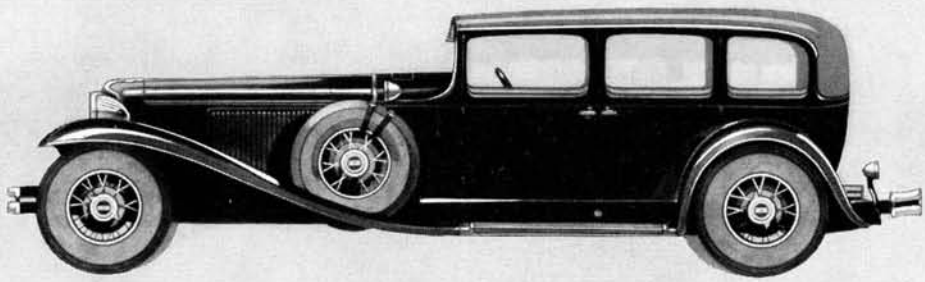
Companions In Depression—by Raymond B. Fosdick

Future of the Rocket · · Oil Prospecting by Airplane

SCIENTIFIC AMERICAN

March · 1931 ★ 35c A Copy

RESEARCH ON THE MYSTERY OF THE AURORA



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EIGHTY-SEVENTH YEAR • ORSON D. MUNN, Editor

CONTENTS • MARCH • 1931

THIS MONTH'S COVER

Our cover artist, Howard V. Brown, has this month made a composite painting. The aurora shown is similar to that in the painting by Harold Moltke which was submitted by Dr. D. la Cour, an outstanding Danish meteorologist, at the recent meeting of the International Geodetic and Geophysical Union in Stockholm, Sweden. The instruments are those shown in illustrations which accompany the article entitled "The Aurora—Elusive Mystery of Science," and the site is a snow-streaked ridge in Alaska where American men of science are observing the aurora at the present time.

SCIENTIFIC AMERICAN DIGEST

ACROSS THE EDITOR'S DESK

OUR editorial policy, here on the SCIENTIFIC AMERICAN, has frequently been criticized, both favorably and adversely, for its conservatism. We have always held, however, that conservatism is a necessity if a scientific magazine is to publish material that can be relied upon as being authentic as to source and accurate as to detail. Even at that, with this policy constantly in mind, there occasionally comes a time when too strict adherence to conservatism must be avoided in the light of sound theory. The "moon rocket" is a case in point. Poohpoohed by many as impossible and wildly imaginative, the recent donation by the late Daniel Guggenheim of a large sum of money for research on rocket problems has put a new face on the entire subject. The author of the article on rockets that appears in this issue has presented the facts and has looked into the future with eyes that take these facts into consideration.

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If, due to uncontrollable conditions, local power plants sometimes fail to supply the amount of power needed by the community, what can be done to tide them over? This is the question that confronted a power company of New England, where plants are largely hydro-electric and so are greatly affected by droughts. The answer was found in a portable power plant that could be sent to any point along the coast and used until the unusual conditions abated. The details of this floating plant will be found in this issue.

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In this issue, also, Raymond B. Fosdick bares some pertinent truths relative to the economic status of the United States—facts that you and I have vaguely considered in our moments of communion with ourselves but which not many of us have been honest enough to admit openly. In view of the depression's disastrous effect on the world, it is well for us to take stock of ourselves and try to grasp the meaning of the interdependence of nations as brought out in Mr. Fosdick's able article.

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Ladders for fish so that they can get up-stream to spawn despite man's encroachment in the form of dams; a new method for determining the hardiness of wheat without the necessity of waiting for winter weather to tell the story; how life-size and miniature groups of animals are prepared for museums; something of the glory that was Peru's —these and many other subjects form the body of this issue, backed up as usual by many shorter items of wide general interest in the SCIENTIFIC AMERICAN Digest.

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Speaking of conservatism, as we were in the first paragraph above, another example comes to the fore as we glance through the tentative schedule for the April issue. Most of the daily papers, and many magazines that should have known better, carried a story about a "meteorite" that fell through the hood of an automobile. The story was submitted to us, but we turned it down because of its lack of authenticity. Now we can present the facts, even though the story comes to our readers a little later than other publications printed it. News may be news only if new, but facts are necessary to science and it often takes time to assemble them so that the resulting article is accurate and not just the snap judgement of some biased or uninformed reporter.

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How often all of us have wondered, as our train threaded its way through a maze of tracks in a great railroad terminal, how it is humanly possible to prevent numerous smash-ups. The signaling and control system behind the efficiency that guides our train unerringly into its proper track is nothing short of marvelous; and the story of it, to be published in our next issue, is a story of almost incomparable human ingenuity. Railroad men who have already seen this article have congratulated us upon it for they say it clears up many details of railroading which, even to them, were previously mystifying.

●

In the Naval Research Laboratories in Washington, significant things have been done with the gamma rays of radium. Having a shorter wavelength than X rays, these gamma rays have been used to study the internal structure of metals and materials. The process, however, is much simpler than the procedure with X rays. No delicate tubes, elaborate wiring, and so forth are necessary, for a tiny capsule of radium salts, placed before the material to be studied, does the trick. These researches will be discussed in a coming article.

