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November
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SCIENTIFIC AMERICAN

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EIGHTY-EIGHTH YEAR • ORSON D. MUNN, Editor

CONTENTS · NOVEMBER · 1932

ACROSS THE EDITOR'S DESK

IN line with an editorial ("Out of Adversity") in our March, 1932 issue, comes a letter from far-off India, inquiring about air-conditioning equipment for the home. The letter, signed by the Private Secretary to the Yuvaraj Saheb of Limbdi, requests information about plants for conditioning the air in various sizes of homes, and other data pertinent to the subject. The requests have been taken care of, and the letter, in our files, furnishes inanimate evidence to support our editorial contention that "manufactured weather" can provide the basis on which can be built an enormous business, world-wide in scope, that may serve as one of the levers that will lift us out of the still current depression. American manufacturers are taking hold of the problem with characteristic vigor. Seemingly, it won't be long before home air-conditioning will be available to all who require it, whether in the United States or in India or in the desert regions of Africa.

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On the tentative schedule for our December number, we find an unusually intriguing title for the regular monthly astronomical article by Professor Henry Norris Russell. It is: "The Eclipse, Bad Weather, and a New Way Out." It is well known that one of the reasons why a total eclipse of the sun means so much to astronomers is that it gives them an opportunity to study the solar corona. But when bad weather intervenes, and the eclipse is not visible, what is to be done? Mark Twain is credited with saying that "Everybody grumbles about the weather, but nobody ever does anything about it." But astronomers have. They have released themselves from the shackles of weather conditions, as far as the study of the corona is concerned, by . . . But that's the story that Professor Russell has to tell, and he will tell it, in next month's number, far better than we could in this limited space.

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In the heat of tropical jungle or the cold of arctic waste the movie cameraman plies his trade to capture for your amusement or edification a few feet of film. Far different are such "locations" from the studio and carefully constructed sets of Hollywood, but the cameraman gets his story in picture and sound regardless. Andrew R. Boone, whose articles have appeared before in these pages, has written of the troubles that must be met and overcome in taking talkies under extremes of heat and cold; the resulting story, with special photographs, is scheduled to appear next month.

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"It has long been recognized . . . that the carriage of a nation's goods to foreign markets in its own vessels is an important aid in the maintenance and extension of trade with these markets." Thus writes H. Gerrish Smith, President of the National Council of American Shipbuilders, in an article scheduled for our December issue. America needs and wants a powerful merchant marine; Mr. Smith tells how and why we are getting it.

●

"Your Internal Menagerie," by Professor Robert Hegner, Ph.D., of Johns Hopkins University, is an article, to be published in December, that will interest everyone, as it deals with a subject that is close to all. Says Professor Hegner: "Man . . . is known to be parasitized by about 25 different species of protozoa, 85 different species of worms, and several dozen different species of insects." He has singled out the protozoa for his discussion and points out the economic fact that "one field in which the study of the protozoa of man has taken a leading rôle is that of rendering the tropics as habitable to man . . . as are the temperate regions . . ."

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Spectacular feats in aviation are followed closely, in almost every instance, by practical applications of the lessons so learned. Everyone hears of the spectacular, because it is "news" in the newspaper sense of the word, but the practical applications are usually not so considered and therefore are less widely heralded. An excellent case in point embraces the trail-blazing flights of Lindbergh and of our Army Good-Will Flyers to and around South American countries. The pioneering flights were magnificent demonstrations; the daily flights of transport planes over the same and greatly extended routes are no less magnificent, but they lack the sensationalism of "news." In fact, the commercial operator deliberately avoids the spectacular; transportation is a *service*, reliable and trustworthy, and not a stunt. In a coming issue, a transport operator will tell of a unified contact between the United States and 30 countries and colonies of the Americas. Spectacular or not, the facts make one proud of the progress of aerial transport in America.

Editor and Publisher

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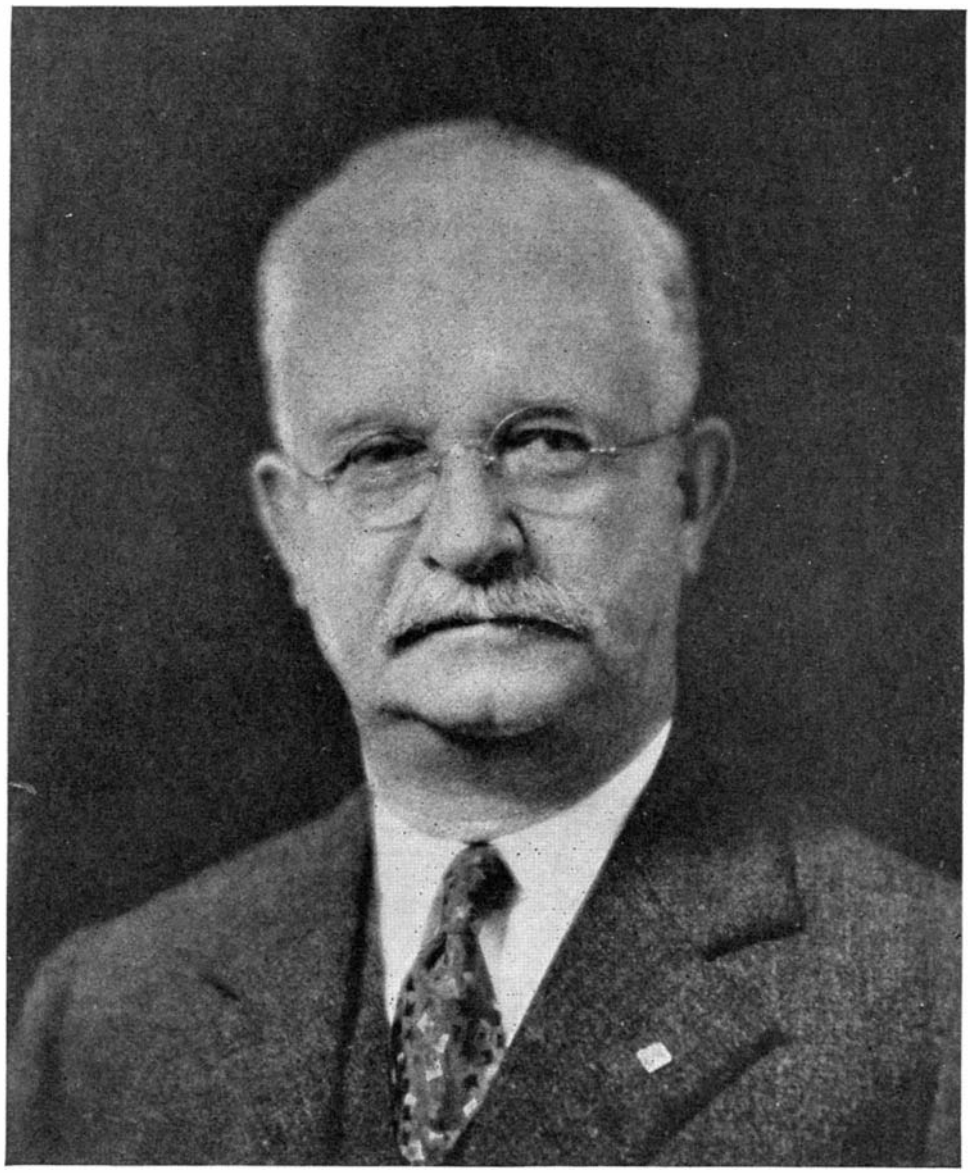
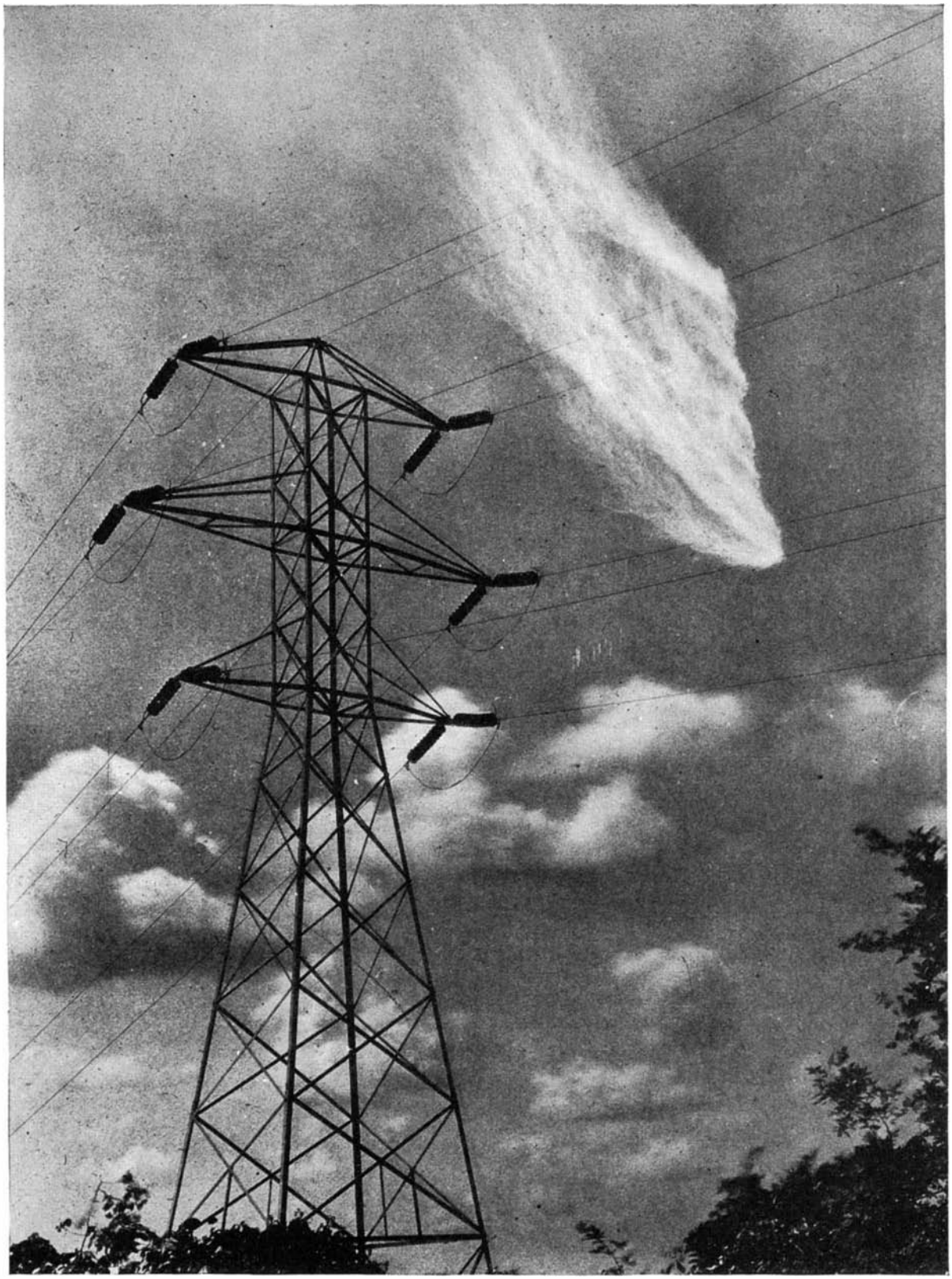


CHARLES LATHROP PARSONS

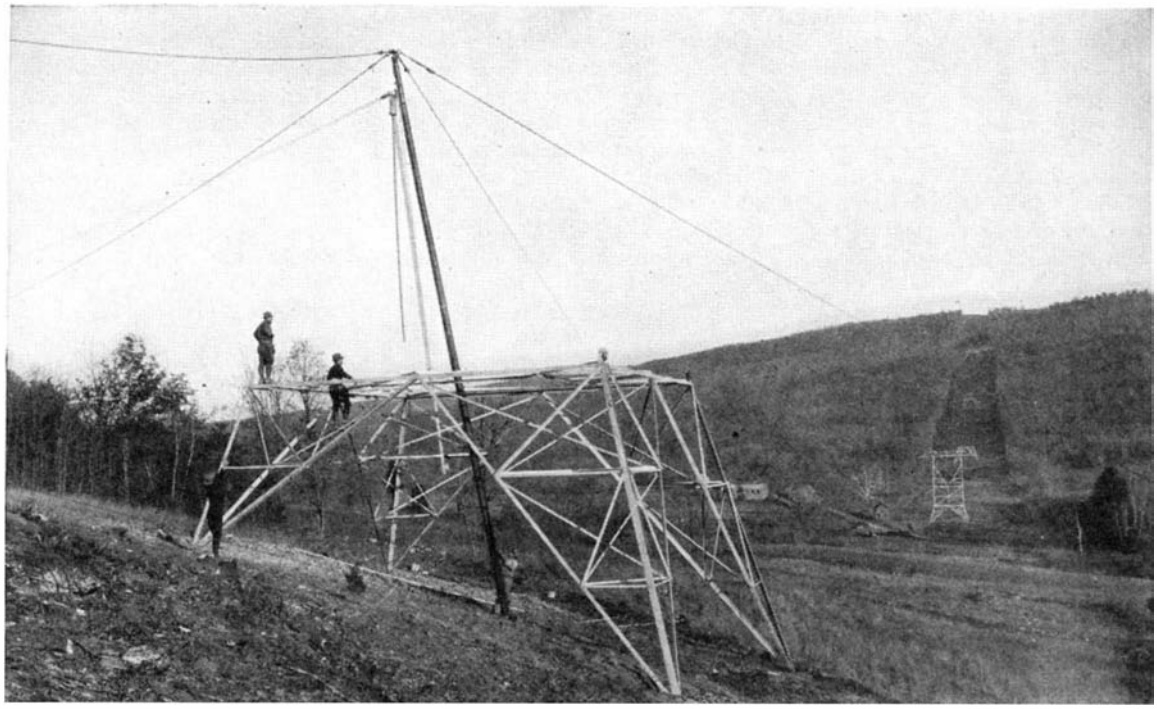
FOR distinguished service to chemistry, the Priestley Medal, highest honor of the American Chemical Society, has been bestowed upon Dr. Charles Lathrop Parsons of Washington, D. C. Dr. Parsons is one of the best known chemists in the United States, and has been secretary of the Society for 25 years. He has contributed widely to the development of that organization as the largest professional body of its kind in the world.

During the World War, Dr. Parsons acted as chief investigator in Europe of the nitrogen situation, his report being adopted as the basis of national policy by the War Department. He also was a member of the Nitrate Commission and chairman of the committee on the use of zirconium steel in light armor. Many other distinguished honors have been conferred upon him here and abroad. He is a former vice-president for America of the International Union of Pure and Applied Chemistry, and for eight years was Chief Mineral Chemist and Chief of the Division of Mineral Technology of the Bureau of Mines, Washington. Numerous articles on chemical research have been written by Dr. Parsons, who long has been recognized as an authority on mineralogy and its allied sciences. He and A. J. Moses published a treatise, now in its fifth edition, entitled "Mineralogy, Crystallography, and Blowpipe Analyses," which is a standard textbook in many colleges. He also is the author of other works of a chemical nature.



'FIREWORKS' BETWEEN THE WIRES ON A POWER LINE

WIRES on a transmission line are so spaced that during normal operation there is no danger of arcing between wires. But an arc, once started, will draw power from the line and the arc will continue until the line is disconnected. Such an arc may be started by lightning, but this is so uncertain that to study lightning effects, engineers throw a fine copper wire across the line. The fine wire fuses and starts a spectacular arc of several thousand amperes.



Erection of each tower of the hundreds on a transmission line is no small engineering problem

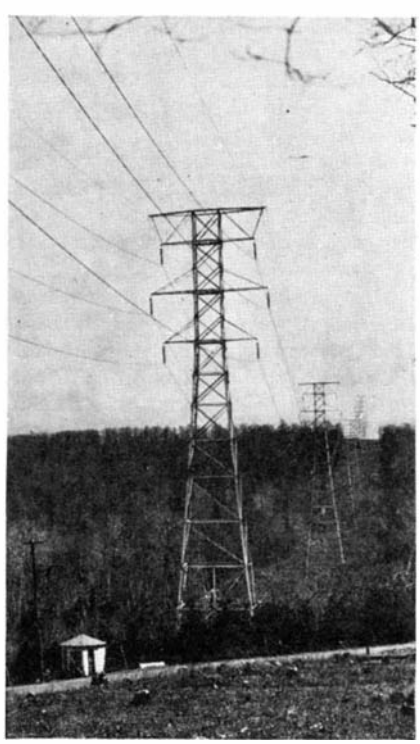
THE TRANSMISSION ENGINEER'S JOB

By JULIUS J. TOROK*

THE attention of a traveler gazing idly out of the window of his coach became centered upon a "power line" that happened to run parallel with the road for a short distance. His attitude was not that of idle curiosity but rather of a professional nature, and with his glimpse of the line, he seemed to lose all interest in the rapidly changing scenery; he leaned back in his chair and closed his eyes. Perhaps it was the warm afternoon sun or the monotonous clicking of wheels on the rails that carried the traveler back 10 years or more to an important milestone in his engineering career.

Several large power companies had just consolidated. After the rearrangement of personnel, he had been appointed as engineer in charge of transmission and with it came the heavy responsibility of uniting these companies electrically by means of transmission lines.

His first attack on the problem was from the statistical standpoint. He realized that industrial conditions were continuously changing and that a system adequate for the present would be unable to handle the increased demands that would appear in the coming years. He set up a statistical department composed of a group of engineers to study the industrial history of territories served and their power requirements. From such data it was possible to determine fairly accurately, by curve projection, the power requirements in the next five or ten years. Thus the fundamental premises of his problem were obtained; namely, the load requirements at important points and the capacities of the larger generating stations.



A well-designed line to carry 132,000 volts to distant consumers

At the same time he set a group of engineers to study the characteristics of the station apparatus and also of such equipment as would be installed to take care of future demands.

THE purpose in making these extensive studies was to investigate the electrical stability of such a unified system. It was realized that the generators in an improperly designed network of transmission lines would lose synchronism at times of severe fault. After months of hard work involving tedious calculations and conferences with research and transmission engineers who had developed the analytical methods, the requirements for the new lines were established.

At first, studies were made on the more important inter-connecting lines. The most troublesome factor involved in the problem was that of inductance, because this factor determines the amount of power the line will transmit. In a mechanical analogy, inductance

*Transmission Engineer, Westinghouse Electric and Manufacturing Company.

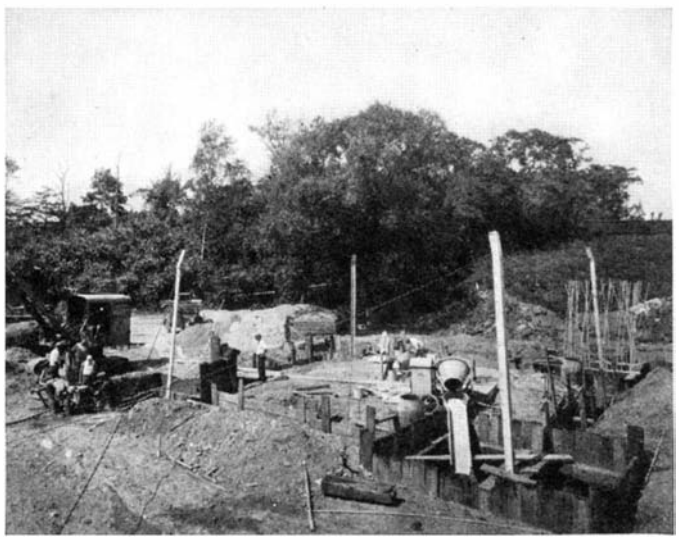
may be likened to a spring inserted in tandem into a driving rod. If the resistance to the force exerted by the driving rod is large, only a small part of the motion is transmitted, most of the motion being taken up by the spring. Of course, the stiffer the spring the less motion will be absorbed by the spring and the more energy will be transmitted. In this analogy the limberness of the spring corresponds to the inductance in the transmission line. Inductance varies directly as the length of the line.

Some control of the inductance can be obtained by changing the spacing between the conductors but this is far from sufficient, especially since the minimum spacings are determined by mechanical considerations such as swinging of the conductors. The most satisfactory method of increasing the power limit is to reduce the inductance by using parallel circuits or to increase the transmission voltage. By paralleling two circuits, the inductance can be cut in half and approximately twice as much power transmitted. This, in the mechanical analogy, corresponds to doubling the stiffness of the spring in the rod or to placing another spring beside the first, and thus increasing the effective stiffness. Often in the practice two circuits are used. Generally they are placed on one tower to save right-of-way space and tower cost.

IN the next group of calculations the effect of increasing the operating voltage of the line was studied. The power that can be transmitted over the line varies approximately as the square of the voltage. Thus by doubling the operating voltage, three or four times as much power can be transmitted over the line. That was truly an alluring lead.

The question then arose; should many parallel lines of low voltage or one or two lines of high voltage be constructed? The problem was attacked from two standpoints: first, cost; and second, reliability. The statistical group was requested to investigate the performance of typical lines in service throughout the country. At the same time a cost analysis was made of station apparatus and transmission lines that would be required for various voltages. The apparatus and tower cost estimates were obtained from the manufacturers while the average cost of right-of-way for urban and rural districts was available in the reports of earlier constructions.

The summarized results were interesting and showed conclusively the field of the high and low voltage lines. The terminal apparatus cost was approximately proportional to the voltage. The line cost, however, rose only moderately with the voltage for a given amount of power to be transmitted. Thus for short distances the lower voltage lines proved most economical, while for long lines the higher voltages proved less costly because of the reduced number of circuits needed to carry the power. From available data it appeared that the higher voltage lines, per mile of circuit, were more reliable than the low voltage lines. Most of the trouble appeared to be caused by lightning. Some of the line outages and short circuits were caused by sleet forming on the conductors and breaking them or causing them to swing into each other; occasionally birds would ground the line and cause circuit opening devices to trip out.



When the nature of the soil makes concrete foundations necessary, a comparatively large concreting plant is used

Most conclusive in the report was the high mechanical reliability of the steel constructed tower line. The wood construction, however, showed a strikingly low initial cost.

The statistical report showed that the highest voltage used for transmission purposes was 220,000 volts (220 kilovolts). The first line with this rating had just been placed in operation. There were numerous 132-kilovolt and 110-kilovolt lines operating throughout the country, while 66 kilovolts was quite common. All this considered, it appeared that 132 kilovolts was fairly well established as a practical transmission voltage. The cost studies showed that for the new line 132 kilovolts would be the most economical as the system was fairly extensive and a considerable amount of power would have to be exchanged between various parts of the system. The first and most important link in this construction program was the tie line between the base load generating stations. It was necessary that this particular line be made as reliable as possible. A double circuit steel tower line was finally decided upon. The higher cost of the steel construction was justified by the added reliability.

Having decided upon 132 kilovolts, the next step was to choose the proper size of conductor. There are two factors that determine the minimum size of conductor that can be used. One is the maximum current that will be sent over the line for any appreciable length of time. The conductor must be able to carry this without excessive losses. The other factor is the corona limit of the conductor.

When the voltage between wires, as on a transmission line, reaches a certain definite value the air particles around the wires become ionized—that is, electrons are removed from some of the molecules, thus disrupting the air. An increase in diameter of the conductor reduces the electrical stress in the air around the conductor, and so permits the conductor to be raised to higher potentials without forming corona. The bluish light that is given off during corona formation is only a visual manifestation of this phenomenon. More significant is the fact that corona is a source of power loss. For example, a 30-mile line operating at a voltage that just forms corona may dissipate 30 kilowatts. If the voltage is doubled, the loss may be as high as 4000 kilowatts. The latter, however, is an abnormal state obtained only in unbalanced conditions and only for a short time, and in staged tests.

THE disrupting of the molecules makes the air very active chemically, and for this reason conductors about which corona forms, oxidize very rapidly. Although this second factor is of lesser importance, it is another reason for designing the line to have a corona point well above the operating voltage. In other words the conductor must be large enough to avoid corona formation under normal operating conditions. The conductor size is set by either corona limits or current-carrying capacity, depending upon which requires the larger conductor. For voltages above 132 kilovolts the determining limit is more often set by the corona. The diameters for the more common high voltages are as follows: For 66 kilovolts the conductor diameter should be at least 0.25 of an inch; for 132 kilovolts, 0.575 of an inch; and for 220 kilovolts, 1.0 inch.

These studies had been compiled into a report. So clear was the reasoning and so obvious the conclusions, especially the use of economic statistics in justifying the project and its details, that soon after the report was submitted to the officials of the company, the project was voted on and passed. His superiors' comment of "A nice job, Jim," had compensated him for his headaches and worries.

Then the real work began. His first act was to hire an airplane and have a photographic aerial survey made of the general territory over which the line would run. With these photographs it was possible to lay out more specifically the most desirable general location of the line. Then men were sent out to survey this territory and draw up profile maps and maps showing property boundaries. This work took considerable time as part of the territory being surveyed was in mountainous country where there were no roads and where to cover a few miles would often take a day's hard walking and climbing.

THE exact path of the line was then established and the location of the towers spotted on the maps. The right-of-way men were sent out to negotiate for lease or purchase of property. In some cases the property was leased for perpetuity; in some cases the property, after being purchased, was released to the former owner for a nominal sum. In a few cases where the property owners demanded exorbitant sums for their property, condemnation proceedings were necessary. In such instances an equitable price was set by court.

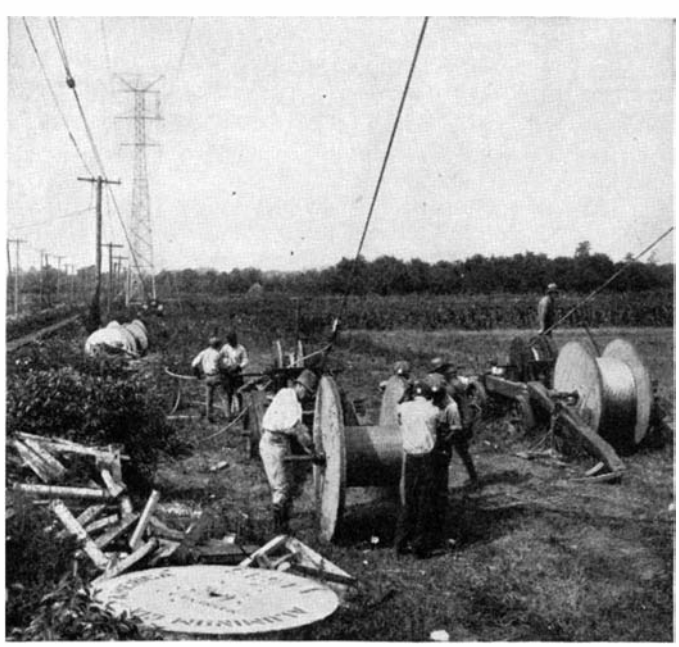
He mused over the peculiar notions of some of the people. One resident was afraid that lightning would be attracted to his house by the line, when in reality the line protected the house much better than any popular system of lightning rods.

During the time when land purchases were being made, the steel companies were requested to submit bids accompanied by designs of towers for the line. Negotiations were started with electrical manufacturing companies for the transformers, circuit breakers, switches, and insulators. When the designs were completed, they were checked and re-checked and finally the contracts awarded. Then surveying parties were again sent out to stake out the tower footing locations.

The first step in the construction was the establishment of camps for work crews. The right-of-way was cleared and the steel for each tower delivered to the proper location, each piece being marked and readily identifiable by the blueprints. Excavation for the footings was then made. The type of footing varied with the soil. In good average soil, grillages were used. The grillage consists of channels or angles bolted at right angles to the tower leg. In swamp land a concrete base was laid and the grillage placed in this. In cases where the footing was very poor, piles were driven and the tower built on these. In some instances towers had to be erected on bed rock. There bolts were simply grouted into the rock and the tower legs thus fastened.

IN the cases of the towers with the grillage footing, the bottom section was used as a pattern for setting the legs in their proper positions. The various members were then pulled into place by a gin pole and bolted. Usually, pulling steel members into position was done by tractors. However, at locations where it was impossible to drive a tractor, the members were pulled up by hand.

When the towers were completed, pulleys were hung in place of the insulator strings and a tractor cable passed through the pulleys. Then one end of the conductor was tied to the cable and pulled through by the tractor. The conductor was then joined to the preceding section by compression sleeves. These sleeves are made as follows: A steel sleeve is pressed over the two ends of the steel core by a portable hydraulic press, and then another sleeve of aluminum pressed over this. The reason for the double sleeve is that the steel sleeve furnishes the mechanical strength while the aluminum sleeve carries the current.



In stringing the conductors, a large anchored tractor having a cable drum, pulls the wire in from distant spools

In order to have the conductors strung at the right tension, sag charts were prepared. A sag chart is a graphical description of the position of the conductor at all points between the towers. The tighter the conductors are strung, the higher their location at mid-span. With a given sag the conductors will be at a given tension. The sag was measured by sighting through a transit clamped to the tower at the proper level. Thus the conductors were strung at the proper tension. When the sagging was completed, the insulator string was raised, fastened in place, and the conductor fastened into the clamp. The conductor was strung in 5000-foot sections, temporarily dead-ended.

The insulators chosen for the line were of the suspension type. Pin insulators were not practical for such high voltages because of the high cost and weight. These suspension insulators could readily withstand a continuous load of 5000 pounds and would even hold a short-time load of 20,000 pounds. Metal rings were attached to the ends of the insulator string to force the arc to form between the rings, in the event of a flashover, instead of around the insulators where the heat of the arc might crack the porcelain.

Work had already started on a less important line that was to feed a remote section of the system. Because of the relatively lesser importance of the line and the low load requirements it was found that 66 kilovolts as the operating voltage and wood pole construction, would be the most economical. The cost per mile of this line was only a fraction of that of the steel line. The right-of-way was through sparsely settled country. The steel line cost approximately 50,000 dollars per mile while the wood pole line, because of the low cost of construction and especially the low cost of right-of-way, cost 5000 dollars.

AND so other lines were built in rapid succession until the original plan of the network of lines was nearly completed. However, the lines that had been placed in operation gave some trouble during the summer time. Lightning would cause the lines to flash over and they had to be switched out of service, occasionally cutting off the power and darkening entire communities. A large electrical manufacturing company proposed a joint investigation of lightning on the engineer's lines. They worked up a schedule of tests and

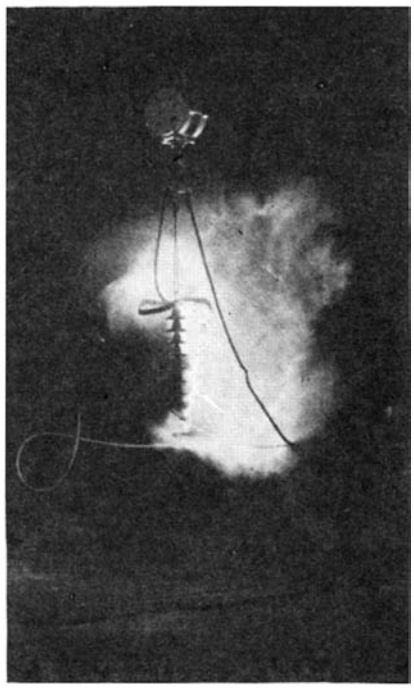
a list of equipment that would be necessary to make these tests. The cost of the proposed investigation was quite high but the company officials soon perceived the value of such investigations, especially when it was shown how these tests would save new construction and improve reliability of service. The request for the necessary money was granted.

Early in the following spring the equipment arrived. It consisted chiefly of a cathode-ray oscillograph, lightning generator, and gas-electric engines for furnishing electric power. The equipment was mounted on trailers for the sake of portability. Two young engineers were assigned to aid the manufacturer's engineers in the investigation. The first camp was constructed under a new line which was complete except for a few miles adjacent to the lightning study station.

TWO types of investigations were conducted. In one were recorded, by means of cathode-ray oscillographs, the magnitude and shape of surges impressed upon lines by lightning. In the other investigation, which was carried on while there were no storms, artificial lightning created by a lightning generator was impressed upon the lines and its behaviour studied. These investigations lasted for nearly five years.

The results were in many respects contrary to expectation, and in general were such that they could not be explained by the prevailing induced voltage theory. The induced voltage theory states that a charged cloud appearing above the transmission line will cause a charge to collect on the line and be held there by the cloud. When the cloud discharges to ground, the charge on the line is liberated and will flow in both directions over the line. This theory was used to explain the flashover of lines.

Cameras and observations showed that lightning had struck very close to the line and yet oscillographs recorded voltages of low magnitude, only a small part of the values necessary to cause the flashover of insulators.



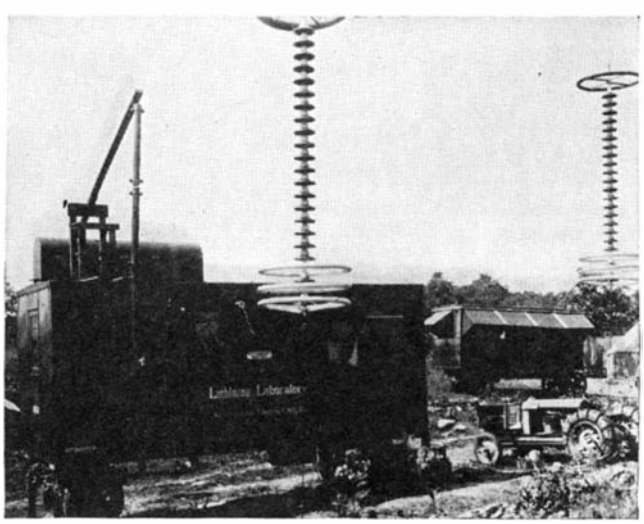
Arcs about insulators with rings, in a spectacular laboratory test

His face broke into a smile as he pictured the audiences, their comments and discussion after the presentation of the joint paper written by the manufacturer's engineer and himself, the one in which the direct stroke theory was proposed. The direct stroke theory states that during thunderstorms the high voltages which flash over insulation are caused by the cloud discharging directly through the lightning stroke into the transmission line.

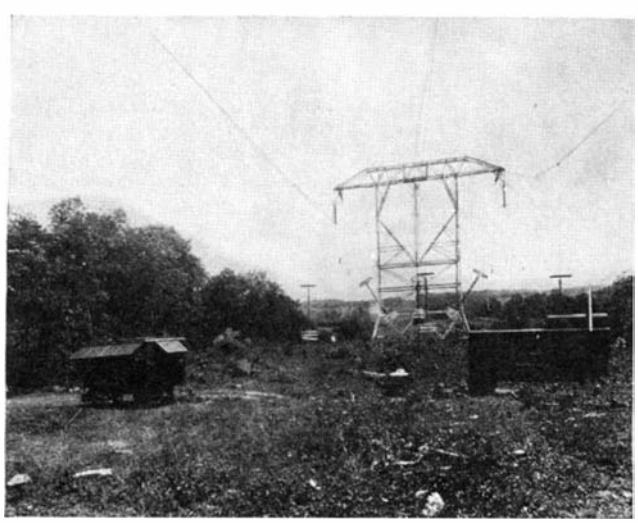
Several other papers followed, each presenting a new phase of the investigation. Several complete systems of protecting transmission lines had now been developed. The ground-wire scheme, which consists of wires electrically connected to the towers and strung over the power conductors, was revised and made the most effective under average conditions. Ground wires were raised and extended outward to prevent lightning from striking the outermost conductors. The ground wire, if struck, would conduct the surge to the tower and then to ground without causing flashover of the insulators. The ground resistance of the tower must be low, otherwise the potential of the tower to ground will become high and cause a flash to occur over the insulators from the tower to the conductor. They also showed in one of their papers how to obtain low ground resistance on towers. Occasionally this becomes too expensive and on rocky soil almost impossible. In that case lightning arresters could be placed in parallel with the insulators. These limit the voltages across the insulators to a safe value.

THE improved types of designs he incorporated in a new line recently constructed. The statistics he used in designing the new line were quite different from his first compilation. There are now over 1000 miles of 220-kilovolt lines, 4000 miles of 132-kilovolt, 10,000 miles of 110-kilovolt, and 27,000 miles of 66-kilovolt lines. For this new line he chose 220 kilovolts because of the great length and large quantities of power involved. The ground wires he placed well above the conductors, and supported them by special vertical arms which set off these towers as different from the others. It was this line that had started him on his reminiscences.

"Brush yo' off? Brush yo' off?" He came to with a start. The porter was standing over him reaching for his bag. The afternoon was well nigh over; the sun was sinking back of the buildings of the distant city. There was a click of coin as the train came to a standstill in the station. "Thank yuh suh! Thank yuh suh!"



Cathode-ray oscillograph trailer and power supply unit for use in the outdoor laboratory where lightning was studied



The lightning research station which was set up near a transmission line where electrical storms were frequent

OUR POINT OF VIEW

Too Old at 40?

TWO or three years ago there appeared simultaneously in American and British periodicals a long series of articles and letters bitterly assailing industry's rapidly growing practice of classing as too old for employment a man of forty. Not only did this habit affect the industrial worker but also the office worker of the non-executive class and the professional man. Younger, "more alert" men were wanted, so these older ones were discharged and found it very difficult to obtain new jobs commensurate with their training and experience. The practice is still observed, and nothing much seems to have been done to aid the despairing "antiques."

Now, however, a psychologist, Dr. Walter R. Miles, who has previously written for SCIENTIFIC AMERICAN, announces the results of a series of tests which he says proves that this age limit of industry is mere "calendar worship." In these tests, in which 863 persons, aged from 5 to 95, figured, he showed that motor ability, such as hand and foot skill, falls off with age but not as much as sometimes believed; that in reaction time, 25 percent of those over 80 were as quick as the average for the group; that, in intelligence, a quarter of the oldest subjects scored above the general average; that imagination showed no appreciable age change; and that in acuity of eyesight, perception, and memory, the older subjects made good scores.

In this connection, we recall a remark Henry Ford once made to us in commenting on the practice of one European nation of giving old-age pensions to all persons over 65 years of age. "To think," he said, "of being shelved as useless at what should be one's most productive age!" Solon, Sophocles, Pindar, and Anacreon labored on splendidly as octogenarians. Goethe, Kant, Buffon, Newton, Fontenelle, and Harvey—the discoverer of the circulation of the blood—did some of their best work after 80. Landor is said to have written his most beautiful "Imaginary Conversations" at 85; Izaak Walton's pen was most fluent and forceful at 90; Hahnemann married at 80 and made some of his most fruitful discoveries at 91; Michelangelo's brush at 81 was as vigorous as it had been at 21; and Titian was doing good work at 90.

