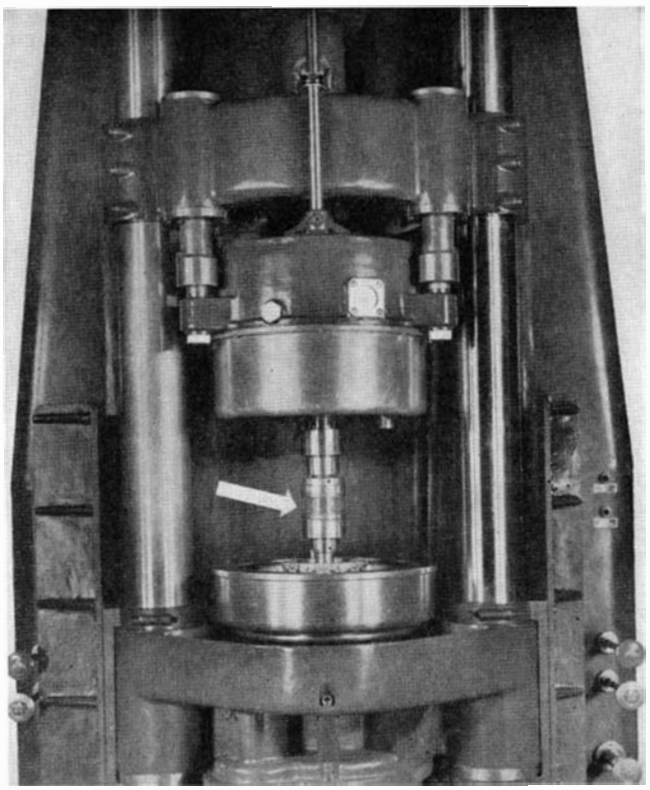
Already applications of the new process are engaging the attention of engineering departments in widely divergent fields. It is stated that aircraft engine designers are experimenting with the method and that machines for the heat treatment of oil-well casings, to increase overall strength, are now under construction.

The outstanding application of this heat-treating method, and the one which shows most graphically its implications and possibilities is that which is now producing cylinder liners used in the Diesel engines of the Caterpillar tractor line. This is regarded as the first 100-percent production application of electro-magnetic heat treatment to the cylinder bores of internal combustion engines. The treatment produces an interior bore surface of controlled hardness, resulting in a longer-wearing sleeve with markedly improved physical properties.

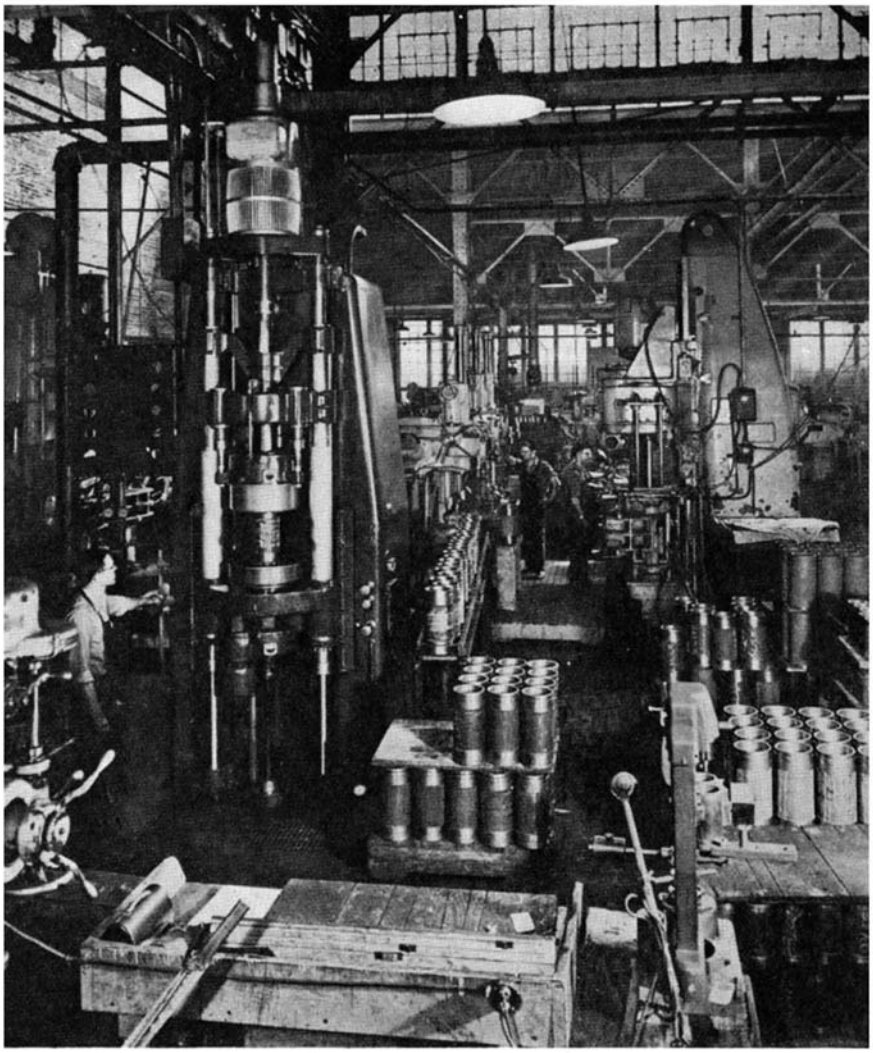
IN THIS installation, to which has been applied the name "Hi-Electro," the heat-treating machine hardens the inside diameters of the cast-iron liners to a surface hardness of Rockwell "C" 52-55, which is subsequently tempered to a slightly lower hardness. Depth of the hardened area developed is approximately .070 of an inch. Liners from 10 to 15 inches in length, with bores varying from 3¾ to



**Placing a Diesel cylinder sleeve in position in the induction heat-treating unit for hardening operation**



**Arrow points to hardening head and quenching device in operating position, but without sleeve in place**



**Heat-treating machine (left center) for electro-magnetic hardening of Diesel-engine cylinder liners is located directly in production line**

5¾ inches in inside diameter, for different sizes of Diesel engines, are in production. Following the operation of hardening and tempering, the bores are honed to the final finish, after which the liners are finish-turned for insertion into the cylinder blocks.

The finished sleeve is reported to be superior in physical characteristics and wear-resistance to any which have been previously produced. While the bores are extremely hard, providing maximum resistance to wear, the sleeves are not brittle, and quality and uniformity of product are maintained at high standards.

An interesting feature of this method of heat treatment is the fact that the hardening operation serves as an additional check on previous inspections of the units treated; the treatment emphasizes any porosity or imperfections which may have escaped visual and surface examinations.

Differential hardening by electro-magnetic induction is accomplished through the concentration of high-power, high-frequency currents in the surface zone to be hardened. As applied in the new method of hardening the inside diameters of cylindrical objects, such as cylinder liners, the currents are caused to flow almost entirely in the shallow internal surface zone to be heated and to be so concentrated that the temperature of the zone affected is raised to hardening temperature before any substantial amount of heat can drift to the remainder of the piece.

IN THIS way, the required heat is almost instantaneously generated in the zone to be hardened. This thermal energy is then "trapped" through the immediate application of a controlled water quench. An extremely hard surface is thus obtained, while the remainder of the cylinder, due to the speed of the operation, has remained relatively cool and has therefore not been affected from the viewpoint of hardening.

As the power input and timing of the current application, and the volume, pressure, and angle of direction of the quench are accurately controlled, it follows that the hardness developed, depth of the hardened area, and the area treated are also controlled within exceedingly close limits. The time required for the entire heating and quenching operation is a matter of but a few seconds.

The first successful application of the process was to the bore of automobile hubs, in which a section of the interior surface was hardened to form a roller bearing race. More than 4,000,000 of these units have been turned out for a major automotive manufacturer without a failure being reported.

COMPOSITE heat treatment is also possible with the new process. A tube which has been heat treated throughout may, as one engineer has expressed it, be "kissed" on its interior surface by the heat-treating head to produce a still harder face, thus improving wear-resistance of the bore, while retaining high physical characteristics.

High speed of production is another advantage. In the automobile hub application, for example, three to four hubs per minute are being hardened with each machine in operation. Aviation cylinders, it is claimed, can be treated at the rate of 60 to 100 per hour per machine.

The operation is accomplished through the use of a carefully engineered induction-heat head which is drawn evenly through the bore under treatment; conversely, the part may be drawn progressively over the heat head. As this head travels through the bore, a high-frequency current is applied, setting up the magnetic lines of force which result in heating of the metal under treatment. This operation is followed immediately by the controlled water quench.

The movement of the head, application of the current, and operation of the quench are all entirely automatic, thus removing any possibility of error in the process once the machine has been set for a particular operation. It is not necessary that the source of high-frequency current be placed adjacent to the machine. The power can be successfully transmitted over considerable distances

with negligible power-line losses.

The heat-treating set-up is extremely flexible, and is carefully designed for rapid change-over from one size bore operation to another. This makes possible efficient treatment of different size units without time-consuming change-overs.

As the machine is compact enough to be placed directly in a production line (as in the Caterpillar application), the need for trucking or handling of parts between the line and heating ovens is eliminated, and only one operator is required.

The heat-treating machine is, actually, a machine-tool developed for the purpose of heat treating by induction; it reduces the process of heat treating to machine-tool precision. Thus it meets the demands of modern industry for simple operation, improvement of product, increased speed of production, and uniformity of units produced. Further, it substantially lowers production costs in many applications.

The process makes possible the production of improved units in nearly every type of machine in which cylindrical metal bores are subject to wear or stress. Hardness is produced at points of greatest wear, while a tough, ductile core is retained to provide maximum strength. Physical characteristics of the parts treated are, in effect, "tailored" to fit wear and strength requirements.

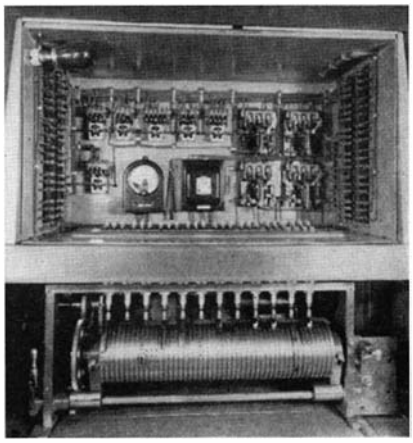
Where design of a unit permits, the outside diameter, and all other unhardened areas, can be machined after heat treatment of the inside diameter of the bore. As the depth of the hardened area is accurately controlled, the area which can be machined after the bore has been hardened can be very precisely determined.

The Budd process permits redesign of parts with lowered weights and costs in cases where localized heat treatment may favorably alter the metallurgy of the casting or forging to the point where a predetermined internal area of the original casting or forging becomes a hardened wear-resisting surface.

In materials containing temper or uncombined carbon, recombinations of this carbon at an accelerated rate can be accomplished through this method of induction heat treatment, thus increasing the "hardenability" and strength of the area treated. The grain size of the treated material may be made consistently smaller, which is an advantage in most applications; improved physical properties can be developed in this manner.

Gross distortion, scaling, necessary straightening, decarburization, the necessity for using more stock in order to compensate for adverse distortion, and grinding checks due to lack of uniformity of structure, are no longer problems. The short cycle, in combination with the rapid quench which follows, virtually eliminates oxidation. At the same time, it has been found that annealing or normalizing treatments are less frequently required before hardening than when other methods of heat treatment are applied.

To the question, "How long a cylinder can you treat?" engineers answer, "How long a bore do you have in mind?" Lengths varying from a fraction of an inch upward can now be treated, and it requires only the adoption of known engineering principles to the design of equipment to handle lengths other than those now being processed.



**Automatic controller, "brains" of the production-line heat-treating machine, maintains timed sequences of operation by means of precision cam switches**

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# New Tin From Old Cans

## Can the Tin from Our Used Tin Cans Be Salvaged—Profitably?

ALBERT G. INGALLS

A FEW months ago there was doubt whether a Pacific war would not catch this nation seriously short of tin, an almost if not entirely essential material for our civilization. Since then the tin situation has eased very considerably. Thanks to the "stock pile" of tin this nation has laid in we now have better than a year's supply of tin on hand, and it is hoped that in case of a war in the Pacific the situation could be dealt with after the lapse of that time, either by winning that war early or by a combination of using Bolivian tin and exercising economies in the use of the tin we already have. Thus the tin situation is well in hand but not necessarily solved, since wars have an inconsiderate way of lasting longer than the armchair commentators prophesy. In case, then, of a pinch, what would be our chances of recovering the large amount of tin used on tin cans, instead of throwing it away as we do at present?

This proposal has been under recent discussion in Government circles and in the tin trade and industry. The Technological Committee of the National Academy of Sciences has advised the Government that, unless and until an emergency in the supply of tin renders it imperative to conserve tin without regard to its cost, the cost of collection and recovery would be prohibitive. Others think similarly or acknowledge that the question is close to the economic borderline. Yet, despite this, tin from the used and thrown out cans of one large American city is being salvaged and at an actual profit—small, but at least a profit. Can this be just one more instance of a mere fact demonstrating the fallacy of a fine theory?

LET'S look briefly at tin, by means of a very few, rounded-off, painless statistics. (For exact statistics, see "Metal Statistics, 1941").

The world produces something like 150,000 tons of tin a year. (It's higher just now, creeping

toward 200,000 but this is abnormal.)

About two thirds of this tin comes from British Malaya, the Netherlands East Indies, and other places in the Far East.

About one sixth of it comes from Bolivia.

The United States consumes almost half of the world's output.

Something like half of this half goes into solder, bronze, babbit,

Photographs courtesy *Engineering News-Record*

**Used tin cans separated from refuse at Hyattsville, Maryland**

collapsible tubes (toothpaste, shaving cream, and so on), tin-foil, type metal.

The other half goes into tin plate.

About 90 percent of this tin plate, accounting for about 30,000 tons of tin a year, is used to coat steel cans. Tin cans contain about 98½ percent steel and 1½ percent pure tin.

We make about 17,000,000,000 tin cans a year.

TIN is not an abundant metal on this planet. It therefore costs something like four or five times as much as copper and eight or ten times as much as lead (present price of tin, about 50 cents a pound). Our hefty American appetite for tin is so strong that it keeps sucking that metal out of the earth in the Far East and hauling it around the earth's bulge to this almost tinless country in a perpetual stream. We use it only once and then throw it away. How expert is the job of minutely dispersing the 30,000 tons of tin which we withdraw from this planet's tin bank every year is seen when it is realized how efficiently we go at it. In the first stage we ship the 17,000,000,000 cans, full of food or other content, far and wide, and in the second we send the emptied cans to refuse dumps where, after the iron in them has rusted down, the tin is left in extremely small amounts in 17,000,000,000 places. The tin still is on earth but might as well be on Pluto as far as its availability to future generations is concerned. This, however, is only a conservation argument—another comparable one being the fact that we are placing millions of tons of iron about equally out of future reach by sending it to the ocean floor. We are "conserving" it.

While some have theorized that the tin from used cans cannot be salvaged profitably, the Washington Suburban Sanitary Commission, at Hyattsville, Maryland, just outside of the District of Columbia, recently has been and still is salvaging this kind of tin and selling it at a low but clear profit—and saving the tin as well. Harry R. Hall, Chief Engineer of the Commission, states that, after deducting transportation costs, labor, power, engineering, and administrative costs, also fixed charges on installation, the Commission's collected cans, crushed and baled, have been affording a profit of $3.67 a long ton. Can other municipalities do the same? Possibly they can at present when tin is high. No doubt the profit would vanish if tin prices fell even a small amount. Even so, the Hyattsville experiment is significant.

In salvaging used tin cans there are, of course, troubles.

Training the public—the average householder—to segregate tin cans when refuse is set out for city scavengers is a real problem in human engineering—you can push

**Used cans crushed and baled for shipment to a de-tinning plant**

machines around, but humans are harder.

The collected cans must then be crushed and baled, in order to save space in freight cars en route to one of the nation's de-tinning plants.

When the cans reach these plants they are again a problem. Ordinarily such plants work only on clean trimmings and scrap from can factories. The salvaged cans contain the faded remains of corn, beans, and tomatoes and are not as popular at the plants as sweet, clean tin trimmings.

The reagents that bring about the de-tinning of used cans don't get at all the tin, much of which remains in the seams.

The steel from the cans has a lowered sales value because it contains about one part in 1000 of tin, making it poor steel because of this tramp alloy.

What of substitutes for tin as a protection for the steel of cans? None having tin's long list of admirable qualities has forced its attention on the world thus far. Tin is possibly more nearly ideal for can covering than many have realized. It is at once: Strong. Inexpensive in the small amounts used on each can. Light. Nontoxic. Sanitary. Easy to work. Durable. Good to look at. Perhaps we get more of a psychological something out of food from a shiny, bright tin can than we realize.

It will not be hard to find substitutes for tin on cans if the necessity arises, but it will be hard to find a substitute that equals tin in all these respects.

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## BETTER TOBACCO

### Aromas Transferred by Chemical Means

THAT "good five-cent cigar," with color and aroma equal to a quarter perfecto, may be just around the corner, thanks to new chemical means for processing tobacco, developed at Columbia University and reported by *Science Service.*

One of the steps in the new treatment consists in the extraction of the aromatic substances from tobacco with alcohol. These substances, which give certain tobaccos their choice properties, are not affected by the treatment, and can be transferred to other tobaccos in which they are lacking. This will make possible the salvage of costly aromas from tobaccos that would otherwise have to be discarded for other reasons. It is even possible to achieve the effect of a blend by treating one kind of leaf with several kinds of aroma extracts, the Columbia experimenters reported.

Along with the aromatic sub-

stances, the resins that make certain kinds of tobacco undesirably dark also go into solution. This necessitated a second step in the process, to decolorize the extract before it is used. This is accomplished by passing the solution through a fine-pored carbon mass, on which the dark resins are adsorbed.

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**CANADA FAR AHEAD: In the production of platinum metals Canada now stands far ahead of Russia, with 57 percent of the world total, while Russia has only 19 percent. South Africa is third, with 11 percent, the United States is fourth with 9 percent, and Colombia fifth with 6 percent.—Review of Scientific Instruments.**

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## COTTON HOUSE

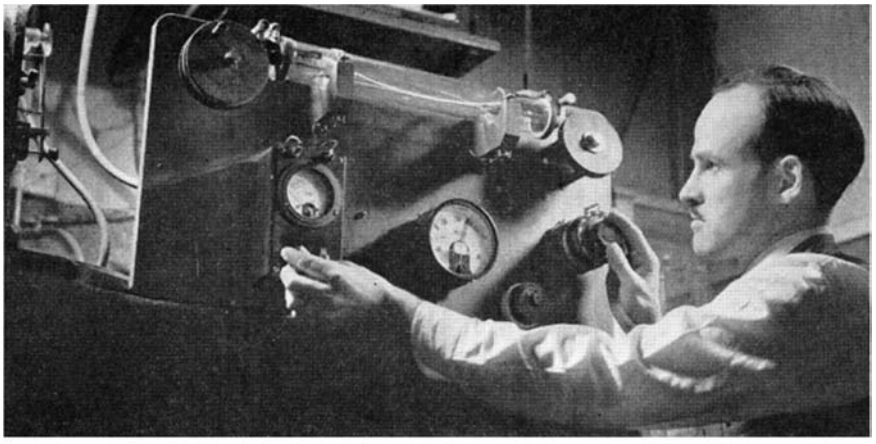
### A Possible Outlet for Surplus Crop

IN THE model cotton house, sponsored by the Department of Agriculture as an example of low-cost housing with special reference to defense needs, the walls are insulated with a water-repellent, fire-resistant cotton "blanket." This form of insulation, called Reyn-O-Cell, a product of the Reynolds Metal Company, is installed in the ceilings and the outside walls. More than one 500-pound bale of cotton

**Cotton "blankets" for houses provide insulation, are fire-proof**

goes into the house in this form; one-third of a bale of cotton is used in the flame-proof fabric covering the ceilings and the inside and outside walls of the house. The fabric is hot-pressed to fir plywood sections with a synthetic resin adhesive, providing a canvas-like surface which can be decorated in any manner desired.

It is claimed that the cotton "blanket" insulation, with space on either side for the circulation of air, will withstand extremes of climate. The air circulation aids in dissipating condensation and minimizing structural decay. In setting up the cotton house, the prefabricated ceiling, sidewall, and floor sections are tied together with a system of steel rods. Only 62 hours of labor are required for the complete erection of the house, ready for occupancy.



**Wisp of wire controls carbon content of steel**

## CARBON GAGE

### Hot Wire Controls Steel Quality

IN THE Endogas method of treating steel, developed by Westinghouse Electric and Manufacturing Company and reported some time ago in these pages, a protective gas is used in the heat-treating furnaces to prevent softening or scaling of the surface during treatment. It is necessary, however, that the protective gas be of precisely the correct composition for the work in hand.

Since the carbon content or pressure of Endogas is the critical factor, it must be carefully controlled. It is not possible, however, to make this determination quickly enough by ordinary chemical analysis; therefore there has been developed what is called a "hot wire carbon gage." In this gage a thin steel wire is heated for a few minutes in a test sample of the Endogas until a "carbon balance" is established between the gas and the wire. Because the wire retains its carbon in a solid form known as martensite, its electrical resistance and certain other physical properties can then be used as a measure of its carbon content, which in turn measures the carbon pressure of the gas. By means of this gage the quality of the furnace atmosphere can be quickly determined at any time and pre-adjusted to suit the carbon content of any steel to be treated.

## PARTITION

### Prefabricated, Ready for Plastering

BUILDING partitions in which all materials, with the exception of plastering supplies, are designed, fabricated, and shipped knocked-down as a complete unit, is the latest development of the Reynolds Metals Company. The new product, named Reyn-O-Wall, is a lightweight partition system, two inches thick, for use in the construction of non-load-bearing walls, and is made of two layers of steel-reinforcement securely attached to each other, leaving an air space or hollow core between the layers. The core is reinforced on both sides with vertical galvanized steel V-shaped ribs.

Simplified erection is claimed as an outstanding advantage of this new type partition wall. The prefabricated core sheets are self-supporting, requiring no studs, and are erected in units extending in one piece from floor to ceiling. U-shaped anchor clips of galvanized wire are supplied for firmly securing adjacent core sheets together. The resulting wall is lighter in weight than ordinary partitions, and the hollow core provides high sound-deadening value, eliminating the drum-type noises frequently experienced with solid

core partitions. As it is fire-resistant as well as sound deadening, and saves floor space, it is especially suitable for use in apartment houses, hotels, office buildings, post offices, schools, hospitals, and the like; because of its low initial installed cost, it is recommended for use in low-cost housing projects.

The partition provides substantial savings in plaster materials. Mortar thickness, uniformly maintained over the entire partition surface, prevents the tendency toward map cracking frequently caused in old-style construction by abrupt changes of mortar volume when applied to partition surfaces of the conventional type.

Door frames, electric light outlets and conduits, pipe lines, and so on, are set in place prior to erection of the system of partitions. A metal box-type base and perforated ceiling runners, together with accessories, are supplied. The base is installed directly upon finished concrete or wood floors, and the runners are tied or nailed to the ceiling, depending on the construction. The core sheets are then set in the slots in the base and attached to the vertical leg of the ceiling runner. They are securely fastened in place with annealed steel tie wires. The partition is then ready to receive a uniform thickness of plaster.

## COOL GLOVES

### Air Currents Protect Worker's Hands

In many industrial processes it is necessary for workers to handle hot materials and finished products, and in some cases even the protection of asbestos gloves is not sufficient; heat will strike through the gloves and produce scorch burns.

In one manufacturing process—the production of sealed-beam headlights in the Westinghouse Electric and Manufacturing Company's Lamp Division—employees have to lift highly heated units as they emerge from an oven. In order to produce more comfort for these workers, "air conditioned" gloves have been introduced. A low-pressure air hose is extended into the gauntlet of each glove to provide a circulation of cool air which eliminates possible burns. A surprise effect of the use of these air-conditioned gloves was that it also made possible a better product. There is less shrinkage in the lamp glass because, with the worker using air-conditioned gloves, it became possible to make a change in the pre-heat temperature.

**Prevents scorched hands**

## RUN-IN

### Engines "Broken-In" Electrically

What is believed to be the industry's only battery of electrical run-in stands for light-plane engines is used by the Lycoming Division of the Aviation Manufacturing Corporation for the "break-in" run of 65 and 75-horsepower Lycoming engines.

Tests have proved that this "cold" run-in for a period of six hours, followed by operation at full rated speed under the engine's own power, produces better results than when the engine is operated on the test stand entirely under its own power.

For Information on New Products and Processes, See the Section

**Industrial Growth**

Page 88

Before beginning its electrical run-in, each new engine is completely assembled, including all accessories, and is equipped with an oil filter to pick up any dirt or chips which may be in the engine. Fresh oil is then circulated through the engine while it is operated electrically at a speed of 1700 revolutions per minute. A flexible coupling drive is used between the electric motor and the engine, and a pressure switch is connected between the oil pressure line and the motor switch to cut off the motor automatically if the oil pressure drops below the normal operating point.

**Electrical run-in stands test 50 airplane engines daily**

# INDUSTRIAL TRENDS

## DRINK IT . . . OR SIT ON IT

FROM the coffee bean of Brazil has come, for many years, a beverage that is as truly American as are chewing-gum and ice-cream. From the same bean, as a result of American ingenuity, now may be obtained furniture and wall paneling made of Caffelite, a plastic that is making a bid for its own place in the industrial sun. Nor do the possibilities end with furniture and paneling; these are reported to be the major uses to which the new plastic is to be put, but they are only part of the story.

Many months ago (October 1939) this magazine recorded the development of a plastic material made from surplus coffee, a raw material which is so plentiful in Brazil that over 800,000,000 pounds of it, on the average, have been burned annually for the past 10 years. Obviously, such waste could not go on unchecked; it offered too much of a challenge to the inquisitive minds of those men of research whose business is to find uses for everything but the squeal.

But on this page we are not so much concerned with actual processes; our aim is to seek out and report the implications of developments as they reach the industrial stage, thus laying the foundation for an estimate of future possibilities based on present-day trends. For those who want to know more of the background of coffee plastics, the reference given above will serve; for those who would evaluate coming events by an analysis of the shadow that is cast before, the following paragraphs will point the way.