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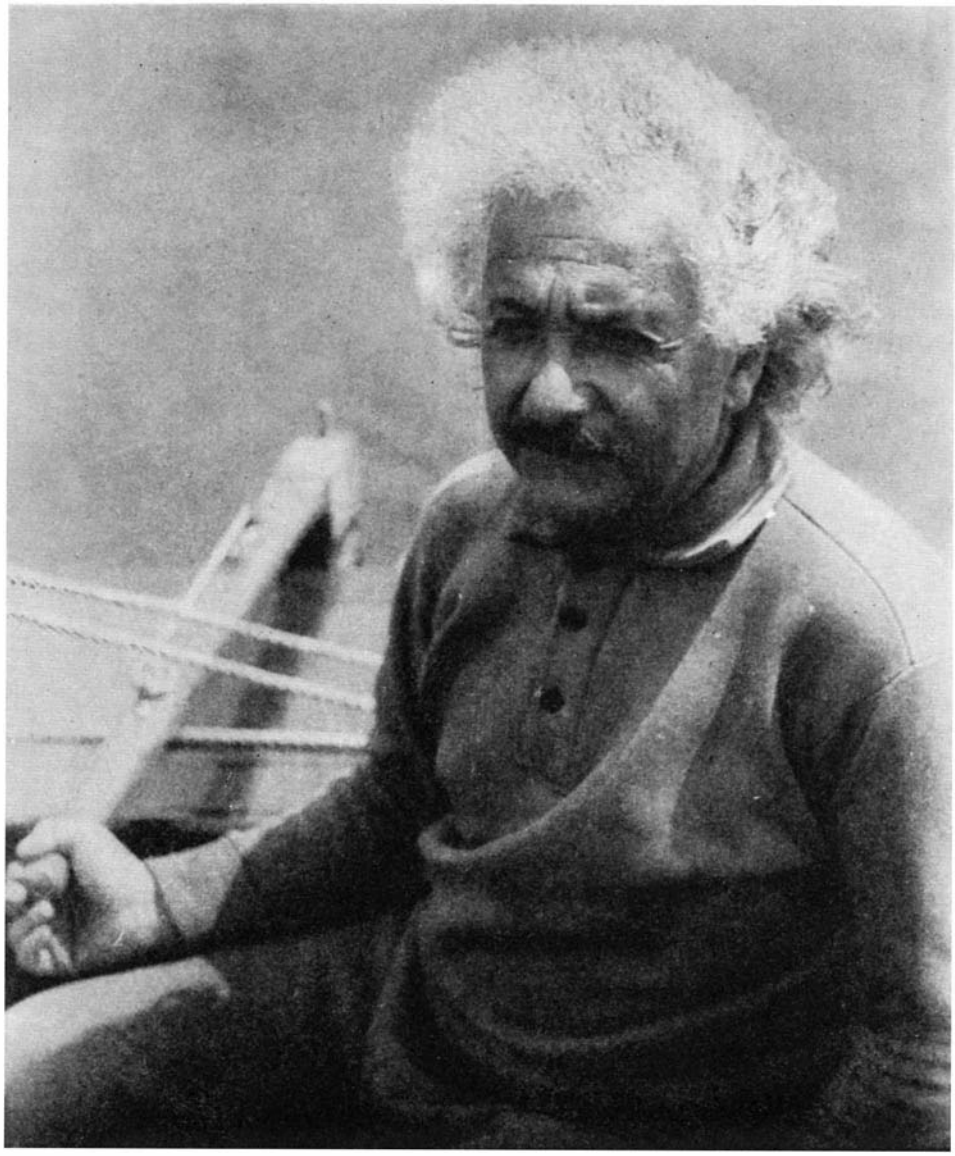
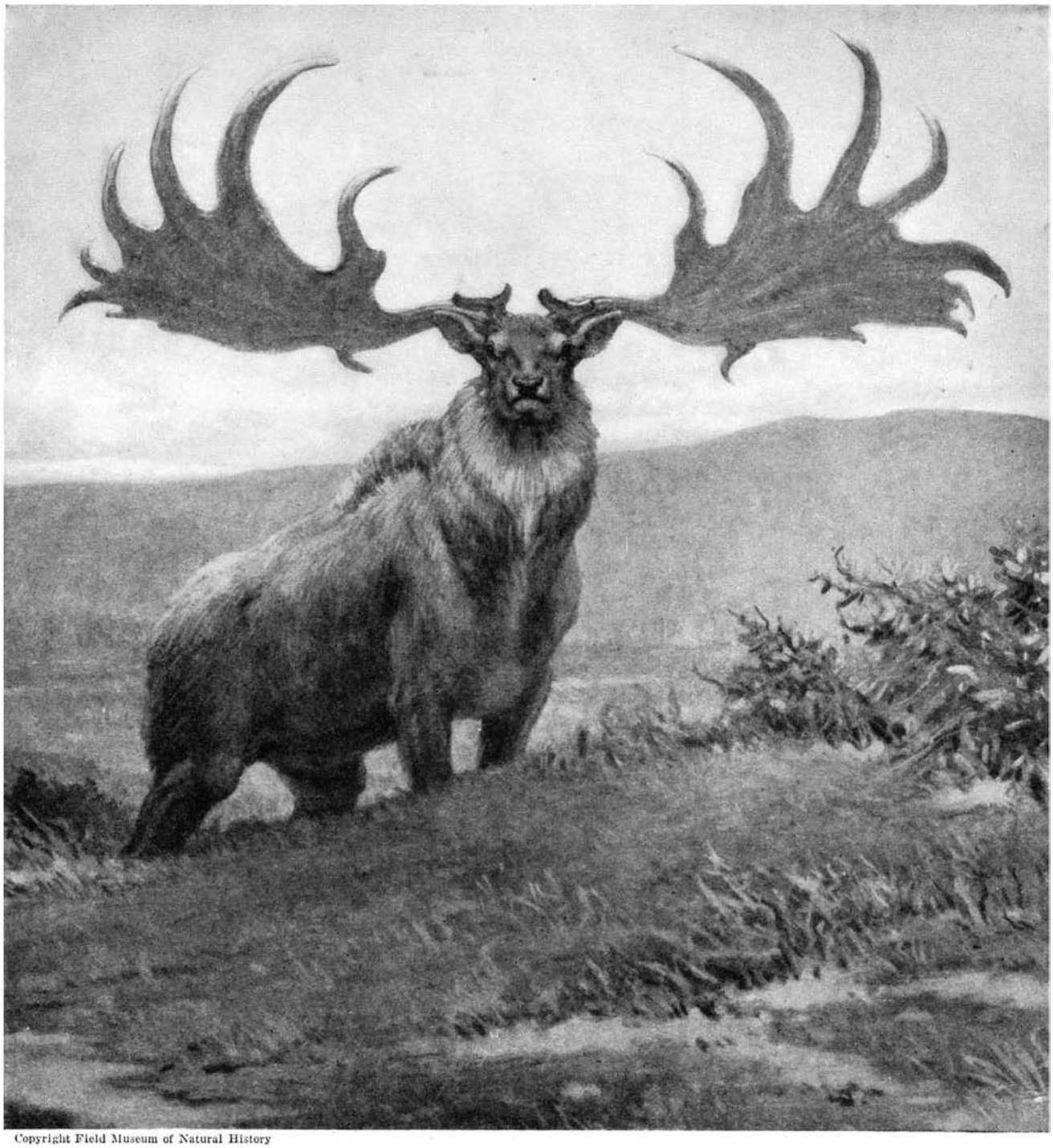
Other features for April will include information on such subjects as radio and the police, an outstanding railroad bridge, the industrial uses of vacuum tubes, a new method of making superior concrete piles, and many others. Our cover illustration will present an unusual angle of an engineering subject.



EINSTEIN GOES SAILING

LIKE other normal human beings Einstein plays part of the time, and sailing on the lakes just outside of Berlin is his favorite outdoor sport. As soon as a man becomes great, people begin to surround him with an accretion of imaginary tradition, and find it difficult to think of him as pursuing the pastimes of ordinary folk. For example, this photograph of Einstein lay a few days on the editorial desk and several persons remarked that the professor's facial expression was "most profound" and that he no doubt was "deep in thought about some new recondite theory." The chances are, however, that when Einstein goes sailing he goes sailing, and leaves ashore the whole Einstein theory. Probably his profoundest, most abstruse thought when this snapshot was taken had to do with the theory of the relative probability of dinnertime. It is doubtful whether the great physicist-mathematician knows or cares a rap in practice, whether the metacentric height of his craft is subtended by the square root of the center of effort of the mainsail or not—so long as she is properly trimmed and points up as close to the breeze as she ought. In this picture, physicist Einstein finds one thumb enough to hold the helm, and the chances therefore are that the wind has petered out.

