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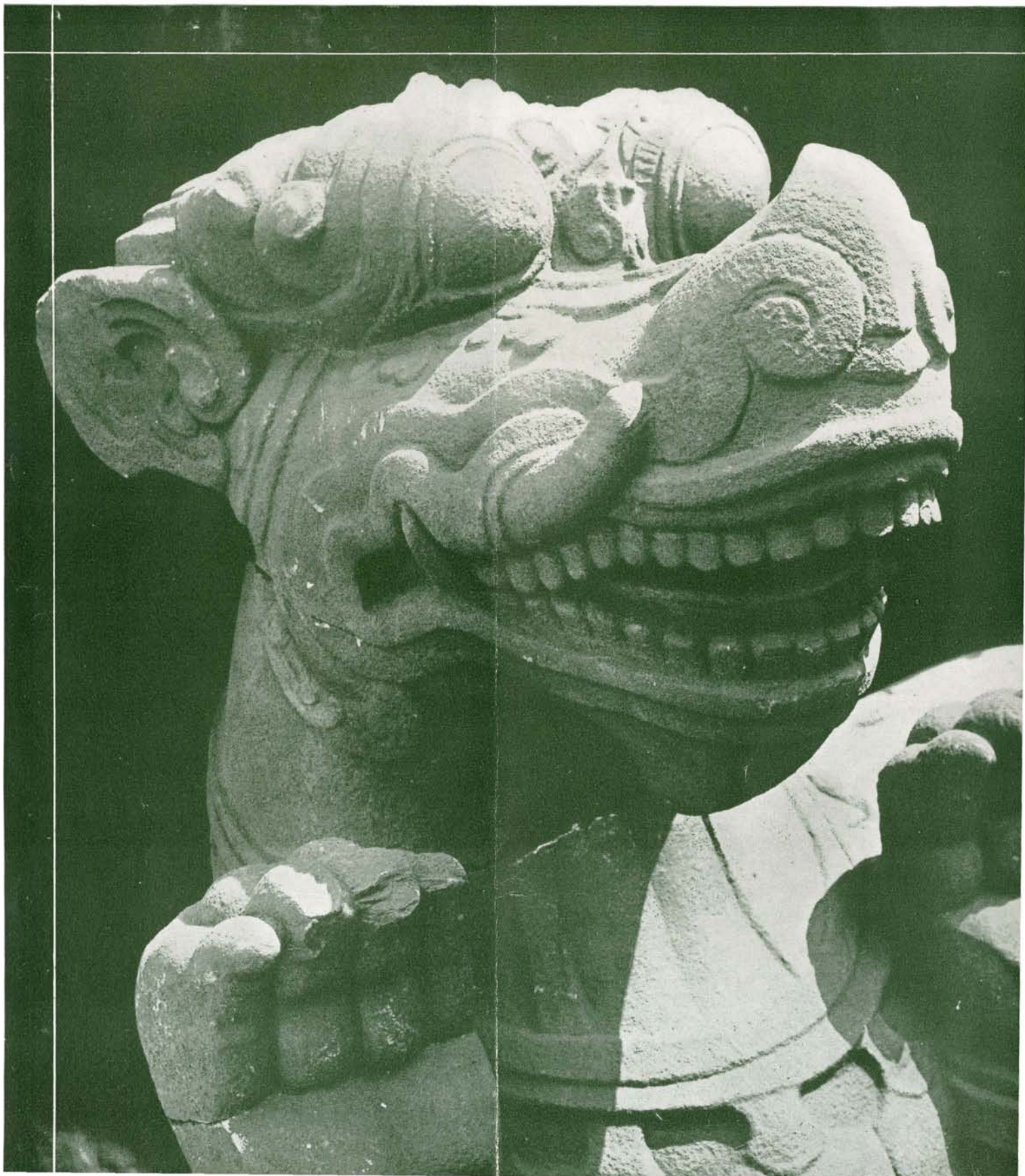

A Personality, A Promise, An Invitation

To Readers of Scientific American:

PROFESSOR Alexander Klemin needs no introduction to old readers of Scientific American, who have benefited by his regular monthly contributions as associate editor for the past 10 years. It seems fitting to remind readers both old and new of the wealth of knowledge and experience that lies behind every sentence that Professor Klemin writes, for even a casual examination of his distinguished record amply proves his unique equipment to compress years of research, knowledge, and experience into a brief paragraph or even a single sentence.

Relying upon the helpful co-operation of our contributing editors, our Editor, Orson D. Munn, with the able assistance of the staff, each member of which is a distinguished specialist in his field, promises a dynamic, vital, and helpful editorial program for the coming year.

A significant example of the timeliness of our editorial coverage, was the publication of articles on cosmic rays in our September, 1935, issue, research on these mysterious rays from outer space being the primary purpose of the stratosphere flight from the hills of Dakota scheduled for early fall. Although the successful flight of Captains Stevens and Anderson was delayed, our readers received, three months prior to the actual achievement, the background information on cosmic rays. When the new information, secured through the successful venture, is scientifically evaluated, our readers will be informed of the result.

Our Research-Leaders-Help-Us-Edit program for 1936 assures the reader that no important development in research and science will escape his attention. You, too, can help us edit, by suggesting subjects that you would like to have included.

KLEMIN, ALEXANDER: Honor Graduate London University, B.Sc.; Massachusetts Institute of Technology, M.Sc. (Aeronautical Engineering). LL.D., 1934, by Kenyon, conferred for advances in aeronautical science. Instructor in Aeronautics, Massachusetts Institute of Technology, in charge of Aerodynamic Laboratory; during World War. Consultant in Aerodynamics, Bureau of Aeronautics, Navy Department. Officer in charge of Research Department, McCook Field, Dayton, Ohio. Consulting Aeronautical Engineer. Among clients served: U. S. Air Mail Service in technical problems; Aeronautics Branch, Department of Commerce; Fairchild Aviation Company; Sikorsky Aircraft and others. Gave first course in Aeronautics at New York University. Now Professor, in charge Daniel Guggenheim School of Aeronautics, New York University. Chairman, Aeronautics Division. The American Society of Mechanical Engineers; Acting Chairman Committee on Aeronautics, American Engineering Council. Professional Societies: American Society of Mechanical Engineers; Society of Automotive Engineers; Royal Aeronautical Society; Fellow of the Institute of Aeronautical Sciences. Books: "Airplane Stress Analysis"—Ronald Press, New York; "Text Book of Aeronautical Engineering"—Isaac Pitman & Sons, London, England; "Simplified Aerodynamics"—Goodheart Wilcox Corp., Chicago, Illinois—"If You Want to Fly"—Coward McCann, New York.

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

The SCIENTIFIC AMERICAN DIGEST

CONTENTS · JANUARY · 1936

COVER

FRENCH archeologists in Annam, a part of Indo-China, recently excavated a number of striking sculptures which were found to belong to a civilization of Hindu origin which existed in that country and dated back almost to the beginning of the Christian era. One of these sculptures, shown on the front cover, was an architectural decoration and has a dragon mask. The length of the sculpture is 66 inches. Further details of the excavations are given on page 4.

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

IT IS frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for January 1886 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?

ORSON D. MUNN, *Editor and Publisher*

DON'T BLOW OUT THE GAS!—"A new device is designed to prevent all danger arising through the ignorance or carelessness of persons who blow out a gas jet. By means of a simple contrivance, which is reliable in its action and is operated by the force of the wind necessary to blow out the light, the cock is turned and the supply cut off."

STEAM CARRIAGES—"Street locomotion by steam has just made a great stride in the domain of practice. Messrs. Dion. Bouton & Trepardoux have succeeded in manufacturing steam vehicles of all sorts and of all dimensions from the tricycle up to the largest omnibuses and merchandise vans. This result is the outcome of their quick-vaporizing, circulatory, inexplosive boiler, which is applicable to all the industries in general."

ARTIFICIAL LEATHER—"Artificial leather is, according to a French invention recently patented, made by a cotton fabric, the warp threads of which are very slightly twisted, and the weft threads of which are finer than usual. This fabric is serrated on both sides, and immersed in a preparation consisting of a decoction of linseed, rabbit skin glue, linseed oil, and coloring matter."

ELECTRIC RAILWAY—"The city of South Bend, Ind., has introduced an electric street railway. The system in use, the Van Depoele railway, has been in successful operation at Toronto, Canada, for the past two years, and it is expected to be introduced shortly into Minneapolis and Detroit. The railway at South Bend is operated by an electric current transmitted by overhead wires."

GLASS FLOORS—"The substitution of glass flooring for boards continues to increase in Paris, this being especially the case in those business structures in which the cellars are used as offices. At the bank of the Credit Lyonnais, the whole of the ground in front is paved with large squares of roughened glass embedded in a strong iron frame, and in the cellars beneath there is sufficient light, even on dull days, to enable clerks to work without gas."

MECHANICAL HORSES—"*Chamber's Journal* mentions a gentleman who, being prevented, by physical disqualification, from continuing the exercise on horseback which had always been so beneficial to his health, was possessed with the singular notion that it would be possible to construct a machine which, when seated upon, could be made to evolve the same action as a galloping horse. The inventor made his machine; it answered its purpose to his complete satisfaction; and the device having been patented, it has recently been manufactured and brought before the public."

PHONING TO SHIPS—"For the last eight months the Telegraph Construction and Maintenance Company has had several of its best operatives located in the neighborhood of the Naze, off which the most dangerous sands round England are to be found. These gentlemen are hourly in communication by telephone with a lightship which is anchored ten miles out, in the vicinity of the Swin passage. It was considered improbable that the human voice would be conducted ten miles, especially in rough weather; but this has been now proved to be thoroughly practicable."

LELAND STANFORD JR. UNIVERSITY—"Senator Stanford, of San Francisco, has executed a deed of trust by which lands and funds to the value of $20,000,000 have been devoted to the establishment of a great university at Palo Alto, Cal."

KEELY MOTOR—"One of our contemporaries reports that Isabella, ex-Queen of Spain, is not only an owner of considerable real estate in Philadelphia, but is a shareholder in the Keely motor. From the same source we learn that the motor Keely promises positively to mote very soon, but it begins to be believed that his mote is the much-quoted one which is all in his eye."

INSECT TRAPS—"During the past summer the insect destroyer shown in the accompanying engraving gave most satisfactory results during thorough and practical tests by the inventor, Mr. Dudley H. Manning, of Sibley, Iowa. The under surface of the conical top, through the center of which the chimney passes, is bright, as are also the partitions that extend inward from the upright of the frame and carry the socket for receiving the lamp."

AUTOMATIC STEERING—"The old war vessel *Tallapoosa*, which has been undergoing a thorough overhauling at the Brooklyn Navy Yard, has among other improvements been supplied with an electrical steering apparatus, by which the ship guides her own course automatically. The automatic action is obtained by means of an electrical mechanism, which is attached to the compass."

GRASSHOPPERS—"It is reported that the citizens of Helena, Arkansas, were recently aroused early in the morning by what seemed to be a heavy rainstorm, but they found the sky perfectly clear, and the air full of dark flakes which afterward proved to be a cloud of grasshoppers. They pattered against the roofs and windows of the houses in large numbers."

HEARING AID—"A prize is offered, of 3000 francs, by Baron Leon de Lenval, of Nice, France, for the best readily portable instrument constructed according to the principle of the microphone, for improvement of hearing in cases of partial deafness."

AND NOW FOR THE FUTURE

¶The Carbon Monoxide Danger in Driving Automobiles, by Prof. Lawrence A. Clousing. How to Avoid it.

¶High Voltage Experiments that May Have a Definite Effect on Power Transmission, by Andrew R. Boone.

¶A Pure Science Article by Prof. E. U. Condon, on the Conversion of Matter into Energy.

¶American Archeology — The Great Serpent Mound in Ohio, by Capt. Dache M. Reeves.

¶Radium from the Arctic Used in the Fight Against Cancer, by James Montagnes.

Personalities in Science

© Bachrach

MAJOR EDWIN H. ARMSTRONG

MAJOR Edwin H. Armstrong, professor of electrical engineering in Columbia University, recently gave the first public demonstration of his new staticless radio system before the Institute of Radio Engineers, which in 1917 awarded him its medal of honor for "engineering and scientific achievements in relation to regeneration and the generation of oscillations by vacuum tubes."

Born in New York City on December 18, 1890, Major Armstrong commenced research with the vacuum tube during his freshman year at Columbia in 1908. In 1912, while still an undergraduate, he invented the regenerative circuit for high frequency oscillations, which revolutionized radio transmission and receiving apparatus and is the basis of modern radio. He was graduated from Columbia with the degree of Electrical Engineer in 1913. In 1929, Columbia conferred upon him the honorary degree of Doctor of Science.

Twenty-one years of effort to achieve a radio system devoid of static began in April, 1914, when Major Armstrong started investigations with the late Prof. Michael I. Pupin in the Marcellus Hartley laboratories of Columbia University. In April, 1935, Major Armstrong announced that he had successfully developed an ultra short-wave frequency modulation system which eliminates static, fading, and tube noises.

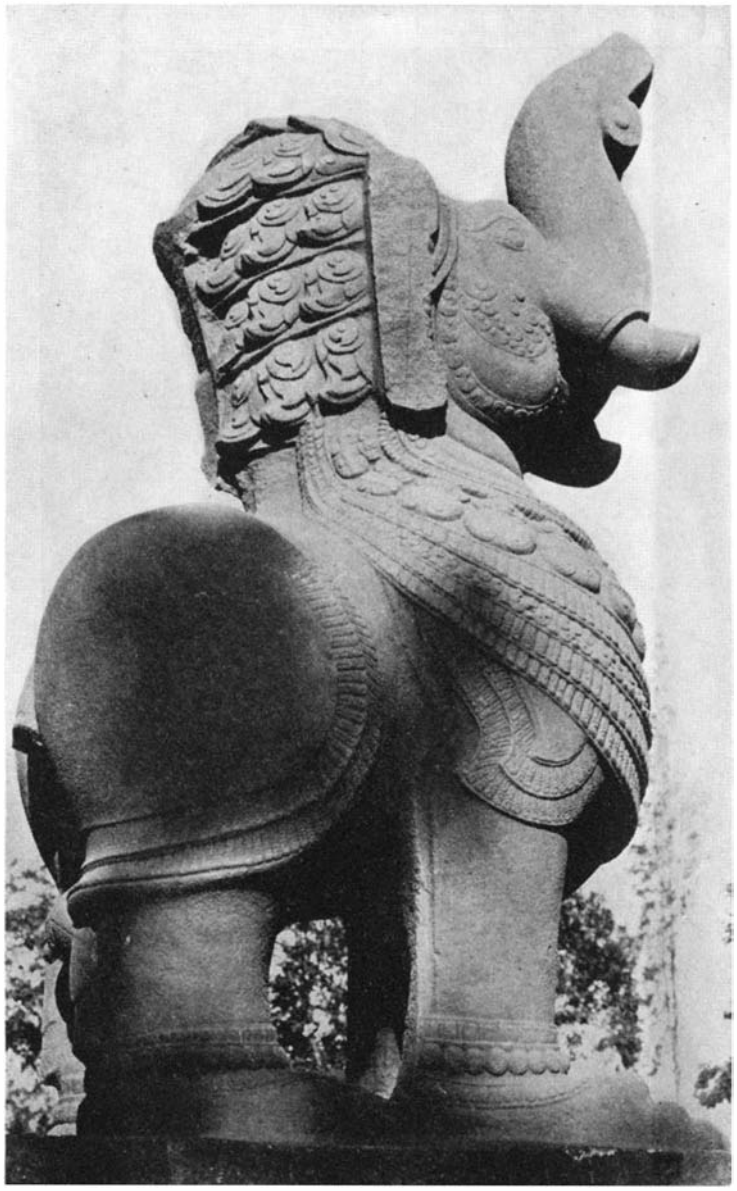
Major Armstrong invented the superheterodyne, universally used in broadcast reception, while serving overseas in the Signal Corps of the A. E. F. during the World War. After the War he continued his work with Prof. Pupin until 1922. In 1920 he discovered the super-regenerative circuit, which is widely employed in ultra short-wave police communication, in airplane equipment, and in amateur communication.

By 1922, Prof. Pupin and Major Armstrong felt that they had exhausted every possibility. Prof. Pupin turned to other investigations, but Major Armstrong continued to devise new theories and to prove each of them wrong. The first glimmering came in 1924. After years of work following that lead, he arrived at the theory of frequency modulation. Major Armstrong estimates that for this period of investigation between 50,000 and 100,000 measurements are now preserved in records. The work came within the class once described by Thomas A. Edison as "10 percent inspiration and 90 percent perspiration." Success was not due to any brilliant idea suddenly plucked out of thin air, but to painstaking experimentation which frequently required a set-up in which more than 100 vacuum tubes operated at one time, and the use of every measuring instrument known to the radio art.

The key discovery of the new system consists in introducing into the transmitted wave a characteristic which does not exist in the waves produced by nature. A receiving system is then used which is not responsive to waves of natural origin, but only to the waves having the special characteristic.

Besides discovering the essential principle of the new system, Major Armstrong had to invent numerous pieces of apparatus to put it into working shape. The system will principally be used in ultra-short and micro-wave signalling, as the frequency band required is greater than may be used on the normal broadcast wavelengths. The band width used at present on seven meters is about 150,000 cycles.

Frequency modulation is diametrically opposed to amplitude modulation, now used in broadcasting. With the special arrangements of the Armstrong system, static will not affect it even when lightning strikes within the immediate vicinity of the antenna. More than one program can be simultaneously transmitted, using one transmitter and one receiver. Facsimile copies of printed matter have been transmitted on the same wavelength simultaneously with a musical program. Receivers must be especially designed for the system. Selective fading, causing musical instruments to produce strange noises, and speech to become unintelligible, is non-existent.

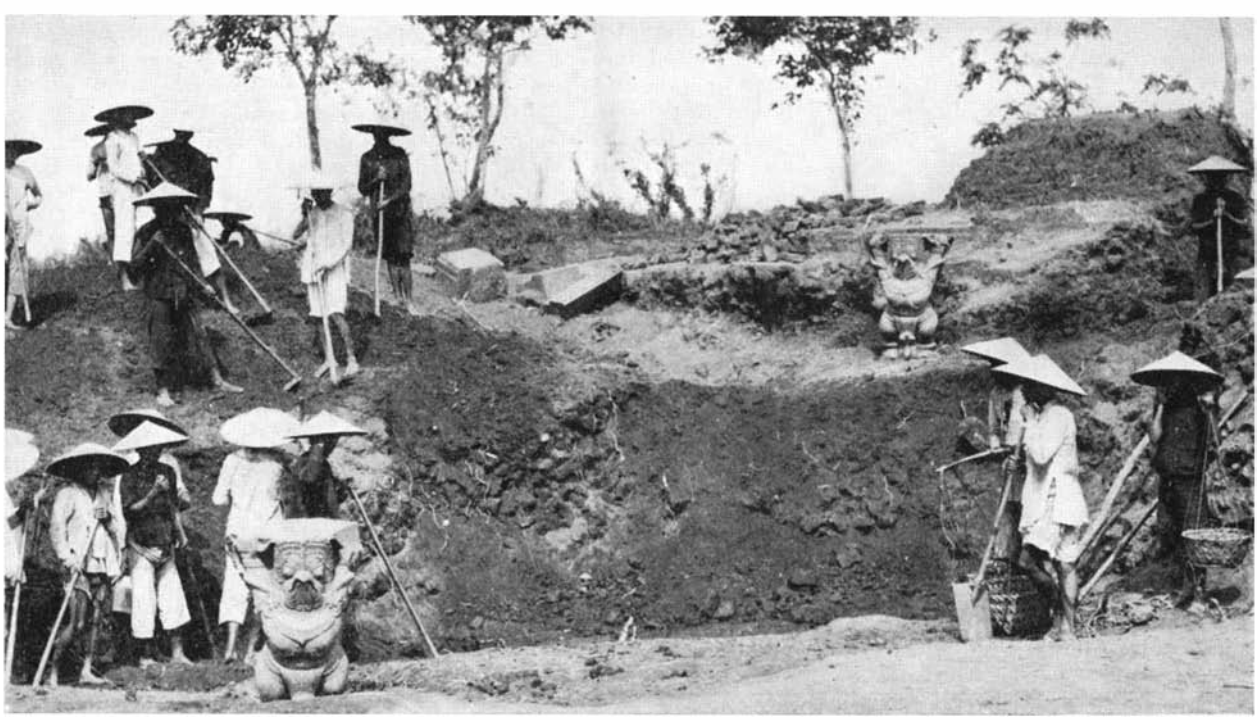


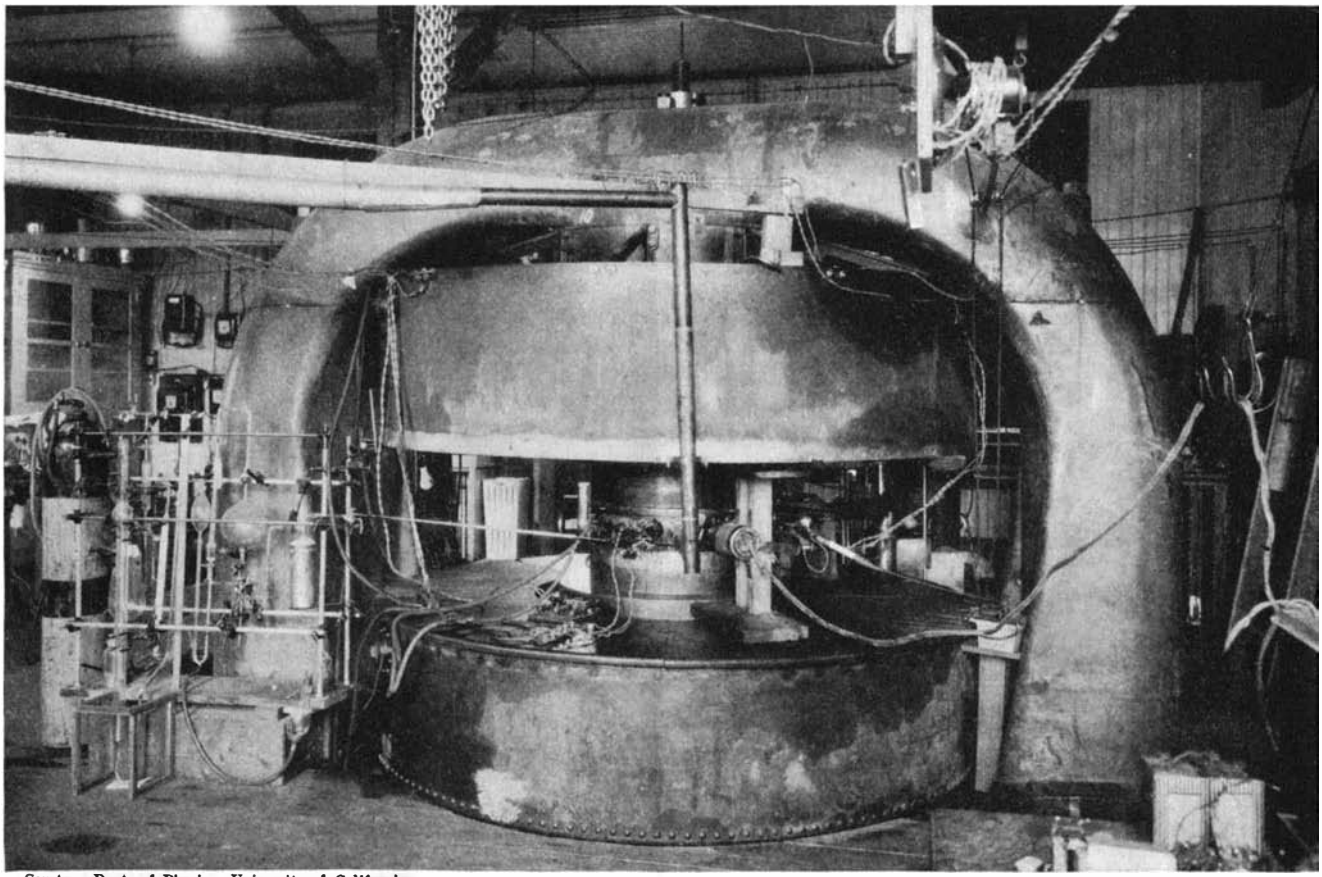
ANCIENT ART REVEALED BY A PEASANT'S PLOW

EAST of India, and occupying the Indo-Chinese Peninsula south of China, lie three countries, Burma, Siam, and French Indo-China. The coastal strip of French Indo-China, along the South China Sea, is Annam. Before the French conquest (1884), Annam was a self-ruled empire, and before the time of that empire there was another empire, the Kingdom of Champa. Inscriptions discovered by the French have indicated that this Cham Empire, of antiquity about equal to that of the Christian Era, was of Indian origin, for the inscriptions were in Sanscrit. How this first civilization in Annam spread there from India, which is 1400 miles air-line distance and 3000 miles by sea—the only practicable route—is a question in itself. Recently a peasant in Annam, while plowing, struck on a stone which obstructed his plow, and he therefore stopped to dig it out. The "dig" proved longer than he anticipated; for the stone was the upraised trunk of the stone elephant shown in the illustration at the left, seven feet in height. Agitated and fearing reprisals from the spirits of the Beyond, according to Jean Yves Claeys, Inspector of the Archeological Service of the French School of the Far East, who gives the account in the *Illustrated London News*, he rushed to the mandarins, and thus the archeologists got wind of the find. It dates from somewhere between the 11th and the 15th Centuries.

Left: **The stone elephant, after excavation**

Below: **Excavating other sculptures nearby**





Courtesy Dept. of Physics, University of California

The 80-ton cyclatron of Prof. Ernest O. Lawrence of the University of California. It consists essentially of an immense electro-magnet, between whose large pole pieces there is a large, flat, vacuum tank. In this circular tank ions are set in motion and kept whirling in a circular path by the magnetic field, at each revolution gaining velocity. Finally they are flung with immense speed and terrific energy at the chosen targets. The effect is equal to that given by a potential difference of 2,000,000 volts, and the apparatus is used in connection with the atomic research described by Professor Condon

ARTIFICIAL 'RADIUM'

Making Other Elements Artificially Radio-Active . . . What Happens . . . Central Importance in Physics Today . . . Treatment of Cancer

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

RADIUM is the best known of a group of chemical elements, known as the radio-active elements, which have the property of spontaneously emitting various kinds of radiation in the process of an atomic disintegration. The radiations emitted, especially the gamma rays, have proved useful in the treatment of cancer. These naturally occurring radio-active substances are of great rarity and consequently of great expense. Therefore the recent discovery of means of making other elements artificially radio-active marks an advance in physics which may easily prove to be a great boon to medicine.

By writing "radium" instead of radium in the title, it was intended to indicate that what is now being produced in the physical laboratory artificially is not the chemical element radium, but artificially radio-active substances which have in common with radium the property of spontaneously emitting the radiations which are known to have therapeutic value.

The important discovery that matter may be made artificially radio-active is an outgrowth of the great burst of experimental discoveries that have been made in the physics of the atomic nucleus within the past five years. First publication of the discovery was made on January 15, 1934, by Irène Curie, daughter of the famous discoverer of radium, and F. Joliot, her husband. For this discovery they were awarded the 1935 Nobel Prize in chemistry. Since their pioneer work, others have extended and confirmed the original observations, so that studies on artificial radio-activity now form an important part of the research program of a number of leading laboratories of the world. Especially noteworthy in the subsequent developments has been the work of Enrico Fermi and collaborators in Rome, of Lord Rutherford and his co-workers in Cambridge, England, and of Ernest Lawrence at the University of California in Berkeley.

In order to get a clear understanding

of the recent discoveries it is necessary to recall a little of the general picture of the structure of the atom as revealed by physical research in the 20 years since Bohr built his atomic theory on the picture of the nuclear atom as developed by Lord Rutherford. According to this picture, every atom is constructed out of a central massive part called the nucleus, surrounded by one or more small units of negative electricity called electrons. The nucleus carries a charge of positive electricity, so that the whole atom is electrically neutral. Different chemical elements are characterized by having different numbers of electrons around the nucleus: the number of electrons around the nucleus of an atom is called its atomic number. The arrangement and behavior of these electrons is almost entirely responsible for the chemical properties of the atom, and great progress in understanding just how these electrons behave in the formation of chemical compounds has been made since the discovery of the principles of wave or quantum mechanics ten years ago. Chemical elements are known corresponding to atomic numbers up to 92, which is uranium, although a great many of the elements are very rare. The ones which are naturally radio-active correspond to the large values of the atomic number; thus uranium is radio-active. But the ones which play a prominent part in current researches on nuclear physics are those of low atomic number, for a reason that will be brought out later. For that reason, and to fix the ideas, it is convenient to have at hand the following short list of the elements of low atomic number:

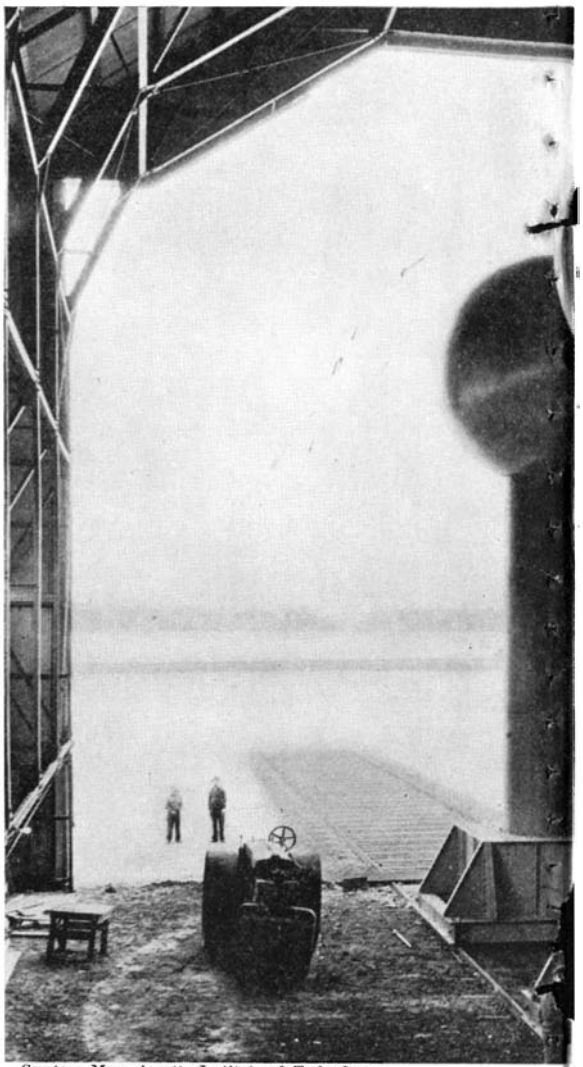
Name of element	Number of electrons outside nucleus	Chemical Symbol
Hydrogen	1	H
Helium	2	He
Lithium	3	Li
Beryllium	4	Be
Boron	5	B
Carbon	6	C
Nitrogen	7	N
Oxygen	8	O
Fluorine	9	F
Neon	10	Ne
Sodium	11	Na
Magnesium	12	Mg
Aluminum	13	Al
Silicon	14	Si
Phosphorus	15	P
Sulfur	16	S

IN the last column is given the abbreviation by which chemists refer to these various elements. Every one of these elements, it will be noticed, is one of fairly common occurrence and well-known in daily life.

Thus the number of electrons outside the nucleus is definitely correlated with the nature of the chemical element. But there is a way in which different atoms of the same element may differ; namely, in the mass or weight of the nucleus. On the whole the different masses of atoms of the same element usually do not differ a great deal, and the chemical behavior is only slightly influenced by the mass of the nucleus anyway, so for most of chemistry it is not important to distinguish between the different *isotopes*, which is the technical name for the elements of like atomic number but differing atomic weight. However, a difference in mass means a different structure to the nucleus, and so different isotopes must be counted as different substances altogether, when we are interested in the structure of the nucleus of the atom. The most striking case in which the chemical behavior of two isotopes is appreciably different is that of hydrogen. The rare isotope, of mass twice that of ordinary hydrogen, is sufficiently different in its chemical properties, so that the gas of such atoms has been given a special name, deuterium. The discovery of this isotope of hydrogen, for which Professor H. C. Urey of Columbia University was awarded the Nobel Prize in chemistry in 1934, has proved of great importance both in purely chemical studies and also in research on the physics of the nucleus.

Most of the progress in atomic physics up to five years ago was concerned with the behavior of the electrons around the nucleus, and very little progress was made in understanding the structure of the nucleus. In view of the complexity of the problems presented, it was indeed fortunate that the general problem of atomic structure could be thus dissected into two quite separate parts, the physics of the outer structure and the physics of the nucleus. Although a great deal of information about nuclei, especially of radio-active elements, was amassed by researches since the discovery of radium about 40 years ago, the modern period of study of the nucleus may be dated from the Fall of 1928.

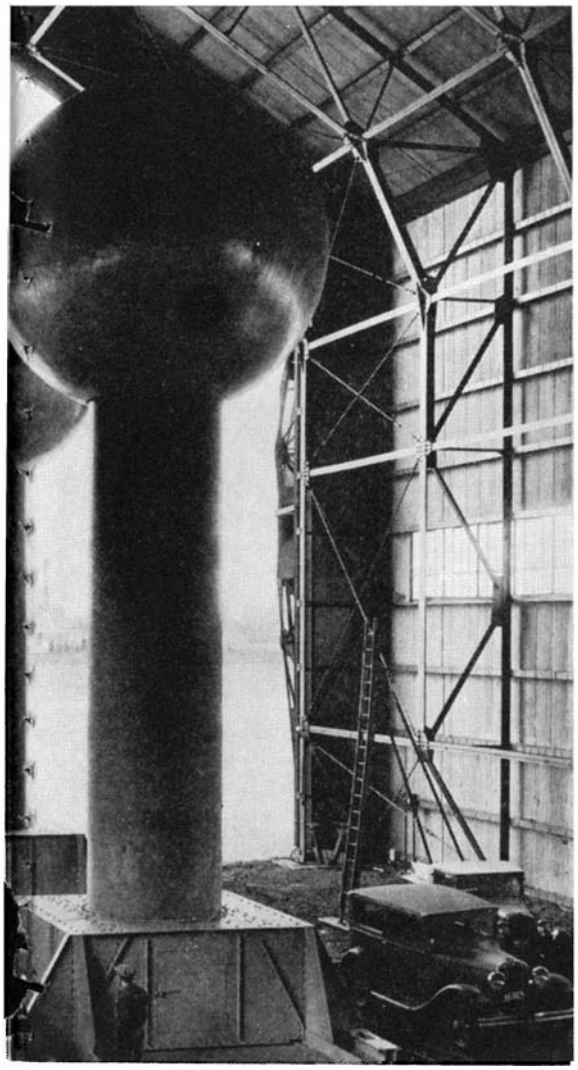
AT that time the first essential application of the wave mechanics to a problem of nuclear structure was made to give an account of the way in which radio-active elements spontaneously disintegrate with the emission of high speed helium nuclei. This was done simultaneously and independently by R. W. Gurney and E. U. Condon at the Palmer Physical Laboratory of Princeton University, and by G. Gamow, then at Göttingen, Germany, now a professor at George Washington University in Washington, D. C. This work made it clear that, in disagreement with previous ideas of mechanics, it is easier for particles to go in and out of nuclei than had been supposed. The success of the theory in explaining some important features of natural radio-activity at the same time made it clear that production of nuclear changes by bombarding materials with high energy electrical particles might go more readily than had been supposed. Up to that time it appeared that the bombarding particles would have to be given energy by the application of potentials of many millions of volts. The quantum mechanical work indicated that much lower voltages would suffice to produce results.