It is probable that by the time these words reach the reader there will be in operation in Sao Paulo, Brazil, the first commercial plant for the conversion of coffee to plastics. According to present plans, the capacity of this plant will be 215 bags (135 pounds each) of coffee daily. From this will be produced some 18,000 pounds of Caffelite each day. Following the completion of this first plant, two more are scheduled to be placed in operation next year. These three units will provide a potential production of 500,000,000 pounds of coffee plastics and by-products per year. That this huge total quantity will be made available to markets of the world for some time to come is unlikely; estimated world consumption of all plastics is only about 750,000,000 pounds annually. But as the use of plastics continues to increase by leaps and bounds, the time is probably not far distant when a goodly portion of this potential production will be put to useful purposes.

Chief among the outstanding features of the versatile Caffelite, developed by H. S. Polin Laboratories, Inc., New York, is its low cost. Present claims, backed by substantial experimental work, are that it can be produced at well below the cost of the various plastics now in wide use; these are available in the United States at prices from 14 cents a pound and up. Just where Caffelite will fit into the price picture cannot yet be definitely stated, but the whole scene is pretty sure to be favorable toward it.

Versatility of the coffee plastic is seen in the facts that it may be used as a complete molding plastic in either thermoplastic or thermosetting types, that it may be mixed with a variety of other plastic materials to reduce final costs, that it has chemical properties similar to those of the phenolic resins.

An interesting and industrially important sidelight on the manufacture of coffee plastic is the list of by-products that are obtained in the process. This list includes oils that are useful in the production of cosmetics, lacquers, insecticides, soaps, and other materials; vitamin components of interest to the producers of medical supplies; and caffeine, used in soft drinks.

## NEW TIRES FROM OLD

CONSERVATION of rubber supplies, a highly desirable measure in these days of economic uncertainty, may prove a blessing in disguise to at least one industry. Started some years ago to provide inexpensive motor-vehicle tire service for those who must count pennies, the tire retreading and recapping industry has grown steadily to a point where it recently received the blessing of the Rubber Manufacturers' Association. No longer an unwanted ugly duckling to be kept out of sight when company calls, the tire rebuilding industry is now assuming the role of an important factor in the tire world.

Leaders in the rubber industry have predicted that there will be a sharp curtailment of rubber consumption by the last half of 1942. This will mean, of course, an equally sharp reduction in the number of motor-vehicle tires produced. And since tire consumption is rising rapidly in the United States—replacement tire shipments early in 1941 were 25 percent ahead of those of the year before—it becomes obvious that any satisfactory expedient to reduce the need for large quantities of rubber will be well received.

## FILM SUBSTITUTES FOR CANS

DEHYDRATED foods, declared equal in nutritive value to canned foods by the Food Committee of the Army and Navy Rations Board, may help to solve at least part of the tin question discussed on this page last month, and on page 61 of the present issue. This assistance is becoming evident by the success of dehydrated soup mixtures now being sold on a national scale, protected from moisture and contamination by an envelop of Pliofilm, product of Goodyear Tire and Rubber Company.

Although soup is not the only food being packaged in Pliofilm, it serves as a shining example of the possibilities of the process. The water content of a can of soup may be as high as 80 percent. By removing this water, and later replacing it just prior to serving, not only can the soup be delivered to the consumer without the use of a tin can, but savings are found in weight and hence in shipping, handling, and storage costs. Tests involving merely placing the contents of a soup package in water and boiling for the specified time, show that the resulting food is fully equal in gustatory satisfaction to the canned variety.

The moisture-proof properties of Pliofilm have been amply demonstrated by the use of the material in raincoats, shower curtains, tobacco pouches. Now it is protecting the soup mixtures as well as malted milk, buttermilk, molasses, and other food products in dehydrated form.

—*The Editors*

# The Healing Poison

## Snake Venom Stops Bleeding and May Win a Place as a Deadener of Pain

A. H. ALEXANDER

When three-year-old Donald Richardson was admitted to the hospital in Kansas City, the doctors were not too hopeful about his chances. Donald was suffering from the rare disease, purpura hemorrhagica. Like the dread hemophilia—scourge of Europe's royalty—this disease is also one of uncontrolled bleeding. Donald was bleeding internally. Blood oozed slowly from his tiny blood-vessels, and formed purple splotches on the lining of the mouth and nasal cavities. The child grew steadily weaker as the precious fluid seeped through the thin-walled capillaries. Death was inevitable unless the hemorrhages could be stopped.

Calcium, iron, gallic acid—the old classic remedies—were tried, but without success. Time was precious. Hurried consultations were held. Finally, it was decided to try snake venom. But in each doctor's mind was the question: Could a three-year-old survive the treatment? It was new, experimental, hazardous.

The parents were approached. He may not live through it, they were told—but it's the last desperate chance. With faces wept weary by weeks of anxious waiting, they gave their consent.

In a nearby biological laboratory a white-robed assistant gingerly lifted a four-foot moccasin from its cage. Its thick, dark body squirmed vigorously in an effort to escape, but firm fingers held the reptile. A cone-shaped beaker stood nearby, with a thin membrane stretched across the top. The technician brought the snake's head near the beaker, and with a deft manipulation the jaws were forced open. The long, needle-like fangs sprang into view. Quickly the operator forced them through the membrane, and at the same time his experienced fingers found the snake's poison sacs and pressed them gently. There was a spurt of venom as the fangs pierced the membrane. With experienced fingers the assistant massaged the poison glands in order to obtain a maximum yield. The viscous, yellow fluid dropped slowly from the tapered fangs. When the last drop had been gained, the snake was carefully put back in its glass box.

The venom was rushed to the hospital. Would it save the child's life; a life that had scarcely begun?

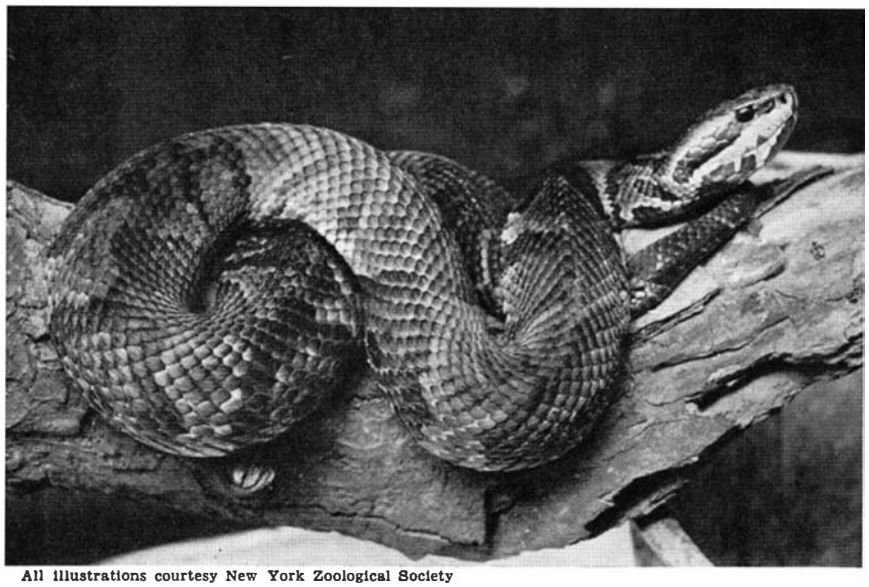
For several years scientists had been experimenting with moccasin venom as a coagulent. There had been some success—nothing spectacular — but evidence which showed that it hastened clotting and to some extent strengthened blood-vessels. On the basis of these results, the physicians hoped that by injecting small quantities into Donald's blood stream they could augment the natural clotting agent.

The first injection was three drops. The doctors waited. No harmful effects. After several days they repeated. Again they saw no evidence of negative results. They increased the dosage and shortened the time interval. For three weeks they continued to administer the venom. The child's resistance to the poison increased until he was able to withstand as much as 15 drops —a fatal dose for many an adult. Slowly the blood vessels grew stronger. The ugly purple blotches began to disappear. Snake venom had turned the tide. A smiling child emerged from the hospital—cured of the insidious purpura hemorrhagica.

It must be emphasized that not all the results with venom have been as dramatic and gratifying as in the case of Donald Richardson. Nevertheless, there has accumulated in the past few years a mass of experimental data to support the view that snake venom may one day have a fixed place in therapy.

References to the use of snake venom can be found in the literature of many peoples. These ancient accounts often relate marvelous cures of cancer, leprosy, epilepsy, and so on. The medical scientist of today approaches with skepticism these accounts of miraculous cures with snake venom. He realizes that many of the drugs and remedies which fill the old pharmacopoeias are vestiges of the days when black magic was considered more important than science in the cure of disease. At the same time, however, he is aware that occasionally these remedies have a basis in actuality.

Every physician knows that there is no sharp distinction between a drug and a poison. When used unwisely, many of our most beneficial drugs become poisonous. Conversely, a number of poisons—strychnine, mercury, arsenic—are



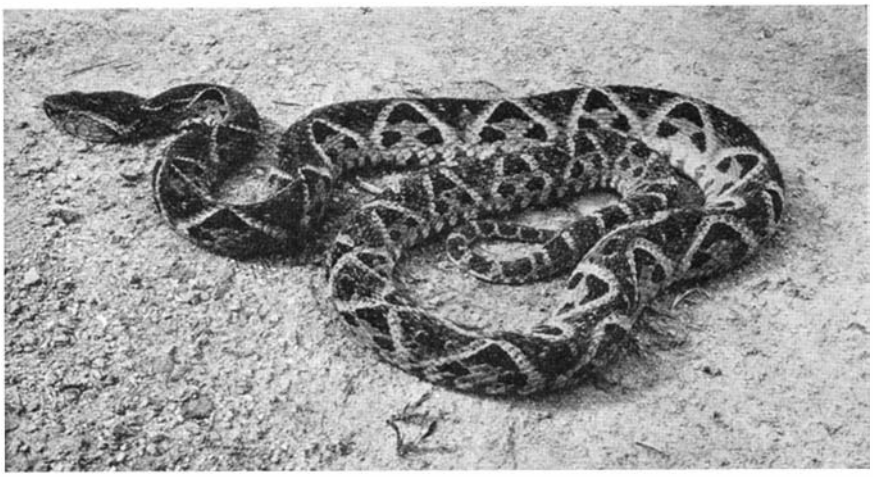
All illustrations courtesy New York Zoological Society

**The water moccasin, whose powerful venom is used to stop bleeding. In some cases the poison is used in a high dilution of one part to 3000**

valuable medicinals when employed carefully. The most important factor is the size of the dose; not necessarily the character of the drug itself.

Roughly speaking, there are two kinds of toxins in snake venom: one which attacks the blood cells, and another which destroys the nerves. The former is called hemolysin; the latter neurotoxin. Venom may be of one type or the other; often it combines both. Cobra venom is essentially neurotoxic in effect; the moccasin's is hemolytic. Hemolysin breaks down the blood cells. Neurotoxin, on the other hand, attacks the nerve centers and the nerve endings. This brings about a paralysis which, when it reaches the respiratory organs, results in death by asphyxiation.

The greatest success thus far with snake venom has been in the control of bleeding and in the relief of pain. It must not be assumed, however, that the last word on venom therapy has been said. On the contrary, the work is still in its infancy. Some of the conclusions of the early enthusiastic investigators have not withstood the test of re-investigation. Nevertheless much research is going on and progress is being made. But, until more definite results have been obtained, physicians will continue to be wary about making sweeping claims.



**The fer-de-lance, of tropical America. Diluted to one part in 5000, its venom is applied directly to bleeding tissues, often in dental surgery**

ONE of America's foremost researchers in the use of venom is Dr. Samuel Peck, of the Mt. Sinai Hospital, in New York City. In 1931 he and a colleague, Dr. Sabotka, discovered that they could make rabbits resistant to an acute type of focal purpura by injecting moccasin venom. With other types of skin hemorrhages they had equally encouraging results.

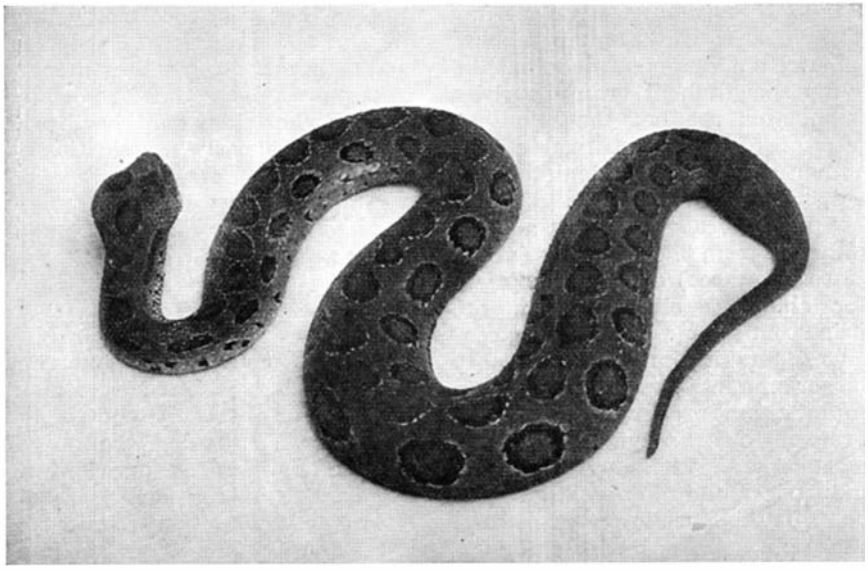
The blood of hemophiliacs—congenital bleeders—which normally required as long as from 20 to 45 minutes to clot, could be made to clot firmly in 17 seconds by adding a dilute solution of the venom of the Daboia snake. This snake, a native of India, is commonly called Russell's viper; its bite is extremely poisonous. Hemophiliacs rarely live to a ripe old age. When a victim of this incurable disease starts bleeding, the danger is acute. Small skin abrasions, or a minor operation, may lead to the loss of a huge quantity of blood. The mere extraction of a tooth often proves fatal. The venom of Russell's viper has helped in some cases to stop this kind of bleeding. Chronic nose bleed, as well as other types of intractable bleeding, has responded to treatment with venom.

At the Mayo Clinic, Doctors C. H. Watkins and G. J. Thompson tried moccasin venom for a serious kidney disorder which is accompanied by blood-stained urine. Improvement in the control of the hemorrhages was noted in all cases.

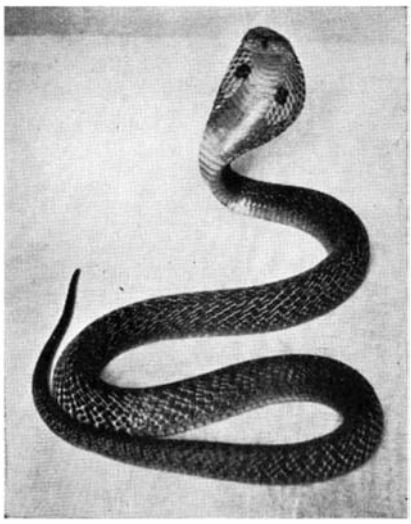
AT THE gynecological and obstetrical service of the Lincoln Hospital, in New York City, moccasin venom was tried on 100 expectant mothers. The problem was to study its effect on bleeding at childbirth. The women were divided into two equal groups. One group was given venom injections previous to delivery; the other was not. Subsequent results showed that the period of bleeding was definitely shortened for the injected group. The amount of blood lost was also materially decreased. An analysis of the blood in the cords of the new-born infants indicated that no venom had entered into the circulation of the child. Neither mother nor child suffered harmful effects. It was suggested that the use of venom in childbirth might be especially valuable for anemic women, where loss of blood is dangerous; also in those patients whose previous history indicated a tendency toward excessive bleeding.

In India, the sinister and deadly cobra has been public enemy number one for many years. In recent times, however, scientists, many of them Indian, have turned the enemy into a friend. The cobra still kills thousands of natives each year. But in the hands of medical scientists the venom is not a weapon of death; it has become a valuable aid in the triumph over pain.

The experimenter, Macht, has



**The Russell viper, which causes more deaths in India than the cobra. Its highly toxic poison, greatly diluted, is also used to stop bleeding**



**The venom of the cobra is largely neurotoxic and is one of the class used to stop intractable pain. Effect is much more enduring than opiates**

demonstrated that cobra venom, like opium and morphine, relieves pain by its action on the higher centers of the brain. But, whereas the action of the opiates is quick and short-lived, the venom, on the other hand, is slower to manifest itself, though the effect lasts longer. Five mouse units of venom injected twice a week is often sufficient for alleviation of pain. Venom is not habit forming and, unlike the alkaloids, does not induce sleep. Cobra venom not only acts on the brain, but it also paralyses the sensory nerve endings. Macht injected the venom into muscles, and then showed that the sensitivity of the nerves to the shock of an electric current was diminished. Nevertheless, Macht's findings require fuller confirmation by other scientists before they can be regarded by medicine as safely established for widespread use.

Macht's investigations, when sufficiently substantiated, may add a new pain killer to the doctors' list. Already there have been scattered reports indicating its successful use in specific cases. At a hospital in Salpêtriére, France, it proved valuable in relieving cancer pain in advanced stages. In this country, two Southern physicians used it in relieving the pain of shaking palsy. In India, two native doctors, J. S. Chowan and R. N. Chopra, have had interesting results treating leprosy with cobra venom. Seventy-five percent of the lepers in that country have the nerve type of the disease; infection is primarily along the nerve lines. The suffering seems to be like that of neuritis, with muscular pains, pins-and-needles sensations, and the peculiar feeling that ants and flies are crawling on the skin. In this disease, an important factor in the restoration of health is the necessity of keeping up the patient's morale. Relief from pain is therefore a primary requirement.

Cobra venom was distributed to the various leprosy hospitals in India. It was given extensive use. The results indicated that most of the patients were afforded relief from the shooting pains of nerve leprosy. In about 6 percent of the cases the results were negative.

There is still much to be learned about the exact role of venom in the relief of pain and the cure of disease.

The venom of other animals, particularly the bee, has been tried in rheumatism and arthritis, but as yet the results have been inconclusive. Experimenters in many countries are hard at work. New preparations and new techniques are under scrutiny. Perhaps, one day . . .

• • •

## SALT LOSS

### Leading Medical Journal Favors Its Replacement

THE amount of sweat excreted by workers in hot industries is known to be prodigious, at times amounting to several pints an hour. Consumption of water alone to replace abnormal loss of body fluids leads to the condition commonly referred to by miners and furnace workers as "water poisoning." Present-day knowledge of water and metabolite balance has demonstrated that the symptoms of heat cramp or heat exhaustion are not the result of overconsumption of water but rather the serious depletion of chlorides.

Normally, a man needs a daily intake of from 8 to 15 grams (about ¼ to ½ ounces) of salt to make up for chlorides eliminated in the urine and sweat. In case of excessive perspiration, considerably larger amounts of salt are required to maintain proper balance. The practice of supplying industrial workers with salt, therefore, in hot industries and in hot weather rests on sound physiologic principles. Close observation by many industrial physicians indicates that harmful results need not be expected in otherwise healthy men if there is rough approximation between salt loss and salt replacement.

Many industries, because of convenience, provide salt tablets by dispenser to be taken by the worker with each drink of water. Dextrose is frequently incorporated in the tablet on the assumption that a quick energy source is provided and that it is of value in combating shock associated with heat exhaustion. Actually, blood sugar levels in hot industry workers are not found to be measurably altered.—*Journal of the American Medical Association.*

## NEW DRUG

### Sulfa Drug Causes Less Nausea Than Older Treatments

ONE of the new sulfa drugs, sulfadiazine, is as effective in pneumonia and other similar infections as the best of the older chemical treatments, but with less discomfort due to the treatment, three Boston physicians, Dr. Maxwell Finland, Elias Strauss, and Osler L. Peterson, have reported to the *Journal of the American Medical Association.*

Toxic effects were relatively mild and infrequent, only 9.2 percent becoming nauseated.

Sulfadiazine was used in the treatment of 446 patients with various infections. It appeared to be highly effective in the treatment of the following diseases: pneumococcic, staphylococcic and streptococcic pneumonias; meningococcic infections; acute infections of the upper respiratory tract including sinusitis; erysipelas; acute infections of the urinary tract, particularly those associated with Escherichia coli bacilluria, and acute gonorrheal arthritis.

## GONORRHEA

### One More Disease Gets Its Walking Papers

COMPLETE control of gonorrhea is promised by a new treatment which cures in 100 percent of the cases, Dr. William Bromme, of Detroit, has declared, according to a *Science Service* report.

Complete cures in three days of 100 out of 100 men were achieved by sulfathiazole treatment, Dr. Bromme reported. Large doses of

the drug, averaging 60 grains a day, continued in the same dosage for 48 hours after the patient is apparently cured, are the secret of how to achieve real cures of this dangerous and often crippling disease, he said.

The patients in his series were crane operators, foundrymen, and others employed in heavy industries. None of them lost a single day from work while taking the treatment. The sulfathiazole is given by mouth. Mild nausea in 23 patients and fever of 100.6 degrees, Fahrenheit, not enough for most persons to know they had fever, in six patients, were the only reactions to the drug.

All previous methods of treating gonorrhea have failed, Dr. Bromme stated, because the drugs used could not get at the germs. It has been a common medical mistake, he said, to suppose that gonorrhea germs stayed on the surface of the infected area long enough for medicines applied to surface areas to reach the germs. It takes only a few hours for the gonococcus to get below the surface to the deeper tissues where it lives.

Sulfathiazole succeeds in killing the gonococci where other drugs have failed because it also gets below the surface. This same situation explains the failure of attempts at chemical prophylaxis of gonorrhea, Dr. Bromme believes. The disease had developed in 36 of his patients despite the use of various commercial prophylactics.

The prompt, complete cures of gonorrhea possible with adequate sulfathiazole treatment will lead to the disappearance of the crippling caused by gonorrhea. Dr. Bromme predicted that within 20 years there will not be a case of gonorrheal crippling or other complication to demonstrate to medical students.

## DESENSITIZATION?

### Warns Against Chewing Poison Ivy Leaves

WARNING against chewing poison ivy leaves in an attempt at desensitization to the poisonous principle of the plant appears in a report by Dr. Seymour H. Silvers, of Brooklyn, New York, in the *Journal of the American Medical Association.*

He reports the case of a woman who, having had ivy poisoning from contact with the plant for seven years, had been advised by her physician and friends to chew the leaves of the plant with the idea of preventing further attacks. As a result she had a severe eruption on her face, lips, and around her mouth, and her tongue and cheeks were so sore that she could not eat properly for two days.

Protection against ivy poisoning is frequently attempted by injecting gradually increasing doses of the poisonous principle, something like the desensitization treatments for hay fever. While it is possible to try giving this treatment by mouth, Dr. Silvers states, "it is unwise to suggest the chewing of poison ivy leaves, for the dosage cannot be controlled by this method and untoward reactions may result."—*Science Service.*

## DIAGNOSIS

### Detecting Viruses, Toxins, and Poisons

A NEW method of detecting viruses, toxins, poisons, and other tiny and invisible substances suspected present in liquids is disclosed in a patent recently issued to Dr. Irving Langmuir of the General Electric Research Laboratory.

The procedure, Dr. Langmuir explains, may prove useful to the study and control of biological reactions involved in the diagnosis and treatment of disease. The method provides for the immersion of a conditioned slide in a liquid containing the suspected virus, toxin, or poison, and for the measurement by optical methods of the film, usually less than a millionth of an inch thick, that adheres to the slide.

Stearic acid, a fatty acid, is spread on the clean surface of a dilute solution of barium chloride in water in a tank. A chemical reaction causes positive ions of the barium chloride to unite with the negative carboxyl group of the stearic acid to form barium stearate, an insoluble soap, on the liquid surface. A clean slide is dipped repeatedly into the tank until 47 layers of the transparent barium stearate, each 1/10,000,000 of an inch thick, have been applied smoothly to the slide. The slide then is dipped into a one percent solution of thorium nitrate.

This procedure constitutes the conditioning process which makes it possible to apply to the slide a substance that has a specific reaction toward the particular toxin, virus, poison, or other substance for which the test is to be made by an investigator.

If the suspected substance is present in the solution tested, *adsorption* of a single layer of uniformly thick atoms or molecules of the substance will take place on the slide surface, producing an increase in film thickness and a corresponding change in color.

It is known that thin films of a transparent material, such as barium stearate, reflect iridescent colors, the color of a film being dependent upon its thickness. A film which has a thickness of 47/10,000,000 of an inch reflects a purple color when illuminated by white light. If the film is made slightly thicker, the color changes toward blue. Therefore, changes in thickness can be measured by observing changes in color. In actual practice, the films commonly are illuminated by sodium light and the changes in intensity of the yellow sodium light are measured.

Each type of substance in solution is expected to produce a characteristic increase in film thickness and corresponding change in color of the conditioned slide. Once these characteristic thicknesses and colors for known substances have been determined, identification of suspected substances will be a matter of check and comparison with the established standards.

## LIP CANCER

### May Come from Chronic Sunburn, Not Smoking

SO-CALLED smokers' cancer, when it occurs on the lower lips of laborers, may be due to chronic inflammation from habitual sunburn and not to smoking, as has previously been believed, according to Dr. George C. Andrews, of Presbyterian Hospital, New York, reports *Science Service.*

"Sunlight, like most things that are good for us, if indulged in to excess may be harmful, even to the point of causing cancer," he said.

He sees no reason, however, for alarm on the part of persons who go in for suntan as a fad or who work in outdoor occupations, because skin cancers occur where they attract attention when still small and they can all be cured if properly treated.

# A Puzzle Solved?

## A New and Promising Interpretation of the Old Problem of the Solar Corona

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

FIFTEEN years ago the spectroscopic study of the heavenly bodies left us with three great unsolved problems. We knew the origin of most of the lines and bands in the spectra of the Sun and the stars, but the dark absorption bands in the spectra of the major planets, and the bright emission lines in the spectra of the gaseous nebulae and the solar corona, had never been matched in the laboratory despite many efforts. Enough was known about atoms by that time to make it certain that these unknown spectra were not produced by atoms of some strange kinds unknown on Earth. We were sure they must be due to known elements or compounds, and suspected that they might come from common substances under unusual conditions. The discovery of their origin showed how true this was. The planetary bands are given by ammonia and methane—acting in thicknesses far greater than had been tested in the laboratory. The nebular lines turned out to be due mainly to oxygen, nitrogen, neon, and argon—literally to thin air. But the problem of the coronal spectrum still defied solution.