Several months ago the editor stated that the Einstein theory was accepted by the majority of scientific men qualified to judge of its validity, and this conservative assertion was challenged by certain readers who do not accept relativity. In the latest edition of the Encyclopaedia Britannica Sir James Jeans, writing on "Relativity," is less conservative; he says acceptance of the relativity theory is "universal and complete."



EXTINCT BECAUSE OF TOO MUCH EVOLUTION

THE giant Irish deer often attained an antler spread of 12 feet. It became extinct in the 14th Century, doubtless due to over-evolution of the antlers. Its body was about the size of that of a moose and the animal was the largest of the deer family. A skeleton is on exhibition in the Field Museum of Natural History in Chicago, while the painting, done by the scientific artist Charles R. Knight and presented by Ernest R. Graham, is on the walls. Mr. Knight is not merely an artist but a student of paleontology, and before he undertakes paintings of extinct animals he makes a thorough study of the scientific background. He has promised to tell in an article in the SCIENTIFIC AMERICAN how he approaches and executes a typical painting of this sort, in order that no errors in science will enter.

Professor Krogness in the new auroral observatory near Tromsoe, Norway. Note telephone headset; also three auroral cameras, the chronometer, and the large spectrograph

THE AURORA—ELUSIVE MYSTERY OF SCIENCE

By N. H. HECK

Chief, Division of Terrestrial Magnetism and Seismology,
United States Coast and Geodetic Survey

EVERYONE who has seen the aurora at once asks for an explanation. Not many years ago any that might have been given would have little significance today. The developments of modern physics have made it possible not only to adopt a definite type of explanation, but progress has been made in outlining theories which explain the more important facts.

With this understanding it is my purpose to outline the principal known facts of the aurora and to give the present status of the efforts to explain it by theories acceptable to science. This discussion is peculiarly appropriate at this time since recently there has begun at Fairbanks, Alaska, the first comprehensive program of auroral observations under good conditions that has been made on the North American continent, except observations carried on from time to time by Arctic explorers. The program, which is to continue for five years, is being carried on at the Alaska Agricultural College and School of Mines with the financial support of the Rockefeller Foundation and with the assistance of the Carnegie Institution of Washington and the United States Coast and Geodetic Survey. The latter provides information regarding the earth's magnetism from its magnetic observatory at Sitka, Alaska, which though nearly 1000 miles to the south, records magnetic conditions not too greatly different from those at Fairbanks. Auroral observations have been carried on at Sitka for a number of years, but under very unfavorable conditions on account of the generally rainy and cloudy weather of southeastern Alaska. Fairbanks in sharp contrast has ideal weather conditions except for extreme cold, and it also has the great advantage of being within the belt of maximum auroral frequency.

SCIENTIFIC auroral investigations started in Norway where the relatively large number of people living in the region of maximum frequency provides better conditions for the study than in most other parts of the belt. The more favorable conditions do not, however, take away the credit of initiative of the Norwegian investigators, who have been willing to face the difficult problem and endeavor to find a solution. Many have worked in this field but especial credit must be given to four men who have done outstanding work in their own country and who have stimulated others there and elsewhere. These are Birkeland, Störmer, Vegard, and Krogness. The three latter are living and constantly adding to the store of knowledge in regard to the aurora. The importance of the work in Norway has been recognized by the Rockefeller Foundation which has helped to finance a magnificent new auroral observatory.

The work has steadily become international. As an example, the International Geodetic and Geophysical Union, through a committee of which Carl Störmer is chairman and the writer is member for the United States, has published an auroral atlas and instructions for auroral observations. One of its features is a classification of auroral forms, which is necessary to an understanding of the subject. The classification is very complete and only the more important forms will be listed.

Remembering that the different forms are often poorly defined and that different forms may occur at the same time, there are two classes of forms: those without ray structure and those with ray structure. Forms without ray structure include: Homogeneous quiet arcs (Figure 1); homogeneous bands (Figure 2); pulsating arcs, sometimes entirely disappearing and then reappearing in the same place; diffuse luminous surfaces, widely spread but without distinct boundaries. Forms with ray structure include: arcs with ray structure (Figure 3); bands with ray structure (Figure 4); draperies (Figure 5); rays (Figure 6); corona (Figure 7). The figures are reproduced from Störmer's new auroral catalog. This rather formidable list is in itself ample evidence of the complex phenomenon which we are trying to explain.

In the earlier days when the development of theory was impossible because of inadequate knowledge of physics, excellent work was done by the statistical method. This brought out very clearly the distribution of the aurora in the arctic region and established a very important fact. This is that the lines of equal intensity are nearly circular in form, with the center of the circles near

Figure 1

Figure 2

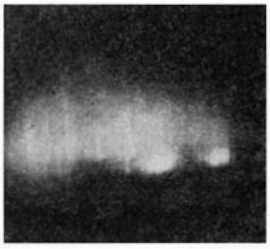


Figure 3

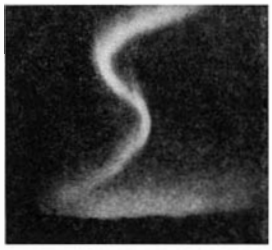


Figure 4

Figure 5

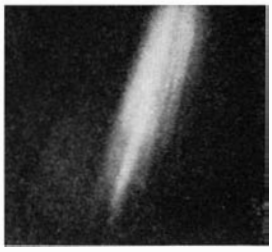


Figure 6

Figure 7

Störmer's seven forms of auroras, reproduced from his new atlas

Smith Sound in Greenland. Studies of the earth's magnetism have given a significance to this place, since if we assumed that the earth's magnetism is due to a magnet near its center, the axis of this magnet, prolonged in the general direction of the north pole, would reach the surface at Smith Sound. For convenience, we will call this the north auroral pole. The belt of maximum auroral frequency is found to be 23 degrees from the auroral pole and this fact has proved to be a very serious stumbling block in the way of those who are trying to provide satisfactory theories. The frequency falls off rapidly both to the north and south of the maximum auroral belt. The facts are probably similar for the antarctic region, but for obvious reasons the observations there are incomplete and it is not possible to draw the lines of equal auroral frequency. (See map, page 155)

IN the case of most physical phenomena, methods of observation are obvious but the aurora is far above the earth and beyond our reach and it is therefore not possible to make direct observations in the region where it occurs. On the other hand, of all the phenomena which investigation has shown to be related to the aurora, it alone can be directly perceived by our senses, and this is a very great advantage. However, the unaided eye must be supplemented by instrumental means and the first thought is naturally the use of photographic methods. This is not as easy, even for quiet forms, as it might seem, since the aurora, while bright against the darkness of the night, is relatively feeble, and it is difficult to take satisfactory photographs. There also must be a definite purpose in taking the photographs in order that useful facts may be brought forth. Störmer has done much to solve these problems and it is no longer difficult to take satisfactory photographs. He also has found it possible to measure the height of the aurora above the earth by combined photographic and astronomic methods. The method requires that there be two observers, each with a camera, located at two stations, the distance between which is known (as, for example, ten miles) with direct communication by telephone or radio so that the cameras may be exposed at the same instant. A selected auroral form is photographed at the same time at each station, this being made possible by directing the cameras at one or more selected stars. The aurora is photographed against the stars and the displacement with regard to the stars at the two stations gives the necessary data for computing the height of the aurora.