Courtesy Massachusetts Institute of Technology

The high-voltage electrostatic machine developed Bedford, Mass. It will give a 10,000,000-volt potential

Shortly thereafter began the great program of bombarding matter with high energy particles, which has been thus far the principal mode of research on the physics of the nucleus. The general method is to produce a beam of ions, let us say of hydrogen or deuterium. The ions are atoms which have lost one or more electrons by a proper kind of impact of the kind akin to those occurring in ordinary neon lamps or in the sparks of an automobile ignition system. Being now electrically charged, if these ions are introduced into a space where there is a high voltage, they will be acted on by electrical forces and acquire great speed, hence great momentum and energy. Such a beam of swiftly moving ions is made to strike against a target of the material under investigation. What happens? It is known that the nucleus has a diameter only about one ten-thousandth of the diameter of the whole atom. As individual atoms in the target are so small that there can



by Dr. R. J. Van de Graaff and set up near New current to be used for bombarding atomic nuclei

be no hope of aiming at the nucleus, it follows that a great many of the high speed ions rush into the target without getting extremely close to any atomic nucleus. As they penetrate the target they mix with the outer electrons of the matter, and so lose their energy and are brought to rest. Thus the great majority of them are brought to rest without ever having an intimate encounter with the nucleus of any atom in the target.

Those ions which happen to be headed fairly directly at a nucleus will tend to come close to it, although this tendency is reduced by the fact that there are electrical forces of repulsion between the ion and the nucleus, as both are charged with like kinds of electricity. This repulsion bends the path of the ion away from the nucleus. But naturally this effect is smaller the greater is the energy of the ion—that is, the greater the voltage of the electrical apparatus with which the ions have been given their energy. It is also smaller for the elements of low atomic number, which is the reason most researches have thus far been made with these elements. So a certain very small fraction of the ions makes a really close and intimate collision with one of the nuclei of the target, perhaps one in 10,000,000 or 100,000,000. What happens in the case of these very few impacts is the object of study.

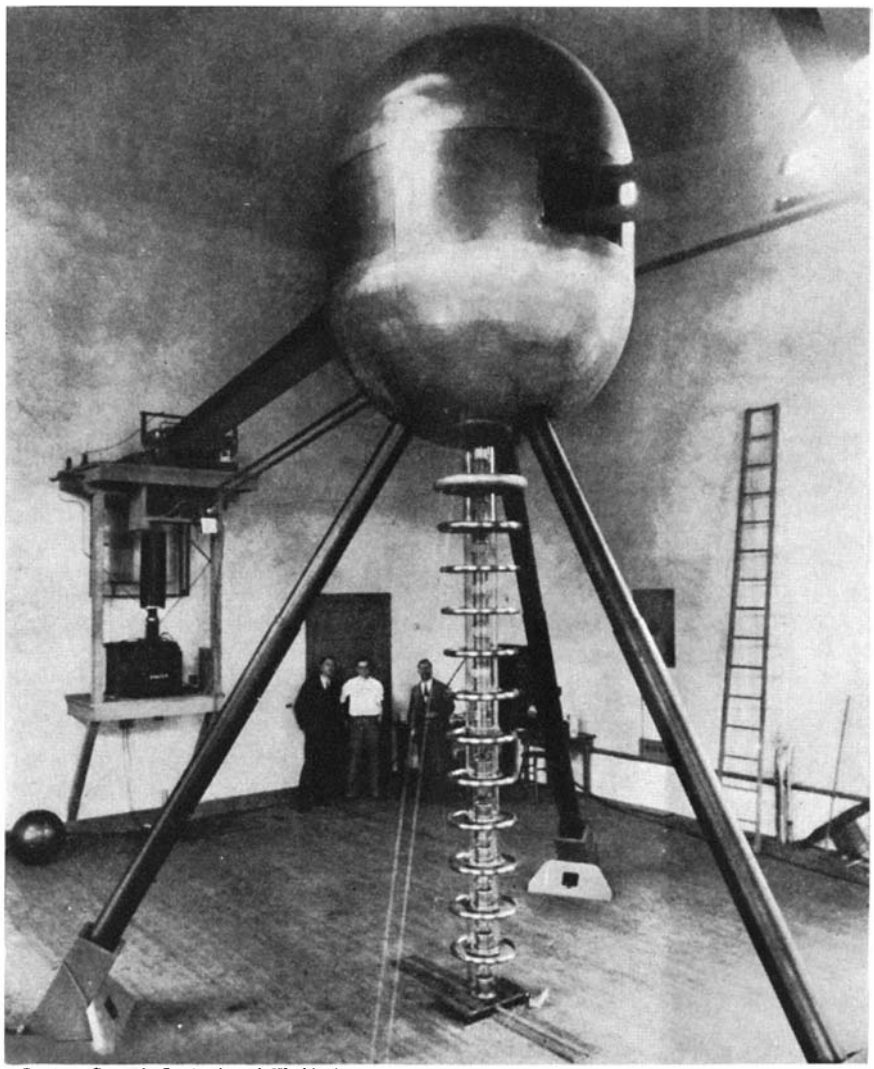
In the different laboratories different methods are used for obtaining the high voltages necessary. Probably the most ingenious and fruitful of these is that developed by Lawrence at Berkeley, in which the ions are made to be accelerated again and again by the same electric field and so the effect of having 2,000,000 volts is produced, even though but 10,000 is used. Now that the Lawrence "cyclatron" is in regular operation, Berkeley has become the leading center of research in nuclear physics in America. Another important method is the high voltage electrostatic machine developed at Princeton by Dr. R. J. Van de Graaff. This has been fruitfully adapted to research on nuclear physics by Dr. M. A. Tuve at the Carnegie Institution of Washington. Meanwhile Van de Graaff has devoted his attention to the development of an extremely large apparatus of this kind at Round Hill, Massachusetts, for the Massachusetts Institute of Technology, which when brought into operation on nuclear physics problems will provide much higher voltages than any yet used.

So much for a brief outline of the general method. What are the results? The results, all accumulated in the last three or four years, are that artificial transmutations of elements, through changes in the nuclei of the elements, are now being produced and studied regularly in a number of physical laboratories throughout the world. Many of these transformations are accompanied by the release of large amounts of atomic energy, in which the actual mass of matter is transformed into energy of motion of the particles produced. Such a possibility was first predicted theoretically by Einstein as long ago as 1905. There is no hope as yet of actually developing these processes as a source of power because of the infrequency of successful hits, as already mentioned. Although in the case of a successful hit the amount of energy released is often great compared with the energy of the single ion which causes the transformation, so much energy is wasted in accelerating the many particles which do not make a hit that, on the whole, much more energy is put into such an experiment than can be taken out of it. Also at present there is no known way of getting out the released energy in a useful form.

Among the atomic transformations so produced there are a number which go to completion slowly; that is, they exhibit the phenomena of radio-activity. The first example of this kind was discovered by Curie and Joliot, as already mentioned. They bombarded several elements, among them aluminum, with high energy helium nuclei as obtained from a naturally radio-active substance. It had been known before that this resulted in the production of various radiations from the aluminum target. The new discovery consisted in the observation that the aluminum target continued to send out a radiation of high energy particles for several minutes after the bombardment stopped. Investigation showed that the aluminum was sending out high energy positrons. Positrons are a new type of electrical particle discovered in September, 1932, by Dr. Carl D. Anderson at the California Institute of Technology in Pasadena. (See article on positrons in Scientific American, August, 1935.) They are like electrons, in that their mass is small compared with that of an atomic nucleus, but carry a positive electrical charge instead of a negative, as does the electron.

By standard methods of chemical analysis it was revealed that what happens in the case of aluminum bombarded by helium nuclei is this: the helium nucleus may be captured by the aluminum nucleus with the emission of a neutron. Neutrons are particles, also first discovered in 1932, through the interpretation by Dr. J. Chadwick of Cambridge, England, (for this Chadwick has just received the 1935 Nobel Prize in physics) of experiments made by Irène Curie and F. Joliot. They have no electrical charge but have a mass about the same as that of a hydrogen atom. In consequence, the resulting nucleus has two more charges than the original aluminum nucleus and hence must be phosphorus, as reference to the list given earlier in this article shows. But on checking up the masses involved (four units added by the helium and one taken away by the emitted neutron) the atomic weight of the phosphorus nucleus produced would be three more than that of the original aluminum nucleus, or 30. Such a phosphorus nucleus was hitherto unknown, and the reason is now obvious, for these researches show that such a nucleus is unstable and spontaneously disintegrates in a few minutes, emitting a positron with consequent production of a nucleus having one unit less of nuclear charge, hence being number 14 in the list; that is, silicon. The silicon produced is stable, and nothing further happens to it.

This instance is typical of the kind of transformations involved in at least a dozen instances which have been studied since the original discovery of Curie and Joliot. Later work by Cockroft, Gilbert, and Walton in Cambridge, by Crane and Lauritsen in Pasadena, by Tuve and Hafstad in Washington, and by Law-



Courtesy Carnegie Institution of Washington

Another form of the Van de Graaff electrostatic machine, adapted to research on nuclear physics by Dr. M. A. Tuve of the Carnegie Institution of Washington

rence, Henderson, McMillan and others at Berkeley, have shown that similar artificial radio-active substances may be produced by bombarding targets of various materials with high energy nuclei of hydrogen and deuterium obtained by accelerating the ions with high voltages as already described. Among these, the result of bombarding sodium by high speed deuterons is of particular interest. Deuteron is the name for the nucleus of the rare hydrogen isotope, deuterium. This was studied in detail by Lawrence at Berkeley.

In this case there is ample evidence that the deuteron is captured by the sodium nucleus in the case of successful hits, and a proton (nucleus of ordinary hydrogen) is emitted, leaving the resultant nucleus heavier by one unit than before but with the same electric charge, so it is still sodium. The resultant nuclei are radio-active and continue their activity for a much longer time than in the case of aluminum bombarded by helium nuclei. Another important feature of the radio-sodium so produced is that it emits a high energy gamma radiation; that is, a radiation of the same character as the X rays which would be produced if an X-ray tube could be operated at about 5,000,000 volts. This type of radiation is known to have important therapeutic action in the treatment of cancer, and already experiments using radio-sodium are in progress at Berkeley. Every effort is being made to increase the voltage and the current of ions bombarding the sodium target, in order to produce larger supplies of this material.

The way in which the activity of these substances dies out is by a law of geometrical progression. In the case of radio-sodium it is half gone in 15 hours, one fourth remains after 30 hours, one eighth after 45 hours, and so on. In consequence it was possible last April for Professor Lawrence to have his colleagues at Berkeley prepare some radio-sodium and send it to him by air-mail for demonstrations of its properties before the physical colloquium at Princeton and elsewhere in the East.

Another important property of these artificially radio-active materials with regard to possible medical applications is that, except for their radio-activity, they are chemically like the ordinary material. Radio-sodium may therefore be injected into biological materials without fear of biochemical complications, for sodium is a constituent of common salt which occurs in all biological fluids. Moreover, its radio-activity is completely gone in a few days, so that dosage will be easily controlled. Still another point deserves mention in this connection: with the possibility opened up of producing radio-activity artificially in a large variety of chemical elements, it may prove possible to utilize the ordinary chemistry of the material to put the radio-active material where it is most needed in the organism. Thus phosphorus concentrates in bone tissue, so treatment with artificial radio-phosphorus would be indicated where it was desired to apply the radio-active radiations to such tissue.

Too much must not be expected right away from the biological applications, however. It must be remembered that the whole effect has not been known for more than two years and that, as yet, the means for producing these interesting new materials in quantity are completely lacking. Several years more of intensive work will probably do much toward extending our knowledge of the physical conditions necessary for production of these radio-active elements. In the meantime some biological study can be made with the small quantities available, pending the time when physicists will be able to produce better supplies of the new substances.

NATURALLY these developments occupy the place of central importance in physics to-day, and laboratories everywhere are equipping themselves to take part in the detailed studies which have yet to be made, just as several decades ago they were concentrating their resources in an attack on the outer structure of the atom. Several eastern laboratories, including Princeton, Rochester, Cornell, Columbia, Michigan, and the Bartol Research Foundation at Swarthmore, now have under construction apparatus of the Lawrence type for producing high energy ions, so we may look forward to an accelerated progress of studies in this field.

Curiously enough the total cost of all this work is probably well under 100,000 dollars, yet in spite of its great potential value to humanity, nothing has been contributed to its support by our government at a time when billions are being spent on all sorts of strange and uncertain projects. The principal "contribution" to research in physics which has been made by the present administration, so far as I am able to learn, has been a drastic cut in the appropriation for the work of the Bureau of Standards, whereby its work in physics has been quite effectively curtailed.

OUR POINT OF VIEW

Death and the Motor Car

IT seems that the active campaign against automobile accidents which has been carried on through the editorial pages—this one included—of many periodicals throughout the country, is beginning to bear fruit. So grave is the situation, even with the progress which has been made, that we feel justified in surveying the entire subject here, and once more dwelling on the factors that must be improved.

When considering motor-car safety—or, rather, lack of safety—it is necessary to subdivide the whole subject into three general divisions. The driver, the car, and the highway must be considered as separate entities. True, the consideration must overlap at times, and frequently the three units must be treated as one, but if they are kept in mind as individual factors, it will aid in clarification.

The driver of a motor car is the only part of the trinity endowed with a mind. He has the power to think, to direct the operation of his vehicle. If he, as the thinking link of the chain, fails, all else fails. If our highways are to be safer and motor-car accidents are to be reduced, one of the definite points of attack must be the driver. Human nature being what it is—rugged individualism, personal rights, and what-not complicate the picture—the problem becomes involved. Standing on what he considers to be his "rights," the driver naturally resents any implication that *he* is at fault. That *he* should be subjected to mental and physical tests before being allowed to drive a car is unthinkable—from his standpoint. That *he* needs education in safe driving is all poppycock. That *he* is discourteous, thoughtless, careless, and all the other things that contribute to accidents, is not even to be mentioned. But possibly *he* is wrong. *He is* wrong. So many of the accidents today point to human frailties that the education of drivers may be taken as a foregone conclusion. Such education must be taken up and carried forth forcefully by communities, states, and the federal government before any other safety factors will have much effect on our present unenviable accident record.

The motor-car manufacturer frequently is held responsible for accidents. "Cars can be driven too fast; limit them mechanically to 45 miles per hour maximum speed," say the unthinking. Little do they realize that the maximum speed of a motor car is a definite index of its development, its efficiency, and its perfection. Furthermore, the acceleration possible with modern high-speed cars is frequently a prerequisite of safety. On the other hand, accidents at 45 miles per hour can be just as horrible, just as disastrous as those at much higher speeds. Any attempt at limiting mechanically the maximum speed of cars can have little effect on reducing accidents, but conceivably can have a very definite effect on increasing them.

Motor-car manufacturers this year have concentrated more on improving the safety features of their cars than in any year past. Radical improvements in brakes have brought the cars under better and safer control of drivers; automatic operation of choke and throttle have made it possible for the driver to keep both hands on the wheel—where they belong—for a greater percentage of driving time; better lighting equipment is tending to make night driving safer; and safety glass all around is now the rule rather than the exception.

Highway construction has come in for mature consideration during the past year. Three, four, and five lane highways built only a few years ago have come to be termed "Death Highways," and rightly so. The realization has been reached that, in congested areas where traffic on super-highways is heavy, something more than a white line is needed to keep traffic separated as it moves in opposite directions. Parkways are the coming thing, and many are under construction at the time of writing.

We have here touched briefly the three major factors in motor car safety. To these, among others, should be added the need for uniform traffic laws, better policing of congested areas, elimination of busy grade crossings, and drastic enforcement of traffic regulations.

Above all stands the human element. Educate the driver, inculcate in him the principles of courtesy and consideration for others, be sure that he is mentally and physically fit to drive a car. Then watch our accident rate drop.

Transatlantic Monstrosities

TWICE, recently, one of our esteemed British contemporaries has quoted statements to the effect that Washington and American shipping interests have been concerning themselves with plans for construction of a super liner to surpass both *Normandie* and *Queen Mary*. Rather surprised at the first, we let it pass as a rumor of no consequence; on reading the second, we began to wonder whether some secret maneuvering were taking place. A query to the Department of Commerce elicited the response that "At the present date we are not informed of any intentions or activities in the type of new construction you mention."

Strange! Or can it be that the Department of Commerce has not been consulted, only the bureau which is to hand out the money being let in on the secret so far? There's chicanery somewhere without a doubt. "Where there's smoke . . ." Yet P. A. S. Franklin adds to the mystery by denying "a report that the United States Lines will build a ship of 100,000 tons." They will, he says, proceed with plans to build a third liner similar to the *Manhattan* and *Washington*, but slightly larger.

The record thus seems clean. But is it? We wonder. Somewhere somebody has discussed the matter, seriously or with intent vague. However that may be, it is well to say a word of warning against such transoceanic monstrosities lest, in a spasm of nationalism, the nation be propagandized into piling absurdity on absurdity.

As spectacular examples of man's handiwork, the *Normandie* and the *Queen Mary* are successes; as financial ventures they can never be anything but failures. The former has operated at a great loss (to the French Government), for American travelers, on whom all transatlantic liners depend for their existence, are turning more and more to American ships to keep their money at home. The "blue ribbon of the Atlantic" and the prestige—for which the *Normandie* was built—cannot offset her failure as a profit maker.

The American *Manhattan* and the *Washington*, on the other hand, cost far less per ton to build; are each only about a third the size of the *Normandie* but are still huge, comfortable, luxuriously appointed, and fast; and their operating cost is far less than one third that of the French ship. The deduction is simple: from four to five of the smaller size can be built and operated with the same capital required for one of the larger; more frequent schedules can be maintained and more passengers carried; and in a war emergency, a fleet of the smaller would serve us far more efficiently as naval auxiliaries than one monster. Let us, then, talk sense, even though it be only to start a rumor!

CIVIL AVIATION IN

By REGINALD M. CLEVELAND

AIRCRAFT in warfare is a controversial subject that has been the cause of spoiling much white paper with printer's ink. All too frequently that spoilage has been for naught—to put forth the ill-considered mouthings of irate militarists or pacifists, as the case may be. Here, however, Mr. Cleveland has taken the long view, the sane view. Without wasting words, he has drawn a sharply delineated picture of the position in which American air transportation would find itself in the case of a national emergency.—*The Editor.*

MUCH loose talk has been heard of late about the conversion of civil aircraft into instruments of war. In Europe there is some foundation for the theory that large transport airplanes would be useful as bombers because, until very recently, British and European passenger airplanes—with a few notable exceptions—have been adaptations, with comparatively little change, of craft primarily laid down to the specifications of air ministries for bombers.

In the United States, however, military aircraft of all types, and civil aircraft, large and small, have pursued a development along widely divergent roads. It is true, of course, that aerodynamic improvements, first applied to either military or civil airplanes, have soon found their place in the craft of the other category. There has been, in other words, an exchange of ideas, especially along engineering lines, which has been beneficial to both types of airplanes. To assume, however, that American transport planes could be converted successfully to bombers, or smaller fast mail ships to pursuit and attack craft. is to fall into serious error. The civil aircraft of this country, which, by reason of their remarkable speed and safety records, have aroused so much envy, are not stressed for military maneuvers with military loads. They are constructed and stressed for the specific function they perform so well, but cannot be considered in the light of combat equipment.

THERE are other aspects, however. from which civil aviation in the United States can indeed be considered a backbone of national defense. If the popular conception of huge airliners carrying a ton of bombs instead of a ton of passengers and of sleek mail ships spitting fire from hastily-mounted machine guns will not stand the acid test of fact, the less romantic, but much more important, conception of civil aviation as a pool of invaluable pilot reserve material, as a network of strategically placed airports, and as an incomparable means of rapid military transport, always ready for use, most emphatically will.

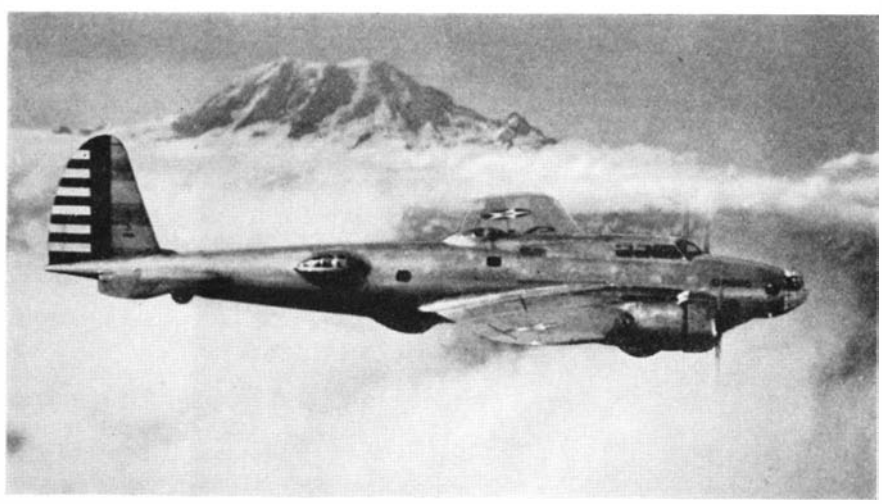
The most recent compilation of figures shows 14,177 persons holding pilot's licenses in the United States. This, of course, is exclusive of military pilots. Of the civil total, 7132 held the highest rating, transport license; 828 were limited commercial, 5395 private, 717 amateur, and five industrial—the last named a grade for which licenses are no longer issued.

On the same date there were, however, only 6972 aircraft holding license. Of these, a very large number would be entirely useless for purposes even contributory to defense. It is safe to say that at present not more than 2000 airplanes in the civil category could be of direct use in time of national emergency. It is evident, therefore, that there is a very considerable surplus of transport pilots. Some authorities who have given careful study to the question hold that many more transport pilots will be needed in time of emergency than the actual number required to fly the number of serviceable airplanes—serviceable, that is, in the sense of military auxiliaries. But it is evident that even allowing for a number of transport pilots double that of such useful planes, a large reserve of these highly-trained men would still be available.

They could and would be used, of course, to train other pilots and to speed the whole machinery of augmenting the actual useful force in the air. Many of them would make ideal material, possessing a head start of obvious value, for combat pilots.

The most recent figures on airports and landing fields in the United States, compiled by the Bureau of Air Commerce, show 2343 of all types. Of these; 693 are partly or fully lighted for night operation. Of the total, 717 are municipal and 539 are commercial airports; 277 are Department of Commerce intermediate landing fields; 619 are auxiliary fields; 59 are army airdromes; 26 are naval air stations; and 106 are miscellaneous government, state, and private airports and landing grounds.

The importance of this network of airports, linked in a nation-wide system of more than 20,000 miles of lighted and radio-equipped airways, could hardly be overestimated in a time of national emergency. It is generally conceded that any war of the future will be primarily a war of the air. This involves, however, not merely aerial combat, but the aerial movement of troops, of fuel for combat airplanes, ammunition and bomb reserves, replacement and repair parts, and a host of other items for which speed will also be a prime necessity.



Stressed for different services. A giant Boeing bomber*, and at right . . .

A Federal airway, in the present sense of the term, means much more than the shortest airline between two points. The facilities now provided on every Federal airway include rotating beacon lights at approximately 15-mile intervals; intermediate landing fields so located in relation to airports that landing

*The recent crash of this ship was apparently not due to defects in design, but to other factors beyond control.

National Defense

areas are available at intervals of about 50 miles; radio communication stations for weather broadcasts and emergency messages to aircraft; radio range beacons for directional guidance; radio marker beacons for assistance in locating strategic points, such as intermediate landing fields, and, in many cases, for giving directional guidance over short distances; and weather reporting service involving the use of teletypewriter circuits and point-to-point radio.

It is in the elaborately integrated system of civil aviation and especially of air transport, making use of these far-flung airways, that the greatest contribution to national defense is to be found. Air transport service has reached a speed three times that of the railroad. Large fleets of airliners can cross from coast to coast in 16 to 17 hours. Hundreds of transport planes could be mobilized for any emergency and flown from one end of the country to the other within 24 hours.

The experience in the World War proved conclusively that transport equipment cannot be developed quickly enough after a declaration of war, and that therefore equipment and facilities can be established more efficiently and at less cost by normal development in times of peace. All who have given serious thought to preparedness, including those who had the responsibility of creating new industries and other facilities during the World War, agree that Government support is especially warranted when modest subsidies in peace will pay for developments which will prove costly out of all reason in both time and money if postponed until forced by an emergency.

THE present development of large passenger planes, fast night mail ships, and auxiliary equipment, is due in large part to the gruelling work demanded in scheduled airline operations. Flying millions of miles, nearly half the time at night, in all kinds of weather, over every conceivable kind of country, month after month, year after year, contract mail lines have forced the present rapid rate of improvement and made it available for emergency use.

Both the Army and Navy have some transport airplanes, but they are entirely inadequate in number and carrying capacity to meet an emergency. Multi-engined transports, cruising at 175 to 200 miles an hour, of which the scheduled airlines have about 90 percent, would be used on the airlines themselves during any war emergency which might arise, to meet the inevitable demand for accelerated speed of transportation which is inherent in a war. At the same time, they would be required by the military forces for the swift transport of supplies, personnel, and munitions at the base of supply and in the zone of operations.

It is held that if war ever should be forced upon the United States, our combat air forces would require air-transport co-operation under four sets of circumstances: One; if the United States were attacked, the quickest possible type of transportation would be needed to concentrate aerial defense at the point of attack. Two; if an enemy secured a foothold on the American continent, surface transport into that zone would undoubtedly be useless, and air transport would be employed to the fullest extent. Three; if the war theater were across the water, the fastest possible transportation would be required between points in the interior of the United States and ports of embarkation. Four; in any theater of war, transportation at maximum speed—assured only by air—would be required between supply bases, concentration areas and the front lines.

In view of the accelerated speed of flight, both civil and military, conclusions of the American Aviation Mission which studied the lessons of the air in Europe in 1919, seem now to apply with even increased force.

"For economic reasons," it stated, "no nation can hope in time of peace to maintain air forces adequate to its defensive needs, except through the creation of a great reserve in personnel, material, and producing industry, through the encouragement of civil aeronautics. Commercial aviation and transportation development must be made to carry the financial load.

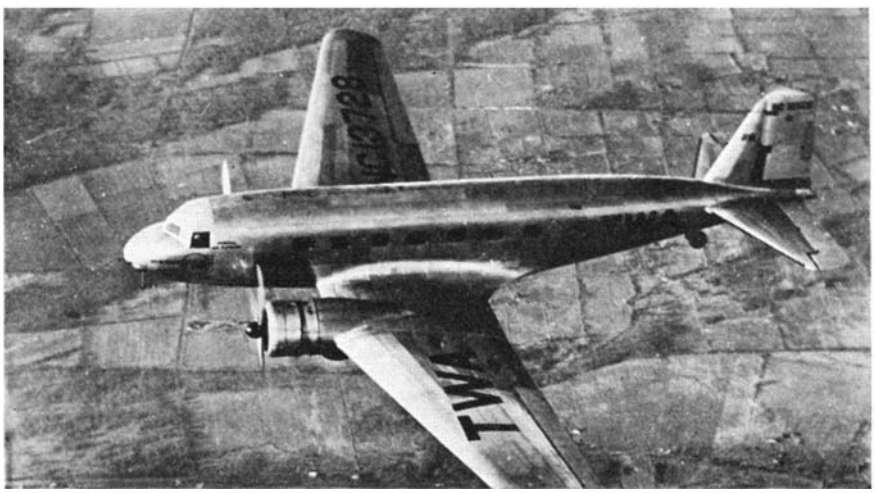
"Past experience and every economic consideration point to the vital need for the formulation by the United States of a definite, comprehensive and continuing policy for the development of every phase of the aircraft art. Our Government is now faced with the task of nursing and actively encouraging a new transportation industry whose healthy growth is vital to the future progress and defense of the nation."

MAINTENANCE bases of major air lines*, which would be of great value to our military forces in case of a national emergency:

Butte, Mont.—National Parks Airways.
Cheyenne, Wyo.—United Airlines.
Chicago, Ill.—United Airlines; American Airlines.
Cleveland, Ohio.—Pennsylvania Airlines & Transport.
Dallas, Texas—Braniff Airways.
Detroit, Mich.—Central Airlines.
Fort Worth, Texas—Bowen Airlines; American Airlines.
Kansas City, Mo.—Transcontinental and Western Air.
Los Angeles, Calif.—Western Air Express Corporation.
Miami, Fla.—Eastern Air Lines Division of North American Aviation.
New Orleans, La.—Wedell-Williams Air Service Corporation. (Overhaul base at Patterson, La.)
St. Louis, Mo.—Chicago and Southern Air Lines.

*Compiled by Bureau of Air Commerce, Department of Commerce.

. . . a TWA Douglas transport, mechanically flown by the Gyro Pilot



THE 'SPACE-PENETRATING POWER'

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington
President of the American Astronomical Society

VISITORS to an observatory on a "public night" very often ask: "How far can you see with this telescope?" The only direct answer is: "That depends on what you are looking at." With the unaided eye, a glow-worm may be lost to sight at perhaps a hundred yards, while the Andromeda nebula could be seen at a million light years.

With a small change, however, the question becomes reasonable. How faint an object can be observed with a given instrument?—or in more technical language: What is the limiting stellar magnitude which can be observed?

The importance of the question is obvious, but to answer it is not so simple as might appear, for the result differs greatly for various methods of observation.

The simplest case is that of ordinary visual observation of stars. A good objective, whether lens or mirror, combined with a good eyepiece, produces an image of a star, upon the retina of the eye, which falls practically upon any one of the sensitive nerve-endings. So all the light gets to the place where it is wanted, and the main question is how much light falls upon the aperture of the telescope. This is evidently proportional to the square of the diameter of the clear aperture. A ten-inch telescope should collect a hundred times as much light as a one-inch telescope, and show stars five magnitudes fainter. It is found by experiment that a one-inch objective, in good adjustment, will show stars to the 9th magnitude: so a 10-inch should go to the 14th magnitude, and a 100-inch to the 19th. The general formula is simple:

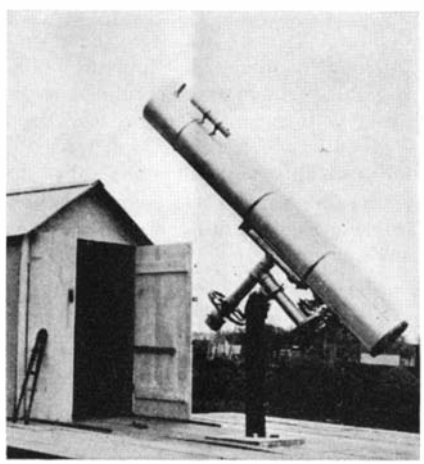
$$m = 9 + 5 \log d \qquad (1)$$

when m is the limiting magnitude, and d the common logarithm of the diameter of the objective.

IF we tried to get a formula accurate to tenths of a magnitude, we would have to consider the loss of light in passing through the glass of the lenses, or on reflection from (possibly tarnished) mirrors, but we need not bother with this.

Allowance would also have to be made for differences in eyes—though the general run of observers seems to be about equally good at seeing faint objects, with an occasional case of exceptional vision like Barnard's. Incidentally the assumption should be expressly stated that defects of refraction in the observer's eye are corrected by spectacles.

One provision, however, must be made: the magnifying power of the eyepiece must not be too low. It is well known that the ratio of the diameter of the objective to that of the beam of parallel rays which emerges from the eyepiece is equal to the magnifying power. Now the pupil of the eye is about one fifth of an inch in diameter (under the ordinary conditions of faint light in an observatory). If the "emergent pencil" is of larger diameter, only a part of it will enter the eye. To avoid this, the magnifying power must be at least five times the diameter of the objective in inches. A power of 500 is necessary to get the full benefit of the 100-inch mirror, and 1000 would be needed for the 200-inch.



A 10-inch telescope with housing that rolls off on a track, made by R. G. Stephens of Kennebunk, Me. "It is very easy," he writes, "to roll the house back over the telescope when through observing, and all is then secure." The observing is done entirely in the open air, as shown

All that has been said so far deals tacitly only with good seeing conditions. Every observer, amateur or professional, is only too familiar with the bad nights—perhaps very transparent to the naked eye—on which the images of the stars not only dance about, owing to the irregularities of atmospheric refraction, but frequently "burst" into diffuse patches, changing from one instant to the next. Under such conditions, the faintest stars are lost altogether and the effective limiting magnitude is changed for the worse; that is, its numerical value on the familiar scale is lowered.

But present-day professional observations are made mainly by photography. Here we have two different questions: First: What will our telescope show with a given exposure—say one minute—and second: What will it show if we go to the limit of practicable exposure?

The first problem is very like that of visual observation. Our supposed exposure is far too short to fog the plates. If the seeing is very good, the photographic images of faint stars will be as small as the inherent limitations of the photographic emulsion permit—about 1/800 of an inch in diameter. Once again all the light, barring instrumental losses, gets to the desired place, and a ten-fold increase in diameter should show stars five magnitudes fainter. We will have an equation of the same form as (1), but the numerical constant will evidently be different for different kinds of plates (extra-rapid or lantern slide) and also for different fixed exposures.

HERE, alas, we meet with one of the saddest facts in astronomical photography. To increase the exposure ten times, with the same intensity of light, does not produce the same effect as to keep the same exposure but make the light ten times stronger—it produces a smaller photographic blackening.

If the simple "reciprocity law" just stated held good, the limiting magnitude would increase by 2.5 log t (t being the exposure time) but the actual gain is about 2 log t—sometimes a little more. This peculiarity of photographs, discovered by the lamented Schwarzschild, is a serious matter for long exposures. To get stars five magnitudes—100 times—fainter we have to expose about 300 times as long. By the time the exposures reach into hours, however, astronomical photography meets with a new and unescapable obstacle—the fogging of the plate by the general light of the sky.

It has been known for 20 years or more that only about a third of the light which is received from the heavens on a perfectly clear dark night, in places out of reach of artificial light, comes directly from the stars. About an equal amount originates in the earth's atmosphere. Just as the sun's light is scattered by day, to give the blue sky, so

OF TELESCOPES

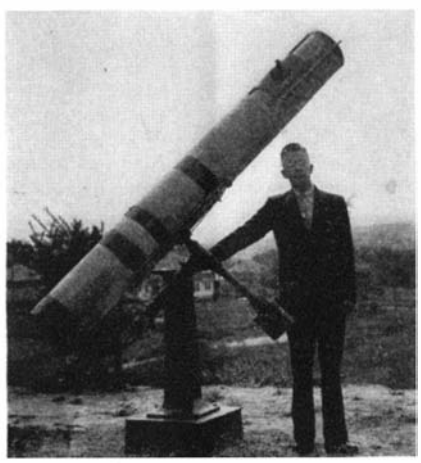
Compare Two Telescopes With Same Aperture but Different Focal Lengths . . . Limitations of a Great Telescope . . . Seldom at its Best

star light must be by night; but the greater part of the observed luminosity shows a spectrum of bright lines or bands, and seems to be something like a permanent faint aurora (though probably not of exactly the same physical origin). Finally, a considerable portion of the light of the night sky comes from the extension of the zodiacal light over the whole heavens, and is presumably due to sunlight reflected by myriads of tiny particles scattered through the whole inner part of the solar system.