Each year a large New York firm lists the deaths of about 60 successful men who have died in the preceding year. Holding high offices in large corporations at the time of their deaths, most of those listed have passed 60 and a large percentage have passed 70, 80, and even 90. True, these men were executives and those mentioned above were artists and scientists, not industrial workers or office "help"; but if age added experience to their early training and ripened them into men of large affairs, so too should years of conscientious application to a job make of the worker, white collar or denim variety, a valuable asset to his particular business. The latter does not so often become physically so old at middle age that he can be arbitrarily classed as useless; but he does sometimes allow worry about the future to give him a senescent attitude. The need, therefore, is for further research in this important psychological subject and perhaps the employment by corporations of psychologists who can scientifically gage the abilities of personnel. The man so often "too old at 40" may be a conscientious worker whose rich empirical knowledge and the intelligence with which he applies it will more than offset his loss of speed and physical ability even up to the age of 60 or 70.

Airplane Engine Reliability

AMONG the many records for airplanes set up at the National Air Races, recently completed in Cleveland, there was one which was not accorded the applause to which it was entitled. This was the lack of a single engine failure during the several days of the races. This record is all the more remarkable in view of the fact that many of the engines on the racing planes were "suped-up" so that they had a performance output of three or four times their rated horsepower. It may seem impossible that such a result could be obtained—that the materials in a 200 horsepower engine, for example, could withstand the terrific strain of producing 600 to 800 horsepower—but such is said to have been the case at Cleveland.

It used to be that engine failure was the most frequently stressed cause of airplane mishaps. The engine reliability record of the National Air Races shows why this is now the exception rather than the rule—because engines are now built with a very large factor of safety as regards the materials of which they are constructed and the precision with which they are assembled. The result is that the flying public now has every confidence in airplane engines.

Peace in Radio

WE have several times taken the opportunity to protest in these columns against the abuse of radio broadcasting by advertisers. A break in the clouds appears at the moment of going to press. One of the large broadcasting chains has announced that it will place limitations on the amount of time that may be devoted by each program "sponsor" to direct advertising, and on the position of the sales appeal in the broadcast. When will some daring advertising executive test the feasibility of a simple announcement of his company's name and product as the only advertising in his program? The reaction of the intelligent listening public should be instantaneous and gratifying.

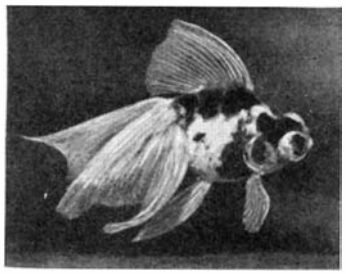
Expensive Babies

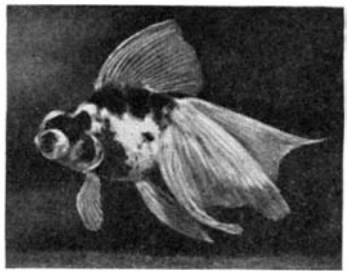
THE eugenists and the geneticists have both recently had their say, in separate conventions of course, concerning the future of the human race. The most despairing note that emanated from each seemed to center about the fact that the morally and culturally higher classes in this country are practicing too much birth control.

Commenting on these two conventions, a woman writes, in a letter to *The New York Times*, that the scientists overlooked the economic reason for "birth control" among our university classes. She feels that babies are too expensive and says that "our more intelligent young people are unwilling to bring children into the world without assurance that they will be able to care for them decently and educate them properly. As things now stand, they are forced . . . (1) to postpone having children until late youth; (2) to limit the number rigidly; (3) or to descend to the pauper class and accept charity."

Close observation shows that she is largely right. Is she also right in suggesting that a premium be placed upon the reproductive energies of the better class of our young people, especially by the reduction of maternity costs? It is a question of national import and we shall hail the day when governmental interest is directed intensively toward finding an answer to it.

GOLD FROM GOLDFISH





THE inexperienced should not try goldfish farming any more than they should try rabbit breeding or silver fox raising. It requires land, water, climate, good brood stock, skill, and financial resources. Wishing to see how this industry is carried on successfully under the best conditions, one of the editors of SCIENTIFIC AMERICAN made a special visit during the spawning season to one of the largest of the 450 goldfish farms in the United States. This particular hatchery is located near Frederick, Maryland, the home town of Barbara Fritchie and Francis Scott Key.

The goldfish, which belongs to the carp family, was introduced into the United States in 1874 by Rear-Admiral Daniel Ammen. It is a native of China, Japan, and Korea.

Goldfish farms will be found as far north as Ontario and as far south as Florida, but many of the successful breeders are located somewhere near the Mason and Dixon Line. It is a pleasant ride to Frederick, where we picked up G. L. Thomas of the Three Springs Fisheries as our guide. The farm is nine miles away and consists of 200 acres of water-lily ponds and fish hatchery ponds.

We were quick to realize that goldfish raising is not, perhaps, "big business" but is a sizable industry; here some 10,000,000 goldfish a year are raised and shipped. Leaving the public road we proceeded along dirt roads bordered with ponds. The smaller are the spawning ponds, the larger are the rearing ponds. In the former are from 50 to 200 pairs of brood stock. These ponds are disinfected in the spring and every particle of grass is removed. The sides of the pond are boarded to eliminate any vegetation along the water's edge in order that there may be no natural place where the fish can spawn.

THE nests are board frames with poultry netting at the bottom. To this is sewed Florida moss. In the morning, during spawning time, the male begins to pursue the female who sees and enters the fish nest. She spawns directly over and onto the moss, dropping the eggs which are then fertilized by the male. The spawning goes on sometimes until noon and when one of these nests is well covered it is said to contain sufficient eggs to hatch 10,000 fish. The eggs have a sticky substance which causes them to adhere to the nests. When first deposited the egg measures 1/16 of an inch in diameter and is slightly flattened; fertilization takes place in a hole in this flattened place. The nests are gathered every day during the spawning season and are hauled to the cement hatching tanks. Each tank will contain about 10 nests. The hatching time depends upon temperature and varies from four to 20 days. The goldfish, when first hatched, have a sticky substance which enables them to adhere to the sides of the tank or to the moss.

For the first three days of the fish's life it hangs suspended, or buoyed up, in the water by its head, this being the largest part of its body. During this time the fins and tail are developing and the fish is absorbing the egg sac, which is nature's food housed for him during this period. While this external development is taking place, there is also an internal development, for at the end of three days the air bladder has developed and filled with air, which places the fish in a horizontal position. Now, for the first time, the fish realizes its ability to move through the water by the movement of his newly developed fins and tail.

As soon as the art of swimming has been learned, the fish is also ready to take food. In the heavily stocked cement tanks it is necessary not only to afford every protection possible but to add food for many thousand fry. Dozens of

One of the hundred spawning ponds. The cook house for fishes' food, and the shipping room are to the left

hard boiled yolks of hen eggs are used daily. The yolk is forced through bolting cloth. In suspension in water, it is sprayed from watering cans upon the surface of the water in the cement tanks several times daily. Young fry require as much food as their own bulk daily.

Fancy goldfish must be guarded and protected against sudden changes in temperature. If unprotected, a too sudden change, such as frequently occurs at night, may result in the death of all the fry. Matting is often used to cover the tanks.

AFTER about a week's stay in the cement tanks the fry are transferred to the rearing ponds. These have been disinfected and then stocked with the best natural fish food obtainable, including daphnia, a minute freshwater crustacean. In addition to the natural food there is added oat flour. As the fish grow, their diet is amplified by the addition of cooked grains. The goldfish is naturally a vegetarian. The "pantry" on the goldfish farm contains a power steam cooker which makes batches of one and one half tons each three times a day. When cool, the contents of this gigantic cooker is hauled out to the ponds where it is dumped in by the spadeful. Feeds of all kinds are blended. The feeding occupies the entire time of three men.

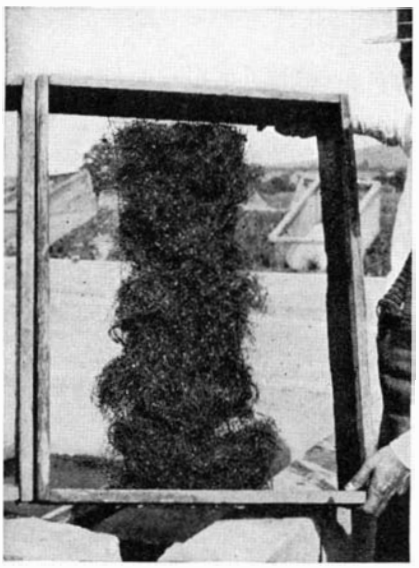
The growth of the goldfish is forced by feeding. The ponds are constantly checked both for growth and health by seining the fry for examination. Sometimes, enemies make such onslaught in a short time that it is found advisable to drain the pond and restock, or it may be that the fry are so crowded as to retard growth and so make it necessary to remove some by seining.

A laboratory is maintained to guard the fish against parasites and other enemies which must be destroyed if any of the goldfish are to be brought to maturity. The worst enemies are frogs, snakes, and the larvae of large water beetles and dragon flies. Birds are also enemies of goldfish; men constantly guard the ponds with shotguns.

The ponds are drained through an underground tile system. As the water leaves the pond through a valve to the drain pipe, it is carefully screened with hardware cloth. This lets the water out and holds the fish in the lowest part of the pond. To see this mass of goldfish so thick that they color the water is a sight never to be forgotten. The fish are then dipped up into buckets and carried to screened vats where they are held awaiting sorting and grading.

Hatching tanks each contain ten nests. After hatching the fry are taken to rearing ponds

Fish are carried to the sorting and grading room in buckets almost solid with life. Here they are quickly passed over the tables covered with oilcloth. First they pass over the sorting table where are removed any uncolored goldfish or any other varieties of fish that may have gotten into the rearing ponds. Fish eggs from game fish may be transferred from rivers to rearing ponds on the feet of birds and hatching there grow very rapidly, feeding on both the natural and the cooked food.

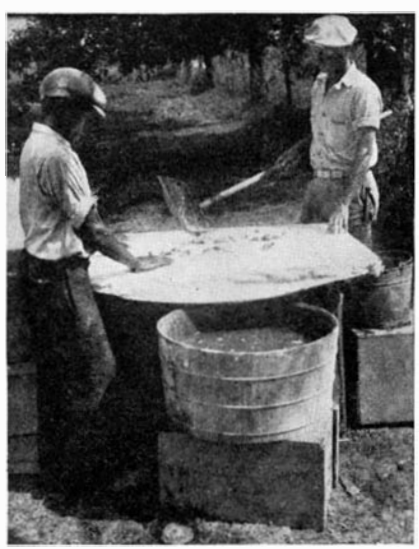


Fish nests of Florida moss are sewed to chicken netting on frames

From the sorting table the fish pass directly onto and over the grading table. This is covered with wetted oilcloth, which is laid out in one-inch squares. Here the fish are graded in from three to five sizes, for sale. From here the fish go to the tempering and storage ponds miles away, where they are prepared for shipment. Here fish are kept in cool spring water. Water heavily impregnated with lime seems to be ideal. As the fish come from the rearing ponds, especially in hot weather, they are soft and will not stand long-distance transportation. Placing them in cool spring limestone water for a week or more tempers or hardens them so that they will stand handling.

Shipments of goldfish are made by express and by trucks. An express-car load of fish leaves Three Springs Fisheries five times a week. Shipments are made in specially designed cans giving maximum air and water surface. The transportation companies issue special instructions to their employees relative to the care of goldfish in transit. About 35,000,000 goldfish are sold annually in the United States. For our photographs we are indebted to William T. Innes of Philadelphia, Editor of *The Aquarium* and author of an authoritative book on goldfish, and to G. L. Thomas.

Examining fish for enemies and to see if pond is properly stocked



Sorting fancy goldfish on improvised table covered with wet oilcloth

STAR COLORS AND STAR TEMPERATURES

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

FROM the days when man first gazed intelligently at the stars, he must have noticed how they differed in color. The contrast between the pure whiteness of Sirius and Vega, the yellowish light of Capella, the deeper yellow of Arcturus and the red of Betelguese or Antares, impresses even the casual sky gazer. It is only since the present century began, however, that these colors have been fully interpreted.

It was realized in a general way a good deal earlier that white stars must be hotter than red stars, just as white-hot iron is hotter than red-hot iron. Before the general statement could be made precise, two things were necessary. Astronomers had to devise some method for the accurate measurement of star colors, and physicists to develop the theory which connects the color of the light of an incandescent body and its surface temperature. The latter problem proved to be one of the most important in modern science for, in its solution, Planck was led to the first formulation of the quantum theory which has so profoundly changed our physical conceptions. For the present we need recall only that his investigations made it possible to calculate just how much light of any color (that is, belonging to any specified region of the spectrum) would be emitted by a standard radiating body of any given size and temperature. This opened up several different methods for finding the temperature of an incandescent body.

THE whole amount of heat radiated from a given area might be measured, or the amount of radiation of a specified wavelength, or the relative proportion of the radiation of different wavelengths. The second of these evidently describes the apparent brightness of the surface when observed with an apparatus transmitting only light of the given color; the third, by defining what mixture of the various wavelengths reaches our eyes, determines what the color of the integrated light from the body shall appear to be. All of these methods have been applied to find the temperature of the sun's surface, and the last two are in daily use in many industrial processes.

When it comes to the stars, however, the "brightness temperature" can no longer be determined; for, though we can measure how much light a star sends us, it is very rarely indeed that we can find by any independent method what is the area of the surface from which this light originates. But the "color temperature" can still be found from the relative intensity of the star's light in different colors. The result would be exact if the light came from a solid surface of standard radiating properties. It actually comes from a hazy atmosphere hotter at the bottom than at the top, so that its color is a blend of the redder light from the upper layers and the whiter light from the deeper and dimly seen regions. The net effect may be expected to correspond closely to the temperature of some intermediate region part way down in the atmosphere, and this "effective temperature" is all we can hope to find.

HOW far the difference between the radiating powers of the actual gases and an ideal standard surface will disturb our results is a difficult theoretical question. We can at least avoid one source of error by making our measurements in regions of the spectrum which are as free as possible from dark or bright lines.

So much for theory. Now for the practical task of measurement of star colors. The simplest method is the comparison of measures of brightness, that is, of stellar magnitude in the ordinary sense—made visually and photographically. The eye is affected mainly by yellow and green light, the ordinary plate by blue and violet. Red stars are therefore fainter photographically by amounts proportional to their degree of redness or "color index." The colors of thousands of stars have been measured in this way—or better by substituting an isochromatic plate with a yellow screen for the visual observation. When the response of the plates to light of different wavelengths has been determined by suitable tests, there is no great labor in passing from the color indices to the corresponding color temperatures, which can then be found for great numbers of bodies.

Measures of this sort unfortunately have no power of selecting the regions of the spectrum which are clear of absorption lines; they lump together the whole range over which the plates are selected. The results must therefore sometimes be taken with reserve. For example, there are two principal types of red stars: Class M, with dark bands in the spectrum due to titanium oxide, and Class N with bands due to carbon. The titanium bands are very heavy in the red, yellow, and green but feeble in the violet; exactly the opposite is true of the carbon bands. Hence the N-stars show a redder color than that corresponding to their real surface temperature and their color temperature comes out too low, while for the M-stars it is too high. Comparison with measures of the total heat radiated by the stars (which are less affected by these complications) shows that this is indeed the case.

Despite these difficulties the color indices yield results of great importance. They show that stars with similar spectra are very similar in color and hence in temperature. Giant stars of great real brightness, however, average slightly but definitely redder than dwarf stars of the same spectral class. Both of these facts are explained by the same physical process. The character of a star's spectrum depends upon the ionization of the atoms in its atmosphere. This is strongly favored by high temperature, hence there is a steady and conspicuous change in spectrum in passing from the coolest to the hottest stars. Low pressure also favors ionization. The giant stars are of large size and the force of gravity at the surfaces is weaker and the atmospheric pressure less than in the dwarfs, hence any given stage of ionization and any specified type of spectrum appears at a lower temperature in the former. The sun, for example, has an effective temperature of 5800 degrees, Centigrade; Capella, a giant star with very similar spectrum, a temperature of 5400 degrees.

FOR more precise work the spectroscope is used, so that regions free from disturbing lines can be selected. Different stars may now be compared, not only with one another but with some artificial source of which the color temperature has been accurately measured in the laboratory. The investigator then knows exactly what he has in hand. He still has to allow for the absorption

of starlight in coming through our atmosphere—blue light losing more than red—and for various other complications. But his final results merit confidence. Only the brighter stars can be observed, for obvious reasons.

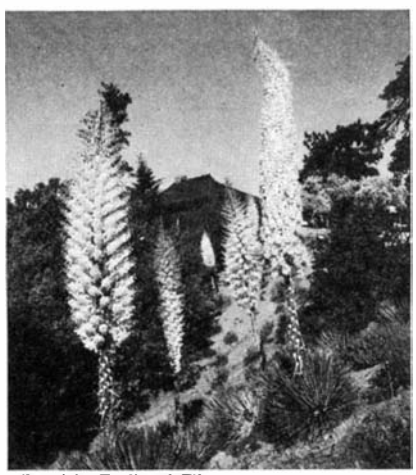
The first work of this sort was done at Potsdam more than 20 years ago by Wilsing and Scheiner, observing visually with an ingeniously designed spectro-photometer attached to the great five-foot telescope. They found temperatures ranging from about 3000 degrees for red stars in Class M to 10,000 for the white stars of Class A (like Vega), and 15,000 degrees for some stars of Class B which show higher ionization in their atmospheres. No other absolute measures (comparing with laboratory standards) seem to have been made until very recently, when an admirable investigation was completed at Greenwich. Here the observations were photographic and the terrestrial standard was an acetylene flame from a burner constructed according to exact specifications and, moreover, tested most carefully in the British National Physical Laboratory. The color temperature of this flame was 2420 degrees—lower than that of the coolest stars—but by interposing a blue screen the color was made a fair match for starlight, at the cost of another laborious set of measures to find the precise absorption of light of different colors by the screen.

THE final result for the average temperature of a star of Class A was 14,300 degrees. This is considerably higher than previous determinations but probably more accurate, though it is still uncertain by 1000 degrees each way. The temperatures found for solar type stars (Class G) ranged from 5200 to 6500, the dwarfs being hotter than the giants—in good agreement with previous determinations.

For the B-stars the temperatures ran up to 22,000 degrees. This is what might be expected from the high ionization in their atmospheres. A few of these stars, however, were unquestionably yellow instead of white, one or two of them having the color corresponding to 8000 degrees temperature.

Similar yellow stars have previously been found by Wilsing and Scheiner, and by other observers.

Here is a real puzzle. The unequivocal evidence of the spectral lines shows that the atmosphere of these stars is very highly ionized and must be very hot. Yet the color of their light indicates a relatively low temperature. Which conclusion is correct? Practically all investigators agree that the temperature must really be high. We know enough about ionization now to be practically certain that atoms of oxygen and nitrogen (for example) could not possibly be so thoroughly ionized as they are in these stars if the temperature was only 8000 or 10,000 degrees. On the other hand there are a number of things which might change the color of the light. The most obvious of these is a dark nebula composed of gas or extremely fine dust between us and the star. Blue light would be more weakened than yellow, in passing through such a cloud, and the light of a star shining through it would be reddened like that of the declining sun.



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Yuccas near the living quarters of the astronomers on Mount Wilson

In some cases these abnormally yellow stars are near nebulae or actually involved in them, so that this explanation is reasonable. Very distant stars, too, may be reddened by the scattering of their light by the exceedingly rarefied gas which fills interstellar space. There are other yellow stars, however, for which this explanation does not appear plausible and no one knows what causes their anomalous color. A very pretty piece of evidence that these stars are really much hotter than their colors would lead us to suppose, has been presented by Dr. Beals of the Dominion Observatory at Victoria.

The highest known state of ionization is presented by the Wolf-Rayet stars, in which the spectra contain broad, bright bands superposed on a much fainter continuous background. Edlen has recently identified some of these bands as arising from atoms of nitrogen which have lost four, and of oxygen which have lost five, electrons. So it can scarcely be doubted that they must be the hottest of all stars. Yet these colors correspond to temperatures ranging from 17,000 degrees down to 8000 degrees.

The worst problem presented by these stars—the enormous width of the bright bands in their spectra—has recently been solved by Dr. Beals, who suggests that the stars themselves are surrounded by envelopes consisting of atoms of light elements blown away by the pressure of radiation and flying outward in all directions at enormous velocities. Something of the same sort certainly occurred in Nova Aquilae, but there the emission of gas was short-lived and gave rise to an expanding nebula, while in the Wolf-Rayet stars the emission appears to be continuous. This theory, strange as it appears at first sight, accounts nicely for the observed facts.

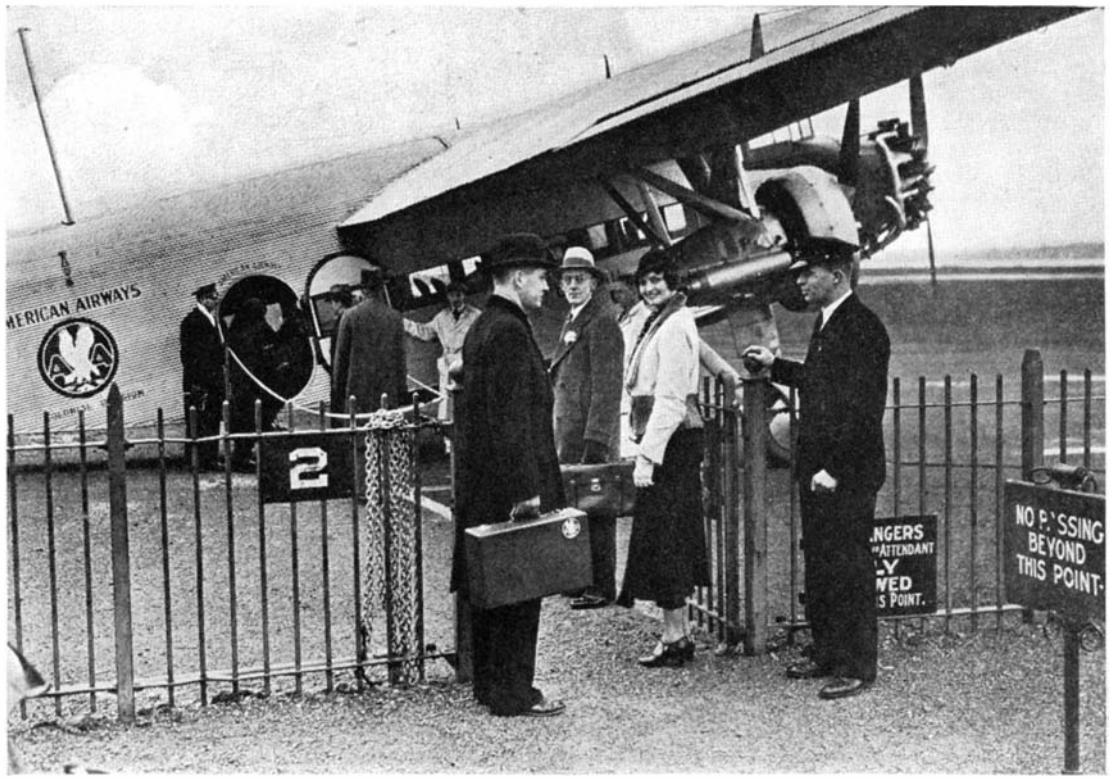
Now this gaseous envelope must be similar in nature to a small nebula. It must be far too thin to shine by its own light like a dense incandescent body—so each atom in it must be fed individually with the energy which it later discharges in the visible bright lines. For the source of this energy we have to look to ultra-violet light—very short waves emitted from the central star. Such light, falling on an atom, is capable of expelling an electron from it. When the atom thus ionized picks up another loose electron it will give out the energy it previously absorbed, perhaps in one stage, as ultra-violet light, more probably in several successive stages, some of them resulting in the emission of visible lines.

FROM the amount of energy emitted per second in these lines we can find how many atoms have performed the corresponding process. The total number of atoms which have re-combined with electrons must be greater and, since the whole process continues steadily for years, an equal number of atoms must absorb ultra-violet light and become ionized.

In this way it is possible to estimate how much ultra-violet light must be emitted by the central star—or rather, to get a lower limit for this (since some of the star's light may get through without getting caught by any atom). Comparing this with the directly measurable light of the star in the visible region, we have a new way of finding the temperature which may give too low a result but cannot be too high.

Applying this to two typical Wolf-Rayet stars, Beals finds temperatures of 69,000 degrees and 71,000 degrees. Spectrograms of Nova Aquilae, treated in the same way, indicate that when its light was fading in the autumn of 1918 its temperature must have been at least 64,000 degrees. Finally, the same method was applied to P Cygni, one of the most remarkable of the yellow B-stars, with a color temperature of only 6000 degrees. From the bright lines of hydrogen in its spectrum Beals finds that the actual temperature must be at least 18,000 degrees; from bright helium lines, that it exceeds 25,000 degrees.

Little or no doubt remains that these strange stars are really hot. The problem of their color remains to tempt the theoretical student.—*Jamestown, Rhode Island. August* 26, 1932



THE BUSINESS MAN TAKES WINGS

Speed, Safety, and Comfort Are the Key-Words that Open the Way to Modern Air Transportation for the Man to Whom 'Time is Money'

By CHARLES R. MARSHALL

I RECENTLY had occasion to make a business trip from New York to San Francisco, which necessitated visiting several cities in the middle west, south, and southwest. I have always been interested in flying, and in the past, whenever possible for me to use the commercial air lines, I have done so. Therefore, it was not necessary for anyone to sell me on the idea of making this proposed trip by air; rather it was a question of the amount of time I would save, plus the convenience and ease of traveling by air.

I called the New York office of American Airways, Inc., who operate a business travel planning service, and gave them the list of cities I wished to visit. This list included Cleveland, Columbus, Cincinnati, Louisville, Atlanta, Dallas, El Paso, Los Angeles, and San Francisco. In the next morning's mail I received from them a complete itinerary for this trip, together with a memorandum of the expense.

I left New York on a Sunday night at 7:45 over the New York Central Railroad. The next morning I was in Cleveland at eight o'clock and spent the entire morning and part of the afternoon on business. About 3:30 P.M. I left for the airport as I wanted a little time to talk to Major Berry, the manager of the port, before our ship took off at 4:30 for Columbus. As I stood with Major Berry in the lobby of the Administration Building at the airport, I could not help but be impressed with the businesslike methods and the matter-of-fact attitude of the various attendants.


Mr. Marshall

I believe that the average person still looks upon flying as somewhat of an adventure, but in the 20 minutes that I was waiting, I saw the plane from Chicago bound for New York land and discharge 12 passengers. Mentally I tried to picture the age and occupation of each person who got off the plane. I particularly noted that six of these passengers were women. I should judge that these people were from many walks of life and varied in age from 18 to 50 years. While this ship was landing, another transport plane was circling over the airport, waiting for the "all clear" signal to land, and it had hardly come up to discharge its passengers when I heard the drone of another motor and saw a third ship coming in. There was no particular hustle or excitement on the part of the attendants—they simply went about their work of taking care of the baggage and attending to the personal wants of the passengers, as you would expect to find them doing at the average railway terminal.

In a few minutes the loudspeaker announced that our ship was ready, so four other gentlemen and myself went out to get aboard. When I arrived at

the airport an attendant had taken my baggage, handed me a check for it, and I did not see it again until I landed at Columbus.

I was particularly interested in the ship in which I made the flight to Columbus because it was powered by a single engine, and it was the first time I had been in this type of plane. I had never before traveled in a plane that had so little vibration. It was perfectly easy for me to talk with my fellow passengers in practically a normal tone of voice; the noise was much less than in the other ships in which I had flown. I later found this was because the cabin was insulated. All of this impressed me so much that when I left the ship at Columbus I asked what kind it was and learned that it was a Pilgrim with a Cyclone engine.

WE arrived at Columbus at 6:08 and by seven o'clock I was at my hotel, ready to spend the evening with a business associate there. I was quite surprised when, as I registered, the clerk asked me if I were the Mr. Marshall who had just come in by plane. When I told him I was, he said he had a very nice room reserved for me. I learned, upon inquiring, that the American Airways dispatcher at the airport had telephoned, making the reservation for me.

On Tuesday morning I left Columbus at 9:10 and 77 minutes later arrived at Cincinnati. "Strangler" Lewis, the well-known wrestler, was on the ship with me, and he told me that he always flew whenever it was possible for him to do so. He explained that it meant money to him because he could be in so many different cities during a year. On that particular day he was flying to Memphis for a wrestling bout and was planning to leave the following morning for Chicago for another match that night. If he had not been able to fly he simply could not have been in Chicago for this next bout.

I had plenty of time in Cincinnati to make several business calls because I did not leave until 7:34 in the evening, arriving in Louisville at 8:38, or 7:38 Central Time.

This flight was after sundown and was my first experience in night flying. The lights on the ground twinkled like myriads of stars and it was interesting to watch for the flash of the beacons on our course. These beacons, located on high ground, are spaced at 10-mile intervals and show a flash about every six seconds. Each beacon has a characteristic flash, color, or signal so that the pilot can always determine his location.

On Wednesday morning I left for Atlanta in a big tri-motor Ford at 8:11, making stops at Nashville and Chattanooga, and arriving at Atlanta at noon. It was a beautiful trip, particularly over Lookout Mountain at Chattanooga. On Thursday morning we left Atlanta at 8:35 for Dallas. This time we were in

a tri-motor Fokker, making stops at Birmingham, Jackson (where we stopped 20 minutes for lunch), Monroe, and Shreveport.

On this plane we all had an opportunity to see how the two-way radio communication with the ground stations actually functioned. Over each seat there was a little plug with a set of head phones, and all we had to do was to connect the head phones and hear every bit of conversation between our own pilot and the ground, as well as all other calls and reports that were being made by the ground stations.

Our pilot was reporting his position every 20 minutes, together with the visibility and the ceiling. The ground station then advised the pilot of the weather ahead, giving direction and speed of the wind on the ground and at various heights, together with the visibility and ceiling. For example, a typical conversation was as follows: The ground station would call: "Birmingham to 415 H—your position and weather please." The pilot would answer: "415 H to Birmingham—my position over Beacon 41 B, flying at 2500 feet, ceiling unlimited, visibility unlimited." The ground would then okay the pilot's report and give him conditions at Birmingham. "Birmingham to 415 H. Okay 415 H. Weather Birmingham, ceiling 5000, visibility unlimited, no surface wind."

In addition to this phone conversation we could hear the pilot tune in occasionally to the dot-dash signal of the radio beacon, thereby checking his course. When one stops to consider, the pilot on an organized air line today knows more about conditions ahead of him than does the railway engineer. The railway engineer can only operate by block signals, whereas the transport pilot knows exactly at all times the operating conditions far ahead of him.

We arrived at Dallas at 3:53. Here again I was impressed with the number of planes that were coming and going. Ships were arriving from and leaving for Brownsville, San Antonio, Galveston, Houston, Amarillo, and Wichita Falls. This was probably the most active airport I had seen. Several air lines maintain hangars and there are also many private concerns who operate flying schools.

As I had about two hours to wait for an associate of mine who was flying that day from Columbus, I went through the shops which the American Airways, Inc., maintain at Dallas. And what a great feeling of confidence in modern air transportation this immediately gives one! One large building is devoted to the over-hauling of the ships. Here the wings are removed, the engines and instruments taken out, and the ship completely dismantled. The wings, struts, and cabin are inspected, reconditioned, and painted with many coats of "dope."

IN another building the motors are completely taken apart, replacements made where necessary, then assembled and put on a block test for 12 hours. Other buildings contain laboratories for calibrating compasses and delicate navigating and control instruments.

Nothing is left to guesswork; the work is all done by skilled men who have been trained under Department of Commerce regulations. An overhaul job takes from three to six weeks and when completed the ship is like new.

Friday morning at eight o'clock we took the Los Angeles plane, planning to stop off at El Paso. The day was bright and sunny which gave us a beautiful opportunity to enjoy the passing scenery. Stops were made at Fort Worth, Abilene, and Big Spring, arriving at El

The pilot on a passenger plane using the two-way radio communication with ground stations

Paso at 12:34. It was interesting to see the landscape change from the rich black soil to the red and sandy soil, then the sage brush, and finally the mountains and sand of the desert. We could see the herds of steers making for water holes, with the young heifers scampering off into the desert, startled by the noise of our engines.

At El Paso the pilots and ship were changed and there was a 20-minute stop for luncheon. I wanted to see a little of Juarez so had planned to take the ship the next day for Los Angeles, or I could have left that same night about midnight had I cared to do so.

Saturday noon we left for Los Angeles and it seemed good to be in the air again where it was cool and clean. From El Paso to Phoenix we were flying over the desert. Nothing but sand and sage brush, but the lights and shadows on these sandy hills were gorgeous. Stops were made at Douglas and Tucson.

WHEN we arrived at Phoenix we again found ourselves among beautiful orchards and fields. After a 20-minute stop for refreshments we were on our way—next stop, Los Angeles.

This last hop was the most beautiful of all; up the Imperial Valley to the gateway of southern California, through the pass between the Coast Range and the foothills of the Sierras. I will never forget the thrill of seeing those snow-capped mountains on each side of us as we flew through the pass—then on over the fruit ranches to Los Angeles, where we landed at 7:15, just at twilight.

We left at 8:30 that same night by train for San Francisco, spending Sunday there. On Monday morning at 9:15 we were off again by plane for Los Angeles, arriving there at noon. Tuesday we started from Los Angeles at 6:15 A.M. for our return trip to Dallas. It seemed a little misty when we arrived at the field, but upon taking off the pilot immediately climbed through the clouds to about 3000 feet where the sun was shining. Here was another beautiful sight; an ocean of clouds as far as we could see, with here and there a mountain peak piercing the billowy whiteness. We flew above the clouds for about an hour, when suddenly they disappeared and we saw we were approaching the pass.

We arrived at Dallas at 8:50 that night and although we had been over 14 hours in the air, I did not feel tired. A young lady who came aboard at Tucson was flying through to Syracuse. She left our plane at Fort Worth to take another ship which would fly all night to Cleveland, there to transfer to another plane reaching Syracuse at noon. Just about 26 hours from Tucson, Arizona, to Syracuse, New York!

I spent Wednesday in Dallas and left Thursday morning at 7:50 for Cleveland. Stops were made at Texarkana, Little Rock, Memphis, and Nashville. From Nashville our route was the same as my trip down, with stops at Louisville, Cincinnati, and Columbus, arriving at Cleveland at 7:51 P.M. I could have taken another ship at Cleveland which would have put me in Newark before midnight, but decided to make a call in Cleveland the next morning. I planned to leave Cleveland at noon on Friday but all the reservations were sold out so I finally took one about 8 o'clock which arrived in Newark at 11:24 P.M.

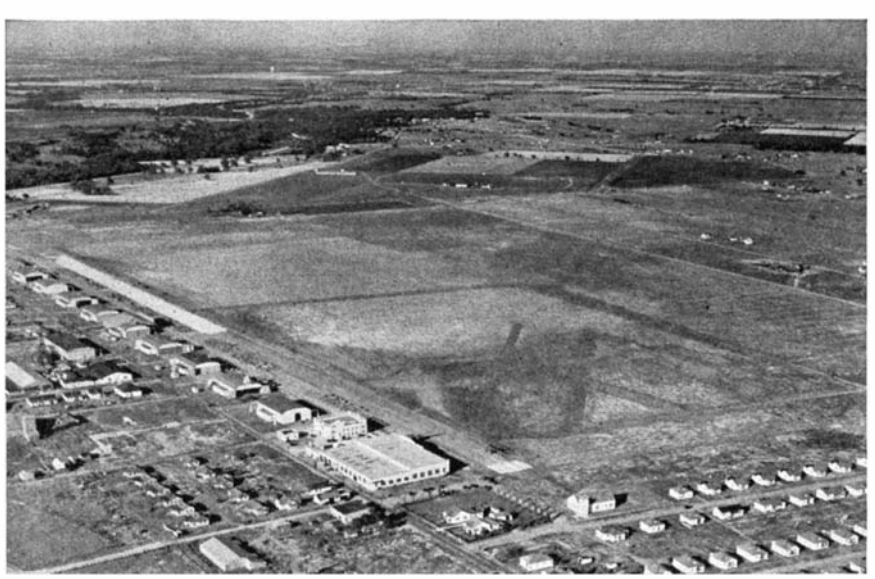
This trip proved many things to me, but particularly the dependability of air transportation. The planes all departed and arrived on schedule. The ships were comfortable, cool, and clean. The pilots were most considerate in taking off and landing—you just seemed to float in and out of the landing fields. Either the pilot or co-pilot occasionally came back into the cabin to see if the passengers were comfortable or if he could answer questions or be of service in any way.

Many of my friends have indicated that they are fearful of being dizzy when aloft. I have had the same feeling myself when looking out of the window of a tall building, but it is not noticeable when flying. One leaves the ground gradually and as the ship climbs there is no sensation of great height—simply a feeling of comfort and relaxation.

Flying, in my judgment, is no longer an adventure. It is everyday transportation, the same as the railroad or steamship. True, some schedules have to be cancelled or delayed, because of bad weather, but in all the time I was away, we were never even delayed because of weather conditions.

Obviously, one of the greatest advantages of traveling by air is the saving in both time and money. My trip was completed in 12 days, allowing for plenty of time at each city for business conferences. This same trip by railroad, allowing for a stop-over in each city, for at least as long as I stayed in each, would have taken a total of four weeks.

ANOTHER interesting comparison might be made regarding the expense of such a trip. Assuming that I had gone by rail at all-year tourist rates, transportation alone would have cost $201.14. My transportation by air amounted to $322.10, including all meals en route. To both of these figures must be added living expenses and value of time, and anyone can easily figure his own savings in salary and living costs for the 16 days that can be saved on such a trip.



An air view of Love Field, Dallas, Texas

New Light on Sasanian Culture

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The ruins of the Sasanian palace—531-579 A. D.—at Ctesiphon in Mesopotamia. The hall is 86 feet wide

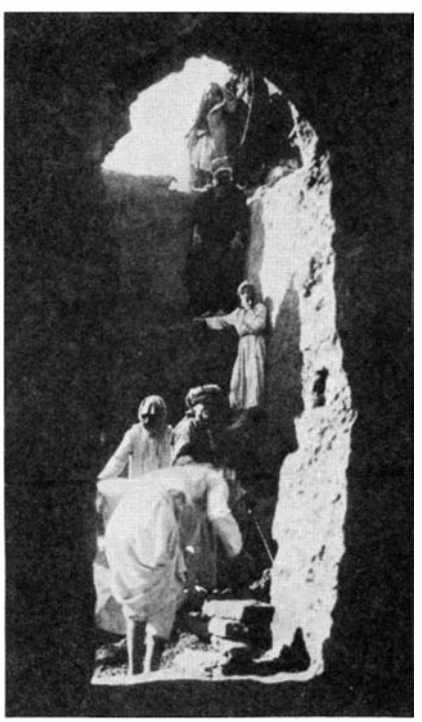
ATTENTION was called to the excavation at Ctesiphon in SCIENTIFIC AMERICAN for October, 1930. Further particulars are now available. The staff of the Islamic Art Department of the German State Museums has been joined by that of the Metropolitan Museum of Art and the work is being carried on by the two groups.