A vast number of these determinations have been made, but only a few characteristic results obtained in Norway need be mentioned. In the maximum auroral belt the bottoms of the various forms range from 90 to 100 kilometers (56 to 62 miles) above the earth, with heights for the upper portions from 300 to 500 kilometers (185 to 300 miles). In one case when observing in the vicinity of Oslo, Störmer obtained a height of 1000 kilometers or 620 miles. The lowest he has obtained is 80 kilometers or 50 miles and, in spite of the fact that persons have reported seeing the aurora reach the earth, there is no instrumental evidence to support this.

If photography can be successfully employed for the quiet forms, the obvious thought is—why not motion pictures for the moving forms? While the idea has merit, experience has shown that true motion pictures are impossible because the exposure must be at least two seconds. Pictures at this interval would be valuable though scarcely able to follow the fastest moving forms. There are many problems to be solved before the use of this method will be entirely satisfactory.

Another method of direct observation is the use of the spectroscope and this has been done by Vegard. Using a special type of spectroscope he found a definite line in the green portion of the spectrum. Careful study of its characteristics did not result in identification with any other known line of the spectrum. The source of the line was a real puzzle. Vegard, after experiments in bombarding solid nitrogen by cathode rays in the laboratory, was able to obtain this line and he therefore advanced the idea of the existence of crystals of solid nitrogen in the upper atmosphere. Later, however, McLennan obtained the line from a mixture of oxygen and helium. (See McLennan, "Mystery of the Green Line," SCIENTIFIC AMERICAN, January 1929.—*Ed.*) It is significant that the green line has been found to be present in the night sky everywhere.

IN addition to direct observation of the aurora by the means that have been described, another line of attack has been the study of correlations of the aurora with other phenomena. Since the auroral belt is in the general region of the north magnetic pole it is natural to see whether a relation between the earth's magnetism and the aurora can be found. While the occurrence of auroras in the maximum auroral belt does not always correspond to pronounced magnetic disturbance, there are no known cases where an aurora seen far to the south has not corresponded to a magnetic storm and usually to a severe one.

Many theories hold that some sort of ray reaching the upper atmosphere spirals around the lines of force of the earth's magnetic field. The line of force passing through a given point has a definite position with regard to the earth. If at a height of several hundred kilometers above the earth the direction of a line of force is unchanged from that which it is observed to be at the surface we should expect to find that, in the case of those forms of aurora with rays extending outward from the center, the center would lie in the direction given by the observation of the earth's magnetic field at the surface of the

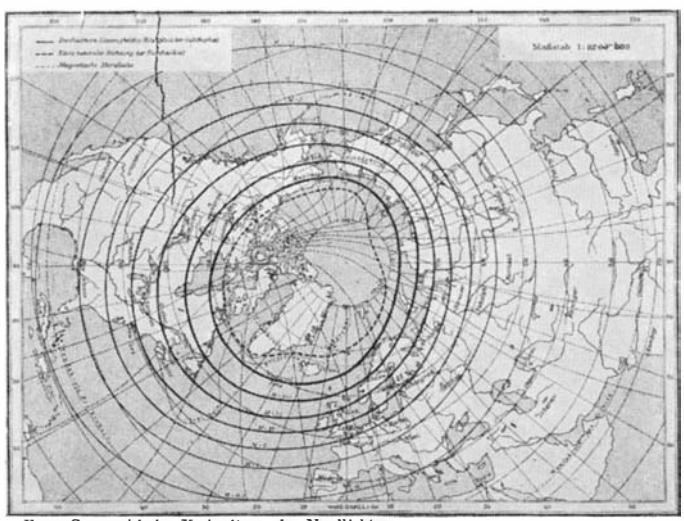
earth. It is found by observation that such centers almost correspond but may vary by as much as one degree.

Minor fluctuations in the aurora have also been associated with changes in magnetism. We have sufficient evidence that these two phenomena are closely related and, therefore, work in developing theories in the one field may be not only helpful but essential in the other.

We all recognize atmospheric electricity in the form of lightning, but this, though often severe, is a local, temporary phenomenon. In all parts of the earth, as evidenced by observations, there is, however, a continuous discharge from air to earth, minute in amount but measurable. It would be reasonable to expect a relation between this and the aurora, but careful observations in Norway at the time of a strong auroral display showed none. Earth-currents in the upper layers of the earth's crust, also minute in amount but measurable, are found in every part of the earth. At times these become very great and are able to interfere with telegraph and similar transmission. The important difference between these and atmospheric electricity is that earth-current disturbances occur in connection with strong magnetic storms and with aurora reaching far to the south. The relation between the great auroral displays and increased earth-currents may be considered to be established.

IT has been stated that great auroras are associated with disturbances in communication by wire or cable. Since the aurora exists in the region of the atmosphere through which radio waves must pass, its relation to radio reception is one of very great importance. Observations have been made at a number of places and, while conditions are changed during periods of disturbance, it is by no means established that communication is seriously interfered with. It is only recently that a theory has been developed and observations have been made which seem to explain this situation. In the early days of radio it was difficult to understand how radio waves passed around the earth, since there was no adequate explanation for their taking curved paths. The conception of the so-called Kennelly-Heaviside layer, an ionized layer about 100 miles above the earth, has solved the problem and observations have made it possible to determine the height of the layer. This is done by recording the difference in time between the wave which traverses a direct path from transmitting to receiving station, generally called the ground wave, and the wave reflected from the layer. This layer should not be considered as a fixed and definite, sharply reflecting surface, but rather a zone in which the radio waves are reflected or refracted. This layer does not remain at the same height all of the time but goes through daily fluctuations. In fact, at times echoes indicate that there are reflections at a number of different heights.