If we could get above the limits of our atmosphere, we would lose fully half the general sky-brightness—less near the sun where the zodiacal light is bright, and more near the poles. But to get a really clear sky, between the stars, an explorer would have to go far toward the confines of our system. If he could settle down on one of the satellites of Uranus (which are probably too small to have any atmosphere) he would see the heavens appear very differently. Apart from the bright haze around the sun, the sky would be black, and the Milky Way would be vastly more prominent than to us—including the dark regions of obscuration—while the Andromeda nebula would be conspicuous.

BUT we earth-bound astronomers must struggle with the light of the sky as we find it. There is no use increasing our exposures after plates become definitely fogged by this cause, and we have no longer to deal on our negatives with star images on a clear ground, but with darker spots in the incipient fog. Experience shows that if such an image on our plate is of considerable size (say a millimeter in diameter) it will be perceptible if the intensity of the image-forming light is but a few percent of the uniform sky foreground. But our star images are very small, and under these conditions it is found that to get anything definite, the light falling within this image from the star must be about equal to that from the diffuse illumination of the sky.

This changes things enormously. At the ideal limit, when the star-images were as small as the plate-grain permitted, there would under some circumstances be no gain at all in using a large telescope. This sounds absurd; but it is simple enough. By hypothesis, we have exposed long enough to begin to fog the plate, so that longer exposure would be no gain. For a telescope of given focal length the star image, 1/800 of an inch in diameter, corresponds to a definite region of the sky, of a given diameter in seconds of arc. From this bit of sky, we will get a definite amount of light, simply from the general illumination. The star which sends us more than this amount will show a visible image: one which sends us less will be lost in the background. With the large aperture, the exposure would of course be much shorter, but the final picture would be the same.



A 10-inch telescope with tube of waterproofed cardboard, made by Chas. W. Sloper, Pittsfield, Mass. Casein glue was the waterproofing agent and the telescope stood out in the rain and the sun for a long time without damage—though the seams were very carefully blocked

There would, however, be a great advantage under these conditions in using a *long* telescope. By increasing the focal length—while the star-images are still of the minimum possible size—the area of the sky whose light faces on the region of the images is decreased, and stars previously unobservable may be reached. We may now compare two telescopes of the same aperture, but different focal lengths. The light received from the star is the same in the two cases, but, with the longer focus, the sky-light on the plate is much fainter (inversely proportional to the focal length) and so we may make a longer exposure before we fog the plate. Theoretically, in this idealized case, the limiting magnitude should be given by

$$m = \text{constant} + 5 \log f \qquad (2)$$

(f being the focal length). For the same focal length, the large aperture would have a great advantage in speed.

Telescopes of the same kind are usually designed with more or less the same value of the focal ratio d/f. For refractors, this is usually about 15—for reflectors it may be made as small as five or even less. Among telescopes of the same type and focal ratio, the large aperture regains its full advantage, for d is proportionate to f, and equations (1) and (2) give the same relative performance.

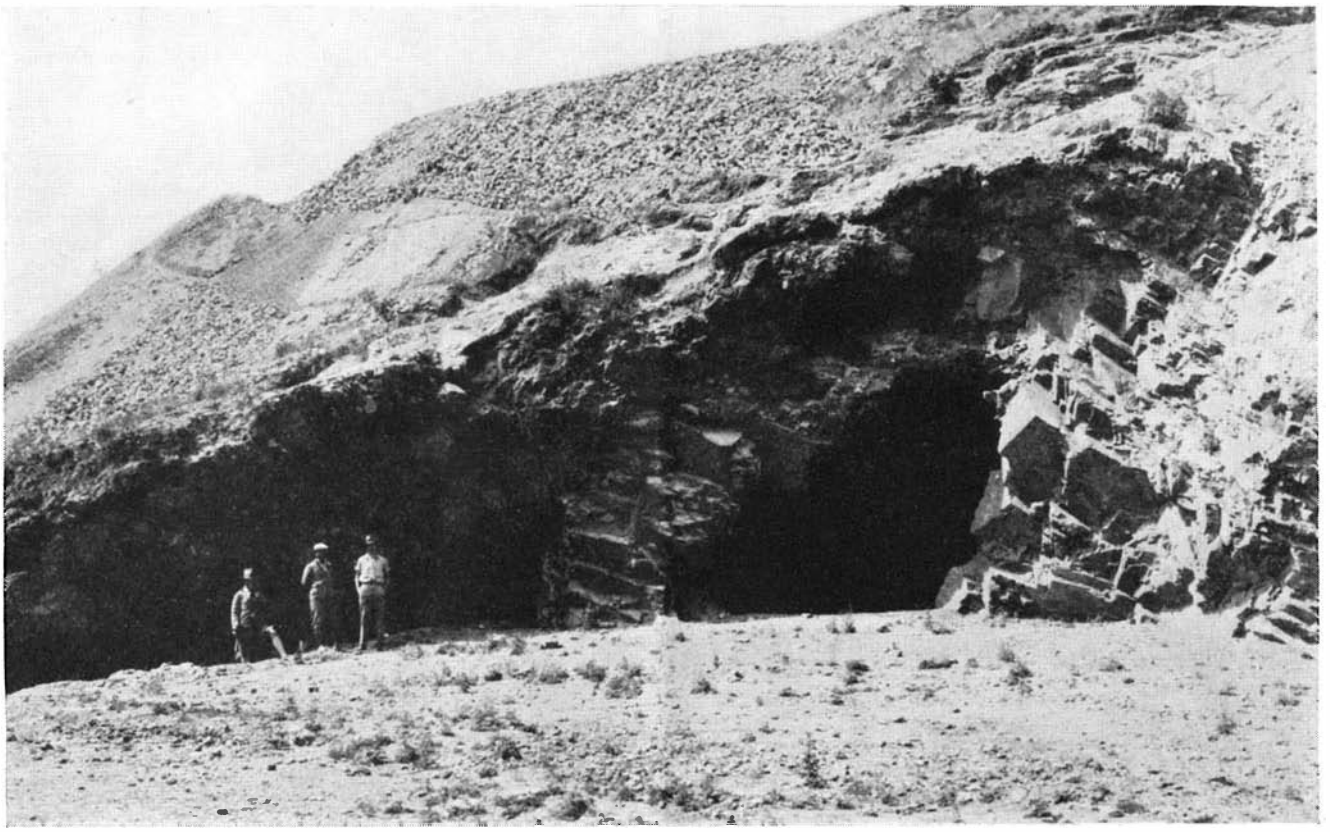
These considerations are valid, approximately, only under very rare conditions of good seeing. On ordinary nights, the star images in the field of view of a large telescope dance about by much more than 1/800 of an inch, so that the photographic image of the star is a more or less fuzzy "tremor-disk" whose diameter depends on the weather (astronomically speaking). Under extreme conditions, we may assume that the average distance to which the image deviates from its mean position is a definite number of seconds of arc. Within a few seconds of time, the star dances all over the region, so we may assume that the tremor-disk has a fixed angular size whatever the exposure. On this assumption, the amount of general sky illumination which gets mixed up with the star's light is a fixed quantity, depending on processes which occur in the earth's atmosphere, and not in the telescope. The limiting brightness of a star observable in this particular grade of bad seeing will thus depend only on the effective diameter S of the tremor-disk: and the equation may easily be derived

$$m = \text{constant} - 5 \log S \qquad (3)$$

Under these ideally bad conditions one telescope is as good as another—providing always that the exposures are made to the fog-limit—but the worse the seeing, the more stars we lose.

THE full advantage of a great telescope can therefore be realized only under the best conditions of seeing. Everyone knows that this is true for the study of fine details, such as double stars or planetary markings; but it is less well recognized that it is true also when it comes to the detection of very faint, and doubtless very distant, stars.

The writer is much indebted to a discussion of this topic (at a colloquium meeting yesterday) by Dr. J. A. Anderson, who has kindly permitted this non-technical account to be given here. —*Mount Wilson Observatory, Nov. 2.*



The entrance to the cave at Choukoutien where the skull of Peking Man was found. Natural passages in the limestone formation lead to the floor of the cave, 60 feet below the entrance. Rocks fallen from the walls long ago buried the skull deeply

THE FOOD OF PEKING MAN

By DR. RALPH W. CHANEY
Research Associate, Carnegie Institution of Washington
Chairman, Department of Paleontology, University of California

THE feeding habits of the earliest man-like animals have been known only through conjecture. Our human ancestors of a million years ago had not mastered the art of writing, and so did not leave grocery lists or books of recipes as evidence of their dietary preferences.

From analogy with the feeding habits of the large modern apes, they may be supposed to have eaten both plant and animal food. Such an omnivorous diet is also suggested by the character of the fossil teeth of early man, which seem to be suited for chewing a wide variety of foods, both flesh and vegetable.

The actual record of early man has until recently included no direct evidence as to his food. *Pithecanthropus erectus*, the Java man discovered in Java in 1891, is represented only by a portion of the skull and a few skeletal fragments. The Dawn Man, *Eoanthropus* from Piltdown, England, is also represented by incomplete material, with no suggestion as to food and feeding habits other than that afforded by his teeth.

It was only with the discovery of a third race of primitive man, dating, as in the case of *Pithecanthropus* and *Eoanthropus*, back to the beginning of the Pleistocene, or Ice Age, that actual living quarters of our early ancestors were discovered.

Members of the National Geological Survey of China, under the supervision of the late Dr. Davidson Black, uncovered several skulls and numerous teeth of the oldest human inhabitants of Asia during the past six years. In addition, stone implements, hearths and uneaten fragments of food have been found in the home of these ancient cave dwellers. Here is the first record of the diet of the most ancient human individuals known from the continent of Asia.

LIMESTONES deposited in a shallow sea hundreds of millions of years ago are exposed in the Western Hills near Peking, the former capital of China. Due to the dissolving power of underground water, caves have been formed in the rocks of these hills which at various times have offered shelter to the early human inhabitants of China, and to hyenas and other animals which make their dens underground. Portions of the caves in the Western Hills became partly filled with fragments of rock which fell from walls and ceilings, and which became cemented, through the deposition of calcareous material by percolating waters, into a solid mass known as breccia.

So it came about that in our day, Chinese workmen, quarrying limestone for building material and for use in road construction, came upon these irregular masses of breccia which they left untouched because of their impurity. In 1923, the famous Swedish paleontologist, J. G. Andersson, studied these breccias, and discovered in them fossil bones of rhinoceros, bison, and other animals no longer living in northern China. The painstaking excavation of these bone-bearing masses of breccia has resulted in the unfolding of an early chapter of human history on the continent of Asia.

The town of Choukoutien (pro-

Man's First Dietetic Record Found in His Actual Living Quarters . . . Oldest Known Inhabitant of Asia . . . Fossil Garbage . . . A Rare Specimen

nounced Cho-ko-tyen), lying 30 miles west of Peking, is a local center for the mining of coal and the quarrying of limestone. Some years ago, a railroad was built to transport these heavy products to Peking, but recent political unrest in North China has caused the diversion of its rolling stock to the activities of war. As a result, long lines of camels—the two-humped bactrians of interior Asia—plod along the dusty roadways, now and then delaying the progress of our donkeys as they climb the long slopes to the quarries.

On the hill above Choukoutien, and beside the cave containing the most productive bone deposits, the National Geological Survey of China has built a commodious laboratory with living quarters for the staff of scientific workers engaged in this detailed excavation. Here have come visitors from all parts of the world, including many famous anthropologists and paleontologists, attracted by this most complete record of early man. Scattered over the hillside are fragments of breccia removed from the cave whose entrance offers shelter from the warm sunshine.

IT SEEMS certain that one or more entrances were used as doorways by man and other animals in the past. These have fallen in or been covered up, and their possible discovery during future excavations may disclose important facts now concealed. Down through limestone passages to a depth of 60 feet below the present entrance, the floor of the cave is reached—the actual living quarters of the oldest known inhabitant of Asia. Here, covered over by many feet of breccia, have been found the skulls which indicate that this early man had mental attainments sufficient to raise him well above the level of other animals.

From his discovery near the city of Peking, he is called "Peking Man"; his scientific name is *Sinanthropus pekingensis*[1]. Proof of his technical skill is found in the crudely fashioned flakes of quartz—the tools with which he cut and scraped. His use of fire is shown by the several feet of ashes, piled deeper against the walls of the cave where a not too fastidious Peking Woman may have swept them rather than carry them outside the cave.

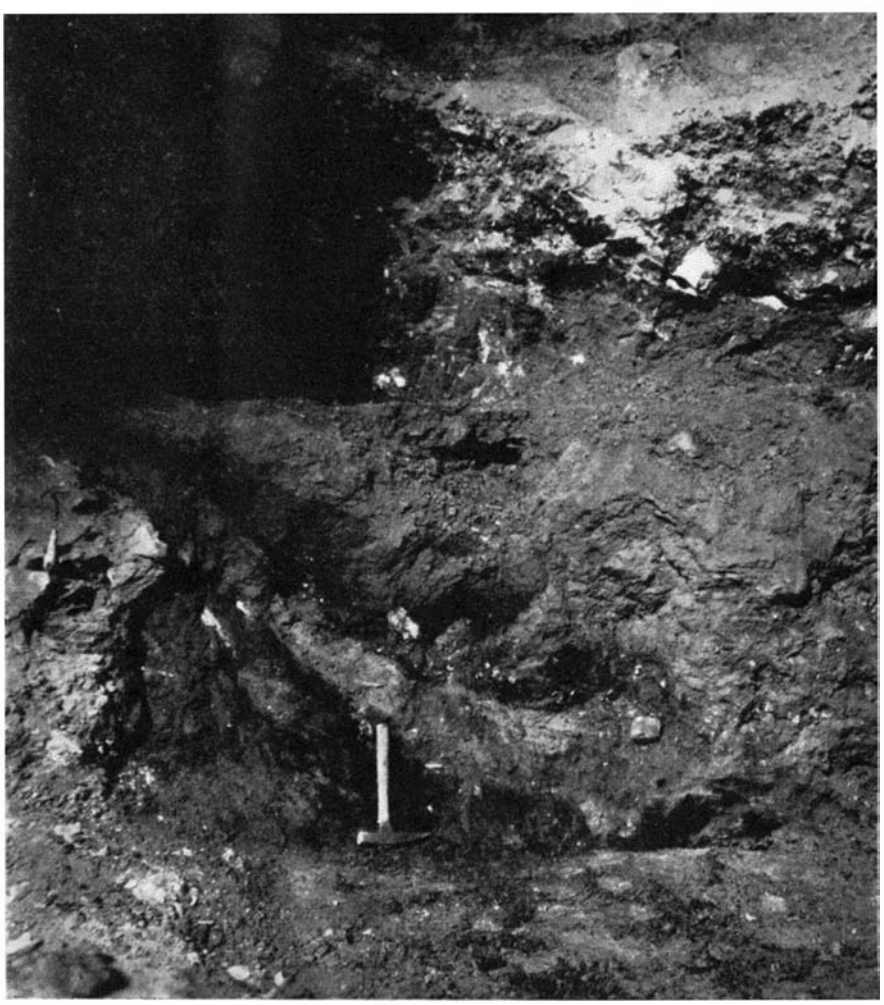
Several significant discoveries have been made in these ash layers. Bits of incompletely burned wood have been identified as similar to plants now living in northern China and in other lands with a somewhat cool and dry climate. Abundant fragments of charred bones indicate that here were cooked choice cuts of horses, bison, rhinoceroses, and other game animals which ranged the Western Hills and adjacent plains during the past, and which have no living relatives in North China today.

These animals, used as food by Peking Man, indicate a plains country, probably with trees confined to the stream borders as in semi-arid regions today. The fact that this man lived in caves, and that he made fires to keep himself warm or to cook his food, may be interpreted as indicating that the climate was characterized by low temperatures. During this same epoch of geologic time, large portions of North America and Europe were covered by thick sheets of ice, and so this time-period of the earth's history is commonly called the Ice Age. Glaciers appear to have been absent in northeastern Asia, due to its relatively dry climate.

About 20 feet above this lowest level of human occupation, and occurring in breccia containing numerous quartz artifacts and bone fragments, there is a layer several inches thick, made up of thousands of fragments of the shells of seeds. The markings on their surface indicate that they represent the shells of hackberry seeds—small globular bodies, smaller than peas. How they got into the cave and were broken into bits is a problem of major importance.

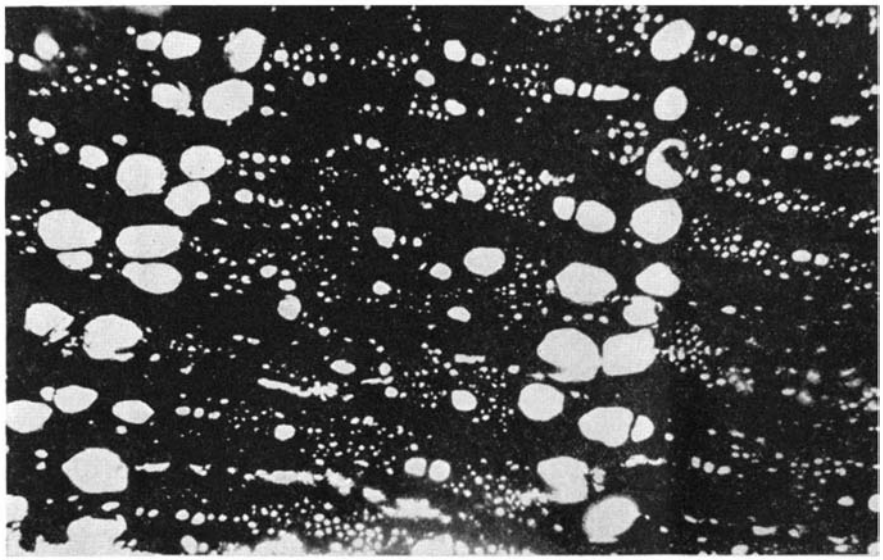
THE modern hackberry (*Celtis*) occurs as a small tree in the forests both of North America and Asia, but is most characteristic as a shrub on semi-arid slopes and stream borders. Neither wind nor running water—two of the more common agents of transportation—may be supposed to have carried these seeds into the cave. Equally impossible is the assumption that hackberry bushes lived in the cave, for direct sunlight is essential to the growth of all higher plants.

It seems certain that large numbers



This cave contains deposits of ashes many feet thick, also charred bones, indicating clearly that it was long occupied by people who knew the use of fire

[1]Scientific American, June, Sept., Nov., 1930, contained articles on Peking Man.—*Ed.*



Fragments of the charred wood of the redbud found in the ash deposits in the cave. Note the traces of annual rings, indicating a climate like that of today

of hackberry seeds were carried into the cave, and their shells crushed while they were being eaten. The question arises as to whether early man or some other animal was responsible for bringing them into the cave at Choukoutien.

The fruits of the hackberry are like small cherries, skin and pith enclosing a shell, within which lies the seed. In the more arid parts of the United States, these fruits are extensively used as food by birds and rodents, and by the native Indians. Certain trees and shrubs bearing especially large or sweet fruits are regularly visited by the Indians of the Southwest.

THE fruits are in some cases eaten like those of the cherry—the skin and pith swallowed, and the shell rejected whole. Or they may be chewed so that the shell is broken into fragments, the larger of which are ejected from the mouth.

The most common use, however, is as a flavoring for meat or bread. The fruits are crushed fine, and the liquid strained away and cooked with other food, leaving a residue of shell fragments which are cast aside. If Peking Man utilized hackberry fruits in this fashion, we should expect to find in his cave-home accumulations of broken shells like those actually occurring.

The presence of the fossil bones of rodents in the cave at Choukoutien suggests the possibility that they, rather than Peking Man, may have carried in the fruits of hackberry whose shells have been preserved in the cave deposits. With this possibility in mind, an effort has been made to determine how related living rodents open hackberry shells to secure the edible seed within.

All authorities consulted have indicated their belief that these animals would chew a small opening on one side of the shell rather than break it into fragments, in much the same fashion as a squirrel opens a hickory nut. Dried hackberry fruits were fed to several types of caged rodents in the laboratories at the University of California, but either these animals were not hungry, or they were unfamiliar with this type of food, for in no case did they chew through the shells of the berries given them.

The behaviour of caged monkeys was more significant. They readily accepted the dried fruits and crunched and swallowed them, shell-fragments and all. No monkeys are known to have lived in northern China during the Ice Age. The fragmentation of the shells in the cave deposits is interpreted as indicating the probability that they represent the food refuse—fossil garbage it might be called —of the human inhabitants of the cave, rather than of its rodent population.

Here then is the earliest record of the use of plant food by prehistoric man. In a land so cool and dry that there were few fruits and nuts, Peking Man may be supposed to have gathered the hackberries from bushes near his home, and to have mashed them in the preparation of his meals as do the modern natives of our Southwest. The abundance of shell fragments in the cave deposits may best be explained in this manner.

THE brain cavity in the skull of *Sinanthropus* definitely indicates that this early human race was capable of speech. We can almost hear Peking Woman adjuring Peking Child, in a language lost in the obscurity of a million years, to eat his hackberry pudding in lieu of orange juice, or other vitamin-containing foods of the modern diet.

As I was about to leave this hill in northern China, in whose caves ancient man made his home nearly 1,000,000 years ago, my Chinese associates courteously offered me the opportunity of selecting a small piece of the cave breccia to take with me. I picked up from the pile of material excavated from the cave a block which weighed about two pounds, on which were exposed fragments of charred bones and a large quartz flake. An irregularity at one end required trimming, and with my hammer I broke it off. To my surprise there appeared on the broken surface of this piece of breccia an almost complete hackberry seed.

Here in one block have been preserved not only the remains of a prehistoric meal, both meat and vegetable, but the crude stone implement with which Peking Man may have killed his bison, cut his meat, or mashed his hackberries. These cave deposits tell the story of the feeding habits of man before he himself recorded the details of his life in writing.

About 20 feet above the lowest level of human occupation a layer several feet in thickness was found, made up largely of the crushed shells of hackberry seeds

Surer Artificial Respiration

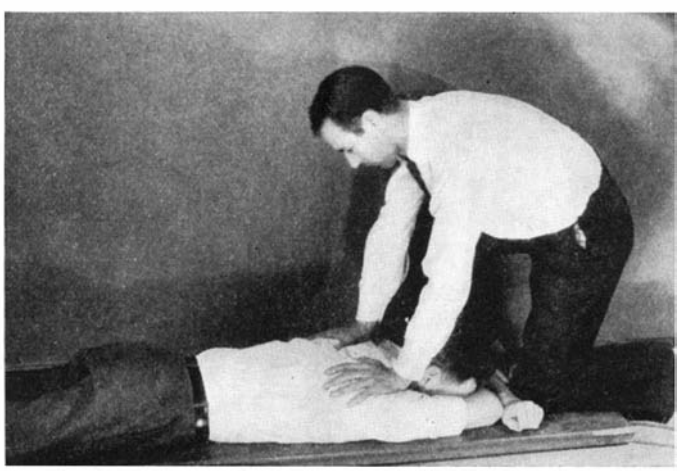
Nielsen Life-Saving Technique Surpasses, by 41 Percent, the Widely Used Schaeffer System

By F. D. McHUGH

FOR the first time in many years the Schaeffer prone pressure method of artificial respiration for insensible persons who have been, to all appearances, drowned, asphyxiated, or electrically shocked, has been improved upon. A new system of inducing respiration and resuscitating persons who have apparently died has a 41 percent higher efficiency than the Schaeffer method by actual test, in that it gives deeper breaths for a proper cleansing of the lungs, and more breaths per minute. It was developed by Holger Nielsen, a Danish sports inspector, as a result of years of study. So well recommended does the new system come that there is every assurance that the new system will replace the older, long-accepted, Schaeffer technique.

In the early part of the century, Sir Edward Schaeffer invented the system which has since borne his name and which has been the means of saving the lives of hundreds, if not thousands, of people. In this system the person to be resuscitated is placed face downward while the operator kneels over him facing the patient's head, his knees beside the hips of the patient. The operator places his hands firmly on the lower ribs of the patient, one hand on each side. He then leans forward, throwing the full weight of his body on his hands to compress the patient's lungs and thus expel air (and water in the case of a drowned subject). A quick release of the pressure after four seconds permits the patient's lungs to expand with a sharp intake of breath. This process is continued, at three-second intervals, until the patient revives or it can be definitely shown that there is no hope.

INSPECTOR Nielsen began the study of the Schaeffer system and also of the Silvester, another commonly used system, some years ago. He discovered that by both of these the respiration induced was not sufficiently deep to cleanse the lungs thoroughly. He realized that, for best results, the air should be forced deeply into the lungs. The Holger Nielsen technique which came as a result of these studies is more or less similar to the Schaeffer except that the operator kneels astride the patient's head and exerts the pressure of his hands on the patient's shoulder blades. The patient is placed face downward as in the older method and the operator kneels as shown in the accompanying illustration. His hands are so placed that on the release of the pressure he can slide his hands off the shoulder blades to grasp the patient's arms and lift them slightly. Lifting of the arms removes the patient's weight from his chest so that the lungs are permitted to expand much more than in other systems. The result is that about twice as much air is drawn in, according to authorities who have tested the system; noxious gases or water are evacuated; and natural breathing is started much earlier.



Resuscitator kneels astride the patient's head, presses downward on shoulder blades, and lifts arms on upward movement

In applying this Nielsen method to a patient, first remove his clothing or any parts of it, at least, which will tend to hamper the free movement of the patient's shoulders and lungs. Lay him face downward on a flat, hard surface. Should this surface be sloping, be sure that the patient's head is at the lowest point. Arrange his arms as shown in the illustration, bent and folded under his forehead, not so much to protect his face from bruising but to prevent any twist of the neck which would interfere with breathing. A handkerchief should be placed beneath the patient's mouth and nose to prevent the intake of dust. When patient and operator are in position, the patient's back must be slapped sharply between the shoulder blades several times to cause the tongue to fall forward out of the mouth. If this is unsuccessful, the operator draws it forward with his fingers.

Artificial respiration is then administered by the operator swinging his body forward, throwing only his weight, but no muscular force, onto the patient's shoulders. The movement is slow so that the pressure is progressive. The pressure is continued until the operator's arms are in a vertical position which he holds while he counts up to four. The operator then swings backward to release the weight and as he does so grasps the middle of the patient's upper arms, pulling them backwards just enough to lift them slightly without disturbing the position of the patient's head or torso. This position is held while the count is continued up to eight. The operator then assumes his original position and repeats the routine, the entire procedure being completed from seven to eight times a minute. There should be no break in the rhythm of this action until strong normal breathing is induced or for at least four hours in the event that no natural breathing may be detected.

Professor August Krogh, Nobel Prize winner of the Rockefeller Institute in Copenhagen, was the first authority to investigate this new system. After exhaustive tests on insensible persons, he gave it his unqualified endorsement. The faculty of medicine at the University of Copenhagen, the Danish Red Cross, the Danish Life Saving Association, the State Board of Public Health, and other interested bodies also have investigated and approved it. The Danish Red Cross has, in fact, adopted it and advised its use on all bathing beaches and in many industries. In countless instances the Nielsen method should be of great value in an emergency in the absence of, or before the arrival of, mechanical resuscitators.

We are indebted to Professor August Krogh for these facts.

DIESELS FOR BATTLESHIPS?

Large Number of Small Engines . . . Greater Fuel Economy . . . Quick Replacement, Repair . . . Simple Overhaul . . . Spares for Replacement

By CAPT. A. M. PROCTER, U. S. Navy (Ret.)

TWENTY-THREE years ago, the first ocean-going ship propelled by Diesel engines was put in service by the Eastern Asiatic Company of Denmark. This ship, after a long and profitable career, is still carried in "Lloyd's Register of Shipping" with the highest rating. The success of the *Seelandia*, and of other motor-ships which followed, led to the complete motorization of the Eastern Asiatic fleet; and, after the war, this new form of power attracted the attention of ship owners in other European countries.

In a few years the threat of the Diesel engine became so serious that, in the words of Sir John Biles, "Something had to be done to improve the thermal efficiency of the steam turbine."[1] This efficiency was materially improved by increasing the temperature and the pressure of the steam, but the fuel consumption of the steam turbine plant, in service, is still about double that of the Diesel engine, and the threat has not been met.

The steamer has continued to lose ground, and the latest returns given in "Lloyd's Register of Shipping, Quarterly Report" show that the motor horsepower of Diesel engines building, in the world at large, on September 30, 1935, exceeded that of steam plants by about 60 percent. If the horsepower of the *Queen Mary* (which is still carried in the total of the steam machinery under construction) is excluded, the Diesel horsepower is nearly three times that of the steam horsepower.

In spite of these well known facts there has been little enthusiasm outside of Germany for this form of power on the part of the designers of naval surface craft. This is somewhat difficult to understand because, on previous occasions, the naval designer has led the way in adopting improvements in marine engineering.

The use of internal combustion engines in submarines was forced from the beginning because, in spite of numerous attempts, it has not been possible to design a steam plant which would stand up under the rigorous conditions existing in this type. It is possible that the memory of troubles with early submarine engines has produced a fixation in the naval mind, which has not been removed by the evidence of the fact that commercial ship owners have found the Diesel engine to be fully as reliable as the steam engine.

[1] "Brassey's Naval and Shipping Annual, 1927."

The fact that it is possible to develop the power required by a modern battleship has been demonstrated by the German ship *Deutschland*. This ship and four others which have been laid down are fitted with a new type of high-speed engine developed by the Augsburg branch of the Maschinenfabrik Augsburg-Nurnburg, working in collaboration with the German Admiralty.

It must be admitted, however, that there has been, as yet, insufficient experience with this type to determine its endurance life, or its reliability in service. This will be a matter of several years; but, in the meanwhile, there is a type of engine available which has gone through a long period of development, and which is now available for the maximum power required.

THE use of this type—the four-stroke trunk piston engine—necessitates the use of a much larger number of units than that to which the marine engineer has become accustomed by experience. The presentation of the evidence justifying its use makes necessary a discussion of the details of the most mysterious of all professions—that of the ship designer. I will quote, therefore, Mr. Harry Ricardo, F.R.S., who, in delivering the sixth Thomas Lowe Gray lecture before the Institution of Mechanical Engineers, stated: "If, therefore, some of my statements and proposals appear outrageous, I must claim from you that tolerance which is the prerogative of either youth or inexperience. A cat may look at a King—presumably with an expression no courtier would dare to assume.

"I am going to look at the marine engineer with the cynical stare of the cat, secure in the knowledge that he will not harm a mere landsman. There are times, I think, when the outsider, ignorant of the traditions and quite undeterred by that vast accumulation of superstition which ties the hand of the expert, may happen on a new theme, or at least start a new train of thought."

Ricardo proposed the use of 75 motor-bus engines, with a direct current electric drive, for the propulsive plant of a 6000 shaft-horsepower cargo ship; and gave excellent reasons in support of this plan. I am suggesting a similar plan for a battleship drive, but with a smaller number of larger engines. This plan has, in addition to the well-known and often stated advantages of any Diesel installation, certain special advantages which may be enumerated as follows:

(a) A much greater freedom is given to the ship designer in the treatment of the problems with which he is primarily concerned.

(b) Since the removal of an engine, and its replacement by a spare, would be a matter of hours, all major repairs could be transferred from the ship—where they can not be properly made—to a shop where the engine could be rebuilt by methods developed in modern automotive practice.

(c) With 25 percent of spares—as is now the practice with turret guns—an annual replacement program would provide for the complete renewal of the plant, with new or rebuilt engines, once every four years.

(d) When better engines are developed—as will surely be done during the life of any ship laid down at this time—the whole plant could be renewed, one group at a time, without interfering with the operating schedule.

(e) Since not more than 25 percent of the engines would be used at ordinary cruising speeds, all routine examinations and minor repairs could be made at sea as well as in port, and a materially higher percentage of availability would be possible.

(f) The danger of a material reduction in power by breakdowns would be reduced.

(g) Since the working speed range of the engines would be not more than 40 percent of the total range, there would be no difficulty whatever in keeping clear of dangerous periods of torsional vibration.

(h) Since the engines can be installed under a deck which is far below

the water line, and between bulkheads far removed from the ship's side, they would be practically immune to attack by guns, bombs, and torpedoes.

The design of a battleship must, obviously, be a compromise between a number of conflicting interests; and it is inevitable that each group involved in its design and operation should approach the problem from a different angle. My own approach is that of an officer who, owing to the accidents of the service, has spent more than a fair share of his time in the operation and repair of worn out machinery. It is natural, therefore, that the most important advantage seems to me to be that listed under (b) above.

It is probable, however, that a judgment unbiased by personal experiences would be that the most important advantage lies in the freedom given to the ship designer in treating the ship as a whole as a fighting unit. Owing to the small size of the engines, they can be put in spaces which would not be available for larger units; and, after the military characteristics of the ship have been determined, places can always be found for the engines where they will be comfortable, contented, and well protected.

The number of arrangements possible is very large, and ranges all the way from a maximum of concentration, with the engines in three tiers behind the main armor belt, to a maximum of dispersion, with the engines in one tier extending beyond the main belt.

It is obvious that, with a large number of small units, electric drive must be used. This requires an addition of weight, and the fuel consumption at full power will be greater than that possible with the direct or geared drive. There are, however, certain fundamental facts which make it possible to keep the weight within the limit available and to keep the fuel consumption, at cruising speeds, down to that possible with a much smaller number of large units.

THE extra weight of the electrical equipment is balanced by the fact that, in engines which are geometrically similar, and which run at the same piston speed with the same mean effective pressure, the weight per unit of power varies directly as the ratio of the linear dimensions.