These lines could be investigated only during a total solar eclipse, until Lyot, in 1937, invented a most ingenious way of observing the stronger ones in sufficiently clear air. Nor are they very numerous; but 22 of them have been detected and measured, from the ultra-violet to the infra-red, and not one agrees with any known laboratory line. (A red line at λ6374 agrees closely with a line of oxygen; but three other oxygen lines, spectroscopically related to this one and always appearing together with it, are absent in the corona, so that this coincidence must be accidental.)

As time passed, the problem of these lines has become more and more puzzling. They can not be ordinary "permitted" lines—these have been thoroughly listed for all the elements. Nor can they be "forbidden" lines of the same sort that appear in the nebulae. All spectral lines (we may recall) are produced by transitions of some atom from an excited state of high energy to a state of lower energy. Normally such a transition will happen in something like a hundred-millionth part of a second; but there are other transitions so improbable that the atom must be left alone for a whole second, or even more, before they have any good chance of occurring. If an atom, in a given state, has the alternative of getting rid of its energy by a probable or an improbable transition, the number of the latter will obviously be negligibly small. But there are some "metastable" states such that, though the atom still contains more energy than in lower states, all the transitions to these are of the improbable sort. If left alone long enough, it will make one of these transitions, and unload its energy. But in a stellar atmosphere, or in an electric arc or spark, the atoms collide with one another millions of times per second, and the improbable transitions are "forbidden"—not by any absolute law of nature, but by the disturbing influence of their neighbors. In the nebulae, where the density is exceedingly low, collisions are so rare as to be negligible and the forbidden lines appear strongly.

THE density of the corona is probably quite low enough to offer no serious obstacle. But an atom can also be got out of a metastable state by absorption of light, which knocks it up to another state of much higher energy. The corona is exposed to a tremendous flood of sunlight, and metastable atoms in it would not be let alone long enough to have a chance to emit forbidden lines. This argument, due to Eddington, still holds, after allowance is made for the fact that many of these absorption lines are far in the ultra-violet, where the Sun's radiation is weak.

This apparent *impasse* has just been most ingeniously circumvented by an explanation of the coronal spectrum offered by the brilliant Swedish physicist, Dr. Edlen, of the University of Upsala. If very highly ionized atoms are present in the corona, their "permitted" absorption lines will be beyond the ordinary ultra-violet, almost in the region of soft X-rays, where the Sun's radiation is probably very weak. Such atoms would be little disturbed and would have a chance to emit these forbidden lines.

EDLEN was led to his interpretation in a different way. Having one of the very few spectrographs which will record the very short waves just mentioned, he has been systematically studying the spectra of highly ionized atoms and working out their energy levels, metastable and otherwise.

It was the German spectroscopist, Grotrian, who first noticed, in 1939, that a transition from a metastable level to the bottom-level in an iron atom which had lost nine electrons would give a line agreeing with the red coronal radiation at 6374, and that others in iron with ten electrons gone would give a fainter line at 7892.

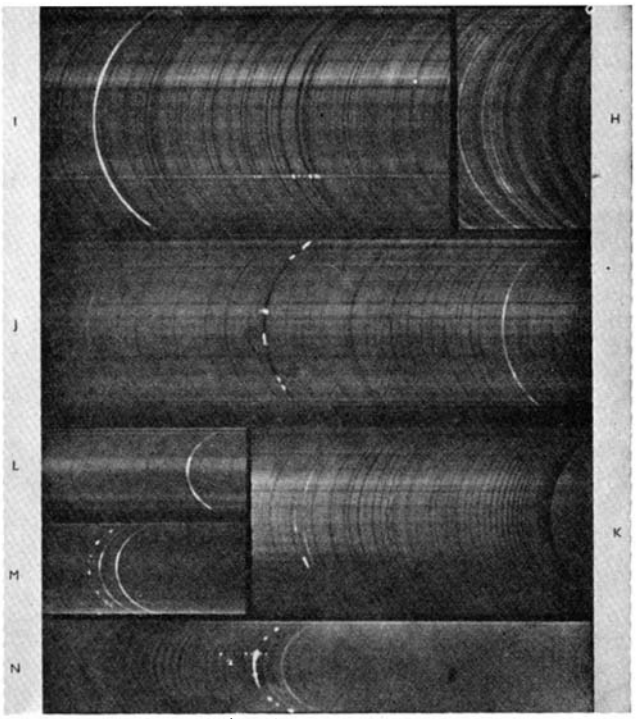
Following this lead, Edlen identified two fainter lines in the ultra-violet as due to similar transitions in Ca XII and Ca XIII—that is, calcium atoms deprived of 11 and 12 electrons. (Ca I denotes calcium with *all* its electrons, Ca II has *one* gone; hence the apparent discordance.)

In these four cases, the spectra and energy-levels had already been worked out, so that the position of the forbidden lines could be predicted with considerable accuracy. (There is an inevitable loss of precision in working out the position of a visible line from measures in the short wave region. It is the number of waves per centimeter that really counts, and the relatively small value for the visible line is derived from the difference of two much larger numbers for short waves, so that its percentage accuracy is lower.)

The spectra of still more highly ionized atoms of iron have not yet been worked out. But, from the

many cases already studied for different elements, it is possible to find general rules, governing the relative positions and separations of the metastable levels, which permit the extrapolation of the known data to predict those for higher degrees of ionization.

When this was done, the results were remarkable. An iron atom deprived of 13 electrons should have only one metastable state. The transition from this to the "ground-state" gives a line agreeing (within the uncertainty of prediction) with the famous green coronal line at 5303, the strongest in the whole spectrum. This is the only forbidden line of Fe XIV. For Fe XIII (12 electrons gone) there are four metastable states. The transition from the lowest of these to the bottom gives Lyot's very strong infra-red line at 10747; that from the next above to this, his other great infra-red line at 10798; while that from the third state to the second accounts for the strongest ultra - violet line, at 3388.




Courtesy *L'Astronomie* (Paris)

**Spectrum of the solar corona, photographed by Lyot with his coronagraph. Lines mentioned in the text, in the order of mention, are: 6374, in *J*, at right; 7892 in *L*; 5303 in *I*, at left; 10747 and 10798 in *M* and *N*; 3388 in *H*. The illustration is a composite**

SEVEN coronal lines are now accounted for by iron atoms deprived of 9, 10, 12, or 13 electrons. Why not other numbers also? The rules of spectral structure show that an iron atom deprived of 7, 8, 14, 15, or 16 electrons has no metastable state. With 11 electrons gone there are four such states, but so grouped that transitions between them give lines too far out either in the infra-red or ultra-violet to be observed. To complete this list, we may note that iron atoms lacking from one to six electrons give forbidden lines which have been observed in novae and some peculiar stars, but not in the corona.

We can hardly ask more of iron. Its forbidden lines account for 90 percent of the whole intensity of the bright-line spectrum of the corona. Applying the same principles of prediction to other elements, Edlen identifies six more coronal lines as forbidden lines of nickel, from Ni XII to Ni XVI. Since a neutral nickel atom has 28 electrons, while iron has 26, the stripped atoms have in both cases from 13 to 17 electrons, and the spectra are similar in structure; for example, Fe X and Ni XII. The strongest of these nickel lines is at 3601. It belongs to Ni XVI and is exactly analogous to the strongest iron line at 5303.

This study gives identifications for 15 out of the 22 well-established coronal lines; but this is hardly a fair statement, as the seven remaining lines are all faint and contribute less than three percent of the total radiation. Some of these faint lines may be identified when the spectra of other elements can be studied; but potassium, chromium, manganese, and cobalt, for which good data for prediction exist, "do not account for any of the coronal lines as yet observed." These elements, by the way, are much less abundant in meteorites than iron and nickel.

The energy required to remove so many electrons from these heavy atoms is great. To pull another electron off requires from 230 to 350 volts for the various states of iron, from 320 to 450 volts for nickel, and about 600 volts for calcium. It is noteworthy that the behavior of the lines in the corona is related to this. Lyot, some years ago, grouped the lines which appeared to be strengthened or weakened in the same regions. One group contains "200 volt" lines, and and the other correspond to about 350 volts.

Where the enormous energy required to tear the atoms so much to pieces comes from is still unknown. We have only one clue. The coronal lines — notably the green line — are very wide. Lyot, who has made the best observations, finds a width of about an Angstrom unit. Now, forbidden lines are by their nature very sharp, and the only reasonable cause for the observed widening would be rapid random motions of the atoms, ranging up to 30 km-sec in each direction. Atoms moving as fast as this would probably do each other a good deal of damage when they did collide, and this may help to account for the high ionization.

It is hard to see how these stripped atoms can maintain so high a degree of ionization if the corona, as has generally been supposed, contains many free electrons. But apparent difficulties of this sort often turn out to be guide-posts directing us to new knowledge.

One difficulty, moreover, disappears — the fact that the coronal lines have never been produced in a terrestrial laboratory. To smash even the outside of atoms to this extent, and then keep individual atoms smashed for an enormous length of time, such as a second, still far exceeds our technical capacity.

The other abundant elements in meteorites — oxygen, magnesium, aluminum, silicon, and sulfur — when ionized to the same level of energy, have no forbidden lines in the observable region.

Until such spectra as Fe XIII and Fe XIV have been thoroughly analyzed in the laboratory, Edlen's conclusion cannot be regarded as established above all doubt. But it is the first, and indeed, the only rational explanation of the spectrum that has ever appeared. The author plans to confirm and extend it, so far as his obligation of military service to his country permits.

*—Princeton University Observatory, June 2, 1941.*

# 'Sky-Hooks' in Bridge Building

## Temporary Cables Slung from Towers Help Build Fixed-Arch Span Across Niagara

HERBERT H. FOSTER

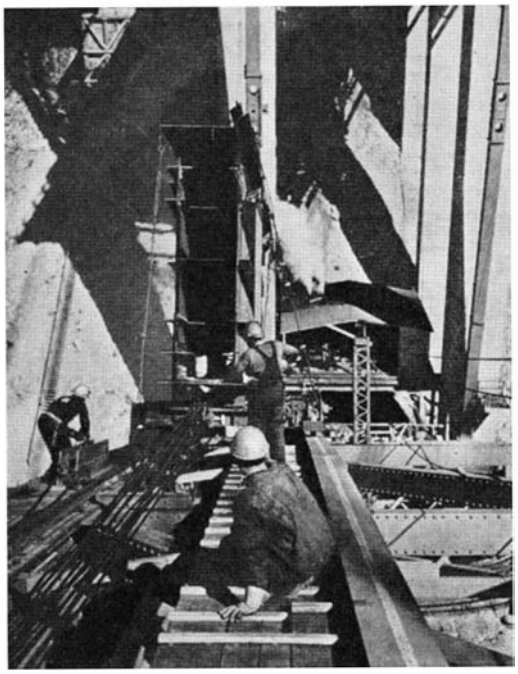
DESIGNED to replace the famous Honeymoon Bridge, destroyed by a record ice jam in 1938, a fixed-arch bridge is nearing completion across the Niagara River and gorge. The new structure, called the Rainbow Bridge, is reported to be the largest of its type in the world. According to present plans it will be opened to traffic sometime during the fall of 1941.

One of the engineers on this unusual project has well summarized the out-of-the-ordinary aspects of the job by stating that it was "about 90 percent engineering and only 10 percent erection." Some idea of the difficulties involved may be gleaned from the fact that the arch spans what is rated as the fastest natural flowing water in the world. Hence it was decided that it would be economically impractical to erect any kind of supporting piers or bridge substructure in the stream.

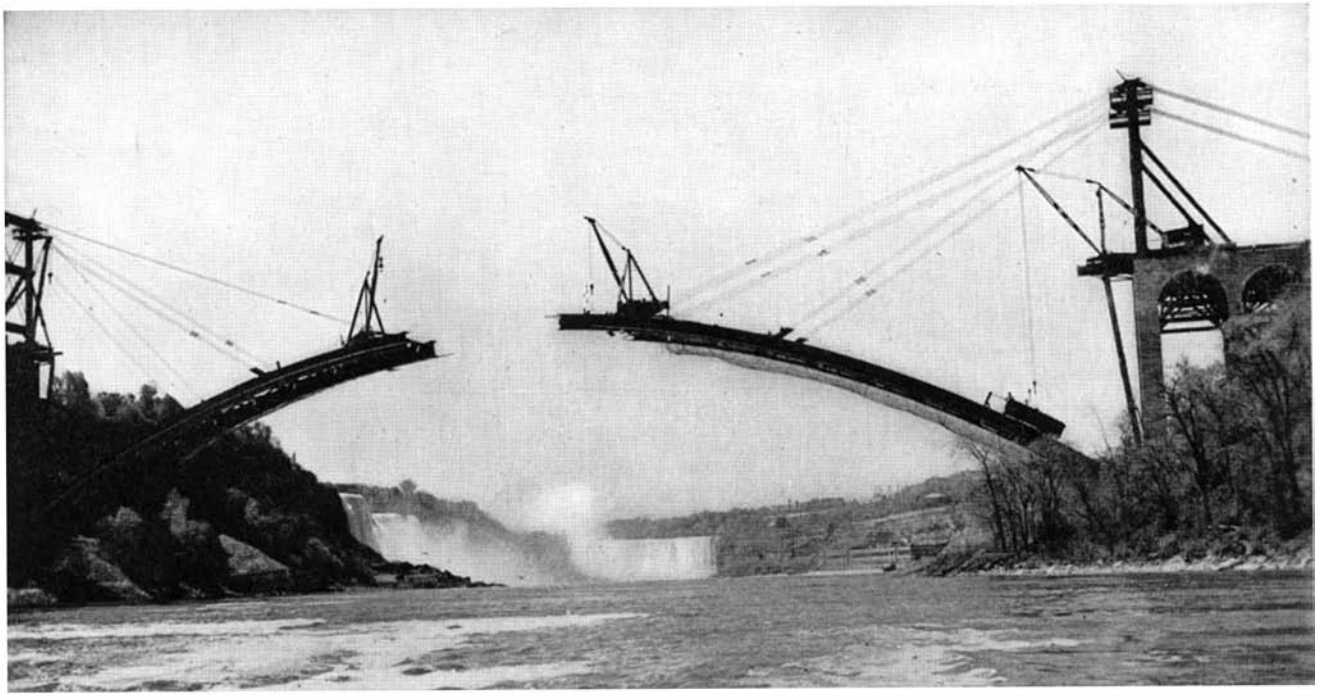
At the bridge site, the imprisoned river, forced by the falls through the narrow gorge, flows at a speed of from 25 to 30 miles an hour. At this point the stream is over 175 feet deep. It has a volume of about 6,000,000,000 pounds of water a minute.

Ground was broken for the bridge project on May 16th, 1940, at a site close to that formerly occupied by the Falls View (Honeymoon) Bridge. At this point, about 1000 feet down-stream from the American Falls, the gorge is some 200 feet deep and 1000 feet wide. The steel arch of the bridge has a span of 950 feet—the completed deck will be 1450 feet long—and rises from supporting abutments on the Canadian and American sides of the river to the level of the top of the deep gorge.

The main arch span, of the hingeless ribbed type, consists of two steel box girder ribs spaced 56 feet apart. Each section of the arch is made up of 24 girders, each 12 feet high and weighing from 49 to 75 tons. Approximately 3500 tons of steel are used in the arch and 2000 additional tons in supporting structure and decking. The two ribs of the arch are braced with



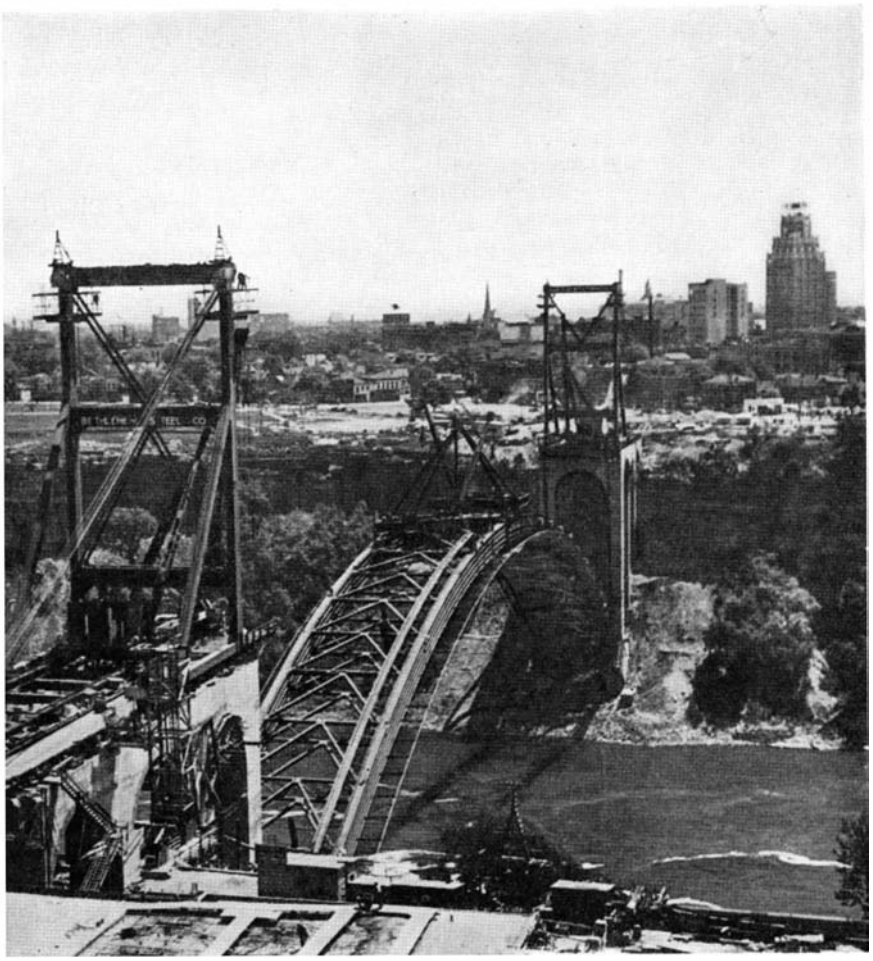
**Motivated by a stiffleg derrick, 55-ton section of steel box girder moves up the curve of the Rainbow Bridge arch, to take its final place in the structure**



**Forming a new frame for an old vista of Niagara's cataract, the 85-ton derricks, on the shore abutments, and the 40-ton derricks, perched high on each span above Niagara River, speed construction of the Rainbow Bridge**

steel members for rigidity and to resist forces produced by wind pressure and live loads.

Steel columns, resting on the arch ribs, will support the steel floor girders and concrete deck. The deck will carry two 22-foot roadways separated by a four-foot mall. A 10-foot wide sidewalk will be provided along the south side of the deck, facing the Falls. The roadways will be practically level and on grade with the natural top level of the gorge. Other than the railings, there will be no superstructure to obscure the view of the falls and the turbulent river below.

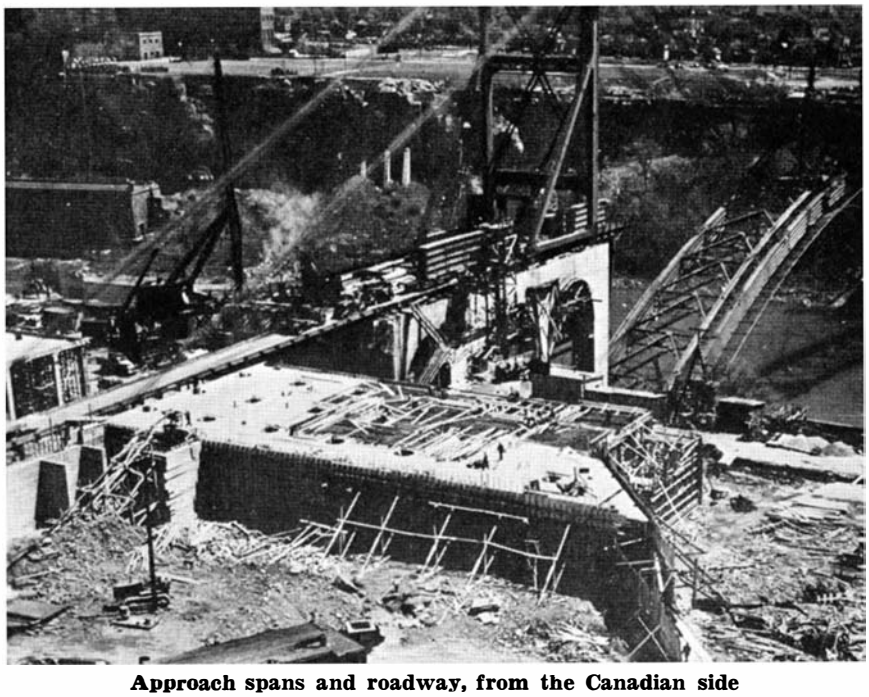


**With arch completed, save for keystone, which will soon be nested between the two spans, the cables and the false-work are being removed**

WITH the use of supporting substructure rejected as impractical, a method had to be devised to hold the arch girders in position during construction. Hence resort was made to a system of "sky-hooks" instead of the usual false-work. These sky-hooks consisted of a series of cables suspended from towers, which were used only during the construction and were later dismantled.

On each side of the river were built huge concrete abutment piers, located 50 feet back from the water's edge. These piers, and the approach spans, rest on solid rock; since they are placed back from the river edge they are high enough above any possible water or ice-pack level to preclude damage by forces of nature.

On top of each of the Canadian and American abutments were erected the steel sky-hook towers. At the edges of the gorge on each side were placed 85-ton derricks, and, on temporary floors built on the concrete abutments, were located 40-ton stiffleg derricks. Sections of the arch were first delivered to the edge of the gorge and then lowered by the 85-ton derrick to the smaller derrick. The first three ribs were cantilevered out and supported by the first set of cables slung from the tops of the towers. The small derrick was then moved out on the ribs and the next girders were erected. A second set of cables held these in place. Then the first cables were slacked off and lengthened to support the next girder sections. In turn, the second set of cables became the fourth and last set to support the girder sections.



**Approach spans and roadway, from the Canadian side**

The towers for holding the supporting cables were held in place by 16 other cables which were fastened to concrete anchorages weighing 650 tons and buried in rock. Similar construction methods were used on both sides of the gorge and work was carried on simultaneously from each shore.

When all of the girders were in place there was a gap of about 11 inches between the two 475-foot sections extending from each shore. In this gap were placed four 500-

ton jacks which took up the thrust of the two sections. These jacks will later be replaced with a steel keystone accurately machined to fit the gap. While this keystone is being fabricated, the construction equipment will be dismantled. After the keystone is inserted the deck erection will begin, the small derricks working back from the center and the large derricks working out from the sides.

The reasons given by the designing engineers for the selection of a fixed arch type of bridge for this particular job are that it saves steel and is absolutely rigid. Such construction is possible only in a location where, as at Niagara, a solid rock foundation can be secured. No definite estimate has been made as to how much the bridge will lift or sag when it expands or contracts as the temperature changes, but it is said that the variation will be so slight as to be unnoticeable.

When the entire project is complete, there will be 12 approach traffic lanes on the American side and 14 on the Canadian side, to facilitate custom's inspection.

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**ANCIENT ENGINEERS: Forty centuries before telescopes made possible a greater precision, the ancients were able to orient a pyramid true north within 3 minutes 23 seconds of arc, the error being about one part in a thousand. Ordinary engineer's transits are accurate to the nearest minute.—American Antiquity.**

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## TUNNEL TRUCKS

### Guard Against Trouble in Vehicular Tube

TRAFFIC jams in vehicular tunnels can be serious; trouble occurs occasionally and must be anticipated. Thus, stationed at either end of the Queens-Midtown Tunnel, New York City, are high-speed "trouble tractors," ready to dash into the tunnel and haul out the helpless vehicle which is causing congestion. These two tunnel guards are White tractors with superstructures and equipment designed especially for the job. A 97-inch wheelbase makes it possible to turn in a very short radius.

When a vehicle becomes stalled in the tunnel, a signal is sent to the emergency crew at the outlet of the lane involved. The tractor at that end rushes into the lane counter to the normal flow. Upon reaching the disabled vehicle, traffic in the adjoining lane is stopped just long enough for the tractor to turn around in front of the stalled machine. The turn is accomplished with only one backing and forward cut of the wheels. Then the disabled vehicle is drawn out in the same direction as it is headed.

Power steering on the tractor helps to make possible fast, short turns; a double drum winch and cables equipped with hooks make it easy to lift and tow disabled cars. Dollies, jacks, and other equipment are provided for handling wrecks promptly. In addition. the tractor carries a diversified array of fire extinguishers.

## NON-SKID

### Grooves in Concrete Highways Are Effective

BRUSHES with steel bristles, stroked transversely on freshly-poured concrete pavement, make grooves just right to give a maximum of non-skid quality to the wearing surface and to diminish night glare, according to experience on Oregon state highways. Since this plan was first tried some two years ago, the practice has been to finish off all Oregon concrete pavements in this way. Results are reported to be highly satisfactory, according to *Engineering News-Record.*

Ordinary brooms, lacking the stiffness of metal, do not give satisfactory results and surfaces finished with them are not nearly so "non-skid" as when the steel bristles are used. With the steel, the grooves tend to be continuous and are sharply defined; thus they aid in drainage as well as in affording grip for tires. The grooves eliminate the water film on the surface which acts as a lubricant under the tires and, at night, reflects the light of oncoming cars.