THERE are two phenomena which are of special interest to the short-wave radio operator—fading and skip-distance. Fading is due to interference between the direct or ground wave and that reflected from the layer. It is particularly in evidence for short-wave radio reception during a widespread magnetic storm, but is not important for long-wave reception. Skip-distance is generally considered to be due to the fading out of the ground wave before that distance from a transmitting station is reached at which the reception by way of reflection or refraction from the Kennelly-Heaviside layer reaches the earth with considerable strength. The shorter the wavelength, the less is the distance at which the ground wave loses energy. Skip-distance varies from day to night and from summer to winter and with the frequency of transmission. During strong magnetic storms it has been found that the height of the layer is greatly increased and then it remains at an unusual height till the storm is over; later the variations in its positions become normal. During such storms the skip-distance conditions are greatly changed and stations ordinarily difficult to receive come in with ease, while others ordinarily reached become impossible to receive.



From Geographische Verbreitung des Nordlichtes, H. Fritz, Justus Perthes, Gotha

Auroras in the arctic. The heavy lines are "isochasms," lines of equal auroral frequency. They center around Smith Sound at the northwestern corner of Greenland, which is therefore the north auroral pole. The innermost heavy line marks the belt of maximum auroral frequency. The dotted lines are the magnetic meridians; they converge at the north magnetic pole in Boothia Peninsula, northern Canada

Not enough work has been done in this subject in the auroral region and other parts of the polar regions. Observations in Norway do not appear to indicate very great difference in the height of the Kennelly-Heaviside layer there and elsewhere. The Byrd expedition found extremely variable conditions which are not yet fully explained. The relation of the Kennelly-Heaviside layer to the aurora needs much additional investigation.

The relation of the aurora to solar changes is important since these are undoubtedly the source of the phenomenon. The idea has been advanced that auroras and magnetic storms are related to the eruptive solar prominences which at the time of an eclipse are seen to extend far beyond the sun, and it is thought that some of these may reach the earth. The sunspot frequency is associated with the frequency of auroras that extend to low latitudes, and there are other possible solar relations which will be brought out in the discussion of theories.

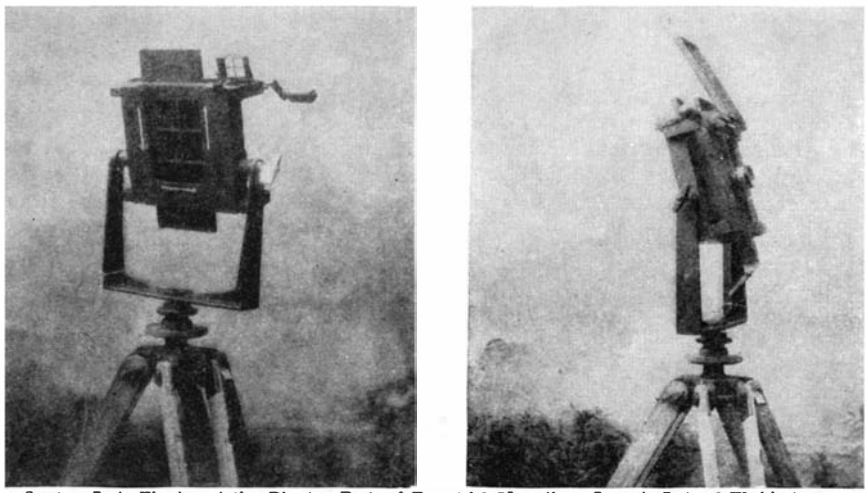
It is evident that there are a great many possibilities to be considered, and the problem of explaining the aurora is at first thought staggering. Some progress has been made, however, in developing the type of theory which it is hoped will eventually lead to complete explanations.

AS elements in the problem we have, then, the sun with its known disturbances, the earth with its variable atmosphere and magnetic field, the aurora and other allied phenomena. The evidence is fairly complete that some type of emission from the sun is responsible for the aurora, either directly or by setting up secondary effects within the earth's atmosphere. It is not unlikely that both primary and secondary effects play a part.

The simplest conception is that of a beam like a searchlight coming from a small aperture in the sun. This was one of the first ideas advanced by Birkeland. By his theory a circular pencil of corpuscular rays is shot out from the sun and traverses space until it reaches the earth's magnetic field. It has been found mathematically that the forces acting on the rays are capable of distorting the shape from a circular to an enormously elongated one with axis along the maximum auroral belt. The indi-

vidual rays follow along a line of the earth's magnetic field until stopped or until so completely absorbed that the rays are no longer able to produce visible radiation. Possible paths of the rays depend upon their initial velocity and their susceptibility to deflection from a straight path.

This theory seemed so reasonable that a great deal of work has been done on it in Norway. Birkeland constructed a small magnetized sphere which he called a *terella* and bombarded it with cathode rays to see whether he could produce effects resembling the aurora. He made many thousands of experiments and among them he produced a luminous polar ring resembling the auroral belts. Störmer then joined him in submitting the results thus obtained to mathematical analysis.



Courtesy J. A. Fleming, Acting Director, Dept. of Terrestrial Magnetism, Carnegie Inst. of Washington

An auroral camera, designed in Norway. The small crank shifts the plate

A SPECIAL effort was made to find trajectories for the rays which would theoretically bring them to the center of the earth, as such rays would penetrate farthest into the earth's atmosphere. Rays following this direction or departing from it only slightly can spiral along the lines of force of the earth's magnetic field, while others a little farther away may spiral around the earth, producing luminosity only after passing around the globe several times.

Vegard in 1911 began an investigation which has been carried on by Störmer and others to find whether any type of rays which had become known in connection with the development of X rays and radium would serve to explain the aurora. He was satisfied that the alpha rays of radium came nearest to accomplishing this. These start with a definite velocity and if they strike a layer of homogeneous matter they penetrate with straight-line orbits and with little scattering. He claimed that they would have sufficient penetration, but others limited the possible penetration to 250 kilometers from the earth. Besides, the auroral belt thus deduced is too near the auroral pole. Other types of rays have been tried. Chapman has worked out a combination of rays which he considers to be more satisfactory than any single type.

At this point all theories seem to come to the necessity of secondary effects. Störmer's theory calls for setting up a ring at a great distance from the earth, probably as far as the moon, and the current set up in this ring by the rays from the sun accounts for the observed phenomena. He claims that only a small change in the observed values of the earth's magnetism at the earth's surface would be caused by such a ring, but that it would bring the auroral belt to the right place. From recent radio investigations in Norway he has found that echoes have been received 15 seconds after the signals were sent out, and he considers that the radio wave has penetrated the Kennelly-Heaviside layer and has been reflected from the outer ring called for by his theory. Störmer agrees that this entire theory is not yet acceptable. He claims, however, that exceptionally strong currents in the outer ring can account for the widespread aurora.

A recent theory of a somewhat different type, though not differing greatly in fundamentals, is the ultra-violet radiation theory of Hulburt and Maris of the United States Naval Research Laboratory. They consider that the activating force is a burst of ultra-violet light from the sun. Ordinary radiation of ultra-violet light sets up the usual magnetic and auroral conditions, while unusual flares are responsible for unusual conditions. Ionization takes place high above the earth. Charged particles are carried from this region along the lines of force of the earth's magnetic field and for some reason give up their energy in the vicinity of the earth to produce the aurora.