There are, moreover, certain modifying factors which turn the scale still farther in favor of the small engine. These are:

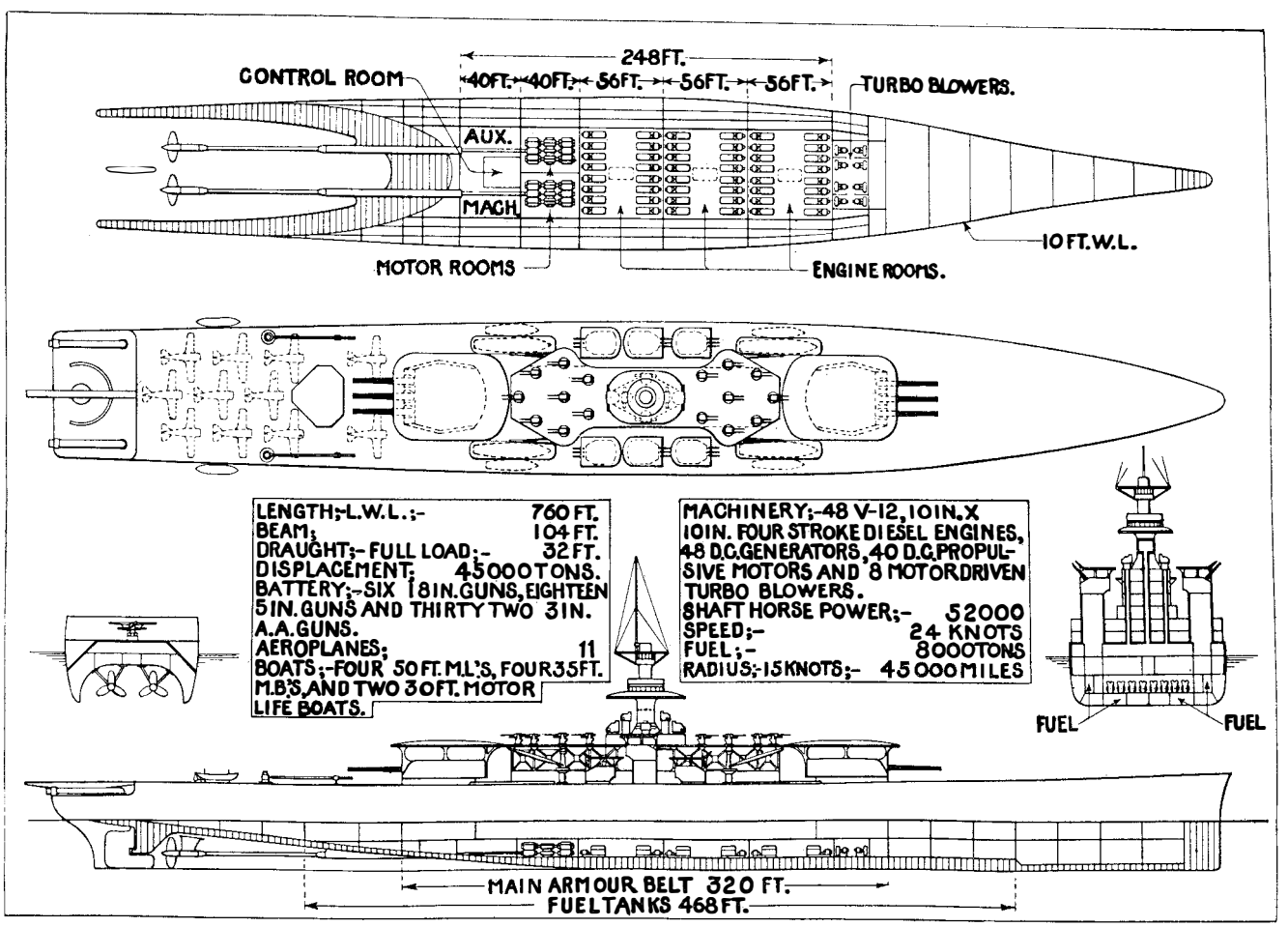
(a) As the size of the engine is increased, a point will be reached where it is no longer possible to preserve geometrical similarity, and it becomes necessary to use a type with a materially greater weight per unit of cylinder volume.

(b) The heat stresses, which are one of the most troublesome factors in the internal combustion engine, increase with an increase in the cylinder diameter, and limit the mean effective pressure at a lower value than that possible in a small cylinder.

(c) The unit bearing pressures which can be safely carried, decrease as the size of the bearings increase; and since, at high speeds, these pressures are due almost entirely to inertia forces, there will be a progressive decrease in the piston speed as engine size increases.

The electrical transmission loss will increase the specific fuel consumption at full power, above that possible with the direct or geared drive; but, in naval vessels, this is not important. At cruising speeds it will be possible, with a multiplicity of engines, generators, and motors, to select a number of units which will insure that they run at the point of maximum economy. This will more than balance the electrical transmission loss, when compared with large engines running at less than 25 percent of their rated power, and the economy of the proposed installation should be better than that possible with the alternative installations.

One of the many solutions possible is shown in the drawing. The proposed



Plan and elevation sections of proposed battleship showing installation of many Diesels

ship shown has a length about midway between those of type b and type c given in an article on "The Washington Conference and Naval Design," by Sir George Thurston, in "Brassey's Naval and Shipping Annual, 1923." This ship has a "standard" displacement of 35,000 tons; and, though somewhat longer, has about the same general characteristics as those of the *Nelson* and *Rodney*, which are the only ships which have been built in accordance with the Washington Treaty.

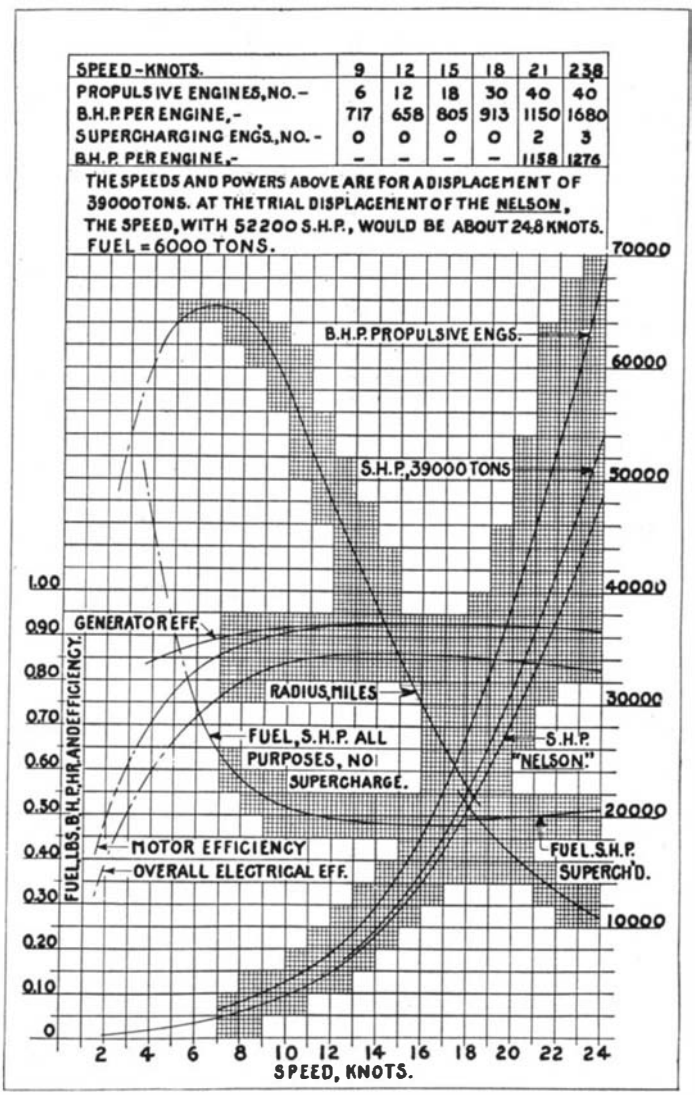
Since the limitations of this treaty are no longer binding, six 18-inch guns have been substituted for nine 16-inch guns. The weights of the guns and their mountings will be practically the same as those of the *Nelson* and the *Rodney*, but the weight of the turret and barbette armor will be materially reduced by substituting two turrets for three.

The main armor belt—which covers but 42 percent of the water line—has been reduced to about 80 percent of that of the *Nelson*, with a saving of about 1000 tons, which is available for some of the many demands made on the designer for weight in excess of that at his disposal. Up to the quite recent past it was held that the function of the armor belt was to protect the flotation of the ship, and all of the United States battleships from the *Maine* class, up to and including the *New York* and *Texas*, had complete water-line belts. The weight limitations were such that, in some of the early ships, the depth was so small that the top of the belt was under water when the ships were loaded.

Insistence on deeper and thicker armor made such demands on the weight schedule that it was not possible to provide a complete water-line belt, and it became necessary to provide other means of preserving flotation. The problem seems to have been solved, as was shown by the Germans at the battle of Jutland, by adequate subdivision, by water-tight compartments, and by preserving trim by counter-flooding.

In the *Nelson* and *Rodney* the weight of the armor has been concentrated to protect the ship against disablement by shells penetrating the machinery spaces, and against destruction by shells penetrating the turrets and magazines.

In the sketch shown, the attempt has been made to suggest the probable effect on design of a recognition of the increasing importance of aircraft, by fitting a larger and more adequate anti-aircraft battery, by providing a greater airplane equipment, and by fitting bursting hoods over the turrets. These details, however, have no bearing on the main purpose of this study which is to show the possibility of realizing the enormous advantages of the Diesel drive.



Graph of Diesel operation discussed by author

The machinery equipment proposed has 48 V-type, 12-cylinder four-stroke, supercharged engines driving direct current generators. The propellers are driven by 40 geared direct current motors; and, since the motor-driven supercharger blowers can be driven by three of the engines, five engines are available for the ship's auxiliaries and for reserve. The engines are all of the same size and power, and each of them can be used for propulsion, supercharging, or for carrying the ship's auxiliary load.

The engines, generators, and motors are removable through a hatch in the deck above (covered by a bolted plate) into a fore and aft passage which leads to armored trunks at the forward and after ends. Since all supercharging and ventilating air is taken through these trunks, there is no necessity for water-tight doors or hatches of any kind through the armored deck. The engine exhaust pipes are carried in fore and aft passages outside of the engine compartments and discharge over the stern.

Performance data of the proposed installation are shown in the graph. These data are based on a minimum fuel consumption of 0.40 pounds per brake horsepower per hour, which is conservative when compared with results which have been obtained in a number of recent engines.

The cruising radius curve is based on a fuel capacity of 6000 tons, but since the capacity of the ship shown in the drawing (with wing tanks and double bottom tanks eight feet deep) will be at least 8000 tons, the actual distances will be about 33 percent greater than shown by this curve.

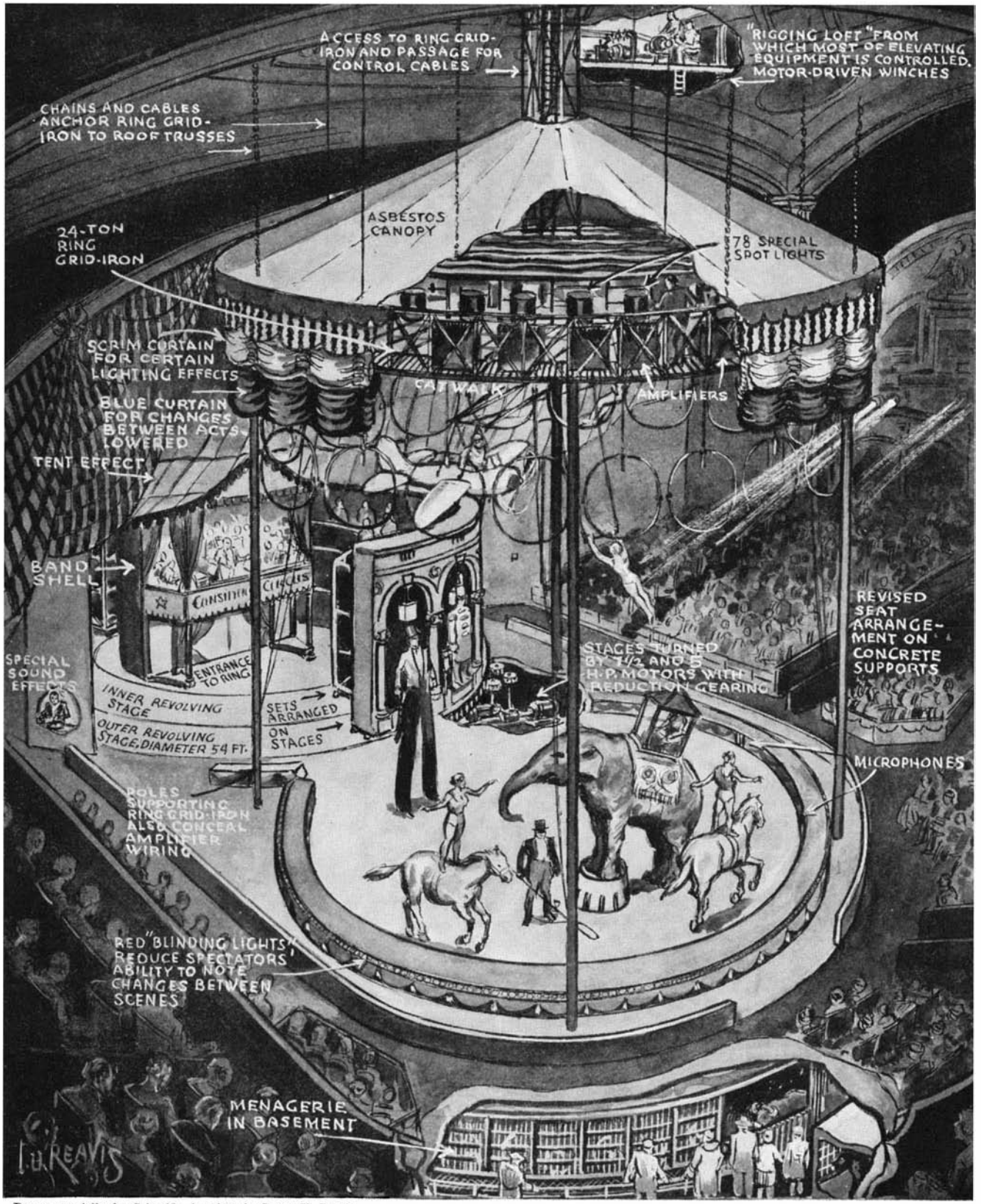
The maximum power—52,200 shaft-horsepower—is based on a piston speed of 1800 feet per minute and a brake-mean-effective pressure of 130 pounds per square inch. That these values are within the limits justified by present practice is shown by the results of two recently built German engines.[2]

A Maybach V-12, Büchi-charged engine, built for the new three-car trains on the Berlin-Hamburg run, is given a maximum rating of 1834 feet piston speed and a brake-mean-effective pressure of 142 pounds per square inch. An Augsburg engine with a cylinder diameter of 11.81 inches—which is materially larger than the engine here proposed—has a maximum rating of 1743 feet piston speed and a brake-mean-effective pressure of 136 pounds per square inch.

These engines are built for a service in which the conditions are much more severe than those for naval vessels. In traction service, full power is demanded for short periods every day; and, at the end of a year the number of hours during which full power had been used would be enormously greater than in

(*Please turn to page* 53)

[2] *Gas and Oil Power* (London), March, 1935.



Drawn especially for Scientific American by Logan U. Reavis

The "Big Top" in a Theater

"LADEES an' Gennelmen! The big show is about to start!" And a big show it is—the circus that appeals to kids of all ages has, by the exercise of ingenious engineering design and construction, been set up in the famous old Hippodrome in New York City. At a production cost estimated to be about 200,000 dollars, some 700 seats were removed from the orchestra, a complete circus ring was installed as shown, and two of the largest revolving stages in the world were built. The seats on the main floor were rebuilt and supported on reinforced concrete sloping upward at an angle that affords an unobstructed view of the ring to everyone. The circular gridiron is one of the notable mechanical features. It permits rapid handling of scenery and also affords space for the location of the lighting fixtures. From it is also suspended the aerial acrobatic equipment. It is planned that the show will eventually go on the road in large theaters and under canvas in smaller towns.

RUBBER TAKES THE

Persistent Rubber Research . . . Product Sticks to Old Jobs, Does Them Better . . . New Uses . . . New Research . . . Potentialities for the Future

A thin trickle of milky fluid from incisions cut in the rubber tree makes its way, through research, into great industries where it is now indispensable

DAMPING out the physical shocks of a highly mechanized world is still the major function of rubber. But there are properties aside from vibration absorption which give high rank to this strange, natural resin. Persistent refinement has multiplied types manyfold so that today rubber can be applied in ways undreamed when the first crude, bulky gum shoes introduced it to man's service.

Rubber is now safeguarding airplane surfaces from the abrasive force of rain and hail and it is even being employed to protect air transports from the hazard of ice formation on wing edges. It is now lining metal tanks used for the shipment and storage of chemicals. And quite recently was announced the successful imparting of an antiseptic quality to rubber which should make it a much better qualified material for, say, surgical gloves.

Step into research laboratories to discover what manner of studies are being carried on; list the tangible accomplishments in the past few years and you will find that the significant work with rubber has been mainly one of establishing better controls over materials and processes. Months and years of laborious, penetrating research have brought out the many latent characteristics of rubber. It can be worked at will to produce a product hard or soft, more or less flexible, highly resistent to chemicals, more durable, or perhaps to combine several qualities in chosen proportion. The main advance in rubber has been to make it deliver better service and nothing illustrates this fact so well as the automobile tire.

An automobile tire, regardless of its price, represents a skilfully developed product. Few articles in the public's hands are subjected to such savage abuse and expected to like it. And that it does "take it" is proof of high attainment. There have been no revolutionary changes in tire construction in many years, yet the tire of today gives double and sometimes triple the mileage of one produced only a few years ago. Extraordinary wear has been built into the product and even so the makers are not satisfied. Tires will be made even better through the agency of research.

Today's tire is a balanced product; it is a compromise and must be so. Perhaps you think wear could be increased by adding more rubber to the tread, or perhaps you think it should cushion better or skid less. No single quality in performance can be altered without affecting all the others. Cornering, the quality which permits adequate steering control; cushioning, which is the quality of flexibility; and durability, which is what gives life, are the three main factors governing tire performance. To establish a satisfactory balance between these factors has taken years of study and experimentation. If more rubber is added to the tread it affects both cornering and cushioning factors; if cornering is improved by giving more rigidity to the carcass it affects cushioning, while if more flexibility is provided so that bumps can be "swallowed" better, the steering qualities are changed. Actually, there does exist a state of unbalance but of a different sort. A tire carcass, if undamaged, outlasts the tread.

CHEMISTS are trying to solve this state of unbalance by compounding rubber to give it longer wearing life without sacrifice of other qualities, and, strange to say, there is research being conducted to improve the carcass. Experiments are being made with rayon as a substitute for cotton in the manufacture of tire fabric. It is claimed that rayon shows a better resistance to the heat which is generated internally, but as yet the right type of rayon hasn't appeared. Militating against any prompt substitution is the present superiority of the carcass over the tread and the large amounts of capital which tire manufacturers have tied up in cotton fabric mills.

Assuming that tire casings can be made to last longer in service and go to pieces all at once (without hazard), there is always the inner tube to threaten trouble, and a puncture-proof tube is a perennial dream. Puncture-proof tubes have come, been punctured, and then gone into the discard, ever since there were such things as tires. One doubts the possibility of ultimate success. From the earliest types, which employed such odd materials as feathers and molasses, there have been some advances. The newest devices on the market are three in number. One utilizes a double inner tube, the innermost one of fabric, designed to slow the passage of air in case of a blowout and permit the car to be brought safely to a stop. Another employs a substance which floats freely in the tube and is supposed to be thrown centrifugally into a puncture aperture.

Shocks of Industry

By PHILIP H. SMITH

The third is a tube with the rubber in compression, ready to close any hole that should be made in it.

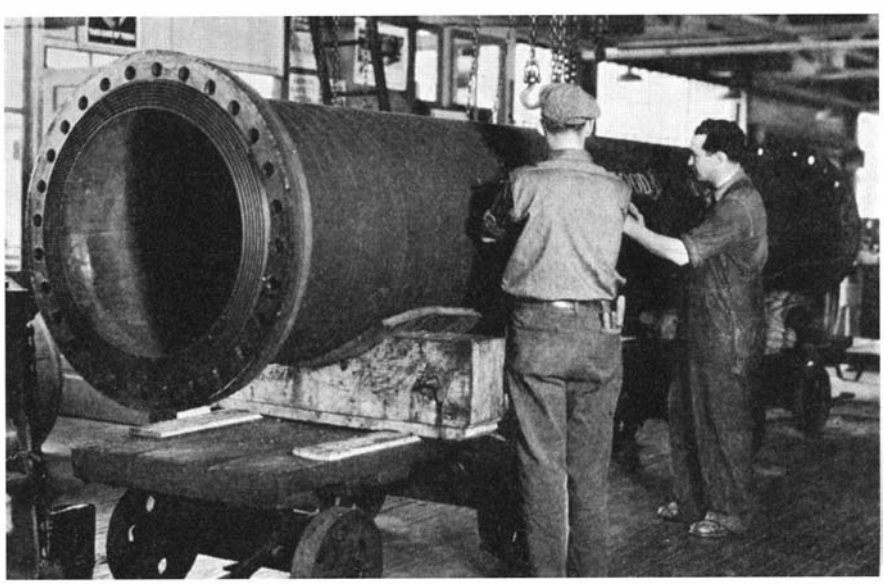
One solution to the present disparity between carcass and tread life is re-treading. It is, however, a makeshift and one that tire manufacturers as a whole do not view with approval. During the past two years re-treading has made great headway and it cannot be wholly ignored. It is now possible to re-tread a tire to make it deliver close to double the regular mileage, due to certain technical advances such as the development of delayed accelerators, the flat cure, the circular (clamshell) mold and the advent of large-diameter tires. The make-shift of it becomes apparent when it is realized that re-treading requires a sound carcass for satisfactory results and there are proportionately very few tires which come up to standard. If cords are cut with a nail, if the cords are broken by running against sharp obstacles, or the fabric is broken down by running under-inflated, re-treading is not only unwise but uneconomical.

Rubber research, which has put the world on cushioned wheels, has not stopped with tires. That has provided merely the foundation. As one moves upward from tires to chassis and body of the present day motor car, one gets an appreciation not only of the penetration in the automotive field, but hints of broader applications. One of last year's lowest priced cars boasted the use of more than 164 pounds of rubber, and this figure is certain to rise because a still newer model in the low-priced group claims 400 distinct rubber applications. Springing is being rubberized to a point where ultimately metal may be done away with altogether. Bodies are being insulated from chassis, engine mountings are universally featuring rubber in some form, and almost every place where there is movement and contact of metals is being cushioned. Coming in for greater attention is the possible use of rubber universal joints to cushion the drive between transmission and wheels. In this application, the technical problem has been to get a device that will not overheat under severe operating conditions and will hold the drive shaft in alignment at all times.

A NEW use for rubber in the automotive field, heralded as a desirable departure, would make it a bonding agent in the manufacture of brake lining and clutch facings. It has been brought forward in an attempt to get away from the present ply construction. The bonding agent is introduced during the weaving process and a heavy type of lining, which is later compressed to form, is woven. The bonding compound is the factor governing the frictional quality of the lining; hence, by varying the compound at will, low or high friction qualities can be imparted to suit specific needs.

Coming into wider commercial use is sponge rubber, the first experimental applications being for seat cushions, arm rests, and panel insulation. It is being used quite successfully as an inner tube for heavy army trucks and armored cars where puncture-proof characteristics are more to be desired than easy riding qualities. Its adoption for seat cushions is being held up because, in its present state of development, it weighs more than the orthodox spring type cushion, but a solution of this handicap is hinted at as being met by combining sponge rubber with rubberized spun hair. There is already on the market a rubber-insulated hair cloth which is fabricated into loops forming a series of figure eights. This is being employed in the openings between metal springs of an inner-spring type mattress to distribute weight more evenly and eliminate the need for tufting.

Revolutionary and much desired would be rubber fenders, as any one will agree who has driven in metropolitan centers. Except for buses, rubber fenders are impractical at this stage. Reinforcing steel would be required to give form, and mountings would likewise have to be of metal with the net result of much added weight where weight is undesirable. What we do see coming into use is rubber fender liners to reduce noise and prevent flying stones

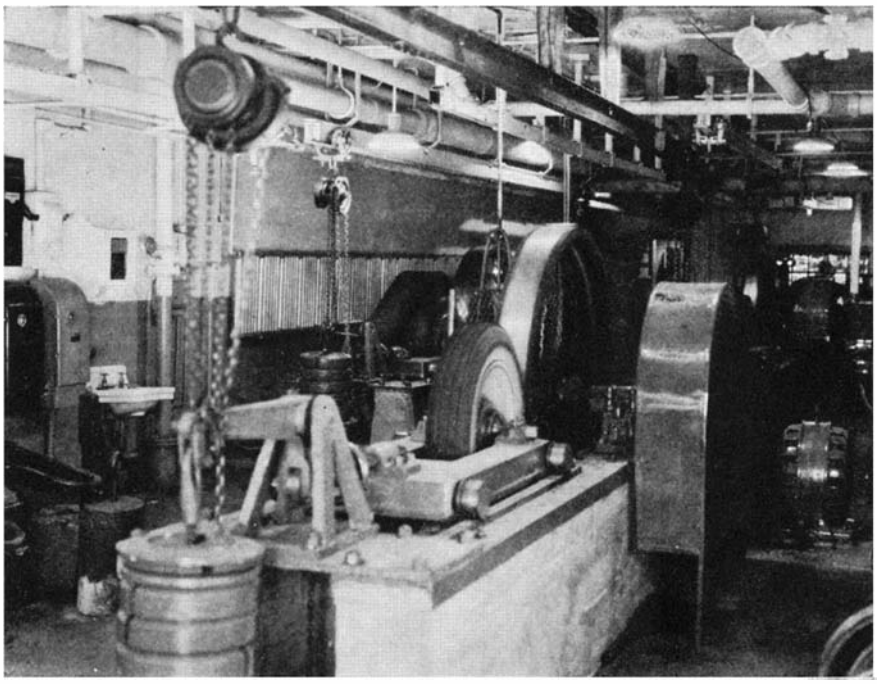


Believed to be the largest rubber lined hose ever constructed: a dredge discharge hose 30 inches in diameter in 18-foot sections with rubber end-flanges

IN order that laymen — and even scientists are laymen in fields outside their own!—may keep close tabs on the doings in widely separated branches of industry, we have presented a number of Mr. Smith's articles during the past year. This is the tenth of his fine reviews in which he correlates facts, evaluates them, and points out the possible (or probable) future.

Do you like these articles? Have they given you the new insight into industry that they aim to give? Are they valuable in building your store of knowledge? Have they helped you solve some of your own problems?

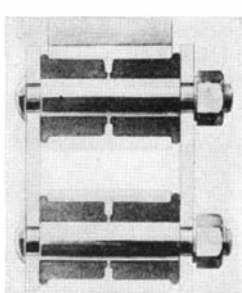
Scientific American is edited for you. Help us edit it better by giving us the answer to those questions. We would greatly appreciate it.—*The Editor*.



Valuable data on tire wear are learned from this test. Tires are pressed against the revolving, cog-rimmed wheel with a pressure equal to normal road weight

and gravel from denting the metal surface.

Now that the automobile has given rise to the development of satisfactory sound and vibration dampers, other types of transportation vehicles are adopting them. A French rail coach mounted on pneumatic tires was recently demonstrated in this country; light inspection cars have tried out solid tires for high speed running, while domestic rail cars obtain freedom from jar through a method of assembling rubber rings under compression into the wheels. Even the crawler type of tractor has been utilizing rubber, substituting for the steel track-laying band a continuous rubber belt with blocked-off tread design, reinforced longitudinally with steel cables. It is claimed that the rubber belt type of drive takes half the power of the ordinary steel track, while speeds as high as 50 miles per hour are possible.



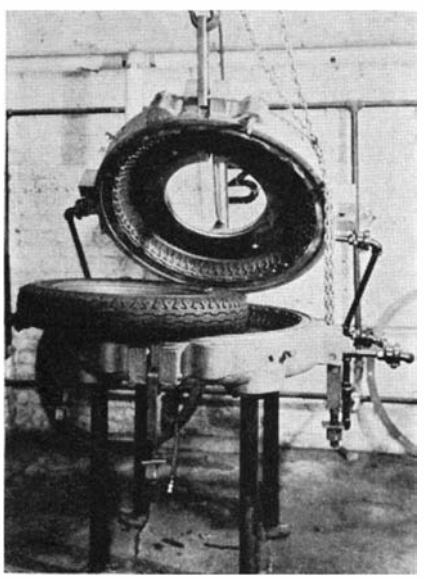
No metal touches metal in this rubber-insulated spring shackle

Many of the rubber applications found on transportation equipment are suitable in modified form for industry, but the truly significant industrial use stems from the development of processes to affix rubber to metal with an inseparable bond. This discovery has made it possible to line tanks for chemicals, to cover pipes which are to be buried underground, to combine metal springs and rubber for suspensions, and to mount heavy machinery with more effective vibration dampening.

Several types of rubber-to-metal bonding processes are now in commercial use. One process involves the plating of the metal with brass and then vulcanization of the rubber to the brass. Another method employs a series of binders beginning with one that will adhere to metal and ending with one which bonds with rubber, the intervening binders being ones which will bond with each other and thus by transition unite the two extremes. One of the metal-binding rubbers was discovered quite by accident. Treating rubber with certain acids produced a new compound, named Thermoprene, having extraordinary tenacity in clinging to anything in contact. It is a rubber compound and not a synthetic rubber such as Duprene, Thiokol, and Koroseal, which have been described already in these pages.

One of the outstanding uses for the rubber-to-metal bond is to make shock and vibration dampers for heavy machinery units. One type of damper comprises two pieces of metal with rubber bonded between in the form of a sandwich. One metal piece is fastened to the floor, the other to the machinery and the vibrations are taken through the rubber in shear. This sandwich form also serves for automobile engine supports. Another version is used for supporting the weight of a street car on its trucks. Here there are two cylindrical rings of steel with a third ring of rubber between them and bonded to them. The inside ring is raised above the outer ring so that the load is applied to the rubber in shear. In more complex forms, design is such that additional deflection under loads brings greater amounts of rubber into action.

Of the several applications of rubber-to-metal in shear, those which have to do with cushioning vehicles are the most obvious, but the opportunities to apply this new development to factory machinery are practically unlimited. There are advantages to be had in damping down vibrations for the comfort of the people working within the factory walls and also a great saving in wear and tear on the building proper. It is difficult to figure in dollars and cents the losses to industry from the incessant shaking given to its workshops, but the factor of building depreciation is known to be large enough to warrant extended use of these new vibration absorbers.



The full-circle retreading mold for used tires as discussed in the text

To reach its present high state of development as a suitable lining for metal tanks and tank cars, rubber has been required not only to adhere to metal without impairment due to the contraction and expansion following temperature changes, but to withstand wetting and drying and permeation of the liquid contents. Under most conditions the lining must not alter or discolor the contents and should the lining be damaged inadvertently it must be possible to make repairs easily and inexpensively. That rubber linings meet all these requirements bespeaks a great accomplishment for rubber chemistry. But if this is unconvincing, try to tear off rubber that has been bonded to metal.

Crude rubber has been put to uses which are startling because departing so widely from the expected. On many counts it vies with rubber latex for headlines. Employing it as a filler for the expansion joints in concrete highways is a new use with possibilities. Anyone who has driven over concrete

following a hot day has known that joint filling material left something to be desired. Expansion forces up the asphalt to form ridges to the distraction of the motorist and the detriment of the highway. Once squeezed out there is no return of the material, so sponge rubber was conceived as the material that would overcome this defect. Rubber filling returns to its normal position when the slabs contract, thus permanently keeping out water and dirt.

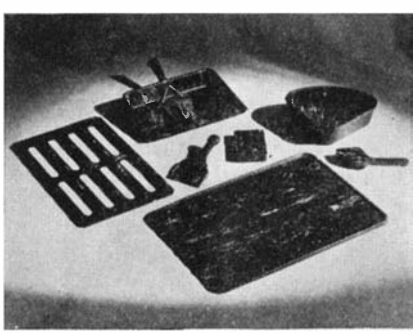
ANOTHER recent application aims at safety rather than comfort. It is a de-icer for aircraft. It is simple but effective, comprising three rubber tubes placed longitudinally along the wing. The middle tube centers on the leading edge, while the other two are placed below and above it. When atmospheric conditions cause the formation of ice, the middle tube is inflated by compressed air and simultaneously with its deflation the other tubes are inflated. The performance is repeated in rapid sequence to produce a rocking effect which cracks the ice so that it is blown away. This de-icer is a small affair, involving nothing that has not been available for a long time, yet it solves a problem which has worried airplane designers, owners, and operators.

The employment of rubber as a paint base has already been discussed at length in these pages.[1] However, in the months intervening since details were given of the hydrocarbon derived from crepe rubber, and of the chlorinated form, development has been carried forward swiftly to work out practical applications, to determine what the base is best suited for and the proper materials to be used in combination with it.

Most of the really practical accomplishments with rubber have been achieved by intensification of inherent properties through chemical treatment. Now comes something radically new. Rubber has been given a property that it never possessed in its natural state and that property is antisepsis. It is almost too soon to talk about this scientific achievement, for although it is in practical use it has hardly emerged from conclusive tests. Originators of this product claim that the quality of antisepsis is given to rubber through actual chemical change of the rubber molecule. Further claims for this rubber are (and they sound almost unbelievable): killing of bacteria, inhibiting bacterial growth, capacity to change acids to alkalies.

[1] Scientific American, April 1935, page 194.

Boulder Dam type trucks weighing 60,000 pounds give tires much punishment hauling loads of coal over jagged mountain roads from a strip coal mine

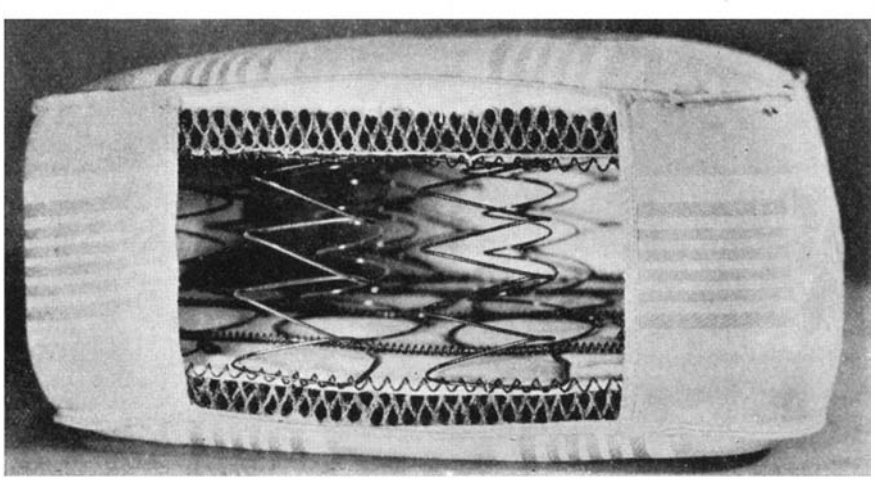


Hard rubber has recently found many uses in a variety of products

One can imagine a wide field for this particular rubber and it occasions no surprise to learn that it is being used now for surgical gloves and for such protective products as dress shields and baby pants.

CHEMISTS are somewhat divided as to the potentialities of present research. There are some who hold that the rubber-sulfur base must be abandoned if any marked progress is to be made; others believe that painstaking research along established lines will yield adequate returns. It seems likely that there is some truth in both. Rubber is at the point where years of laborious study may yield a sudden unpredictable discovery, either as a radical departure from the present course or as a logical step in it.

Chemists have no illusions about the vastness of the unknown and they are attacking rubber chemistry from many angles. More study is going into antioxidants to prolong the useful life of rubber; search is being made for new and better reinforcing pigments; new compounds are being evolved and tested; and control of reclaiming processes is being bettered to the end that used rubber will be more uniform and better suited to the many uses to which it is being put. The process of refinement is unceasing and rubber flowers into forms which promise to give it an even wider play in commerce and industry.



Something very new under the sun: hoghair and rubber combine to make a springy, tuftless mattress. Note the rubber "figure eights" at top and bottom

Photographs courtesy *India Rubber World*, *S. A. E. Journal*, B. F. Goodrich Co., and U. S. Rubber Co.