The ruins of Ctesiphon lie on the banks of the Tigris River about 25 miles south of Bagdad. During the struggle between the generals of Alexander the Great, which followed his death in 323 B.C., one Persian province after another broke away. About 300 B.C., Seleucus founded Seleucia on the west bank of the Tigris, on the east to west trade route, and made it one of the great centers from which Hellenistic culture flowed out into the older Orient. Ctesiphon was settled across the river in 53 B.C. After various vicissitudes Seleucia became a deserted spot and Ctesiphon flourished as its heir. Here the Sasanians remained in control for over 400 years.

The country was prosperous, the arts flourished, and much of the art we are now recovering dates from this period. The fate of Ctesiphon was sealed, however, when in 636 the rude desert Arabs, quivering with religious zeal—and with one eye on the fabulous riches of the Sasanian capital—met and routed the supercilious soldiers of the last ruler, Yezdegird. The next year Ctesiphon was thoroughly plundered, and if half of the tales of the Arab historians are true the loot must have been tremendous. The new Arab cities of Kufah, Basrah, and Wasit drained it of its trade and the founding of Bagdad in 762 completed its ruin.

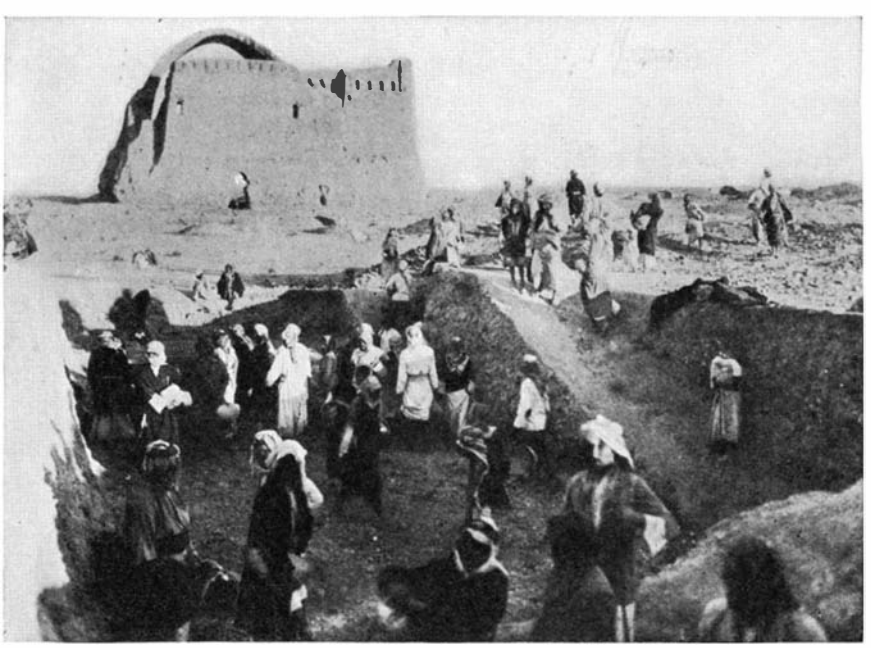
Today only the remains of a great palace, the Taq-i-Kisra, and a small village around the tombs of Muhammad's barber, Selman Pak, and of Imam Hudhaifah mark the site of the once great city. Unfortunately the precarious condition of the façade of the old Sasanian palace makes digging near-by impracticable. A high mound behind the palace was excavated and at a depth of 30 feet the archeologists came upon a floor. As this was cleared they uncovered drains of unglazed baked clay, channels for hot air, and an oven. This was a Sasanian bath at the same level as the floor of the palace and clearly belonging to the original palace enclosure.

In another near-by mound, five Sasanian houses were excavated, the walls being made of unbaked mud bricks of the same character as the surrounding soil. There was a thin plaster floor on a foundation of mud bricks a foot or two below the surface. By following the plaster it was found that the walls had disappeared but they could be traced by the blanks left in the floor.

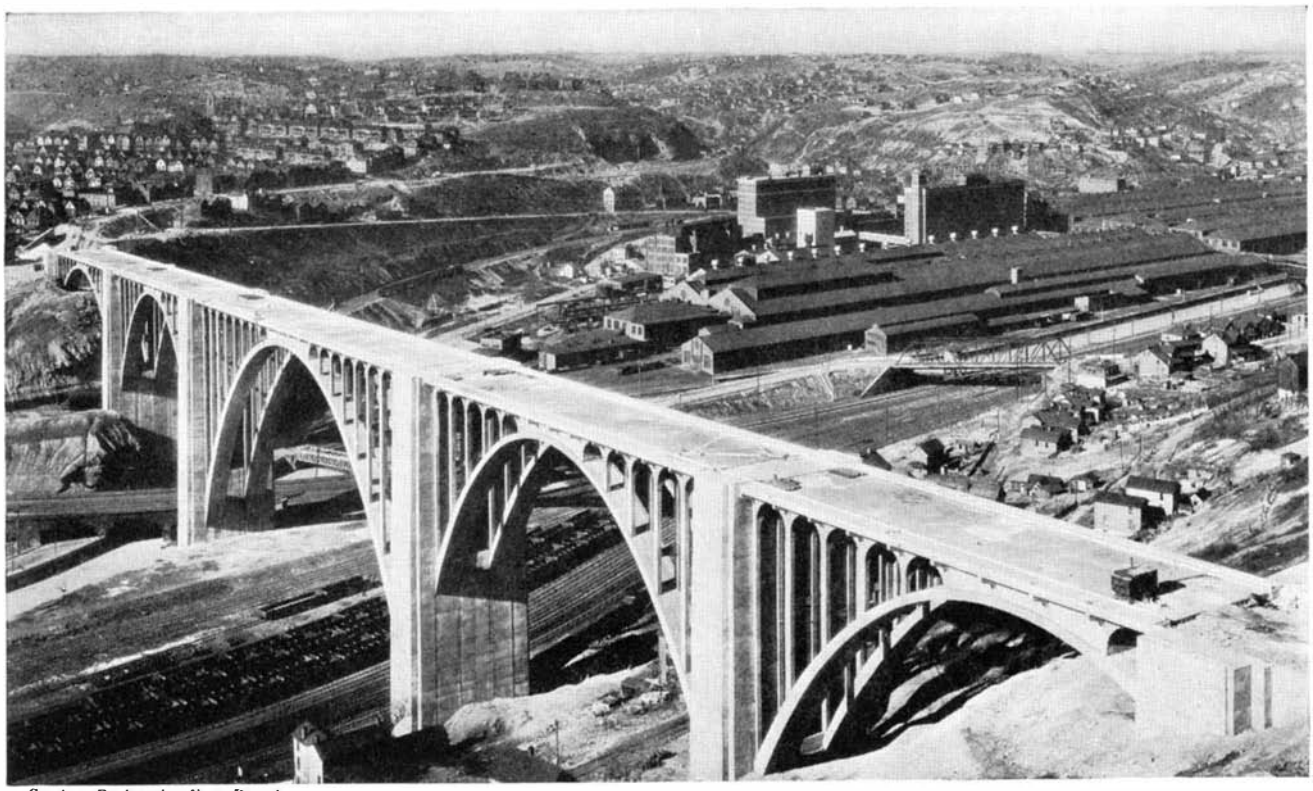


Working at low level, baskets containing earth are passed by hand

A great deal of ornamental stucco was found, adding a great variety of new patterns. A definite chronology must await more material and a comparison with pieces from Kish and Damghan.



Workmen clearing a trench behind the great palace at Ctesiphon. During most of the season 500 men were employed, on three different levels in the trench



Courtesy *Engineering News-Record*

With the longest central concrete arch in America: the George Westinghouse Bridge. Westinghouse plant beyond

CONCRETE BRIDGE MAKES NEW RECORD

By V. R. COVELL

THE Pittsburgh-Philadelphia Pike, laid out in pioneer days and now a part of the Lincoln Highway, dipped into valleys and climbed over hilltops in western Pennsylvania in a manner very disconcerting to the motorist of today, but at no place were the conditions less favorable than about 11 miles east of down-town Pittsburgh, through the congested Turtle Creek Valley and eastward up the nearly 9 percent grade for about a mile. For years studies had been made of projects to overcome this barrier to easy transportation, but the cost involved seemed prohibitive, until in 1929 Allegheny County and the Pennsylvania Department of Highways entered into an agreement to construct a new highway 2.8 miles in length including a bridge, at a physical and property damage cost of 4,500,000 dollars, with a maximum grade of 4.5 percent to the east, thus to by-pass the crowded, narrow streets of East Pittsburgh and Turtle Creek in the valley, and the heavy grade and circuitous route to the east, with a saving of .64 of a mile in distance.

The entire project, similar to first-class railroad construction, is spectacular for much of its length, but the outstanding feature is the George Westinghouse Bridge, named for the founder of the Westinghouse Electric and Manufacturing Company and near the main works of that company. Looking up the valley from the bridge to the north one sees the group of buildings from which the first broadcasting was done from KDKA, the pioneer broadcasting station of the world. To the south can be seen the industrial Monongahela River valley; the site of Frazier's Cabin, that of the first white settler west of the Allegheny Mountains which was visited by George Washington upon his return from Fort LeBoeuf near Lake Erie; as well as a portion of Braddock's Field upon which the English General Braddock was mortally wounded in a battle with the French and Indians, George Washington being his aide. The latter site is now occupied in part by a large steel mill. One hundred and ninety feet below the new bridge, the trains on the main line of the Pennsylvania Railroad thunder past, crossed overhead by the Union Railroad, and underneath by a main highway carrying a street railway, and by Turtle Creek, the stream which drains the valley 220 feet below the floor of the structure.

Ramps and underpasses are constructed at points on the approaches to the bridge so that the necessity for left hand turns is largely eliminated. At the west terminus there are 12 lanes of travel: two in the center exclusively for car tracks, two three-lane ramps for the route to the bridge, and two two-lane roadways for the route to East Pittsburgh.

The bridge, designed and constructed by the Department of Public Works of Allegheny County, at a cost of 1,667,000 dollars, ranks with other large engineering projects of recent years in this country, and has attracted the attention of the engineering profession to a marked degree. The design, which is graceful and pleasing, consists of a series of reinforced concrete spans, with a central span of 460 feet center to center of piers, the longest in the Western Hemisphere; two symmetrical side spans, each of 295 feet; and two unsymmetrical end spans, one of 196 feet and the other of 277.5 feet; with a total length, including the pylons, of 1595 feet.

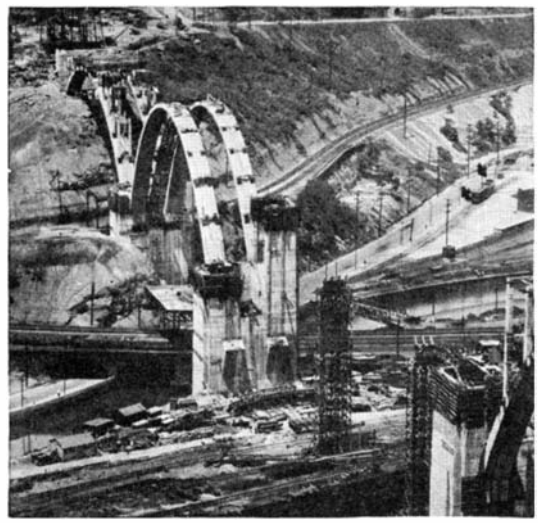
The roadway, which has an ascending grade of 4 percent toward the east, is paved with brick and is 42 feet wide between the granite curbs, with two seven-foot sidewalks which are guarded

with a raised, reinforced concrete, safety curb just behind the roadway curb. Each abutment is marked with two 30-foot granite pylons which are designed to receive historical sculpturing and the upper portion of which will be floodlighted, while each of the four piers is marked with smaller granite pylons. The ornamental handrailing is constructed of malleable iron castings and structural steel and is designed to resist impact of vehicles which might by any chance climb over the safety curb guard. The design of the arch ribs is a fine example of the use of shallow, wide arch ribs with no cross-struts, which results in a reduction in the uncertain stresses, and in better appearance and greater lateral stability for both the centering and the completed structure.

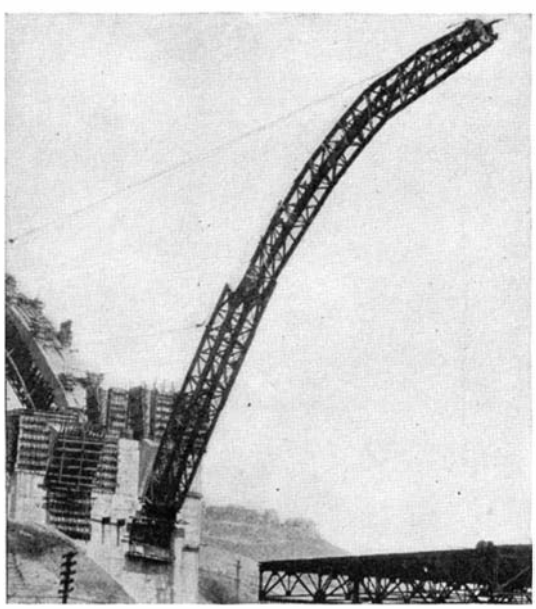
THE foundation for the east abutment, on a site very difficult of access and constructed before the state's contractor for the remainder of the highway had made the 130 foot cut just behind it, was excavated by hand and the concrete conveyed from the top of the hill through a 400-foot chute to a receiving hopper and then placed with hand buggies. The tail tower of the cableway was erected on this abutment.

All concrete masonry was founded on rock formation, which in the case of the east pier was rather soft red shale, but of ample bearing strength to carry the superimposed load. At the abutments and other piers better material was reached. Piers 2 and 3 were designed as caissons to be placed under air pressure, but the condition of the alluvial deposit on top of the rock was such that the use of air was not necessary. Pier 2, just east of the railway yard, was carried to a depth of 90 feet, and but little pumping was required to keep the hole unwatered.

The concrete for the west abutment, the foundations, and the lower 30 feet of the piers, was placed from mixers located adjacent to each unit. In the meantime the cableway system, with a capacity of 30 tons and 1600 feet in length, was erected, there being two 2¾-inch cables over the north rib and one 2½ inches in diameter over the south rib. The order of construction was: first, two end arches, followed by the two side arches, and finally the main 460-foot span. The main tracks of both the Pennsylvania Railroad and the Union Railroad were protected from falling materials or machinery by the erection of sheds with heavy timber roofs. These are to be seen under the two completed arches in the illustration directly above.

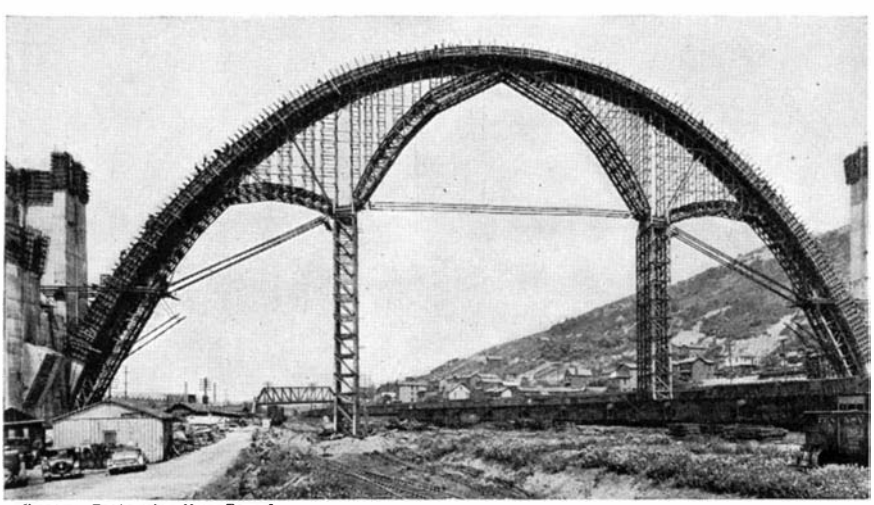


Twin ribs of smaller arches completed and towers being erected for building main arch



Erecting the steel centering upon which the concrete forms are to be laid for an arch

Steel centering was used throughout and was so designed that it could be taken down and re-erected several times, all the material being required for the main arch. For this latter arch it consisted of three-hinged tied arches, supported by two steel towers 163 feet apart, with a total weight of 710 tons. The centering for the north rib of each arch was set first by means of the cableway and after this rib was poured and had attained sufficient strength, the centering was lowered and slid horizontally with jacks on runways into position for the south rib. This operation required special skill for the main span. Light steel centering was built up on top of the main arches to carry the forms. The rib forms were built especially tight, three-ply, ¼-inch veneer board being used to cover four-inch by four-inch lagging for the intrados, and the side forms made of two-inch tongue-and-groove lumber. All seams were filled with sawdust and glue, after which, form oil was applied.



Courtesy *Engineering News-Record*

Centering and forms for a rib of the longest arch. After this arch was concreted, the centering was lowered and jacked sideways for the other rib

THE coarse aggregate for the piers and abutments was river gravel, and that for the superstructure, crushed limestone; the concrete for the latter, as well as for the upper part of the piers, was mixed in a central plant and conveyed by the cableway. High-early-strength cement was used for the keys in the arch ribs, thus effecting a large saving in the time required for curing and permitting the shifting of the centers with less loss of time. Excavation of 32,900 cubic yards of material, and the use of 1600 tons of reinforcing steel and 69,750 cubic yards of concrete were required to complete the work. Work on the structure began May 15, 1930 and was completed, except for the finishing touches, December 28, 1931.

Is Space Curved?

By JOHN P. NIKONOW, M.E.

WE are passing through an interesting period in the development of our concepts of the physical world. It may be called a "Period of Great Unconformities," by analogy with such periods in the history of our earth when the quiet, harmonious development of life under ideal conditions of tropical or semi-tropical climate was suddenly interrupted by ice formation and the advent of severe winters.

Many scholars remember serene and happy days for scientists, at the end of the last century, when different branches of science were comfortably established on good, apparently solid foundations and on good roads, destined to travel surely and unerringly to the ultimate goal of knowledge.

But the new century came, with new discoveries which would not fit in the old theories. Some of the roads of science were found to lead nowhere or to dead ends; others crumbled up and became impassable. New roads had to be found, planned or built.

THE atomic theory was one of the first to suffer. The harmonious simplicity of the atomic structure gave place to a baffling and mysterious complexity. The beautifully developed wave theory of light largely broke down in the face of new discoveries. Then came the collapse of the famous postulate of the conservation of matter. Indeed, it was found that matter can be destroyed and dissipated in the form of radiation. On the sun, for example, a tremendous amount of matter is being destroyed every second—4,200,000 tons, to be exact. It is then radiated away in the form of light and heat.

The law of conservation of energy also does not seem to be rigidly strict. In observing sub-atomic collisions scientists were puzzled to find that the particle encountered by a wave sometimes exhibits greater energy than there is in the portion of the wave that hits it.

It appears that some of the foundations of our science have cracked and must be rebuilt. Our scientific progress is based largely on the interpretation of observed phenomena with the help of mathematics and logic. Mathematics has often led us to puzzling discoveries where our logic failed to follow it. We have also found that even the logic must be used with a great deal of caution and discretion. One of its fundamental principles—that with a given set of causes and conditions we must always get the same result—has been found to be only approximately true when applied to phenomena inside of atoms. Logical deductions, when based on laws and conditions as they exist on earth, may often lead us astray.

Logical deductions have been used extensively to prove that the earth is flat, that space is infinite, that the number of stars is infinite, that objects moving in straight lines and in opposite directions can never meet, that two parallel lines never meet each other, and many other time honored "absolute" axioms and postulates.

Logic is one of our greatest gifts, but we often have a tendency to abuse it, especially when trying to solve nature's riddles on the basis of data known to us through our five physical senses.

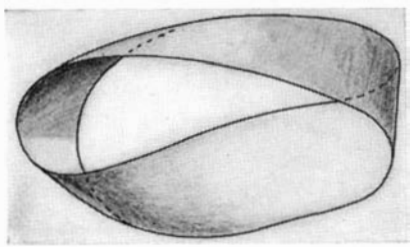


Figure 1

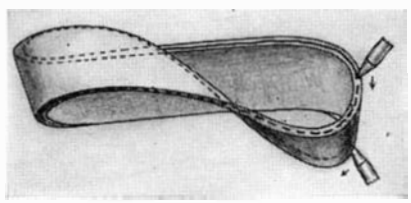


Figure 2

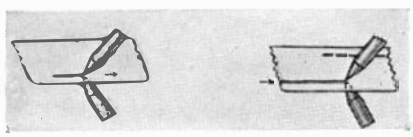


Figure 3

Figure 4

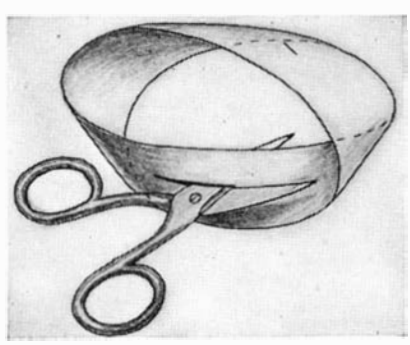


Figure 5

Mathematics has already shown us that the physical world is much greater and much more complex than we can see even with the greatest telescopes and super-microscopes. Einstein's mathematical deductions have shown us the possibility of a four and even a five dimensional world, while we can conceive with our senses only three dimensions—length, width, and height. His calculations show that the universe is not infinite, although it has no definite bounds; that space is warped by the presence of matter; that two parallel lines may meet in such a warped space; and that a straight line may ultimately come back to its starting point.

We have often heard people denouncing the Einstein theories because they are not acceptable to our logic. How can two parallel lines ever meet if they are always kept apart by a certain distance? How can a straight line ever come back to its starting point? How may space be finite when we can always imagine something beyond?

THE fault with these arguments is that they are based on our physical senses alone. Science has already shown us that we have no right to claim that the world consists of such things only as we can see or hear. Lacking one of these senses we would be compelled to reduce still further our conception of the universe.

But are the Einstein theories so contrary to our everyday logic? Do we have to give up any attempts to visualize his new world and to trust only Einstein's mathematical deductions? As a matter of fact, some of the most radical conceptions of the non-Euclidian (or Riemannian) space can be reproduced before our eyes by means of an artificial "warped" space.

Figure 1 represents a model of such a space. It is simply a paper strip the ends of which are glued together so as to form an endless band. One end before it is glued must be turned half way around.

This space may be very thin (two dimensional) or very thick (three dimensional). It may be of great width, and we can easily imagine it to merge into some other kind of warped space. We shall simply consider that our paper strip represents a portion of a complete space. Our world may represent some such space. The paper strip may simply correspond to directions in

which objects, including rays of light, must travel. Such a world will be finite but endless, because nothing, even rays of light, will ever be able to get out of it.

There is nothing metaphysical about this space. You can turn this strip of paper in your hands and see all about it. Yet it is different from our ordinary space, as some very interesting experiments can prove.

Many people ridicule the idea that two parallel lines can meet. Yet they can meet, even in our experimental world. For convenience we shall take a thick strip (Figure 2) and draw two parallel lines on the edges, starting both at the same time. To distinguish them we may draw one with red and the other with black, or make one solid and the other dotted.

After having drawn the lines once around the strip we shall be surprised to find that the red line joins the black and the black line joins the red. In other words, the black and the red lines converged—came together—although they remained parallel all the time.

For the next experiment we shall use a strip of thin paper and draw two parallel lines, starting both at the same time and in the same direction, but on the opposite sides of paper—that is, separated only by the thickness of the paper. One line again will be red (or dotted) and the other black (Figure 3).

AFTER having drawn these lines once around the strip we shall find that the red line appears on the same side of paper on which we were drawing the black line, but near the other edge of the strip (Figure 4). In this case we drew two parallel lines separated by the thickness of the paper, yet they became separated by a wide distance on the strip.

Our strip of paper may simply represent a division in space. On one side will be a "positive" space, on the other "negative." But we can also imagine another divisional surface passing through our space and separating new spaces. To demonstrate this possibility we shall cut our paper in two with scissors (Figure 5). Will we get two separate spaces? We would if we had a simple space. But in a warped space we again get one space but of different dimensions and properties (Figure 6). It is twice as long and has a different curvature. Yet this space represents simply a modification of the original space: we have not added anything and have not removed any portion of it. We simply cut through this space with another surface, which for our purposes may even be imaginary. This means, therefore, that the new space was all the time included in the old space. In such a world, then, the ray of light may take either the original curvature and travel around it in, say, five billion light years; or it may take the second curvature and travel ten billion light years.

That our space comprises two different worlds at the same time may also

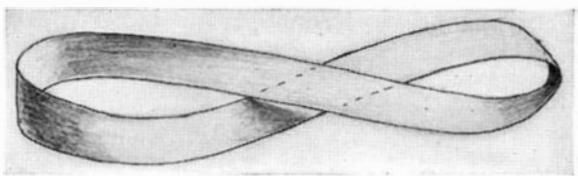


Figure 6

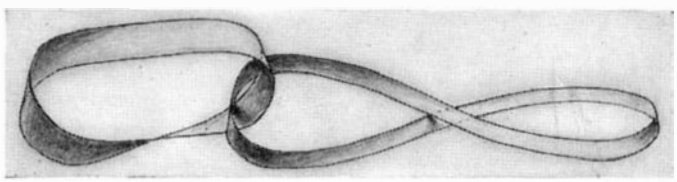


Figure 7

be shown by the following experiment.

We again split a paper as in Figure 5, but this time near the edge, keeping the same distance from the edge all the time. Upon completion of the cut, when our scissors have returned to the original incision, we shall find that we now have two separate spaces (Figure 7), one like the original but narrower, and the other, enmeshed with the first one, narrow and twice as long.

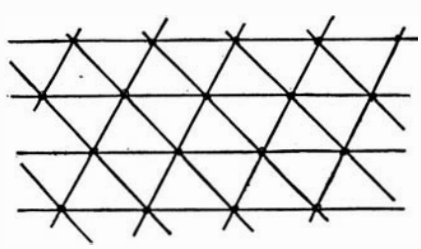


Figure 8

Again we must conclude that both of these spaces were present in the original space at the same time.

It may be objected that the paper is tangible or material, while the space is immaterial, mere nothingness. We can, however, easily imagine the paper to be only a dividing surface between two different kinds of spaces, or as a direction in which the rays and objects must travel.

At the same time, the mere fact that we cannot touch or feel space does not mean that it contains nothing. It may be filled with ether, which may have different properties in different directions, thereby causing the effect of a curved space. Or it may have lines of forces or "fields", caused by the presence of material objects, being thereby "warped".

The conception of ether is, perhaps, the most difficult in science. Ether, if it exists at all, must have properties of a solid body in order to transmit transverse vibrations of light rays, radio waves and so on, yet it must be extremely tenuous as it offers practically no resistance to the movement of celestial bodies. The speed of light, perhaps, is the property of ether itself because the light always travels at the same speed regardless of the speed of its source.

It may be that space has some other structure. A theory was advanced some years ago that space has a lattice-like structure formed of mutually interfering stationary waves of radiation filling space. This implies, of course, some medium for these radiations, even if it is supplied by the radiating bodies themselves. The presence of stationary waves forms a definite three dimensional structure and makes it easier to understand the strange behavior of space. Such a space, formed by parallel rays, is shown in Figure 8 (Erwin space). Its properties will be substantially the same whether we have material particles in the corners or intersections, or just nodes of the stationary waves. The complete structure will act as a solid body in transmitting transverse vibrations. It may be warped, of course, by the presence of material objects, and such warping or curvature may cause the effect of mutual gravitation between the bodies.

INERTIA may be also explained by some such structure in space. It may be simply imagined that the structure responds differently to an already established motion or to a new one.

This theory does not, however, represent a complete solution of the problem of space, and science is not yet ready to say its final word and to unfold the true picture of the structure of interstellar space. Mathematical analysis enables us to see where our eyes fail, explaining the observable phenomena, utterly defying our logical conceptions of the visible world. The theory of the "exploding universe," for example, had been developed mathematically long before the extremely remote high-speed nebulae were observed, thereby modifying our pattern of the universe, but not affecting the proved and measured space curvature near massive celestial bodies.

We must not, therefore, denounce the new theories only because they do not always agree with our understanding of the things as we see and feel them on our earth, or because they seem to be "logically" untenable. The simple experiments described above must serve as a warning to "fundamentalists" in science that our logic is not an all-powerful criterion of scientific theories.

LOOKING AT STRESSES

Complex Stresses in Engineering Structures Made Directly Visible by a New Method

By MAX MARK FROCHT, Ph. D.
Associate Professor of Mechanics, Carnegie Institute of Technology, Pittsburgh

THIS age has at various times been described as the iron age, the steam age, or the electric age. It might, perhaps, be more adequately described as the age of stress and strain.

We are constantly surrounded by multitudes of forces, by powers capable of destruction and ruin but leashed and restrained by the brain of the eingineer. Whether at work or at play, whether at home or out of it, we entrust our safety and our very lives to the silent guardian known as *the safe stress.* We walk on tunneled streets and ride in man-made caves. We live on columns, beams, and girders; ride on trusses and arches; sleep on trains and rails. We are hoisted to, and dropped from the tops of dizzy skyscrapers with breath-taking acceleration by the slenderest of cables. Whether on land or sea or in air our security depends upon the stresses in the engineering structures about us. The safety of humanity to-day depends more upon these stresses than upon avoidance of any political upheaval, scourge, or plague. If the world at large is not stress-conscious it is only because the engineering profession has with few exceptions done its work well.

The world at large is little familiar with the methods and difficulties connected with the problem of stress determination. Of the several ways available for the study of stress distribution the neatest and most effective is the photo-elastic method, the explanation of which forms the basis of this article.

Engineers speak of three kinds of stresses: tension, compression, and shear. Tie rods, cables, and wires are in tension. Posts, columns, and connecting rods of engines are in compression, whereas shear stresses are produced by dies and in screw threads.

It is, however, a mistake to think that stresses always occur in pure form, that is as pure tension, compression, or shear. The opposite is true. There are some structural members and machine parts in which one stress dominates, so

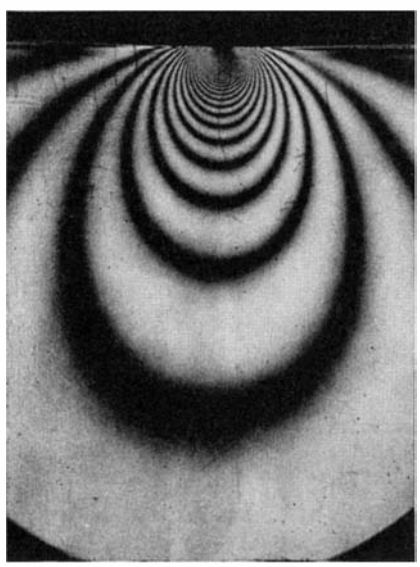


Figure 1: **Load is applied at top center, plate supported at bottom**

that for practical purposes the others may be neglected, but as a rule the stress systems that are called into play are of a complicated character, containing simultaneously all three. Moreover, stresses vary from point to point in a body, and from plane to plane at one and the same point.

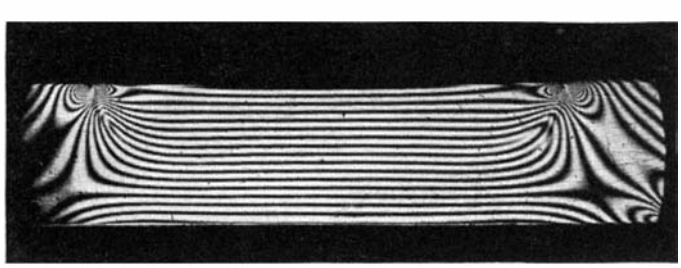


Figure 2: **The stresses are applied near the ends on top edge**

The last-mentioned fact is of great significance. To be precise, one should not speak of the stress in a body, or even of the stress at a point in a body, but of the stress at a point across a definite plane in a body. At each point of a stressed body there are planes known as principal planes. On these planes, which are always perpendicular to each other, the shear stresses are zero and the tensile or compressive stresses, that is, the normal stresses, contain the greatest and least of all normal stresses at that point. The normal stresses on the principal plane are known as principal stresses.

Photo-elasticity deals with stresses in one plane, and its most direct result is the maximum shear stress. It is a fortunate coincidence that this stress, which is very easily obtained by the photo-elastic method, is the only stress of practical significance in ductile materials such as mild steel, because experiments show that such materials fail when the maximum shear stress reaches a critical value. Thus in machine design the strength of the parts is based upon the maximum shear stress and not upon the principal stresses.

FOR stresses in one plane there is a fairly simple relation between the principal stresses and the maximum shear stress. If, for example, the principal stresses be both tension—one equal to 4000 pounds per square inch and the other 10,000 pounds per square inch, so that their difference is 6000 pounds per square inch—then the maximum shear stress would be equal to 3000 pounds per square inch; that is, the maximum shear would equal the difference divided by two.

The same result would hold if both stresses were compression instead of tension. If one principal stress be tension and the other compression, then the maximum shear is obtained by taking the sum of the numerical values and dividing that by two, instead of their difference, as before. If we agree to call tensile stresses positive and compressive stresses negative quantities, then the above discussion can be summarized in the very brief statement that the maximum shear stress is equal to half of the difference of the principal stresses. The maximum shear stresses always act at 45 degrees to the principal planes.

Now stresses are usually determined by abstruse and laborious mathematical processes. When thus determined they are at best mental abstractions, impossible to visualize and difficult to verify. *The photo-elastic method is the only*

method which makes stresses, their formation, growth, and intensity visible to the naked eye.

This is especially true of the maximum shear stresses. Consider, for example, Figure 1. This picture, as will be explained later, tells the story of the stress distribution in a rectangular plate when it is subjected to a concentrated load at the center of the upper edge. In a similar way Figure 2 tells of the stress distribution in a beam subjected to pure bending.

To obtain such pictures, small scale models of the stressed bodies are made of a transparent material such as glass, celluloid, or Bakelite and placed in an apparatus known as a polariscope, Figure 3. Space does not permit an exposition of the optical principles on which the polariscope is based. Its power to produce these unique pictures and through them to reveal the stress distribution is due to polarized light and the temporary double refraction which takes place in the models under stress.[1]

Leaving the technical matters of the polariscope, let us consider the stress patterns, as the pictures are called, and their interpretation. These patterns consist of dark fringes separated by white bands. Next we call attention to the unique character of these stress patterns. By this we mean that the peculiar shapes which the fringes assume, their number and relative positions, are completely and uniquely determined by the shape of the model and the type of loading acting upon the model under test. This is shown in the illustrations.

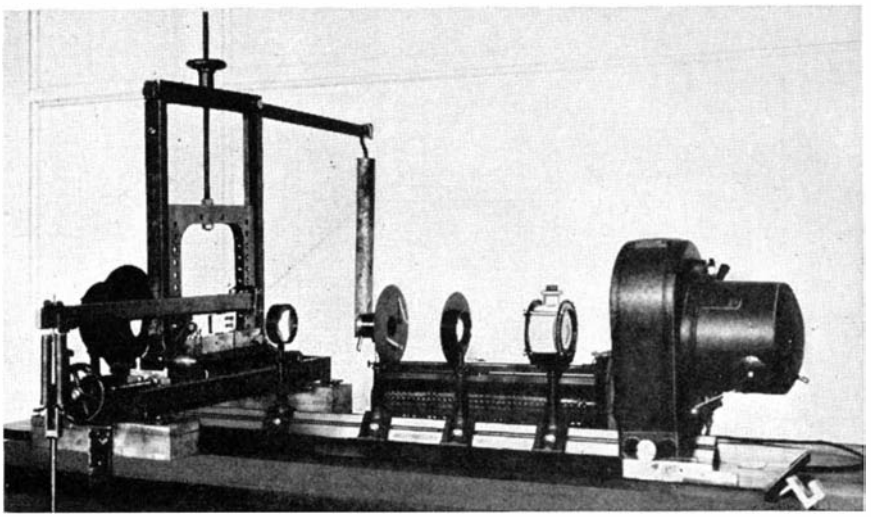


Figure 3: **The polariscope; also the straining frame for the model under test. When light is passed through homogeneous material having no differences of rigidity between one direction and another there is no undue disturbance of its distribution. But if the same medium is put under stress the light that is transmitted is resolved by the polariscope into two rays which travel with different speeds. Certain wavelengths are eliminated by interference and such appearances as those in the accompanying illustrations are produced. The polariscope contains prisms which polarize the light; that is, change its vibrations from all directions to a single direction, and analyze it. See text books of physics.—*Editor***

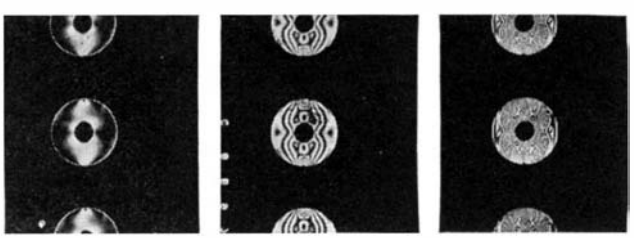


Figure 4: **Showing three stages of fringe formation. Disks are loaded at the top and bottom**

The story of the formation of these fringes is not only interesting but important in the process of stress determination. The best way to see the fringe formation is of course in a laboratory demonstration. Next to that would be to view a moving picture record, sections of which are reproduced herewith. When the model is free from stress the picture consists of uniform darkness. As the load is gradually increased the field becomes illuminated, except for those points at which there are no stresses or at which the principal stresses are equal.

As the load is further increased a state of stress is reached at which some points, those of highest shear stress, darken again, and upon additional loading brighten up again. Each element of the model thus alternates between complete blackness and brightness, as illustrated in Figure 5. Corresponding to a given system of loads, each point goes through a definite number of cycles of black and white. This number is of fundamental importance and is known as the fringe order. In other words the fringe order at a point is given by the number of times the particular point darkens during the application of the load.

It is these unique stress patterns with their continuous and distinct fringes that provide the basic data from which the stresses are determined. In interpreting these stress patterns the following rules are of value.

First; all points on the same fringe are subjected to equal maximum shear.

Second; the numerical value of these shears is directly proportional to the fringe order; that is, the shear on fringe two has twice the value of fringe one, and so on.