It will be seen, then, that the problem of the aurora is definitely understood; that observations have been made in many fields; and that a general type of solution that may eventually prove acceptable has been established. Those who have given their lives to the study of the subject consider that we are still in a pioneer stage. The great need is for continued observations and especially for simultaneous observations of the different related phenomena in the region of the aurora.

MUCH more should be known about the aurora within a few years if the present plans of the Polar Commission of the International Meteorological Committee, on which practically all countries doing meteorological work are represented, are carried out. The plan is to repeat after 50 years the successful Polar Year program of 1882-1883, of observations in meteorology, terrestrial magnetism, aurora, and allied subjects, with such additions as the developments of science and increased ability to penetrate the polar regions will permit. In the Polar Year of 1882-1883, 15 stations were occupied in accordance with the plans of the International Polar Conferences of Hamburg. These included Point Barrow in Alaska, and Lady Franklin Bay on Ellsmere Island, northeastern Canada. The latter is memorable for the important work done by the Greeley Expedition before it met disaster.

The plan is to reoccupy the original stations wherever practicable, and a number of additional stations. The Commission has expressed the hope that the United States, through the government or otherwise, will make, in addition to meteorological observations, magnetic and related observations at Fairbanks, Alaska, and if possible at Lady Franklin Bay. Auroral observations will be included at a number of stations in addition to the permanent observatories in Norway and the one now being operated at Fairbanks.

There is little use in making these observations unless it is certain that they will be studied. The international plan provides for such studies, and for the United States a number of organizations are taking an active interest. The Carnegie Institution of Washington, through its Department of Research in Terrestrial Magnetism, co-operates with all countries in this work and is in close touch with the work of the Coast and Geodetic Survey in terrestrial magnetism and allied subjects. The Weather Bureau and the Coast and Geodetic Survey are interested in the results which may be obtained, and all civil and military branches concerned with radio have a more or less direct interest. This also is true of many other organizations throughout the country.

OUR POINT OF VIEW

Freedmen's Slaves

THE strange travesty of slavery existing in a nation that was founded by freed or escaped slaves 100 years ago as a haven for others of their kind and given a name to symbolize forever their freedom, was made known recently when Secretary Stimson notified Liberia that if she did not clean house she would lose our friendship. It seems to be a common human failing that we should do our utmost, once we have achieved some goal or purpose, to prevent others from enjoying it or working toward it.

Britain's Markets

THE Prince of Wales sailed for Argentina in January, "taking seriously his job of salesman for the Empire," with four British automobiles, his own Moth airplane, and what-not, to "sell" Britain to South America during the exposition of British industries in Buenos Aires. This entire "push" is directed principally against American manufacturers, and since some British products can beat ours hands down, it would be well for us to look to our markets lest they slip from our hands to those of the British. The Prince is no mean salesman!

Ballyhoo on the Radio

RADIO listeners will overwhelmingly agree with the comments of Dr. Lee deForest on the present intolerable conditions in the broadcasting field, and radio manufacturers will do well to use their united influence to rid the air of ill-advised advertisers who are so effectually monopolizing it and automatically silencing the sets. For be it known that Mr. Ultimate Listener is the final arbiter of the air and by a turn of the switch excludes the offending program. Unfortunately this remedy automatically denies his family the programs which they expected to enjoy when the set was purchased.

We believe that if radio advertisers seriously considered the present situation they would realize that interlarding 70 percent entertainment with 30 percent advertisement does not gain the attention or good will of potential customers. Every one knows that good programs cost money and that a large part of this cost must be covered by fees from advertisers. But no paper or magazine would long survive that similarly over-emphasized its advertising; and we are convinced that the present unbalanced radio programs must be recast promptly if the popularity of programs is to be preserved. Offending concerns need only listen in on some of the well-arranged programs, where 10 percent or less of the time is given to advertisements and 90 percent or more to a carefully chosen and well rendered program, to obtain models that will cause the radio industry to thrive and enable the American listener to enjoy high grade entertainments at his own fireside.

Coast Defense

AFTER years of squabbling between the Army and the Navy on the subject of which service's air force will defend our coastline, the Army has won the honor. This seems a wise assignment of the job for, after all, the fleet would need all the planes it could muster in the event of a war. This final settlement of the question will now make possible for the first time the organization of a permanent and highly efficient system of air defense of our coasts which, by its presumed effectiveness, should add one more link in our chain of preparedness to prevent war.

Mussolini's Salesman

GENERAL ITALO BALBO, who seems ever to smile above that black beard which disguises his youth—he's in his early thirties—has called the world's attention to the progress of Italian aviation by leading a squadron of 10 planes, in military formation mind you, across the south Atlantic. Two planes crashed with a loss of five lives and two others were forced down at sea but these mishaps did not deter the youthful general. And since Italy is well represented in the population of South America, particularly in Argentina, this grand gesture by Mussolini to stimulate Italy's South American trade—for such it was—may have profitable results for Italy. At any rate, the flight showed that great argosies of the air can cross the south Atlantic carrying freight and mail. We refuse, however, to take seriously the claim made by at least one European newspaper that Mussolini did it to show the United States that he can send fleets of bombing planes to our very doors.

Imperialistic America

SENATOR ASHURST of Arizona recently proposed that we purchase a portion of Lower California and of the state of Sonora from Mexico—just like that, without so much as a by-your-leave! To Mexicans, this sounded like imperialism; and it threatened to destroy much of the good will created by Ambassador Morrow. It called forth cries of "curious" and "ridiculous" and doubtless inspired unprintable thoughts. The Mexican people are not to be blamed for resenting such high-handedness for it implied that they would have nothing whatever to say in the matter. Fortunately for the relations between the two countries, the proposal was, is, and will be simply a proposal—nothing more.

International Affairs

Renewed Hope for India's Autonomy

AFTER passing through several crises that seemed about to wreck the conference, the delegates at the Round Table in London have reached a solution acceptable to the British and Indian participants, and one that will probably be supported in Parliament by both the Labor and Liberal members. This happy outcome is a real triumph for Prime Minister MacDonald, who has shouldered the enormous responsibility of attempting this settlement. Under the provisions, control of the Army and foreign finance will remain with the Viceroy; except for these restrictions, India is granted a representative government responsible to an Indian Legislature.

When the Indian princes of the independent states definitely threw in their lot with the rest of India, the old argument, that there was not one India but several Indias, disappeared. When Lord Reading accepted the agreement for the Liberal party it was plain that any opposition in Parliament by the Conservatives would be futile, even if they would be disposed to follow the lead of Winston Churchill in opposing the demands of the Indians.