A Bigger and Better

CAPE COD CANAL

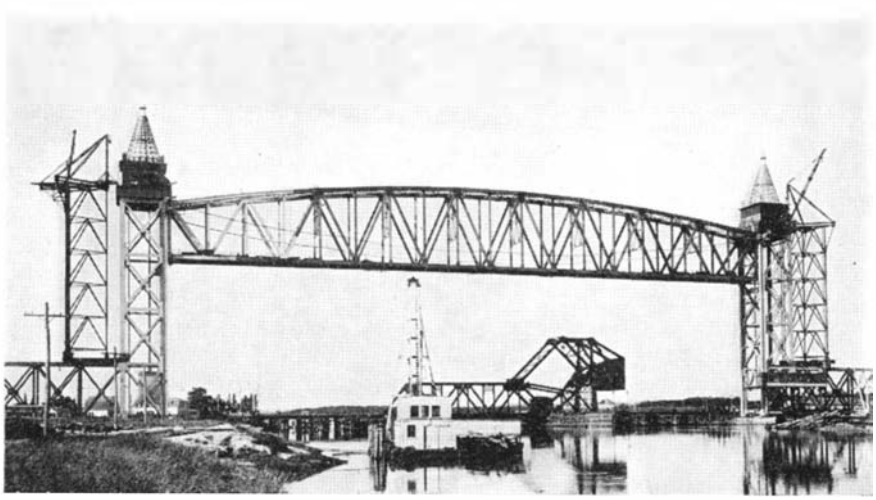
By R. G. SKERRETT

CAPE Cod Canal is now undergoing changes that will allow it to accommodate annually the movements of shipping carrying substantially 10,000,000 tons of cargo—about five times as much as that man-made waterway has averaged yearly since the Government bought it in March, 1928. Depending upon the route followed by a craft in approaching Boston from the south, the canal saves from 65 miles to 166 miles, and effects fuel economies ranging from 50 to 200 dollars a trip. But, what is equally important, the sheltered run through the canal renders unnecessary the navigating of Cape Cod's dangerous offshore waters that each year costs on an average the lives of fifteen people and property damages of more than 500,000 dollars.

The Pilgrim Fathers, more than 300 years ago, urged the digging of a canal to connect Cape Cod Bay with Buzzards Bay, separated by a sandy peninsula less than eight miles wide. The wedding of those two bays was not effected until July, 1914, when the Boston, Cape Cod and New York Canal Company cut through the final intervening barrier of earth. The canal was accepted as finished by the Commonwealth of Massachusetts in April, 1916, by which time dredging had produced a channel 25 feet deep, with a bottom width of not less than 100 feet. At that time, the waterway represented an expenditure of 13,000,000 dollars by the canal company.

As a wartime measure, the Government took over the canal in July, 1918; and later purchased it for 11,500,000 dollars, immediately making it a toll-free route. The waiving of tolls added to the popularity of the waterway; during the first year of Federal ownership 1,405,782 tons of cargo passed through the canal. The latest published statistics show that 2,804,998 tons of cargo were carried over that route in 1933, and indicate a steady increase in the use of the canal.

The canal was intended to obviate the offshore run around the cape through waters where shifting shoals, deceptive currents, dense and frequent fogs, and seasonal gales have long had to be reckoned with by craft engaged in coastwise trade. In the two decades from 1900 to 1921, 974 vessels were wrecked in the waters about Cape Cod, and the property losses totaled about 10,000,000 dollars, while 300 lives were snuffed out. Yet, despite the seeming advantages of the shorter and safer route via the canal, figures reveal that only about 20 percent of the water-borne cargo moving in and out of Boston, between that port and ports to the south, is carried through the canal. It is to change this situation for the greater security and convenience of coastwise commerce that the Cape Cod Canal is undergoing radical and noteworthy changes.



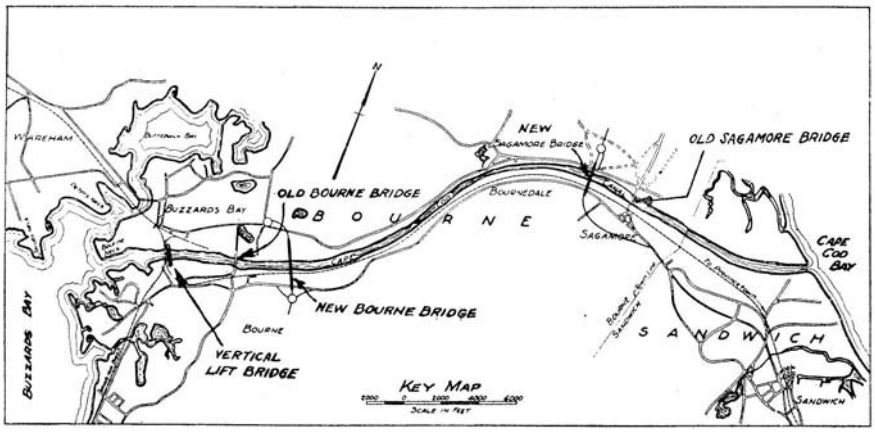
The new railroad bridge over Cape Cod Canal near the Buzzards Bay end, with its great lift span in raised position. Its clearance above water level is 135 feet

Cape Cod Bay and Buzzards Bay are so surrounded by land that the tide wave that flows in from the sea does not reach the innermost sections of those bays simultaneously. It is high tide in Buzzards Bay more than three hours before the water in Cape Cod Bay arrives at the same stage. Further, while the rise and fall of the tide in Buzzards Bay is normally through a range of close to four feet, the corresponding movement in Cape Cod Bay is in excess of nine feet. These differences of level between the two bodies of water cause currents in the canal that have velocities up to more than five miles an hour. These currents tax to the utmost the skill of the man at the wheel.

From November, 1915, to June, 1930, there were 75 recorded accidents in the canal and most of them were groundings caused by these tidal currents. The estimated damages—not all being recorded—totaled more than 800,000 dollars. The same currents eroded the canal banks, and created shoal areas. Well-nigh continuous dredging by the Government has failed to restore the channel to its original depth, and vessels drawing in excess of 20 feet of water do not use the route. These circumstances make it understandable why so many shipmasters take the seaward course around Cape Cod.

IT was manifest that the canal should have a deeper and wider channel, and it was proposed that locks should be constructed at the Cape Cod Bay end of the waterway to produce a currentless or slack-water route. Locks are objectionable wherever traffic is heavy, because they entail delay. The Government technicians, therefore, have abandoned the plan to build locks for reasons to be explained later, one of which, unforseen, came to light in the construction of new bridges over the canal.

More than 5,000,000 dollars is being spent on three new bridges to supplant the three old ones that were built by the Boston, Cape Cod and New York Canal Company. The two new highway bridges were finished recently, and the new railroad bridge is nearing completion. All the old bridges are of the bascule type and low. Well-nigh all of them have had to be opened to permit vessels to pass. The opening and closing of these bridges have alternately arrested land traffic and water traffic. The two new highway bridges, however, have channel spans that afford a vertical clearance of 135 feet; the spans are so long between their two supporting piers that there is ample room for the broadening of the channel to the projected splendid width. Each one of these new bridges carries a road



Map of the Canal showing the old and the three new bridges

way 40 feet broad, designed for four lanes of motor vehicles, and a sidewalk six feet wide.

The new railroad bridge is of the vertical-lift type, the lift span measuring 544 feet between the points where it engages the guideways in the two supporting steel towers, each of which is 275 feet in height. The lift span will travel vertically a total distance of 130 feet, and can be raised or lowered to that extent in two minutes. When in the fully raised position, the span will be 135 feet above the surface of the canal; and ordinarily this greatest of lift spans will be held aloft for the convenience of shipping and will be lowered when the relatively infrequent train is to cross the canal. The channel between the pier fenders of this bridge will be 500 feet wide as compared with the opening in the old railroad bridge which is but 140 feet.

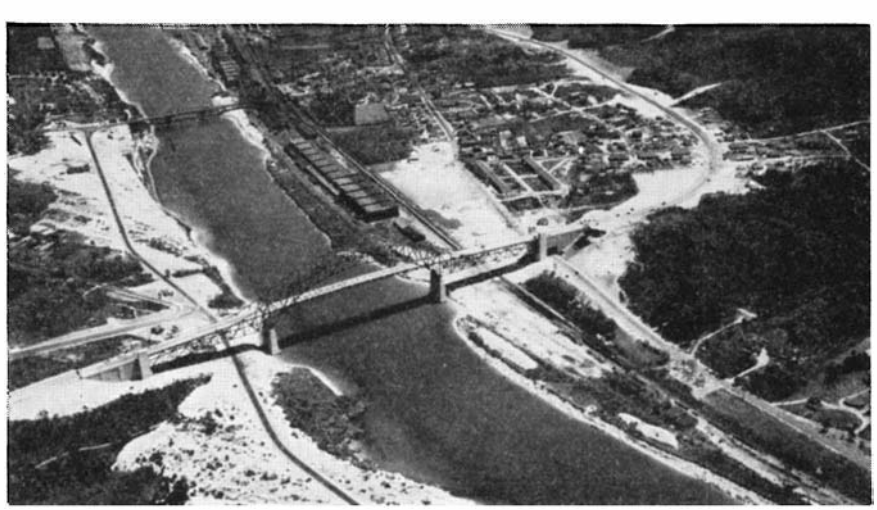
THIS brings us to the reasons for continuing the canal as an open sea-level waterway. Cape Cod and the neighboring region is gripped occasionally by winters of exceptional severity; the winter of 1933-34 was one of that kind—with ice 18 inches thick formed in the open, wind-blown waters of Buzzards Bay. If the waters of the canal were stilled by locks and exposed to the low temperatures, they would freeze quicker and thicker in their sheltered course than the waters in Buzzards Bay. Such heavy ice would inevitably block the canal and the locks, and prevent either the opening or closing of the lock gates. But there is still another reason for the abandonment of the plan for locks.

In excavating for the foundations for the three new bridges, numerous boulders were encountered, some of them weighing many tons; and the presence of those, buried more or less deeply in the prevailing sand and gravel, added greatly to the difficulties of preparing the pier foundations and likewise increased the cost. The area traversed by the canal is what is known as a glacial terminal moraine, and the reasonable assumption is that the geological conditions at the proposed lock sites would be similar to those at the bridge pier sites. To build locks and support them properly in such ground would be so expensive as to make them undesirable; hence the course now being carried out was adopted.

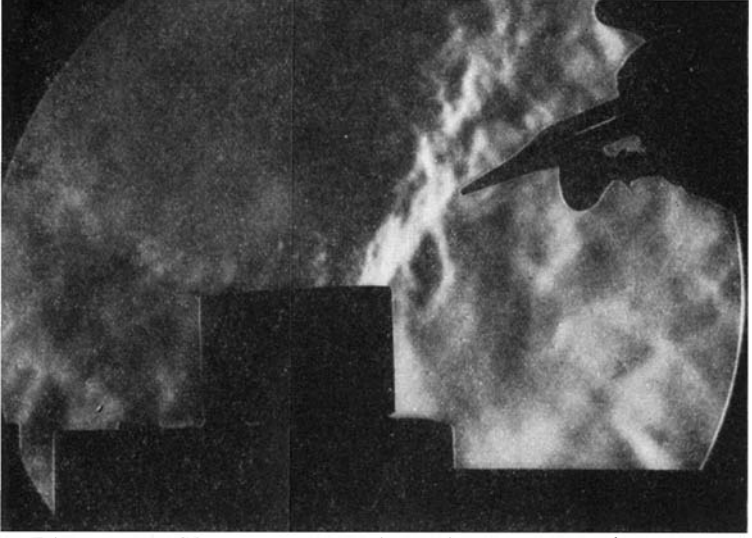
To make the canal an adequate route for a much greater volume of shipping than has used it up to the present, the Chief of Engineers has endorsed the plan that calls for a land cut that will provide a depth of water of 32 feet and a channel with a bottom width of 540 feet—more than five times its original width. The channel has latterly been broadened to 205 feet, with a marked improvement in its navigability. From the western end of the canal, a new and nearly straight channel 500 feet wide and 32 feet deep is to be dug in Buzzards Bay to a point westward of Wings Neck. From that point to deep water, the channel will be 700 feet wide. This new channel is to take the place of the old sharp-angled and considerably narrower channel, 5.3 miles long, that now constitutes the western approach to the canal. There will be a capacious mooring basin in the canal near its Cape Cod Bay end; another large mooring basin outside the western end of the canal at one side of the new channel; and a channel 100 feet wide and 15 feet deep will connect the Buzzards Bay channel with Onset Bay to the westward. Onset Bay will provide a land-locked haven for yachts and other small craft. At present a vessel skirting Cape Cod can find no harbor or refuge or protecting lee between Provincetown and Marthas Vineyard, 110 miles distant.

Heretofore, traffic has been put through the canal alternately from one end of the waterway to the other, and sizable vessels have not risked collision by passing in the canal. When the new channel is completed across the peninsula, it will be reasonably safe to maintain two-way traffic simultaneously and thus add tremendously to the value of the waterway and to its capacity to serve shipping. The Army engineers, under whom the work is being done, believe that the wider and deeper channel between the two bays will bring about adjustments of levels that will reduce the head or slope that causes the currents and, to that extent, make the guiding of vessels through the canal an easier task. This, in combination with the much broadened route, will prove a boon to shipmasters and dissipate objections to the canal that have prevailed in the past.

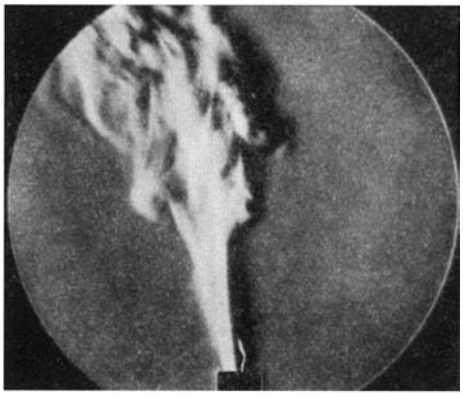
APART from providing a safer, shorter, and better route than the offshore one, where dense fogs occur more than 1000 hours annually, it should be remembered that the Cape Cod Canal is destined to serve as an important link in the intra-coastal waterway, which is now partly completed. That waterway will eventually afford a sheltered, inland course for vessels of certain kinds, among them pleasure craft, moving up and down the seaboard between the Gulf of Mexico and the ports of New England. Any way it is viewed, the Cape Cod Canal should stand forth as an engineering undertaking of the first magnitude, and one that will benefit the entire nation.



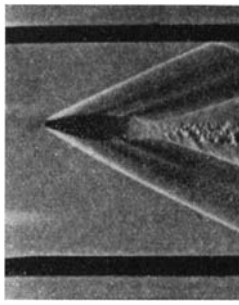
Air view of the fine new Sagamore Bridge which has a clearance of 135 feet above the waterway. Just beyond is the old one that is to be demolished very soon



Ether vapor rising from a small vessel, vaporization being hastened by an air jet blown over the ether from the right



A stream of warm air rising from the hot flame of a burning tallow candle



A striking illustrati of the sound waves tween two parallel lines) reflect the he ner similar to light mirror. Note turbul

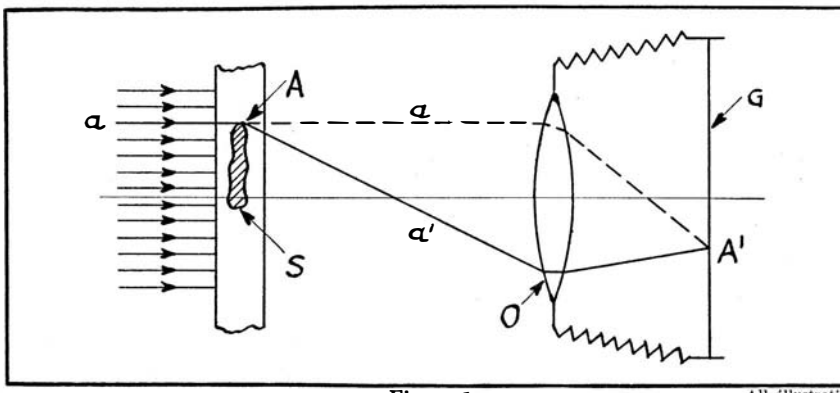
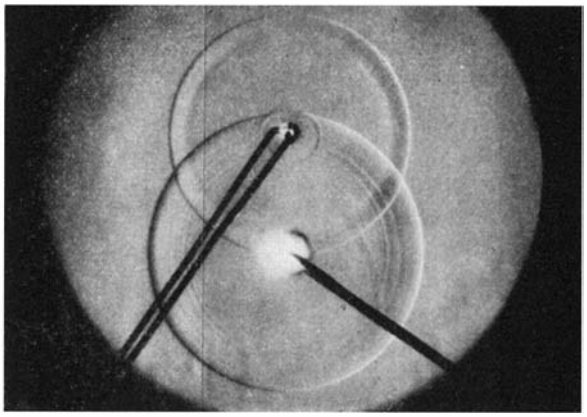
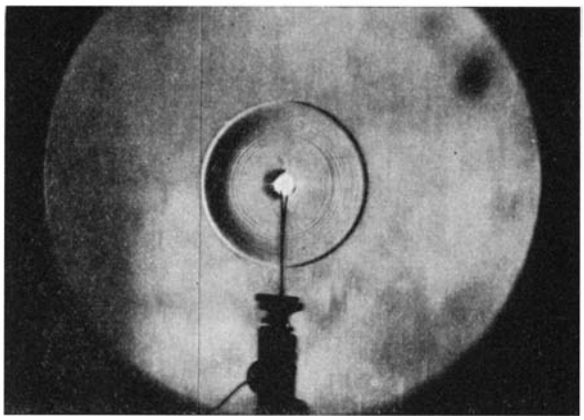


Figure 1

All illustrati

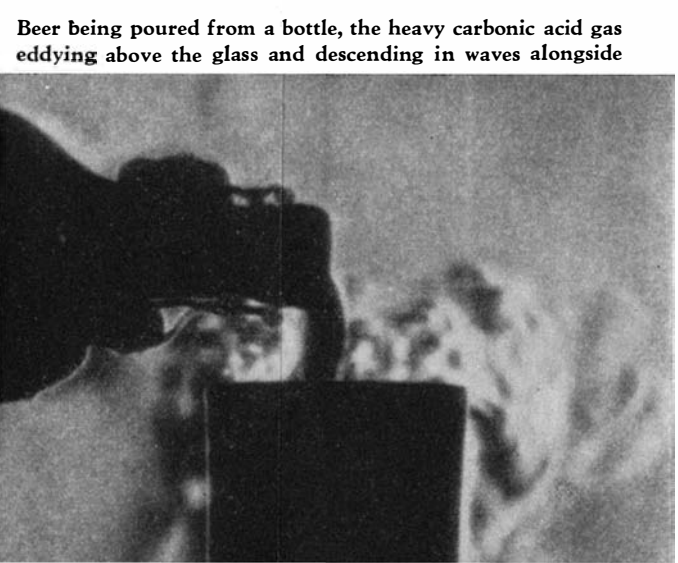


Large and small sound waves spreading from sources (sparks) giving sounds of different values



Miniature thunder. A sound wave of great intensity and steep wave front spreading from a spark

Beer being poured from a bottle, the heavy carbonic acid gas eddying above the glass and descending in waves alongside



'SEEING' T

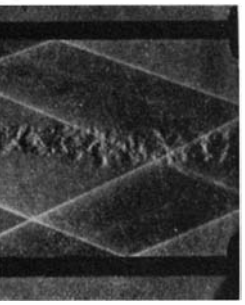
By DE B

THE ability to photograph certain phenomena in the fields of acoustics, ballistics, flow-physics, heating, and so on, is of tremendous value to the research worker. By means of the "streak" method, which may be used in both still and motion-picture photography, such photographs may be obtained as are reproduced on this page.

In order to understand the streak method of photographing invisible phenomena, it is helpful to remember the effect, so often seen on hot days, of railroad tracks in the distance seeming to wriggle under the scorching sun. We all know that a beam of light, passing from an optically denser medium to a thinner one (or vice versa), is refracted. Now, in the case of the railroad tracks, warm air forms eddies above the hot rails as it rises, because hot air is less dense than cold air. And because the density of the warm air is constantly changed by cool air currents pressing from the sides, a beam of light from any point of the rail has to pass alternately through layers of warm and cool air, which means that it is continually more or less refracted. This has the effect of making a section of rail appear to bend either up or down, more to the right or to the left. In similar manner an object viewed throu a poor grade of window glass, whi is composed of irregular sections (thic er or more curved areas), is apparen distorted.

Generally, uneven areas in a mediu are referred to as "striae" or "streak Thus a sound wave is a streak, becau the propagation of sound depends the spreading of various densities of t air. Another example is gasoline or eth vapor in the air. The streaks themsel are invisible, and their effects are se by the human eye only when they cau distortion of light rays coming to t eye from an object of known shape. is possible, however, to photograph th streaks, as explained below.

A typical streak in a glass pane illuminated, in Figure 1, by para light rays. At point A the beam strongly refracted (a') through margin of the streak. If we now fo the camera sharply on the window pa (and thus also on the streak), the fracted pencil of light a', through effect of the lens O, appears on exac the same spot A′ of the ground glass



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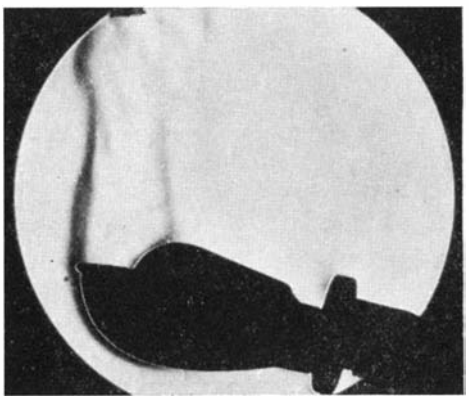
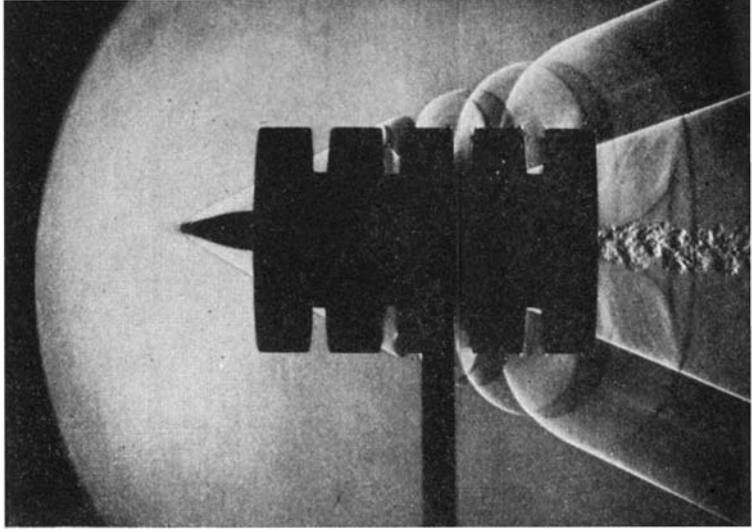
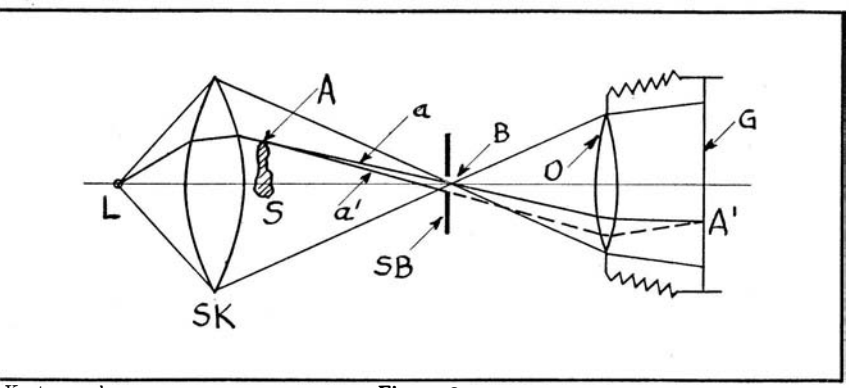


An electric incandescent bulb and reflector send up a stream of warm air

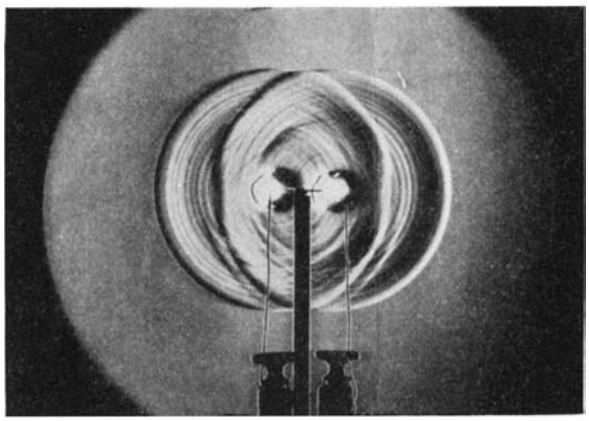


Sound waves from a bullet passing through a cylinder with openings at the sides, as revealed by means of "streak" photography

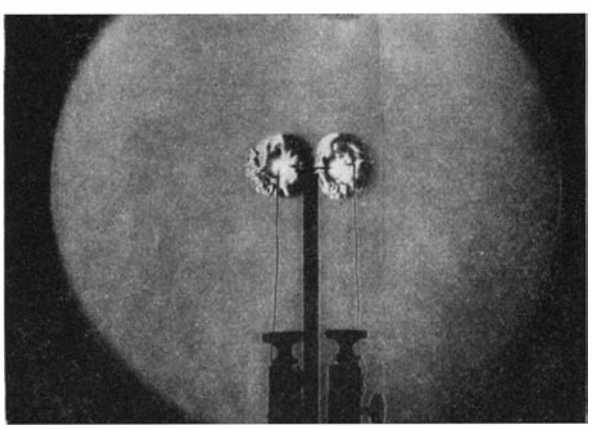


Kerstonewyork

Figure 2

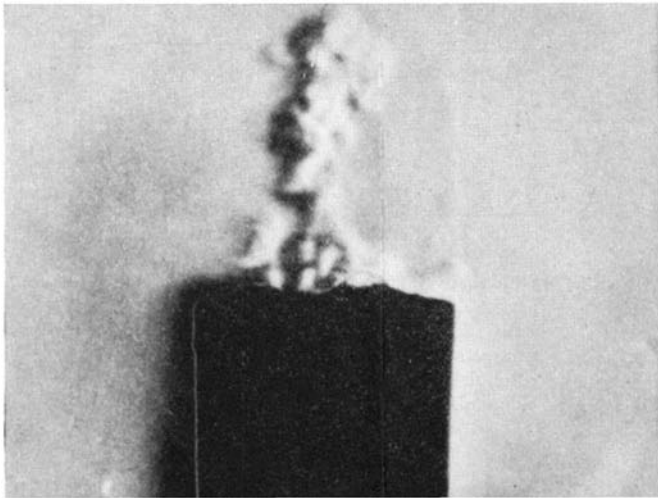


Two sound waves spreading simultaneously, and practically independently, from two spark gaps



Sound waves from these two spark gaps have passed beyond camera range, leaving only the heated air

A bubble, rising to the surface of a glass of carbonated water, has just burst, and the vapor is being pushed up



INVISIBLE

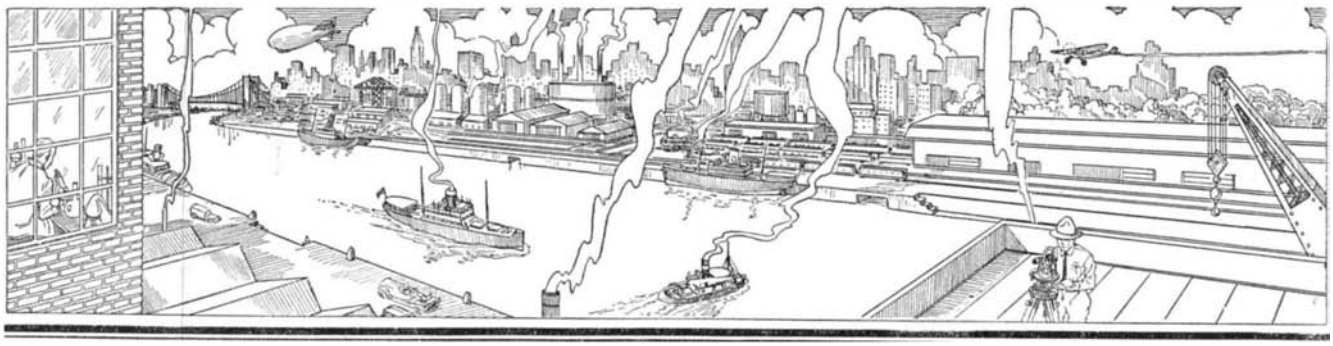
ERSTON

s if there were no streak at all, and as the beam had not been refracted. The non-refracted ray is marked *a*.) onsequently, the point A′ on the round glass has the same luminosity intensity of light) as if no streak were resent. In other words, the ground lass is evenly illuminated all over, and ie streak cannot be seen.

If, however, the refracted rays are educed or "stopped down" by means f a diaphragm, so that they cannot ompletely pass through the objective, ie streak becomes visible. In order to op down the refracted rays evenly, the rrangement shown in Figure 2 is usuly employed in principle. With the id of a concentrated light source L nd the lens SK, a convergent pencil of ght is produced, which has its focal oint at B. Behind B the camera (obective O with ground glass G) is laced, and focused sharply on the oint S, where later on the streak (for xample, ether vapor) is to be placed. If a single ray of light strikes the round glass at the point A′, and a reak is placed at the spot S, the ray is then refracted downwards and fols the path *a′*. But it also reaches point A′ due to the optical reproduction of the lens O, and because of this fact the streak remains invisible.

However, it will be seen that the ray *a′*, the same as any other ray refracted by the streak, no longer passes through the point B. If a circular stop SB is now placed close to B, ray *a′* is stopped down (the subdued part is shown as a dotted line), and likewise every other ray that has been refracted by the streak. Consequently, the point A′ now appears darker on the ground glass. The same happens with light passing through any other point of the streak, varying, of course, in accordance with its refractive power. Thus, the entire streak appears on a light background.

Actual procedure naturally requires certain modifications in the diagrammatical set-up shown here, because certain assumptions, which we have made to elucidate the process, do not exist in practice. The technique of this process was discovered in 1864 by the eminent physicist Toepler, and has been named after him "Toepler's Striae Method." But it is only in recent years that this method has been practically applied in many branches of industry and science.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Frost Chaser

THE mechanical frost-dispeller pictured here is a typical example of new equipment found in a limited number of California orchards. It is installed on the ranch of A. H. and R. W. Hills in the Porterville orange district. A 450-horsepower 12-cylinder Liberty airplane engine drives an 8-foot propeller. The engine and propeller are mounted on a 40-foot steel tower, the platform of which slowly revolves when the engine is running. The spinning blade creates a wind, circulates the cold air that always settles close to the ground, and nowhere in a 40- or 50-acre area can Jack Frost find a quiet spot to lay down his white mantle.

Courtesy *Standard Oil Bulletin*

An airplane propeller and engine help protect orchards from frost

Soap versus Soapless Soap

FOR many years the manufacture of soap proceeded along conventional lines with but slight change due to technological developments. Suddenly, however, the soap market was threatened by the development of the so-called "soapless detergents," the sulfated higher alcohols of the fatty acids, with their remarkable properties of lathering freely in even the hardest waters. Originally of foreign origin, these processes and products have been studied and improved through the work of a number of American companies, notably Procter and Gamble, Du Pont, and the National Aniline and Chemical Company.

The soap industry, stirred by this infusion into its ranks of organic chemistry of a new order, has counter-attacked along several lines. One of these was the use of sodium hexametaphosphate as an adjuvant to soap. This is said to put old-fashioned soap on a basis where it can compete in performance with the results obtained with the higher fatty acid sulfates and at a lower cost. Thus, a challenge raised by chemical research in one direction is met by chemical counter-attack.—*A. E. B.*

Constructing World's Largest-Bore Tunnel

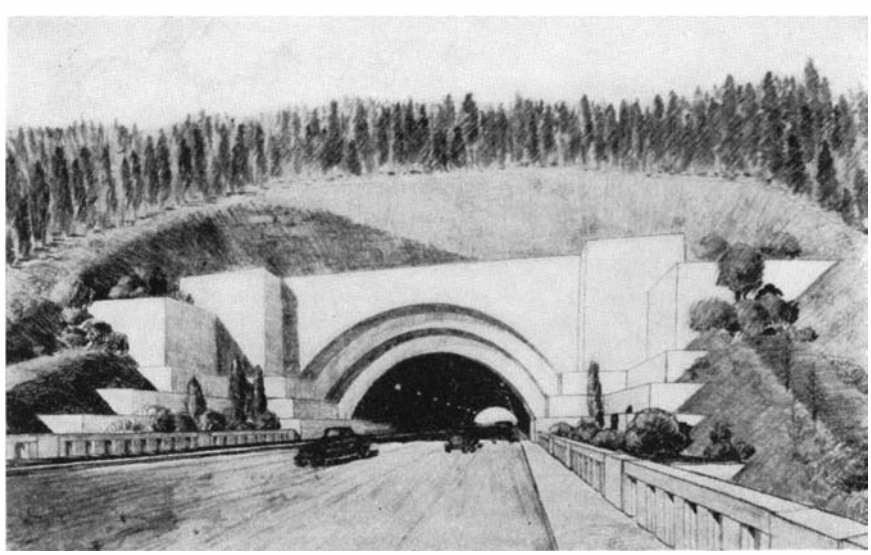
MORE than 350 feet of the 540-foot Yerba Buena Island Tunnel of the San Francisco-Oakland Bay Bridge is now completely lined with concrete of a minimum thickness of four feet on its side walls and a minimum thickness of three feet over its crown, according to Chief Engineer C. H. Purcell's last report to State Director of Public Works Earl Lee Kelly.

The crossing of Yerba Buena Island, a military and naval reservation, occupying a 400-acre outcropping of sandstone, is by means of a reinforced concrete viaduct, four 288-foot steel truss spans, and a 540-foot tunnel.

The main vehicular tunnel, without its concrete lining, will be 76 feet wide by 58 feet high, making it the largest-bore tunnel in the world. It will accommodate two traffic decks. The upper deck will have six lanes for fast automobile travel; the lower deck will have three lanes for heavy trucks plus two tracks for interurban trains.

A tunnel was chosen for this portion of the work rather than an open cut because the very high and steep side slopes of the latter would have created the hazard of dangerous slides. In addition, such a cut would be a restriction to the best use of the island by the government agencies occupying it, and would have created an unsightly scar.

In constructing the tunnel it was anticipated that the rock for the first 200 feet from the west portal would be somewhat broken and incapable of supporting itself. Cement grout under as much as 300 pounds pressure was pumped into 25 1½-inch holes which were bored horizontally into the rock and over the crown of the tunnel before any digging was started. By this means the rock was sufficiently strengthened.