Third; crowded and sharply curving

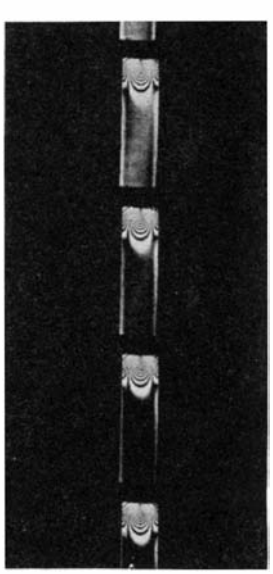


Figure 5: **Showing fringe formation in straight bar. Axial compression**

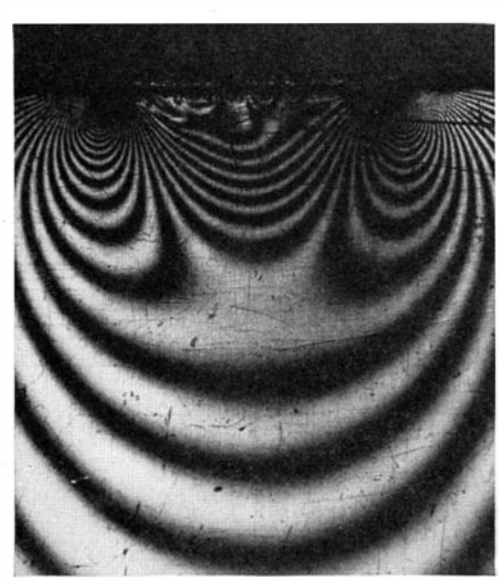


Figure 6: **Here the stresses are concentrated at the edges of a large plate**

[1]For a brief description of the polariscope see author's paper on "Recent Advances in Photo-Elasticity". *Transactions A. S. M. E.*, Vol. 53, 1931.

fringes represent evidence of localized increases of stress, or stress concentrations, to which we shall presently return.

From a practical point of view we are interested in the maximum values of the shear stresses. These occur at the point of highest fringe order, or the points which are first to darken in the stressed and illuminated model. The numerical value of the maximum shear stresses corresponding to fringe number one, or any other fringe, can be determined in several ways. The simplest is to use a comparison beam in pure bending. Such a beam must be made of the same material and thickness as the model. The stress in such a beam at a point of a given fringe order can be accurately determined by elementary engineering methods.

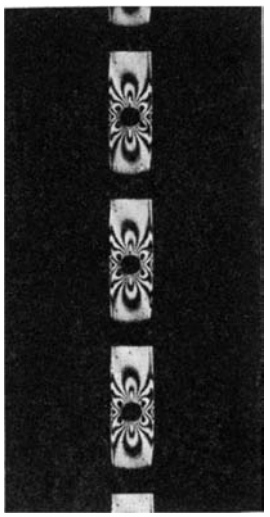
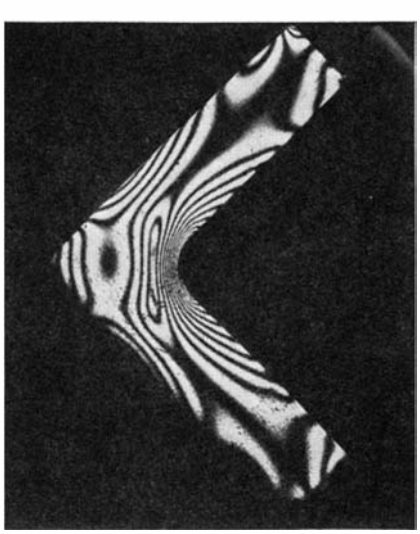


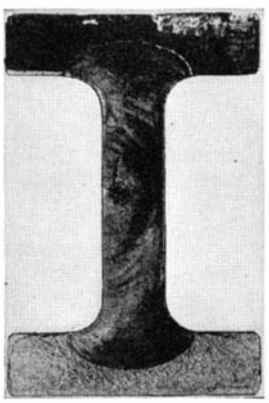
Figure 7: **Effect of a circular hole on the uniform stress distribution in the bar**

Let us now return to Figure 1. It is seen that the fringes become crowded as we approach the vicinity of the concentrated load. The fringes in that vicinity are of very high order, which means that the stresses there are high. These stresses, however, rapidly diminish as we move away from the point of application of the load. This is, perhaps, the most typical example of stress concentration. It is interesting to observe that even a very small load will produce large stresses in the immediate vicinity of the load. In fact, these stresses are so big that some material will always be in a plastic state; that is, will always exceed the elastic limit. This is the universal effect of concentrated loads. Strictly speaking, therefore, no structure containing concentrated loads can be so designed as to be completely within the elastic state.



This phenomenon of stress concentration, typified by the concentrated load, is produced also by various other causes and plays a tremendous part in the safety of machines and structures. Most failures of machines in service originate at and spread from such sources of stress concentration.

Figure 8: **Showing the failure of a connecting rod, as caused by an imperfection in material. Note fracture**



As a next instance consider the pressures produced by a flat die, punch, or block bearing against a similarly flat edge of a large plate. It is commonly thought that such conditions result in a uniform pressure distribution. This, however, is grossly misleading, as can be seen from an inspection of Figure 6, which represents the stress pattern for the pressure distribution under a flat die acting on a flat edge of a large plate. At the edges of the die the fringes are crowded and curved very much like those shown in the case of the concentrated load of Figure 1. A study of the fringe formation shows that the fringes start to form at these edges, spread downward, unite and split, one half moving downward, the other upward. The fringes at the edges are of the highest order and hence the greatest stresses are there.

Thus it is a misconception to think that forces transmitted through flat or plane surfaces are of a uniform character. They are not. It is important to note that a block of rubber, lead, or wood will materially reduce the stress concentrations and so even out the pressures under the die. This has practical significance. It suggests, for instance, that in order to avoid stress concentrations, machines should be mounted through blocks of wood rather than directly on concrete footings. The same is true with regard to the action of columns. These stress concentrations always exist on the boundary regardless of its shape.

A third illustration of stress concentration is the circular hole. Figure 2 shows a slender prismatic bar under concentrated compressive loads at the ends. The stress pattern shows that the bar as a whole, except for the ends, alternates between uniform darkness and lightness. In terms of stresses this means that they are of uniform intensity. Compare this with Figure 7, which shows the effect of a circular hole upon the uniform stress distribution in this bar. The stress pattern is radically more complicated and the fringes are more numerous and crowded near the hole. This may be taken as evidence that the stress distribution is no longer uniform.

CAREFUL photo-elastic investigations have shown that the effect of a small hole is to triple the existing uniform stress. The paradoxical thing about such holes is that the smaller their size the worse their effects. Circular holes have been the cause of failure of many machines. Steam turbine disks have been known to fail because of large localized stresses originating at smaller rather than larger holes.[2] The thing which matters is not the size of the hole but the sharpness of the curvature, and the curvature of a small hole is greater than that of a large hole. It is for this reason that a tiny crack, a small blow hole, or an imperfection in the structure of the material may prove detrimental to the safety of a structure or machine. Figure 8 shows a striking picture of the failure of a locomotive connecting rod which originated at a point of stress concentration caused by imperfection in the steel.

Now consider Figure 9. The two angles shown are of exactly the same dimensions, except for the corners, which are rounded off with different

[2]See article by Wilfred Campbell on "Protection of Steam Turbine Disk Wheels from Axial Vibration". *Transactions A. S. M. E.*, 1924.

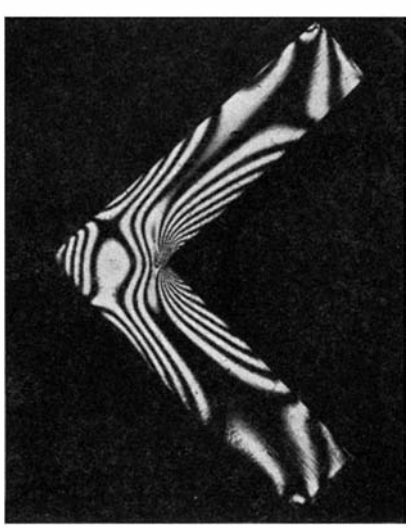


Figure 9: **Showing the effect of a fillet on the stress concentration. Dimensions of angles were the same except for the fillets. Loads same**

radii. Such curves inserted in corners of angular elements or in straight pieces of different dimensions, as is usually the case in shafts, are known as fillets, and as a last example of stress concentration we mention the effect of such fillets. It has been conclusively established that the intensity of stress concentration depends on the size of the fillet and increases as its radius decreases. It thus behooves designers to eliminate sharp corners. Truly sharp corners would cause rupture even under very small loads. Fortunately such sharp corners do not exist, as no tool can be made that would have theoretical sharpness, that is, an infinite curvature.

The reader probably wonders whether the results from transparent models truly represent the conditions of stress distribution in structural materials such as steel. The answer is in the affirmative. There is both theoretical and experimental evidence to show that within the elastic limit the stress distribution is independent of the material as long as the material is the same all the way through and is free from special directional properties; in other words, as long as the material is homogeneous and isotropic; like glass, for example, but not like wood, which is fibrous.

The history of photo-elasticity dates back to 1816 when David Brewster discovered accidental double refraction. The science developed slowly because of the absence of a suitable material. The early experiments were performed on Jellos and glass. The objection to Jellos is self-evident. Glass would be a good material were it not for the difficulty of machining it. It also has a rather small index of refraction. The introduction, however, of celluloid as a working material made photo-elastic research not only possible but practicable. Most of the work in photo-elasticity to date has been done on celluloid models and with white light as a source.

In very recent years two important developments have taken place. First, Bakelite has been found to be superior to celluloid as a material for photo-elastic investigation; second, monochromatic light bids well to replace white light.

The advantages of Bakelite over celluloid can be graphically seen in Figure 10, which shows two disks of the same dimensions and under identical loads. The Bakelite disk shows six fringes for the one fringe in celluloid. The fringes are also sharper and clearer. The use of Bakelite thus results in greater precision of stress measurement. The difficulties connected with the use of Bakelite were due to the initial stresses which are found in commercial Bakelite in its unstressed state. A process has, however, been found which successfully removes the initial stresses; that is, it anneals Bakelite.[3] All the fringe photographs shown in this article were made by the author from Bakelite models annealed by his process.

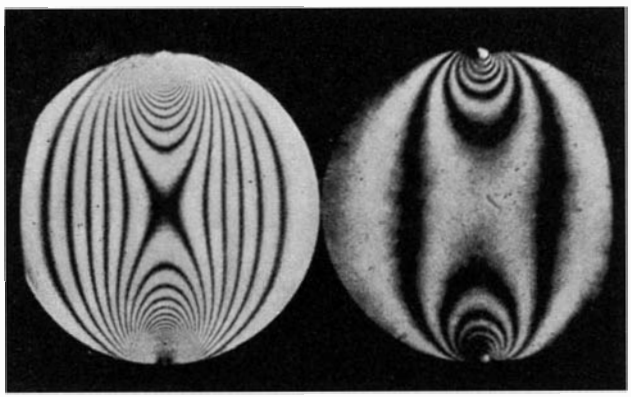


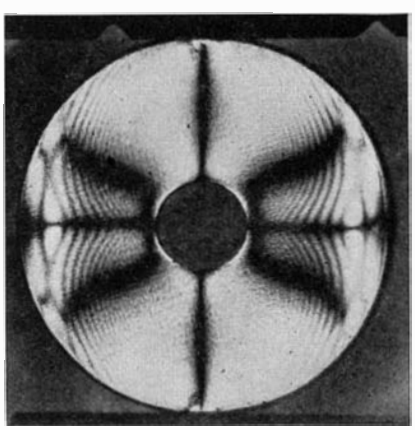
Figure 10: **Showing relative optical sensitivity of Bakelite and celluloid. Both models and loads identical**

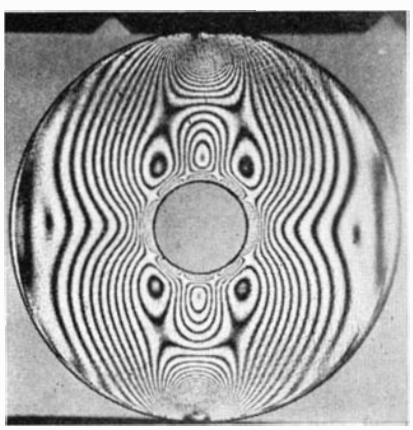
THE advantages of monochromatic light (light of one color) over white light are too numerous and technical to discuss here. We shall mention only one. With white light as a source, the stress patterns do not consist of black fringes separated by bright bands but of a group of adjoining color bands. The bands follow the same shape as those shown in the fringe photographs in this article. The colors, however, vary and show with greater or less distinctness yellow, red, and green. These patterns are extremely beautiful and interesting. However, they yield less accurate results than monochromatic stress patterns.

Figure 11 shows a stress pattern obtained with white light, which is known to consist of a mixture of the several fundamental colors, whereas Figure 12 shows a stress pattern obtained from light of one color; that is, a monochromatic source which in our case was green. These photographs speak for themselves and show beyond the shadow of a doubt the superiority of the monochromatic over the white light source. This is especially true under higher stresses. All the rich and significant detail of Figure 12 is totally absent from Figure 11. The difficulty with white light is due to the fact that under higher stresses the bands become so crowded and the colors so faint as to be of no value, whereas with monochromatic light the fringes of even the 20th order stand out with striking clearness.

The slow development of photo-elasticity, even after the introduction of celluloid, must be attributed to the use of white light. It is a matter of common knowledge that color photography and printing, in addition to introducing inaccuracies, is vastly more expensive than the corresponding black and white photography and printing. This no doubt accounts for the great poverty of books on this subject. The monochromatic method, though only a few years old, has already greatly contributed to the dissemination of photo-elastic knowledge by providing an effective and inexpensive medium with which to record and convey photo-elastic observations. The introduction of annealed Bakelite models and the fringe or monochromatic method, have eliminated the subjective or personal element so characteristic of the older methods of color matching and free-hand drawing. They mark the end of photo-elasticity as an art and the beginning of photo-elasticity as a science.

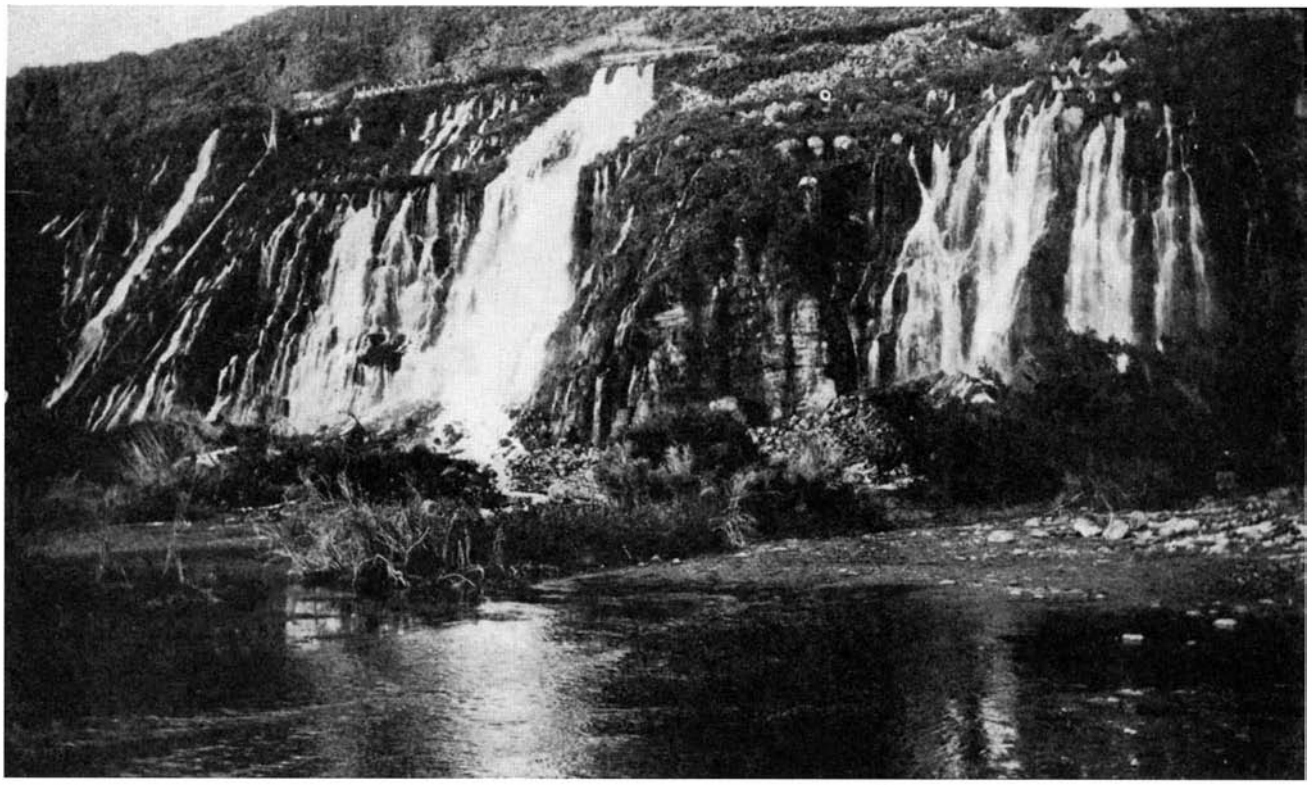
Photo-elasticity has already materially contributed toward the solution of many problems in stress analysis, and further progress may be anticipated—notably in such fields as impact stresses, tool cutting, stresses due to centrifugal forces, and gear action. Within its scope, photo-elasticity is more powerful than the X rays, revealing as it does the fascinating, complex, and important phenomenon of stress distribution.





[3]See author's paper, citation 1.

Figure 11, **at left: Bakelite disk under vertical loads. White light.** *Figure 12,* **at right: Same under a smaller loading (monochromatic)**



Huge volumes of water pour from the sheer walls of a cliff at Thousand Springs, Idaho

BIG SPRINGS

By GUY ELLIOTT MITCHELL
United States Geological Survey

A SINGLE "big spring" in Florida—the giant Silver Spring—could supply New York City and its 7,000,000 people from its clear blue depths with all the pure water they could use. There are a number of other huge springs in the United States that could furnish any of our other large cities with all the water needed, and there are hundreds of individual springs any one of which could give an ample supply to the entire population of a city the size of Washington.

There are said to be more than 11,000 large springs in the United States, some of them officially named, others so called by their users. There are springs so big that good-sized rivers emerge from them, navigable for passenger and freight boats; other springs, pouring from high cliffs, form majestic waterfalls from some of which thousands of horsepower have been developed.

Some of these springs are clear as crystal, others magnify articles in their depths of several score of feet, others appear an intense blue, others boil up as in great cauldrons, and others, issuing from black rocks of volcanic basalt, form snow-white waterfalls 150 feet or more in height.

Limestone and volcanic rock are the main sources of the very large springs. The limestone must, of course, contain large solution channels produced by active and large circulation of underground water, the water and air dissolving and eating away the limestone. There is much difference in the fluctuations of springs, both large and small; some springs lack storage capacity and discharge their waters swiftly after a rainfall, even becoming quite muddy. In some limestone spring systems great caverns may be submerged beneath the water table and may function as huge subterranean reservoirs. Springs from them are perennial and relatively constant and discharge clear water even in times of heaviest rainfall.

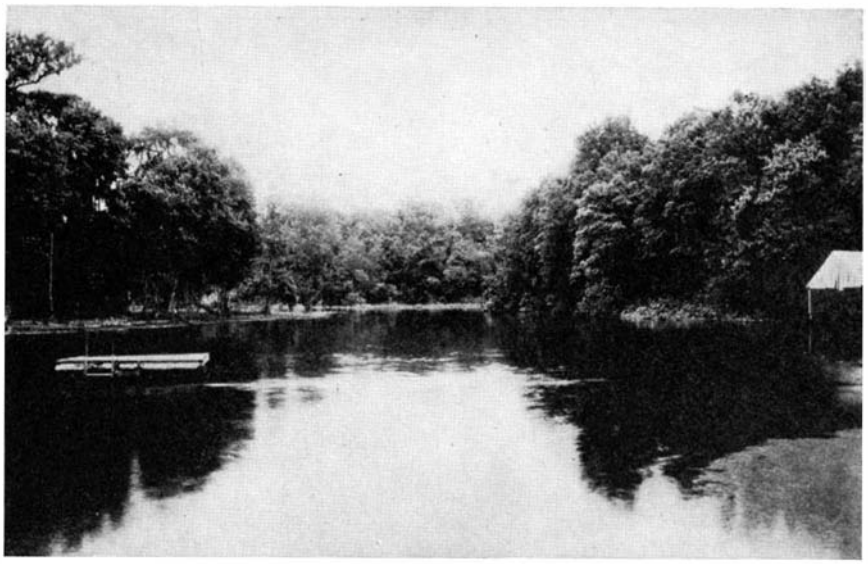
THERE are many thousands of mineral springs and so-called mineral springs. All springs are mineral springs, for water is itself a mineral, but some springs are so highly mineralized that their waters are undrinkable, such as some of the salt and alkaline springs of the West. But the waters of large limestone springs are only moderately limy. To produce large springs, water must flow rapidly through large openings and the mineral matter dissolved becomes diluted by the great volume of the water. The largest limestone springs are in Florida—the beautiful Silver Spring is the largest—and the largest sandstone springs are found in Montana, while in other northwestern states are many huge springs issuing from rock of volcanic origin.

The temperature of the water of large springs, as a rule, is not much different from the local average temperature. Where such large quantities of water discharge freely, communication must obviously exist between the points of intake and delivery.

The United States Geological Survey designates as springs of first magnitude those in which the discharge is 100 second-feet of water or more. A second-foot of water is 448 gallons a minute or 645,120 gallons a day. Springs of second magnitude discharge between 10 and 100 second-feet and those of third magnitude between one and ten second-feet. The Geological Survey has described 65 springs in the United States that have an average discharge of 100 second-feet or more—64,000,000 gallons a day—and a number of these are huge springs or groups of springs

that have a flow of between 500 and 1000 second-feet. Of these, 38 issue from volcanic rocks, 24 from limestone, and three from sandstone.

Besides these springs of first magnitude that flow at least 100 second-feet, there are many hundreds of springs ranging from 25 to 75 second-feet. That even these latter are enormous springs may be realized when their flow is compared with the flow from great pumping plants or, better yet, from that of the largest artesian wells in the country. The artesian well of greatest volume in the United States—a New Mexican well described in SCIENTIFIC AMERICAN for June, 1927—has a flow of 5710 gallons a minute or less than 13 second-feet. The flow of this great well—really an artificial spring outlet—would surely size up favorably with many a local "big" spring, yet it would take five or six such wells to equal the flow of any one of hundreds of springs that are classified as only of second magnitude.



A small part of Silver Spring, Florida. As the author states, this single source could supply the entire population of New York City with the purest of water

IT is by no means easy to say offhand which is the biggest spring in any region. This necessitates a careful measuring of the discharge, not only for one or for a few days but for long periods, covering a whole year at least, for comparative valuation of high water, low water, and average flows.

The most famous big spring in the east is Silver Spring, Florida. This great spring is the principal source of the picturesque Oklawaha River, which flows tortuously into the St. John. A moonlight trip up the Oklawaha in one of the little river steamers was and perhaps still is one of the most charming experiences possible in America.

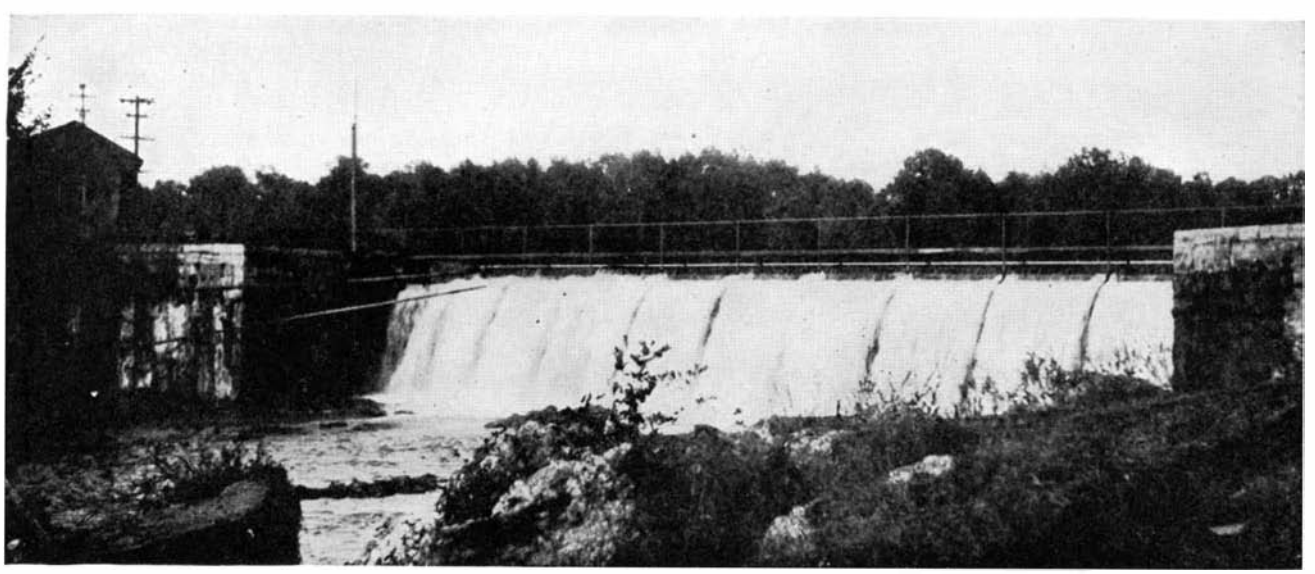
Winding up the little river overhung with luxuriant semi-tropical verdure and with turns so sharp that the small steamer can sometimes scarcely round them, with now and again the searchlight throwing its yellow glare on the live-oaks and cypress trees with the picturesque Spanish moss fringing the river's edge, you finally come, after a spell of fairyland illusion, on to the broad bosom of Silver Spring, bathed in the perfect moonlight. In the morning you view nothing less than a lake, large and very deep, but with water so crystal clear that objects at the bottom seem within reach of the hand. The spring forms a natural aquarium, with 32 species of fish. The fish are protected and have become so tame that they feed from one's hand. At the call of the guides hundreds of them of various glistening colors gather beneath the glass-bottom boats. Silver Spring has a discharge of over 800 second-feet, which is more than enough to supply the city of New York. This, as has been mentioned, is the largest limestone spring in the United States and possibly in the world.

Mammoth Spring, Arkansas, is a mysterious river which issues from a large cavern into a pool over 60 feet deep, its waters supplying electric energy for Mammoth Springs and several other towns.

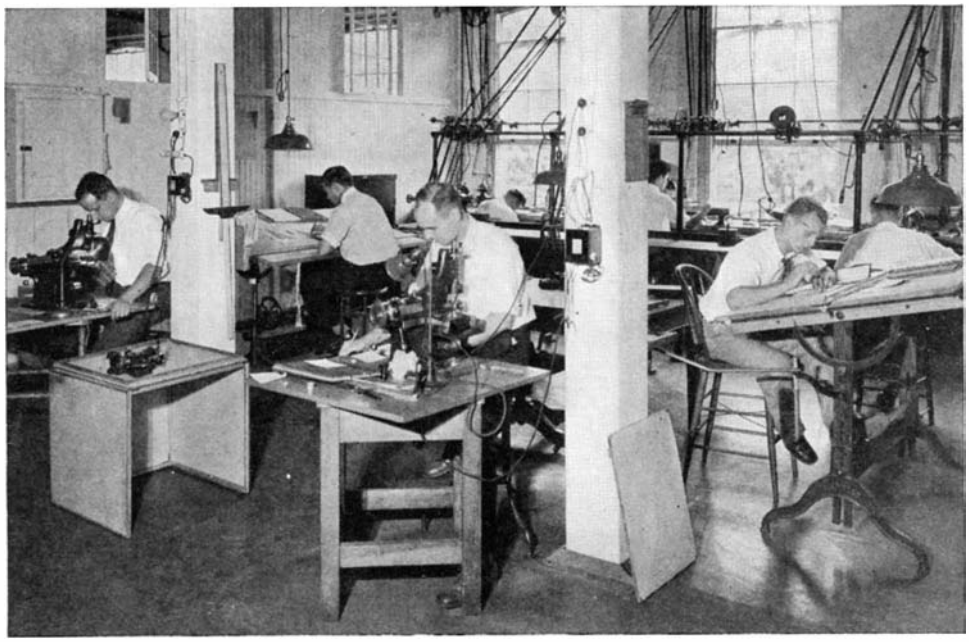
Montana has four huge springs, of which Giant Springs, near the city of Great Falls, ranks among the very largest springs in the United States. This is not a group but one huge upburst of water.

In Idaho, along the Snake River Canyon, Nature has produced a very riot of great gushing springs pouring their waters from the porous lava formations. They are known as Thousand Springs, and form a great waterfall perhaps unique in the world. It is about the height of Niagara and more than 2000 feet long.

Unfortunately not even one large city in the United States can avail itself of our abundant spring water, much of which is as pure and good as any bottled water sold at a dollar a gallon.



Water from Mammoth Spring, Arkansas, flowing over the dam at the end of the pool



The model room has watch-making equipment for the production of a single watch. Two years' time and 100,000 dollars are usually required to produce a new model, with the necessary tools for full production

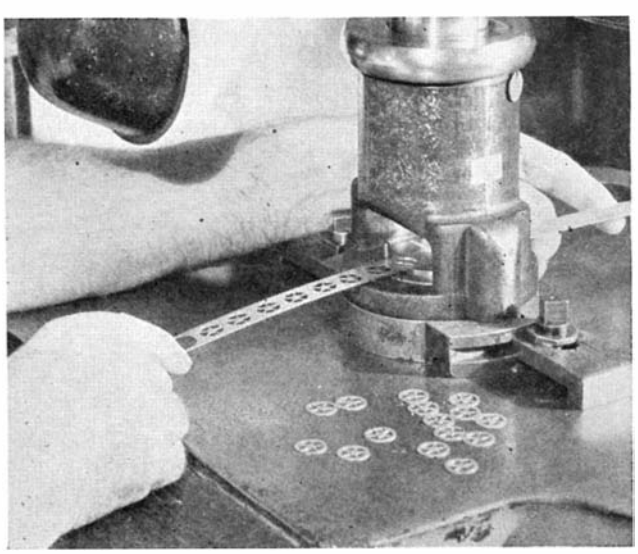
WHY A WATCH KEEPS TIME

By A. A. HOPKINS

THE little machine you carry in your pocket or on your wrist is an exceedingly active little affair and can never be accused of laziness. The balance unit, for example, vibrates 432,000 times a day and makes no fuss about it. How is it that so much accuracy can be "built-in" in such a small space? Careful design, ingenious machinery, high-class labor, and elaborate inspections give the composite answer.

If you are thinking about designing a new watch, forget it unless you have 100,000 dollars, two years' time for the construction of dies and tools for quantity production, and a model room equipped with elaborate tools for the hand production of just one watch by a corps of watchmakers who are peers of any mechanics in the world. The number of preliminary drawings required is almost as great as for designing a locomotive. Even an almost microscopic screw is drawn out to Brobdingnagian proportions.

We all know what a watch is but how many of us could give a really accurate definition? This might answer: "A watch is a scientific instrument designed to record for individual use the passing of time as determined by comparison with accurate timepieces corrected by astronomical observations." A watch is technically known as a "movement" and is composed of five major units; first, the pillar plates and bridges which form the supports for the little shafts and other parts of the mechanism; second, the mainspring in its barrel; third, the wheel train, the purpose of which is to carry or transfer the power of the mainspring to the escapement; fourth, the escapement, for control and regular releasing of power. Without this, the train would run down at once. Fifth is the balance-wheel unit consisting of a balance wheel mounted on a balance staff (shaft) and carrying the hairspring and a roller with a jewel pin, all acting as a unit control of the escapement action.



Tiny wheel blanks are cut from strip stock in this press. Then teeth are accurately cut and rigidly inspected

The mainspring is wound with the aid of the stem and crown. This spring sets up a tension which imparts movement, by means of teeth on the barrel, to the train which consists of wheels and pinions on tiny shafts which run in jeweled bearings secured to the barrel and train bridges. The purpose of the train is to transmit the power of the mainspring to the escapement. One revolution of the center wheel equals 60 revolutions of the fourth wheel, 60 revolutions of the fourth wheel equal 600 revolutions of the escape wheel, 600 revolutions of the escape wheel equal 18,000 back and forth vibrations of the pallet. Thus, to time the regular movement of the hands, means are provided to move the pallet back and forth 18,000 times per hour. The balance wheel and hairspring come to the rescue.

The escape wheel is blocked intermittently by a forked member (the pallet) which has two jeweled arms which wig-wag back and forth. A tooth of the escape wheel is momentarily in contact with one of the pallet arms and pushes that arm out of the way. The other arm intercepts the wheel and prevents it from revolving continuously. Therefore the escape wheel moves a fraction of a revolution at a time. The length of time that each arm

Left: Gage for checking diameter of pivots and holes in jewels. The diameter of each pivot is determined and the proper jewel selected

Right: The jewels are individually inspected with a binocular microscope both before and after they are placed in their gold settings

Below: The jewels are threaded on a wire and are held together by the cylinder. Diamond dust is applied; the jewels are polished by rubbing

in turn remains at interference with the escape wheel is determined by the tension applied by the coiling and uncoiling of the hairspring attached to the balance wheel, which is the "brains" of the watch. Such in brief is what our little pocket or wrist companion is constantly doing for us—snipping off time. The hands give the outward manifestation of the activity within.

In the manufacture of a watch 178 pieces of mechanism must be fabricated, fitted, and assembled. Fifty of these parts are moving parts. The number of operations is about 1500. The parts of the mechanism are so small that in many cases all operations are necessarily conducted with the aid of a watch-maker's glass.

IN detailing the construction of a watch, let us begin at the foundation, which is the pillar plate that carries the jeweled bearings for one end of the tiny shafts. The bearings for the opposite end are carried in the barrel and train bridges which are the most conspicuous features of the movement. The pillar plate is punched from strip stock. It is then machined on both sides, profiled and recessed to obtain the proper wheel clearance. These operations are all performed by machines which are extremely accurate as the dimensions must be held within the tolerance of .0005 of an inch. The barrel and train bridges go through a number of operations and are engraved with the model number, the serial number, and the maker's name. This is done by a pantograph engraving machine. These pieces are "damaskeened" to produce a pleasing effect.

Having the foundation and the roof, as it were, the other parts must be made to fit them. The wheels, balance units, and so on, are held in position by tiny steel shafts. All these little shafts are highly polished and run in jewels. The pinions which mesh with wheels have from six to twelve teeth cut on a portion of the surface. The wheels of the train are punched out of strip stock. The wheel blanks are placed on an arbor in lots of 25 to 50 and the teeth are accurately cut on an automatic machine. The wheels must be accurate to .0005 of an inch. The material flows through the factory in lots of 100 and soon begins the matching of parts.

This jewel-inserting machine forces the mounted jewels into their places, making a tight friction fit

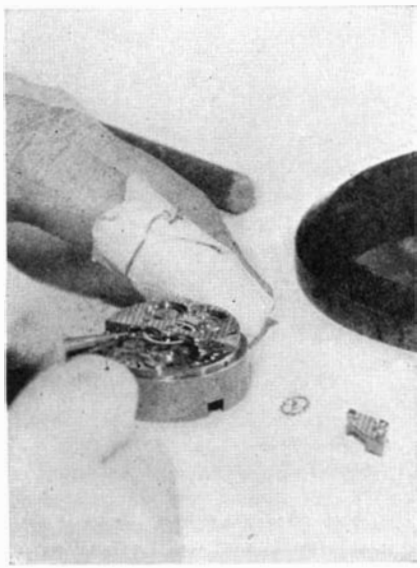
The jewels form the bearing surfaces for the pinions and staffs. The number of jewels in a medium high-grade watch varies from 17 to 23 jewels; cheap watches have seven, down to none at all. The number is uneven because of the jewel pin on the balance wheel. Jewels are known as "bar" and "olive" jewels. The former are used for the train and escapement and the latter for the balance wheel. The "olive" jewels consist of a hole jewel and an end-stone so that both end and side friction is eliminated. Rubies and sapphires are the jewels used and they are mounted in gold or composition settings. The jewels are opened to standard size and polished by a most interesting manual operation. About 70 jewels are strung by a girl's nimble fingers on a fine wire. They are then bunched by a cylinder, diamond dust is applied to the wire, and the girl runs the cylinder back and forth until the sharp edges are smoothed off.

AFTER the train wheels and pinions are made and the jewels placed in their settings, it is necessary to fit each jewel to the respective pivot which will run in it. This is a fine gaging operation. The diameter of each pivot is determined and from this the proper jewel is selected. The entire jewel setting, after selection, is placed with the beginnings of the watch and moved along with 99 others. Many of the screws are so small that 25,000 can be placed in a thimble. Tweezers and minute screwdrivers are worked with the aid of a watch-maker's glass. On the benches are often seen pieces of corn pith which are invaluable for parking some bits of the watch's anat-

omy. It has been found that dough is an excellent cleaning material for small parts and daily a batch of dough is made up that never reaches the oven.

Now assembly begins and the working unit is reduced from 100 to ten. The first operation is to set the jewels into the plates and bridges. Formerly jewels in their mountings were fastened in by screws. Now in the best watches they are held by friction, the jewels being forced into position in the plates and bridges by a special machine. Then the train and the escapement are assembled and the mechanism is ready to receive the life-giving heart which entitles it to become a member in good standing of the great family of timepieces.

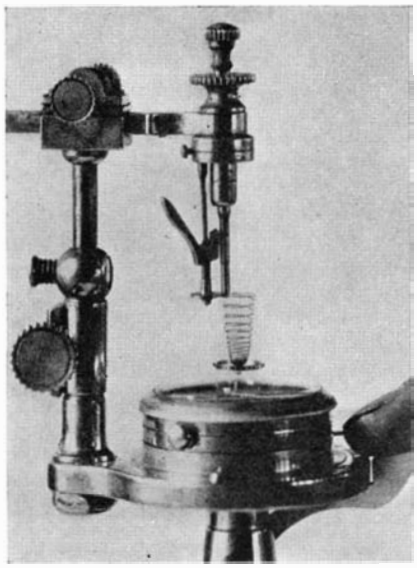
The balance wheel and the hairspring



The first step in assembling a watch is to put the wheels and bridges together so that the entire wheel train will function properly

are the pulsating heart of a watch. The number of vibrations per second has already been referred to. The selection of a hairspring of the proper length, width, and thickness, so that its strength is in exact proportion to the weight and diameter of the balance wheel, is one of the most delicate operations in fine watchmaking. This work is accomplished by means of a vibrating tool. The balance wheel and hairspring being tested are suspended in the center and the motion is synchronized with a master vibrator in the base of the tool.