Mr. MacDonald's tactful leadership, the sympathetic attitude of the Viceroy, Lord Irwin, the unexpected harmony

(*Please turn to page* 208)

MEASURING THE ROTATION OF THE STARS

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

THERE must be some limit to the amount of information regarding a distant star, which can be obtained by studying the lines in the spectrum, but this limit is still far from being reached. For nearly 70 years it has been realized that from the exact positions of these lines we could find out what kinds of atoms absorb them, and so make a qualitative analysis of the star's atmosphere. It was realized too, but more vaguely, that the strong lines must be produced by abundant elements, and in recent years this knowledge has developed into a thorough quantitative analysis which tells us not only what substances are in the star's atmosphere but how much of each one, and explains many things that once were puzzling.

In sunspots, whose light can be studied with very powerful spectroscopes, most lines appear double, proving the existence of a magnetic field which acts on the absorbing atoms. This is an old story now, but it is only recently that the existence of powerful *electric* fields in stellar atmospheres has been satisfactorily established.

EXPERIMENTS in the laboratory showed years ago that when light-emitting atoms are subjected to a powerful electric force their spectral lines are split up in a complicated fashion. This "Stark effect," named for its discoverer, resembles somewhat the Zeeman effect produced by a magnetic field. For the heavier elements, and in particular for most of the lines of the metals, this effect is small, but for hydrogen and helium it is large and the separations are much wider than can be produced by any practicable magnetic fields. For the successive lines of a series (like the familiar hydrogen lines) the electrically separated components are more and more numerous and cover a wider range (which is not the case with the magnetic separation). More remarkable is the appearance of entirely new lines under the influence of the electric field, especially in helium. These lines have been identified as forbidden lines which arise from transitions within the atom, which under ordinary conditions are extremely unlikely to happen and so do not produce lines of perceptible intensity. An external electric force operates (in a manner easily explained theoretically) to break down this prohibition and make these transitions occur far oftener, so that the corresponding lines become easily visible though not strong. Now the strongest of these forbidden helium lines (at wavelength 4469.84, in the blue) has recently been definitely identified in a number of stellar spectra by Dr. Otto Struve of the Yerkes Observatory. It is near the strong helium line at 4472 but clearly separated from it, and agrees exactly with the electrically stimulated helium line and with nothing else. Two or three similar lines appear to be present in the same stars. This is a very convincing proof that powerful electrical forces are actually acting on the atoms in the atmospheres of such stars, for example, as *Gamma Pegasi.*

BUT certain difficulties arise. The first is theoretical. The atmospheres of hot stars like this are full of free electrons and consequently must be rather good conductors of electricity. How can electric forces continue to exist for even a thousandth part of a second in such a conducting atmosphere? Would not the electrified particles move about until they had neutralized the original disturbance?

The next difficulty is observational. Electric fields powerful enough to cause an appearance of the forbidden lines split up some other susceptible lines, like those of hydrogen, into widely separated components. Yet in the stellar spectra the hydrogen lines are single, although very broad and fuzzy.

The solution of the puzzle is simple enough. The electric forces in a star's atmosphere are powerful but extremely local, differing completely in amount and direction from one atom to the next. A hot atmosphere is full of free electrons and the positively charged ions from which these have been separated. Every one of these charged particles is the center of electric force and if we could pick out an atom at random in the atmosphere we should be practically sure of finding two or three charged particles among the half dozen which lie nearest to it in all directions. Once in a long time the influences of these neighboring particles will happen to counterbalance one another, but usually there will be a pretty lively electric force acting upon the atom. Great numbers of helium atoms therefore will at any moment be in a position to absorb the forbidden lines, and enough of them will do so to account for their observed intensity.

As for the hydrogen lines, if we could isolate those hydrogen atoms which at a given instant are subject to an electric field of given magnitude we would doubtless find them absorbing just the definite pattern with its numerous components which we get in the laboratory. But other atoms at the same time are subject to greater or smaller electric forces and would give more or less widely spaced patterns, and when all are at work at once these are all smeared into a single wide hazy line with no definite internal structure. After a millionth part of a second all the atoms will have shifted their positions over and over again, but the average effect will be unchanged. It is still possible, however, to tell that the Stark effect has been at work, for if it has we would expect those lines which show the widest patterns under the definite conditions of the laboratory to show the broadest smears under the chaotic disturbances in the stars.

Just this happens. Among the various series of lines into which the helium spectrum has been analyzed some show a very small Stark effect, while for others it is pronounced; and the haziness of the stellar lines varies in direct proportion to this. The hydrogen lines which show a huge Stark effect are still broader, while the practically unaffected lines of carbon and silicon are sharp in the stellar spectra.

THE whole effect of which we have been speaking varies greatly from star to star. This again might have been predicted. The denser the star's atmosphere the stronger will be the electric forces, the hazier the sensitive lines, and the stronger the forbidden ones. When we find, as sometimes we do, a star in which the forbidden lines are invisible and the rest are unusually sharp we may conclude that it or at least its atmosphere is of unusually low density. This means that we have to do with a star of unusually large diameter and great real brightness.

This relation between sharp lines and great luminosity has been known for years and has been used for finding

spectroscopic parallaxes. With increased understanding of the physical processes this may become an important method of finding the distances of these remote stars.

Though these "pressure effects" are fairly conspicuous in the spectra, the actual pressures are very low. According to Dr. Struve's calculations the atmospheric pressure in a star that shows the effect strongly is only 1/10,000th of that of the earth's atmosphere at its surface. In the highest stars it must be far less. There is plenty of other evidence that these values are not far from the truth.

EVEN in the sun the Stark effect appears to be present for the hydrogen lines, which are normally wide and not so black as other lines of equal strength. Since there are undoubtedly many free electrons in the sun's atmosphere this might have been anticipated.

In some stars, however, the lines are widened in an altogether different way. For example in the spectrum of Altair *all* the lines are exceedingly wide, and most of them are so faint that they can be photographed only on a slow and contrasty plate and with carefully timed exposures. When this is done it is found that large numbers of lines are present, all equally wide and with fairly sharp edges (except the very wide hydrogen lines), as if the narrow and rather dark lines of an ordinary spectrum had in some way been spread out into broad faint strips with the loss of most of their depth. This is quite unlike the Stark effect, which conspicuously "plays favorites," widening some lines more than others, and when it does act produces an effect which dies away slowly so that the dark line fades away gradually without definite edges.

It was long ago suggested that this type of widening of the lines could be produced by a rapid rotation of the star. One side will then be coming toward us and the spectral lines absorbed here will appear to be shifted toward the violet, while those from the opposite limb will be equally displaced to the red. Thus all the lines will be equally widened and a simple calculation shows that they will appear as shallow but sharply bounded darker regions in the spectrum.