How the tunnel on Yerba Buena Island will appear when finished

When completed, the tunnel will be continuously lined. The roof will be supported by 16-inch steel arch ribs spaced every three feet. This steel will be embedded in concrete with a crown thickness of three feet.

Due to the large cross section and short length of the tunnel, no mechanical ventilation is provided.

In the construction of the main vehicular tunnel, the open portals at both the east and the west ends were first excavated.

A novel method of excavating the world's largest bore tunnel was conceived by Chief Engineer Purcell and his staff, the novelty of which consists chiefly in that they first build the tunnel and then dig it out.

Three bores were drilled through the island for the tunnel. The three bores, one at each lower side and one in the crown, are blocked out into a horseshoe-shaped excavation through the rocky island. This horseshoe-shaped excavation is then concrete- and steel-lined from three to five feet thick before the inside or core of the tunnel is dug out.

With the tunnel completely lined for most of its length of 540 feet, a power shovel enters the portal to remove the thousands of cubic yards of rock within this 58 by 76-foot bore. Through this bore a four-story building could be pulled upright. —*California Highways and Public Works.*

Taking out the core of the Yerba Buena tunnel, after the lining is in place

SMOTHERING FISH

FISH can smother in a lake and have actually done so in one up near Wallingford, Connecticut. A correspondent to the journal *Science* says that water plants absorbed most of the oxygen from the water so that the many fish living therein died in gasping agony.

Extinguish Oil Fires with Water!

WATER is being used successfully to fight oil fires, the National Fire Protection Association reports. The water-for-oil-fire method, which apparently breaks basic rule No. 1 of fire-fighting techniques, is illustrative of progress and research in the fire-extinguishing field, says the Association.

The new oil fire-fighting method consists of a fine spray of water forcibly ejected from special nozzles installed in sprinkler pipes or on a hose. The secret of success seems to be that the spray droplets must be of a critical size; if too large, they splash the burning oil and spread the fire; if too small, they cannot extinguish the flames. So don't rush out and throw water on the next oil fire you see.

Although not yet submitted to fire underwriters' organizations for final testing and approval, installations have already been made for the protection of electrical oil transformers and high-pressure oil systems. —*Science Service.*

Blood Test Before Marriage

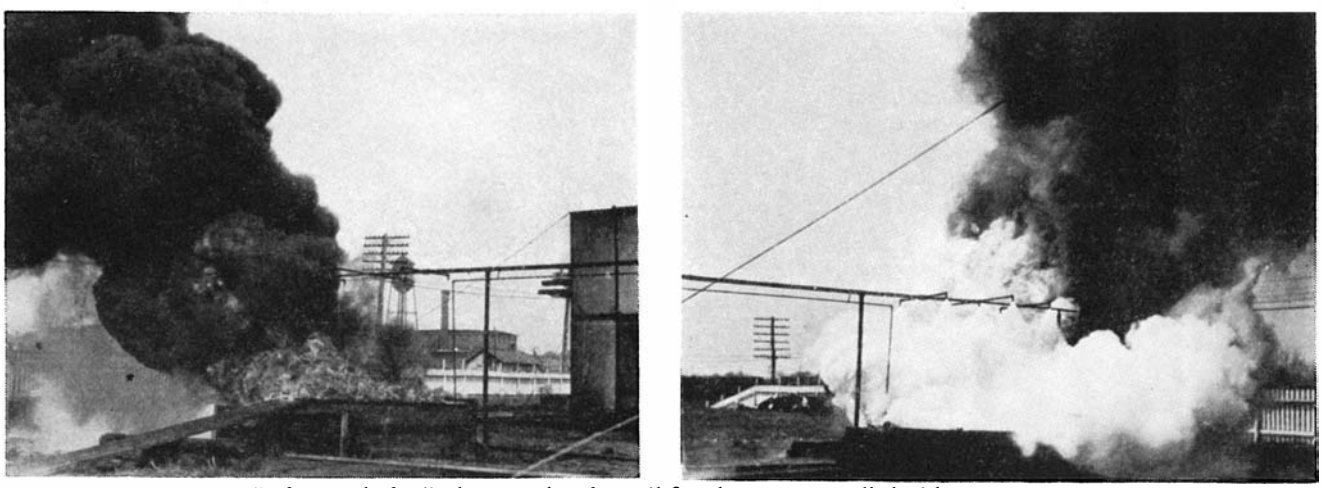
AFTER the first of January, all applicants for a marriage license in the State of Connecticut must pass a Wasserman or Kahn test before a license will be granted. The certificate must be based on a blood examination by an approved laboratory. The blood examination will exclude the possibility of the dreaded venereal disease, syphilis, which in certain stages is readily communicable. Other states requiring medical examination upon the issuance of a marriage license are Wisconsin, Oregon, North Dakota, Alabama, Wyoming, and Louisiana. North Carolina repealed its law last year.—*Science Service.*

EARTH TIDES

MOON tides in the earth's crust? Yes, scientists have shown that such is the case, and their delicate instruments have proved that Pittsburgh rises and falls from 13 to 23 inches a day.

Pacific Airline Bids Accepted

AIRLINE operation by Pan American in the Pacific will probably be in effect by the time this issue reaches the reader. Postmaster James A. Farley has accepted the Pan American bid for carrying airmail across the Pacific. The bid calls for a maximum rate authorized by law of two dollars a mile for a specified 800-pound load and one dollar a pound for each 1000 miles in excess of 800 pounds carried. This means



"Before and after" photographs of an oil fire that was controlled with water sprays

that the Post Office will pay a maximum of 17,200 dollars for each flight across the Pacific, or slightly more than 50 cents a letter when a full mail load is carried.

The specifications call for weekly trips each way between San Francisco and China, with Hawaii, Midway, Guam, Wake, and the Philippine Islands as the intermediate points.

Pan American was the only bidder so there was no question of competition but only a question of whether the six-man cabinet committee would accept the one bid. It may seem at first that the possible bill of 1,665,000 dollars a year to the United States would be generous, but it is not undue remuneration when the size and cost of operation of the huge China Clippers are considered, and when we remember that Pan American has spent 4,200,000 dollars on its preliminary preparations in the Pacific.

The inauguration of this service will be another stepping stone in the progress of world aviation.—*A. K.*

A Flying Club-Car

A BOEING 247-D high-speed airplane has been recently delivered to the Phillips Petroleum Company. It is very tempting to look at a photograph of the interior of this

Inside the flying club-car

ship which contains such luxurious appointments as overstuffed easy chairs, built-in radio, and telephone communication between cabin and ground stations. To cruise at 200 miles an hour in such a cabin certainly appears very attractive.—*A. K.*

A Tailless Private Airplane

WE have often had occasion in these columns to speak of the experiments which are being conducted under the auspices of the Department of Commerce in the construction of planes suitable for the private flyer. Definite information regarding these experiments is somewhat slow in forthcoming; however, we now have a description and the essential data on the *Arrowplane,* which has been built on the Pacific coast by Waldo Waterman, an experienced constructor and aviator.

Like the Hammond Model Y described in our October issue, the *Arrowplane* has its main wheels behind the center of gravity, and an auxiliary wheel ahead of the nacelle or fuselage. This type of landing gear makes for stability in taxying on the ground and is of assistance in side or cross-wind landing, lessening the possibility of the unpleasant "ground loop." At the same time, by virtue of the front wheel the flier can land his machine, apply brakes violently without nosing over, and stop in a very short distance, even if his approach to the ground is *not* the correct one. Obviously these factors are likely to be helpful to the novice pilot. The pusher arrangement, with engine in back, makes for excellent vision, and the noise of the engine and propeller does not bother the passenger.

These features have already appeared in the Hammond. The Waterman *Arrowplane* embodies certain other interesting departures from conventional practice. Thus the machine has no tail surfaces in the usual sense of the word. The wings are swept backwards, and at their outer and rear extremities the movable surfaces can be depressed or raised simultaneously (in which case they act as elevators) or given opposite displacement on either side (in which case they act as ailerons). These control surfaces are balanced by small external wings, sometimes called paddles (like those used on the Dornier *DoX*) which are placed well ahead of the hinge line of the control surfaces. The mechanical arrangement for the dual function of these control surfaces is not so complicated as might at first appear, and has been very well realized. The fins and rudders are disposed at the outer tips of the wings. The two rudders are operated one at a time. Thus if the rudder on the right tip is displaced outwardly, its increased drag tends to turn the machine to the right, and at the same time the side or "lift" force on the rudder also tends to turn the machine to the right. Conversely, outward displacement of the left rudder yaws the machine to the left. The two rudders can also be displaced inwardly simultaneously; in this case they cease to be rudders and function merely as air brakes.

The advantage of such rudder arrangement is that the rudder is never blanketed or rendered ineffective no matter how high the angle of attack of the machine may be, and therefore remains effective even if the machine is spinning. Stalling and spinning tendencies are also lessened by the

Waldo Waterman in the cabin of his tailless airplane. See the text

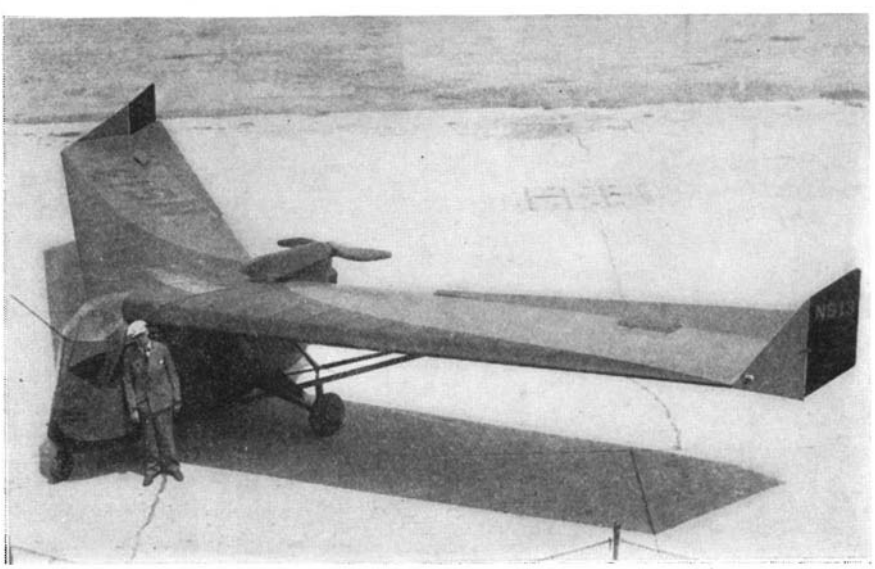
low loading per square foot of wing area.

The criticisms likely to be made of this type of aircraft, as of the Hammond Y, are that it is likely to be slower than a conventional machine of similar weight and horsepower, and that the public objects to pushers.

The main characteristics of the *Arrowplane,* as supplied to us by the manufacturer, are as follows: Maximum speed, 110 m.p.h.; range, 350 miles on 26 gallons of gas; weight empty, 1310 pounds; gross weight, 1900 pounds; span, 40 feet; overall length, 18½ feet; landing with stick all the way back, without leveling out, within 500 feet of an obstacle 35 feet high.

The American public is enamoured of the automobile, and the *Arrowplane* has tried to follow automobile practice inside the cabin. With the new landing gear, a very low slung cabin is possible, and the position of the seats, doors, and so on, follows motor car practice.

Newspaper stories also tell us that the wings will ultimately be made detachable or folding, and a gear drive introduced from the pusher engine to the rear wheels. In other words an attempt will be made to



Looking down on the Waterman *Arrowplane,* designed for private flyers

build a combination airplane-automobile.

Whether this last plan is seriously entertained or not, and whether the *Arrowplane* lives up to the first favorable impression, it certainly merits careful study by designers and fliers.—*A. K.*

An Airport Directory

THE first airport directory of the United States, dated 1935, has appeared, and comprises over 200 pages, listing airports by states, giving main dimensions and facilities, and including photographs from above of all the main landing points. The utility of such a volume to all aircraft operators and owners is obvious. A knowledge of airports is as indispensable to private flying as an understanding of air maps. Perhaps some day maps and airport directories will be distributed from aerial service stations in the way automobile maps are given away by the generous oil companies!—*A. K.*

Visibility in Meteorology

WHEN the Weather Service was being organized for the airmail in Canada, the question of suitable visibility marks became a serious problem, as there appeared to be no general text on the subject of visibility. A very intensive search of the literature of the subject was made and the results published in Middleton's monograph, "Visibility in Meteorology," published by the University of Toronto Press.

From a practical point of view, when the visibility is very low, as in a real fog, air transport is greatly handicapped. While the book does not offer practical remedies, it does tell all that is known about visibility—the behavior of light in the atmosphere, the appearance of objects, the calculations of visual range, and the dependence of visual range on other weather elements.—*A. K.*

Ring Light for Aircraft Instruments

ILLUMINATION of instrument dials is an important matter in flying. Reflection or glare results in eye strain, delays reading of instruments, and diverts the pilot's attention from other duties. The luminous painting of dials is not satisfactory especially at dusk and dawn, and an additional source of illumination becomes necessary. The Pioneer ring light has been designed to eliminate these difficulties. The ring light employs a glass rod curved around the circumference of the instrument dial. The glass rod is so constructed and treated that light is carried around the periphery of the dial and is distributed evenly over the dial markings and the end of the pointer. The result is a soft, even light without glare or bright spots, regardless of the angle from which the dial is observed. A small electric light bulb is the source of light, and a resistance unit is built into the plug so that the instrument may be connected directly to the lighting circuit. After the ring has once been installed, the snap ring, pointer, dial or, if necessary, the movement, may be removed without disturbing the lighting system.—*A. K.*

How the dial of an air-speed meter shows up with ring light

The Navy amphibian, *XP3Y-1*, that recently set a new non-stop flight record

Parts of the instrument ring light

A Navy Seaplane Record

THE international record for non-stop flight for a seaplane was recently broken by Lieutenant Knefler McGinnis, U.S.N. and a crew of five in the Navy amphibian *XP3Y-1*. The flight took them from the air base at Coco Solo, Canal Zone, to San Francisco, California, and covered an air-line distance of 3300 miles.

This is not just another record, but an important demonstration of the speed and endurance which can be counted upon in our newest patrol boats. Sixty of the new type seaplanes will be built by the Consolidated Aircraft Corporation in San Diego, California. When the Navy has these staunch patrol boats backed up by two fast tenders and the two new 20,000-ton aircraft carriers, the *Enterprise* and the *Yorktown*, its vast air patrol fleet in the Pacific will be remarkably efficient and effective.

Little detailed information is available on the *XP3Y-1*. From the photograph it is clear that not only is an amphibian gear incorporated in the design, but the tip floats also retract into the wing in flight. Another interesting feature is the way in which the engine nacelles have been arranged close together so that the propeller tips almost touch.

It may be noticed that the horizontal tail surfaces are very high out of the water, as a help in rough seas. One peculiar thing that we may surmise from our illustration is that the tip floats swing out outward and form a tip extension to the wing. Swinging outward in this fashion is, of course, an easier mechanical problem than raising the tip floats upwards into the wing as has been the practice hitherto.—*A. K.*

Roof Top Landings

JAMES G. RAY, of the Autogiro Company of America, is one of the most experienced and skilful 'giro pilots in the world. He has recently added to his list of exploits by landing on and taking off from the roof of the new Philadelphia Post Office, flying mail to and from the airport. The machine employed was a small two-seater cabin plane of only 75 horsepower. The landing area on the roof was only 365 feet long running north and south, and 288 feet wide. The problem was complicated by the presence of pent-houses on the east and west sides, some 16 feet in height, which housed the ventilating machinery, elevator machinery, and other mechanism of a large building. Such machinery is generally housed in haphazard fashion on a roof top, and its enclosure in the pent-houses was a concession to aircraft landing needs. There were also parapets at the north and south ends, about four feet in height, but these obstacles were minimized by sloping the roof surface at each end to meet the top of the parapet walls.

Even with these obstructions, and in spite of the restricted area of the roof, and in spite of the currents always present in the disturbed skyline of a great city, no particular difficulties were encountered. It may now be taken for granted that while autogiro operation on large roof tops will call for skill and considerable practice, such operation may be considered as entirely practicable. The possibilities of such operation in hastening airmail deliveries are obvious.

This is an age of streamlining; planes, automobiles, trains, and ships are all subjected to this process. Mr. Ray, writing in *Aviation*, points out that streamlining may also be applied to buildings.

On the windward side of a structure, an upward current of air may generally be expected. In fact it is the upward current of air on the windward side of a hill which is so frequently utilized in glider soaring work. An upward current of air at the edge of a building may also be expected on a sunny day because warm air always tends to rise. A paved courtyard at the base of a wall exposed to the sun's rays will naturally give rise to a more violent upward current than an area planted to grass or shrubs. A strong wind, or these upward thermal currents, will cause eddying or air disturbance at the edge of a roof. The moral

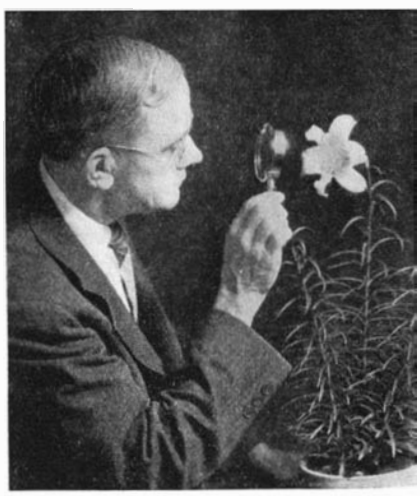
is that the pilot must stay away from the edges.

Similar troubles are of course experienced on aircraft carriers, and the landing area of a carrier may be gently curved at its end. Mr. Ray suggests that the tops of buildings might be rounded off to minimize the effects of winds or thermal currents. If the edges were provided with an aerodynamic deflector or guard, the otherwise harmful currents would be converted into helpful horizontal ones. The subject merits further exploration in the wind tunnel. At any rate, here is another application of aerodynamics for architects and inventors to consider. Besides being aerodynamically helpful, such devices might conceivably be made to have architectural merit.—*A. K.*

Nondehiscent Lily—Patent Applied for

IN its history the General Electric Company has had countless patents filed by its engineers and scientists. Now it is invading a new field in the government patent office. C. N. Moore, of the G-E Research Laboratory, has applied for a patent on a "nondehiscent regal lily." Appropriately enough, the flower in question is, at least temporarily, being called the Roentgen regal lily for it was among X-rayed bulbs of ordinary regal lilies that the new form was found.

The term "nondehiscent" means that the anthers of the flower do not open and shed their pollen. Ordinarily the commercial growers of regal lilies must pluck the pollen-laden anthers of the flower promptly, for



C. N. Moore examining a nondehiscent lily from X-rayed bulbs

the anthers quickly swell and burst after the flower has opened, shedding a wealth of golden pollen that sticks tenaciously to the white petals, more or less ruining the flower for display or commercial purposes.

In the spring of 1931 Mr. Moore, investigating biological effects of rays, treated bulbs of regal lilies with varying doses of the rays. Of 100 bulbs obtained from a commercial grower, 25 were kept as controls; 25 were subjected to 30 milliamperes and 200,000 volts at 20 inches for 15 seconds; another 25 were given similar treatment for 30 seconds; and the final 25 were so treated for a minute. The bulbs were then planted in a Long Island garden.

The untreated bulbs grew into normal plants that year. Among the treated ones were a few monstrosities—deformed stems, twisted and misshaped flower petals, and similar defects—which offered no desirable possibilities; the other treated bulbs seemed to have produced normal flowering plants.

The results were different the next season, however, when plants and flowers grew from embryonic structures present the previous year at the time of raying. Progeny of two of the bulbs that had received 30-minute doses of X rays produced flowers with nonshedding anthers.

Each succeeding year has seen the new strain continue true. Bulbs and bulblets from these two bulbs treated in 1931 have continued to bear nondehiscent flowers—the property is now considered as a fixed character, and the Roentgen lily is now established as a variety of the regal lily.

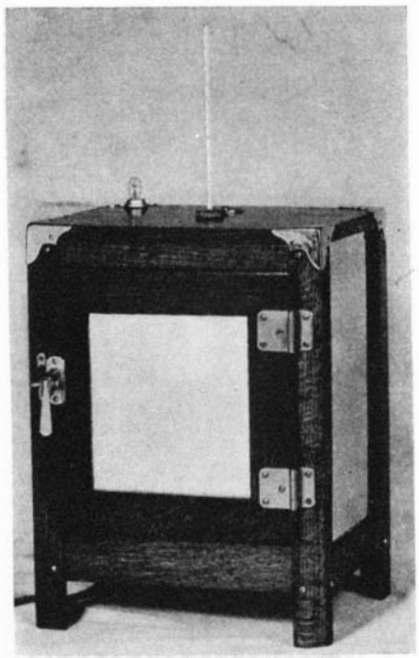
"Investigations with X rays in biological fields have long showed that surprising mutations and variations are to be expected if living cells are subjected to bombardment with X rays," says Mr. Moore. "If something happens to a chromosome of an egg cell or a young pollen grain when it is approaching maturity, it is likely that a 'sport'—offspring with different characteristics—will be produced. Such 'sports' occur spontaneously, and more or less rarely, in nature. Such happenings are increased in number many hundredfold when the single cell encounters the shattering force of the X-ray beam and the electrons which it releases."

The nondehiscent regal lily is but one of a multitude of biological changes which have been effected in the G-E Research Laboratory with X rays and cathode rays. Abnormalities of many kinds have been observed in a wide variety of plants, but the new variety of the regal lily is the first to which the phrase "patent applied for" has been appended.

Inexpensive Bacteria Incubator

DESIGNED for the microscopist who needs a high grade piece of equipment, but who does not have a great deal of cultures to take care of at one time, a new incubator has the added virtue of being inexpensive. It is particularly suitable for the private physician's office, for the advanced amateur, and for school laboratories.

It is built of metal, oak finished, and is double-walled. The insulation is a combination of the best grade of mineral wool and thin aluminum sheet. The aluminum sheet is very effective in preventing heat losses due to radiation. This combination produces a unit with very slight temperature variations between different levels of the interior. The thermostat is a commercial unit which is produced in large quantities but is extremely sensitive. It holds the temperature of the incubator to + or —.5 degree, Centigrade. The use of this commercial thermostat and this type of insulation makes it possible to market this incubator at a price unusually low for a unit of this type.



The inexpensive bacteria incubator designed for use by microscopists

The interior is 12 inches high, 9 inches wide, and 7½ inches in depth. It is equipped with an adjustable ventilator and a neon pilot lamp. The power consumption is less than 25 watts.

Refrigeration with Steam

STEAM is turned to ice in a fraction of a second by the vacuum method of refrigeration, the latest developments in which were described to American Chemical Society members at a recent meeting by D. H. Jackson of the Croll-Reynolds Engineering

***Left:* An ordinary lily, with pollen on petals. *Right:* A nondehiscent lily**

Company. Live steam flows through small jets at extremely high velocity (4000 feet per second) into a condenser. As the steam expands coming from the jets, it cools instantaneously, the loss of heat being so rapid that icicles are said to form at the end of the jets.

Since its recent commercial development, this refrigerating process has been extensively applied for producing chilled water used in air conditioning of railroad cars, restaurants, theaters, and so on.

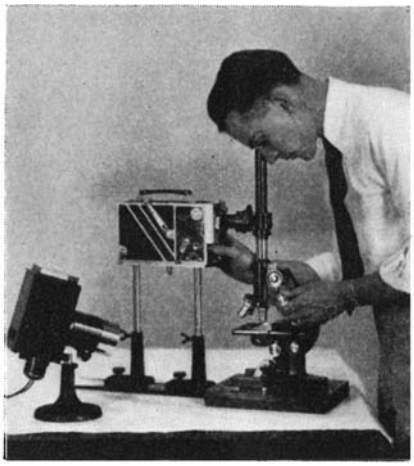
When first developed, the process required high-pressure steam from industrial boilers. Recent improvements include adapting it for low-pressure steam available from small heating boilers.

Industrial applications of the process are numerous, including chilling of yeast cultures and wort in breweries, mash and whiskey in distilleries, fruit and vegetable juices in canning plants, various chemical solutions, oils, milk, and the like.—*A. E. B.*

Micro-Movies

THROUGH the co-operation of the Bausch & Lomb Optical Company and the Eastman Kodak Company, a new apparatus has been designed for making microscopic movies. The use of the 16-millimeter camera has previously been somewhat limited in the scientific field. The cost of fitting up a movie camera to make microscopic movies ran well over the thousand-dollar mark and was limited more or less to 35-millimeter cameras and film.

Now the Cine-Kodak Special may be used with a special observation eyepiece which acts as a beam splitter. The beam splitter eyepiece is fitted to the front of the camera in place of the regular camera lens. In the beam splitter is a 45-degree prism, silvered but unbacked, which causes part of the light to be reflected to the film and part to be transmitted through the eyepiece so that the operator can observe the action and the field while the picture is being made.



New and inexpensive set-up for taking micro-movies, described here

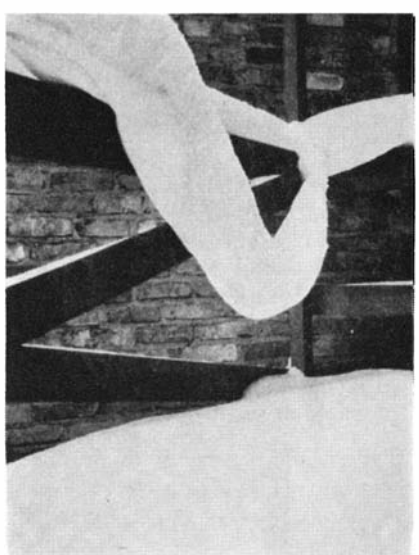
Not only can films be made in black and white, but with the new Kodachrome film pictures in natural color can be obtained. The use of color film with polarized light produces some extraordinary results. The growth of crystals of organic compounds in regular and slow motion, filmed with polarized light, gives a mixture and change of color in the crystals of extraordinary beauty. Doctors, medical students, and scientific workers can make records in monochrome or color, for purposes of record, teaching, or scientific study. The amateur, at modest expense, is enabled to secure films of the activities of live specimens.

Snow Garlands—Meteorological Rarity

FROM a reader, Edmond P. Gibson, of Grand Rapids, Michigan, the editor has received the following:

"I am enclosing two photos [one of which is reproduced. *Ed.*] of a strange freak which occurred outside of my office window. Briefly, this is what happened: A heavy layer of snow formed on the porch railing and on a windy day of alternate freezing and thawing, it slowly tipped toward the building as if to fall. The following day the temperature held at 32 degrees, Fahrenheit, and the garland slowly lowered under the alternate conditions of momentary freezing and thawing. In the afternoon it snowed and a second layer replaced the first on top of the railing, while the garland continued to lower. I snapped the pictures in the afternoon and the following morning the wind destroyed the freak.

"I examined the remains of the garland to see whether there might be a string or something of a nature to act as a tension member or a reinforcement in the structure of this miniature suspension bridge. There was no such foreign substance in it and the necessary tension must have been furnished by the frost alone."



An unusual garland of snow, commented on by Prof. Humphreys

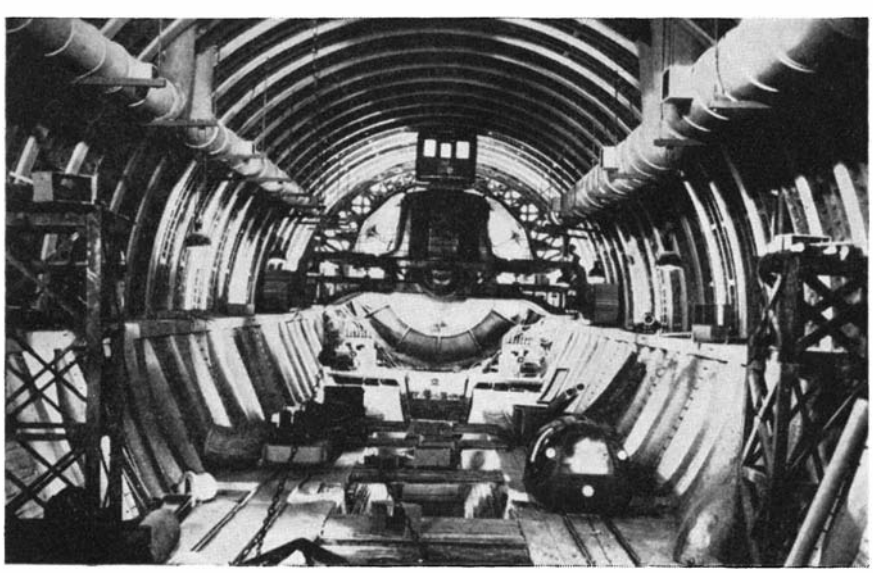
Mr. Gibson's communication was referred to Prof. W. J. Humphreys, physicist of the United States Weather Bureau, author of "The Physics of the Air" (standard reference book), and editor of *The Monthly Weather Review*, technical meteorological journal published by the Bureau. He finds that only four previous accounts of snow garlands are on record, and adds:

"What is the explanation of this holding of snow crystal to snow crystal in a continuous suspension bridge from anchorage to anchorage? Nothing, we are told, is more impossible than making a rope of sand, and yet of ice sand, that is, of snow crystals, Nature makes suspension bridges, or garlands, if we prefer art to engineering. How does she do it?

"The fact that these garlands do not occur when the snow is dry, but only when it

MOLECULES

MAKING big ones out of little ones (molecules) is one way of making gasoline. Natural gas and waste refinery gas are treated by the chemical process known as polymerization—which makes two or more molecules join and form a larger molecule—and the result is gasoline, benzol, toluol, and xylol.



Occasionally the movies offer us something mentally stimulating and a case in point is "Transatlantic Tunnel," a recent G-B production. In this film, in which huge mechanical sets such as the one shown above were used, a tunnel is bored under the Atlantic Ocean from England to the United States, using a newly "invented" radium drill. The photograph above was taken looking into the set of the tunnel with the radium drill at the far end, and toward the lower right is shown one of the high-speed cars for transporting workmen to the working face

is wet, from partial thawing, rules out the suggestion that the snow crystals, or flakes, cling to each other by irregularities on their sides and faces, like so many prickly-burrs. But while one suggested explanation is thus removed, another is so strongly supported by the same facts as to compel its acceptance. This is, that the snow crystals, being wet, are strongly drawn each to its adjacent neighbors, by the surface tension of a water film, and thus through film and flake the whole snow-garland tenaciously held together from end to end.

"The following experiments are convincing of this: Take a lot of unglazed bits of paper, 1 to 2 millimeters across, and roll them together to the size and shape of a cigarette and try to suspend the collection from its two ends without other support. Immediately it falls apart like the fabled rope of sand. Roll them together again and then put enough water on them to make them wet through and through but not drippy. Now they are held together by the surface tension of water films and will hang nicely in a festoon supported at the two ends only. And as it is with the bits of paper so it is also with snow crystals. They fall apart when dry and cling together when wet. The garland is first formed of damp snow whose flakes and particles are held together then, and often for many hours thereafter, by the surface tension of water films."

SOY-BEAN PRODUCTION

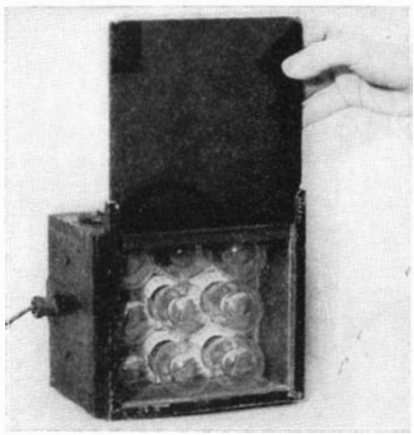
FROM an acreage of 50,000 in 1907 to more than 5,000,000 in 1935 is the record made by soy-bean cultivation in this country. Thus production of this valuable farm product, brought here from the Orient, has increased a hundredfold in less than 30 years.

Portable U-V-Ray Box for Art Examination

THERE has been developed at the Metropolitan Museum of Art, New York, a small, readily portable, ultra-violet-ray producing apparatus which can be simply used, without danger to the operator, on either alternating or direct current. This equipment, which was developed by Mr. James J. Rorimer, Curator of the Department of Medieval Art, and which has proved very satisfactory in the routine examination of works of art, will also be valuable for the stamp collector, jeweler, geologist, and any one using the long-wave ultra-violet rays.

The box illustrated in the accompanying photograph was fitted with nine porcelain sockets which were connected in parallel and fastened to a plug which fits into the ordinary electric outlet. The box was made of sheet metal so as to conform to the Fire Underwriters' regulations and also for handling convenience. In the sockets were placed the ordinary blue glow lamps (argon mixed gas) which are produced by the General Electric Vapor Lamp Company. These lamps are said to be the "only source of near ultra-violet light which combines simplicity with cheapness." Over the front of the box is a slide opening which would hold the standard molded glass filter which is supplied by the Corning Glass Works. It is important to use the smoothly molded filter to obtain the best results. The red-purple, 5mm., Corex A, 986 is preferable to the Violet ultra, 686, for most examinations with ultra-violet rays.

The results to be obtained with this convenient apparatus are usually as satisfactory as those to be obtained with larger and stronger equipments requiring a mercury lamp, rheostats, and other complicated devices with which the average person is either not acquainted or with which he does not wish to bother.



Nine sockets and special lamps provide a handy source of ultra-violet

Speedy Fueling System for Army

THE practicability of 100 percent motorization of nearly every branch of the Army was proved in the maneuvers at Pine Camp, New York, according to army officials. The concentration of 36,000 men and officers at the area was accomplished largely by motor transport. Officials declined to reveal just how quickly this was done, but declared that it was accomplished in record time and with a minimum of confusion.

The maneuvers, the largest peacetime concentration in the history of the country, depended entirely upon gasoline-operated vehicles, not only for the transportation of supplies, but also for the movement of men, equipment, and guns. Trucks, tractors, tanks, armored cars and even taxi cabs were utilized in the movements that simulated actual warfare.

Army units were spread throughout the area, which covers over 100 square miles, at widely separated intervals, and it was necessary that trucks transporting food and supplies be fueled at various points at definite times so that the source of supplies be uninterrupted. In addition, tactical vehicles such as tanks, tractors, armored cars, and motorized artillery and machine gun units had to receive gasoline on schedule during actual maneuvers in the field.

To assure that this phase of the tactics was carried out effectively, a commercial oil company, in co-operation with the Quartermaster's Staff of the First Army, set up a system that employed 18 trucks which operated throughout the area, delivering Mobilgas at points dependent upon the day's moves. These trucks, which have a capacity of 1600 gallons each, loaded at four railheads and are capable of refueling vehicles at the rate of 100 gallons a minute. This speed is made possible by a specially developed system of four hoses, two of which are run from each side of the truck. One of each of these sets is run from the truck's pumps over portable hose racks so that two lines of vehicles may be fueled on each side of the truck at the same time.

Four lines of military vehicles may be refueled at once with this new system

New Cure for Stubborn Wounds

FROM a clue provided by an insect, entomologists of the United States Department of Agriculture have discovered a new way to heal stubborn wounds quickly, painlessly, and cheaply. The new treatment is the application of a solution of allantoin, a bland, odorless, harmless, and easily obtained product found in both insects and plants.