The balance wheel incorporates in its construction certain definite principles that make it possible for each vibration to take place in a fifth of a second. It is necessary that these vibrations be constant during changes due to temperature, position, and running down of the mainspring. In some of the best watches the bimetallic balance wheel and the steel hairspring have been superseded by a monometallic

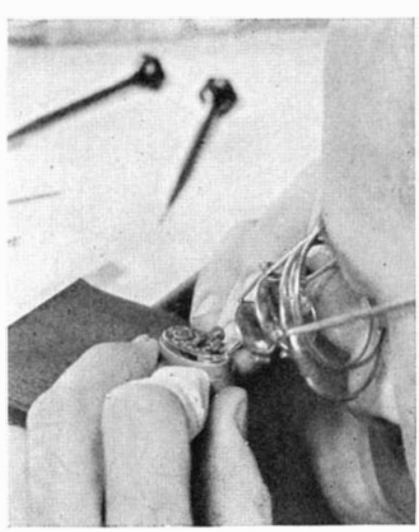


Vibrating tool synchronizes the hair spring with a master vibrator

balance wheel and an Elinvar hairspring. (See the SCIENTIFIC AMERICAN for October 1931.) Elinvar is rustless and is not permanently affected by magnetism.

The balance staff is the little shaft that supports the balance wheel and the jewel pin. It is by all odds the most vulnerable part of the watch and this is what you usually break when you drop your watch. With the use of a two-piece balance staff it is possible to change staffs in repairing the watch without damaging the adjustment of the watch movement. These new balance features and friction jeweling are the outstanding advances in horology in a decade and are achievements of the Hamilton Watch Company.

All necessary adjustments are made possible by the built-in factors of the balance wheel. If you will examine a balance wheel you will notice that it is fitted with tiny gold screws. There are 22 holes and 16 screws. These screws are provided for the purpose of obtaining the proper relationship between the weight of the balance wheel and the strength of the hairspring. The exact location of these screws determines to some extent the compensating qualities of the vibrating assembly. The operation of placing the screws requires skilful work on the part of the highly trained girls.



Putting in the balance-wheel unit gives the watch the breath of life

The heart of a watch is installed in the finishing room. Here expert watchmakers place the balance-wheel unit in the movement. Their work consists of obtaining proper endshake and sideshake on the balance staff and also of placing the hairspring in such a position that the coils of it are perfectly aligned. When the last adjustment is made the mechanism begins to run under its own power. The watch now

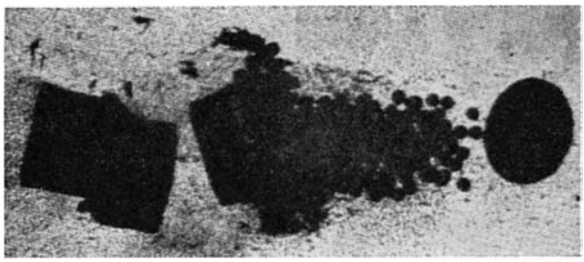
Painting luminous materials on dials; a special pen avoids danger

goes through numerous rigid inspections. After each watch is found to be in good running order it is sent to the timing department.

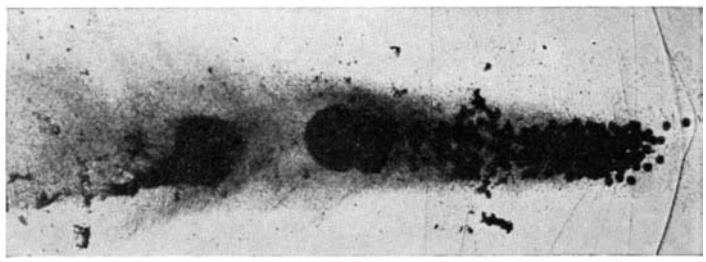
Here watches are run for a definite test period. The little machine is new and may run a little too fast or too slow. This gain or loss of time is corrected in the timing department by means of different weight balance screws. The watch is not yet really a watch but is only a movement for it lacks "face and hands."

Dials require the co-operation of artists and die sinkers. The die maker cuts the artist's conception in steel. On inlaid enamel dials the numerals are filled with enamel and they are "fired" in an electric or gas furnace. Radium dials are very popular. The radium substance is painted by hand by operators with a pen especially designed for the purpose, thus eliminating the dangerous brush.

Once the hands are on and the movement is cased, we have a real timekeeper ready for a lifetime of service.



Pancaked, scattering charge from a standard shotgun



Re-aligned and choked charge from a compensated shotgun

Gun Recoil Control

GUN recoil—which causes flinching, bruised shoulders and cheeks, and a lift of the gun muzzle off the target—may now be practically eliminated by the use of a device called the Cutts Compensator. This device, which is to be screwed onto the end of the gun, is a short tube having an expanded chamber and a bullet exit port only slightly larger than the diameter of the gun barrel in the case of rifles, or having the required choke in the case of shotguns.

In the expanded section are peripheral slots or ports through which the hot gases are deflected at the moment the bullet or shot charge passes through the tube's muzzle. These gases exert against the tube, and therefore against the gun itself, a force opposed to the recoil and its resulting muzzle lift. The principle involved is similar to that of the steam turbine wherein the blades react to the force of the steam jet. The bullet of a rifle seals the tube muzzle against the forward motion of the volume of gas but does not touch the Compensator; hence only a very small volume of leakage gas escapes forward. Spark photographs reproduced below illustrate the rifle Compensator's action.

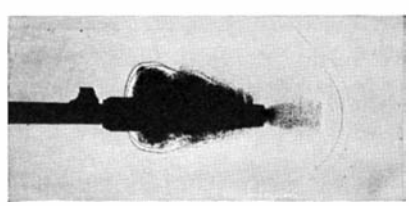
IN careful tests, recoil reduction has run as high as 62 percent but for most installations is around 50 percent. Furthermore, it has been shown that muzzle velocity is increased. The weight of the Compensator for sporting rifles is from four to six ounces.

A rifle so equipped may be fired indefinitely without shoulder pads. Moreover, the firer is not pushed out of position, and a second shot may be fired from any position of delicate balance, an exceedingly important consideration in big game hunting. In addition, the rifle does not move off the target immediately upon firing, so the shooter is better able to "call his shot." Consequently, everything is forgotten except concentration on the sights with the result that shooting is greatly improved.

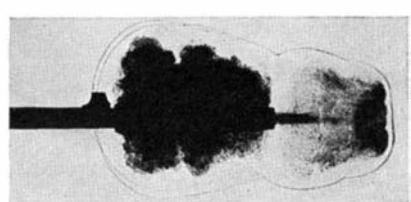
On automatic rifles, the Compensator returns the gun to the target after each shot, thus making possible a faster and more accurate rate of semi-automatic (auto-loading) fire. When mounted on machine guns, a considerable saving in weight is obtainable without sacrificing accuracy. This fact holds true right on up the line even to larger ordnance. The increased mobility due to the reduction of weight is evident.

SHOTGUNS are compensated by cutting off six inches of the barrel and then mounting the Compensator. The overall length of the gun is the same and the balance and velocity are not disturbed. When the shotgun is fired, the gas is exhausted through the side ports, thus reducing the recoil. The pellets are then re-aligned and choked at the Compensator's muzzle in the absence of the white-hot powder gas normally present during this operation, and friction heat is reduced. It is this gas heat and friction heat in uncompensated guns which cause the softening and damaging of the pellets so that they do not fly true. By eliminating these two factors, better charge patterns are obtained because pellets are not damaged. Also the powder wads are mangled by the gas turbulence in the Compensator expansion chamber and are so retarded that they can never again pancake the rear of the shot column. This is clearly shown in the two spark photographs reproduced at the top of this page.

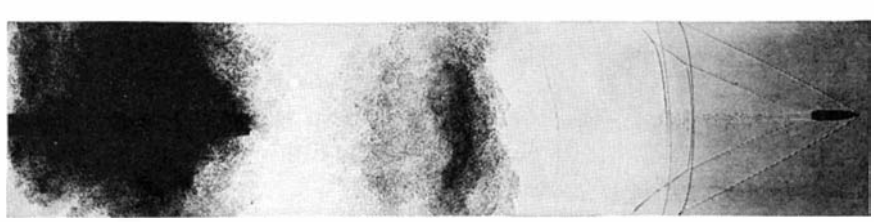
The result is an entirely new type of shotgun having the following advantages: Less shot pellet damage; evenly distributed patterns with killing velocities to the outside edge of the charge, and with no breaks or blows; and recoil reduction. The Compensated shotgun becomes, in effect, seven guns because of the seven quickly interchangeable choke tubes. Two of these tubes are closer than the present full choke and one is wider than the full cylinder. In short, every type of field shooting, as well as traps and skeet, may be covered with one compensated gun.



Rifle compensator; bullet still in chamber; gases emerging from ports



Bullet leaves the chamber with only a slight leakage of gases forward



Main volume of gas still acting to reduce recoil as the bullet speeds on

Photographs courtesy Lyman Gun Sight Corporation and Peters Cartridge Company

Finally, all gas except original leakage gas has been ejected through ports

Endurance Cut From the Hillside

By AUSTIN C. LESCARBOURA

STONE cutting is one of the oldest arts, and one of the most recent to feel the influence of the machine age. Even today, when engineering has done its best to reduce the labors of the men who cut our buildings from the hilltops, the human hand is essential in fashioning the stone for the builder's use. For while steel and wood, and pipes and wires lie buried in the dim recesses of the giant skeleton, the stone is the visible dress that gives form and substance to the beauty of the architect's dream.

From the time of the Pharaohs to the era of the airplane and radio, men have translated their visions of beauty into the lasting qualities of edifice and monument. Of their lineage is the firm of Grenci and Ellis from whose Mohegan Quarries at Peekskill, New York, artisans have hewn the granite for building the majestic Cathedral of St. John the Divine in New York City.

When, in his imagination, the architect pictures the building which is about to take form on his drawing board, his choice of building material is conditioned by many factors other than those of mere beauty and form. For the monumental type of building that is to endure through the centuries he may well choose granite. In that case the granite contractor is then called in. This contractor maintains a staff of engineers who draw up the details for the cutting operations. This of course takes time, for each side of the building must be drawn in detail, showing the location of the various stones, each of which is given a number by which it is known as it passes through its many operations from cutting to the final laying.

DETAILED cutting calls for much experience with granite. Each job presents different problems of cutting that must be solved on paper before the work begins. Most of the modern buildings are hung on steel frameworks, the walls carrying practically no weight. For these buildings, a curtain of stone suffices, which is dowelled to the steel frame, with pins fitted into holes in the granite blocks. In the Cathedral, the walls carry all the weight without the aid of steel.

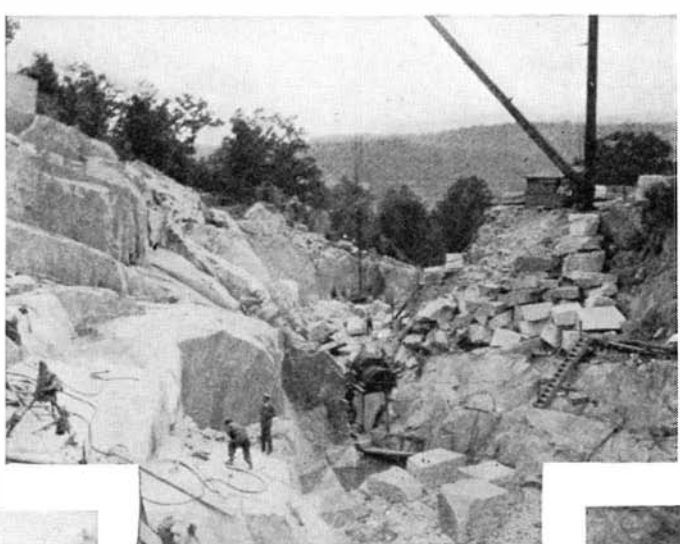
The quarry proper is far different from the white gash the traveler often sees from the highway. The smooth white "benches," as the faces of granite are called, show the marks of drill and wedge which have cleft them from their bed, while all about are the chunks and pieces split off as unfit for use because of size and quality.

Along one bench, the pneumatic hammer is grinding out the holes that are to hold the space bars and wedges that will split a great chunk from the parent mass. At intervals of about one foot, inch holes are placed for the space bars, while between them along the line at which the block is to crack off are small shallow holes for the starting wedges.

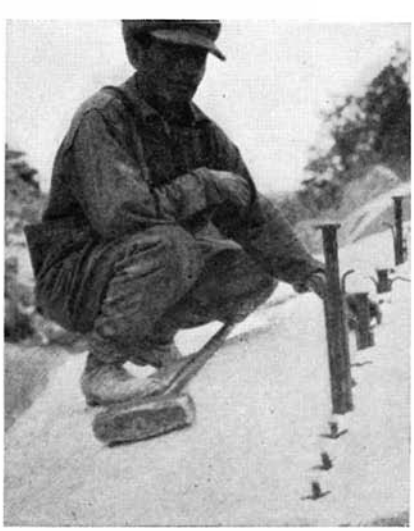
Little blasting is done for there is too much danger of discoloration and damage. The space bar and wedge do the trick, with possibly a small starting shot in the case of the larger blocks.

The drilling over, space bars—bars of steel similar to drills—and wedges are fitted into place. The stocky quarryman swings his enormous sledge, driving space bars and wedges into the holes prepared for them. Each in turn receives its few blows. Three times around and the line of wedges shows a fine hair crack; a few more blows and the granite is definitely split along the line of the drill holes.

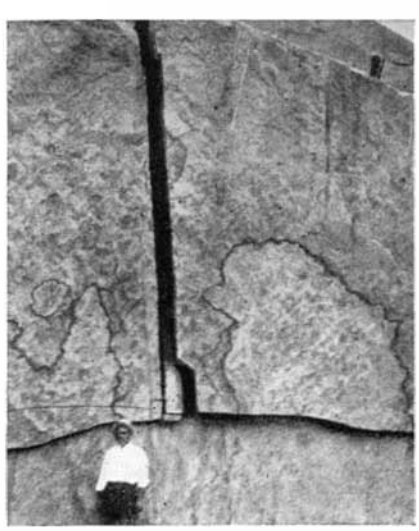
The huge blocks are slung in chains and carried aloft at the tip of a giant crane to be laid carefully aboard the cradle of the mine cableway which carries them down the moun-



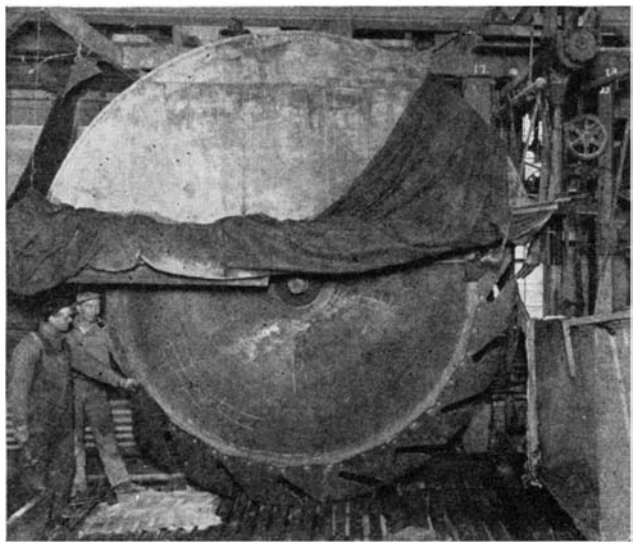
Equipment which shows the influence of the machine age lies scattered about the modern quarry. Bench cuts, blocks ready for removal, machinery, and much waste stone are indicative of the activity here



Left: **Bars and wedges, inserted in holes, start a crack on a bench and will finally break off a huge block**



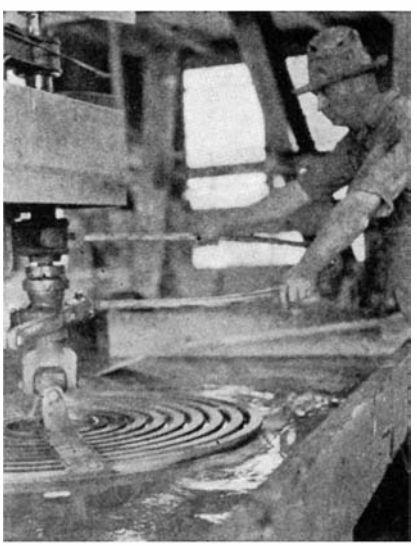
Right: **The size of this block which has been split away from a bench is shown by comparison with the man**



Left: **Workmen putting new teeth on one of the huge stone cutting saws. This saw does not actually cut the stone but grinds steel shot into the cleft at high speed to wear away the stone**

Below: **The first polish. A swiftly rotating wheel, mounted on a universal joint and on an arm that may be swung about the supporting pedestal of the machine, will polish the surfaces of almost any kind of curve**

Below: **The second polishing wheel. Here a rotating polisher made up of concentric rings and so mounted that it may be moved about the work, gives a high degree of polish to stone**



tain to the cutting shed. In times not long distant 12 teams of powerful horses would skid the blocks down a roadway; now one man at the brake drum controls the entire trip from quarry to cutting shed.

Here the first operation is that of sawing the block to size, for today huge blocks of granite are cut by saw as in the lumber mill the forest giant is carved by ripping blades. But this operation is, however, not a cutting action but one of abrasion at high speeds. At the point where the teeth of the saw enter the cut a stream of water carries with it a load of steel shot, which are carried along the cut by the saw and pressed into it, wearing away the stone and cutting a path for the saw. The water then carries the shot and granite dust out of the cut, the shot being collected for another trip through the machine. At other points in the cutting shed the gang saws work on the same principle as the rotary saws. These are used to slice one chunk into many thin slices for curtain walls and plane surfaces.

Before the installation of the granite saw each separate block had to be quarried to as near the size as was possible and then hand chipped to size. Of course the waste was enormous. Now, however, it is necessary only to waste the part actually cut out by the saw.

Cut to size by the saws and ready for routing and grinding, the block is marked with the symbol that it carries to the building, and by which it has been detailed on the drawing and ordered by the stone mason. These symbols have been used in stone cutting since the first edifices were built block by block.

Since the stone mason works on schedule, he notifies the granite contractor what pieces to deliver first. Having been marked, the piece goes to the routers, where the huge fixed pneumatic hammers chisel the squared surface to somewhere near its finished outlines. Here the block begins to take shape, and here the artistry of the sculptured piece begins to be evidenced.

THE grinding wheels are mounted on electrically controlled carriages which permit the whirling disks to reach at any angle the block cradled underneath. The wheels may be adjusted to cut the arc of any size circle into the block, bringing it down to exact size and ready for the polishing process.

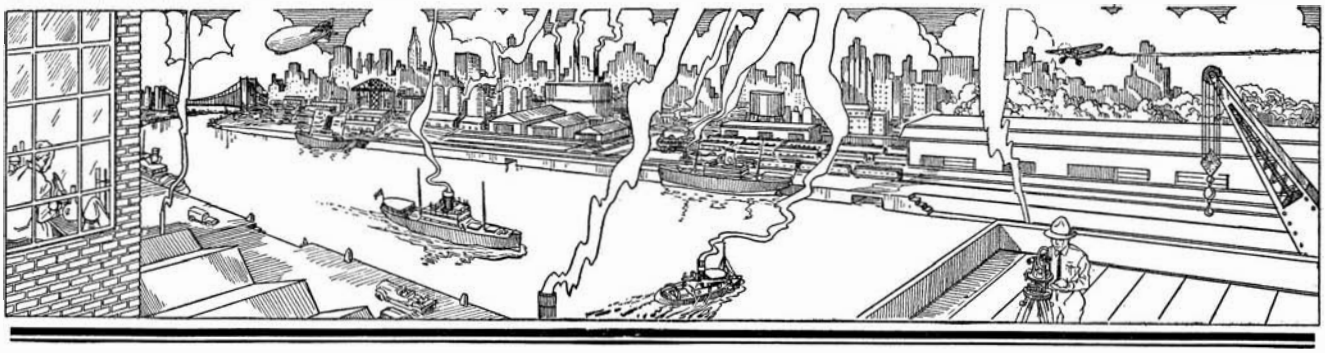
The polishers are steel disks also mounted so that they may reach any smooth surface of the block. They revolve at high speed and with an abrasive dust bring to the surface the degree of luster required. This polish may vary from the smooth grain of the ground down stone to the mirror-like surface of high luster granite. The final touch is usually given by hand to smooth out the kinks and add that refinement that comes from hand work alone.

The relief work is usually in the form of hand carving with the aid of finger grip hammers. Many set forms of ornamental design are used: bas relief eagles and standing eagles, or again lion heads, gargoyles, and similar designs.

The actual cutting finished, the blocks are held at the cutting plant until ordered by the stone mason, who notifies the granite contractor each day what he will need the next. In this respect granite work resembles steel work, which also comes to the building in units ready for the day's assembly.

In churches and public buildings of the smaller type, the effects of ruggedness given by granite are desired, but the enormous expense of cutting to plan is out of the question. These buildings use the random range ashlar type of construction. Ashlar is a square cut stone, and when the stone mason selects at random from a quantity of these rough cut stones the effect is one of ruggedness and strength.

The quarry also gets orders for special work such as stone chairs, grottoes, and other massive stone work. The specifications for a memorial grotto to the late Madill McCormick called for natural granite boulders. These had to be carefully selected and shipped with the moss that originally grew on them in order to maintain the natural effect.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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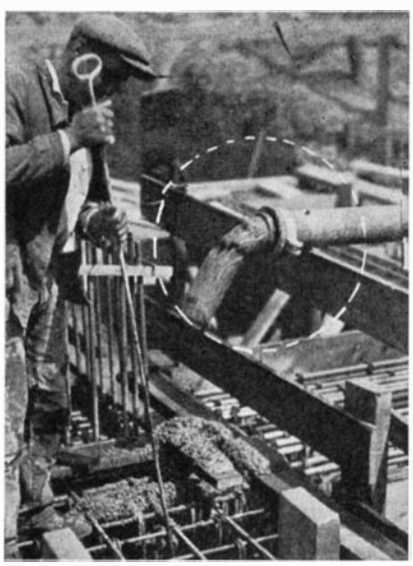
Rat "Digests" Part of a Steel Ball Bearing

THE powerful eroding effects of the acids in the digestive tract have been strikingly demonstrated in an experiment on a rat, performed by Frederick Hoelzel of the department of physiology of the University of Chicago. Mr. Hoelzel made a laboratory rat swallow a steel ball bearing, which passed through the animal's digestive tract in 15 days. On emerging, it weighed 24 percent less than it had at the beginning of its alimentary journey. To another rat, Mr. Hoelzel administered a hundred small pieces of iron, which were all passed out of the digestive tract by the end of about 10½ days, with a loss of 12.5 percent.—*Science Service.*



Placing concrete by direct pumping, a method new to this country. Flowing concrete is visible in circle

Concrete Pumped Through Pipes

FOR the first time in America, concrete was pumped to the forms in quantity when the Pumpcrete, owned by the Chain Belt Company, went into action on the Thirty-Fifth Street Viaduct in Milwaukee, in August.

Pumpcrete is a concrete pump, developed in Europe for delivering concrete to the forms by direct pumping action, and apparently is the successful solution to a method of placement by direct pumping that has long interested concrete engineers.

The Milwaukee demonstration lasted twelve hours, during which the Pumpcrete handled 125 yards of mixed concrete to forms, including one and one half hours' idle time waiting for delivery.

The pump is of the piston type, gasoline or electric motor driven, and has a capacity of 15 to 20 yards of concrete per hour, and is portable. It will transport concrete 500 feet horizontally, or up to 72 feet vertically.

Five-inch pipe was employed in the pipe line and the aggregates of relatively large size were moved through it, all day long, without a bobble. The pipe used was in 10-foot lengths, equipped with quick couplings.

Must We Eat Copper?

THE old query "Have you had your iron today?" may soon have to give way to a revision: "Have you had your copper?" At the recent meeting of the American Chemical Society, two independent researches added new evidence for the importance of copper in normal blood formation. The two research teams were both from the University of Colorado; one consisted of Hermann B. Stein and Robert C. Lewis, the other of F. Aline Underhill, James M. Orten, Edward R. Mugrage, and Robert C. Lewis.

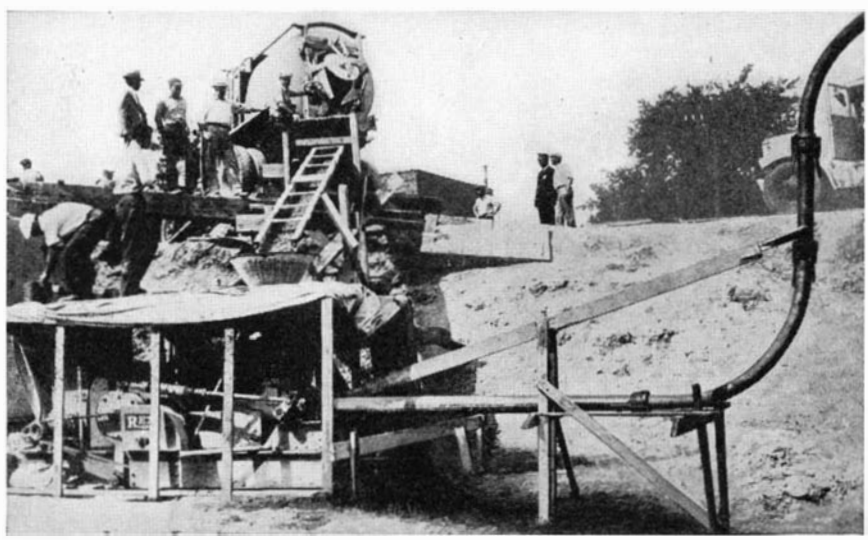
In the first series of experiments, anemic rats were given copper in their diet, with no change in the amount of iron. Their red cells increased approximately two fifths in number in five weeks, while the hemoglobin, or blood-iron, showed only a slight increase.

In the second series of experiments, rats became anemic and died in a short time on a diet of milk and iron alone but grew normally and lived many months when copper was added to their ration. At the end of from 12 to 22 months, they were entirely normal in both blood and body tissues.—*Science Service.*

Unbreakable Glass

A NEW form of plate glass which is said to be practically unbreakable has been put on the market in Germany. This new product differs from the well-known shatter-proof glass used in modern automobiles in that it is not laminated but is a solid sheet of glass. The makers claim that it is more resistant to impact, pressure, and vibration than laminated glass.

An 18-ounce steel ball, dropped on this



Concrete, mixed in a Moto-Mixer, is dumped into a hopper of the Pumpcrete which then pumps it many feet vertically and horizontally to the pouring site

glass from a height of about eight feet, will rebound without leaving a mark. The elasticity of the glass is so great that a braced sheet will bend under the weight of two men, but after removal of the weight will return to its original position. This glass, which is called "Sekurit," has half the strength of steel and twice the elasticity. It is not sensitive to temperature or atmospheric influences; since it has no lamination, the danger of bubble formation or darkening is eliminated. Of course, this glass is wholly transparent and does not change with age. Of particular interest is the fact that, when fractured by a sufficiently strong blow, it does not shatter into long splinters but crumbles up into granular pieces which have no sharp edges. —*A. E. B.*

A Camera Race-Timer

THE Kirby Two-Eyed Camera, used officially in timing speed events at the National Air Races in Cleveland, is a combination motion-picture camera and timing device that photographs with mathematical accuracy both the finish of a race and the time of finish. It was developed by the Bell Telephone Laboratories for Electrical Research Products under the sponsorship of Gustavus T. Kirby, Chairman of the Olympic Games Committee and Chairman of the Advisory Committee of the I.C.A.A.A.A.

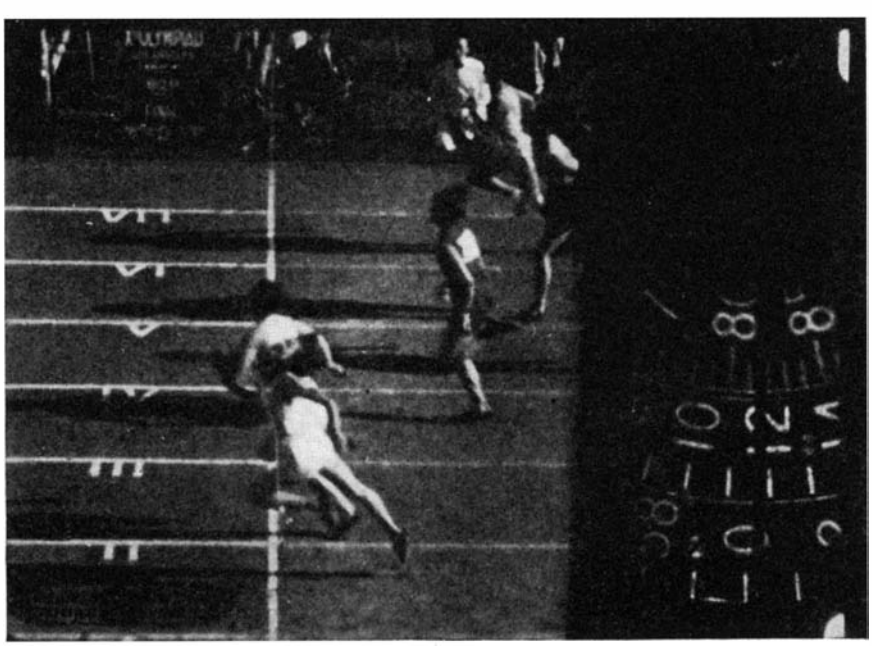
It was used this spring, for the first time, at the Columbia-Syracuse and Princeton-Cornell track meets and was used at the I.C.A.A.A.A. games at Berkeley and the recent Olympic Games at Los Angeles.

The Two-Eyed Camera had its inception in an incident that happened about five years ago. Kirby and other I.C.A.A.A.A. officials, looking at a motion-picture record of the finish of an intercollegiate race, realized that second place had been won by a man who had not even been placed by the judges. From that moment he realized that a more rigid method of determining race finishes and timing was necessary.

Fundamentally, the Two-Eyed Camera is built around a tuning-fork clock so precisely built as to register time accurately to 1/100 of a second. Three concentric dials keep time, one registering minutes, another seconds, and a third one-hundredths of a second. These dials are connected by wires to the starter's gun so that they begin to revolve the instant the hammer of the starter's gun clicks. When the race is started by a flag, the camera photographs the starter's flag as it is waved and the time is registered photographically on the same film. In events where the start and finish lines are not at the same point, two cameras are operated synchronously by electrical interlocking, one at the starting point, the other at the finish line.

The camera is a 16-millimeter motion picture camera capable of shooting 128 frames a second. The dials revolve from the moment the race starts. The camera is operated as the participants approach the finish line. The camera simultaneously photographs both the participants finishing and the time of each picture as shown by the constantly revolving dials. The finished film shows indisputably the order of finishing and to gage the time it is only necessary to pick out the frame showing the racer crossing the finish line. In the same picture is his time, forming a permanent record of the race.

The photograph record of the time dials occupies about one fourth of the film space.



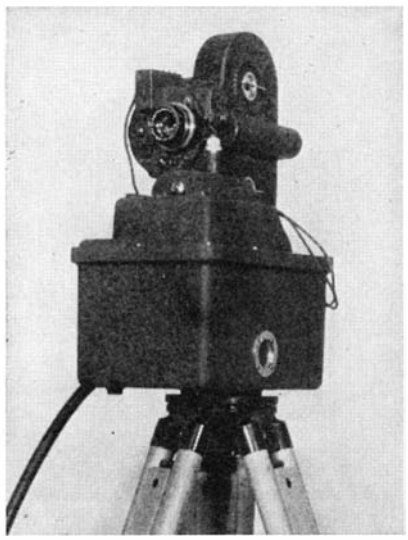
The finish of a race at the Olympic Games, as reported by the Kirby Two-Eyed Camera. On same film is the time in minutes, seconds, and hundredths of seconds

Why Hangovers Hangover

AN explanation for the well-recognized "hangover" following alcoholic debauches is found in a study just completed by Drs. Harold Himwich, E. F. Gildea, and L. H. Nahum at the physiological laboratories of the Yale Medical School and in the Institute of Human Relations.

Dr. Himwich, who has previously determined that drinking large doses of alcohol leads to radical changes in glucose and lactic acid content, the carbon dioxide capacity, and the acidity of the blood, noted that some of the dogs used in his experiments had unusually high values for lactic acid of the blood long after the last trace of alcohol had disappeared from the blood and after the other abnormalities had been corrected. So he called in some of his associates and turned to human subjects. They have studied carefully nine individuals who were recovering from more or less prolonged alcoholic debauches. And each of them had an increased concentration of lactic acid in the blood.

There also seemed to be some correlation in these human subjects between the recovery of the individual and the disappearance of this accumulation of lactic acid in his blood. At least, in one case, even four days after recovery from alcoholic coma, the lactic acid content of the blood was still high and the patient was still showing some signs of delirium tremens. Two other patients who recovered from acute alcoholism within 24 hours had normal lactic acid values within that time.—*Science Service.*



The camera that times races. The timing clock is wholly enclosed

Fuel Combines Oil and Coal

EXPERIMENTS in England are said to have proved the efficiency of a new fuel which combines powdered coal and oil. The fuel has been tested over a six months period. Forty tons of coal are included in every 100 tons of the new fuel. It is regarded in England as a possible stimulus to the coal industry. If the new fuel were to be adopted by one of the larger steamship lines, it would open a new market for about 400,000 tons of coal annually. The process for mixing the coal and oil has not been made public.—*A. E. B.*

Recent Advances in Food Technology

WE are indebted to Laurence V. Burton, Editor of *Food Industries,* for the following collection of interesting facts illustrating some recent contributions by the chemical engineer to the production and distribution of foodstuffs. "Frozen canning," in which fruits are preserved by freezing in an alcohol bath, is being developed at Stanford. . . . A Wisconsin baker recently kept bread fresh for four weeks by freezing it. . . . Subjecting grapes to carbon dioxide before placing them in refrigerator cars prevents much of the commonly experienced shattering in transit, Department of Agriculture scientists find. . . . Formation of lumps in sugar can be prevented by adding calcium phosphate

to it, a member of the American Chemical Society asserts. . . . Good quality cheese can be made from frozen milk by a slight modification in the manufacturing process, New York State Experiment Station has discovered. . . . By precooling fruit before placing it in refrigerated cars, the number of car icings between California and the East can be reduced from ten or twelve to one with a saving of 30 dollars per car (for oranges). . . . Artificial drying of rice, which seldom contains less than 25 percent moisture when harvested, is a practical means of raising the grade of the product, the Department of Agriculture has determined.—*A. E. B.*

The unique oil furnace is almost as ornamental as it is utilitarian

Unique Combustion Principle in Oil Furnace

A REVOLUTIONARY principle of combustion is employed in the new oil furnace which has been announced, after several years of study, by the General Electric Company. The furnace is designed for use primarily in homes. Economy of operation, safety, quietness, and fully automatic operation are the outstanding advantages claimed for the equipment. Actual savings in every experimental installation over the previous heating system ranged from 14 to 53 percent.

The furnace comprises a co-ordinated boiler, burner, and control, designed and manufactured as one unit. It will automatically maintain an even temperature in the home in winter, and will heat water for domestic use the year 'round, without manual supervision. It is, according to the manufacturers, quiet, clean, and presents a finished appearance which permits the furnace room to be transformed into another living room.

The lower part of the unit houses the boiler and the combustion chamber. In the upper section, carefully insulated from the lower, are the controlling devices and the oil-burner mechanism which prepares the air and oil for combustion. The oil-burner nozzle and the electrodes for the electric arc ignition project down into the combustion space through sealed openings.

The principle of combustion is unique. Finely divided particles of oil are blown from the nozzle under air pressure and are directed towards the bottom of the furnace. A small amount of air, fed in around the nozzle, cools the nozzle and the electrodes and starts the combustion at a point some distance below the nozzle. The greater part of the air supply, however, is taken from the blower of the oil burner through a duct at the left side of the furnace and enters the bottom of the combustion space, directed upwards. The meeting and mixing of the burning oil vapor spray with this secondary air supply produces a diffused flame. The path of the flame is down the center of the combustion chamber, "mush-rooming" out where the secondary air is encountered and passing up all along the walls in contact with the hot refractory lining. Thus the length of the combustion path is nearly twice the length of the chamber, and the oil can be completely burned before leaving the chamber.

The boiler is designed for the down-draft, counter-flow principle widely used in power boiler practice. The products of combustion, after passing to the top of the combustion chamber, sweep through a short lateral pass and down over the fabricated boiler tubes. Thus the gases are hottest where the water is hot, and are cooler where the water is cooler, toward the bottom of the boiler. The gases pass out to the stack through a chimney connection at the bottom of the boiler. The combustion spaces are entirely surrounded by the boiler water, as in the highly efficient Scotch marine boilers. This, and the heavy insulation all around the boiler, prevent any considerable heat loss to the basement. A hot water heating coil, built as an integral part of the boiler, heats an ample supply of water for domestic use.

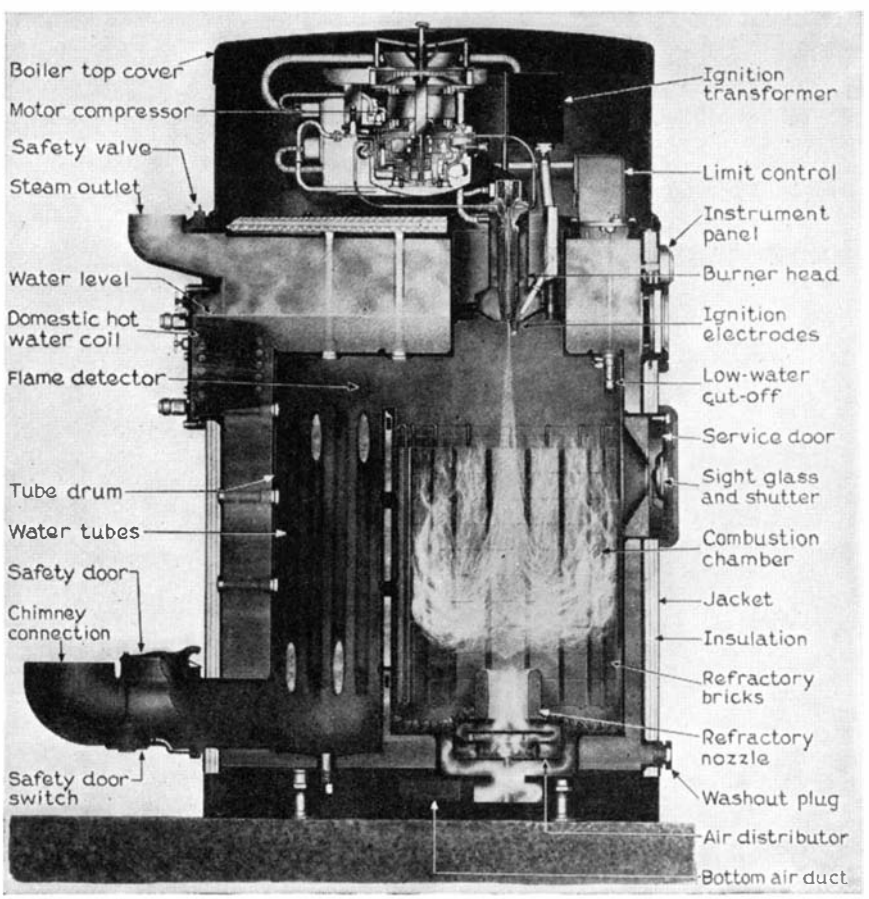
The burner is of compact design having all rotating parts mounted on one shaft and constantly lubricated under pressure by a sealed-in oil supply, and requires no manual attention to oiling. The motor has no brushes to require maintenance. The fine atomization made possible by the impact-expansion principle, worked out by General Electric engineers (See SCIENTIFIC AMERICAN, September, 1932—*Ed.*), produces a highly efficient, clean, semi-luminous flame and permits the use of the economical No. 3 heavy domestic fuel oil.