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**WHERE LIES OUR POWER: Dean Potter, of Purdue University, estimates that the total power-generating capacity of the country is about 1,231,000,000 horsepower. Of this, roughly 80 percent is credited to trucks, buses, automobiles; about 7 percent to locomotives; 5½ percent to agricultural prime movers, and less than 5 percent each to central stations, mines and quarries, marine engines, and scattered sources.**

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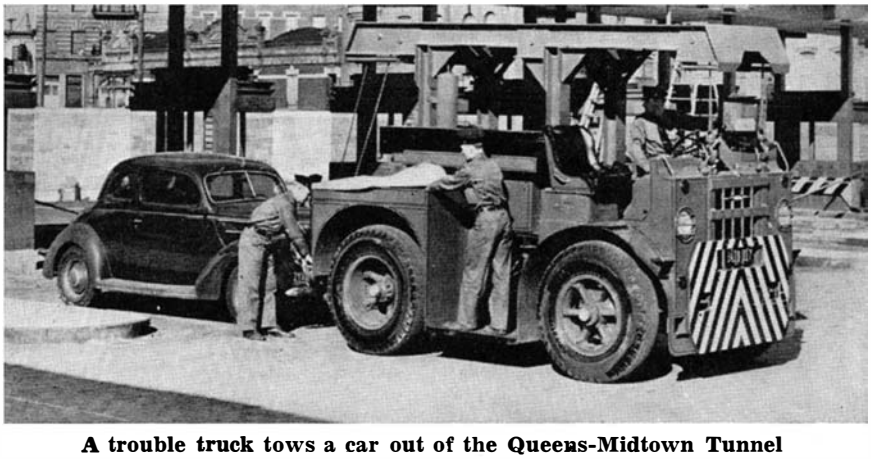
## GAS STORAGE

### Liquefaction of Fuel Saves Space

THE greatest quantity of natural gas stored above ground in one place, 150,000,000 cubic feet, has been concentrated in three relatively small Hortonsphere tanks at Cleveland—but in liquid form. (See also page 328, December 1940 Scientific American.—*Ed.*) The three spherical tanks, each only 57 feet in diameter, hold an amount of gas that, in its normal gaseous form, would require 50 tanks 102 feet high and 150 feet in diameter.

This is the first commercial application of the liquefaction of natural gas for concentrated storage, and it solves the peak-demand problem that has plagued the natural-gas industry for years. An ingenious method of compression and refrigeration liquefies the natural gas so that it takes up only a fraction of the space normally required. The storage tanks are heavily insulated, and when needed the liquid gas is withdrawn, heated, and moved to the gas mains in its original gaseous form.



**A trouble truck tows a car out of the Queens-Midtown Tunnel**

# OUR Point OF VIEW

## FOR THE BENEFIT OF ALL

A WEALTH of mechanical genius and inventive skill lies in that group of workers who are employed at the benches and machines of industry throughout the nation. Yet—with minor exceptions on a small scale—there has been only one organized attempt to tap this rich pool; the Revere Award, sponsored by Revere Copper and Brass, Inc., winners of which were recently announced. Through this Award, wage earners in the broad field of the metal-working industries were encouraged to turn their talents towards inventions and processes which would speed up the defense plans of the United States in either military or industrial aspects.

Here indeed is a worthwhile means of bringing to light, and to practical use, those products of the human mind which otherwise might lie forever hidden and useless. The difficulties encountered by inventors in finding assistance in the development of their ideas are too well known to need repetition; if others in a variety of industries would follow the lead of Revere, these difficulties would be materially reduced, development work would be accelerated, and industry and the general public alike would reap the benefits.

Although the Award was opened specifically to the metal-working industries, this term was so broadly interpreted that the prize-winning entries covered a wide range of endeavor. The prizes offered totalled $10,000. First prize of $5000 was awarded for a radio system for blind landing of airplanes. Second prize, $2500, went to the inventor of an electro-magnetic riveting gun. The third prize, $1000, was given for a structural design eliminating the use of rivets and clips. Six additional prizes of $250 each were awarded for inventions as widely varying in nature as conservation of vital alloys, speeding production of ammunition supplies, a device for increasing safety and efficiency in motor transportation, a system for increasing the effectiveness of bonded metals, and a device for eliminating a large part of the manual labor in certain assembly operations.

We offer our sincere congratulations to the sponsors of the Award and to the men who so ably assisted in weighing the merits of the suggestions received from wage-earners in industry. Here is proof of the ability of the rank and file to produce ideas that are practical, useful, needed. May similar helping hands be extended in other fields to encourage inventive initiative and, by so doing, bring the resulting benefits to the nation at large.—*A. P. P.*

## MEN OR MECHANIZATION?

SHOULD this nation create a mass army of 3,000,000 or 4,000,000 men and equip it with eight or ten mechanized divisions, as the War Department has planned, or should it stop at a 1,500,000-man army but equip it with at least 25 mechanized divisions? Is the military mind, in going only part way with mechanized divisions, once more exhibiting military-mindedness—the familiar old conservatism and inability to move at one step *all* the way up to the point indicated as optimum by experimental demonstration?

There is nothing profound about the reason for a many-tank force; it is rather simple. Our remote ancestors fought with their teeth, and later with bludgeons. Then came stone weapons and finally steel and firearms. Each of these advantages over tooth fighting power multiplied offensive strength several times more than the last. A parallel evolution of man-multiplying power also took place in human industry in peacetime, when man, with a relatively small, weak body and force, learned to take command of matter and force far in excess of his own bulk and strength. Now in the industrial world there is little reluctance to make full use of advances demonstrated by experiment; industry siezes on them with avidity. Why, then, is there so much slow reluctance to make the indicated advances in the art of war? Why do military minds often have to be pushed and driven into change or, if not quite that, why do they make changes so by halves instead of all the way that these often are of little or no realizable value when the trial by combat comes? The answer boils down mainly to one factor—a matter of competition. In industry there is perpetual and keen competition. In the miliary art there is less. Suppose that during about four-fifths of the time competition between industrial concerns died down from white heat to dull red. This is what happens in the military world. Less urge.

In order to bring about a major change in the world of the soldier it often has been necessary to call in a civilian—a procedure which always strikes the soldier as oddly incomprehensible. An excellent example of a civilian who, having the necessary power, used it, not reluctantly, not slowly, not half-heartedly, but as fully as demonstrations in World War I and in Spain indicated, is the present German leader. While we detest his moral principles (if any), we must not make the mistake of low-rating the paperhanger. He saw the point in mechanization, brought it about.

The tank multiplies man-muscle many times more than previous multipliers in the military realm. Intelligence controls it while inanimate matter and natural forces do its work, on a scale representing masses of men far out of proportion to its apparent scale of importance.

The remedy? There is no ideal remedy, but much will certainly be accomplished if pressure of public opinion can be brought to bear on the elderly military men who determine policy in these matters, through the people's representatives in our government. In past wars we threw human bodies and bodies and bodies against our enemies, but human bodies are poor stuff with which to stop huge forces. Present-day warfare calls strongly for tanks and tanks and tanks—non-living matter and controlled raw force. But if we fail initially to exert enough force on our military men we may find ourselves with about half as many tanks as circumstances require and about twice as many men as we really need.—*A. G. I.*

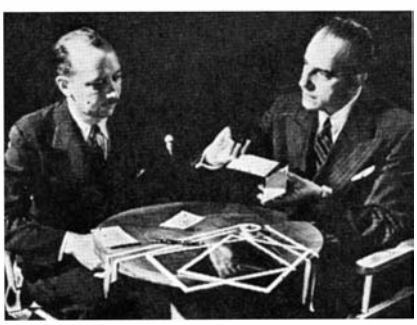
# Our Search for the Supernatural—V

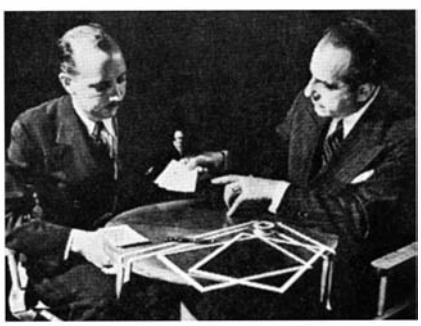
## Independent Writing "Phenomenon" is Produced Through Natural Means

AS DESCRIBED in our July issue, Reverend Edward Lester Thorne, of United Spiritualists' Church, produced before the Scientific American Committee for the Investigation of Psychic Phenomena an alleged spirit message, purportedly signed by Sir Oliver Lodge and addressed to Dunninger, Chairman of the Committee. Conceived by so-called "independent writing" and scrawled in large characters on a small, white card the message consisted of the single word, "Bottle-neck," which, according to Dunninger, is a descriptive term among magicians and exponents of legerdemain for a type of handcuffs. Although Dunninger conceded that the word "Bottleneck" was "a sign of three things in connection with the three messages" confided to him in code by Sir Arthur Conan Doyle, Thomas Alva Edison, and Houdini prior to their respective deaths, he emphatically stated it was *not* one of the messages, nor was that word contained within any of them.

Our Committee, however, was primarily concerned with the method of production of this so-called spirit message, and whether or not it could be produced only by means of spiritistic or supernatural forces. Shortly after Reverend Thorne's seance, therefore, Dunninger, in the presence of members of our Committee, undertook to "duplicate or explain" the production of the message "through natural or scientific means," in accordance with the conditions governing the work of the Scientific American Committee for the Investigation of Psychic Phenomena. (April 1941)

Although the term "slate-writing" was originally applied to "a spiritualistic or conjuring performance, in which writing is mysteriously made upon a slate," (Webster), in more modern times it has come to encompass all forms of pneumatography, including so-called independent writing. In this connection it is interesting to note that in 1853, M. Planchette, a well known French spiritualist, invented an instrument designed for the purpose of communication with spirits. It consisted of a thin, heart-shaped piece of wood, mounted on two small wheel-castors, and carrying a pencil, point downward, for the third support. A hand was placed on the wood and the pencil wrote, presumably by spirit control through the medium. Some 25 years later an American toy-makers' firm adopted the idea, producing what was possibly a fore-runner of today's Ouija board. The latter is described by Webster as being "a trade-mark for a board, on which the alphabet and various signs are written, used with a planchette to obtain mediumistic messages." The word "ouija" was derived from the French "oui," meaning "yes," and the German "ja," likewise meaning "yes."





*Left:* **Cards are displayed (Step 2); message card is "accidentally" dropped.** *Right:* **Retrieved, message card is "forced" on the visitor**

THE actual origination of "spirit-writing," of which slate-writing is a relatively modern development, is shrouded in the fog of legends and antiquity. It has been claimed that a form of the planchette, or Ouija board, was in use in the days of Pythagoras, about 540 B.C., and that followers of his celebrated doctrine held seances or meetings at which a mystic table, moving on wheels, gravitated toward signs inscribed on the surface of a stone slab. Later trace of some such form of mechanism for supposed communication with the "spirit world" is found in Scandinavian legendary lore of about the 12th Century, and has to do with a little ivory doll that drew mystical hieroglyphics for one Völsunga, a high priest of that day, who based his prophecies on the doll's writings.

Thus are found scattered records of ancestral forms of slate-writing and its development in many lands and varied forms until, about 1860 or 1865, Henry Slade, an American medium, became known principally for his slate-writing exploits. In 1876 he visited England, was cordially received, and succeeded in impressing many people until Professor Ray Lankester published in the London *Times* a letter describing one of Slade's seances. Professor Lankester claimed he had prematurely snatched the slate from the medium's hand and had found a message written thereon, although no sounds of the scratching of a slate pencil in the course of writing had been heard. As a result, Henry Slade received considerable adverse publicity, the controversy raged, and Slade was tried and found guilty in a court of law. The conviction was quashed on appeal and the medium returned to the United States, where he continued his slate-writing demonstrations for several years.

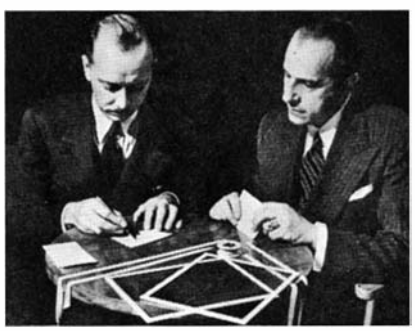
While slates of one form or another are still used by mediums, the modus operandi of slate-writing has been expanded to include almost any substance on which writing may be legible. In the case of Dr. Thorne, two sheets of single-strength window glass, seven by nine inches, with their edges taped for protection of the hands, formed a "sandwich" into which a white card, previously endorsed by Dunninger, had been placed. The glass sandwich was securely taped to the table and when the card was later removed, it bore the words, "Dunninger Bottleneck Oliver Lodge."

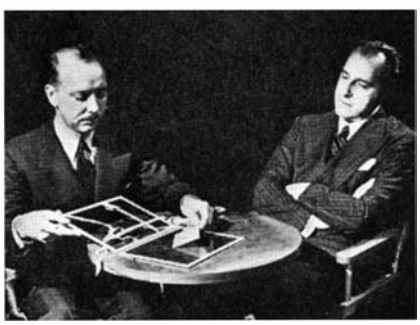
It must be remembered that the Chairman of our Committee, among his several accomplishments, is considered our ranking authority on conjury; that it was he who guided and advised Houdini when the latter assisted Scientific American in its psychic explorations of 1923 and 1924. It must also be borne in mind that Dunninger, in the course of his life work as magician, mentalist, and psychic investigator, has attended over 1000 seances, and that thus far he has witnessed nothing that he has not been able to duplicate through the conjurer's art, or explain by natural means. In so doing, his exploits have often proved so convincing that he has been accused of being "psychic," but unwilling to admit the possession of either psychic or supernatural powers.

In duplicating Dr. Thorne's demonstration of independent writing, therefore, Dunninger expressly stated that his production of a "spirit message" would be accomplished solely by means of trickery and sleight-of-hand. From a package of plain, white cards, face down so the writing could not be seen, was the prepared message card. Placing the balance of the package on the table, the "medium" showed the selected cards to the "visitor."

*Step 2:* To obviate any possible claim of trickery, however, the medium went further and hastily flipped the cards before the eyes of the "visitor." During this process one card—the prepared message card—was intentionally, but apparently accidentally, dropped, writing side *down,* on the table. After both sides of the remaining four cards had been rapidly displayed to the "visitor," the dropped card was retrieved and the entire handful, five in number, was proffered for a selection.

*Step 3:* To sleight-of-hand performers and card manipulators there is a technique known as a "force," by means of which the magician manages to induce the subject to choose the exact card the magician desires him to select. Through an adaptation of this trick, the "medium" caused the "visitor" to select the prepared message card.





***Left:*** **To identify card, "visitor" writes name (Step 4).** ***Right:*** **After waiting period, seals are broken, and the "visitor" finds the message**

similar to those used by Dr. Thorne, he selected one and wrote on it, "Dunninger 'Bottleneck' Oliver Lodge." This, he explained, would normally be done privately by the medium, and in advance of any public demonstration. Then, with the assistance of Mr. A. Paul Peck, member of our Committee and a representative of the Universal Council for Psychic Research, who posed as the "visitor" to a "slate-writing seance," Dunninger, taking the part of a "medium," proceeded with the performance which, for the sake of convenience in description, may be divided into six steps, as follows:

*Step 1:* Displaying the entire package of white cards to his "visitor," Dunninger shuffled off five from the top. Among these,

*Step 4:* Instantly after the card was "chosen," so rapidly that the eye could scarcely follow the movements, the "medium" dropped the remaining four cards, plucked the "chosen" card from the "visitor's" hand, and, placing it writing side down on the table before the "visitor," requested that he sign his name so that he could later identify the card.

*Step 5:* The card was then placed between the panes of glass—signature side *up* and message side *down* —and the "visitor" was permitted to tape the glass solidly to the table and to place the pencil atop the glass, leaving both pencil and card in full view. (At this point in a spiritistic seance any one of a number of procedures, such as the singing of a hymn, indulging in a period of absolute silence, or possibly a "trance" would customarily follow. In his demonstration, however, Dunninger naturally omitted this phase of the presentation.)

*Step 6:* After a moment or two, the "visitor" opened the glass sandwich, removed the card and found thereon the supposed "spirit message."

When, as in the case of any feat of legerdemain, a routine has been assiduously practiced and rehearsed, it is next to impossible for even the fastest eye to follow the intricate and rapid movements of the hands. In this, the members of our Committee were agreed, and they further concurred in the verdict that Dunninger had fully complied with the governing regulations by *duplicating* Dr. Thorne's performance through *natural* means.

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## What They Say .....

L. C. M., California: "I beg to assure you that any research in Spiritism will be a praiseworthy success and benefit to all mankind if conducted in a logical way."

B. R., Cuba: "I was surprised to read that, upon hearing it said in the voice of Mrs. Ericson, 'Tell them to take photographs,' immediately two flash bulbs were set off with blinding luminosity. You should know, my dear Mr. Dunninger, that intense light exerts a chemical, dissolving action upon the ectoplasms and the perispiritual figures or shapes which are psychically captured by the seeing mediums, a capture which cannot be obtained by those who lack this supranormal faculty or sensibility."

M. W., New York: "In reference to your offer of $15,000 for concrete information about Supernatural Phenomena, I must say that it is below your dignity and intellectual self-respect. How could you embroil yourself with the pack of frauds or gullible fools who try to communicate with the dead?"

R. C. G., Maryland: "May an old subscriber drop in for a chat by letter? Your article 'Search for the Supernatural' interested me, because from my limited personal experience, I think the supernatural, spiritistic phenomena, and mediums (fake or real) may be three problems. I believe you can go further than you dream, if it is handled right."

# Bats on the Beam

## Nature's "Built-in" Equipment Controls Blind Flying by Supersonic Broadcasting

LOUISE BOYDEN

WE HUMANS pride ourselves on the aids to blind flying invented in recent years, but when it comes to this field of aviation, bats are still ahead of men. They don't need the intermediary of an array of instruments on an instrument panel, as in an airplane, for their apparatus is all "built-in" and is operated just as efficiently in total darkness as in daylight. And total here means total. Bats are not blind, but neither bats nor any other animal can see anything in total darkness.

What is this mysterious sense which bats have been using for millions of years? How do they wing their way through the tortuous passages of lightless caverns without bashing into projecting rocks and invisible corners? That is a secret which scientists have been trying to solve without success for the last 150 years. Now, however, two Harvard investigators, Robert Galambos and Donald Griffin, have finally discovered the key. Through 10,000 experiments with hundreds of bats, these investigators have proved that an early theory about the blind flying of bats is actually true.

BACK in 1794 an Italian named Spallanzani found that these animals could weave their way through a maze of silk threads strung across a room, even though their eyes had been removed. In 1908 an American who substituted wires for the threads found that blinded animals made an even better showing than those with full vision, but that, if their ears were plugged with plaster of Paris, the number of collisions they made with objects increased from 25 to 66 percent. Finally, several investigators made the assumption, still unproved at the time, that somehow bats used the echoes of sounds reflected to the delicate membranes of their inner ears to guide them away from collisions. In fact, Sir Hiram Maxim, inspired by the theory (which he proposed in Scientific American in 1912) that the echoed sounds perceived by bats were those caused by air waves or pulsations from the beat of their own wings, invented an apparatus for detecting obstacles in the path of a fog-bound vessel. Low-toned vibrations sent from the bow of the ship were reflected from hidden rocks and vessels and recorded on deck by a sensitive membrane. Experimentation now has shown that the principle behind the uncanny blind flying of bats really is essentially the same as that which Maxim employed, the main point of difference being that, in place of low-toned vibrations, bats use supersonic sounds unheard by human ears.

SUPERSONIC sounds are those having a frequency above the 20,000 vibrations per second which the average human is able to detect with his ears. In flight, bats emit cries with a sound spectrum of between 30,000 and 70,000 vibrations a second.

Now, if these sounds are inaudible to us, how do we know that bats give them off? It was the impossibility of testing this that stumped scientists for a century and a half on the whole question. But modern research finds strange applications for its discoveries, and when Professor George W. Pierce, of the Harvard Physics Department, invented a device for obtaining audible beat notes from supersonic waves, the biologists Galambos and Griffin soon found a new use for it.

They placed bats in a soundproof room with a supersonic detector and observed that, when the creatures were held quietly in the hand, no supersonic waves were recorded; as soon as the bats began to fly, however, the audible beat-notes from high-frequency sounds poured forth from the loud speaker. To give an idea of these volleys of staccato sounds, we may compare them in their impression to radio static during a bad electric storm.

It therefore seemed clear that bats give off cries with a very high frequency, and it remained only to be ascertained whether they really depend on them in avoiding obstacles.

To test this hypothesis, Galambos and Griffin erected a gauntlet in the sound-proof room. They suspended a number of steel wires vertically from the ceiling to the floor, with a 12-inch path between each pair of one-millimeter wires. It was then up to the bat to steer a course between these obstacles without the aid of eyesight. Considering that its wingspread was nine to ten inches, there wasn't much more than an inch of clearance on either side. This test of bat skill would be like asking the pilot of a plane having a 30-foot wingspread to fly along an opening only 36 feet wide between two wires an inch and a half in diameter — a difficult stunt even for an aviator guided by vision.

The Harvard scientists found, however, that, even if a bat's eyes were heavily coated with collodion, it could dodge between these barriers, without even brushing, 75 times out of every 100 trials.

Now what is the outcome if the bat is deprived of its hearing? By tying each bag-like ear of an animal around a tiny glass tube passing to its inner ear, Galambos and Griffin arranged it so that, by filling the tube with cotton or taking the cotton out, they could alternately close off the inner ear or leave it open. What happened whenever the ears were completely plugged provides a convincing piece of evidence. First of all, the bats were very reluctant to fly. Most of the time they preferred to sit on the floor and dig frantically at the offending ear plugs. When they were forced to take to their wings by being picked up and dropped in mid-air, they bumped into walls, collided with wires, and finally dropped to the floor or clung to a wall. They behaved just like a blind man in an unfamiliar room. They fumbled. They were confused. From a score of 25 collisions per 100 trials made by blindfolded bats that could hear, these deafened bats jumped to a bad score of 65. As soon, however, as the tubes were unplugged, the percentage of collisions fell again to 25.

The next step in the experimentation was to find out what would take place if the bats were

made voiceless. This was a little more difficult. But the Harvard investigators were able to gag the animal temporarily by first tying its snoutlike mouth with linen thread and then sealing the lips with collodion. The result was that the score of collisions again jumped to 65 percent. The supersonic broadcaster — that is, the bat — could no longer give off volleys of sound as it flew.

Just to make doubly sure that the supersonic sounds really were cries rising in the animal's larynx, Galambos and Griffin made two more observations.

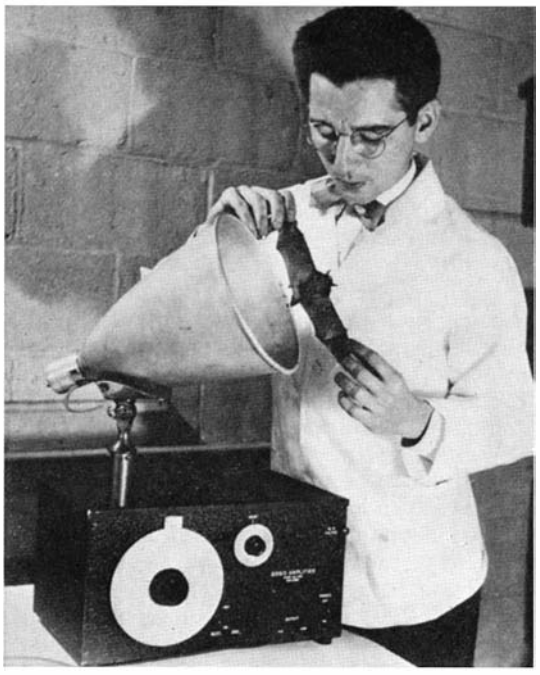
In one, they found that, if they held the bat's head for short periods under water, during these periods no high frequency sounds came forth from the recording apparatus.

In the other, by looking at the back of the bat's throat through a microscope, they were able to see movements of the membranes at the base of the tongue, and these movements coincided with the supersonic sounds recorded by the detector.

Another bit of evidence is the fact that one can hardly imagine an instrument better fitted to produce high-frequency cries than the membranes of the larynx of a bat. Like the E string of a violin, they are fine, and they are capable of being stretched by the tension of a very strong musculature.

But the most dramatic sign-post to the way bats use their cries in blind flying came again through the supersonic detector. On a moving tape attached to the machine was traced a curve showing the frequency of bursts of sound in numbers per second. This varied according to the bat's position with regard to the obstacle. It started at 30 bursts per second when the animal was flying in the clear at its normal rate of five feet a second. Then, when the bat approached within about ten feet from the wire, suddenly the rate jumped to 50 per second. As the animal drew still nearer to the wire, the bursts slowed down gradually to 30 and continued at that speed as the bat veered away and avoided the obstacle. But, when a bat was prevented from using its ears, these staccato volleys of sound did not change their rate, no matter what the bat's position or distance with regard to the wires. The explanation seems to be this: As the bat approached the wire, the echoes of its cries were reflected from the obstacle to its inner ears. Speeding up the cries had the effect of producing more and sharper echoes. This, in turn, gave the bat a clear idea of its orientation with regard to the obstacle.

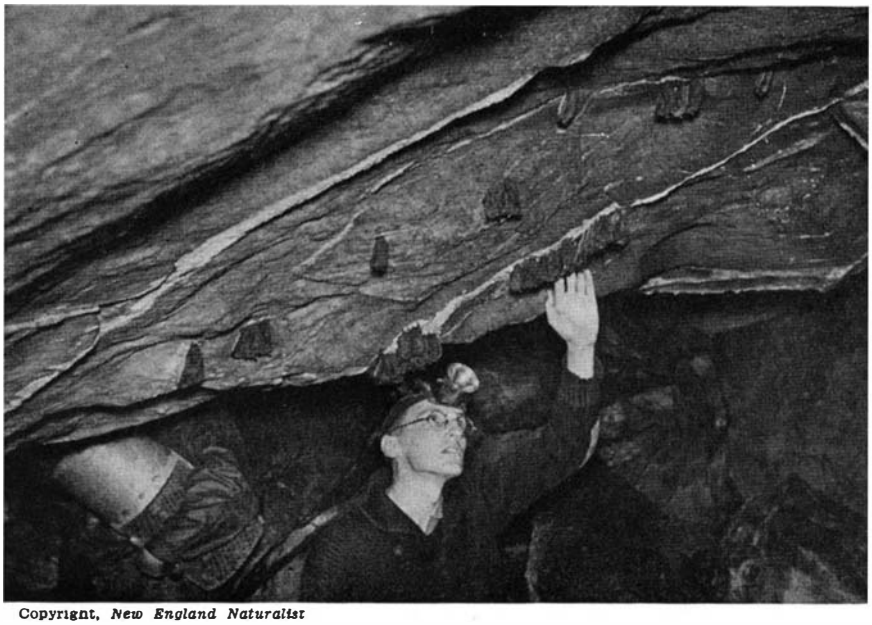
All these experiments were performed in a laboratory with isolated bats. What happens in nature, where the same cave is alive with hundreds of them? Does each individual recognize its own supersonic cries? Galambos and Griffin have discovered that they can follow the progress of individual bats as they fly along passages toward the exit. If the human ear, aided by a complicated apparatus, is able to distinguish one bat's cry from that of another, it would appear that the bats themselves should be able to accomplish the same feat with their own highly sensitized equipment.