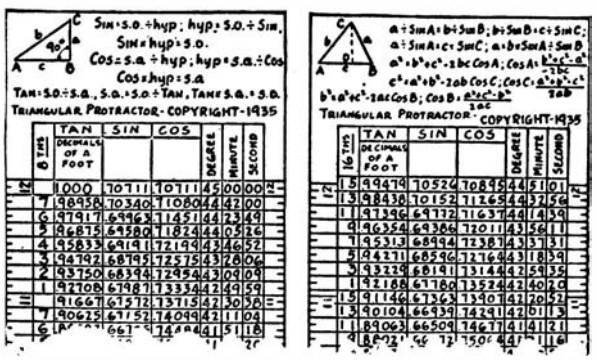
The insect that gave the clue to this discovery is one of the flies—in the maggot stage—that gained fame as a medical aid on World War battle fields, where an army doctor found that wounds infested with maggots healed better and faster than wounds without them. Since then surgeons all over the world have used maggots in treating deep infections difficult to cure by ordinary surgery. (See "In Defense of

Insects," Scientific American, Sept. 1935, pages 124-126).

Government entomologists, who have developed methods for rearing and shipping sterile maggots to hospitals, have at the same time sought the secret of this maggot's power to heal. Dr. William Robinson, of the Bureau of Entomology and Plant Quarantine, now finds that allantoin, which is given off by the maggots as they work their way through a wound, is responsible for part of this power. Allantoin, Dr. Robinson says, is not a new discovery. Dr. C. J. Macalister, who used it successfully 23 years ago for ulcers, reported that European peasants had long applied the roots of comfrey, which contain allantoin, to sores.

Triangular Protractor

A NEW triangular protractor scale which eliminates the ordinary protractor and combines an ordinary scale (half full size); a decimal scale; a straight protractor with degrees, minutes, and seconds; a bevel, or slope, scale; and a trigonometric computer, has just been developed by Lew Koen.



With the new triangular protractor, part of which is shown at the left, it is possible to perform many mathematical calculations and to compute complicated figures

The Triangular Protractor Scale is a mathematical instrument for measuring and computing angles, triangles, complicated figures, roofs, and so on, accurately. It is based on the principle of triangulation with a base of 12 inches and altitude to correspond to the required angle up to 45 degrees; for angles between 45 degrees and 90 degrees, the 12 inch base becomes the altitude and the base is measured to correspond to the difference between the required angle and 90 degrees; for angles between 90 degrees and 135 degrees, the 12 inch base becomes the altitude and the base is measured to correspond to the difference between the required angle and 90 degrees and drawn adjacent to the 90 degree angle; for angles between 135 degrees and 180 degrees, the base is 12 inches and the altitude corresponds to the difference between the angle and 180 degrees—the difference and the angle are supplementary.

The decimals of a foot for each 1-8, 1-16, and 1-32 of an inch are given in the column marked Tan.

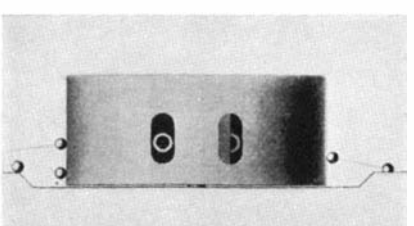
The following natural trigonometric functions are given: Tan (Tangent), Sin (Sine) and Cos (Cosine), and corresponding angles in degrees, minutes and seconds.

Ordinary problems in addition, subtraction, multiplication, and division can also be solved directly by use of the protractor allowing the use of even large numbers without complications.

"Whipped" Concrete

A HEAT insulating material with a heat-transfer coefficient comparable to cork may be produced from Portland cement, with or without the addition of mineralized wood fiber, by a process developed by the Porete Manufacturing Company. This product, known as Poretherm, is usually made in one of two weights, either 19 or 32 pounds, per cubic foot. It can be made in precast shapes, in the form of slabs and blocks, or it may be poured in the field. The 19-pound material is used for insulating refrigerated spaces and for high temperatures up to 700 degrees, Fahrenheit. Its crushing strength is 40 pounds per square inch. The 32-pound material is used for ordinary insulating and for fireproofing steel structural members. Its crushing strength is 150 to 200 pounds per square inch.

This material is mixed in an ordinary concrete mixer, using Portland cement and water to which Porete foaming agent is added. Without chemical action, air is whipped into the mixture to form a concrete containing great numbers of small air bubbles. For the 19-pound material the coefficient of heat conductivity is 0.37 B.t.u., and for the 32-pound material, 0.63, as compared with 0.30 for cork board.—*A. E. B.*



Exterior of the *Monitor* turret

SAVAGE SALVAGERS

JUNK dealers of today had their prototypes in pre-Columbian America. Down in the Blue Ridge foothill country, Dr. David I. Bushnell, Jr., of the Smithsonian Institution, has found many ancient Indian axes and ax-like weapons which were salvaged and rechipped generations after they were first used. Scientists learn from this that there were two distinct long-separated periods of occupancy in piedmont Virginia.

Monitor Drawings Come to Light

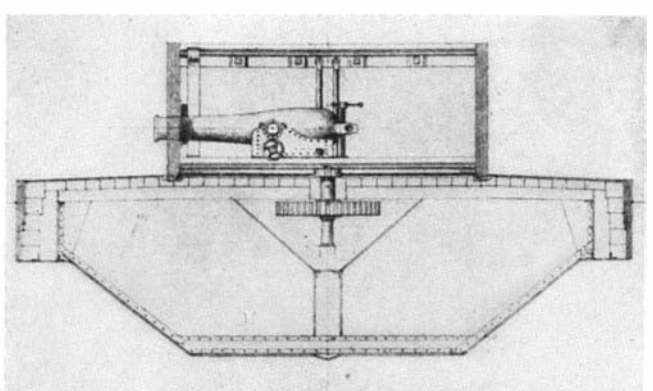
WE quote below from a letter which we had intended to publish in our Navy Number but which had to be held aside for lack of space. This was forwarded to us by Mr. G. Emil Hesse, Narrkoping, Sweden:

"Many people have no doubt wondered what became of John Ericsson's papers and other things. His parlor furnitures were donated to the Nordiska Museum in Stockholm. Everything in the drafting room was sent down to the office of the Ericsson Coast Defense Company's office, which was organized by some of his friends.

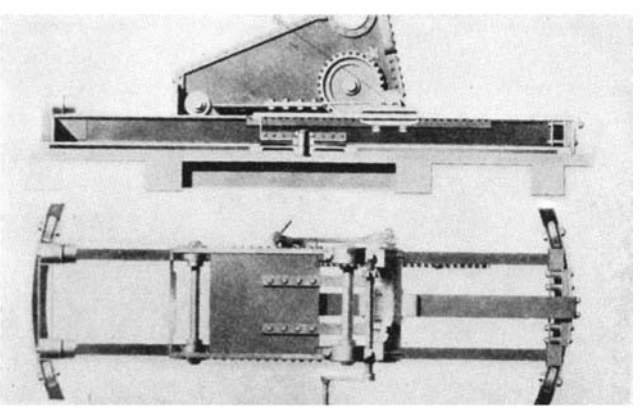
"I became the Consulting Engineer of the Company, and I bought everything in the drafting room, and sent it home to Sweden—instruments, drafting board, drawing table with two drawers full of drawings, but only three of the *Monitor*. One hundred and thirty drawings are at the Technical Museum in Stockholm as a loan.

"They were exhibited in March last year to about 400 invited people, also the Crown Prince. They have never been shown

(*Please turn to page* 49)



Cross-section of the *Monitor* hull and turret



Side and top views of the *Monitor* gun carriage

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Esquire	5.00	Review of Reviews	2.50
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THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

WHO says the world isn't getting better? Suppose we have a look at it and see. Five years or so ago, when "Amateur Telescope Making" was just passing through its puberty, there were two great bugbears in the telescope making art—making pitch laps and silvering telescope mirrors. Then several men of science discovered a way to apply coatings of reflecting metal on glass by evaporation in vacuo and, as a result, far fewer mirrors are being silvered today than yesterday. Perhaps silvering is headed toward the gate. Bugbear No. 1—silvering troubles—has thus been largely disposed of.

And now Bugbear No. 2 is also on the way out. You whose dispositions have been wrecked by pitch lap making may make your salaam to four modest men in Pittsfield, Mass. and Bridgeport, Conn.—Everest, Munn, Morse, and Carlson, for these benefactors have now taken the bug out of the second bugbear. Thanks to them you can now make a lap in your sleep, that is as uniform and perfect as a waffle. The Pittsport Door Mat is the answer. The picture on the opposite page shows (bottom half) what the P. D. M. is like, and the series of pictures on the page you are reading shows just how it is used. It is a specially designed, specially made grid of flexible rubber which you lay on the glass tool, fill with melted pitch, strip off and, lo, your lap is made and without any of those idiosyncrasies which, as you well know, will somehow or other turn up in an ordinary pitch lap no matter how much profanity you direct at it while working on it.

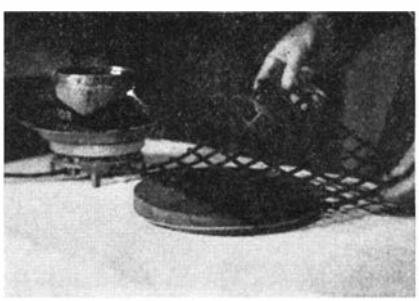


Fig. 1—The start

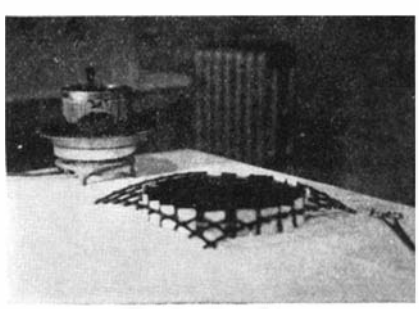


Fig. 2—The dams

Fig. 3—Pouring

Closely examine the photograph on the opposite page. The mat, when ready for use, looks as shown at the bottom. Its thickness is 3/16", its size 12" x 12", and the grid is made up of members of flexible rubber cast in one piece and having a cross-section like that of a typical channel in a pitch lap—that is, ¼" wide at the side which casts the top of the channel, and about half as much at the side which lies on the glass tool and makes the bottom of the channel. The mat gives facets one inch square and all alike. When the door mats first come from the manufacturer there is a thin rubber web over the whole of one side, and this must be cut away before the mat can be used. At the top of the same picture that job is shown partly done. A sharp chisel or sharp wet knife is the best tool to use for this. Of course, the manufacturer could himself do this job but the mat would then cost you more than the dollar it does cost, hence you get the mat plus some exercise, and no extra charge for the latter.

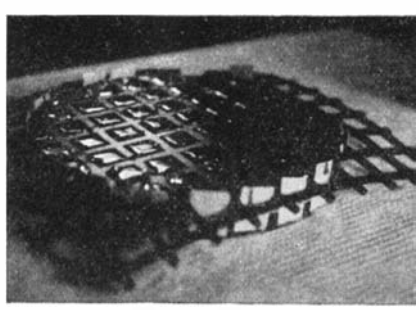


Fig. 4—Poured

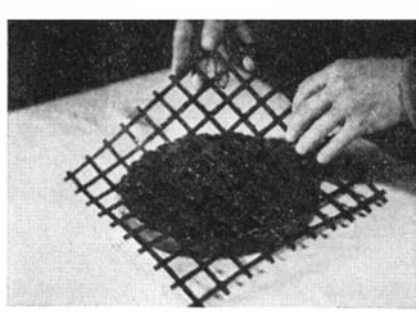


Fig. 5—Peeling off

To use the door mat, according to Everest, you place the tool, face up, on a table and tie a string loosely around it, or snap on a rubber band or two. Then you lay the mat on top—all as shown in Figure 1.

Next insert cardboard strips around the edge, for dams (Figure 2). Everest says that pitch applied in such small amounts as one facet at a time (as you will see later) has no tendency to creep under the rubber or through little openings around these dams. He also writes: "We make our laps on a clean white table cloth, as shown in the photos." However, if your wife hasn't the fine disposition his has, we advise the addition of a bed pad.

Now (Figure 3) pour melted pitch into each of the square openings, using a spoon. This same photograph shows—at least the original does—the famous unruly Everest hair which Porter immortalized in a sketch in A.T.M. It seems that when Wallie was rounding a shoulder of Pike's Peak, on his way to California in '49, a big grizzly bear suddenly reared up near him and his hair instantly reared up too. Since then he never could make it lie down or do a thing with it.

Figure 4 shows the squares full of pitch. Of course it will occur to anyone to pour them all to about the same depth. Now chill the lap under a cold water tap and (Figures 5 and 6) peel off the door mat. It won't stick, and when it is first put on it needs no goose-grease to keep it from sticking.

Now soften the lap under the hot water tap and press it to contact with your mir-

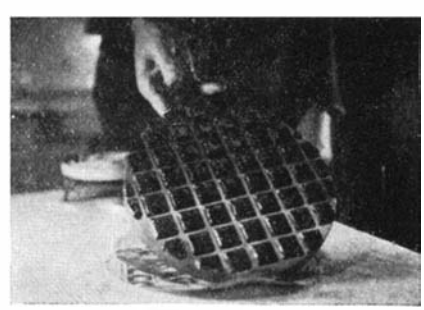
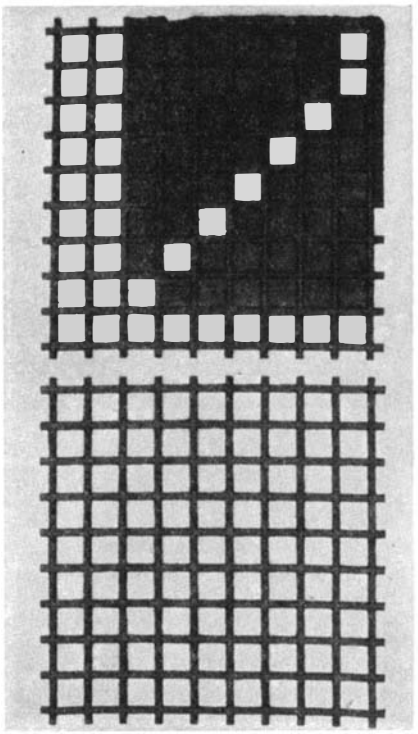


Fig. 7—Result

Fig. 8—Hardness test



The Door Mat. *Top:* Partly cut out. *Bottom:* Ready for business

ror. Then trim off the little irregularities caused by pressing—a simple matter, as Wallie says, like the small trimming you have always done on laps in order to keep the channel open during a polishing job.

Figure 7 is the finished job—hold up the page and squint your eye along both sets of channels. Isn't it a dandy? Here is what Dr. S. H. Sheib of Richmond, Va., who borrowed your scribe's door mat, has to say:

"Dear Doc: I have tried out the door mat you lent me and find that it does everything that is claimed for it. These gentlemen deserve the gratitude of all telescope nuts for relieving them of the abominable and profane job of channeling pitch. Removal of the web is easily effected, as you have suggested, with a sharp 1" chisel, but may be done equally well, though more slowly, with a sharp wet pocket knife.

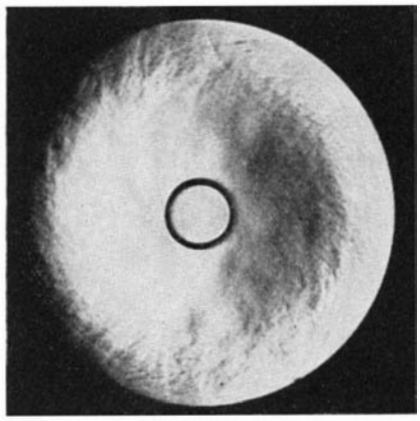
"In making the lap one must remember, of course, to smear the top of the tool with turpentine, and to place the center of the tool at the corner of one of the facet squares, in the regular manner. This done, it is difficult to imagine how even the most inexperienced worker can fail to make a perfect lap every time. There is no need for rush or hurry—if interrupted at any stage, the work may be set aside and resumed at any later time without risk of injury to the lap. The V-shaped ribs of the grid show no disposition to cling to the pitch, provided the whole is well cooled after the squares are filled, but part readily, leaving beautifully straight, clean, smooth channels without a trace of pitch on the bottoms."

In the final photograph of the series you see Wallie testing by finger nail for hardness on his pet scale, which you will find added to page 364 in the new edition of A. T. M.

We asked Everest whose baby this new thing is and he says that the "only" thing he can take credit for is the idea. He says Ralph Munn then made the mold and the pre-

liminary samples, but had a little trouble getting perfect door mats, and so he accepted the offer of H. F. Morse to complete the development at Bridgeport, Conn., where they have had more experience with such things, and Morse was assisted by G. Carlson, also of Bridgeport. Morse then "made arrangements," Everest says, "with a manufacturer to supply door mats at a dollar each to any of the maniacs who desire them."

A lot of the above must sound much like a sales talk but, if so, it can't be helped, and no apology is offered to the cock-eyed world for it. The four who got up the door mat aren't making anything from it, and their only idea was to find a rubber goods manufacturer who would undertake to bother with it. They found that door mats could be made and sold, non-profit, for about 75 cents plus postage. Blame your scribe for suggesting that the price therefore be set at an even dollar, postage free anywhere within the confines of the planet. It is true, this penalizes the nearby purchaser for the benefit of the distant one, but it saves a lot of preliminary bother about ascertaining mailing costs to all sorts of out-of-the-way places and the "injustice" probably will not seriously affect anyone.

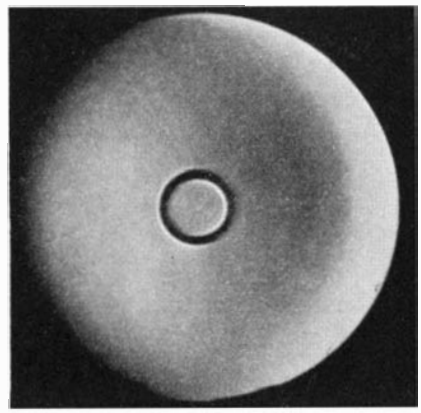


The mangled mirror

As there still seems to be some uncertainty about the degree of refinement required of a good optical surface, three recent illustrative focograms are reproduced on this page. The job shown above was ground and polished by an amateur, as the Pyrex, perforated primary mirror for a 12½" Gregorian. The mirror is approximately an *f*/5. The owner says he sent his mirror to a man who offered to refigure mirrors and that, when he sent it, there were no scratches on it. A fee of 25 dollars had been quoted for its correction. he says, "up to any measurable error." This focogram represents the mirror when he got it back. Not only is the surface deeply scratched and scored in many places, but it is very lumpy in the small areas not scratched. Study the reproduction closely. The Ronchi bands also were zigzag, the owner writes, "like a snake."

Of course 25 dollars was too little, in the first place, to charge for refiguring a 12½" mirror—far too little. Men like Pierce or Tinsley or Lower would probably ask much more, and rightly so. But a promise that can't reasonably be kept should perhaps not be too freely made, in the first place.

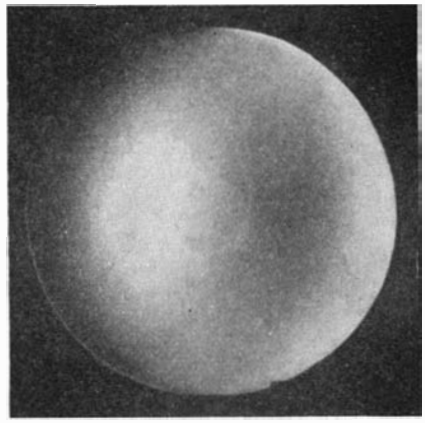
The figurer, when the matter was submitted to him by Scientific American, after the owner had failed to get results, offered to refigure this mirror. But in the meantime the owner had decided to try it himself, and he was able, to his own surprise, to produce the result shown at the top. We leave it to the reader to judge which is the better of the two.



Same mirror—owner's own job

The job at the bottom of this column is the 8" primary for an *f*/5 aplanat, and was entirely made by Mary A. (Mrs. A. W.) Everest, 15 Allengate Ave., Pittsfield, Mass., with the moral and intellectual support of her husband, Wallie Everest. She made free use of his advice, but slapped his hands whenever he tried to touch the mirror, and he is considerably prouder of it than she is. Three ¼" scratches and one ¾" scratch show on the original focogram, but they are so fine and thin that they did not pick up in the half tone. The little nick at the bottom is the shadow of a part of the test rack. On the other hand, about 80 percent of the faults of the other (at left) focogram do show—they are so gross that a half tone could not help picking them up. There are no lumps and bumps on the Mary Everest mirror—the surface is an *optical surface* with smooth texture. (We gave such surfaces a name, a year or so ago, but it isn't decorous!) The high lights blend into the shadows in a gradual, even transition. The edge is not turned—note the left hand diffraction ring, as per A.T.M., 371. The "crest of the doughnut" (A.T.M., 262) is in the right place, seven tenths of the distance from center to edge. This mirror would rate as high grade workmanship in any kind of society.

Perhaps no one should set up as a professional, paid refigurer of mirrors "up to any measurable error" who cannot do high grade work; and perhaps, if work really is



Mary A. Everest's workmanship

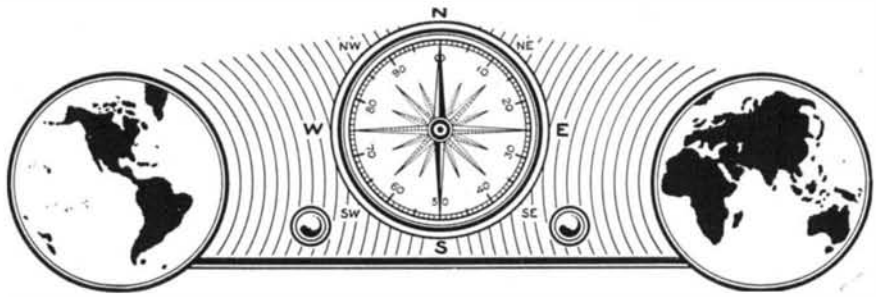
to be turned out on a buzz saw, at a quoted price which makes high grade work impossible, that fact ought in fairness to the inexperienced seeker of help to be frankly stated beforehand. These comments will also serve, it is hoped, to warn the inexperienced—just the ones who are least likely to sense the same fact—that they should not reasonably expect a high grade refiguring job on a 12½" mirror for 25 dollars, since refiguring a mirror is almost as big a job in some cases as making a new mirror. On the other hand, a pit or two, or a light scratch or two, is not as important a thing to notice as the surface texture ("schoolmarm's leg," if smooth) and the edge—these are the two most important things. By the way, look in vain for the left hand diffraction ring on the middle focogram—or the upper one, for that matter.

We have purposely given no names or identifications in the above, as the motive for publishing these blunt comments is not to hurt anyone but to warn the inexperienced about the fallacy of low-priced services in optics, and perhaps to help keep the general standard of workmanship at a good level.

PROF. C. C. Wylie, astronomer at Iowa State University, Iowa City, Ia., and President of the Midwest Meteor Society, writes that he has been sending observers above the clouds in airplanes to count meteors. "If any of your amateur astronomers have airplanes and would be interested, I will be glad," he adds, "to correspond with them." Here is a chance to die as a true martyr to science—not tamely in bed.

William Tyler Olcott, 62 Church St., Norwich, Conn., author of numerous books on amateur astronomy and one of the founders of the American Association of Variable Star Observers, asks us to announce that any person with a telescope of 3" aperture or larger can engage in the work of the Association, which has a membership of 330. This organization is mainly amateur and its meetings bring together amateurs from many states. No one should feel backward about applying for membership. Another chance to be a (live) martyr.

THE new edition of A.T.M., described elsewhere, contains a chapter emphasizing rigidity in mountings, explaining the principles of getting it, and showing how to make three massive new mountings of solid concrete which Porter, the author, labels "Porter's Follies;" also 16 fine new drawings by Porter. Everest's new chapter on HCF is not a revision but an entirely new story, describing his successful technique. Pierce has a brand new chapter on clock drives. The quoted matter on pages 234-240 has been replaced by a full, illustrated treatise on close machine figuring, by Hindle, and the matter on pages 337-343 of the previous edition is replaced by a valuable treatise on the calculation of sidereal time, by the Mayalls of sun-dial fame. About a dozen new notes appear in the Miscellany, also several dozen minor corrections there and elsewhere, and at the end of the book your scribe adds three pages entitled "A Last Word to the Beginner" and winds up with his own immodest picture. This is in answer to numerous requests, but of course nobody will believe this, so go ahead—all you fellers—and tell him he is no shrinking vi'let and ought to be ashamed of himself!



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN

A Drama in Radio Science

THE true follower of science is sure to be interested in the manner in which man obviates nature's obstacles. That some of man's methods are ingenious is to be expected, but they are not always dramatic as well. The all-wave listener who is fortunate enough to pick up the unexpected call, the snatch of conversation between shore and ship, or the impromptu chatter of a standby operator, is amply repaid for the time he has consumed searching the bands —but the man who is witness to the dramatic use of an experimental radio system is doubly repaid for his patience.

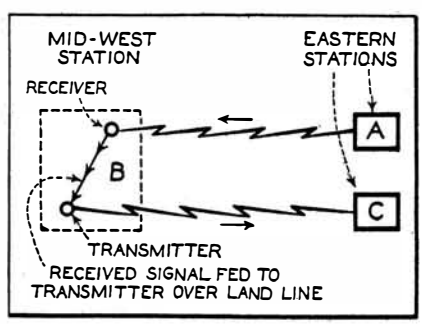
One of the oddities of short-wave transmission and reception is the effect known as "skip-distance." Because of this effect, an amateur, for instance, may be able to carry on an unbroken communication with another amateur a thousand or more miles away, but find himself unable to receive the signal from an amateur transmitter 10 or 15 miles distant.

The situation is odd to say the least, for the signal from a nearby station becomes a "catch," whereas the signal from a distant station is received like a "local." Moreover, interference with communication comes not from transmitters in one's vicinity, but from transmitters 500 miles or more distant. This effect is particularly noticeable in the 20-meter amateur 'phone band and, as might be expected, this prank of nature has been put to good use in many instances; a use, incidentally, that lends much interest to the listener as well as the amateur.

Now, observe the amateur who wishes to operate "duplex"; that is, to arrange his equipment so that he may receive signals during periods of transmission. Under ordinary circumstances, this is quite impossible for, when the transmitter is in operation it blocks the receiver and no signals may be intercepted. However, if the transmitter is removed a sufficient distance from the receiver, and remotely controlled, then it is possible to receive signals while the transmitter is in operation, with the advantage that the other fellow can "break in" on the transmission at any time to ask for a repeat, to laugh, or say what he pleases as thoughts come to his mind, just as two people are able to converse on the telephone. The system, of course, is effective only in the event that both amateurs are able to receive as they are transmitting.

Some amateurs have their transmitters as much as a mile distant from the receiving point. The result is that the ground wave from the transmitter is too weak to cause much interference with reception, while the sky wave is "out of reach" of the receiving aerial. In other words, the amateur places his receiver in a location comparatively free from the signals radiated from his own transmitter. Under these conditions, he may be able to tune in other signals having frequencies only a few kilocycles removed from the frequency of his own transmitter.

And so it is that occasionally, when one least expects it, some amateur station equipped for duplex operation will pull a stunt that adds a bit of drama to the science of radio. Thus, quite recently an amateur



Station B, acting as a relay for A and C, overcomes the skip-distance

on the east coast was anxious to communicate with another amateur just far enough away to make a telephone call an item of expense, but also just near enough that it was quite impossible to make satisfactory radio contact, because of the skip-distance effect. An amateur in the middle west came to the rescue by functioning as a relay station. Since he was equipped for duplex operation, he could receive while transmitting, so he picked up in turn the signals from the eastern stations and "re-broadcast" them, with the result that the east-coast amateurs, situated probably no more than 15 miles apart, carried on a conversation by proxy. The accompanying sketch illustrates the manner in which the three-way contact was conducted.

This sort of stunt is by no means new, nor is it a rarity. The listener is often fooled, however, unless he happens to hang on long enough to realize that there is an intermediary.

Amateurs also go in for "cross-channel" operation, and this is also apt to be misleading unless the listener waits for station calls and gets the hang of what is going on.

In cross-channel operation, one amateur may be set up for transmitting on 20 meters

and another amateur set up for transmission on 75 meters (80-meter band). Therefore, amateur number one tunes his receiver to the 75-meter signal and amateur number two tunes his receiver to the 20-meter signal. From then on, two-way communication may be carried on.

Obviously such a tie-up must be pre-arranged. Consequently, if an amateur working on 20 meters wishes to contact an amateur working (and listening) only in the 75-meter band, he may telephone some other local amateur who operates on 75 meters and ask to have his signals picked up and re-transmitted on 75 meters, in which event he can call the other amateur and maintain contact in this manner, or request the other fellow to listen for his signals on 20 meters, at which time the relay operation can be terminated.

You are apt to run into most anything in the amateur 'phone bands. Since these stations are in operation principally for experimental reasons, it is not unusual if one hears curious transmissions.

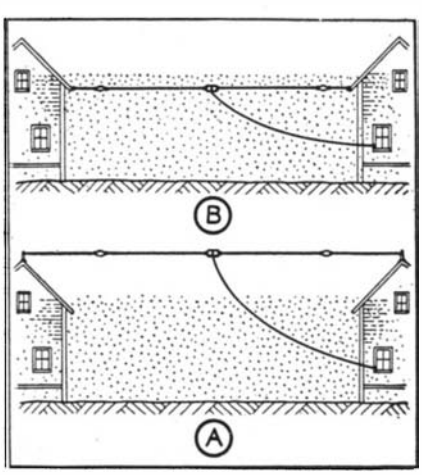
Two-Way Reception

THE listener who enjoys the conversations to be heard in the amateur radiophone and ship-to-shore radiotelephone wavebands can gain a point by using two short-wave receivers, one for each end of the communication link. It is preferable to use a separate antenna for each receiver.

Auto Ignition Systems

THE question is often brought up as to why the interference from the ignition system of an auto should be so pronounced when the all-wave receiver is operated in conjunction with a noise-reducing antenna system.

The answer is that most auto ignition systems are husky transmitters and radiate



All-wave aerial is above noise area at (A), and in noise area at (B)

high-frequency impulses over a considerable area. If these impulses reach the aerial wires proper—which they do in most instances—the "noise-reducing" feature of the antenna system is of no effect.

The accompanying sketch will serve to explain why this is so—and also why *any type* of noise-reducing antenna system is practically worthless unless the horizontal wires are erected above or outside the noise area.

The sketch shows that man-made static is inclined to hug the ground. Therefore, if the aerial proper is placed high enough, it may be kept out of the general noise area. The fact that the lead-in from the aerial passes through the noise area is of no consequence; it is so made that the interference it collects is balanced out at the input to the radio receiver.

The higher the aerial from earth, the less interference from auto ignition systems and other electrical equipment. However, since ignition interference is particularly pernicious, considerable improvement may be had by running the aerial at right angles to the road upon which motor traffic is heaviest.

Use of Tone Control

EVERY modern all-wave receiver is equipped with some form of tone control. This device is included to permit the listener a bit of latitude in tone shading.

Since the average tone control decreases the amount of high audio-frequency amplification when turned to the left, it may be used to advantage as a noise and interference reducer in the short-wave bands.

Most background noise, and certain forms of station interference, are at the higher end of the audible band of sounds. Consequently the tone control is effective in reducing these forms of interference with reception.

Indoor Aerials

AN indoor aerial is seldom satisfactory for reception on any wavelength. When used for short-wave reception, it is apt to pick up more noise than signal. When used for standard broadcast band reception, the signal being received may suddenly become weak, and after a period of time just as suddenly become strong. If the receiver is equipped with automatic volume control, the only noticeable effect may be a sudden increase in the intensity of background noise.

This change is often presumed to be a fault in the receiver. More than likely it is due to nothing more than the closing of an electric-light circuit paralleling the aerial wire. The light circuit forms a tuned or resonant circuit, and functions as an absorption loop. It practically drags the signal voltage right out of the aerial, with the result that the signal intensity suddenly decreases when a light is turned on. The shorter the indoor aerial, the more pronounced the effect. Quite often the effect is noted on the signals from one station only. In this event, the light line is resonating at the same frequency or wavelength as that upon which the station operates.

Verifications

THE fact that you may hear, say, Vienna on the short waves is fact enough in one sense, but possibly pure fancy in another sense. You have heard no station *directly* until you have been able to establish the fact by *final* announcements. There is a great deal of rebroadcasting going on, and the confusing part of it is that many of our own short-wave stations enter into the scheme. The next time you hear a foreigner, make sure first that the signal is not being picked up and redistributed by W2XAF or some other local short-waver, before you spread the news around.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Series Photography

ONE proud father has taken a picture of his baby every month for two and a half years and has noted a change in each one of them. That's a series that will give him and the child's mother pleasure all their lives and will hold intense interest for the child herself when she grows up. Many proud fathers have taken pictures of the youngsters and the number of these pictures taken annually would, if placed end to end . . . But the point is that unless there is a conscious and conscientious effort such as that put forth by the proud father aforementioned, there is a lack of the atmosphere of progression and therefore no series, the field of photography which we intend to advocate here.

A series of photographs should comprise a succession of prints from the beginning onward, showing significant changes, distinctive developments. It may tell a story, describe an incident, constitute a history. In any event, the pictures are related, connected, bound together in progressive fashion by a central idea or interest chronologically expressed in pictures.

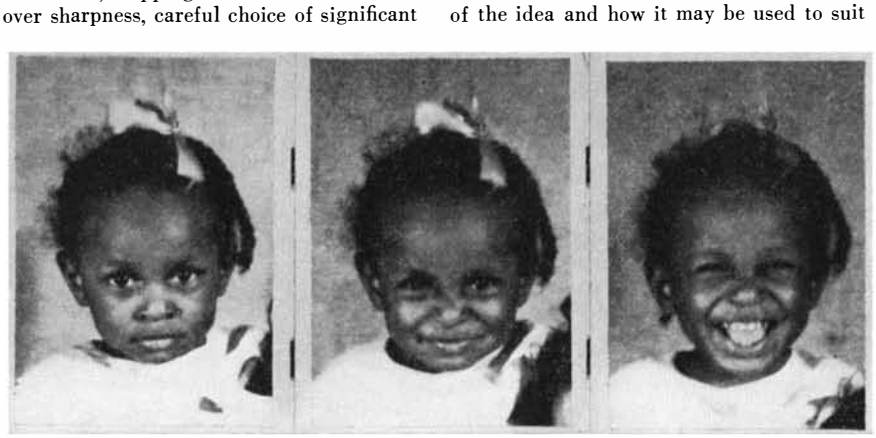
Aside from the series of pictures showing definite changes in the baby or child at successive stages in its life, there is the type of series which illustrates the flowering of an emotion, such as that illustrated in "The Story of a Laugh." These are not easy to accomplish and may often be the result of happy accident, but, however achieved, their value and interest are obvious.

Step-by-step pictures of the building of one's home or the rise of some notable building, bridge, or other structure in the town are types of series which may be photographed from sentimental or historical motives, or both. Watching for good lighting conditions, stopping down the lens for all-over sharpness, careful choice of significant points of view—these are some of the points to be considered if such series are to be worth while.