The furnace is quietly started in response to the thermal control located in the living quarters. The thermal control is an electrically operated combined time-switch, clock, and thermostat enclosed in an attractive case. Safety devices provide against every possible abnormal condition, making the installation entirely safe. The controls also govern the operation of the furnace to provide a continuous supply of domestic hot water all the year 'round.

The new furnace is suitable for application to both steam and hot water heating systems. When used with the latter, the use of the G-E water circulator is specified. For application to warm air systems—both new and change-over—the new furnace is supplemented by the G-E air conditioner.

Alcohol Was a Cosmetic

BEFORE the word "alcohol" was used in its present sense, it was the name for an Arabian cosmetic—powdered galena or antimony, for blackening eyebrows, called "al-kohl," says the *American Journal of Pharmacy*. For years, it meant any finely divided material—even 100 years ago powdered sulfur was called "alcohol of sulfur." Today, it means atomic arrangement, and there are many "alcohols" besides the bev-



The unique construction and principle of the new heating furnace

erage kinds, including synthetic ones, and they are used in making a myriad of products, including vinegar, aspirin, chloroform, insulin, vacuum tubes, and photo films.

Care in Use of Some Laxatives

A HEALTHY 10-year-old boy, living in California, recently ate the contents of a box of a well-known laxative tablet, mistaking them for candy. As reported by a California physician, the boy's temperature rose rapidly, he became delirious, and died nine days later.

"Deceived by their sugar coating, children sometimes unwittingly mistake cathartic tablets for candy," says Dr. F. J. Cullen, of the Federal Food and Drug Administration. "Adults are less likely to make such a mistake, since the food and drugs act requires that laxatives, prepared in chewing gum or confection form, be labeled to indicate that they are a medicine and not a confection. Manufacturers generally are labeling laxatives and cathartics in full compliance with the law."

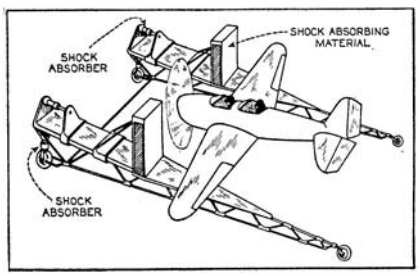
Laxatives have valuable uses, according to Cullen, but an individual not infrequently forms the "laxative habit," and this may prove injurious. The intensity of the effect of cathartics varies from mild to extreme, small quantities of one producing results as intensified as large quantities of another. Generally, the effects vary markedly with different individuals. For these reasons, says Cullen, it is extremely important that the buyer read the labels on these products and keep the articles out of the reach of children. While the food and drugs act does not require that a manufacturer declare the presence of any but a few specified drugs, such as alcohol and narcotics, it does insist that, if the constituents are named, the statement be truthful.

S. S. "Manhattan" Makes Record

WHEN the United States cabin liner *Manhattan*, which was described in our October issue, completed her maiden voyage to Hamburg and back to New York, she had set a speed record for cabin ships for both the eastward and the westward crossing of the Atlantic. She made the crossing from Cobh, Ireland, to New York in just 5 days, 14 hours, and 28 minutes. Her average of 21.12 knots exceeds the speed of many first-class transatlantic liners.

In view of the *Manhattan's* record, W. Irving Glover, Assistant Postmaster General, now advocates construction of a third ship of this type and speed to assure regular and dependable transatlantic mail service. (The second, the *Washington*, was recently launched.) "Greater speed is not necessary in carrying the mails," said Mr. Glover. "What is important, now that we can make deliveries in a reasonable time, is regularity."

On her westward trip, the *Manhattan* carried 1107 passengers and, according to newspaper accounts, they consumed 60 full barrels of Hamburg draught beer and 1600 bottles of wines and liquor.



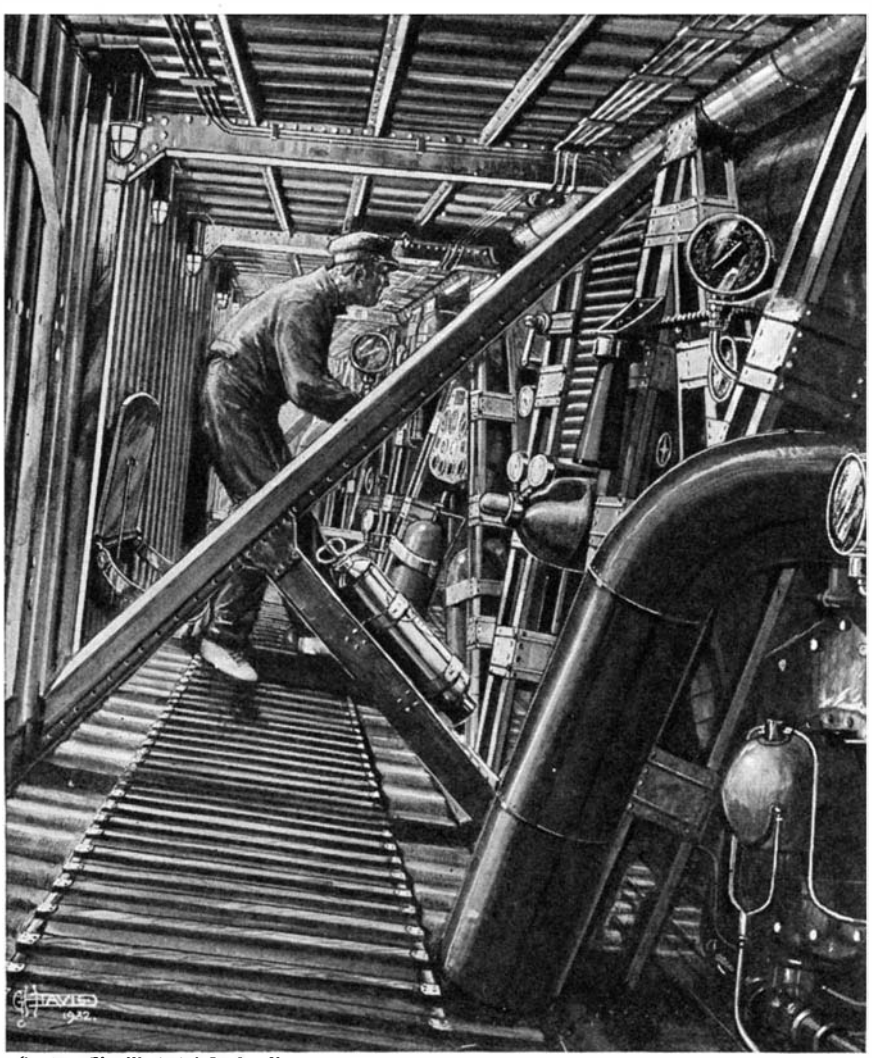
The manner in which a plane comes to rest on the landing carriage

A Landing Carriage for Airplanes

TO land an airplane with a damaged landing gear, or with none at all, is an extremely hazardous undertaking. A landing carriage for airplanes, the invention of William S. Glennan, is therefore of interest.

The carriage consists of two outboard structures, as our sketch shows, on which the wings land. The leading edges hit the vertical buffers which are padded with some shock absorbing material. Also, shock absorbers are incorporated in the carriage to take up the vertical shock. The device may be called an arresting gear, since it opens up interesting possibilities for landing on aircraft carriers, on house tops which are usually limited as to space, or on landing fields which are either badly surfaced or have limited size runways. It might also be called a "reverse catapult" for it quickly absorbs the momentum of flight whereas the catapult imparts flight speed to a plane quickly. The arresting carriage has an added advantage in that it could serve as a truck for hauling the airplane.

Of course, the airplane wings would have to be designed for the loads imposed upon them when landing, but these loads are not excessive. The added weight due to the stronger wing structure required would probably be fully compensated for by the increased performance of the airplane that would result from dropping the landing gear. Where the landing gear is not dropped, the ability to land in restricted spaces is valuable enough to warrant the increase in weight.—*A. K.*



Courtesy *The Illustrated London News*

The engine room of a great liner, not of the sea, but of the air. The corridor within a wing of the new Junkers *G-38*, now in daily use between England and the continent. She is the biggest and heaviest wheeled monoplane in the world, weighing nearly 30 tons when fully loaded; has passenger accommodations for 34 people on two decks; carries a crew of seven; and has huge cargo capacity. Mechanics attend her four 650 horsepower engines in the engine corridors in the duralumin fitted wings while she flies. Her speed is 115 miles an hour

Superchargers and Air Show Records

NOT all the speed records at the recent National Air Races were spectacular ones. They were made possible by years of engineering, and the old records were broken with but a few people being aware of it. When Major James H. Doolittle established a world's land plane speed record of 296.287 miles per hour, his Wasp engine

A plain statement

ANTI-

IMPORTANT INFORMATION FOR THE

In an effort to clear up the confusion regarding anti-freeze, which appears to exist in the minds of many consumers, we give below the outstanding facts. The following statements are guaranteed to be correct and accurate in every particular. They are supported by the highest scientific authorities.

THE problem of preventing freezing in the cooling-systems of automobiles during the cold weather months was one that taxed the ingenuity of car owners for many years. Salt, honey, alcohol, kerosene, glycerine and many other products and by-products were used with varying success. Within the past few years, however, there has been developed a new product, a product specially designed for this one use and purpose.

That product is Eveready Prestone. It is not a general commodity used principally for other purposes: it is an anti-freeze, and nothing else. It is a scientific development, thoroughly approved by all car manufacturers; a product which embodies all the advantages of all materials previously used, with none of their inherent weaknesses.

In developing Eveready Prestone, the laboratories of Union Carbide and Carbon Corporation, keeping in mind the requirements of the U. S. Bureau of Standards for an ideal anti-freeze, worked toward a product which would satisfy the following specifications:

1. It must not boil away. A boil-away anti-freeze is both an inconvenience and a poor protector against sudden changes in the weather. Such anti-freeze requires frequent renewals and leaves the car unprotected when a cold snap follows warm weather.

2. It must be harmless to the cooling-system. An anti-freeze which corrodes the cooling-system is a poor product to put in a car.

3. It must be effective in preventing freezing. The effectiveness of the materials commonly used before the advent of Eveready Prestone varied over a wide range. Some were effective in preventing freezing; others were not.

4. It must not affect the car finish. The fumes of boil-away products were a source of danger to the finish of fine cars. This was a weakness which those who developed Eveready Prestone were anxious to avoid.

5. It must circulate freely at the lowest operating temperatures. A heavy, viscous material, which is not free-flowing, is obviously a poor cooling-agent.

6. It must be non-inflammable and odorless. Winter driving was often made unpleasant by smelly fumes,

# of facts concerning

FREEZE

PROTECTION OF CAR OWNERS

while inflammable mixtures held the possibility of causing serious accidents.

7. It must not "creep." Certain materials in common use had a strong tendency to leak out of systems which were tight enough to hold water but not tight enough to hold these materials. The new product, it was felt, must have *less tendency to leak than water.* Consequently, if a car could hold water it would hold the anti-freeze.

8. It must be packaged as a concentrated product. Many of the products which the public was using, because of their thick, heavy nature in the concentrated form, were sold as water-diluted solutions. The cost of canning and shipping plain water was thus borne by the public. Obviously, if a concentrated product could be packaged and sold the user could be saved that expense. Furthermore, the public had no way of telling how much of these diluted solutions was anti-freeze material and how much was ordinary water. Some brands contained as much as 55% plain water: others contained less. It was decided, therefore, that the new product must be concentrated. Thus the public could be sure of buying a standard product, always the same and always of known value.

9. It must be economical. The laboratories which developed the new product were not interested in low first-cost per gallon. They *were* interested in low cost per season. It was felt that car owners who had been buying boil-away anti-freeze on the installment plan, a few quarts at a time, would not object to a relatively high first-cost if the *all-season* cost were low. The new product, therefore, was priced to cost, for an average winter season, no more than the cost of boil-away anti-freeze.

Thus was developed Eveready Prestone, the only anti-freeze which meets *all* these requirements. But laboratory effort did not stop with that.

A NEW AND IMPROVED PRODUCT AT A LOWER PRICE

Further research developed the product to a point where it gave protection not only against freezing but also against rust and corrosion in the cooling-system. And such is the *new* Eveready Prestone. Its use reduces the corrosive action of water on the metals of the cooling-system as follows: brass, copper, solder, aluminum and zinc, 75%; cast iron, 95%. No other "treated" anti-freeze compares with Eveready Prestone for the prevention of rust and corrosion.

The new Eveready Prestone has been reduced in price. It now offers by far the safest and most economical protection against both freezing and corrosion. The car owner who uses Eveready Prestone is assured of complete protection through all weather changes, freedom from worry and the trouble of replacements, and a clean, rust-free radiator. He insures his car, not only against a freeze-up, but also against the costly repairs that follow a rust-clogged and corroded cooling-system. He prolongs the life of his car.

• • •

National Carbon Company, Inc., Unit of Union Carbide and Carbon Corporation, New York, N. Y.

employed a supercharger the impeller of which was traveling at a rate of 27,600 revolutions per minute, or 460 revolutions per second. Jimmie Haizlip, Captain Roscoe Turner, and Jimmie Wedell, who finished one-two-three in the race across the continent earlier in the week, flew Wedell-Williams ships with Wasp Junior engines, employing superchargers with an average impeller speed of 400 revolutions per second.

In his record-breaking achievement, in which he hoisted the world's speed record by about 18 miles an hour, Major Doolittle flew a Gee Bee ship with a Wasp engine, 770 horsepower at 2300 revolutions per minute, using a General Electric supercharger stepped up to a 12 to 1 ratio. The Haizlip, Wedell, and Turner ships were Wedell-Williams design, with Wasp Junior engines, 530 horsepower, with a G-E supercharger having a 10 to 1 ratio. R. L. Hall, who also figured in the epochal flying, used a plane built by the Springfield Aircraft Corporation, with a Wasp engine equipped the same as Doolittle's.

The supercharger is the development of Dr. S. A. Moss, and was described on page 299, of the May, 1932, issue of SCIENTIFIC AMERICAN.

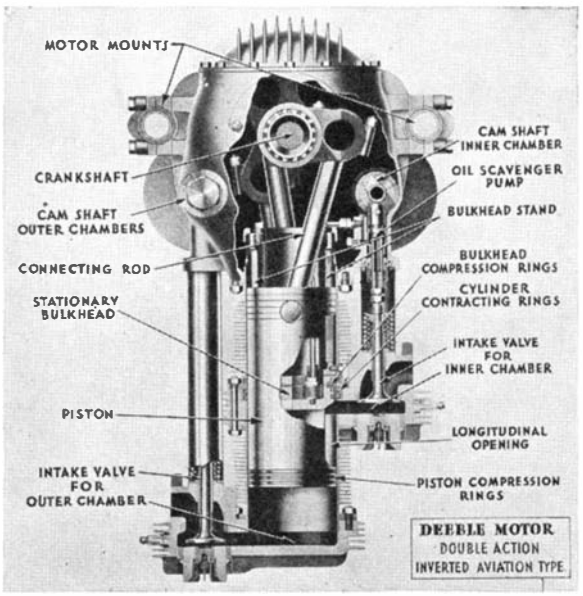
A supercharged motor was indispensable to Jimmie Haizlip when he crossed the continent in September in 10 hours and 19 minutes, averaging over 266.44 miles per hour. All of the leading planes in the transcontinental race were extreme type racers but are forerunners of commercial design. All of the planes in the long flight were entered in the races that followed, demonstrating their ability to stand up under punishment.

The Deeble Motor

AN experimental engine, employing a so-called "double action" principle, is the interesting invention of Roy Deeble, of Deeble Motors, Limited.

The accompanying cross-section of the engine shows its working elements.

The primary series of explosions take place as in any "L" head motor, forcing the pistons downward on a power stroke. The secondary series of explosions takes place inside the pistons, delivering power on an upward stroke without recourse to the use of packing glands around a piston rod as used in the common forms of double acting steam engines. A hollow shell piston, somewhat longer than the usual type, carrying regular bosses and wrist pin at the lower end, is attached in the regular manner to the conventional type of connecting rod. Within this hollow piston is a stationary bulkhead fitted with piston rings and fastened to the engine cylinder by a steel stand extending down to an internal flange at the bottom of the cylinder proper. This steel stand and the cylinder flange are so constructed that they do not engage or interrupt the connecting rod action.



The Deeble inverted, aviation type motor which is described in detail in the accompanying brief item

A longitudinal slot is cut in one side of the piston from just below the piston head to just above the wrist pin bosses. Communicating with this slot in the side of the piston is a valve chamber fitted with an exhaust and intake valve of the conventional poppet valve and also fitted with spark plugs for firing the charge.

As the piston moves up and down in the cylinder a charge is admitted, compressed and fired in the space within the piston, between its head and the stationary bulkhead, and an upward power stroke is imparted to the piston. This secondary firing chamber is entirely sealed from the primary combustion space above the piston by the rings on the piston itself; thus each series of explosions is entirely independent of the other with the exception that the piston and connecting rod are common to both. —*A. K.*

Plane Too Fast for Its Own Gun

A NOTED authority on the military phases of aviation, Major C. C. Turner, writing in the *London Telegraph*, brings up a serious problem in aerial gunnery which has arisen with the exceedingly high speeds of modern fighting planes.

In an English two seater, recently tested, it was found that the gunner in the rear cockpit of a very fast machine was unable to train his gun rapidly in any direction owing to the terrific pressure of the high-velocity air stream. The gun was swept around so that it pointed astern and fired into the machine's own tail surfaces.

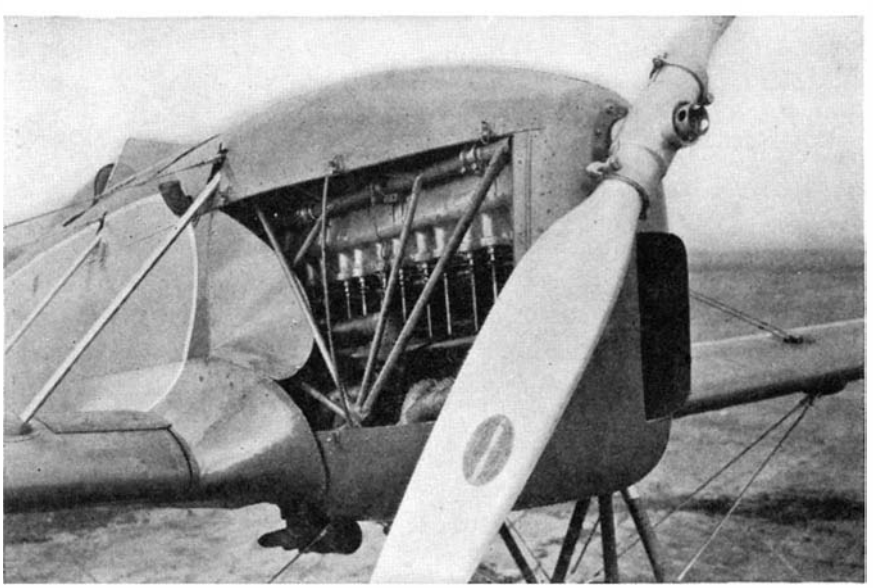
The same difficulty would be met not only in two-seater fighters, but also in bombers and other military types using anything except a gun synchronized with and firing through the propeller.

French designers have met the difficulty, however. They have provided enclosed gun turrets. The gunner and his gun are sheltered in this gun turret which has an opening sufficient for the gun to fire through, but otherwise provides complete shelter. The sides of the gun turret are of course almost entirely window.

In general there seems to be a trend towards more protection for military pilots both in the United States and in England. If a man is to pilot or fight "comfortably" he must be sheltered from air speeds of 200 miles an hour or thereabouts. The tendency appears to be that the pilot or gunner shall be entirely enclosed, following the practice already so frequently adopted with commercial craft.—*A. K.*

Weather Maps by Teletypewriter

THE Airways Division of the Aeronautics Branch, Department of Commerce, has had considerable success in transmitting weather maps over the teletypewriter service that has been in use for



The Deeble motor installed in a plane for preliminary flights

some time for general weather-bureau information.

In order to give this service, page type sending and receiving machines are used which print on sheets of paper instead of tape, although tape machines may be used on the same circuit, but not simultaneously.

The airways weather maps transmitted by teletype are similar to the standard weather maps, in that they show areas of high and low barometric pressures, as well as weather reports at various airports that have heretofore been given over the tape type machines. These reports include information on visibility, temperature, ceiling, wind velocity and direction, and general conditions.

These maps are more complete than the local information given at individual airports and since this service is given at three-hour intervals, the airplane pilot can easily determine whether alternate routes are open to him if his regular route shows unfavorable weather conditions.—*A. K.*

The Nicholas-Beazley two-place training plane

A Helium Compressor on a Railroad Car

THE helium in the *Akron* is said to be worth 420,000 dollars; therefore it is important for the Navy to be able to deflate the airship anywhere, compress the gas and store it. The J. G. Brill Company has built a 43-foot standard gage railroad car (a commercial box car, in fact, with some accommodations for attendants) and in this the Hardie-Tynes Manufacturing Company has installed a four-stage compressor, driven by a 200 horsepower electric motor. The gas lines can be connected to the airship, the helium withdrawn from the gas bags, compressed to 2500 pounds per square inch pressure, and delivered to the tank car at the rate of 15,000 cubic feet a minute. This prosaic piece of apparatus will help the *Akron* greatly toward independence of fixed bases.—*A. K.*

An Effective Training Plane

THE number of flying students has fallen off recently, but a great many student licenses are still being issued. Young America must disabuse itself of the idea that a few hours' instruction and a private pilot's license constitute the wherewithal to earn a living in aviation. But if a young man is willing to regard his flight instruction merely as an introduction to a pleasant and very modern sport, he will find himself well rewarded.

The price of flight instruction (like everything else) has gone down considerably in the last two years, and so has the cost of training planes. What is more, our constructors are giving the purchaser much better finish and better accessories and details than heretofore.

The Nicholas-Beazley NB-4 trainer has the following to offer: A five-cylinder Genet engine of 75 horsepower; a comfortable side-by-side cockpit; top speed of 110 miles per hour; folding wings; air wheels together with oleo shock-absorbers; new style Air Corps type instruments; an anti-drag ring for the engine; larger opening for baggage compartment.

It can be safely said that while our small airplanes are not changing radically year to year, they are constantly being improved, and that they progress as rapidly as the automobile.—*A. K.*

Caterpillar Club Roster Lists 475 Jumps

FULLY 475 life-saving jumps from airplanes have been made in the United States with parachutes, according to the Information Division of the United States Air Corps. The roster of the famous Caterpillar Club, it is stated, contained 460 names on June 30. Fifteen of the aviators listed made the jump more than once.

Proper Gasoline for Aircraft Motors

VARIOUS aircraft operators have been substituting ordinary automobile gasoline for the regular aircraft gasoline on the theory that the same performance and reliability are obtained, and the cost is, of course, considerably less. In the majority of cases, the automobile gas is used only during regular flight; during take off and landing the standard aircraft fuel is employed.

This substitution of a gasoline not made to the rigid requirements of the aircraft engine immediately raises many questions.

Off-hand one would say that automobile gas should be as satisfactory. The compression ratios of aircraft and automobile engines are practically the same, and the maximum revolutions per minute of automobile engines are higher, if anything, than in aircraft engines. However, the automobile engine is seldom operated at or above 70 percent of its maximum horsepower continuously, while the aircraft engine is; therefore, the "knock" qualities of aviation gasoline are not so important. However, to assure anti-knock qualities, automobile gasoline needs "doping" which increases the cost so that in the long run there is little saving to the aircraft owner who uses "regular" gasoline.

The use of automobile gas usually causes higher operating temperatures, which are detrimental to the fine piece of mechanism that the aircraft engine has become. Because automobile gasoline is less volatile it may be less reliable in the operation of the aircraft engine since the carbureter is located farther away from the cylinders than it is in the automobile engine. Then, too, the automobile gasoline in many cases does not have to meet such rigid specifications as to acidity, sulfur and gum content, and the various elements which are likely to harm the engine.

It has been pointed out that the use of proper aviation gasoline is implied in the approved type certificate issued by the Department of Commerce, under which the airplanes are licensed. That the use of other than regular aviation gasoline is undesirable may be recognized by the fact that even inferior aviation gasoline has caused five power-plant failures on one airline recently.—*A. K.*

A New Gasket Compound

A GASKET compound that will not be affected by hot oil, exposure to naphtha, gasoline, kerosene, benzine, or similar solvents or by moisture, or exposure to ozone, has been perfected in the General Electric Research Laboratories. It is known as "Glyptal" and has undergone tests in oil-filled assemblies at temperatures ranging from 210 to 230 degrees Fahrenheit for over a year without showing any effects or developing any leaks.

The compound is a grey or brown resin material, odorless and sulfur-free. It is

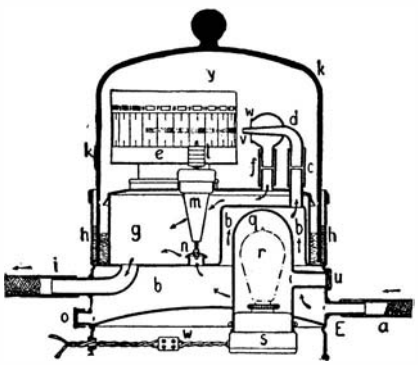
With wings folded back: A modern and effective training plane

flexible and almost incompressible and does not change noticeably under outdoor exposure tests. At temperatures below zero Fahrenheit, it becomes somewhat brittle, but its efficiency as a gasket is unimpaired when assembled in a joint.

For bolted joints the gasket should be as thin as conditions will permit. For screw joints, thicker gaskets are desirable. They should be as wide as practical, totally enclosed if possible, and always used under compression, with the clamping surfaces drawn up evenly so that the compression is uniform.—*A. K.*

Dust Content of Air Registered

IN modern industry the problem of the removal and collection of dust from air and gases is of outstanding importance. Sometimes it is a valuable dust, which must be reclaimed from the gas to avoid waste; sometimes it is a harmful dust, which if left uncontrolled may cause considerable damage through a dust explosion, or which,



The dust recorder described here

if the extent of its presence is not carefully checked, will lead to the choking of a valve. An unusual instrument has recently been perfected for measuring the dust content of the air or gas and making a permanent record of it.

The working of this dust recorder may be seen from the accompanying illustration. The gas to be tested enters at a, flowing in the direction of the arrows, and passes through the heating chamber, b, where it is warmed by a 20 watt incandescent lamp, r, to help it to rise. The gas now flows up through d and issues from the nozzle v on to the chart, which is rotated by clockwork. Because the particles of dust in the gas have considerable velocity they penetrate into the paper chart and become sufficiently firmly embedded to prevent their falling or being blown away; thus a band of varying shades is formed on the chart. The gas having thus given up a part of its dust is deflected back through f into the exit chamber g from which it leaves the instrument. In order further to obtain the utmost clearness of indication the chart paper is supplied in either of two colors—white for dark dusts, and black for light-colored dusts. —*A. E. B.*

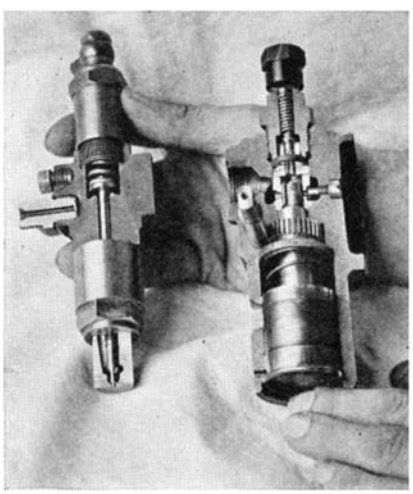
Carbon Dioxide for Whooping Cough

INHALING carbon dioxide, diluted in air or oxygen, has been helpful in relieving the paroxysmal or whooping stage of whooping cough, Prof. Yandell Henderson of Yale University has just reported to the American Medical Association.

The treatment was successfully given to 10 children, ranging between nine months and seven years of age. In all of them, after three or four days of inhalation, the paroxysms were considerably lessened in severity and frequency and by the eighth day the coughing became so infrequent that the treatments could be stopped.

Between 6 and 7 percent of the carbon dioxide mixed with air or a mixture of 7 percent carbon dioxide and 93 percent oxygen was used. The mixture was inhaled through a mask attached to a standard anesthesia machine. A small tent having a capacity of about one cubic foot was used for some children who did not like the mask. The tent apparatus was left in the home and used by the nurse or mother.

The child inhales the gas mixture for 10 or 15 minutes twice a day, either just before a meal or two hours after the last meal. If the child starts to have a paroxysm of coughing at the moment the mask is put



over his face, it is best to wait until the spell is over before giving the treatment, Prof. Henderson advised.

The use of carbon dioxide inhalations for whooping cough grew out of the similar treatment found successful for treating certain stages of pneumonia and for other lung diseases in infants. In whooping cough the idea is not only to prevent the development of pneumonia but to lessen the whooping stage.—*Science Service.*

New Uses for Cotton

A NEW addition to the many thousands of uses of cotton in laminated form is the manufacture of bearings for machinery operating at high pressure. The Cotton-Textile Institute reports that roll neck bearings of cotton fabric, compressed with other material such as Bakelite, are now produced in sizes ranging up to units large enough for service with shafting 12 inches in diameter. Bearings of this type are employed in machinery for rolling steel ingots. Among the advantages claimed for them are long service in heavy duty and added economy due to the fact that they can be lubricated with water.

Safety helmets for miners are now also made of laminated cotton fabric and have been quite largely introduced as miners' equipment in the middle west. Another recent innovation is the use of laminated cotton for running boards on automobiles. Cotton fabric compressed with resinous material is also shaped into pipe and fittings for conducting acids and other highly corrosive fluids. Again, laminated cotton is now used for the manufacture of shoe guides and back-pressure valves for oil well drilling equipment. New uses for the material also take it into the home, for example, in the form of a new housing for electric vibrators. The new air-conditioning installations which provide controlled temperature and moisture in homes also function with various parts made of laminated cotton.

White Alloy for Fine Soldering

A CORROSION-RESISTING white alloy, especially useful in dental and jewelry work, has been patented in France. Used for fine soldering of nickel, nickel alloys and stainless steels, the alloy contains manganese, copper, and nickel, in addition to 49 percent silver and 1 percent gold.

New Stock Car Record

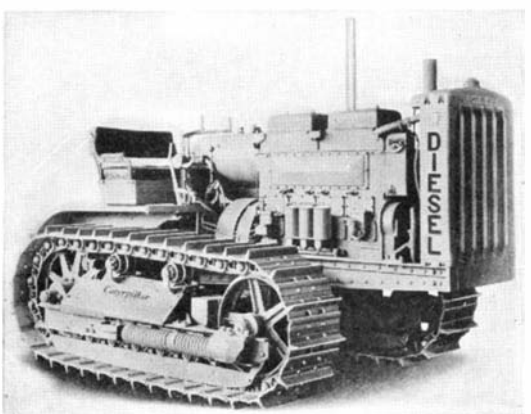
THE time for all American automobile records for high speed was bettered recently by a current model Pierce-Arrow 12-cylinder roadster when Ab Jenkins sped 2710 miles around a circular course in 24 hours, maintaining an average speed of 112.91 miles an hour. His only stops were brief ones for refueling.

The run was made in the salt beds at Salduro, Utah, and was sponsored and authenticated by the Salt Lake City Chamber of Commerce. It bettered all American land speed records for 100 miles or more, including the Indianapolis Speedway mark established by Fred Frame in this year's Memorial Day race.

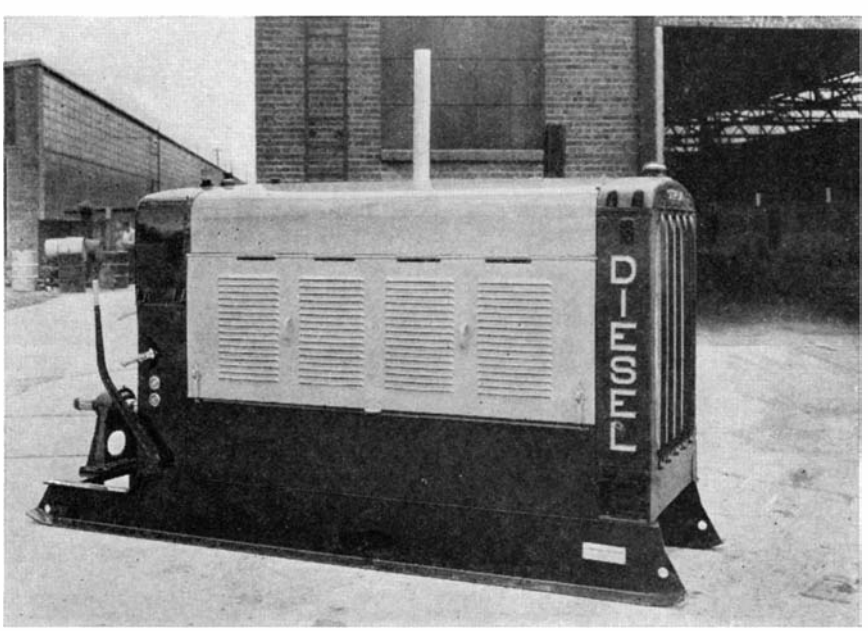
Eclipse Effect on Radio

WHEN we try to interpret something about which we really know so little as the effect of the sun's eclipse on the propagation of radio waves, the best we can do is to start with such theories as we may have and try to carry these theories somewhat further by establishing new facts. In equipping an expedition to make radio observations on this eclipse we had in mind particularly to follow out a suggestion made by Dr. Irving Langmuir who desired to obtain some more data regarding the theory that from the sun there is a corpuscular or electronic emission travelling at a rate of 1000 miles a second.

For the test we selected a radio frequency of 8655 kilocycles because we thought that this wave would have a skip distance not much beyond the distance at which observations were made and that the fringe effects of fading at the edge of the skip distance would be strongly pronounced. We also selected a type of signal with continuous wave radiation interrupted 60 times



After seven years of intensive research, the Caterpillar Tractor Company has applied the Diesel engine satisfactorily to the tractor. The accompanying illustrations show: *At left,* the Bosch single-nozzle fuel valve and fuel pump used, which permits use of pre-combustion chamber and lends itself to quick governing: *At right,* the Diesel tractor: *Below,* the same Diesel engine put up for use as a stationary engine in a form readily transported. The tractor is said to possess accelerating qualities equal to, if not better than, the average gasoline engine. The stationary engine shown develops 85 horsepower at a speed of 1700 revolutions per minute



per second, each interruption being one five-hundredth of a second.

The outstanding result of our observations was that this normally strong signal almost totally disappeared during the two hours preceding the optical eclipse of the sun, which in accordance with the calculations of the astronomers would be the time during which the corpuscular or electronic eclipse would take place. Shortly before the optical eclipse began, the signal came back, first in a scattered way and then strongly and continuously. Therefore, we felt that we had a complete proof of the correctness of the theory of the electronic eclipse.

During this same period, observations by earphones were made on a signal from Germany. This signal was heard during the whole afternoon, but during the period when the Schenectady signal was at a minimum the signal from Germany was at its maximum with a substantial increase.

One fact which is important to keep in mind in attempting to interpret these observations is the calculations of the astronomers that the electronic shadow falls entirely east of the path of the total eclipse where the observations were made. The electronic shadow as shown on published graphs covered a large area nearly bridging the Atlantic Ocean. It is thus easy to see why the signal from Germany came in stronger during the eclipse, since the electronic shadow produced the effect of night over the Atlantic Ocean and a 30-meter signal is known to be stronger over such a distance at night. It is not so easy, however, to see why the presence or absence of electronic bombardment to the east of the point of observation should have such an effect on a signal from the west.

A clue to this apparent contradiction may be found in the observations of A. Hoyt Taylor which indicate that a shortwave signal received a moderately short distance is delayed in arrival so that it appears as if the signal had traveled something like 2000 miles farther than the direct distance from the transmitting to the receiving station, thus indicating that it does not arrive by the direct path but is reflected from some point 1000 miles away.

On this basis our observations during the eclipse may be explained. We can assume that the only signal we were able to receive at our point of observation 200 miles from Schenectady arrived at that point not after a direct travel of 200 miles but through one of these Taylor reflections from some point 1000 miles east. The disappearance of the signal during the electronic eclipse can then be explained if we assume that the reflecting medium had something to do with an electronic bombardment which was absent at that time.

If this theory is correct there remains to be explained the nature of the reflecting medium which is produced by the electronic bombardment. Possibly it is one of those phenomena resulting from what has become known as the Appleton layer and which must be recognized in addition to the Kennelly-Heaviside layer to explain the phenomena of radio.