**Robert Galambos, one of the two Harvard investigators, bat, supersonic detector**

Courtesy *New England Naturalist*

**The common little brown bat, much enlarged (weight one fourth ounce), which had crawled into a crevice in a Vermont cave, to hibernate**



Copyright, *New England Naturalist*

**Investigating bats in a cave at East Dorset, Vermont**

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## YOUR BREATH

### A Little Discovery That May Turn Out Bigger

Two hundred million particles in every breath a person exhales are the reason that the breath is visible on a clear, cold morning.

Discovery of these particles, each nearly 100 times as big as an air

molecule and which were previously unknown to science, was announced recently by Dr. George R. Wait, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, reports *Science Service*. The majority of the particles are stated to be electrically charged, either positively or negatively.

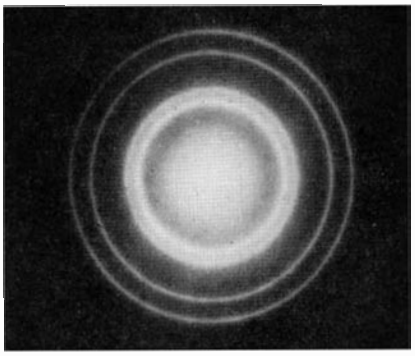
Such particles, Dr. Wait said, are common in the air over chimneys and in the exhausts of automobiles. Perhaps those in the breath, he suggests, are the "smoke" of the fires of life itself, the constant burning in the body which keeps up its temperature. On a cold morning, moisture condenses around these particles and becomes visible. The particles from the lungs, in a room where several people are assembled, quickly capture smaller ions, or broken air molecules, already present. Dr. Wait suggests that perhaps the breath particles play some part, as yet unknown, as carriers of disease-bearing micro-örganisms.

## ELECTRONIC CAMERA

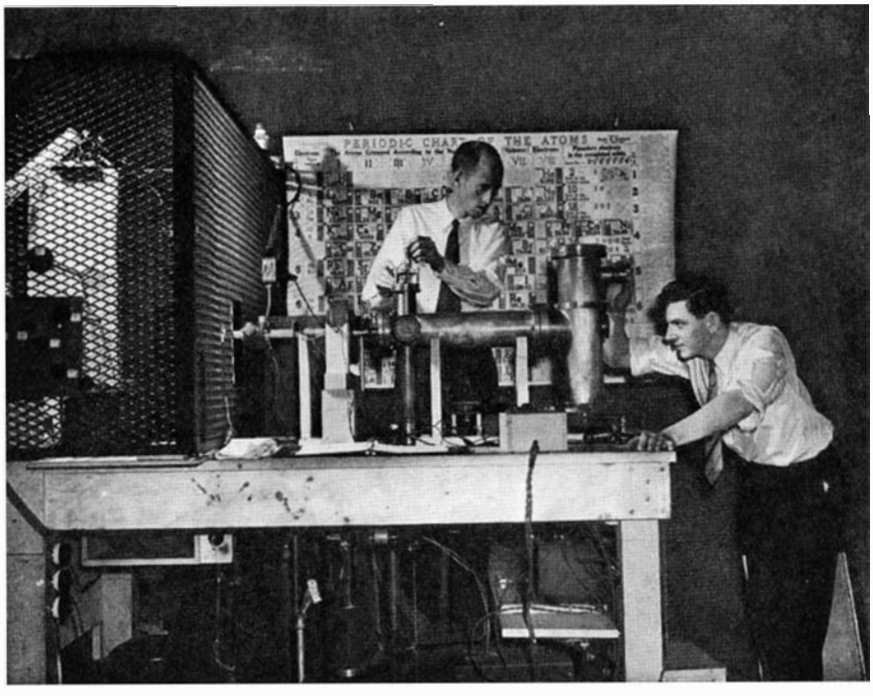
### Studies Thin Films of Crystals, Supplements X-Ray Studies

AN electronic vacuum camera that photographs the crystalline structure of substances measured in millionths of an inch in thickness has been built by Dr. Ralph P. Johnson of the General Electric Research Laboratory. The camera is being used to study deposits on the surfaces of metals, like tarnish, lubricants (such as grease and oil), and the first stages of corrosion. It supplements X-ray apparatus that permits study of the interior of substances of greater thicknesses.

The camera proper consists of a brass tube, about three and one-half feet long, and a focusing magnet. A 40,000-volt electronic beam enters one end of the tube, is focused by means of the magnet upon the material suspended in the middle of the tube, diffracts, and produces a picture upon a lantern slide at the other end of the tube. The tube is evacuated to permit free passage of the electronic beam without collision with gas molecules. The material to be photographed is suspended in such a way that it can be raised or lowered or tilted at any angle to the beam.



**How electronic camera reveals the electronic pattern of gold**



**Using the electronic camera built by General Electric engineers**

Thus electron diffraction has become a powerful supplement to X-ray diffraction in the study of matter, and the electron diffraction camera has taken its place in the laboratory as an important research tool.

**The electronic camera of RCA**

Another electron diffraction camera has been developed by Dr. J. E. Ruedy in the RCA Research Laboratories for use in the study of electron emitters. With it the structure of films or surface layers only a few atoms thick may be readily analyzed.

## RADIO MIRROR

### Counting Meteors in Cloudy Weather and Daytime

WHEN a meteor passes through the atmosphere many miles above the ground, it leaves behind it a radio mirror, a line of broken atoms, which may last for many minutes. By sending radio waves up, and measuring the time of the echo produced by their return, these meteor mirrors may be detected, Dr. J. A. Pierce, of the Cruft Laboratory of Harvard University, reports in the *Physical Review*. In this way, it may be possible to count meteors even in the daytime or in cloudy weather when ordinary means fail.

Astronomers are greatly interested in checking the numbers of meteors entering the Earth's atmosphere, but cloudy weather, and daylight, prevent the records from being complete. Possibly the radio method may be a solution to this previously baffling problem.

# If You Value Your Eyes...

## Eye Protective Glasses Must be Correctly Designed for the Job They Have to Accomplish

**EDGAR D. TILLYER, Sc.D.**
American Optical Company

THE natural protective mechanism of the eye is sufficient to adapt it to ordinary intensities of illumination; to conserve eyesight, however — in addition to having refractive errors corrected and diseased conditions treated — excessive light radiation should be controlled. Thus the increase in outdoor sports and eye-hazardous industrial operations such as welding has posed a problem of adequate eye protection against excessive visible and invisible rays.

For example, when intense infra-red radiation is present, the burning sensation which follows exposure gives a quick warning and consequently it is not so likely to cause injury. The presence of ultra-violet radiation, however, is not felt at the time of exposure and is only revealed by the discomfort and suffering which develops a few hours after the real damage is done. Since the invisible rays are of no aid to vision, it is wise to minimize the risk of injury, in questionable cases, by wearing glasses which cut down glaring light and also absorb the invisible rays.

**Both pilot and passenger are wearing eye-protective lenses which soften glare, absorb invisible rays**

Fortunately, science in recent years has developed special lenses, the properties of which are such that they afford protection against harmful radiation. Such lenses have particular value now in view of the tremendous increase in welding and furnace and foundry operations brought about by the national defense program. The history of the development of these lenses goes back many years. As a matter of fact, long before welding glass came into existence, or sun glasses achieved their present popularity, scientists were seriously at work to discover some practical means of visual protection.

Aucott, in 1561, suggested a spectacle lens of green glass as of "great public utility and benefit," while Pierson, in 1672, championed the cause of blue lenses. Gray or smoke glass lenses were produced and sold in London in 1767. The manufacture of amber lenses was licensed by Royal Patent of George IV in 1832, this step practically completing the color scale and laying the groundwork on which science was later to evaluate the relative merits of the various shades and tints.

Developments followed rapidly at the turn of the century and certain lenses were developed with the actual objective of excluding from the eye the harmful emanations of infra-red and ultra-violet rays. Some of these lenses succeeded better than others, but all have been practically forgotten in the rapid scientific progress made in the past 30 years.

The first really scientific attempt in an organized field to control light emanations was undertaken in 1909 by Sir William Crookes who, as a member of the Glass Workers Cataract Committee of the Royal Society, attacked the problem of eye protection. Crookes made several hundred experimental glasses and, in 1913, after four years of arduous labor, produced a glass of sage green color with good infra-red cut-out; also a glass for ordinary use which cuts out ultra-violet and which today bears the name of the famous English inventor.

At that time a glass with cut-out in both ultra-violet and infra-red, while still retaining complete visual transmission, was a chemical impossibility. In a paper, "The Preparation of Eye-Preserving Glass for Spectacles," read by Crookes before the Royal Society, he stated:

". . . The ideal glass which will transmit all colors of the spectrum, cutting off the invisible rays at each end, is still to be discovered. As far as transparency, however, is concerned it will not be an unmixed advantage for the sought-for glass to be quite clear and colorless. The glare of a strong light on white cliffs, expanses of snow, electric light, etc., is known to be injurious to the eye and, therefore, a tinted glass combining good obstruction to the heat radiation and ultra-violet rays is the best to aim for."

In the face of these findings, research scientists of American Optical Company undertook active experimental work. In 1924, after years of investigation and research, it was discovered that, by a careful balancing of ferrous and ferric iron ingredients and the addition of other oxides, an olive green glass could be made which gave a peak of maximum transmission of useful light closely coinciding with the peak of the curve of eye sensitivity, and at the same time gave the highest possible ultra-violet and infra-red absorption.

**Absorptive lenses protect the welder's eyes**

The first use of the new glass was in the industrial field where those exposed to glare found the glass gave definite protection against radiation which tired and irritated eyes.

Later, in an attempt to solve the cause of aviator's headaches and eyestrain, the United States Air Corps investigated the possibility of using the glass for flying. Tests under actual flying conditions proved that, for high, continuous flight, the glass gave eye relief never before experienced, a cooling effect being particularly noticeable. It was also found that in Air Corps field reconnaisance, observation, and piloting the glass did not distort color values—an important point, since the detection of false color and untrue foliage is essential to successful flying operations.

ANOTHER factor had to be considered. The lenses of earlier goggles were mechanically designed without regard for optics. No attention had been paid to the fact that a deeply curved lens of zero focal power, such as used in aviation goggles, actually had an optical center which must be properly placed just as would be done if the lens had power like an ordinary prescription lens.

After wearing such defective lenses for short periods of time, they caused severe headaches which decreased the pilot's efficiency. It was therefore necessary to create a new optically designed lens out of the new glass. This lens permitted true eye-coördination and therefore accurate, comfortable seeing. On wearing the new lenses, the fliers were delighted to discover that their headaches had vanished.

On the basis of this relief from eyestrain and glare, the new type absorptive lenses were adopted as standard by the United States Army Air Corps and specifications were set up as follows: "The anti-glare glass shall be known as Calobar, or its equivalent . . . the glass shall have high absorption throughout the ultra-violet and near infra-red regions of the spectrum, in order to protect the eye from harmful effects of intense sunlight."

Although its scientific protective values were recognized, the new glass did not come in for its full share of useful application until the popular acceptance of the sun glass. Colored glasses probably gained fashionable reception because of glamor appeal, a fad started by motion picture stars who wore them day or night as a symbol of incognito, as a cloak of psuedo-invisibility.

The public quickly discovered this same glamor appeal and also that cheap, inferior sun glasses may be dangerous to wear. A non-absorptive dark glass will actually allow more rays to reach the eye than if the glass is not worn. This is because the darkness of the glass causes the pupil to open up, making a larger entrance for the unwanted radiation.

Industrial developments of comparatively recent origin, such as arc or flame welding, high-temperature furnaces, and the like, have made necessary the use of very dark glasses, transmitting as little as 0.01 percent of visible radiation. Such glasses, in addition to reducing the amount of light transmitted, must also reduce the transmission of infra-red and ultra-violet to such an extent that these undesired and harmful radiations are reduced to an amount less than that of the visible light transmitted. Twenty-five years ago a welding glass that transmitted less than 25 percent of the total energy of a high intensity source, however dark the glass, was a rarity. Now 0.01 percent total energy transmission would be considered high in the better glasses.

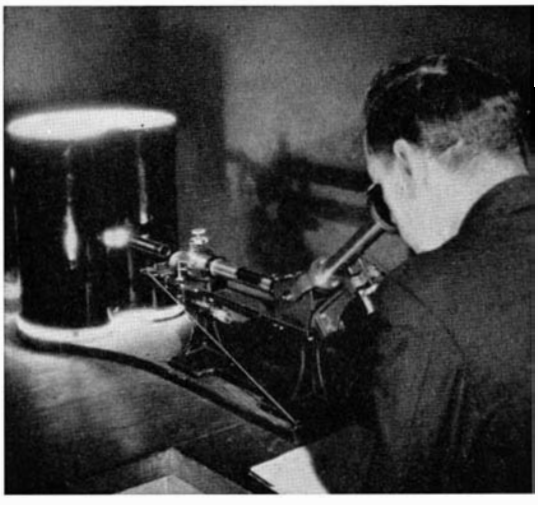
Modern welding glasses must also be strong absorbers in the ultra-violet, in which welding arcs, especially those of high amperages, are very rich. By the use of glass compositions containing as much 9 percent iron oxide, suitably balanced between ferrous and ferric iron compounds, both infra-red and ultra-violet are reduced to the desired extent.

SEVERAL years ago a young Boston physicist, Edwin H. Land, developed a polarizing material which, adapted to sun glasses, does a remarkable job of eye-protection by eliminating reflected glare that is so annoying outdoors, particularly when motoring.

This Polaroid material is a flexible cellulosic sheet, unlimited in area, in which are embedded billions of polarizing crystals per square inch, all lying parallel. For protection, the material is always laminated between sheets of glass or heavy safety film.

Like slightly darkened celluloid in appearance, Polaroid material combs out the light which passes through, arranging the light waves so that they all vibrate in parallel planes. It is as if a beam of ordinary light were like the random waves moving helter-skelter along a rope, tied at one end, and moved about, in all directions, at the other. If the rope passes through a gap in a picket fence, all of the vibrations will not get through, but the ones that do will all be parallel with the gap between the palings.

In practice, the light beam's "fence" is Polaroid material. After it has passed through, its vibra-



**Visual transmission curves of types of glass are plotted with a spectrophotometer**

tions are all arranged in the same plane. It is this arrangement of the vibrations in one plane that makes them controllable, for when a second "fence" of Polaroid is placed in the path of the light, with its "pickets" at right angles to that of the first Polaroid, the vibrations cannot pass and no light gets through.

When the eye looks at any non-metallic surface, it gathers two kinds of light: the diffuse light with which it sees color and detail; and the specular (mirror-like) reflection of the light source, usually thought of as glare. This specular reflection is always partly, often entirely, polarized by the action of the reflecting surface. The amount of polarization depends upon the angle of reflection and the refractive index of the material. The diffuse light, however, is not polarized; by viewing the surface through Polaroid material it is possible to reduce the apparent brightness of the reflections without changing the relative brightness of the diffuse light.

In short, Polaroid sun glasses choose between the useful light with which the eye sees detail, and the reflected glare which is always useless in vision and often blinding. Their advantages outdoors are obvious. Motorists drive with added safety and comfort with road-glare eliminated. Yachtsmen obtain the added benefit of seeing shoals and buoys formerly hidden by reflected glare from water. Skaters, golfers, skiers, and beach enthusiasts find their vision improved and their eye-comfort increased by the scientific glare-elimination. The Polaroid material also cuts out ultra-violet.

WHAT constitutes a good eye-protective glass? Briefly, in addition to absorptive properties, the lenses should be essentially free from flaws (striae, bubbles, seeds, and so on); the surfaces should be essentially free from defects (waves, scratches, and grayness); and the finished lenses should be essentially free from prismatic effect and focal power, regardless of the process by which made.

As it is obviously impractical to determine in a receiving room or at a sales counter whether or not a sun-glass lens conforms to the foregoing standards, the Sun Glass Institute recently established a basis for certification of quality by manufacturers. The certification is in the form of a label which is applied only to sun glasses having lenses that measure up to certain specified standards. The certification label, therefore, serves the profession, the trade, and the public as a means of identifying good sun-glass lenses.

It should also be pointed out that certain high-grade sun-glass lenses can be ground to prescription to correct defective vision, thereby providing protection for those who must have a correction in their glasses.

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## TELEDELTOS

### Electric Recording Paper

### Now Available for Wide Use

SOMETIME ago in these columns was described a recording paper developed by Western Union for use in automatic telegraphy. This paper is sensitive to electricity much as photographic film is sensitive to light. It is acted upon by a tiny metal stylus to turn the paper surface to a permanent black at any point where current passes through it.

Once Teledeltos was a closely guarded secret but it has recently attracted considerable attention in the scientific world, since it simplifies many recording processes, and is now being used extensively by manufacturers and users of recording instruments such as fathometers (for measuring ocean depths), electro-cardiographs, devices for measuring the speed of machinery, and for other purposes.

## COOL

### Headband for Use

### On Hot Jobs

A MODERN perspiration retainer for men working on hot jobs, called the Coolband, has been made available by Mine Safety Appliance Company. When men are working under conditions of extreme temperature Coolband provides greater comfort and safety by preventing sweat from falling into the eyes or onto goggles or glasses.

The band, providing all-around-the-head absorption, consists of a

**Cool, sanitary, comfortable**

soft, flexible band which clings softly without binding. A cooling effect is maintained through constant absorption of perspiration. Sanitation is easily maintained as the band may be disinfected as frequently as necessary. When the band becomes saturated it can be quickly removed and easily wrung free from excess moisture.

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**HIGHWAY TO HEAVEN: San Diego County and the state of California spent $1,500,000 building a special road to the top of Mt. Palomar, 65 miles northeast of San Diego, so that the people could drive up there without difficulty, and this they may do today. The telescope is there, practically ready, except for the main mirror due to be completed in 1942 or later.**

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## UNDERWATER

### Air Trap Conserves

### Swimmers' Energy

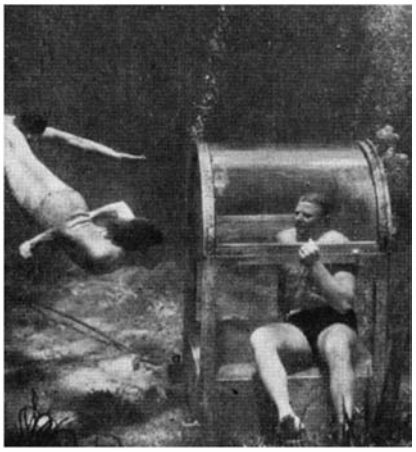
A "FILLING STATION" for swimmers' lungs and an "observation booth" for swimming coaches is being used at Wakulla Springs in Florida. This unique air trap has a roof of crystal clear "Lucite" methyl methacrylate resin plastic, formed in a half-cylinder shape, with ends of solid cypress and an approximate radius of 18 inches. Air is pumped into this half-cylinder trap through a hose leading down from the surface.

The air-filled half cylinder is held to the base of the trap by four three-foot studs. The base is a rectangular box 14 inches deep filled with ballast to anchor the trap to the bottom.

A swimmer merely dives to the trap, swims in between any two studs, and sticks his head up into

the large, half-cylinder air space. The trap accommodates four swimmers at one time, and they may sit on the ballast box and converse while "refilling."

The trap is particularly useful at Wakulla Springs, a thriving center of underwater photography



**Underwater lung "filling station"**

where the clear water permits vision at great depths. Swimmers performing for the cameras at depths of 15 to 20 feet exert too much energy in rising to refill their lungs; the trap allows them to conserve this energy.

Further, the trap enables a swimming coach to observe his students as they swim above him, and to point out to proteges in the trap defects in another swimmer's style.

## BALANCE

### New Checks Assure Automobile Smoothness

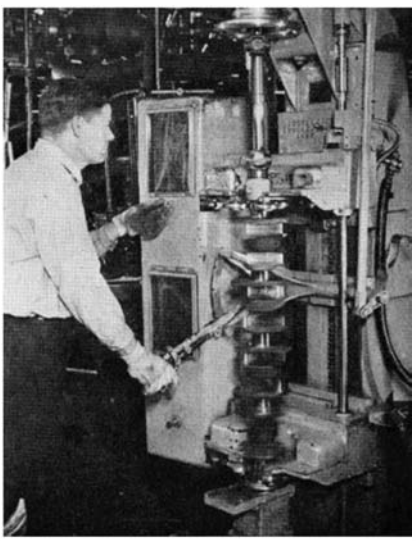
THE importance of balance in vibrationless operation, not only of engines, but also in many other vital elements of the car, is emphasized in a new phase of the manufacturing program now being conducted by Buick. As a result of developments along this line, the balancing of parts going into the manufacture of current models and the design of special machinery and equipment for balancing purposes, has become a major element both in manufacturing processes and design of parts.

The balancing of automobile engines after assembly is the latest step in the campaign for perfectly balanced motor cars. Technically, the balancing operation is regarded as a complete safeguard against the possible production of a "rough engine." Engineers point out that with rotating and reciprocal parts held to within fractional plus or minus limits of perfect balance, the completed engine is normally "in the money." It is possible, however, to have a stacking up of limits in which all of the fractions would be on the plus or all on the minus side. This could result in a "rough" engine. The after assembly balancing operation virtually eliminates this possibility and places each engine in perfect balance within limits of ¼ of an ounce-inch.

Throughout the years of motor-car development it has been a major problem of engineers to reduce vibration, from whatever source, to meet the manifold requirements of smoothness in operation, elimination of noise and the important factor of reduction of wear on moving parts. With the development of high compression, high power, high performance automobile engines, the question of fine balance in all engine parts as well as the various chassis units, and including even the bodies, has become of relatively greater importance than in the past.

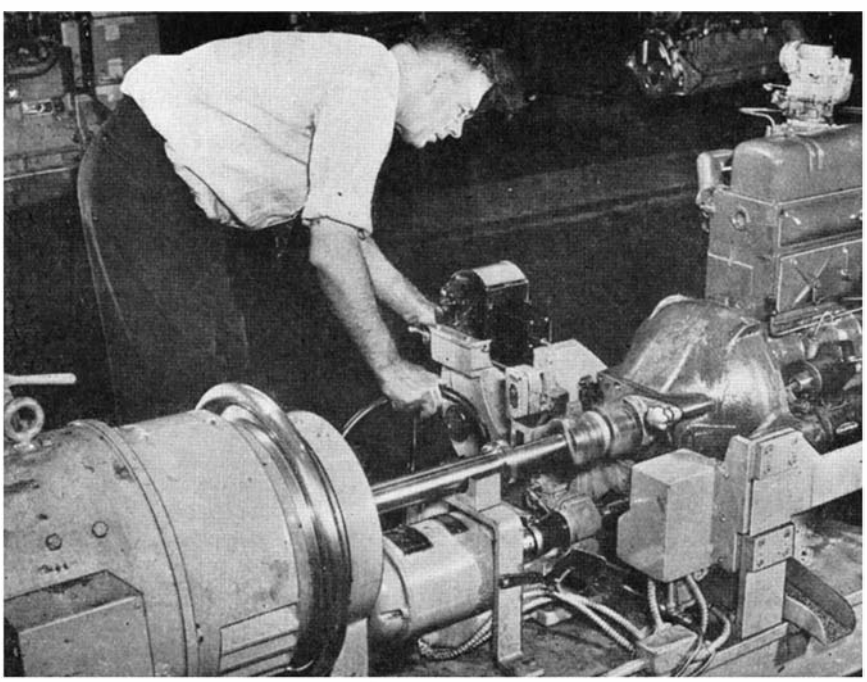
The extent to which Buick already has gone into balancing is indicated by the fact that there are 10 separate balancing operations in the engine plant covering vital parts: The harmonic balancer assembly is balanced to within ¼ of an ounce-inch; the clutch pressure plate ¼ of an ounce-inch; clutch cover and pressure plate assembly is held to ¼ of an ounce-inch limits; the clutch driven plate assembly is balanced to within limits of ⅛ of an ounce-inch; flywheel is held to ⅛ of an ounce-inch; the crankshaft to ⅜ of an ounce-inch; and the completed engine to ¼ of an ounce-inch.

Special types of balancing machines are used to calibrate connecting rods. The rods are checked on the balancing machine, indicators are set to proper limits and



**Spinning detects un-balance**

milling cutters automatically advance to remove sufficient stock, if necessary, so that when the rods are placed on the two knife edges of the checking scale, the limit of 1/16 of an ounce on either end will not be exceeded. Similarly, pistons



**Final check on the over-all balance of an automobile engine**

are measured, weighed, and fitted in a controlled temperature room and likewise held to 1/16-ounce limits.

Extension of complete balancing operations to other parts of the chassis include the balancing of third member assemblies — drive shaft, torque tube, flanges and bearings — and rear axle subassemblies. Thorough checking of the dynamic balance of rotating parts is positive insurance against the incidence of undiscoverable rumbles and other noise in finished cars, engineers say.