The play or game, the picnic or house party may "go home" with you if you have your camera along and use it judiciously. The play will require the modern fast lenses and the game a telephoto, though this may not always be necessary. But a fast lens is no longer a novelty and many an advanced amateur has tasted the thrills of telephotography. Plays and games will call for many shots in order to make it possible to line up a series of prints which will give the story of the occasion.

A series to illustrate an outdoor picnic or a party at some one's house is less of the forthright thing than most series are and depends greatly on the camera man's sense of selection, his feeling for humor, and the way the party is going. If the tempo is not to his liking and picture material not forthcoming, he can create picture material and everybody will be glad to help, for who doesn't revel in picnic pictures? Series at picnics and parties would probably turn out to be a number of series of various aspects of the event rather than a single series tying the whole thing together. The story of how one party learned to swim; the preparation, roasting and eating of a fowl, or what have you; the start-to-finish pictorial account of a hand-to-mouth encounter with the victuals, showing as the first picture a rich "feed" spread out on the cloth, and as the last, a cloth covered with empty bottles, empty cans, and the riotous disorder denoting full stomachs—these are all good subjects. If you go picture-bent to a house party be sure you are well loaded with Photoflood bulbs and flash bulbs; you will never regret it and will be the most popular person of the occasion.

Other types of series might be mentioned, but these few should suggest the possibilities of the idea and how it may be used to suit



"The Story of a Laugh"—an example of series photography, suitably mounted

individual circumstances. To get the most out of your series, be sure to mount them in such a manner that every picture in a series is placed in its proper order and the whole kept together in an album, mounted one after another on a long strip of cloth or heavy paper which can be folded accordion-fashion, or joined together in some other way. For series of pictures not exceeding a half dozen it might sometimes be desirable, if the photographs are compelling enough in interest and are good technically, to arrange them inside a frame to be hung in some appropriate corner.

New Range Finder

GUESS-WORK in focusing is eliminated for camera workers equipped with the new Kodak Pocket Range Finder. Designed with a clip, it may be carried in the pocket like a pencil. Reasonably priced, convenient and simple to use, it makes an exceedingly useful adjunct to owners of focusing cameras who have to estimate distances by the eye or pacing off in order to get the subject sharply focused. While such methods have been and still are adequate for most purposes and under generous lighting conditions and closed-down, depth-producing lens apertures, yet for critical focusing, particularly when using fast lenses at wide apertures, a range finder such as this one is essential. Only cameras equipped for ground glass focusing will give the same sharp results. An ingenious feature of the new instrument is that the correct distance is seen on a translucent scale at the same time one is viewing the subject. Focus is accomplished by turning a knob until the upper and lower portion of a subject, cleft in twain by a bar, coincide. In the opinion of the writer, the dividing bar is too wide for critical matching of the two parts, but practice in the use of the instrument may enable the operator to overlook this.

Compact range finder

Contaflex

USING the Contax camera as a basis and substituting the reflecting mirror type of focusing for the range finder, the Zeiss Ikon organization has turned out the Contaflex. While employing several original improvements, the Contaflex is fashioned on the style of the miniature reflex cameras employing two lenses, one for taking the picture, the other for focusing. With the exception of the range finder, all the Contax features, already familiar to miniature fans, are retained.

The most distinctive and original feature of the new precision outfit is the focusing arrangement. Instead of having a focusing lens of larger aperture than the taking lens, the Contaflex differentiates between the two by employing a focusing lens of 8-cm focal length, while retaining the standard or 5-cm lens for making the exposure. This gives a larger image on the ground glass than the film image, facility in focusing being assisted by a plano-convex lens ground glass, the flat surface being matte. The advantage of this lies in the fact that the light gathered into the focusing lens is concentrated and not diffused, as in the case of the ordinary ground glass.

The front part of the ground glass hood is an albada finder, the semi-silvered mirror of which permits self-portraiture by "composing" one's self in the mirror and also may be used as an eye-level finder for photographing objects in rapid motion.

A built-in electric exposure meter, the prisms of which are exposed to light by lifting the name plate on the front of the camera and thus permitting light to penetrate to the photoelectric cell behind them, stands next to the Contaflex focusing arrangement as the second ingenious departure in construction contained in the camera. It may be manipulated so that it serves even for very weak light conditions. Readings are obtained very quickly from 1/1000th of a second to 160 seconds, an exposure range of 160,000 steps.

Packaged Chemicals

THE package influence has almost wholeheartedly won the art of photography for its own. The darkroom routine of weighing out specified quantities of various chemical ingredients of a developing or other solution is fast fading out of the picture as prepared quantities, conveniently packaged in a box, or ready-mixed solutions in bottles are being put on the market and gratefully welcomed by darkroom workers. Even acid hypo may be had in a concentrated form so that all one need do is pour out one part of this solution to so many parts of water. Thus, good old hypo, which to many is a rather messy job of work to prepare, becomes an arm-chair procedure.

This simplicity obtains also in the cases of various film and paper developers, packages or bottles being available to fill almost any need in these lines. Solutions or packaged chemicals ready weighed out are also obtainable for most other darkroom purposes.

All this does not, however, mean that we may forthwith discard the studio scale and discontinue the purchase of individual chemicals, for there will be special occasions when we shall want to try a little experimenting.

Screw Adapter

AN amateur who recently found himself in a dilemma when he discovered that the screw base on the bottom of his camera was of the metric (European) type, almost despaired that he would ever be able to mount it on an American tripod. But the day was saved when he learned that there are such things as screw adapters threaded on the outside to fit into the base and on the inside to take the American-type screw of the tripod. It is a simple operation to screw in the adapter, and the cost is only a dime.

Try "Shooting" Feet

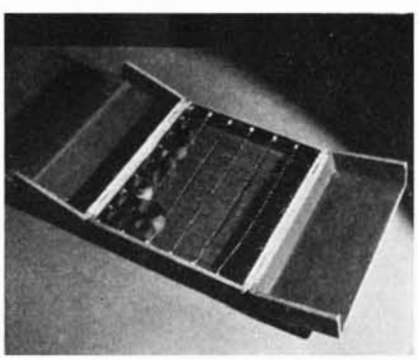
THERE'S more to the human anatomy than the face and while the latter is admittedly the most interesting feature, much can be said of the photographic possibilities of the pedal extremities. Feet can be made a fine subject for the camera pro-

vided a little imagination is used before one attempts clicking the shutter promiscuously. A subject such as this has to be thought out in advance, and a series might take several months to complete for worth-while opportunities may not present themselves as quickly as one might like. Possibilities in this direction might include the feet of a dancing Negro boy, a child's feet peeping out of the sand on the beach, a laborer's feet treading the earth, the feet of a pair of dancers on a dance floor. The list is a long one. Try making one up and then hunt for the subjects.

Home-Made Film File

THE filing of roll-film in the miniature sizes seems to present a problem to the amateur, judging from the great number of suggestions that one hears. Excellent varieties of files for these films are obtainable at varying prices, and most of them are very efficient files, too. Many amateurs, however, prefer to make their own. The idea presented here is offered in the hope that it may suggest a system for some workers who are still grappling with the problem and are looking for help.

An unused silverware box was about to be discarded when the family photographic



A home-made film file for 35-millimeter rolls, designed so that the film may be kept in rolls, yet any individual negative found readily. Any box of suitable size and with a lid may be used. Divisions for keeping rolls in place are formed by crossing lengths of thin copper wire

addict came along. He saw its possibilities, and the result appears in the accompanying illustration. Velvet "upholstery," pieces of wood, nails, the clasp on top, and so on, were ripped out mercilessly, and the box then lined with black paper. A strip of cardboard was glued on to one half of the cover so that the cardboard jutted out about ¾ths of an inch. This was done in order to keep the dust out when the box was closed. Squares were ruled off, eye screws inserted about 1¼ inches apart, and thin copper wiring strung criss-cross, allowing for 48 spaces to accommodate a roll in each space. The spaces were numbered, 1 to 6, 7 to 12, and so on, and a card index used to record the contents of each roll. Now it is a simple matter to hunt through the index for the subject desired and then to pick out the roll containing it.

This system not only saves wear and tear on films, which produces those dreaded scratches, but saves time, temper, and travail. Any similar box may be used, of course.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 38*)

before and never published since 1890, when they came into my care. I bought them in 1918, when the company dissolved.

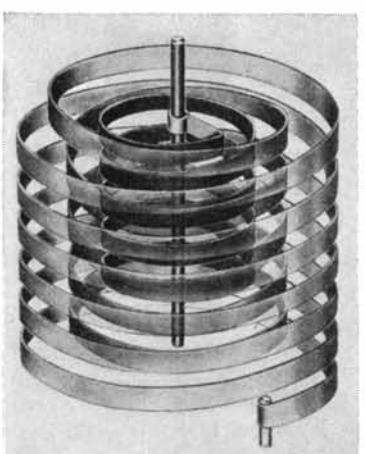
"A four-hour fight (during the American Civil War) gave the control of the sea to the North on March 9, 1862, without the loss of a single man. It took General Grant four years to win on land.

"The importance of the control of the sea was illustrated in the late war. If Germany had had a John Ericsson in 1915, who had held back America and her war supplies, as well as the *Monitor* held back England and France and their war supplies, in 1862, she would have won the war."

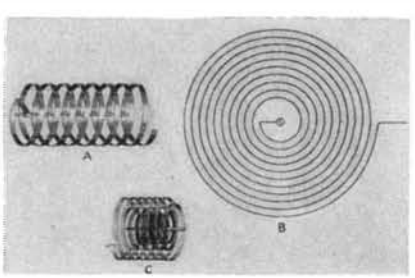
THERMOMETER USES "COILS WITHIN COILS"

A NEW principle of thermometer construction which is said to remove many previous limitations to the accuracy and durability of temperature indicating and control devices has recently been developed in Europe and will soon be introduced into this country. Making use of bi-metal strip which deflects in proportion to temperature change, the principle involves a unique method of winding the strip into a unit of concentric helical coils, so that the forces of deflection are additive, but the forces tending to cause distortion and friction are mutually counterbalanced within the coils.

Using a new form of coil, it is possible for the first time to construct rugged, all-metal thermometers with an accuracy equal



Enlarged view of one of the bi-metal thermometer coils



Three bi-metal thermometer elements to provide same deflection. Coils A and C, 0.32 inch diameter

to or exceeding that of the ordinary spirit of mercury type, according to tests made in the laboratories of the German College of Science and Technology, Prague. Tiny thermal elements less than ¼ of an inch in length, or large elements with sufficient torque to move a pointer six or more feet in length can be constructed with the same general form of coil. Deflection sufficient to space out a narrow temperature range over a 360-degree circular scale is said to be obtained without loss of accuracy.

A coil consisting of concentric helices—in reality, "coils within coils" in which all the forces except that which causes angular deflection are mutally counterbalanced—was found to offer a mathematically balanced unit which was both rigid and compact. In most applications, the unit requires no supporting bearing at the working end. Even when a bearing is desirable, there is no tendency for a shift in the axis of rotation, which ordinarily leads to varying frictional resistance at this point.

Perfected coil-winding machines are now being installed in America at the plant of the Weston Electrical Instrument Corporation. Studies to provide a background for using the principle in instruments specifically designed to meet American requirements are now being carried on by that organization.

SUGAR WINDOWS

SLAPSTICK comedies are few and far between these days but even so a movie villain is now and then tossed through a window. When you see this, don't cringe for fear the glass will cut the actor for the property man has prepared this glass-like pane from sugar.

EXCESS VITAMIN D IS HARMLESS

TAKING large amounts of rickets-preventing vitamin D into the body causes no harm whatever, it is indicated in recent research by Dr. Harry Steenbock, the Wisconsin University scientist whose research has led to irradiation of food products to increase their vitamin-D content.

With irradiation of food products becoming increasingly popular, there is a possibility that many persons consume vitamin D in excess of their needs. Since this vitamin increases the power of the body to fix calcium, it has been a matter of considerable speculation whether this element may be fixed in injurious amounts, or whether the vitamin D may have other undesirable effects.

Dr. Steenbock conducted feeding trials with experimental animals over a 10-month period, allowing them to consume vitamin D in far greater amounts than human beings are ever likely to. While commercial irradiated milk usually contains about 50 Steenbock units of the vitamin per quart, the Wisconsin investigator used milks varying in potency from this figure up to 5000 units per quart.

All the common methods of fortifying milk with additional vitamin D were employed. Some of the milks were laboratory

irradiated, others were produced by cows fed irradiated yeast, and still others were supplemented with irradiated ergosterol and cod-liver oil concentrate.

The experimental animals were given no other food than vitamin D milk to which small amounts of iron, copper, and manganese were added. They were given all they could drink during the 10-month period.

All the animals grew well, were uniform in appearance, and showed no evidence of abnormality whatever.—*Science Service.*

Oilless Compressor

A NEW air compressor requiring no lubrication in the cylinder has been developed by the use of graphitic carbon supporting rings and segmental pressure rings also made of carbon. Metallic friction in the cylinder is thus eliminated.

This design insures against contamination of the air or gas by lubricants during compression. This construction is possible because of the self-lubricating qualities of the carbon rings. The pressure rings are expanded by metallic inner rings so as to give the proper wall pressure.—*A. E. B.*

Modern Treatment for Burns

WARNING against old-fashioned home remedies for burns, such as smearing the burn with butter, grease, ointment, oils, or even that old stand-by, Carron oil, was issued by Dr. A. B. Bettman of the University of Oregon Medical School at the recent meeting of the American College of Surgeons.

"At the present time," he said, "physicians have learned that the best treatment for a serious burn is to give the patient a narcotic, remove the burned tissue, and apply, first a 5 percent solution of tannic acid, and then, immediately, a 10 percent solution of silver nitrate. This forms, almost instantly, a black, leather-like, antiseptic, protective dressing. This is dried quickly and kept dry. No other dressing is applied."

After the actual burns are dressed there must be a comprehensive program of treatment for the patient.

As to first-aid measures in case of burns Dr. Bettman advised the following: "The best and safest procedure in extensive burns is to call a physician immediately, in the meantime keeping the patient warm, and, if no tannic acid solution is available, to make frequent applications of strong tea, freshly brewed with from eight to ten heaping teaspoonfuls of tea leaves to a pint of water. Non-greasy, tannic acid pastes are also of value."—*Science Service.*

Self-Vulcanizing Rubber

"SELF-VULC" is the name of a pair of self-vulcanizing rubber compounds recently introduced. One of these compounds is a liquid and the other is a plastic material; both are used for producing rubber linings and coatings in equipment. Whichever compound is used, it is first necessary to coat the surface with one coat of a priming compound. The liquid rubber compound may then be applied to the surface in any feasible manner such as brushing, spraying, or dipping, after which it vulcanizes itself when exposed to the air. The plastic com-

pound is applied over the priming by means of a spatula or other flat tool and similarly vulcanizes itself cold.

These products are recommended by the manufacturers for protection of both inside and outside surfaces against abrasion, penetration of liquids or gases, and corrosion.—*A. E. B.*

Honey

HONEY as a dressing for wounds was popular at one time in the Middle Ages. Still earlier, during the Roman Empire, it enjoyed a certain vogue; and Pliny refers in a certain passage to fish fat and honey as making a good ointment for wounds. It may well be that the fish fat he refers to was cod-liver oil.

Honey has been re-discovered as a remarkably effective ointment. In a Red Cross hospital in Hamburg, Germany, tests have been carried out with honey during the past half year, and it has been found that even much soiled wounds quickly become cleaner under its influence. But though it cleans a wound, it does not seem to make it heal more quickly than before. As cod-liver oil promotes rapid healing, it has been combined wtih honey in an ointment so as to achieve the double purpose of cleansing and healing.

So in this respect we are back again in the days of Pliny, after many a digression and much circumspection.

How does honey act? Does it cause beneficial fermentation? And which of its many component parts is most potent: its sugar, mineral salts, plant acids, higher alcohols or some ferment? Doubtless the Germans, with their methodical instincts, will isolate each of the component elements of honey, and will try each in turn on a number of cases of varicose ulcers, wounds, and so on. Pending conclusive findings from these future experiments, tests with whole honey will be continued.—*Science Service.*

Roads of Salt

COMMON salt would seem to have little to recommend it as a material for road building, yet experimental highways in New York state survived the recent devastating floods in that area without appreciable effect. The roadways are sponsored by the International Salt Company, and are constructed of clay and gravel treated with a compound made of ordinary rock salt, under a method discovered by Dr. Cloyd D. Looker, research director of the company, and developed in conjunction with Dr. H. Ries, professor of geology, Cornell University.

About 100 miles of these salt highways have been laid down by the producers of rock salt, in various parts of the country, including New York, Michigan, Vermont, Maryland, Indiana, Louisiana, Mississippi, Ohio, Kansas, and Pennsylvania. After several months' use, and carrying heavy traffic, they have proved satisfactory. The rock salt, according to Dr. Looker, not only compacts the clay but also crystallizes in the road surface and retards evaporation of moisture, thereby keeping the top weather-layer moist and firm.

Once compacting and crystallization take place, the surface sheds water, providing practically a non-skid road. The mixture is intended for secondary roads and to provide firm surfacing at small cost, as its cost per mile is about one third that of asphalt and one ninth that of the cement necessary for a concrete road.—*A. E. B.*

The Dancing Pebble

NOT infrequently, in oil-well shooting, a charge of nitroglycerin is placed 4000 to 5000 feet underground. And when a "shot" is fired at such a depth, sometimes there is no evidence of sound or shock at the surface to indicate a blast.

We are told that in some oil fields shooters occasionally resort to a simple expedient to make sure the nitroglycerin has exploded. After loading and making the necessary electrical connections, the shooter stretches over the casing head a thin sheet of paper, placing on top a small pebble.

The observable effect of the blast is either to disrupt the paper membrane or to cause the pebble to jump. This simple device is said to serve its purpose quite effectively.

Laundry Uses Aluminum Paint

THE modern laundryman is all too familiar with the tendency of moisture to collect on exposed surfaces, such as walls, ceilings, and piping. Frequently the condition is such that droplets of water form and fall on completed work, causing unsightly spots and necessitating recleaning.

Although painting of laundries has been in favor for a long time, only recently has any correlation been noted between the type of paint employed and this condensation of moisture on the surface. One interesting observation has been that dripping from aluminum painted surfaces is noticeably light.

A theory advanced for the phenomenon is that aluminum paint dries to a finish that is very slightly rougher than that of gloss paints, thereby preventing the water from running together to form large drops. Thus, though the moisture may still be present, it clings to the surface and evaporates.

CURRENT BULLETIN BRIEFS

WESTON SMOKE ALARM is a four-page circular describing the application of a photo-electric cell and alarm device to smoke stacks, to warn when smoke conditions in the stack become excessive. *Write for Bulletin 136A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WE DRIVERS is a series of brief discussions on driving, dedicated to the safety, comfort, and pleasure of the motoring public. Facts about motor car safety are told in simple, non-technical language and are illustrated with striking drawings. *Write for Bulletin 136B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

YOU'LL SING AT YOUR WORK! is the title of a beautifully illustrated pamphlet describing the latest developments in all-

electric kitchens. Interesting comparisons are made between old and new style kitchens, particularly as to the layout of equipment. *Write for Bulletin 136C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MELANESIANS AND AUSTRALIANS AND THE PEOPLING OF AMERICA, by Ales Hrdlicka, is a survey of theories that America was peopled from Polynesia, Melanesia, and Australia, in addition to Asia. Except for the Asiatic source the author concludes that these theories are not probable. *Smithsonian Institution, Washington, D. C.—25 cents.*

AIR CONDITIONING is an illustrated pamphlet devoted solely to air conditioning equipment for use in the home. It describes both single units for use in any room, and complete systems for permanent installation. *Write for Bulletin 136D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

9-INCH LATHE BOOKLET, while a catalog describing a new type of workshop precision lathe, contains much information regarding the operations that may be accomplished in the home workshop. The descriptions of various lathes are also well worth reading. *Write for Bulletin 136E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

FEDERAL POWER COMMISSION, INTERIM REPORT, POWER SERIES NO. 1, is the first of a series of reports on power sources and power requirements of the United States, as found by the National Power Survey. Of interest to everyone concerned with any phase of the power industry. *Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.—75 cents (coin).*

SOYBEAN UTILIZATION. A 27-page pamphlet on the uses of soybean products. *Write for Farmer's Bulletin 1617, Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents (coin).*

RECENT VIEWS ABOUT SOYA FLOUR. A small pamphlet containing information on soya flour processing, also a bibliography on soy beans. A. A. Horvath, *Agricultural Experiment Station, University of Delaware, Newark, Delaware.—3-cent stamp.*

IT PAYS TO OWN A FIREPROOF HOME describes for the layman the construction of concrete homes, from cellar to roof. It gives the reader sufficient pertinent information on which he may form his own opinions. *Write for Bulletin 136F to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A YEARBOOK OF RAILROAD INFORMATION, 1935 Edition, is a compendium of illustrated statistics covering all phases of railroad operation such as track mileage, cars in use, revenue-tons, mail revenues, and so on. *The Committee on Public Relations of the Eastern Railroads, 143 Liberty Street, New York City.—Gratis.*

CONCRETE ASHLAR WALLS describes a type of wall which is coming into increasingly wide use for homes as well as public buildings. Beautifully illustrated with numerous photographs showing the various effects that may be obtained. *Write for Bulletin 136G to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

DIESELS FOR BATTLESHIPS?

(*Continued from page* 20)

any naval vessel, where full power is required for short periods at infrequent intervals.

At 21 knots, which is materially greater than the present maximum fleet speed, the power required in the proposed installation would be 1150 brake horsepower per engine, and this could be developed with a piston speed of 1600 feet per minute and a brake-mean-effective pressure of about 100 pounds per square inch.

The engine proposed should be built on a weight of 2.0 pounds per square inch of cylinder volume, without the use of light weight materials of an expensive character. This would result in a weight per brake horsepower of 15 pounds; and there should be no difficulty whatever in keeping the total weight within the limit available which Sir George Thurston has given as 87 pounds per shaft-horsepower.

All doubt, however, as to the possibility of installing Diesel-electric machinery has been removed by the abrogation of the Washington Treaty, since it is now possible to consider the total fuel weight as a part of the design schedule. With a fuel weight at least four times the allotted weight of the propulsive machinery, a negligible decrease in the cruising radius would provide a very material increase in the weight available for the machinery.

It is not possible, at this time, to say what form of drive and what type of engine will be used when the final solution has been reached, and it is probable that the latter has not yet been designed. It *is* possible, however, to realize the great advantages of the Diesel drive by using a type of engine which is being purchased by railroad executives—whose reputation for sound conservatism is fully equal to that of naval officers—for use in a service in which the conditions are much more exacting than those in naval vessels.

Owing to the fact that the economy of the Diesel engine holds up much better, at reduced powers, than any form of steam plant, and to the fact that a materially greater maximum fuel supply can be carried, the cruising radius will be increased to more than three times that possible with steam. This great advantage—which will free a fleet from dependence on tankers and fuel bases in any probable campaign—will become available when, and only when, naval operating staffs recognize the possibilities of this form of drive and demand it.

Books SELECTED BY THE EDITORS

THE BACKGROUNDS AND FOUNDATIONS OF MODERN SCIENCE

By Richard E. Lee, A.M., M.Sc., Sc.D.

MOST modern universities nowadays wisely require all freshman students, before taking more specialized work, to attend what is called an "orientation" course in the general sciences. Such courses sweep the whole scientific horizon, covering astronomy, physics, chemistry, psychology, and the biologies, in a broad way, the purpose being not so much to teach mere facts as to provoke thought and understanding of the world in which we live. Many an adult long out of school would enjoy taking such a course, because of its broadening aspects. This can virtually be done now by reading the fascinating books of collateral reading assignments used in connection with these college courses, and this is such a book. It was written by the professor of chemistry and director of the freshman course in science at Allegheny University. Its price postpaid is $4.20.

A general reader edition of practically the same book, with the classroom exercises omitted and the text somewhat condensed, is also available under the title of "Man—The Universe Builder." This latter book is $3.20 postpaid. —*A. G. I.*

BLACKFEET INDIANS

PRIMARILY a book of full-color character portraits of individuals of the Blackfeet Indians, it also contains "Out of the North," a brief, swiftly moving historical account of them, the first authentic one ever written. The portraits—49 paintings, reproduced faithfully 7 by 10 inches and larger—were done by Winold Reiss, foremost painter of American Indians; the text is by Frank Bird Linderman. The volume is something new among books, is as native to America as the Rockies, and as colorful as an Indian sun dance. Measuring 10 by 12 inches and having a total of 72 pages, it is printed on heavy offset paper.—$3.65 postpaid.—*F. D. M.*

NEW NUMBERS

By F. Emerson Andrews

THIS book explains the duodecimal system of notation more clearly and readably than any exposition this reviewer has seen, and readers who have a turn of mind for the curious in simple mathematics should find it pleasant reading. Today we have a duodecimal (12 base) set of units—hours, degrees, inches, and so on—and we use an awkward decimal (10 base) notation in calculating with these units. We are now seeking, it is true, to change our units to metric units to make them fit our decimal notation. But because of their better divisibility, the units we already have are superior to metric units, and therefore it is our notation, not our units, which calls for change. No one in this reviewer's memory who thought long enough— three to 17 minutes—to grasp the central idea of the duodecimal system ever failed to concede its superiority. The matter of making the actual change is, of course, a separate question which does not detract from the interest in the subject. This book clearly explains the system and its uses. Persons having set, crystallized, conventional, or frozen types of minds are advised not to get it—they won't like it. Many of those who still have limber minds doubtlessly will.—$2.15 postpaid.—*A. G. I.*

OVERCOMING SLEEPLESSNESS

By Charles Wescheke, Ph. G.

THIS little book is for people who can't sleep, and is full of practical advice on how to fall asleep. It is so full of good advice about going to sleep that it kept this reviewer wide awake during the hour it took to read it. It describes many practical soporific expedients.—$1.10 postpaid.—*A. G. I.*

PHOTOGRAPHIC ENLARGING

By Franklin I. Jordan

IN a non-technical manner and as though he were talking face to face with the reader, the author of this book puts forth the fundamental principles of enlarging and of the various operations in connection with it. He offers many hints that will enable the worker to turn out better enlargements, and illustrates some of the hints with line drawings. The book is replete with samples of excellent photography, many of them from the camera of the author, and contains a Formulary and Helpful Hints Appendix that is valuable. 7½ x 10 inches, beautifully printed on coated stock.—$3.70 postpaid.—*A. P. P.*

MODERN RADIO SERVICING

By Alfred A. Ghirardi

IN 1274 pages plus a comprehensive index has been packed all of the information that the radio service man needs in order to investigate intelligent-

ly the trouble in radio receivers and also to advise correctly regarding the installation and proper usage of new receivers. The book is thoroughly up-to-date in every respect and covers the very latest information on such things as noise reducing antennas, metal tubes, interference prevention, and so on. The text is prepared so that a minimum of study is necessary in order to delve into the meat of any particular subject, and numerous drawings and photographs aid to a clear understanding.—$4.25 postpaid.—*A. P. P.*

RADIO FIELD SERVICE DATA

By Alfred A. Ghirardi and Bertram M. Freed

THIS is a supplement and answer book to Modern Radio Servicing reviewed above. It also gives in compact form useful data, tables, and formulas that the radio service man needs from time to time.—$1.65 postpaid.—*A. P. P.*

ANECDOTAL HISTORY OF THE SCIENCE OF SOUND

By Dayton C. Miller, Prof. Physics, Case School of Applied Science

THIS is a 100-page, illustrated history of acoustics up to the present century, with main emphasis on the people who have advanced the science, and much less on technical matters. The author is one of relatively few physicists who in this age of atomic physics have specialized in sound, a part of the old physics. He has known the ablest sound specialists of three generations, is himself a musician and one of these ablest specialists, and his story makes good reading. His book throws bright light into a corner of physics which historians of science have neglected.—$2.65 postpaid.—*A. G. I.*

AUTOPOWER

By S. W. Duncan

THIS little paper bound book gives direct and specific information on the conversion of certain types of automobile generators to 110 volt A. C. generators. It also includes valuable information on the testing of armatures. This is not a text book in any sense of the word but a direct and instructive "how to do it" book.—$1.00 postpaid. —*A. P. P.*

THE PHILOSOPHY AND THE CONCEPTS OF MODERN SCIENCE

By Oliver L. Reiser, Associate Professor Philosophy, University Pittsburgh

EDDINGTON, Jeans, and others having aroused popular interest in the philosophy of science, the world is being treated to a number of books which go beyond science itself (oft, perhaps, too far beyond and right out into the empyrean) and this is one of the latest of them. Since scientists are held to have too amateurish a point of view in dealing with philosophy, it remains to be seen whether philosophers are competent to deal with science, and thus reach the desired knowledge of the ultimate. This book by a philosopher discusses some of the philosophical problems brought up in the philosophy of science.—$3.65 postpaid.—*A. G. I.*

SKY HIGH: THE STORY OF AVIATION

By Eric Hodgins and F. Alexander Magoun

THERE are available many historical surveys of aviation, but all too many of them dismiss the truly historical with a chapter or two and then plunge into the developments of the last 15 years. In the present book, which is a revised edition brought up to date, fully half of the running story is devoted to the days prior to 1910. The text is rich in historical information and thoroughly illustrated with interesting old prints. The more modern part of the book is equally well written and deals briefly with record flights and commercial flying.—$2.95 postpaid.—*A. P. P.*

THE RANGE OF HUMAN CAPACITIES

By David Wechsler, Ph.D., Chief Psychologist, Bellevue Hospital

WE who have only mediocre abilities often wonder whether others who have outstanding abilities or even genius are persons like ourselves but simply better endowed, or are really another psychological species (the "divine spark" theory). The author's very scientific study points toward the former: a very slight superiority confers a disproportionate advantage, and it appears that the capable are not actually or quantitatively very far ahead of the rest of us who are not morons. If you have wondered what it is like to be an Einstein, this semi-technical book will tell you.—$2.65 postpaid.—*A. G. I.*

A GUIDE TO SEXING CHICKS

By Charles S. Gibbs, Prof. Vet., Mass. State College

THIS very practical little book reveals the oriental method of deciding, shortly after hatching, whether chickens are going to be nice productive hens or merely noisy roosters, which the author learned first from Chinese farmers.—$1.35 postpaid.—*A. G. I.*

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A PERSONALITY, A PROMISE, AN INVITATION

KLEMIN, ALEXANDER: Honor Graduate London University, B.Sc.; Massachusetts Institute of Technology, M.Sc. (Aeronautical Engineering). LL.D., 1934, by Kenyon, conferred for advances in aeronautical science. Instructor in Aeronautics, Massachusetts Institute of Technology, in charge of Aerodynamic Laboratory; during World War. Consultant in Aerodynamics, Bureau of Aeronautics, Navy Department. Officer in charge of Research Department, McCook Field, Dayton, Ohio. Consulting Aeronautical Engineer. Among clients served: U. S. Air Mail Service in technical problems: Aeronautics Branch, Department of Commerce; Fairchild Aviation Company; Sikorsky Aircraft and others. Gave first course in Aeronautics at New York University. Now Professor, in charge Daniel Guggenheim School of Aeronautics, New York University. Chairman, Aeronautics Division, The American Society of Mechanical Engineers; Acting Chairman Committee on Aeronautics, American Engineering Council. Professional Societies: American Society of Mechanical Engineers; Society of Automotive Engineers; Royal Aeronautical Society; Fellow of the Institute of Aeronautical Sciences. Books: "Airplane Stress Analysis"—Ronald Press, New York; "Text Book of Aeronautical Engineering"—Isaac Pitman & Sons, London, England; "Simplified Aerodynamics"—Goodheart Wilcox Corp., Chicago, Illinois "If You Want to Fly"—Coward McCann, New York.

To Readers of Scientific American:

PROFESSOR Alexander Klemin needs no introduction to old readers of Scientific American, who have benefited by his regular monthly contributions as associate editor for the past 10 years. It seems fitting to remind readers both old and new of the wealth of knowledge and experience that lies behind every sentence that Professor Klemin writes, for even a casual examination of his distinguished record amply proves his unique equipment to compress years of research, knowledge, and experience into a brief paragraph or even a single sentence.

Relying upon the helpful co-operation of our contributing editors, our Editor, Orson D. Munn, with the able assistance of the staff, each member of which is a distinguished specialist in his field, promises a dynamic, vital, and helpful editorial program for the coming year.

A significant example of the timeliness of our editorial coverage, was the publication of articles on cosmic rays in our September, 1935, issue, research on these mysterious rays from outer space being the primary purpose of the stratosphere flight from the hills of Dakota scheduled for early fall. Although the successful flight of Captains Stevens and Anderson was delayed, our readers received, three months prior to the actual achievement, the background information on cosmic rays. When the new information, secured through the successful venture, is scientifically evaluated, our readers will be informed of the result.

Our Research-Leaders-Help-Us-Edit program for 1936 assures the reader that no important development in research and science will escape his attention. You, too, can help us edit, by suggesting subjects that you would like to have included.

31,602 A. B. C. = 300,000 A. R. U.

(Audit Bureau of Circulations) (Active Reference Users)

EVERY significant scientific discovery or laboratory development is immediately recorded and evaluated. This editorial service is not for the specialist in a particular field, but for all research men in industry, for research students in school, college, or university, and for that select group of science-minded individuals who cherish accurate scientific knowledge for its own sake.

Measured in numbers, the readership of Scientific American is not large, and never will be large. Its editorial standard is too high either to appeal to or to be appreciated and understood by the mass mind, yet the Scientific American readership, in its influence and purchasing power, is an unexploited and unused market for many advertisers desiring to reach those who pioneer in Commerce, Industry, School, and Government.

Constantly used as a reference, every issue has a circulation at least ten times greater than the numerical count of 31,602, credited it by the Audit Bureau of Circulations, of which it is a member.

SCIENTIFIC AMERICAN

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AMATEUR TELESCOPE MAKING

Foreword by Dr. Harlow Shapley, Director Harvard College Observatory

PART I. Russell W. Porter, Associate in Optics, California Institute of Technology

Chapter I. Mirror Making for Reflectors
" II. Making the Mounting
" III. 100 Ft. Sun Telescope
" IV. Wrinkles
" V. Adjusting the Telescope
" VI. How to Find Celestial Objects
" VII. Telescope Housings
" VIII. The Prism or Diagonal
" IX. Optical Flats
" X. The Cassegrainian
" XI. Making Eyepieces

PART II. Rev. William F. A. Ellison, Director, Armagh Observatory

Chapter I. The Reflecting Telescope
" II. Tools and Materials
" III. Foucault's Shadow Test
" IV. Polishing the Glass
" V. Final Shaping
" VI. Finishing Touches
" VII. Silvering
" VIII. Mounting the Mirror
" IX. The Refracting Telescope
" X. Grinding the Lens
" XI. Testing and Refining
" XII. Mounting the Lens

PART III. Design Principles of Mountings, by Russell W. Porter (New matter—19 pages)

PART IV. The HCF Polishing Lap for Telescope Mirrors, by A. W. Everest (New)

PART V. Motor Drives for Telescopes, by John M. Pierce of the Telescope Makers of Springfield (New)

PART VI. Instructions for Silvering Telescope Mirrors, by U. S. Bureau of Standards

PART VII. Grinding and Polishing Machines (used by a few who enjoy making them, though most mirrors and lenses are made equally well by hand, and 95 out of 100 are hand made)

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