Fortunately we do not need to wait for the next eclipse in order to investigate this subject further, because the signals that have this peculiar character may be studied

(*Please turn to page* 307)

THE AMATEUR ASTRONOMER

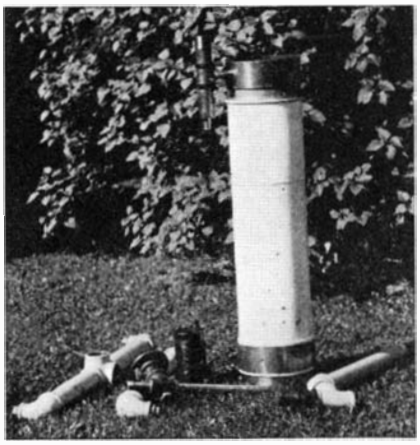
Conducted by ALBERT G. INGALLS

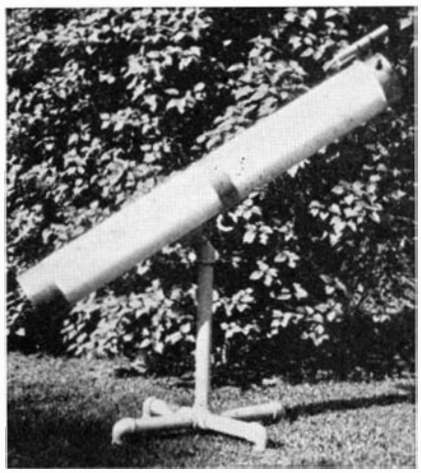
ABOUT 200 amateur telescope makers were present at the annual convention of enthusiasts held this year as usual at *Stellafane* near Springfield, Vermont. This was the sixth annual reunion. The word reunion quite aptly characterizes these gatherings, for many of the same persons have come back year after year, regarding them now as an annual fixture. No formal sessions mark them—they are purposely left open because people come to hobnob and to swap ideas about telescopes in that manner, rather than listen to the dry formal presentation of papers as at most conventions. Many lasting friendships have been formed through these meetings, which last about a day—and a night too, for those who care to sit up and astronomize.

This year a number of amateurs' telescopes were brought to the convention, and all these were noted to be the center of admiring groups. After the usual Saturday evening dinner a few short speeches were made and on this occasion, for the first time since these meetings were instituted, it rained—chiefly, it is asserted with conviction, down the neck of your scribe. As the rain held out longer than the speakers, the contingent of visitors from the club of amateurs in Pittsburgh jumped into the breach and saved the day—or rather the night—with their new invention for penetrating thick skies, exhibiting the Hercules Cluster through a cloud bank two miles thick—at least they said it was the Hercules Cluster, but some cynical spoil-sport averred it was a Crookes spinthariscope substituted for the eyepiece. We pass the hint along for the benefit of those whose friends and neighbors *will* be shown the pretty stars, shine or rain. Mother is the necessity of invention—in Pittsburgh.

Plan to make this convention next year: Old clothes, shirt sleeves, old friends and informality. It's fun.

ABOUT one year behind mouth-to-ear gossip which has spread out in wider and wider circles, at least among astronomers, now it can be told that the 200-inch telescope mirror will not be made of fused quartz. That material proved too costly. It was not the quartz itself which was costly,





The Wassell portable telescope. *Top:* Knocked down. *Below:* Set up

but the expense of fusing it. At present Pyrex is the favorite candidate and the Corning Glass Works is making serious efforts to elect it permanently to office by making a disk. Some time ago various chromium alloys were also given a serious try-out. They failed.

A PORTABLE telescope which can be thrown into a car and taken wherever the owner travels has been made by C. R. Wassell of 506 North Fourth Street, Steubenville, Ohio, who writes:

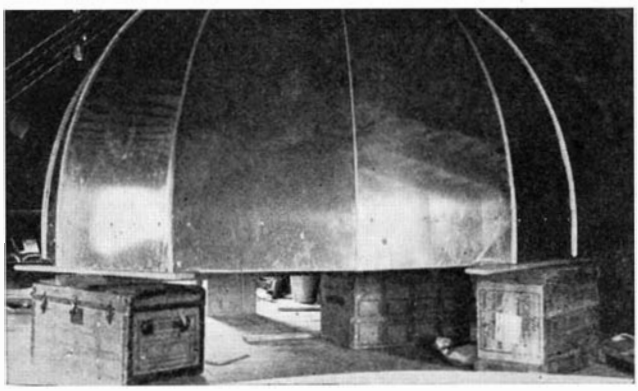
"The instrument is a 45-degree equatorial, which by finger adjustment of the plugs in the four supporting feet may be brought into quite accurate adjustment over a latitude variation of several degrees. These plugs also serve to take up any inequalities of the supporting surface, and the outfit is surprisingly rigid for its weight and nature. Being assembled of stock pipe fittings, with little machine work, the cost was very low.

"The tube itself 'telescopes' to about one half of its working length, and is so designed that the inner section is not marred during transit by friction from the outer tube. The two parts are held together with extreme rigidity by means of six taper pins which pass through the heavy reinforcing bands carried by both inner and outer tubes. The declination axis is of course also attached to the heavy band on the outer tube.

"The pipe fittings may be firmly assembled by hand, without the use of a pipe wrench, and the whole set-up easily made in five minutes. To one who likes to carry an instrument in a car, and take advantage of the wonderful observing conditions often encountered during night driving in the country, the whole outfit has proved a wonderful source of pleasure, and all of my star-gazing acquaintances who have seen it have immediately started to build something along the same lines.

"The mounting includes a revolving head, thus insuring that the observer's neck will be preserved for a horse-thief's fitting end. The finder, of an inch and a half aperture, carries a very old photographic lens as an objective. It is not perfect, or entirely free from color—but it works, and cost fifty cents."

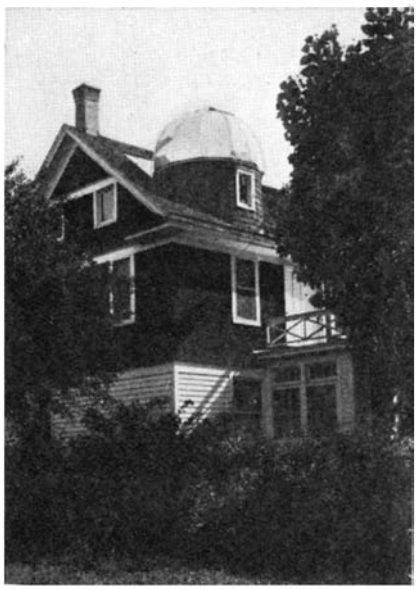
AN interesting observatory, designed in part from the Scanlon specifications, has been constructed by George E. Pellam of The Sprague-Sells Corporation, Newark, New York, and his son John R. Pellam. The photographs reproduced nearly explain themselves. The dome was constructed in the attic of the Pellam residence and later grew right up through the roof, like a mushroom. The shutter is especially well constructed of separate sheets which slide up like a roll-top desk.



The Pellam observatory gestating in the Pellam attic

The same observatory after growing through the roof

INDIANAPOLIS is looking lively. V. E. Maier, 1306 Parker Avenue, that city, writes that the Indianapolis Amateur Telescope Makers are in existence, have 25 members and are going strong, thank you. How odd that certain others of the larger cities have no clubs. Why hasn't Boston one, and Baltimore and St. Louis? Philadelphia expects to have one, as soon as the Fels Planetarium opens there next spring, for the blueprints of that structure show space allotted to amateur telescope makers.



The finished observatory

We also heard something, a year or so ago, about Seattle's intention to organize a club but apparently Tacoma, its sister city, took the edge off that aspiration.

READERS will recall that the immediate discoverer of Pluto, Clyde Tombaugh, the telescope-making farmer boy, had made two telescopes from the instructions in "Amateur Telescope Making." Recently we have run across two other amateurs who have gone professional as a direct result of the previous pursuit of the hobby of telescope making. On a recent visit to Harvard College Observatory we discovered William A. Calder, formerly of Wisconsin, who had previously planned to be a physicist and specialized in that science at the University of Wisconsin, when the construction of several telescopes led him to espouse astrophysics. He is now doing graduate work on the Harvard College Observatory staff. Again, Wilbur Perry was one of the original members of the Telescope Makers of Springfield and early showed special genius for refined work. A year or so ago, Professor R. W. Wood of Johns Hopkins University inquired whether we knew of any young amateur telescope maker whom he could employ and train to help make diffraction gratings. Perry still has this job, and there is at least one honor connected with it: Wood gratings are famous in laboratories the world over and Perry helps make them.

S. B. Tinsley of the Tinsley Laboratories, Berkeley, California, writes, "Have you ever tried making the Foucault test on the poop-deck of a throbbing freighter on the high seas? This is what one of our amateur telescope-making friends who is a sailor has done." Who can match this for adverse working conditions?

CURRENT BULLETIN BRIEFS

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

GLIMPSES OF OUR NATIONAL MONUMENTS is a beautifully illustrated pamphlet of 74 pages which is an excellent piece of propaganda. There is a valuable map. *National Park Service, United States Department of the Interior, Washington, D. C.—Gratis.*

GLIMPSES OF OUR NATIONAL PARKS is a companion brochure to "Glimpses of Our National Monuments." It contains 66 pages and is beautifully illustrated. Everyone who is planning a trip to the Yellowstone National Park or any other of our parks should secure a copy of this excellent booklet. *National Park Service, United States Department of the Interior, Washington, D. C.—Gratis.*

STANDARD SPECIFICATIONS FOR HOUSE FRAMING is a valuable pamphlet on lumber which is superior for building purposes on account of certain refinements. For example, the lumber has squared ends, the pieces are cut to precise standard lengths, the stock is seasoned and it is calibrated every inch with guide lines aiding precision in placing, measuring, fitting, and leveling framing members. *Weyerhaeuser Sales Company, St. Paul, Minn.—Gratis.*

STAINLESS STEEL CASTINGS are now available commercially, guarding against contamination, discoloration, and corrosion. Valves, bathroom fixtures, statues, builders' hardware, and architectural features are among the varied uses of stainless steel castings. *The Cooper Alloy Foundry Company, 150 Broadway, New York City.—Gratis.*

YOU CAN MAKE IT FOR CAMP AND COTTAGE contains suggestions for more than 100 handy and useful articles, each especially suited to the needs and pleasures of outdoor life. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

INTERNAL STRESS OF WIRE ROPE GONE FOREVER is an explanation of how longer life of wire rope can be brought about. *Broderick and Bascom Rope Company, St. Louis, Mo.—Gratis.*

SYMPOSIUM ON RUBBER is divided into two sections. The first group of papers deals with the extent and diversity of the industry, and the structures of rubber in combination with textiles and other materials. The second group includes papers on the flexing of rubber products, shock and vibration properties, deterioration of rubber due to friction, chemical resistance, resistance to water and gases, the electrical characteristics of rubber insulation, and rubber as an adhesive. *American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa.—$1.75.*

LOADS ON PIPE IN WIDE DITCHES (Bulletin No. 108, Iowa State College of Agriculture and Mechanic Arts, Volume XXX, No. 45), by W. J. Schlick, deals with the development and verification of the theory of the loads upon ditch conduits, such as drains and sewers completely buried in ditches, and upon projecting conduits, such as highway and railway culverts. *Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.—Gratis.*

RELATION OF LUBRICATION TO AIRCRAFT ENGINE OPERATION (*Lubrication*, Volume XVIII, No. 7, July, 1932) deals with intensive studies in regard to fuel and lubricating oil requirements. It contains colored diagrams of four leading makes of motors. *The Texas Company, 135 East 42nd Street, New York City.—Gratis.*

TWENTY-FOURTH ANNUAL REPORT OF THE HYDRO-ELECTRIC POWER COMMISSION OF THE PROVINCE OF ONTARIO records the activities of the Commission which co-operates to provide low-cost electrical service to the citizens of Ontario municipalities. *The Secretary, The Hydro-Electric Power Commission of Ontario, 190 University Avenue, Toronto, Canada.—$2.00.*

METAL MINE ACCIDENTS IN THE UNITED STATES, 1930 (Bulletin 362, Bureau of Mines) shows that companies operating metal mines deserve high praise for the splendid safety progress made in 1930 under prevailing conditions. The death rate for accidents at the mines was lower than any year except 1928 and the injury rate was lower than ever before. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

EDUCATIONAL DIRECTORY, 1932—Part III (Bulletin 1932, No. 1, Office of Education) deals with educational associations, boards and foundations, research directors and educational periodicals. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

FOUR-SQUARE LUMBER is a packaged lumber which takes the guesswork out of lumber purchases. This brochure tells why. *Weyerhaeuser Forest Products, Saint Paul, Minn.—Gratis.*

HOUSE DESIGN, CONSTRUCTION AND EQUIPMENT (Publication of the President's Conference on Home Building and Home Ownership) deals with house planning and design, building construction materials and organization, heating, lighting, ventilation, sanitation, and refrigeration. It is a valuable book of 325 pages and is sold at nominal cost. It is handsomely bound in cloth. *President's Conference on Home Building and Home Ownership, New Commerce Building, Washington, D. C.—$1.15.*

CELLOPHANE BELTS AND HOW TO MAKE THEM AT HOME shows three weaves from which stylish cellophane belts can be made. These articles can be made from cellophane package wrappers. *E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

AIRPORT RATING REGULATIONS (Aeronautics Bulletin No. 16) gives the regulations as amended July 1, 1932. *Aeronautics Branch, U. S. Department of Commerce, Washington, D. C.—Gratis.*

COLLOIDAL GRAPHITE—ITS PROPERTIES, USES AND ADVANTAGES AS A LUBRICANT describes the well-known "Oildag" and "Aquadag" or graphited oil and graphited water. *Acheson Oildag Company, Port Huron, Michigan.—Gratis.*

ADVENTURE SHOP would hardly be expected to be located in the shadow of the Woolworth Building, but in the Fiala shop we find everything from sleeping bags to elephant rifles. From this curious stock whole expeditions can be outfitted. Mr. Fiala is an arctic explorer of note. The illustrated catalogue lists all kinds of material for travelers and explorers. *Fiala Outfits, Inc., 47 Warren Street, New York City.—Gratis.*

AIRCRAFT SPEED INSTRUMENTS (Report No. 420), by K. Hilding Beij, presents a concise survey of the measurement of air speed and ground speed on board aircraft. Special attention is paid to the pitot-static air-speed meter which is the standard in the United States for airplanes. A bibliography on air-speed measurement concludes the report. *Office of Aeronautical Intelligence, National Advisory Committee for Aeronautics, Washington, D. C.—Gratis.*

ZEISS REFLECTOR LAMPS, ZEISS-WISKOTT SYSTEM, AND THEIR USES describes mirror-reflectors, shop-window and shop lighting, floodlights and transparent mirrors, industrial and office lighting. Some of the effects obtained are very beautiful. *Direct Importing Company, 471 East Broad Street, Columbus, Ohio.—Gratis.*

USE OF EXPLOSIVES FOR SETTLING HIGHWAY FILLS gives a description of the practical methods employed to ensure stability of highway embankments. There are many diagrams and illustrations. *E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

BACHARACH OPTICAL PYROMETER (Bulletin 296) describes an instrument which is of value in the iron foundry, forging shop, boiler plant, and in the heat-treatment of metals. *Bacharach Industrial Instrument Company, 7000-6 Bennett Street, Homewood Station, Pittsburgh, Pa.—Gratis.*

THE SCIENTIFIC AMERICAN DIGEST

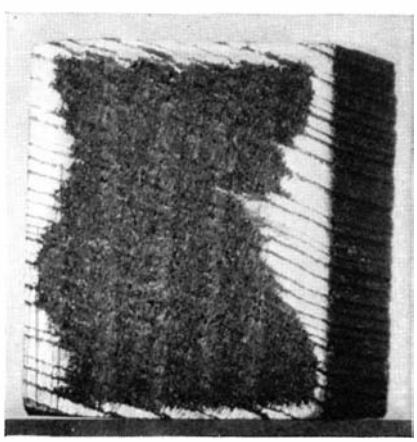
(*Continued from page* 303)

any day. The important fact that we have established is that a signal of a particular wavelength and from a particular distance is almost completely suppressed by the electronic eclipse if this eclipse area lies immediately beyond the point of observation as seen from the transmitting station. —*Dr. E. F. W. Alexanderson, Radio Consulting Engineer, General Electric Company.*

Metallized Wood

A NEW process for impregnating wood with metals was described briefly in these columns some months ago. An article by M. Naphtali of Berlin-Wilmarsdorf, Germany, in a recent issue of *Chemical and Metallurgical Engineering* gives additional details on the properties of wood so treated.

In principle, the process makes it possible to open the microscopic pores of the wood and, through them, to fill the individual cells with molten metal, while retaining the original form of the cells.



Cross-section of wood, lightly impregnated with metal, as described

Because of the latter fact, the finished product consists of a wooden structure, each cell of which has an isolated charge of metal.

The technology of the process is confined to a preliminary treatment of the wood, principally drying, after which it is immersed in molten metal and then exposed to a moderate pressure in a closed vessel. The process is readily controlled, so that the wood can be impregnated throughout. The size of the treated pieces is limited only by the size of the apparatus and the economic time limit of the treatment, which differs according to the purpose. Wooden blocks 16 by 4 by 2 inches in size are completely impregnated in a few seconds. If desirable, the metallization can be so controlled that only the cross-section of the wood is filled with metal, or that only the surfaces are impregnated to a greater or less extent, while the inner zone remains untreated.

The properties of the new material depend to some extent on the types of wood and metals selected for the impregnation. Offhand, the most conspicuous property is

the increase in weight. For example, walnut treated with tin goes as high as 3.83 in specific gravity, or more than half of tin (7.28). In the case of pine, a specific gravity of 4.83 was reached, equivalent to two thirds by volume of metal. It was not found that the tensile strength of wood is much affected either way. The hardness and compression strength, however, were notably improved in proportion to the metal content. In general they become two or three times the value for wood alone; in the case of antimony-lead alloys, considerably higher values are obtained.

The material shows up to special advantage in exposure to moisture or fire. After prolonged intense heating, when the metal has flowed from the surface, the wood will begin to glow like charcoal, but it does not otherwise support combustion. Swelling in moist atmospheres or in water is greatly reduced and even entirely prevented if the wood is strongly metallized.

Electrical conductance depends on the direction of application, as does the heat conductance. In the direction of the grain, a heavily metallized piece conducts very well, but transversely it is an insulator to practically the same degree as wood.

The workability of the material is much like that of wood. It can be planed, drilled, sawed, and so on. Hence it has already been applied experimentally to various industrial purposes, such as exterior structures in corrosive atmospheres, and for decorative purposes. However, a commercial use that has already found wide application is in bearings for various machinery, such as rolling mills.—*A. E. B.*

Alloy in Ford Brake Drums

SPECIAL brake drums have been introduced by the Ford Motor Company—the first to do so in the low-priced automobile field—in order to retain a higher factor of safety in the face of greater speeds, according to an article in *Nickel Cast Iron News.*

"Until a few years ago," the article says, "brake drums were generally manufactured from one of two types of carbon steel, each having its advantages and each serving its purpose satisfactorily. With the trend in the automotive industry toward greater and greater speed, however, manufacturers have been searching for a more suitable material for brake drums.

"It has long been known that cast iron possessed excellent resistance to wear along with good co-efficient of friction. This knowledge was applied and Ford engineers have, after much research, adopted a special alloy gray iron rear drum and a special malleable front hub and drum cast in one piece. The wearing qualities of this iron have been improved by the addition of chrome and nickel.

"Exhaustive tests both in the laboratories and on the road have proved the new drum superior to the old steel drums in brake efficiency, resistance to distortion and to scoring, and in heat conductivity."

Electronic Music

OUR photograph shows two electrical musical instruments invented and developed by Ivan Eremeeff, Russian physicist, recently demonstrated before prominent musicians and composers at the Mechanical and Photoelectric Instrument Laboratories in Philadelphia.

The instruments are connected to the amplifier and loudspeaker of a radio receiving set in order to avoid the necessity of providing each individual instrument with such equipment, and to reduce the first cost.

The source of the tones in both instruments is a system of electro-magnets and toothed magneto-type phonic wheels which are driven by a 1/20-horsepower motor.

The keys on the keyboard are stationary and are constructed of metal. The performer is seated upon a bench which has a metal top, the body of the performer thus acting as part of the circuit. The keys are very sensitive to the touch of the fingers; the greater the pressure, the more intense the volume, providing unlimited possibilities for the musician to express his individual talent. Also provided are a pedal-operated tremolo device, a diminisher attachment, and a volume-control pedal.

Unlike other electrical musical instruments developed up to the present time, these instruments have keyboards which

Two of the new instruments that produce "electronic music"

Installing heating units in electrical hotbeds

permit the player to use both hands simultaneously, as in an organ or a piano, for producing any number of tones at one time, and for playing chords as well.

For the purpose of "silent practice," the instruments are provided with ear-phone attachments permitting the player to switch the output of the instrument from the radio loudspeaker to the phones.

X Rays Cause Premature Old Age in Cancer Cells

WHEN X rays are used to treat cancer, the cells of the cancer are not killed directly but are made to live more merrily, finish their normal life more rapidly, and die of senility at an earlier age.

This answer to the hitherto unsolved problem of what happens when a cancer victim is irradiated and his cancer decreases in size was given to the American Association for the Advancement of Science by Dr. Raphael Isaacs of the University of Michigan, who made observations on 923 patients before he announced his findings.

It is expected that this discovery will be of great importance in understanding various kinds of cancer and other diseases of cell growth, such as leukemia, lymphoblastoma, and pernicious and other anemias.

Treatment of cancer by X rays results in a premature old age, Dr. Isaacs found. The premature old age occurs not in the patient but in the cells of the malignant growth with which he is afflicted. This is a case where premature senility is welcome.—*Science Service.*

Electrical Hotbeds

A NEW device perfected by engineers of the Westinghouse Electric and Manufacturing Company controls the heat for hotbeds in such manner that plants take root in half the time normally required.

The device is placed in a wooden container under the hotbed where the seedlings or sprouts are planted. Then electricity is turned on, the temperature is maintained by an automatic thermostat, and nature takes its course.

Some astonishing results have been obtained by horticulturists who have experimented with the new device. In one case it was found that in replanting cuttings of double petunias, 95 to 98 of every hundred take root when planted in electrically heated cutting benches. Previously when using the former methods an average of five out of every hundred took root.

Geraniums in electrically heated benches had a good rooting system in 18 days, while by the old method few of the "slips" rooted and those that did take root required about 30 days.

Lettuce was found to break ground in three days under the influence of the uniform temperature produced by the new heater.

In northern Illinois the growth of tomatoes under the influence of electric heat was quite pronounced; their growth was uniform and they were much larger in size than those in an adjacent bed without controlled temperature.

Two-Ply Stainless Steel

FOR many years experimentation has been conducted by large steel manufacturers in an effort to produce a low-cost stainless steel. The solution of this problem pointed to a composite metal having a stainless steel surface and a less expensive carbon steel under-surface. The difficulty has been to secure a perfect bond between the two different metals so that there will be no peeling.

Announcement has just been made by the Ingersoll Steel & Disc Company, Chicago, of such a commercially successful two-ply stainless steel. This new metal, to be known as Ingoclad stainless steel, is produced by a patented process from the composite ingot.

Many industries will find countless applications for this new metal where corrosion resistance, strength, and finish are desired. Ingoclad may be deep drawn, stamped, welded, formed and polished. It will be sold at a price that will permit its use in many applications where solid stainless steel would be prohibitive in cost.

According to Mr. R. C. Ingersoll, it has taken years of research to develop the manufacturing process to a point where a perfect bond between the stainless surface

and the carbon steel back is assured. He states that it is now being produced in various gages and sizes of sheets. Facilities will be available shortly to supply all practical commercial sizes.

Don't Worry Too Much About Your Heart

IF your heart skips a beat, if your pulse rate is faster or slower than the average, if your hands are cold and blue, don't imagine immediately that you have a bad case of heart disease. Your heart may not be involved at all, but even if it is, it is a tough organ which will probably do its work throughout your normal life span if given proper consideration. This is the advice of Dr. Frank N. Wilson, head of the University of Michigan Hospital heart station.

Imaginary heart disease, worried over and doctored with fads and nostrums, is almost as important a cause of distress to the person ridden by the idea, as are the two million genuine cases in the United States, says Dr. Wilson. "Athlete's heart," supposedly a great enlargement of the organ resulting from exercise, is a myth, such enlargement in a normal individual being in fact so slight as to be almost undetectable in the living body by the most exact methods.

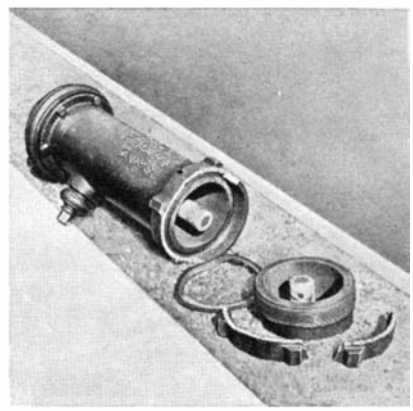
Some other ideas that are popular but not true, states Dr. Wilson, are that tobacco, tea, or coffee "soften" or otherwise injure the heart when used within any reasonable amounts; that lively exercise will injure the hearts of growing children or young adults; that a "skipping" heart indicates immediate or serious danger; that some people may not have a natural and life-long low or high heart rate which indicates no danger; that most drugs affect the heart in customary dosages, while in fact few do; that alcohol has an important effect on the heart, compared with other organs; and that cold or blue hands, dizziness, palpitation, pain over the heart, or difficulty in taking a deep breath necessarily point to organic heart trouble. These latter symptoms are very common in nervous individuals, and in youth especially are seldom due to the heart.

Though you may imagine you have heart trouble and not have it, you may also have it and not imagine it. The best policy is to take your suspected symptoms to a doctor, who by himself or with the aid of instruments in clinics can get very exact knowledge of the condition of the organ, Dr. Wilson advises. If some trouble is actually found, follow the doctor's advice as to the proper amount of exercise; don't get overweight, which gives the heart a harder pumping job; and remember that the heart is one of the strongest organs in the body, normally capable of doing more work than is called for, and with great recuperative powers, so that even if strained or diseased it may come back and outlast organs which seem to be in perfect condition.

Unique Fire Hydrant

A RECENT development in fire hydrant design, known as the Kennedy Safetop fire hydrant, is of special interest to water works superintendents, fire department chiefs, and municipal officials because of the remarkably quick time in which this hydrant can be put back into service after breakage by trucks or automobiles, and the inconsequential cost of repairs. An additional important advantage is that the water pressure need not be shut off while awaiting or making replacements.

The distinguishing feature of the hydrant is the safety breakable section which is located a few inches above the ground line. Both the standpipe and the stem of the hydrant are in two parts which abut each other at this section. The upper and



One of the easily repaired fire hydrants, disassembled to show parts

lower portions of the standpipe are threaded at their abutting ends, and a correspondingly threaded "breaking ring" holds the two portions in rigid alignment. The upper and lower portions of the stem are similarly held firmly in proper position by a coupling which is secured to each portion by a large pin.

When broken, this unique design localizes the breakage to the safety breakable section, yet this section is made to withstand without injury any impact that fire hydrants now commonly used will endure without breaking.

In case of breakage, no excavation is necessary, the only damage being to the standpipe breaking ring and stem coupling which break cleanly at their respective grooves. The entire top section of the hydrant, carrying the bronze nozzles, etc., is merely dislodged from the section in the ground without injury to the major and expensive parts of the hydrant. The hydrant can then be put back in service in less than half an hour at a total cost of less than 10 dollars for labor and materials.

Hydrogenated Lubricating Oil

ANNOUNCEMENT was made in these columns some time ago of the development of the so-called hydrogenation process for the manufacture of gasoline and lubricating oils from petroleum. At the time of the first announcement of the commercial development of this, the Bergius process, by the Standard Oil Company of New Jersey, the writer characterized it as the most significant advance in chemical technique of the last decade. In the meantime, the Standard Oil Company has completed a plant for the large-scale production of various kinds of petroleum products by the hydrogenation process whereby the chemist is able to convert crude oil into practically any desired form of hydrocarbon. The results of this development

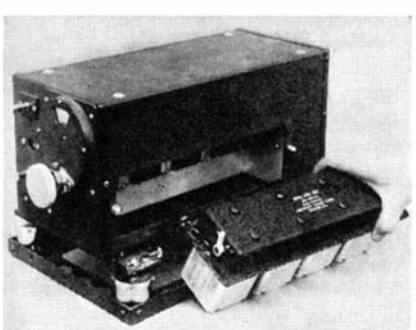
work are now made available to the public by the recent announcement by the Standard Oil Company of its new lubricating oil called Essolube. This manufactured lubricant is said to combine the best qualities of both paraffine and asphalt base lubricating oils, a combination hitherto unobtained.

On August 9, a group of representatives of the technical press and the scientific societies was given an opportunity to inspect the Standard Oil Company's new hydrogenation plant. This was the first public group to see the plant in operation. The plant is now manufacturing Essolube exclusively, although for the first five months of the year the same plant, by a slight variation in the process, was producing a special kerosene which was in heavy demand for domestic range burners. The plant has also made a hydrogenated safety gasoline for use in aircraft and motor boats. The safety feature of this fuel is that under normal conditions it will not ignite as easily as ordinary gasoline.

Of special interest to the chemical industries is a line of hydrogenated solvents for use in paint, varnish, lacquer, soap, and textile manufacture. These solvents have been found to be superior to other petroleum products since they possess characteristics more nearly resembling those of coal-tar distillates. In fact, a substitute for benzol, which has higher anti-knock characteristics than pure iso-octane, has been made by the process and marketed abroad.—*A. E. B.*

Aircraft Radio Covers Two Wavebands

TRANSPORT planes customarily carry two complete radio receivers, one for the Department of Commerce weather and radio-range service in the band of 235 to 350 kilocycles, and the second for reception of signals from ground stations operating in the range of 3000 to 6000 kilocycles. Receivers used heretofore by Eastern Air Transport are capable of covering either band by use of gang plug-in coil sets



Dual-range coils for aircraft radio

but now the development of a "dual range coil set" means that one receiver will be capable of covering either band by the snap of a switch.

No internal changes in receivers already in service are necessary. The original plug-in coil set is merely replaced by the dual coil set. The reduction in equipment and installation costs and the reduction of weight and space requirements for radio make this development of interest particularly for the one-pilot type of ship.

Aircraft Radio Corporation of Boonton, New Jersey, is credited with the design which was undertaken at the request of F. E. Gray, Radio Engineer for Eastern Air Transport.

More Car Power With Redesigned Cooling

COMPLETE reversal of the present concept of engine design will give the 12-cylinder automobile of tomorrow the power of today's 16, according to a report of experiments conducted in the engineering laboratory of the Ethyl Gasoline Corporation, Detroit, under C. D. Hawley, assistant director.

The increase in power, Mr. Hawley declares, will be produced by improvement in what is now regarded as a necessary evil—the cooling system.

Today, Mr. Hawley points out, the engine is built first, and the cooling system installed in the space left. In the future, the process will be literally reversed, he predicts, the most effective amount of cooling space being estimated first, and the engine built in whatever space remains.

"Tests made to learn the value of greater cooling capacity than is built into present cars," Mr. Hawley reports, "have shown that increases in power heretofore expected from larger engines can be more efficiently realized from changes in design to provide better cooling of cylinders and engine parts.

"These tests have shown that as much as a third more power can be gotten under test conditions from a modern high compression engine by merely improving its cooling system.

"Increases in engine size add to the weight of the car at the same time that they increase its power, and this greater weight materially reduces the ability of the car to make a quick getaway in traffic. Exhaustive tests indicate that acceleration from a standing start is more important in fast automobile travel than top speed on the stretch. To permit maximum acceleration, the power output of the motor must be increased with a minimum additional weight.

"More power without added weight is being secured by the use of high-compression engines designed to use anti-knock fuels, but other developments must accompany this if full efficiency is to be realized.

"Smaller engines with larger cooling systems and radiators will yield increased power without adding to the car's weight.

"Cooling of valves and valve seats and even special cooling of the moving pistons themselves yields greater power than the best present high-compression engines, and at the same time increases the life of engine parts. Valves, whose failures are often unjustly blamed on every possible cause, can be made to last several times as long if proper precautions are taken to keep them and their seats cool."

Improved Phosphate Fertilizer

A NEW method for the preparation of phosphate fertilizer in which raw calcium phosphate is completely converted into soluble phosphate, has been introduced in France. In the process, lead chloride is used as an intermediary reagent in a hydrochloric acid solution which, with calcium

phosphate, gives lead chlorophosphate and calcium chloride. The lead chlorophosphate treated with nitric acid gives lead nitrate, and the phosphoric acid remains in solution in the nitric acid medium. The lead nitrate is removed by treating with potassium chloride and a mixture of potassium nitrate, and lead chloride is thus obtained. The latter is used again in the cycle of operations, and at the end a mixture containing nitric acid and phosphoric acid remains. This mixture, when saturated with ammonia, gives a soluble fertilizer, in which the whole of the phosphoric acid is in a soluble state. It is reported that the method has already been put into operation on a semi-industrial basis.—*A. E. B.*

A Carillon Without Bells

DESPITE the fact that there are no bells or even metal tubes in a new carillon tower in the Lakeview Memorial Park, New Jersey, beautiful chime music pours from it. The bell-like tones are produced by a new electric carillon recently

developed by the RCA Victor Company, at Camden, New Jersey. The tower contains simply a sound projector system which sends forth the amplified notes from a number of tuned metal reeds in the chapel building, a thousand feet distant.

As the carillonneur, Bernard R. Mausert, depresses the keys on a 49-note keyboard of an organ-like console, tiny metal hammers strike the reeds and the resultant musical vibrations are amplified and sent electrically to the sound-projecting "carillon" tower.

United States Supplies World with Carbon Black

CARBON black, a jet-black, finely divided material obtained by the incomplete combustion of natural gas, is of world importance and annual sales of the product by the American industry to domestic and foreign markets aggregate over 10,000,000 dollars.

Since the initial production of a few hundred pounds of carbon black shortly after the Civil War, the industry has grown rapidly, as may be evidenced from the record output of 379,942,000 pounds in 1930. This high level was not maintained last year when production dropped to 280,907,000 pounds.

The United States Bureau of Mines reports that 58 plants were operating last year, or 10 less than in 1930. Texas is the leading state for the production of carbon black and the industry centered in the Panhandle and Breckenridge districts supplied about 79 percent of the total output during 1931. Louisiana was second, furnishing approximately 20 percent. Other suppliers were Montana, Oklahoma, Utah, and Wyoming.

The rubber industry is the principal consumer of carbon black, using about 83 percent of the total production as a pigment and filler in tires and rubber goods. The second important use of the black is as a pigment for the preparation of inks and paints. In addition, the product is utilized also as an ingredient in the manufacture of carbon paper, polishes, phonograph records, paper, artificial stone, crayons, and a number of other products.

Left: **The console of the carillon without bells.** *Above:* **The tower**

The United States is the world's only source of supply of carbon black. Several foreign countries have surplus quantities of natural gas but do not manufacture the black. Some countries, especially Germany, have devoted considerable time to research work, in an effort to prepare a black pigment which would compare favorably with carbon black, but results have been unsatisfactory.—*A. E. B.*

Malaria Treatment of Insanity Unsuccessful in Negroes

THE now famous malaria treatment of the brain and nervous disease, paresis, has proved unsuccessful in Negroes, whom it is almost impossible to infect with the usual malaria germs, it appears from a report of Dr. Bruce Mayne, special expert of the United States Public Health Service. Dr. Mayne has been in charge of the breeding of special strains of mosquitoes to be used in giving the malaria to paresis patients.

Dr. Mayne found that Negroes and also many white adults are very resistant to the benign tertian strain of malaria, the strain commonly used in treatment of paresis. When inoculated with blood containing the germs of the quartan strain of malaria, however, Negroes developed severe attacks of malaria. Since a large number of paresis

patients are Negroes, Dr. Mayne has been trying to infect mosquitoes with the quartan strain for use in treating them. Blood containing the germs of this strain is not always available, and cannot be kept longer than 48 hours. So far Dr. Mayne has not been able to develop mosquitoes which will carry the quartan strain and infect patients with it by biting them. However, he has been able to infect mosquitoes with the benign tertian strain by bites on a good malaria carrier.

Dr. Mayne's work has been carried on with the co-operation of the authorities at the State Hospital for the Insane at Columbia, South Carolina. There Dr. Mayne has set up his laboratory, installed coolers, fans, humidifiers, and ice-boxes, and there he breeds the mosquitoes which he infects with malaria and subsequently ships to distant hospitals, out of the malaria belt, for use in treatments. The infected mosquitoes are shipped by express, packed in ice, and are accompanied by an attendant, unless a trained entomologist will be on hand to take charge of them on their arrival at their destination.—*Science Service.*

Huge Platinum Reflectors

A 60-inch searchlight reflector which has an absolutely non-tarnishing surface produced through the use of platinum metals has just been made for the United States Army by the Bart Laboratories of Newark, New Jersey. According to Blasius Bart, the reflector, which was made by an all-electrolytic process perfected by him after 14 years of research, took six months to complete. His laboratory is said to be the only place in the world where these large metal reflectors can now be made.

Inclined "Elevator" for Stairways

FOR those to whom stairways are a hardship, for invalids or semi-invalids, a new inclined elevator called the Inclinator has been developed by the Watson Elevator Company, Inc., of New York. It may be installed beside the stairs of any residence, either in the original plans or after the stairs are built.

The Inclin-ator consists of a two-seated car that is operated in a steel channel rail which is fastened to each step of the stairway close up to the wall. A steel cable raises and lowers it, and a half-horsepower electric motor, generally installed in the basement, provides the motive power. An up-and-down button on the car itself and others at both the top and bottom landings give perfect control of the car; but in addition, the car stops automatically at the top and bottom.

When the Inclin-ator is not in use, the two seats fold up so that there is no restriction of the customary use of the staircase.

How Celluloid Happened to be Discovered

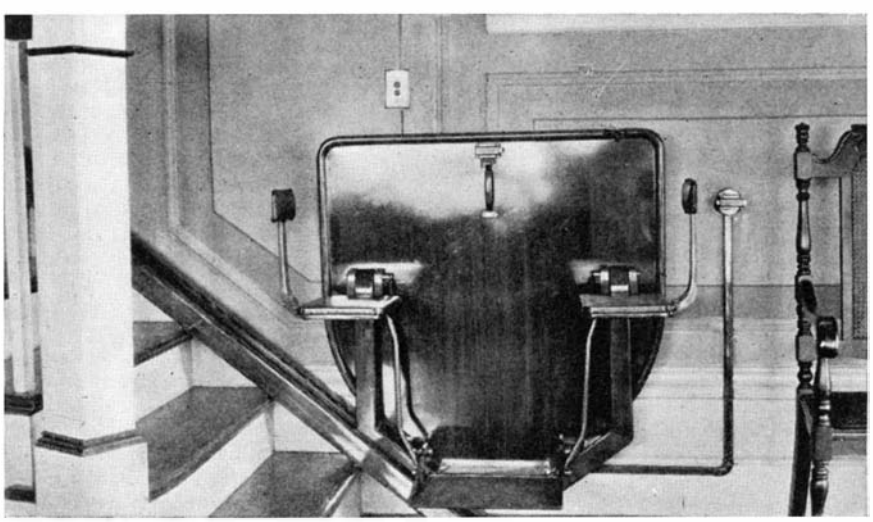
CELLULOID owes its origin, not to a chemist, but to a young printer whose fingers were sore from handling type. The story of this discovery which gave us this material of such universal usefulness is told in the *Hercules Mixer.*

About 1863, John Wesley Hyatt, a young printer living in Albany, began experimenting to discover a satisfactory substitute for ivory in the manufacture of billiard balls, because of a 10,000-dollar prize offered for such an invention. Setting type in the sixties was hard on the hands and one day, Hyatt, finding his fingers getting raw, went to the cupboard for the "liquid cuticle" used by printers. He found the bottle had tipped over, and the nitrocellulose solution had run out and solidified on the shelf. He found it tough and elastic, and it occurred to him that it might be the material for which he was looking.