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**TENDERS: The capacity of passenger locomotive tenders ranges from 4500 to 24,500 gallons, with the average between 15,000 and 18,000 gallons. Tenders employed in freight service have a capacity ranging from 7000 to 30,000 gallons, the most common being from 16,000 to 22,000 gallons.**

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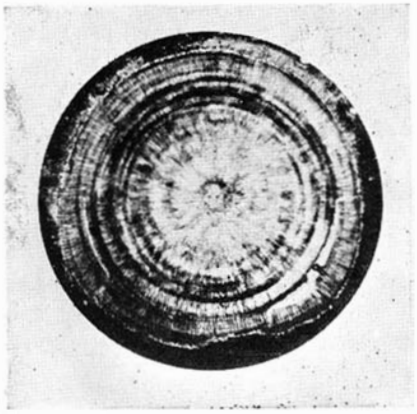
## FOSSIL PEARLS

### The Principle of Pearl Formation Stays Fixed

A RECENT geologic discovery revealed the presence of several fossil pearls that gave indication of being closely akin to species that exist today. Professor George F. Sternberg, of the Fort Hays Kansas State College, found the pearls in the Benton shales, of Cretaceous age, near Hays, Kansas. These shales, and consequently the pearls they harbor, are approximately

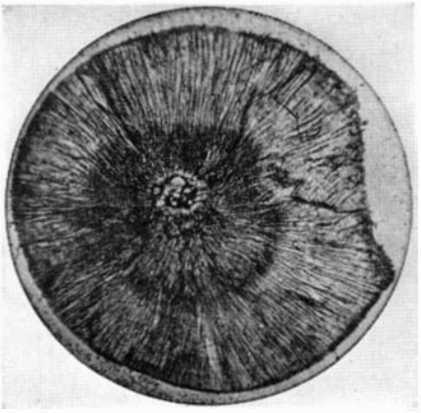


**Cretaceous pearl**

100,000,000 years old, as shown by the geologist's time-table.

One of these fossil pearls, which had been donated to the Bureau of Natural Pearl Information by Professor Sternberg, was thin-sectioned and subsequently examined microscopically. It was found that there exists a striking similarity in structure and constitution, when the pearl of today is compared with the gem of 100,000,000 years ago.

In one of our photographs, representing the ancient pearl, is revealed a crystalline habit that strongly resembles that found in certain species of pearls of recent origin, of which the second picture is typical.



**Modern pearl**

Both of these pearls are composed of the hexagonal variety of calcium carbonate—that is, calcite —and therefore differ from other natural pearls which are composed of the orthorhombic variety of calcium carbonate—aragonite.—*A. E. Alexander, Ph.D.*

## SUN-SWITCH

### Photo-Electric Control for Light and Power

A NEW photo-electric relay for lighting and power, called the Sun-switch, is used to control electrical circuits in accordance with the rise and fall of natural illumination. The user chooses the two lighting levels at which he wishes the load switched on and off, and he adjusts the calibrated dials to the corresponding foot-candle readings. Operation is entirely automatic, no resetting being necessary.

The photo-electric switch is primarily designed as an aid to greater safety and economy in incandescent lighting applications. Important advantages result from using the device in this service, including: Lighting will always be on when needed, regardless of when darkness comes; Lighting will never be on when the presence of sufficient daylight makes it unnecessary; No one need be made responsible for, nor take the time to do, the job of lighting up.

Sun-switch automatic control, developed by the United Cinephone Corporation, may advantageously be applied to: aircraft beacons, airport lights, street and highway illumination, billboards and spectacular type signs, department and retail store lighting, factory lighting indoors (to guard the eyes of workers), factory lighting outdoors (plant protection floodlights), schools, libraries, museums, hospitals, railroad stations, public buildings, and other similar lighting jobs where automatic control can logically be applied.

Special care has been taken in the construction of the switch to make the control rugged and capable of delivering reliable performance. The housing is weatherproof, of drawn metal, 10¾ by 5⅜ by 3½ inches. The door gasket is cork; finish of box is aluminum. The control circuit uses a phototube having a life expectancy of 20,000 hours. Operation is from 110 volts, 50 or 60 cycles, alternating current.

## SKIN PROTECTOR

### Forms Film to Protect Hands and Work

A WATER-WHITE liquid into which a shop-worker dips his hands prior to starting on a job dries quickly to form a skin protecting film. Not only is the skin protected but the film also prevents perspiration from coming in contact with the surface of delicate or finely finished metal parts on which perspiration could cause rusting to start. This liquid, designated as Ply No. 9, has been placed on the market by the Milburn Company.

• • •

**CONTACT LENSES: Today about 8000 people are wearing contact lenses over the eyeball, in place of eyeglasses of the conventional type.**

• • •

## PLASTIGLASSES

### Contact Lenses Now Made of Plastics

THE same transparent methyl methacrylate plastic now used for many products can also be used for contact lenses, the invisible glasses that are worn under the

eyelids. This is provided for by patent Number 2,240,157, granted to Louis L. Gagnon and Harold R. Moulton, Southbridge, Massachusetts, who assigned their rights to the American Optical Company.

The use of plastic, states the patent, "causes the lens to be exceptionally light in weight and resistant to impact and possible fracture."

Another feature is that in the area where the lens makes contact with the eyeball, a thin coating is used of a plastic material which is first soft, and can then be hardened. It is applied while soft, so it takes the form of the eyeball with great accuracy, thus adding to the comfort of the wearer.—*Science Service.*

• • •

**COMPETITORS ADVERTISED: The per capita consumption of apples has dropped nearly 75 percent during the past 20 years, and the products that have replaced apples in the diet of the average American family are those which have been highly advertised, particularly other fruits and canned and fresh fruit juices.**

• • •

## OXOSHIRT

### Diving Apparatus for Life Guards, Sportsmen, and Workers

A LIFE-SAVING "oxygen shirt" to aid life guards in rescuing drowning persons has been invented by Dr. Christian J. Lambertsen, of the University of Pennsylvania Medical School. With this apparatus strapped like a harness to his bronzed back and chest, the life guard will be able to stay under water for from 18 to 25 minutes in depths to 60 feet while searching for drowning accident victims, instead of the usual one minute at depths to 30 feet.

The oxygen harness which thus increases the life guard's life-saving ability weighs just over 12 pounds in air, according to *Science Service.* Under water it is practically weightless. A small cylinder for oxygen or an oxygen-nitrogen mixture fits into a pocket. A nose and mouth mask, rebreathing bags, lead plate, and a soda lime container are the other chief features. The breathing bags, breathing tubes, and inhaler are all buoyant under water and their lift almost exactly balances the under-water weight of the oxygen cylinder, regulator, soda lime container, and lead plate.

The whole life-saving apparatus can be strapped on and be in use within 15 seconds or less. Unlike the deep-sea diver's outfit, it does not require an assistant at the surface but it does not give protection against cold while under the water.

Besides helping life guards and others rescue drowning persons, the new apparatus could be used for inspection and minor underwater repairs of hulls of boats; for pearl and sponge fishing; sport, as in goggle fishing; and, with slight modifications, in mines, sewers, and chemical plants, where the atmosphere is deficient in oxygen or contains noxious gases.

## RHODOPSIN

### Substance in Eye Makes Ten Somersaults a Second

HUMAN vision is made possible by a mysterious substance in the eye known as rhodopsin, contained in the rods of the retina. When light falls upon it, reports the Better Vision Institute, it undergoes a chemical change. The alteration of the substance causes a nervous impulse which is transmitted to the brain.

Rhodopsin has the remarkable ability of changing itself back to its original form in about one sixth of a second. In normal eyes these chemical somersaults take place about 10 times a second, hour after hour, day after day, year after year. The substance may be compared to the sensitive coating on a photographic film, but with the remarkable difference, however, in its power to change itself quickly after exposure to its original form.

## TRAFFIC SPEEDUP

### Surface Transportation Company Uses Two-Way Radio

RADIO is now being used to speed up bus and trolley traffic in New York through a fleet of 20 patrol cars operated by the Brooklyn and Queens Division of the New York Transit System. By means of these cars, controlled from a central dispatching office, busses and trolleys can be quickly and effectively routed around traffic jams.

## COMPRESSION

### Water Measures Ratio in Engine

ACCURATE determination of the volume of the combustion chamber in an automobile engine cylinder head is essential in the production of well-designed motors. One of our illustrations shows a method used by Pontiac to measure accurately the size of these chambers. Since the size of the chamber governs the motor's compression ratio, it follows that by determining the cubical capacity of the chamber,

**Accurately gaged water provides check on cylinder compression ratios**

# Books on Psychic Phenomena

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### Extra-Sensory Perception After Sixty Years

*By J. B. Rhine, J. G. Pratt, Burke M. Smith, Charles E. Stewart, and Joseph A. Greenwood*

A COMPLETE account of the research conducted to date on extra-sensory perception. This book is a summary of what has been achieved so far, a reference work covering the field as a whole, a treatment of all the evidence, a guide to the literature of the subject, a condensation of the greater bulk of it, and a handbook of methods. It includes a digest of 56 articles of criticism of experiments in extra-sensory perception, mainly as made by psychologists, in which these are dealt with without emotion. A solid, serious study. (463 pages, illustrations.) —$2.85 postpaid.

### Forty Years of Psychic Research

*By Hamlin Garland*

AFTER a lifetime spent in investigating spiritualistic phenomena, the author presented the facts as he observed them. He theorized little, witnessed without emotion, and after a clearly stated, factual presentation, he permits the reader to draw his own conclusions. (394 pages.)—$3.60 postpaid.

### Cavalcade of the Supernatural

*By Dr. Harold H. U. Cross*

HIGHLY valued as one of the clearest, most convincing volumes dealing with manifestations all over the world of water divining, luminous effects, materializations, spirit photography. Illustrated with authentic pictures.—$2.10 postpaid.

### Experiments in Psychics

*By F. W. Warrick*

INTENDED for experienced students of psychic phenomena, this book records the results of years of systematic investigation of direct writing and psychic photography. A large number of experiments, accompanied by photographic studies, all made under test conditions, seems, in view of the convincing nature of results, to rule out the possibility of fraud in the majority of cases and to offer strong evidence in favor of the types of psychic phenomena dealt with. (600 illustrations.)—$7.60 postpaid.

DUNNINGER

# YOU, TOO

## Can Investigate The

## SUPERNATURAL

**IN our April issue we announced our intention of exploring the realm of the psychic in an endeavor to determine whether, through mediums, we can communicate with the dead. We want to know if such things as phantoms, ghosts, spirits, or vampires actually visit us. We seek the facts concerning ectoplasmic and other supernatural demonstrations of a physical nature. To aid us in our search, the Scientific American Committee for the Investigation of Psychic Phenomena was formed under the chairmanship of Dunninger, whose world-wide reputation as a telepathist, magician, and psychic investigator is unequalled.**

**In the course of our search the Committee will welcome sincere and bona fide assistance. Should your interest in the psychic lead you to try to discover for yourself a basic, truthful, scientific explanation, you will wish to follow the reports of the Committee as they appear in ensuing issues of Scientific American. For correlative reading, the books listed on this page will be found informative, helpful, and interesting.**

**—The Editors**

# Books on Psychic Phenomena

• • •

### Inside the Medium's Cabinet

*By Dunninger*

A DARING exposé of trickery practiced by fraudulent mediums in presentation of so-called supernatural phenomena. In an exciting series of revelations, this internationally known authority on spiritistic matters divulges the secrets of certain mediumistic personalities who have come within the scope of his experience. Every statement of fact is based on the author's first-hand investigation. (228 pages, profusely illustrated.)—$2.60 postpaid.

### Psychics and Mediums

*By Gertrude Ogden Tubby*

A MANUAL and bibliography for students, this is also an important guide and source book, presenting a scientific analysis of all types of psychic research, both objective and subjective. (210 pages.)—$2.10 postpaid.

### Science and Psychical Phenomena

*By G. N. M Tyrrell*

IF the world is to be saved from the advance of materialism, the author points out, knowledge of man's psychic processes must be extended. This splendidly informed, thoroughly scientific examination of a controversial but increasingly important subject is a unique addition to the literature on psychical research. Brilliantly concise, carefully evaluated, the history of research and the method of collective experiment are described. —$3.85 postpaid.

### Beyond Normal Cognition

*By Dr. John F. Thomas, Ph. D.*

THIS is an intensely interesting study, evaluative and methodological, of the mental content of certain trance phenomena. The author was for some years associated with the Boston Society for Psychic Research. (319 pages, bound in cloth.) —$3.10 postpaid.

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it is possible to check accurately the compression ratio in all the cylinders of the engine. In the set-up shown in the photograph the glass tube containing water is graduated in cubic centimeters. The volume limit of the combustion chamber in a 6-cylinder Pontiac engine is 93.8 to 97.8 cubic centimeters; for an 8-cylinder engine the limit is from 69.9 to 73.5.

## DRESS FORM

### Plastic-Saturated Fabric

### Reproduces Feminine Figure

SCIENCE has come to the aid of the dressmaker by providing a form which makes it possible to fit women's clothes exactly in accordance with the most minute figure variations.

In making the form, sheets of a plastic-saturated fabric are molded to every line and curve of the human figure, being applied over a smooth fitting cotton garment. The soft plastic material is molded carefully to conform to the body like a second skin. The shell thus formed hardens almost immediately whereupon one side is reopened and the shell is removed. The resulting dress form is reinforced, lacquered, and mounted on an adjustable stand.

The thermoplastic material used for this form, made of rubber combined with a variety of waxes, was developed in the research laboratories of the Singer Sewing Machine Company. These ingredients are melted together and used to saturate a knitted fabric. The finished material is stated to be non-inflammable, non-toxic, inexpensive, and easy to apply. The sheets of thermoplastic material are merely warmed to a few degrees above body temperature just prior to molding the figure.

## COMFORT

### Keeping the Home Cool

### in Summer

MEANS of removing heat from the attic make houses more comfortable. Louvers of average size in the gables are said to be of little value, and small openings in the cornice do not help much. Louvered openings as large as ordinary windows are cooling, but must be closed in winter. Additional ventilation through cornices and ridge ventilators is also desirable. Light-colored roofs absorb less heat than dark-colored roofs. The house-construction experts say there is no use expecting very noticeable results from adopting only one of these factors, but all of them together will produce a very considerable effect in keeping houses cooler. — United States Department of Agriculture.

## TIME CAPSULE

### Replica of Historical

### Record for 6939 A.D.

BURIED 50 feet underground at the site of the New York World's Fair of 1939-40 is the Westinghouse Time Capsule described in some detail in these pages when first constructed. There it will remain until uncovered by archeologists thousands of years hence, revealing to the people of that far-distant day a complete record of the early 20th Century.

That the people of the present day may be able to see precisely how this record was made for future generations, a replica of the Time Capsule was recently placed on display at the Hayden Planetarium in New York City.

A glass-covered cutaway in the capsule allows the public to see how the contents are packed. Among the articles visible are a Bible, the Book of Records, a telephone, a baseball, glass tubes of various seeds, and containers of microfilm on which is recorded a 10,000,000 word synopsis of the history, faiths, arts, sciences, and customs of our civilization.


**Replica of preserved records**

## PURIFYING

ON PAGE 337 of our June issue we described in some detail a water purifying process employing synthetic resins. This method, which employs a reaction similar to the zeolite process of water softening, has been made possible through experimental work conducted by the Resinous Products and Chemical Company.



# Industrial Growth

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

## ALL-GLASS TAPE

### Woven Glass Material

### Provided with Adhesive Back

FIBER-GLASS adhesive tape with a pressure-sensitive coating has been perfected by the Industrial Tape Corporation. It was originally designed for use as pipe insulation but is now being used in various industrial fields and is finding increasing uses in the electrical industry and in other businesses where flexible glass tape is needed.

The glass tape is manufactured in 40-inch rolls and then cut to any desired width exactly as paper and cloth tapes are cut; in use it is applied and cut just as any other adhesive tape.

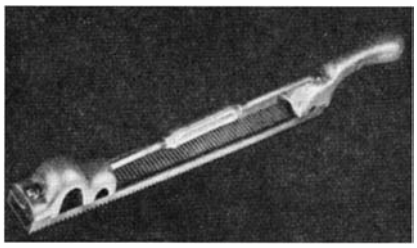
## FILE

### Works on Soft Metals

### Without Clogging

CALLED "A Modern File for Modern Industry," a newly patented tool is provided with spaces between the teeth to allow the chips to pass through. Thus the file works like

a plane with a multiplicity of blades and will not clog even when working on the softest metal. The chips are cleared with a flick of



**The chips go through**

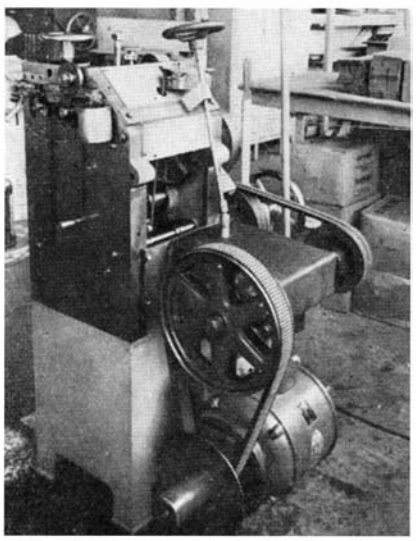
the wrist, all brushing or scraping of clogged teeth being eliminated. This file, known as the "Zipper," is manufactured by the Delta File Works and can be used on flat or slightly convex or slightly concave surfaces. The aluminum handle has an adjustable turnbuckle by means of which the body of the file can be slightly curved.

## VARIABLE SPEED

### Adjustable Pulleys

### For Wide Power Range

Now available on the market is a complete variable-speed pulley drive which can be used on installations of from one to eight horsepower where a maximum speed ratio of 3 to 1 is desired. With this complete drive setup, manufactured by the Ideal Commutator



**Increases or decreases speed of old machines to fit requirements**

Dresser Company, old fixed-speed equipment can be modernized at low cost and made to operate at the most efficient speed for the work in hand.

Both halves of the adjustable pulley move toward or away from

the center line; the belt always remains in the correct plane. The faces of the pulley are curved, giving maximum belt contact at all pitch diameters. The adjustable pulley mounts directly on the motor shaft.

## THICKNESS GAGE

### For Measuring Non-Magnetic Materials

AN ELECTRIC gage for measuring the thickness of any non-magnetic metal when only one side is accessible has been built by the General Electric Company. Thicknesses up to 1½ inches, depending upon the electrical resistance of the metal, can be measured within an accuracy of 5 percent.

Although the instrument was particularly designed for checking the wall thickness of aluminum airplane propellers, it can also be applied to the measurement of brass sheeting, copper tanks, and large pipes.

The gage consists essentially of a bridge circuit, voltage amplifying equipment and an indicating

**For thickness measurement**

instrument. The bridge circuit comprises two inductances with U-shaped cores and a differential transformer. The inductances serve as a gage head and an adjustable balancing head.

The gage head, when placed against a non-magnetic metal, sets up eddy currents within the metal which change the impedance of the head and affect the circuit bridge balance. The eddy currents increase with the thicknesses of the metal.

The effects of these eddy currents upon the bridge circuit, as shown by deflection of the indicating scale, are plotted upon a master curve for known thicknesses of a specific metal within the desired thickness range.

The gage head then is placed against the unknown thickness of that same metal and the scale de-

flection read. This reading is compared with a similar point on the master curve to determine the thickness of the tested piece. It is essential that the contour of the test piece be the same as that of the pieces of known thicknesses from which the master curve was obtained.

The higher the electrical resistivity of the metal the greater the thickness that can be measured. With this gage, which operates on 50 to 60 cycle alternating current, brass, which has a comparatively high resistivity, can be measured in thicknesses up to 1½ inches, whereas copper, which has a low resistivity, can be measured only to ¼ inch thickness.

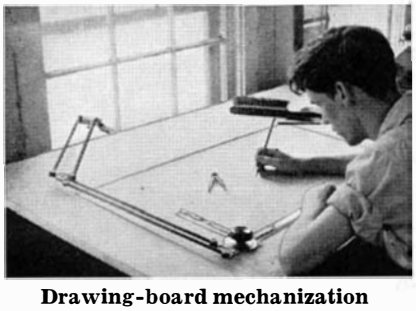
The gage head, encased in Bakelite, can be held in one hand for application against the metal. The remainder of the gage is contained in a steel carrying case and weighs about 30 pounds.

## DRAFTING

### Machine Speeds Up Drawing Board Work

A DEVICE which mechanizes the drawing board, known as Master-Drafto and made available by The Drafto Company, has been particularly designed for industries where ideas must be quickly translated into production.

When permanently mounted on the drafting board or table, this new device combines the use of scales, triangles, and T-square into one operation. The scales, attached to the protractor plate, can be



**Drawing-board mechanization**

moved swiftly and easily to reach any portion of the drawing paper. It will take any size drawing sheet up to 24 by 36 inches.

The stainless-steel protractor plate, at the ends of the arms, can be set to one-half degree readings by use of a graduated vernier. By tightening the clamping device the scale blades can be locked at any angle desired. The protractor is fitted with a latch spring to lock

the scales in any one of four different positions on either side of the zero reading.

## CORROSION PROOF

### Metal Surfaces Protected in Storage or Transit

A NEW liquid material, known as Pro-Cote and manufactured by Fishoilene Inc., is designed to protect the finish of metal surfaces while they are stored or in transit. The liquid dries to a transparent corrosion-proof film which permits ready inspection of the parts. After a film has served its purpose it is removed by rubbing with a dry cloth.

## TRANSFER FILM

### Aids in Speeding Up Defense Production

DEVELOPMENT of Matte Transfer Film, a photographic material for sensitizing metal plates for use in a template process that shortens the time between engineering and test flights in the aircraft industry from two to four months, is announced by the Eastman Kodak Company. The process can also be effectively used in the automobile industry or by any manufacturer using metal templates, nameplates, and so on.

With the use of Matte Transfer Film, engineering drawings can be printed either by contact or by projection on photo-sensitive metal sheets. The processed plates bearing the photographic image are then sent directly to the template department to be cut out and used as a pattern. The templates are made by cutting around the photographic outline by means of a saw or mechanical shears. Other machining operations to which the photo-sensitized metal sheets are subjected are filing, drilling and punching. By this means the costly and time-consuming step of making the layouts on metal by hand from the blueprints, or the necessity of duplicate inspection, is avoided.

If great care is taken in the selection of the cameras and lenses used for this purpose, it is reported that photo-templates can be made with a tolerance of 0.001 inch per foot.

It has been found that the most simple and effective method of producing sheets of photo-sensitized metal consists of laminating Matte Transfer Film to lacquered metal sheets. The film consists of a sensitive emulsion coated on a thin film support, the latter backed by a paper base. When used, the sensitized strip is transferred (or stripped) from the supporting paper base to the lacquered metal plate. This film has a matte surface, so that it will take a pencil line in case changes or additional developments on the processed photographic image are desired.

## TOOL GRINDER

A NEW and larger carbide tool grinder of the double end type, designed so that two operators can grind tools simultaneously, has been announced by Carboloy Company, Inc. The high capacity of the new machine makes it particularly suitable for plants where a large number of carbide tools are being used or ground daily, for use where large amounts of carbide removal are required, and where heavy-duty cemented carbide turning, boring, facing, or planer tools, and so on, are to be conditioned.

The grinder is designed for the use of two 14-inch disk type wheels —one at either end; each end has its individually adjustable tool rest table. The grinder may thus be used, if desired, for rough and finish grinding, or for rough and semi-finish grinding before lapping.

**Two can grind**

To facilitate handling of large tools, tool rest tables are exceptionally large—9 by 22 inches. They are individually adjustable by means of screws operated through detachable crank handles, graduations being provided on the side of the table to assure accurate setting.

# Air Fighters

## Characteristics Desirable in the Military Type that Keeps Bombers Away

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

AN ACKNOWLEDGED authority on military aircraft, E. Colston Shepherd, editor of *The London Aeroplane,* has recently published a pamphlet on his chosen subject. Some of his observations will certainly bear consideration, particularly by our own military forces.

Fighters and bombers are drawing closer together. Ten years ago the fighter was faster than the bomber by a good 30 percent. Today the fighter's margin represents a bare 15 percent; but the fighter will never disappear, because nothing but the fighter is a real defense against the bomber. Anti-aircraft fire can keep the bomber high, break up formations, and impair the accuracy of its bombing; but only the fighter can destroy the bomber before it drops its bombs, only the fighter can make daylight bombing too costly for the enemy. When, last September, the Royal Air Force claimed 185 victims in one day, the British had won their first great victory of the war—without the public realizing the fact. What was the secret of the British victory? "Making allowance for the better training and finer spirit of the British pilots, the German onslaught on Great Britain was beaten by slightly better fighter aircraft," writes Mr. Shepherd. "The superiority was expressed partly in speed, partly in power of maneuver, partly in armament."

Mr. Shepherd elaborates on these three essentials of the fighter. In regard to maneuverability: "Yet the Messerschmidt 110, with its four forward firing machine-guns and two cannons, to say nothing of its speed of 365 miles per hour, has often been shot down by the older Hurricanes, capable only of 330 miles per hour and carrying only eight machine-guns, which have a shorter effective range and less penetrative power against armor than cannon. The secret has lain in the power of the Hurricane to turn more quickly than the bigger machine and so to give it bursts of fire from positions in which it could not reply."

What is the ideal specification for a fighter? "Probably the ideal fighter would be one about 50 miles per hour faster than the best bomber, and armed with eight small cannon able to fire shells at the rate of 600 a minute each for a period of about three minutes. If to these characteristics could be added a range of 2000 miles, an initial rate of climb of 4000 feet a minute, and a ceiling of 45,000 feet, then the lucky air force would have obtained an instrument which would take the heart out of its opponents. Before the war is over there may be such a fighter. For the present the nations have to be content with something less formidable. Fighters have not yet passed out of the stage of mixed armament — machine-guns and small cannon." Here is a specification which our military designers would do well to study. Free from fear of invasion or bombing, with the physical and mental resources of a continent behind them, why should not we be able to build a machine that would give the British and ourselves complete superiority over the Germans?

## FLAPS

### Air Brakes for Dive Bombers

THERE is no danger in great diving speed, be it as high as 600 miles an hour; the danger comes in the subsequent recovery and the large centrifugal forces developed in a curved flight path. When the diving speed is very high, the radius of the recovery curve must also be high; otherwise the centrifugal forces would be enormous. The airplane might be built to withstand such forces, but the pilot would suffer a blackout of his brain. Flaps or air brakes may therefore be used to keep the diving speed within reasonable limits. Without flaps, diving speed is high, the radius of recovery is large, the

height from which the bomb must be released is considerable and the aim is uncertain. With wing flaps is set up a combination of circumstances which is much more pleasing to the bomber—lower diving speed, small radius of recovery, release of the bomb fairly close to the ground, and greater certainty of hitting the target—*A. K.*

## FLYING BOAT

### Most Powerful Patrol Bomber

EVEN the old line Admirals in the Navy Building were perturbed by the story of the sinking of the *Bismarck,* and are almost though not quite ready to admit that sea power without air power cannot exist. However, the Bureau of Aeronautics in the Navy Department has been fully aware of the value of the fleet air arm and of the patrol bomber for many years, and can be proud of the fact that its air effort is modern and efficient.

The most powerful of the long range patrol bombers is the PB2Y-2, a four-engined craft built by Consolidated Aircraft Corporation and shown in flight in our photograph. The PB2Y-2 is a big sister ship to the hundreds of Consolidated twin-engined patrol bombers which have been giving such useful service to the Navy under the designation of PBY.

Certainly the giant four-engined flying boat has a beauty of its own. The huge hull looks as if it had no more resistance than the most perfectly streamlined fuselage of a land aircraft. The bomber's compartment in the nose is perfectly streamlined into the rest of the hull. The windshield protrudes very little. The gun blister at the rear is nicely faired into the top of the hull. The nacelles of the engines stick very far out ahead of the wing, partly no doubt to secure trim, but also as a method of attaining aerodynamic efficiency. The tip floats have been retracted into the tip of the wing. The vertical tail surfaces are out at the ends of the stabilizer, increasing the efficiency of the stabilizer, and are themselves out of all blanketing effects of the fuselage.

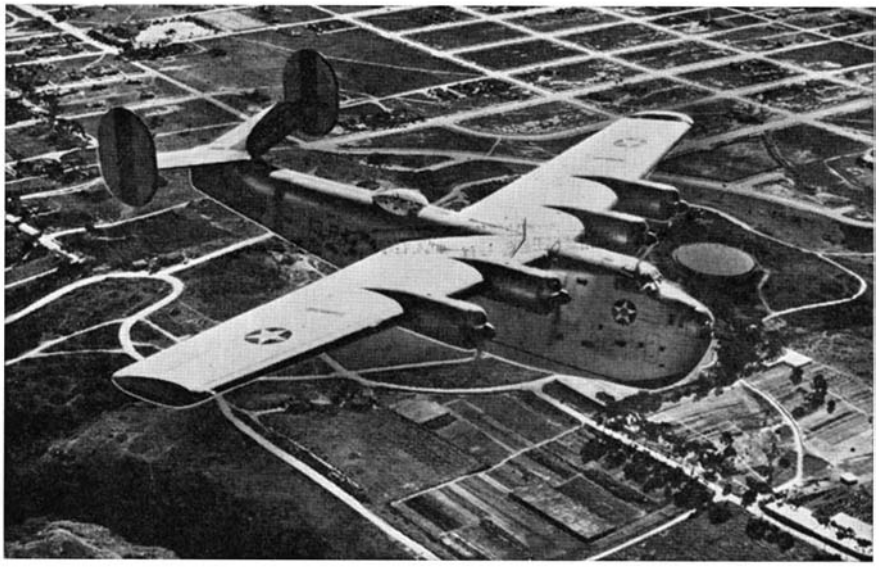
No further information is available regarding these large boats, but they look as if they could give the Germans quite a little to worry about.—*A. K.*

## BALLOONS

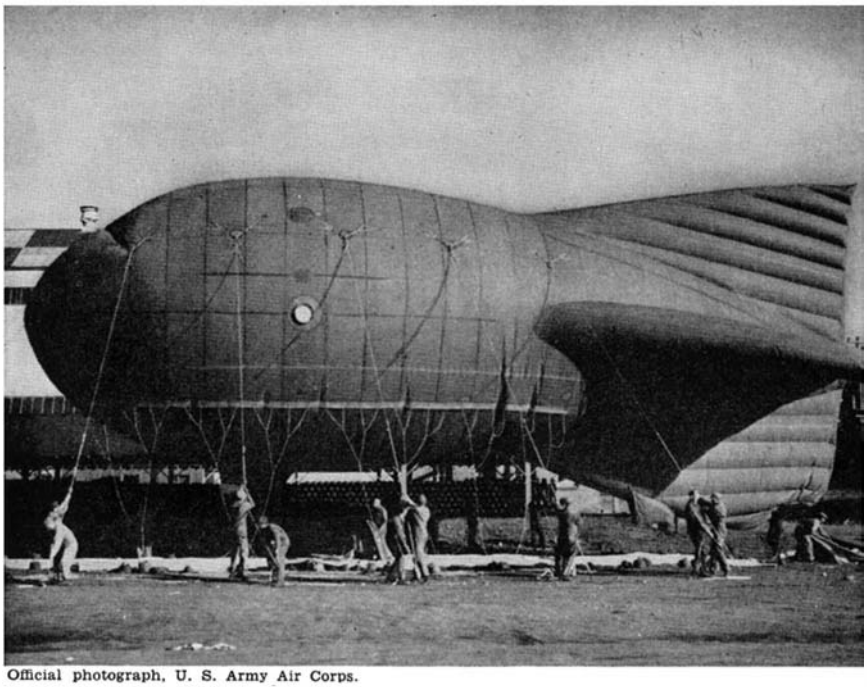
### An Important Factor in National Defense

THE barrage balloon has proved itself of the utmost value in England. It forces dive bombers and other attacking planes to fly at high altitudes, thus decreasing their effectiveness. The development of this method of defense has been the duty of the Army Air Corps; its use will be the duty of the Coast Artillery Corps.

In principle, the barrage balloon is extremely simple. All it has to do is to stay put, not tear away (even in the most violent wind) from the wires which attach it to the ground, not lose gas too rapidly, be able to withstand a good deal of wear and tear, and be capable of being let out or hauled down rapidly and easily. In actuality



**Four-engined patrol bomber—most powerful, clean**



Official photograph, U. S. Army Air Corps.

**Handling a barrage balloon at Camp Davis, North Carolina**

its design problems are difficult. The average size of the barrage balloon, when inflated, is 35 feet in diameter and 87 feet in length. It should be reasonably stable when aloft; that is to say, it should neither nose up too much and pull away in a high wind, nor nose down and lose altitude. Hence the provision of the very large tail surfaces, since the balloon body itself is inherently unstable. In the modern balloon the outer covering is of cotton fabric, impregnated with synthetic rubber. Experiments have shown that the synthetic product holds hydrogen gas better than natural rubber.

It is perfectly proper for our War Department to expand its balloon barrage facilities. They will constitute a valuable defense measure in protecting fleet anchorages, localities where it is difficult for planes to intercept enemy aircraft, and so on.—*A. K.*

## AIRCRAFT ARMOR

### New Process Speeds-up Production

We are indebted to the magazine *Steel* for an excellent description of a new process for manufacturing airplane armor plate, developed by the Breeze Corporations.

The severe limitations on airplane weight require that the gage of the armor plate be as light as possible, consistent with effective resistance to the projectile. Thus, airplane armor ranges up to 44 inches by 44 inches by 1½ inches, most of it being in ¼, ⅜, and ½ of an inch in thicknesses. Armor plate is essentially a nickel-alloy steel. It must be exceedingly hard on the exposed side; tough but more ductile on the interior side.

How is this additional hardness on the exposed side achieved? By carburization; that is, by heat treatment of the surface while in contact with a powder having a high percentage of carbon content. The face-hardened armor plate is thus given extra resistance to penetration.

The Breeze armor plate is as good as any built in the world, but, what is perhaps of most interest in these days when production must be speeded up at all costs, is the much faster carburization process which has been developed. In common practice the plate is packed in a box of carbon powder and placed in a heating furnace. Since the box may weigh twice as much as the steel which is being treated, considerable time and heat are consumed before the contents are raised to the desired temperature. As much as 50 hours may be required for a complete heat for ¼-inch plate. In the new Breeze process, three heats can be carried out on 24 hours. The carburizing treatment is accomplished with a liquid salt bath in an electric furnace. This equipment enables the work to be charged and removed quickly, brings the plates up to the desired temperature quickly and makes accurate control of the temperature possible.—*A. K.*

# CAMERA ANGLES

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

## Bar-Less Zoo Shots

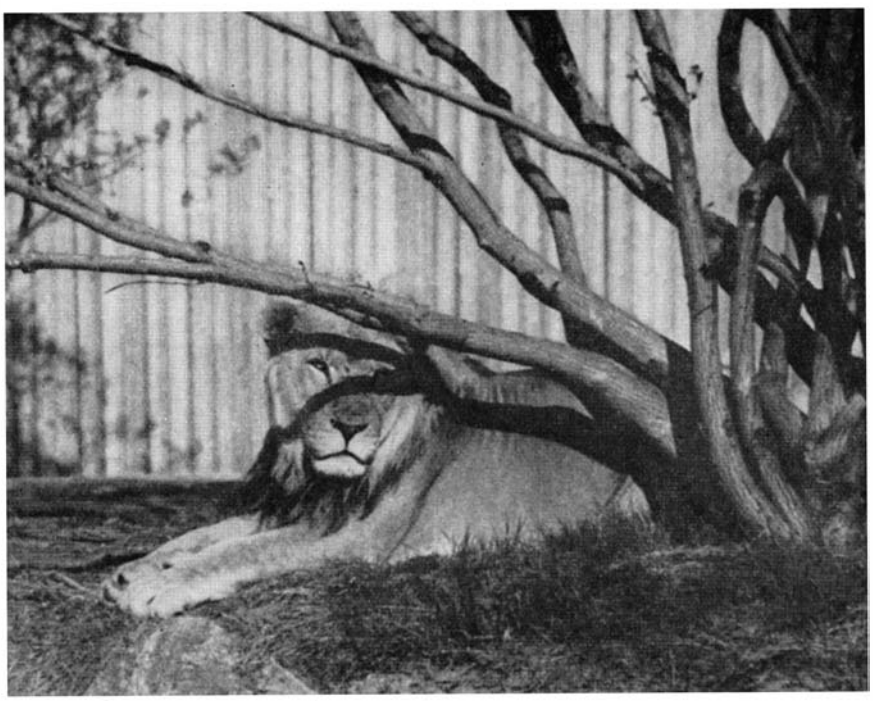
A TREND very heartening to amateur photographers who have had to think up all sorts of tricks to get around the iron-bar problem in shooting natural pictures of animals and birds in the zoos, is currently under way. In several city zoos, lions have the run of a plain, arranged convincingly like the African habitat whence they came, fully open to the view. However, a dry, deep moat separates the edge of the plain from the sightseers—and camera fans, who can now shoot at leisure from a safe vantage point, without bars and with plenty of opportunity for composition and all the other details of picture-making.

However, for really good shots, we believe a long focus lens to be indispensable. The best shots of the king of beasts are, as we all know, made fairly close up or, what amounts to the same thing, at a distance but within the narrow angle of view of the telephoto lens. The fellow with the one-lens camera need not be discouraged, however, if he will only remember that, by cropping a small part of the negative, he achieves practically a telephoto effect in his print. Of course, this makes it mandatory that the film be developed in a fine-grain solution to insure grainless enlargements.

If you have the time to stick around long enough, or the patience and interest to keep coming back to the grounds every once in a while during your peregrinations through the zoo, you will find there is more variety in this subject than may at first appear. Now, the beasts are resting near a rock or a tree, singly or in groups of two or three; now they are strolling down the plain toward the edge of the moat; now they are playing or fighting, sometimes three and four of them at one time. The picture reproduced was made on 35mm film in a camera equipped with a long focus lens. The subject faces the setting sun, completely relaxed and but mildly curious about the people on the other side of the moat. His thoughts seem a long way off.

Large birds also have the run of a plain open to the view without bars. Most of them move around rather leisurely so that it is not difficult to

"Busybody"



"Nostalgia"

shoot them at leisure, provided they come close enough for a decent size picture; others, like the strutting secretary bird you see in the picture, keep moving all the time and you have to be on your toes to get them quickly. The thing to do in this case is to work in good light when you can, close down the diaphragm to permit a fairly deep field of sharp focus, and shoot when the subject comes within reasonable range.

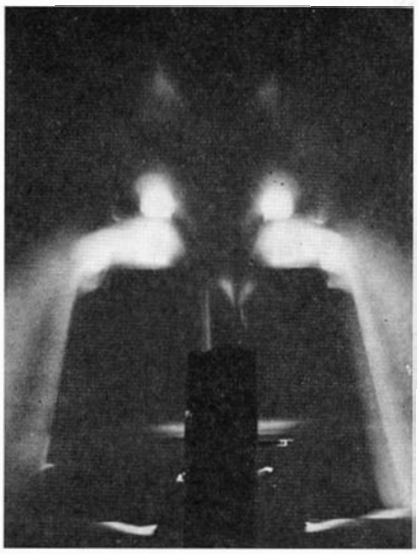
### Light Patterns

THE most graphic proof available that pictures are made of light and shade are examples of the type illustrated here. Cramped for space one day when projecting color slides, we backed the projector, an Eastman Model 2, against a wall, and noticed that the light coming through the various openings in the back of the projector produced an odd pattern on the wall. Convinced long ago that what the eye can see, the camera can photograph, we set up a camera on a tripod and made a time exposure of several minutes.

To make the most of the occasion, we made sure that no other lights were on to wash out the design. The best symmetry of the "eyes" and other features was obtained by pulling the slide holder out as if in position to project a slide. With only half the slide space in place, the design lacked symmetry, and this was essential to get the most convincing result. Both the image and the image producer are shown in one of the pictures, with the crinkle of the wall adding somewhat to the effect.

In an effort to make the most of our discovery, we tried setting the projector up at various angles with relation to the wall, finally hitting on one that produced the second result shown. This we obtained by standing the projector on its "face," that is, lens on table instead of the normal position. In this instance, we wanted to shield the projector so that it would show merely as a dark mass.

**First attempt**



**Projector shielded**

A sheet of black cardboard did the trick. Probably we have not as yet exhausted the possibilities, but here are two for what they are worth.

Try it with your own projector or other similar apparatus. Provide a white or light-toned wall, and make a few experiments. Shoot what looks reasonable. It will "come out" if you give it enough time. If there is enough light to use an exposure meter, read the darkest light portions you can and then double or quadruple the time. The brightest portions will be dense anyway and since, in most instances, the best results will be obtained only if the weaker tones are also recorded, it is better to over-expose the strongest reflections than to under-expose, and thereby lose, the weaker tones.

### Soft Colors, Not Primaries

JUST because the three-color process is concerned with the three primary colors is no reason for choosing these colors when selecting an arrangement for color photography. These colors usually are too brilliant for the best color results. More pleasing effects can be achieved by picking the softer colors and thereby avoiding harsh, candied results.

### Stock Hypo

MOST amateur workers habitually make up a stock of the regular acid-hardening hypo solution and use it on both film and paper. There are occasions, however, when you must use plain hypo, as when toning, making up a reducing formula, and so on. For negatives the acid-hardening formula is advisable, particularly in warm weather, and prints intended for ferrotyping should also be fixed in this bath. However, if you make up a stock of plain hypo—one part hypo to four parts water—the acid or hardener, or both, can be added as required. For toning prints, ¾ of an ounce of sodium bisulfite is added to a quart of plain hypo. A

# Over $1100 in Prizes
# 36 Chances to Win

## Sixth Annual
## Scientific American
# AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

### Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

# THE PRIZES

1st. Three $125 LONGINES, Coronation Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three International Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Brooks FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

**Photograph Contest Editor, Scientific American**

**24 West 40th Street** **New York, N. Y.**

# 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 inches. *All prints must be mounted, otherwise* they will be returned immediately.

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 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. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. 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, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

**THE JUDGES:**

**McClelland Barclay**
Artist

**Ivan Dmitri**
Artist and photographer

**T. J. Maloney**
Editor of **U. S. Camera**

**Robert Yarnall Richie**
Photographer

stock acid hardener may be purchased ready prepared, or can be made up as follows, and kept in a separate bottle to be added, in the proportion of one part stock hardener to four parts stock hypo, as occasion demands:

Eastman Stock Hardener (F-1a)

| | |
|---|---|
| Water (about 125°F.) | 56 ounces |
| Sodium Sulfite, desiccated | 8 ounces |
| Acetic Acid (28%) | 24 fluid ounces |
| Potassium Alum | 8 ounces |
| Cold water to make | 1 gallon |

Dissolve the sulfite completely before adding the acetic acid; add potassium alum with constant stirring. When alum is dissolved entirely, add cold water to make up volume.

### Rapid Processing

A FILM processing technique that makes it possible to produce a dry negative ready for printing in about 10 minutes, is published in a leaflet issued by Wabash and combines a new rapid processing method announced by Agfa with the new Birdseye Sealed-Silver Heat Lamps. Five steps are involved:

1. A rapid working two-solution developer:

*Solution No. 1*

| | |
|---|---|
| Metol, or equivalent | ½ oz. 80 gr. |
| Sodium Sulfite | 4 ozs. |
| Hydroquinone | 1¼ ozs. 30 gr. |
| Water to make | 1 gallon |

*Solution No. 2*

| | |
|---|---|
| Sodium Carbonate (monohydrated) | 13½ ozs. |
| Water to make | 1 gallon |

2. A five-second short-stop bath (1½ ozs. 28% acetic acid in 32 ounces water).
3. Rapid fixation in concentrated hypo formula, such as Agfa's No. 201, made up as follows:

*Solution No. 1*

| | |
|---|---|
| Hot water (125°F.) | ½ gallon |
| Hypo | 3 pounds |

*Solution No. 2*

| | |
|---|---|
| Hot water (125°F.) | 20 ounces |
| Sodium Sulfite | 2 ounces |
| Acetic Acid (28%) | 6 ounces |
| Potassium Alum | 2 ounces |

Add Solution No. 2 to No. 1 and then water to make one gallon.

4. A two-minute wash.
5. Speed-drying with infra-red heat lamps.

Because of the short processing time in each of the baths, the latter must be agitated continuously throughout the designated immersion period in order to avoid uneven results.

The negative is developed first in Solution No. 1 (70° F.) for one minute, followed, without rinsing, by a one-minute development in Solution No. 2. It is then agitated in the stop bath for five seconds, followed by fixation for 1½ minutes. Wash for 2 minutes in running water, but, for

permanence, it is advisable to wash later more thoroughly. Drying time takes two minutes if the following procedure is followed: Remove surface moisture by placing negative on clean ferrotype tin or sheet of glass and swab with rubber squeegee. Immerse in a tray of Agfa Rapid Drier for one minute, rocking the tray continuously. Squeegee the negative again and place in dry developing hanger suspended between two Birdseye Infra-Red Heat Lamps placed about two feet apart. An electric fan, set up behind the negative, is turned on first to send the flow of air across the path of the infra-red rays on each side of the film, as described in these columns in July.

Further details are available in the leaflet.

## Low Viewpoint

EVEN so simple a subject as that shown in the illustration can be given dramatic effect by the choice of a low viewpoint. The camera was about six inches from the ground, a rusty tin can serving as tripod. Stop *f*/32 was used in order to get sharp

**"Low Tide"**

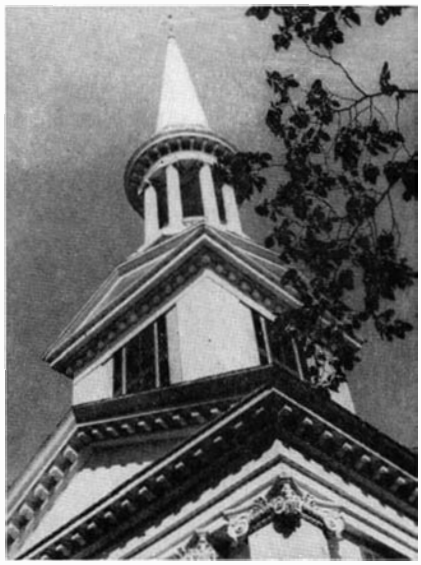
focus all the way through. We chose to feature the reflection in this particular shot, although a fine result may also be achieved by featuring the sky, the mast of the boat running diagonally across a medium-toned sky. In that case the boat and the water would occupy less than a third of the picture. The viewpoint would be the same.

## Hands in the Picture

IT IS always better not to instruct the subject as to where to place the hands, but rather to suggest a pose and let the hands place themselves naturally. However, in many instances, hands do get into positions where they look awkward, even though unposed, and something must be done to bring them into line. Here are a few suggestions. Have the hands close to the body. One hand in half shadow will help to make it less prominent. Resting the head on one hand, with the hand on the shadow side of the face, is a useful idea. When the full hand is shown, bending or folding some of the fingers will help. Posing the hands flat with the fingers drawn up to the second joint suggest amputation; obviously this should be avoided.

## Church Spires

A WHITE church against a darkish sky has a perennial attraction for the camera fan. Its sheer simplicity, the beautiful contrast, and the atmosphere of peacefulness surrounding



**Christopher Wren spire**

the scene, all contribute to one of the most attractive subjects we have in photography. The usual method is to shoot from a distant vantage point in order to include the entire church and make it stand straight. When the limitations of the camera make it necessary to tilt the camera, we usually straighten the image on a tilted easel under the enlarger. Sometimes, however, a more impressive result is obtained by coming close and shooting up at the church at an angle, as in the case illustrated. Make sure your stop is small enough—*f*/32 in this case—to bring everything into sharpness. A tree branch will help to frame the picture and fill space.

## Removing Scum

SCUM streaks, particularly on dry negatives, will print out on paper and require much laborious spotting. Eliminate the scum and you save yourself this trouble. An effective method is to boil a pint of water, cool it, then add ½ ounce of hydrochloric acid. The wet or dry negative is immersed in this solution and allowed to remain for one minute. During this time it will take on a deep blue color, which may be removed by immersing in hypo for several minutes, then washing. Some of the blue will still

remain after washing is finished, but upon drying the blue will have entirely disappeared, together with the offending scum, leaving a clean negative.

### Using Filter Holders

ONE of the most attractive conveniences recently put on the market, especially because it is low-priced, is the Varigram filter holder. The projecting tab at one corner makes it easy enough to hold under the lens for the required exposure time, but most workers will find a

**A clip holds it**

method of attaching it to the enlarger in some way in order to leave their hands free for dodging and other manipulations. One suggestion is shown in the illustration. A small spring clip has been attached to one corner of the lens platform. Because the filter holder is so light, being made of cardboard, the single clip keeps the holder firmly in place.

### Bottle Caps

PREPARED developing and other solutions are sometimes bottled with a metal cap. With use, the metal becomes rusty and, besides being unsightly, the cap is hard to screw off. In any event, the rust cannot be too good for the efficiency of the solution itself. Some manufacturers now use Bakelite caps and these are ideal for the purpose. Standard Bakelite caps for standard brown bottles are now available at about a nickel apiece. A good idea is to stock up on a few of these and replace the metal caps with the Bakelite ones.

### Unfixed Film Edges

IN DEVELOPMENT of roll film by tank, workers find that the edge of the film frequently comes out of the fixing tank unfixed. An effective way to get rid of these whitish streaks along the edges is to agitate the fixing tank for a couple of minutes when fixing is started and again several minutes later. If you follow this procedure, you won't have this trouble again. What happens is that the whole film is shaken free of contact with the developing reel with the result that the edges as well as the negative images themselves, fix out.

### Polarize Your Color Shots

IF YOU have never tried using a Polaroid screen when shooting color film, you have a grand treat in store. A blue sky looks really something very special when darkened by a Polaroid screen placed over the regular lens. Such dramatic effects in black and white are always extremely attractive; when obtained with color, the results are even more satisfying. Use one stop larger than ordinarily to compensate.

### Movie Makers and Thespians

SEEMS to us there's nothing to beat a combination of a movie-making group and an amateur players' club. The two were just made for each other. If a still-camera club offers nothing for movie fans, a group of the latter may well combine with a thespian group. Thus, you will have technicians and players, just as in Hollywood. Naturally, the method of production will have to be slanted movie-wise. At the start, it will probably be necessary to produce only silent movies; later on, with financial improvement, talkies may be inaugurated. New outfits of this type recently placed on the market have made the cost not so prohibitive as it used to be.

### Composing Vacation Pictures

GROUPINGS such as the one shown in the accompanying illustration by Albert Greenfield, New York City, are not easy to compose. But the watchful and alert photographer will frequently be rewarded for his patience

**"Greetings!"**

if he will hold his fire until the several members of the group have composed themselves into some sort of agreeable composition. As the individuals move about and look this way and that, the worker watches his chance and shoots when he can spot at least one dominant point of interest in the group. Here Mr. Greenfield, en route to Haiti, found his point of main interest in the standing, white-shirted, grinning figure.

### Add Color Lexicon

THE deeper we get into color photography, the more new words and new ways of photographic speech we shall encounter as time goes on. Recently, a color man referred to a particular one-shot color camera as having a speed of Weston so-and-so. A puzzled look brought the explanation that the camera was loaded with a certain film which was recommended for use in that camera. Although the black-and-white speed of the film was much higher, this speed was brought down to the stated speed because of the additional exposure time required by the use of filters in the camera.

### Smudges on Prints

IF YOU get a smudge or dirty streak on a print and find that it stubbornly refuses to disappear, despite your efforts with fingers or otherwise, try this. Wet a viscose sponge, then drain it of water by squeezing. The moist, but not wet, sponge can then be passed over the spots on the print. This is particularly effective with such tricky surfaces as Artona Rapid, which take offense at the usual treatment and show worse spots than before. This particular surface attracts lint very readily; the sponge trick gets rid of lint quickly and effectively.

### Multiple Filters

A GROUP of photographic experts, sitting in on an "Information, Please" session at a recent meeting, were stumped by this question: "If you had to use three filters at the same time, having a factor of 2, 3, and 4, respectively, what exposure factor would you use?" The incorrect answer was 9; the correct one was 24. The factors are multiplied, not added.

### Lighting Governs Exposure

WHEN using an exposure meter from the position of the camera, normal timing should be used for most subjects; that is, when the lighting is fairly graduated, and there is a fair balance of light in both high-lighted and shadow areas. On the other hand, when the lighting is flat, it is advisable to use half this exposure time because there are no shadows to worry about and it is therefore not necessary to allow for them, which the normal reading does. With subjects having deep shadows, however, and strong high-lights, double the normal reading to make sure the shadow detail will be recorded.