Hyatt had heard that camphor could be used with pyroxylin, so he simply mixed these two materials together, put the mixture in a hot press, with the result that the two materials combined, and when the press was opened there was a clear, solid homogeneous block of what he named "celluloid."—*A. E. B.*

Florida Vine Shows High Rubber Content

A HYBRID rubber vine which yields twice as much rubber as either of its parents has been produced by the United States Department of Agriculture near Miami, Florida. It is a cross between two plants, both native to Madagascar, one long grown in Florida as an ornamental plant, and the other naturalized in many places in Mexico and the West Indies.



An inclined "elevator" for homes, that operates on the staircase

The planting of Madagascar rubber vines as ornamentals is spreading rapidly in Florida, Arizona, and southern California.

The new hybrid rubber vine showed a rubber content between 4 and 5 percent in monthly periods of analysis, reaching nearly 7 percent in some cases. The vines of the parent species seldom yield more than 3 percent.

Because the seed of the hybrid does not run true and produce the same type of plant as the hybrid itself, the rubber workers propagate new plants by cuttings. The vine is a perennial and once planted, a regular production of rubber might be practicable. Propagation methods are being studied to increase the supply of hybrid material, but none is available for distribution at present.

The department is also experimenting with desert plants which grow in southern Arizona and California and which show prospects for rubber production. The most promising is a native milkweed that could be grown in large quantities in the desert districts, in the event that a domestic production of rubber became necessary.

Chemical Insulation for Telephone Wire

IN the telephone plants of the Bell System, a large quantity of textile insulated wire is used for wiring switchboards. The constant demand for better insulation has recently been met by a process for coating the ordinary textile insulation with a thin film of cellulose acetate—the same material from which non-flammable moving picture film is made. The method developed consists of passing the textile insulated wire through an acetone solution of cellulose acetate. The wire passes through this solution several times, the excess solution being removed and the coating allowed to dry after each immersion. The cellulose acetate film on the wire is dried by a rapid circulation of warm dry air. The acetone thus vaporized is recovered for re-use by absorbing it in activated carbon.

This contribution of chemistry to the electrical industry has resulted in a very efficient insulation which has the advantage of not materially increasing the diameter of the wire.—*A. E. B.*

Non-Lumping Sugar Good for Diet

THE housewife's trouble with lumpy sugar may soon be a thing of the past. Science has found a substance which, added in the manufacture of sugar, prevents lumping and caking. This same substance, calcium phosphate, has been shown to have valuable health properties and provides the elements essential for the development of bones and teeth.

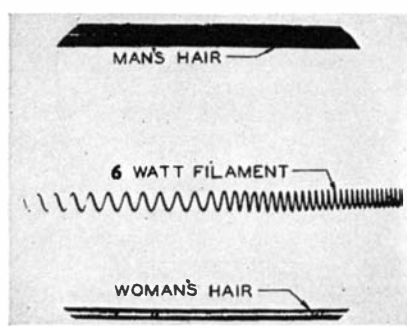
"The addition of 1 percent of tri-calcium phosphate," H. V. Moss, chief chemist of the Provident Chemical Works of St. Louis, declared in a recent report, "completely prevented the formation of lumps in XXXX powdered sugar on standing for 53 days under the normal summer conditions prevailing in St. Louis.

"Calcium phosphate seems especially suitable for use as a sugar conditioner because recent bio-chemical research has shown that it is a valuable addition to the diet. The diet of many Americans, especially those who eat large quantities of white flour and sugar, may be deficient in calcium and phosphorus, which are needed for building bones, keeping the teeth from decay, and preventing the premature appearance of old age. Both white flour and sugar are largely deprived of their original content of these elements during the refining processes, and it seems to be a step in the right direction to restore them to the popular foods."

Invisible Wire Hair

TUNGSTEN filament wire used in the Westinghouse Mazda six-watt incandescent lamp is so fine it is practically invisible. Only four ten-thousandths of an inch in diameter, it is a fifth as thick as the hair of a woman's head and a tenth the size of that on a man's head. After it is coiled, 1390 turns per linear inch, to form the spring-like lamp filament, the outside diameter of the coil is still less than that of human hair.

All six-watt filament wire is drawn from a bar of tungsten three eighths of an inch square, 24 inches long, and weighing one and one third pounds. The bar passes through 95 dies, each with an aperture slightly smaller than the preceding one.



Magnified view of the new filament wire, compared with human hairs

Nearly two thirds of these dies are rough-cut diamonds in which tiny holes have been drilled.

A bar of this metal stretches into wire 207 miles long, enough to provide filament for 666,666 of the lamps. Two weeks of 48 working hours each are necessary to draw one bar into the finished filament wire. In the final drawing the wire moves at a constant speed of 105 feet per minute.

One of the biggest problems confronting modern manufacturing precision in the wire drawing division of the Westinghouse Lamp Company in Bloomfield, New Jersey, is the supply of diamond dies. Trevoux, a little town in central France, is the center of the world supply of these dies. Almost the entire population there is engaged in this tedious task, having inherited their skill. All day long they sit at manually operated machines drilling diamond dies of all sizes. Cheap labor and a skill founded on years of experience enable the people of Trevoux to maintain their position of prominence in this strange art.

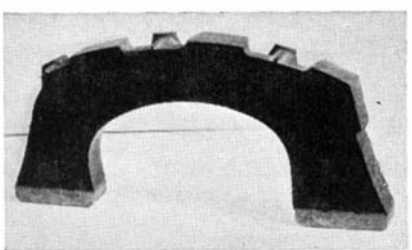
When being drilled, the diamonds are placed in revolving spindles, and hard steel needles, which have been dipped in diamond dust, press against them at the point designated for the hole. The hole is conical in shape and is drilled exactly half way through both sides of the diamond. Where

the apex of each cone meets, barely enough to break through, the tiny hole forms the die.

Six-watt filament wire in its final drawing passes through a drilled diamond which is about the size of a pin point. So delicate is the task of drilling a tiny hole in a mere speck of a diamond that often as many as 30 attempts are made before a good die results.

"Zero Pressure" Tractor Tires

FOLLOWING three years of experimental work, announcement has just been made by The B. F. Goodrich Company, of Akron, Ohio, of a new type of high traction tire known as the "Zero Pressure" and perfected to meet the needs of tractor service. The manufacturers believe that the "Zero Pressure" tire, which has been successful in road work during a long experimental period, can be adapted to all kinds of work that a tractor is called upon to perform in a manner that has never before



been possible with pneumatic or solid tire equipment.

It is called "Zero Pressure" because, although it has cushioning qualities, it has no air under pressure within the tire.

The tire is designed to provide a snowshoe effect in loose or soft soil, or sand, having a tread which deflects readily under load and provides unusual tractive qualities. As the tire is not under air pressure, no penetrating obstacle can damage it or cause delay, nor does it bounce when it strikes an obstruction. It is flexible but not resilient. The tire rides easily, will not damage pavements, requires no inflation, and allows the equipment to operate at a greater efficiency than has heretofore been possible with either solid or pneumatic tires.

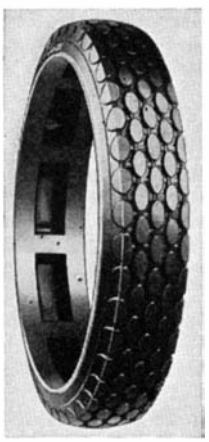
The new tire consists of a rubber arch built on a slotted steel base for application to solid tire wheels. The piers of the arch are of sufficient size and rigidity to provide ample carrying capacity. The all-rubber arch is very flexible, and gives full tread contact.

Skimming Milk Often by Feeding It to Cows

SOME dairymen are finding profitable a practice which virtually amounts to skimming the milk once, and then skimming it again—and again. This is possible only in districts where butter is the principal dairy product and a quantity of skim milk is a by-product.

One way to use the by-product is to feed it to the dairy cows that produced it. The cows require a protein supplement in their ration. The butter maker, however, is interested in the fat. Ordinarily the dairyman feeds a high-protein supplement, such as one of the oil meals. But skim milk contains most of the protein which the dairy cow consumes and does not require for her maintenance. The protein is less concentrated than it is in an oil meal, but it is in an easily available form. Where skim milk is cheap it may be an economical source of protein.

The Bureau of Dairy Industry, United States Department of Agriculture, calls attention to recent feeding tests at the University of Minnesota which indicate that eight pounds of skim milk will take the place of one pound of linseed-oil meal. Knowing the local prices of meal and



Left: **Cross-section of a zero-pressure tire.** *Above:* **Tire on steel base**

skim milk, it is easy for the dairyman to calculate which is the cheaper for him to feed.

When the dairyman feeds skim milk for its protein he sets up what amounts to a circular movement of milk from the cow to the separator and back through the cow to the milk pail. Each time as it passes through the separator he skims the cream and sends the milk back to gather more cream within the cow.

Few cows will drink the skim milk when it is offered to them unmixed with some other feed. The practice at the Minnesota station was to mix the skim milk with the grain feed in a pail and then pour it over the silage. Obviously the quantity of skim milk that can be fed without waste depends upon the quantity of grain and upon its liquid-holding capacity. On account of the fact that cows in summer often receive no silage and but little grain, and as skim milk is very attractive to flies, there is no doubt that skim milk is more advantageously fed in the winter than in the summer.

Sharp Freezer Blades Make Better Ice-Cream

FOLKS who still prefer home-made ice-cream to the more convenient factory-made product will be interested in a rather unusual investigation reported by R. C. Munkwitz and Devoe Meade in a recent bulletin of the University of Maryland Agricultural Experiment Station. After experimenting with various ice-cream freezers, the investigators found that sharp blades on the freezer mechanism produce better ice-cream with less elbow-grease than is possible in a freezer in which the blades have been dulled by long use. Not only is the freezer easier to turn, but the freezing time is cut in half and the texture improved when sharp blades are used.—*A. E. B.*

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Member of the New York Bar

Mushroom Piling Patent Valid

THE United States District Court for the District of New Jersey, at Camden, New Jersey, in an opinion by District Judge John Boyd Avis, recently decided a patent infringement suit of interest to engineers and those engaged in the construction of foundations in beach or water-bearing sand. The suit was instituted by James Ferry Company, Inc., of Atlantic City against Atlantic Construction Company and Anthony Paul Miller, both of Atlantic City. James Ferry Company, Inc. charged the defendants with having infringed patent number 1593445 by installing concrete mushroom piling, utilizing the method patented in said patent. After an extensive trial during which many witnesses were called by both parties, the Court held that the patent was valid and had been infringed.

In his decision Judge Avis found as a matter of law:

> That the patent discloses a method of installing mushroom piling in beach sand, including the lowering of the subterranean water level to a predetermined artificial level by means of well points, such artificial level to be at the approximate top of the proposed mushroom chamber, then digging a hole with a post hole digger or other similar means, and then when the hole is at a point corresponding with the top of the mushroom to be constructed, inserting a metal shell into the excavation the lower end of which is at the top of the proposed mushroom; then continuing to dig and to cause caving and running of the wet sand surrounding and below the lower end of the metal shell, the continued digging causing the wet sand to run to the low point and to be withdrawn by the digger or other similar means, and thus creating an area of excavation of such proportions as may be desired, into which the concrete is poured from the ground level. The patent also discloses such a method without inserting the metal shell.

The Ferry company, owner of the patent, has made extensive use of the patented method in the installation of concrete mushroom piles in the construction of foundations in and about Atlantic City and along the beach front. During the trial it developed that the Ferry company had utilized the method in the installation of approximately 900 concrete mushroom piles in the foundation of Haddon Hall, one of the largest beach front hotels.

MR. LIDDY will be pleased to answer the inquiries of our readers who may desire information relative to the various subjects reported in his department.
—The Editor.

Unfair Competition Suppressed

THE Federal Trade Commission has ordered Bulova Watch Company, New York, to discontinue certain unfair methods of competition. Representing that its watches contain a designated number of jewels is prohibited unless the watches contain the stated number of jewels, "each and every one of which jewels serve a mechanical purpose as a frictional bearing."

Bulova is also directed to stop asserting that its watches are "adjusted" or "adj." so as to imply that they have been adjusted to heat, cold, isochronism and position, unless they have been actually so adjusted, as the term is generally understood in the watch-making industry and by the purchasing public.

Patent Applications and Business Cycles

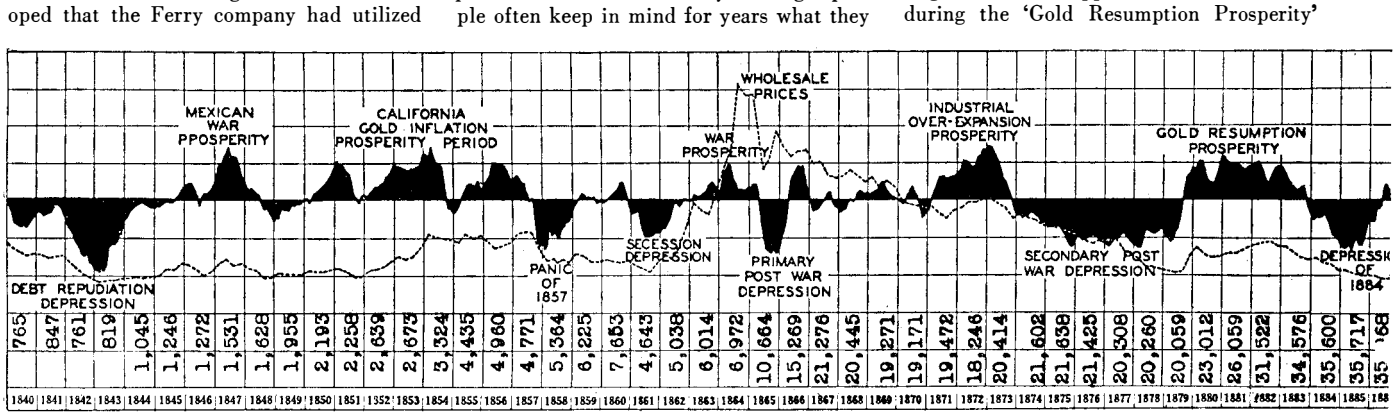
IN some quarters the belief has long been current that the number of patent applications submitted to the United States Patent Office always bears a consistently distinct relationship with the rise and fall of business. Some have held that, taking into account a certain time lag, applications rise and fall in a direct proportion to business conditions. Experience seemed to show other interested persons that as a depression began to make itself felt, patent applications increased by more than normal expectancy for a time and then slumped. The explanation given for this supposed phenomenon is that many average people often keep in mind for years what they believe are patentable ideas and never think very seriously of them until, feeling the need for more money in times of stress, decide to use their savings to obtain a patent.

Opinions differed as to this variation in number of patent applications and no one seemed to know just what the correct answer is. We, therefore, asked the Commissioner of Patents, the Hon. Thomas E. Robertson, for an opinion. In order that he might have as a guide in checking up from Patent Office records the number of applications since the year 1840 we forwarded to him an accurate graph of business conditions which was prepared by The Cleveland Trust Company and a section of which is reproduced below with their kind permission. Upon it Commissioner Robertson has had filled in the patent applications yearly from 1840 through 1931. Careful study of this graph, while giving very little indication of consistency during comparable periods, will prove illuminating. As Commissioner Robertson says ". . . the rise and fall with respect to incoming patent applications has not at all coincided with the rise and fall of business."

Quoting further, he says: "I have had filled in in this chart the number of applications received in each calendar year since 1840 and I am returning it herewith so that you may be able to see for yourself the accuracy of the statement just made. In other words, you will find that, while the applications fell off during the 'Secession Depression,' they had a marked jump during the 'Primary Post War (Civil War) Depression,' the number of applications jumping from 6900 to 10,000, 15,000, and 21,000 during that depression.

"Moreover, during the period from 1870 to 1873, which is described as an 'Industrial Over-Expansion Prosperity' period, the number of applications filed was actually less than in 1867 and 1868, both of which are marked as years having a slight depression. Then, the 'Secondary Post War Depression' showed an increase in the number of applications received for the first three years of that depression.

"Contrary to my statement (above), a large number of applications was received during the 'Gold Resumption Prosperity'



Business cycles and patent applications since 1840, commented

from 1880 to 1883. But, on the other hand, the depression of 1884 did not show a falling off of applications. The number of applications received during that depression was the largest received in the history of the Patent Office up to that time. The 'Panic of 1893' did show a slight falling off; contrariwise, the 'Silver Campaign Depression' of 1895 to 1897 showed a marked increase in the number of applications received. Again, the 'Rich Man's Panic' in the years 1903 and 1904 showed the largest number of applications ever received up to that time. Likewise, the 'Panic of 1907' shows the largest number of applications received up to that year. The depression of 1911 showed an increase of 5000 applications received; but, most marked of all, is the 'Primary Post War Depression' of 1921 and 1922 when the number of applications very materially increased."

Public Patent on Sediment Trap

A PUBLIC patent on a vortex tube and deflector riffle sand trap to remove sand and heavy debris carried by irrigation streams has just been issued to R. L. Parshall, of the Bureau of Agricultural Engineering, Department of Agriculture. The most serious problems in operation and maintenance of irrigation canal systems are those relating to deposits of sand and gravel carried by the stream. It has been estimated that the cost of removing material deposited in the canal system of the Imperial Valley, which is fed by the Colorado River, is a million dollars annually. This cost does not include injuries to the land itself or other incidental items.

The traps were designed as an economical method of removing sediment from canals, and have been installed in several channels in Colorado. In one experimental installation, the trap removed, Mr. Parshall estimated, 60 tons of sand in a day.

Sand and gravel in irrigation canals affect the accurate measurement of flow of water and decrease the carrying capacity of the canal through the deposition of bars, and otherwise raise the bed of the stream. When the silt carried in the canal is deposited in great quantities upon irrigated lands it destroys and injures the land.

The vortex trap is a tapered tube in the floor of a flume built in the canal. The tube lies diagonally across the stream and has a wide slit the full length of its upper side which is placed level with the floor of the flume. The sand and debris are discharged from the end of the tube through the side of the flume into a supplemental outlet channel.

The deflector riffles are short triangular plates fastened to the floor of the flume upstream from the tube, and set diagonally with the water flow. They cause debris to move to the side of the canal for discharge through the wall of the flume.

The trap is beneficial to farmers in keeping heavy sediment out of canals, and is also useful to power plants in removing sediment and debris that would injure machinery. It may also be used to eliminate sediment in municipal water supplies, to segregate foreign matter in sewage disposal plants, to wash and clarify concrete aggregate and to grade sands for building purposes. A further use is in placer and diamond mining and in concentration and separation of ores.

Federal Trade Commission Reversed

WE quote below, in part, a recent decision handed down by Circuit Judge Manton, of the United States Circuit Court of Appeals, Second Circuit, reversing an order of the Federal Trade Commission regarding testimonials in advertising. The Commission's order was published on page 189 of our March 1932 issue.

"This is a petition to review an order of the Federal Trade Commission ordering the petitioner to cease and desist in its advertising and use of testimonials and endorsements of its toilet articles and preparations, for which testimonials or endorsements the petitioner has paid substantial sums of money without disclosing that fact in the advertisements. The petitioner concedes that it paid, to certain well-known persons of the theatrical and social life of the community, substantial sums for consent to use their testimonials with their signatures thereto. The statements contained in the testimonials, the Commission expressly found, were truthful expressions of opinion of and concerning petitioner's products. They accurately set forth the opinion of each of the several authors of the testimonials or recommendations. The Commission, however, found that the failure to disclose that the petitioner paid substantial sums of money to the persons named for the testimonials 'has the capacity and tendency to mislead and deceive the ultimate purchasers of said preparations into the erroneous belief that said testimonials are entirely voluntary and unbought, and tends to and does divert trade from competitors who do not use purchased testimonials in advertising their products.'

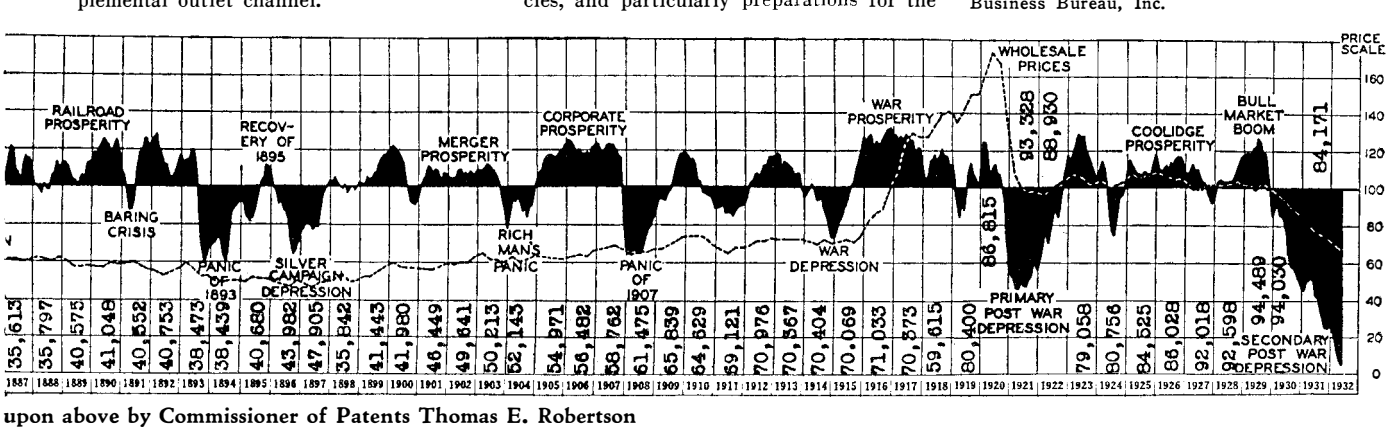
"The petitioner is a New York corporation engaged in manufacturing toilet articles, and particularly preparations for the care of finger nails and cuticle which are sold under the trade name of 'Cutex'. . . . There is no claim of misbranding, falsity, or insufficiency in the statement labeling the product. . . . The endorsements are said to be neither exaggerations nor untruthful. There is no claim of monopoly. It would seem, therefore, that there was no violation of the Sherman Anti-Trust or Clayton Acts. While the testimonials, if having merit, may tend to increase the volume of business, still, if an honest opinion is expressed under the signature of the giver of such testimonial, the public cannot be presumed to be induced to purchase the petitioner's products in any way or manner that might be said to tend to divert trade from competitors who do not use testimonials in advertising their products. It is doubtful if the public is gullible enough to believe that such testimonials are given without compensation. But if they are paid for, providing they are truthful, no one is deceived. . . .

"The Federal Trade Commission Act does not purport to establish a decalogue of good business manners or morals. Its purpose is to strike down at their inception practices which are unfair and which, if permitted to run their full course, would result in the creation of a monopoly and an undue restraint of trade. . . . The Commission does not suggest that these testimonials tend to create a monopoly; they do not have a tendency to create an undue restraint of trade. The strongest argument the respondent makes is that failure to state the price paid for the testimonials amounts to deception and misrepresentation concerning the petitioner's product and in that way the petitioner is able to deprive honest manufacturers of a market. . . .

"The use of testimonials, which are truthfully stated under the signature of the giver, cannot in any sense be regarded as unfair competition or as involving a tendency to restrain competition unduly, and the Commission was without jurisdiction to interfere. . . . Because a prominent person ventures an opinion without being requested to do so is no guaranty either of veracity or good judgment. If the testimonials involved here represent honest beliefs of the endorsers, there is no misrepresentation concerning the product, and no unfair competition is created. We have no right to presume that endorsers of commercial products falsify their statements because they have received compensation. There are no misrepresentations and the Commission was without jurisdiction.

"Order reversed."

Abstracted from a report of the National Better Business Bureau, Inc.



upon above by Commissioner of Patents Thomas E. Robertson

Books SELECTED BY THE EDITORS

RADIO OPERATING QUESTIONS AND ANSWERS

By Arthur R. Nilson, Lt. U. S. N. R. (Ret.), M. I. R. E., and J. L. Hornung, A. M. I. R. E., Radio Inst., N. Y. U.

THIS, the fourth edition of a well-known work, has been completely revised and brought up-to-the-minute. Although a large part of the third edition (1930) has been retained intact, extensive alterations and additions have been made throughout. This book was originally intended for students and operators who are about to take a government examination for a radio operator's license, but its scope is so broad and the information is given in such compact form that it will serve as a handy reference book for anyone who has to deal with the practical operation of radio equipment. The question-and-answer form of the text makes for conciseness in handling data relative to all forms of commercial and amateur transmitters and receivers, as well as aeronautical and police radio, air beacons, meteorological work, and the teletype. 356 pages, profusely illustrated with photographs and drawings.—$2.65 postpaid.—*A. P. P.*

RADIO ENGINEERING

By Frederick Emmons Terman, Sc. D., Assoc. Prof. of E. E., Stanford U.

A BOOK especially prepared for the electrical engineer and the advanced student who is desirous of obtaining a thorough grounding in radio phenomena. The text is arranged in two parts, the first of which treats the theory of tuned circuits and the properties of vacuum tubes. The second part deals with special phases of radio work such as specific receivers and transmitters, antennas, radio measurements, and sound and sound equipment. The book is the easiest reading of any similar text that we have found, yet it is a thorough-going treatise that does not skimp on theory in an effort to be "popular."—$5.25 postpaid.—*A. P. P.*

PHOTOCELLS AND THEIR APPLICATION

By V. K. Zworykin and E. D. Wilson

THIS second edition has been greatly enlarged to include a fresh wealth of information and record the significant advances since this well received text made its appearance. Five new chapters have been added and all has been rearranged and augmented, thus telling the last word in a field which had no bibliography in book form. We predict the new material will make as wide a sale as the first edition enjoyed.—$3.20 postpaid.

REWINDING SMALL MOTORS

By D. H. Braymer and A. C. Roe

MARKED increase in the use of small motors for special services, as in refrigerators, oil burners, washing machines, vacuum machines, etc., necessitated the revision and enlargement of the first edition to give the operating characteristics and construction of the later designs. Here in detail with abundant diagrams, will be found all necessary information for the care and repair of fractional horsepower motors of every description. Included in the appendix is the elimination of radio interference due to the use of small motors. A broad, practical treatise.—$2.65 postpaid.

THE CURATIVE VALUE OF LIGHT

By Edgar Mayer, M. D.

THOUSANDS take sun-baths. Thousands use health lamps. Hundreds of thousands think sun-burn or excessive tan is healthful yet to this vast public the true facts are little known. Here is a book which gives the facts clearly, concisely and honestly. It tells you what light can do and what it *can't*. It tells you how and how long to take your sun bath and what dangers you run from getting excessive tan. It tells you how to use a sun-lamp and what type of lamp to buy. In fact it tells the medical truth in order to right many wide-spread misconceptions and to explode unfounded claims.—$1.65 postpaid.

INDUSTRIAL PSYCHOLOGY

By Morris S. Viteles, Dept. of Psychology, Univ. of Penn.

SUCH authorities as Walter V. Bingham have said of this book: "Industrial investigators and students will recognize in these pages the authority of a scholar who also knows industry at first hand."

Not since the broad outlines of techno-psychology were first sketched by Munsterberg, twenty years ago, has a monumental work on this subject appeared. We use the adjective advisedly for this text 6 x 9½, runs 633 pages plus 17 pages of index. It represents a tremendous effort and covers all available references. It must stand for years as the standard work on this subject.—$5.75 postpaid.

A NEW DEAL

By Stuart Chase

JUST how the author, though a well-known writer, can qualify as an economist is not at all apparent to this reviewer, for even his "Men and Machines" did not indicate any particular grasp of economics and his "Mexico" and other books were anything but along this line. However, it is good mental discipline to read and digest what one does not agree with, though certainly inflation, which is the panacea held out in this book as the cure-all for all our economic ills, cannot find any justification from this review.—$2.15 postpaid.

THE NATION AT WAR

By Peyton C. March

CLEAR cut and straight from the shoulder our Chief of Staff during the World War tells the story of the inside workings of the War Department in procurement, training and sustaining our A. E. F. on various fronts. The author says just what he thinks and does not hesitate to step on anyone's toes, if he disagrees with them. It is a compact, well sustained narrative, backed by documentary evidence of practically all the events discussed. Above all it is a good story.—$3.20 postpaid.

BETWEEN THE BIG PARADES

By F. W. Ward, Adjt. Gen'l N. Y. State

THIS *is* a different war book. It views from a larger aspect than any other we have read, the historic background of the scenes and places encountered, the movements and plans of operation, the inter-relation of situations, while not omitting the anecdote and coloring. All the horror and stark ghastliness is given its due portent, yet none of the degrading and below standard phases are accentuated as they have been ad nauseam in other books. It is well worth reading no matter how much of this sort of literature you have seen, for as

we said before it is different, and in a very acceptable way.—$2.65 postpaid.

BEHIND THE DOOR OF DELUSION

By "Inmate—Ward 8"

HERE is a book every thoughtful person should read, for after all the care of our dependent population must be the serious concern of everyone. The author was committed to the insane "hospital" as a dipsomaniac, so with faculties perfectly normal save the insatiable craving for liquor he sees things as they really are, not even as the doctors and attendants see them. A newspaper man, high in social circles, fraternizes with the real "bugs" and gives you his reactions. Probably there has been published no other book that so intelligently and constructively tells what is and what should be, for it does not go as deeply into the psychology of the mind as does Beers' "A Mind That Found Itself." It should, however, rank with the latter as a supplement and be read by everyone who has his civic responsibility at heart.—$2.15 postpaid.

WINGS OVER POLAND

By Kenneth M. Murray

THIS is the first account of the Kosciuszko Escadrille, that daring bunch of American and Polish aviators who rendered such precious assistance against the Russian Cossacks. Based on a train of flat cars they were shunted to any front where they were needed, bombing bridges and cavalry trains, raking the mobilized enemy with machine guns and covering the stupendous retreat of the Polish army. Thrilling, reckless daring against impossible odds, yet all ending in victory and with their work done, a quiet return homeward of all but three who rest near a beautiful monument—the grateful remembrance of an appreciative nation. A book no one should miss.—$3.20 postpaid.

THE PENNS OF PENNSYLVANIA

By Arthur Pound

AS in "Johnson of the Mohawks" the author has here combined the journalist's sense of the startling with the historian's respect for accuracy. This also is good reading as it is good history, as important in the early days of this nation as any one other consideration. Valiant service during the Restoration period brought this princely grant of territory to the son of Admiral William Penn. The son then changing from courtier and soldier to Quaker and pacifist, though a shrewd politician in tight places. No direct descendants remain, yet the varied stamp of the Penn characters has left an indelible impression on Colonial history.—$3.65 postpaid.

VAN LOON'S GEOGRAPHY

IN his own inimitable way, the author presents the earth and its resources as they relate to human beings. Not statistics and dry outlines and the memorized placing of rivers and cities and "boundries"—those nightmares of our childhood—but information that has something to do with each of us; subjective not objective.

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By J. C. Colcord, W. C. Koplovitz and R. H. Kurtz

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CHINA: YESTERDAY AND TODAY

By E. T. Williams, Prof. Oriental Languages, U. of California

FORMERLY a United States Official in China and with a background steeped in history, the author's first edition at once was accepted as the standard work on the subject. This the fifth edition brings the status up to the spring of 1932. A voluminous work of 743 pages which is a "must" for libraries and research shelves. An agreeable fluent style of writing overcomes the usual staid, text-booky atmosphere and one reads on scarcely realizing the erudite knowledge upon which the facts are based.—$4.20 postpaid.

A GAME OF GOLF

By Francis Ouimet

THOSE of us who have been following golf championships for many years, though we may not now play, will enjoy this modest, entertaining story of the experiences of one of our soundest and most consistent players. Before Bobby Jones began to burn up tournaments, to the present day when he has retired, Ouimet has been playing along winning more than his share of matches. It is a tale to bring back old memories as it runs along compelling one's interest.—$2.65 postpaid.

OUR WONDERLAND OF BUREAUCRACY

By James M. Beck

EMINENT as a constitutional lawyer, the author studies the growth of bureaucracy in the Federal Government and its destructive effect on the constitution. Here are concrete examples of the weaknesses and evils of the system, a frank statement of the inquisitorial and regulatory activities of the Interstate Commerce Commission, The Federal Trade Commission, and so on, and the bureaucratic invasion of states rights in such matters as agriculture, roads, and education. He favors a radical re-organization of the whole Federal system and discusses past efforts in this direction. A masterly and thought provoking work that will be widely quoted.—$3.20 postpaid.

SONS OF THE WILD JACKASS

By Ray Tucker

HERE is a remarkable situation. The publisher writes a foreword in which he acknowledges giving the author a commission to write the book, yet when it is ready it is found to be in entire variance from the ideas of the publisher. What to do? Well, the answer is the book. Few will agree with the author that all the Insurgents in Congress are such demi-gods as they are here portrayed, for most of them have little background to warrant the pose of mentors on every subject that arises. We agree with the publisher that they are self-advertised political opportunists. However, it does one no harm to read the other side of the picture, even if its very extremeness destroys its convincingness.—$3.20 postpaid.

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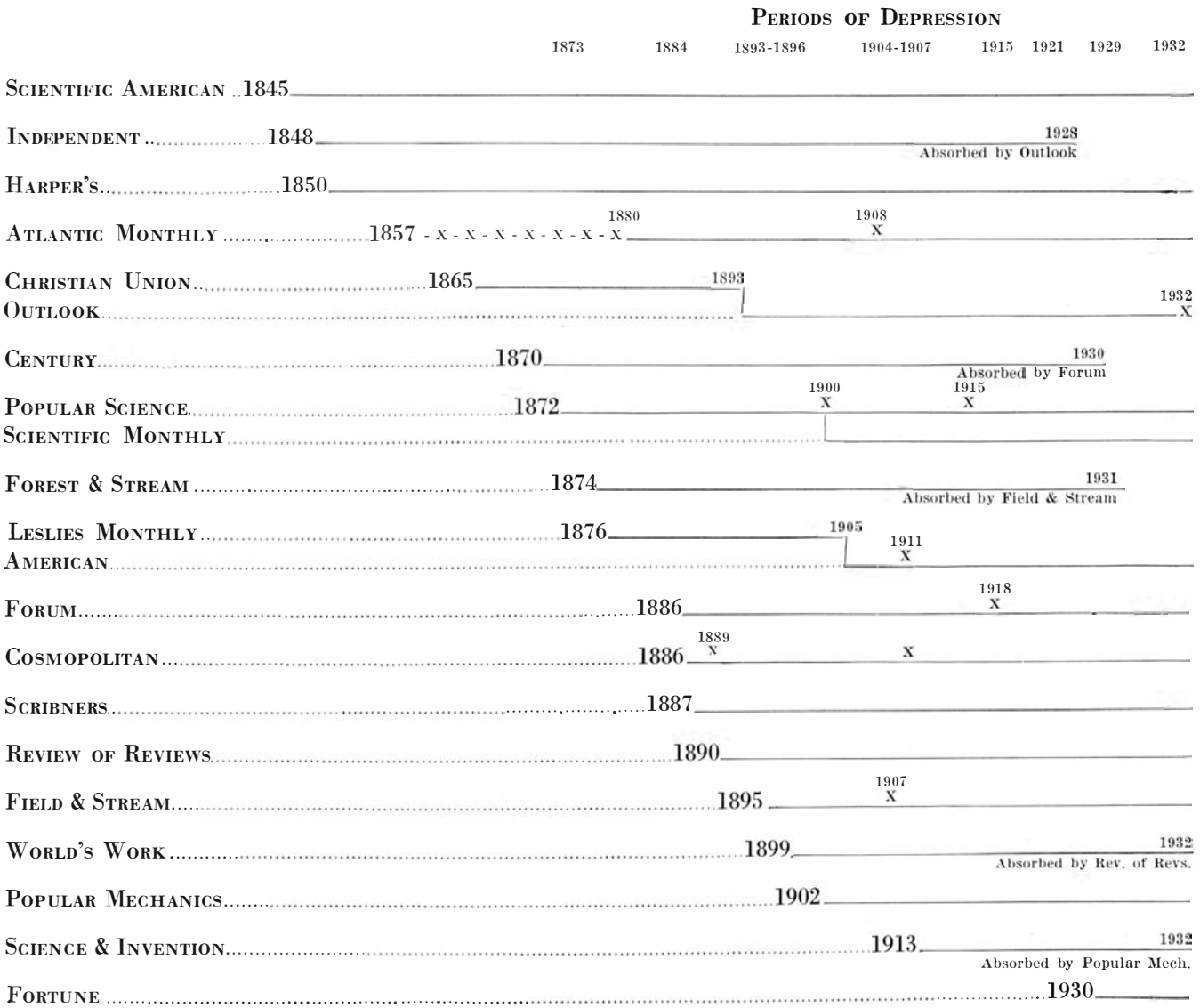

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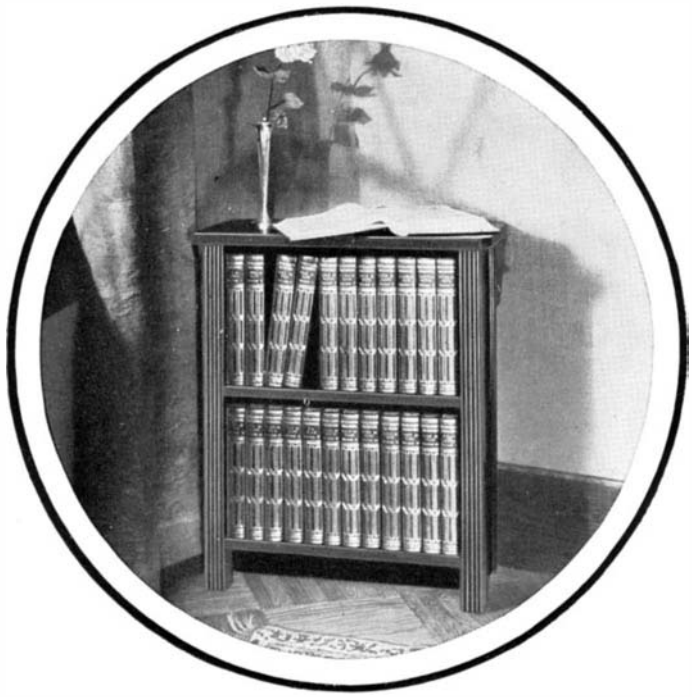

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