### Minimum Distance Work

"FLEURETTE" (goat to you) had an intense curiosity for the Rolleiflex camera with which we were following her around in an attempt

"Fleurette"

to get a close-up shot of her head. The lens panel was racked all the way out, focusing being confined to moving the camera toward the subject until the image became sharp. Every time we moved the camera forward, so did Fleurette. After a few attempts, we finally got the result you see, fully sharp from nose to horns, at *f*/8. The three-quarter angle makes it possible to avoid distortion.

### The Judges

COMPLETE rules of the Sixth Annual Scientific American Photography Contest are published again on page 98 of this issue.

The judges who will decide the fate of the prints entered in this contest are McClelland Barclay, well-known magazine illustrator, Ivan Dmitri, whose work in color photography has been widely published, T. J. Maloney, Editor of *U. S. Camera,* and Robert Yarnall Richie, many of whose photographs have been used in Scientific American and other magazines.

• • •

## WHAT'S NEW

### In Photographic Equipment

CINEMASTER DUO 8MM ($27.50 and up): Uses standard double 8mm film, color or black and white, as well as Univex straight-eight film. Features: combined exposure meter and optical view finder, built-in with etched masks for telephoto lenses; the extinction type exposure meter is operated by a dial on side of the camera; high parallax correction due to small distance between viewfinder and lenses; three speeds—16,

24, 32 frames per second; new type exposure calculator; continuous running—starting button can be locked in taking position; interchangeable lenses include regular Univar Anastigmat *f*/3.5, *f*/2.7 or *f*/1.9 in micrometer focusing mount, plus supplementary telephoto lenses *f*/3.5 in 1"

**The new Cinemaster Duo 8mm camera that uses either standard double 8 mm or straight-eight film**

and 1½" focal lengths; quick, easy loading; footage counter automatically reset for each new loading; special take-up sprocket; improved governor maintains high uniformity of speed during film run; powerful spring motor runs six feet of film at each winding, sufficient for three average scenes; focal plane shutter—exposure time at 16 frames per second, 1/30 of a second.

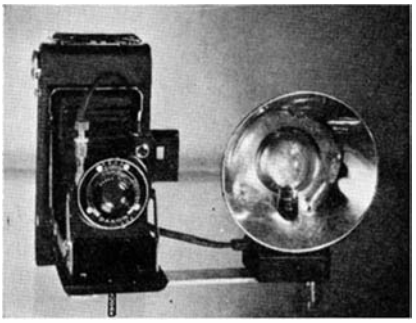
BOOL'S AUTOMATIC SPLICER: Joins 8mm, 9½mm or 16mm film. Made of steel, heavily plated in satin chrome. Splicer mounted on skid-proof, warp-proof, ebony-finished wood base. Splices said to leave neither white or black line (emulsion neither overlaps or separates). Hardened steel file, double-edged, scrapes emulsion evenly. Spring in spindle aids operation. Grooves in cutting leaves catch surplus cement.

PRINCETON PHOTO SWITCHBOARD ($6.95): For control of several light sources. One light can automatically turn on when another is switched off. Unit serves as high-low control for Photofloods; can switch light on and off from camera position. Enables making multiple flash pictures, or up to four flash shots in rapid succession when synchronizer is used; three open-shut flashes in succession without synchronizer.

MINILUM VIEWER ($1.50): Vest-pocket-size viewer for Kodachrome slides. Fitted with battery and electric bulb. Bulb lights up, illuminating slide, when side of case is pressed. Made of all metal; contains ground glass for diffusion of light.

CROWN MULTIFLASH CONTROL UNIT ($35): Designed for use with all flash synchronizers. Features: fires from 1 to 40 bulbs simultaneously, either with synchronizer or open-shut flash; uses 110-volt regular house current; as portable equipment where house current not available, uses high-voltage dry cells such as used in portable radios; neon circuit tester built into panel, allowing user to test line and wiring; may be used with electromagnetic, mechanical, and manual guns, as well as open-shut; may be fired by remote control; power switch has own signal light which can be read at distance; weighs 3½ pounds complete; measures 7½ by 4½ by 4 inches.

SM BULB FITS KALART COMPAK: New SM (Mazda Speed Midget) bulb can be used with Kalart Compak Passive Speed Flash, gun makers announce, who add, Kalart Compak "is



the only complete flash synchronizer having a reflector designed for midget bulbs by lighting engineers." Compak also uses Mazda No. 5 and No. 6 and Wabash Press 25.

"OUR FIRST LINE OF DEFENSE": Official Films presentation, produced in co-operation with the United States Navy. Home movie production available in five standard lengths in 8mm and 16mm. Shows the various Navy units in action—destroyers, cruisers, dreadnaughts, torpedo planes, aircraft carriers, fighting planes.

TEXTILEX QUICK FILM DRYER (40 cents per tube—for roll film; 30 cents per envelope—for cut film): Insoluble, lintless paper for quick drying of negatives by absorption of surface moisture. Designed to produce dry negatives free of dust, scum, and smudge. Available in rolls of five strips for drying roll film, and in sheets—8½ by 10½ inches—for cut film.

R.H.S. ELECTRONIC EXPOSURE METER ($10.95): Features removable dials for all film ratings. Permanently attached universal film-speed dial supplemented by three removable dials each for different combinations of daylight and artificial light film ratings. Supplementary dials provide specifically for eight popular films named on dials or other films not named on dials but having same ratings. Meter reads directly on needle dial in "*f*" stops for any film having rating of 32 when using 1/25 of a second shutter speed. Meter comes complete with three removable dials, complete instructions and genuine leather eveready case.

# YOUR FIREARMS and FISHING TACKLE

**Conducted by A. D. RATHBONE, IV**

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

### Three Little Gadgets

WHEN you look at the gun illustrated below, note particularly the two little gadgets shown under the barrel and the similar gadget on the end of the barrel. The gun itself is a 20-gage, bolt-action, repeating shotgun with detachable clip of two-shot capacity—and a third in the chamber, if desired. But the three little gadgets comprise the crux of this story, for they are machined choke tubes, easily and quickly interchangeable, thereby producing a three-shot scattergun with full choke, modified choke, or improved cylinder choke, as may be desired. And by shooting the gun without any tube attached, you get a true cylinder which, although offering no control over the pattern, is still preferred by some shooters.

**Mossberg's Model 85 D, with three choke tubes**

The novelty and practical ingenuity of this application of varied chokes to one gun is—in case you haven't already surmised—another of those amazing Mossberg productions. Of recent years it has seemed as though the gun world has barely had time to assimilate one Mossberg innovation before another equally unique and constructive development has emanated from that busy plant. The simplicity of this multi-choked shotgun idea is one of its cardinal virtues. If your shooting calls for maximum effective range, simply screw on the full choke tube, while if more scatter and less distance are desired, remove the first and attach either the modified or improved cylinder tube. It's all as simple as that, takes but a couple of minutes at the most, and, best of all, the entire outfit—gun and three tubes—can be owned for less than $15.

As to patterns, the tubes are machined and choked to produce the following averages:

| | |
|---|---|
| Full choke | 70 percent |
| Modified choke | 60 percent |
| Improved cylinder | 50 percent |
| Cylinder | 40 percent |

You'll note that this gun, known as Model 85D, carries the customary Mossberg streamlined design. It is 45½ inches long, weighs 6¼ pounds, is chambered for all 2½ and 2¾-inch factory-loaded shells. It has a molded butt plate, finger grooves in grip, flush type take-down screw, self-cocking action on the upstroke of the bolt, and is equipped with a positive safety, double-locking bolt, and closed-top receiver. Barrel is 25 inches long, tapered, of blued steel and is proof-tested.

A companion gun to Model 85D is Model 83D, a four-shot, .410 bore repeater, also bolt-action, with a length of 44½ inches, a weight of 5½ pounds, and a 23-inch tapered, blued-steel, proof-tested barrel. The .410 is priced at slightly over $12, is equipped with two choke tubes, full and modified, but can also be shot in cylinder bore without any tube attached. Both guns have an exceptionally comfortable "feel," both, because of Mossberg's novel adaptation of the choke tube idea, are suited for field or skeet shooting, and both are illustrated and described in Mossberg's 1941 catalog, a copy of which we'll be glad to send you.

### Kink

CAMPING, fishing, and hunting kinks aren't always a result of logical thought sequence; usually they just happen, like the one illustrated below. Despite the generous proportions of our tackle box, plugs per-

**The tackle stick**

sisted in involving themselves in pestiferous entangling alliances. Also, it doesn't improve one's tackle container to continually put dripping-wet lures into the little compartments. Lastly, it's a long stretch from either bow or stern seat of an 18-foot canoe to the tackle box, placed amidships. So, we cut a stick the proper length, lashed it to the gunwales just abaft the bow seat for the convenience of the - lady - who - catches - more-fish-than-we-do, and draped a goodly selection of plugs and bugs thereon. When not fishing, the tackle stick is untied and reposes on two crotched poles, driven into the ground near the camp.

### Book of the Moment

CAPTAIN CHARLES ASKINS, JR., who ably edits the firearms department of the magazine *Outdoors,* has just published his newest book, "The Art of Handgun Shooting," and if anyone should know whereof he speaks in the realm of pistoleers, it's Captain Askins. He has won 472 medals and 126 trophies in handgun competition, annually burns up approximately 34,000 rounds of ammunition in match and exhibition shooting, and he's still going strong. The new book was written both for beginner and expert, is packed with thoroughly practical advice and suggestions, and, in these national defense days, it will prove a necessity to any who shoot pistols.

### Use the Right Cartridge

FREQUENTLY, when science assists the firearms industry to better its products, that forward step entails necessity of a proportionate increase of knowledge on the part of gun owners to utilize the improved firearms properly and safely. An old, yet still imperative example of this axiom is the graduation in shotgun manufacture from Damascus, or twist steel barrels to barrels strong enough to safely withstand the strength of today's heavier shotgun loads. Ever since man first began making guns, he has endeavored not only to increase accuracy, but also to achieve greater firing power, and even though gage of shotgun or caliber of rifle remains unchanged, amplification of the powder load in modern shell or cartridge often makes it dangerous practice to use today's ammunition in guns of a generation ago.

That this holds true in the handgun field as well as with the shotguns and rifles is attested to by C. V. Bassett, of Smith and Wesson, Inc., who writes: "I've noticed that several writers have been cautioning sportsmen against use of modern shotgun loads in old Damascus steel-barreled guns. It would be a grand thing if handgun shooters could likewise be cautioned against use of loads other than those designed for their arms. All revolver manufacturers have huge numbers of old models out which were made before the days of heat-treated cylinders and such, and which, nevertheless, will chamber modern, high-speed loads. Frankly, these are a source of considerable expense and many headaches to the manufacturers. It is not uncommon for a fellow to inject a .38/44 or .38 Special High Speed cartridge into a gun 40 years old and blow out a cylinder or warp the frame, after which he returns it to the company with a complaint that his nice, old gun 'must have been defective.' Usually the manufacturer fixes it all up for him and cautions him against the use of high-speed loads thereafter. However, the whole procedure is something like locking the barn after the steed is stolen."

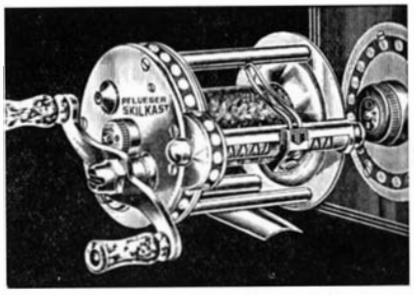
Incidentally, Cy Bassett has authored a constructive folder entitled, "Helpful Hints." Want one?

• • •

## POT SHOTS

### At Things New

ENTERPRISE MANUFACTURING COMPANY, makers of Pflueger fishing tackle, say thumbs are out! Leave 'em home, if you like, for all the value they'll be when you're using one of their new mechanical thumbing reels in your bait casting this summer. Pflueger's "Skilkast" has a mechanical thumber built into the back plate which does away with all need for thumbing after the cast is started. It is adjustable with micro-precision to suit the line and lures used, operates only while line is running out, and makes distance casts simpler and easier without tendency to over-run or backlash. Equipped with light-weight aluminum spool and cork arbor cemented in balance, "Skilkast" has replaceable bearings for double thread shaft, thus permitting level wind parts to be removed without disturbing housing, and is recessed at each end to make possible the wide line guide and still permit line to be laid on full width of spool. Since "Skilkast" came into our angling existence, we've conserved the skin on one good thumb, refrained from being, at times, an irascible fishing companion, and, due to absence of back-lashes, have actually had more time to devote to the big ones. Want a "Skilkast" folder?




**Pflueger's "Skilkast"**

# TELESCOPTICS

## A Monthly Department for the Amateur Telescope Maker

**Conducted by ALBERT G. INGALLS**

IF A mechanism does its intended work, and satisfies its owner, it is a success. A fine telescope drive, with gears and fancy trimmings (machine work), is a pretty thing to have, but also is complex and costly. A good telescope drive (Figure 1), innocent of sex appeal but which gits thar just the same and is simple and inexpensive, has been devised by C. S. Walton, a candy manufacturer, 5975 W. 44th Ave., Wheatridge (Denver suburb), Colo. A neighbor of his, Anton Bohm, gravestone manufacturer, 6815 W. 29th Ave., Denver, on seeing Walton's drive, made up the variation of it shown in Figure 2.

Figure 1 does not show much detail, but there isn't much essential detail to the working principle—a fact which is all in its favor. Horizontally across the pedestal at about waist height there is a 10-32 thread-rod about 15" long. A Hansen 600 Synchron motor, made by the Hansen Mfg. Co., Princeton, Ind., containing a gear train that reduces its speed to 2 r.p.m., is direct-connected to the right end of this rod through a simple, home-made clutch. A traveler moves on the thread-rod toward the left, and a ¼" strip of 0.005" shim brass is

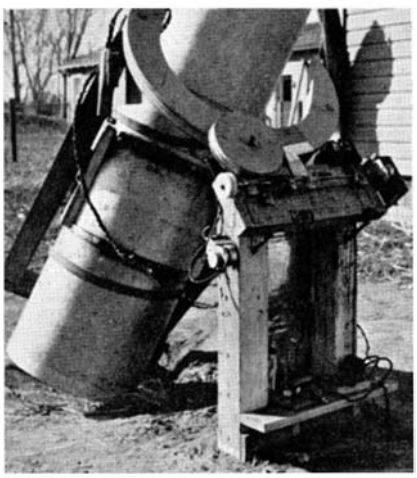


*Figure 1:* **The Walton drive**

connected to this traveler and runs around the nearer side of the large pulley, up over it and down to an idler and a counterweight hung below. The drive from this pulley through to the tube is by way of one of the two rolls on which the big split ring of the mounting rotates, the pulley shown being attached to the end of the stub shaft of that roll. The working principle may, however, be adapted to other types of mounting.

"So there you have it," Walton writes. "Motor to thread-rod; traveler to brass strip to pulley; pulley to split ring; split ring to telescope." When the traveler has crept the length of the thread-rod, returning it to the beginning is a simple trick.

And now for a little refinement that affords small manual adjustments, as in guiding. The left end of the thread-rod thrusts or butts square against the right end of another thread-rod. Now, if this second thread-rod is rotated in its own fixed screw, the effect will be either to add to or to subtract from the total motion of the telescope tube. This feature works as follows: On the nearer end of the second thread-rod is a simple pulley. A foot or so below this on the nearer post is another little Hansen motor belted to that pulley. Seen thrown loosely around the horseshoe, in the photograph, is a heavy wire. This is the flexible, distant, hand control for slowing or speeding the drive by operating that motor at will. A double switch, made from spring clothes-pins and held in the hand, does the trick. To advance the tube slightly, you give the little motor an electric kick. To retard it, you cut the current of the main motor. "No gears to throw in or out, no clamps, no nothing," Walton says. You push the telescope to a star and the drive takes charge from there. He sent some photographs—Pleiades, comet, nebula—made with this guiding control and these speak well for the whole equipment, including the 12" mirror of the telescope.

Walton's neighbor, Bohm, mentioned above, took one look at the drive and ran home to cook up one for himself (Figure 2). It varies a little from Walton's; few amateurs like to copy slavishly. It has no micro-adjusting feature for guiding, hence it is only for visual use. Main motor at right (cost $2) drives screw-rod (cost 5 cents) at 2 r.p.m. through simple clutch. Since the screw-rod has 32 threads per inch, the nut traveler which tows the telescope tube along moves toward the left at the rate of 1" per 16 minutes, and Bohm points out that it is a matter of simple arithmetic to find how far out from the center of the polar axis to attach the little rod that connects the traveler to the lever that drives the tube; final adjustment may then be made exact if there is a slotted hole in this lever. Bohm also has a friction connection between his lever and polar axis, this being the equivalent of a friction disk drive, and this permits quick large shifts while the motor is running.

The weight seen pendant in Figure 2 pulls on a silk fishline running over two small pulleys and to the traveler. This helps the motor and holds the rod against the thrust bearing near the extreme left. What at first appears to be a flywheel, at the left, is simply the convenient handle of an

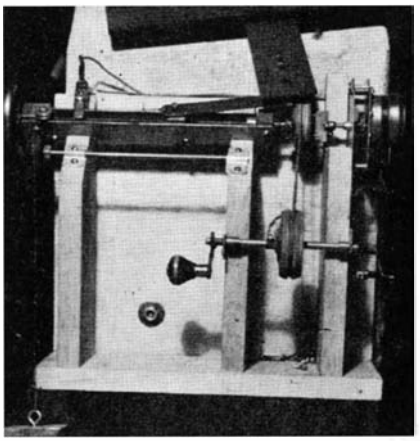


*Figure 2:* **Bohm's modification**

end-thrust screw for the screw plug which takes the end-thrust of the thread-rod.

After about an hour's running the traveler reaches the end of the thread-rod (what it actually reaches just before that, however, is a little limit switch which shuts off the motor in case the observer forgets, thus forestalling a jam). At the end of the hour's run the handwheel is unscrewed and removed, the thread-rod slid far enough to the left to disengage the "clutch" connection at the right. Then, by means of the little crank handle visible below, the traveler is spun back to the starting point in a hurry, ready for the next hour's driving. It sounds complicated, but actually it all works quickly.

Bohm says that, with this drive, it is possible to keep an object in the center of the field with a high-powered eyepiece for the hour's run on the thread-rod.

IN NO place in "A.T.M.," unfortunately, is it clearly pointed out that the handle to be attached to the mirror disk for grinding and polishing (unless the worker prefers to omit it entirely, as some do, and simply take hold of the disk itself) is not intended to be grasped in the hand *in the typical manner* of a handle but is rather a convenient centering device. There is evidence that some beginners do, however, grasp it in one hand, full length, and tightly, throughout grinding and polishing. The result often is a badly turned edge since the pushing effort is usually too high, also since it is practically impossible not to introduce undesirable lateral force components when working this way. (You can pick up a cat by the tail, close to the body, and swing it without a protest, provided you don't bend the tail in any part of the swing, but the cat will tell you from experience that, when you say you don't, you only think you don't.)

## TELESCOPTICS

Probably the whole trouble into which many beginners are misled derives from the unfortunate use of the term "handle." In "A.T.M.A.," Everest discusses the effect of pressure applied too high and shows one excellent form of centering device: a 4½" by 1½" wooden disk, *for working,* carries on its top a 4" by 1⅛" handle *for lifting* the mirror. This keeps the working pressure low.

STELLAFANE convention, Springfield, Vermont, Saturday, August 2.

SPHEROMETERS for measuring sagitta, or depth of curvature, $r^2/2R$, of a mirror, or the curvature of a lens, may be made from a ten-cent-store

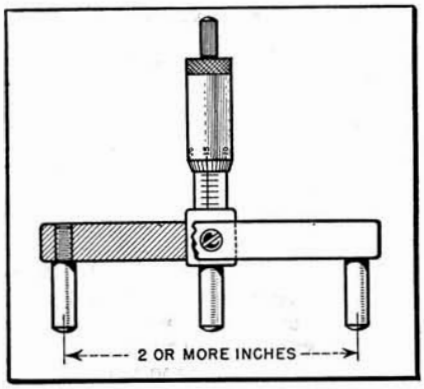



*Figure 3:* **Taylor's spherometer**

micrometer caliper, as shown in Figure 3, which is redrawn from a sketch submitted by D. Everett Taylor, 192 Prospect St., Willimantic, Conn. Saw off the anvil and frame part and substitute the two arms and legs shown. And don't forget that the $r^2/2R$ now employs the $r$ of the spherometer, not that of the mirror!

WHILE nearly all amateur telescope makers test their mirrors at the center of curvature, nearly all professionals test at the focus, with a flat as an accessory; and it is a rather amusing commentary that, even granting the superiority of the test at the focus, some professionals have tested in this manner for so many years that they have come to think, and one of them even to say, that it isn't even possible to test at the center of curvature. It does require a little more mental effort, it is true. However, after one has provided the set-up, the test at the focus is a big convenience, and there are other considerations: more rigorous, for example.

William Buchele, 2832 Sagamore Road, Toledo, O., sends us the photographs shown in Figure 4 and says: "This is a gadget for testing at the focus with a flat. Light source is a 100-watt projection lamp. Its housing has cooling flanges to prevent the lamp from overheating. A thin silvered diagonal reflects light through a hole in the flat, it returns from the glass under test, and passes through the diagonal, thus permitting the

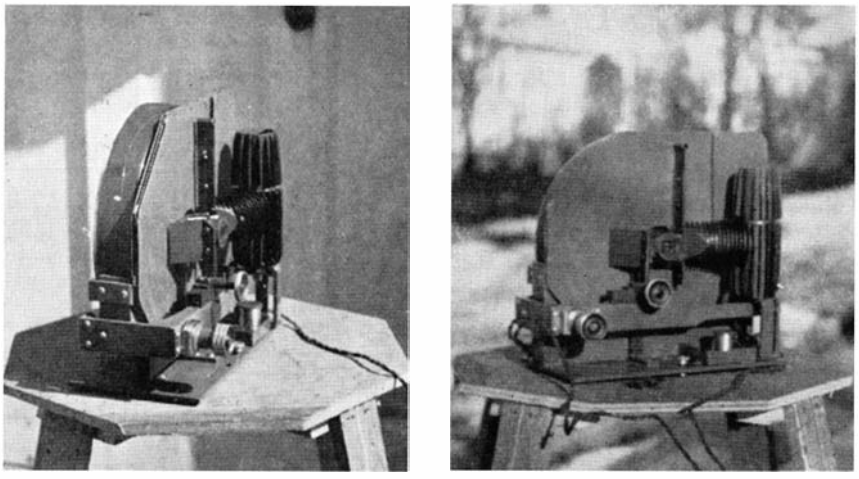


*Figure 4:* **Two aspects of Buchele's test-at-focus gadget**

light source and the eye to be in the same train simultaneously. The gadget has a micrometer screw feed. The dark upright strip in the center is a graduated system of fine and coarse pinholes and slits. There is also an eyepiece, knife-edge and Ronchi grating holder, with lateral rack and pinion feed."

TEST for short focus mirrors, used by telescope-making members of the Detroit Astronomical Society and reported by Eugene G. Brown, 4404 Vermont Ave., Detroit, Mich., is shown in Figure 5. At *b* is the light-source, *c* the perforated mirror under test, *d* a paraboloidal test mirror, *e* the knife-edge or Ronchi grating. "The image produced," Brown writes, "is identical with that produced by a sphere under the Foucault test. We therefore work to this flat image and we interpret our high and low zones exactly the same as we would with the Foucault test.

"Such a test is necessary to produce a good figure in an extremely short focus, such as *f*/2 or *f*/2.5 (unless we use the Gaviola test)," Brown continues, referring to the fact, still not sensed by all, though Ellison explains it in "A.T.M.," that while you usually can get by with a visual estimate of the smoothness of sweep of the curve of a medium or long focus mirror between inside and edge zones, provided only the latter are correct, you cannot safely depend on this on a short focus mirror. Even when the intervening shadows then look smooth, they are so dark that they may easily mask local irregularities which you therefore may let go in ignorance of their existence.

Brown adds that Ralph Tozer of Detroit is the first there who used the test described above. He points out that there are other applications and variations of this test. For example, if a point-source of light is placed at the focus of the paraboloid, a parallel beam is projected from the latter, and this artificial star may be used to test any astronomical instrument, refractor, reflector, or camera.

Another wrinkle, suggested and used by C. M. Davenport, of the Detroiters, is piped-in light for this test. The object *ab* is a bent rod of solid ¼" or ⅜" Lucite, a transparent plastic [obtainable from E. I. duPont de Nemours, Inc., Plastics Department, Arlington, New Jersey and bent in very hot water or oil.—*Ed.*]. Instead of placing a primary light-source at *b*, where its heat would interfere with the test, this is at *a*, well out of the works, and the light follows through the Lucite to *b*. The end of the Lucite rod may either

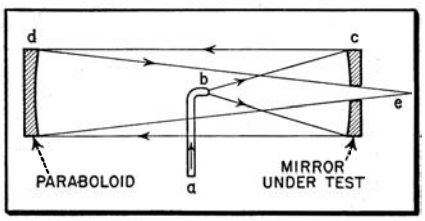



*Figure 5:* **The Detroit test**

be left straight but beveled, or bent, but in either case tinfoil is wrapped around its end and touched with a finely pointed needle ("A.T.M.A.," page 89).

W. S. Bohlman, 823 West Street, Wilmington, Delaware, has similarly used Lucite to pipe light from a removed primary source to the pinhole, thus avoiding a burned nose, also permitting the pinhole to be placed close to knife-edge. He used the Lucite rod from a common throat light such as those commonly on sale at drug stores. This served as well behind a Ronchi grating as in place of the usual pinhole. He suggests a piece of Lucite bent to 90°, its end covered with foil having a pinhole, for testing secondary mirrors.

The above item was shown to Russell W. Porter, who replied that this test has been used at the Optical Shops of the California Institute of Technology in testing the 48" Schmidt correcting plate. However, it apparently was not published, so credit goes to the Detroit amateurs who hit on it independently and offered it for publication. That's the good old rule throughout the world of science.

# Our Book Corner

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