Even in the absence of rotation the spectral lines would not be indefinitely narrow nor perfectly dark. But a little more arithmetic enables one to work out just what would happen to a given observed spectral line if the star which produces it were to be set rotating at any assigned rate. Mr. Elvey (also of the Yerkes Observatory) has recently dealt with this question in a very interesting way. Using the strong magnesium line at λ 4481, which is little influenced if at all by Stark effect, and making the obviously sound assumption that in the stars where it appears sharpest the effects of rotation can be safely neglected, he has calculated what the line ought to look like in stars rotating with different equatorial speeds, and compared the results with his measures of the actual width of the line in various stars, and of the degree of blackness at different points inside it. In this way he has detected more than 20 stars which show definite evidence of rotational widening of the lines, and estimated the velocity of rotation at the equator in each case. The smallest detectable velocity is about 30 kilometers per second, a slower motion giving so little widening that it is confused with the natural breadth of the line. The most rapid motion is 260 kilometers per second in the case of *Alpha Aquilae* (Altair). Three other stars show a motion of about 200 kilometers per second and 8 or 10 more get up to 100 kilometers.

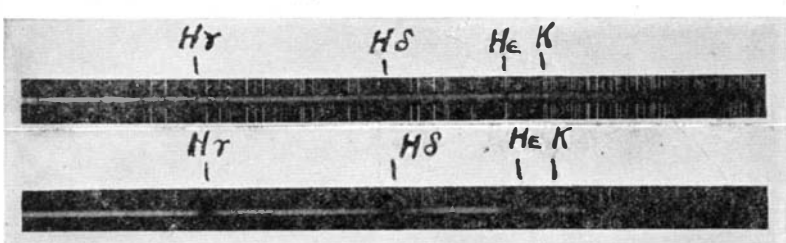
THIS tells us how fast the star's equator is moving, but not how long it takes to go round. To work this out we must know the size of the star. Fortunately we can estimate this in the very cases which are of most interest. Altair, for example, which has a large and well measured parallax, is known to give out nine times as much light as the sun. Its spectrum shows it to be considerably hotter than the sun—about 8500° on the surface as against 6000°, so that per square mile it gives off four times as much light. Hence the star's diameter must be approximately 1½ times that of the sun, or 2,100,000 kilometers, and its circumference 6,600,000 kilometers. Dividing this by the observed velocity, 260 kilometers per second, we find a rotation period of 25,500 seconds or about seven hours. This is the shortest rotation period which the observations indicate for any star.

Next comes *Delta Ursae Majoris* (the star at the junction of the bowl and handle of the Great Dipper) for which the equatorial velocity is 200 kilometers per second. This star is more than four times as far away as Altair and is actually more than twice as bright. Its probable diameter is 2,600,000 kilometers and the corresponding rotation period is 11 hours. For a few other stars the period comes out less than a day.

Some allowance must be made for the fact that only a part of the equatorial velocity (namely, the component in the line of sight) operates to widen the spectral lines. But, even so, it is clear that the large majority of the white stars (to which alone the present discussion applies) must take longer to rotate. Those which go round in three or four days can in due time be picked out by the methods just described (except for the few which have their poles pointing almost toward the sun). The general run of the stars for which the rotational widening is imperceptible probably have rotation periods of a week or more.

ONE further question remains. Can a star like Altair whirl so fast without being broken up by centrifugal force? The answer to this involves such simple arithmetic that it might fairly be set as an examination question for college students. From the well known relation between the real brightness and the mass of the star it appears that the mass of Altair is a little less than twice the sun's, and hence that the force of gravity at its surface is 80 percent of that at the sun's surface. The centrifugal force corresponding to a rotation period of seven hours is found to be 30 percent of the gravitational attraction.

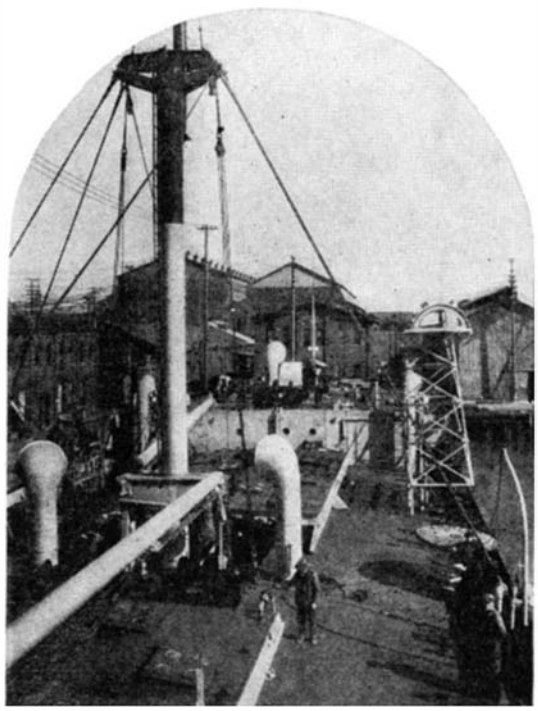
This is considerable, but not enough to break up the star. For the planet Saturn the centrifugal force is 10 percent of the equatorial gravity and the effect is to bulge out the equator so that the polar diameter is about 10 percent less than the equatorial. By this analogy we may estimate that the equatorial diameter of Altair is about half again as great as the polar. A more rapid rotation, say in four or five hours, would probably cause the star to divide into two separate masses such as are known among eclipsing variables. But, as it is, Altair appears to be inside the "zone of safety," though not much inside. As it represents a case of extremely rapid rotation, picked out of a large number of slower moving objects, we should expect it to be near the limit and may well be satisfied with this result.



Above: **Spectrum of *Alpha Cygni*, a very luminous star of low density. Even the hydrogen lines H gamma, delta, epsilon, are narrow, while the metallic lines such as the K line of calcium, are very sharp.** ***Below:*** **Spectrum of Altair, a dense star in rapid rotation. The rotation widens all the lines. In each the comparison spectrum of iron is added to either side. Taken with the 100-inch telescope**

A FLOATING ELECTRIC POWER PLANT

By A. T. LITTLEFIELD
Central Maine Power Company



View of the aft deck of the *Jacona* after its conversion, showing the ship-shore cable tower

THE New England Public Service Company, having its principal office at Augusta, Maine, operates and controls about 80 generating stations in Maine, New Hampshire, and Vermont. A few of these are steam stations but most of them are hydro-electric. It also supplies, transmits, and distributes a large part of the electric service in these three states. The hydro stations are all located inland on the principal rivers. From these generating stations, transmission lines extend to many coast towns to serve the public and numerous important industries. A large part of the energy required by the subsidiaries of the company is supplied by water power but it is necessary to have a certain amount of steam auxiliary to insure continuity of service in time of drought or in case of interruption to transmission lines.

Changing conditions in certain communities are responsible for rather rapid variations in the demand for electric power. These changes require expenditures of large sums for transmission lines or construction of new plants, or possibly both, which in years may be of less service. These conditions are particularly difficult to meet in regions where there is considerable hydro-electric power which in time of drought requires the aid of steam-driven auxiliaries.

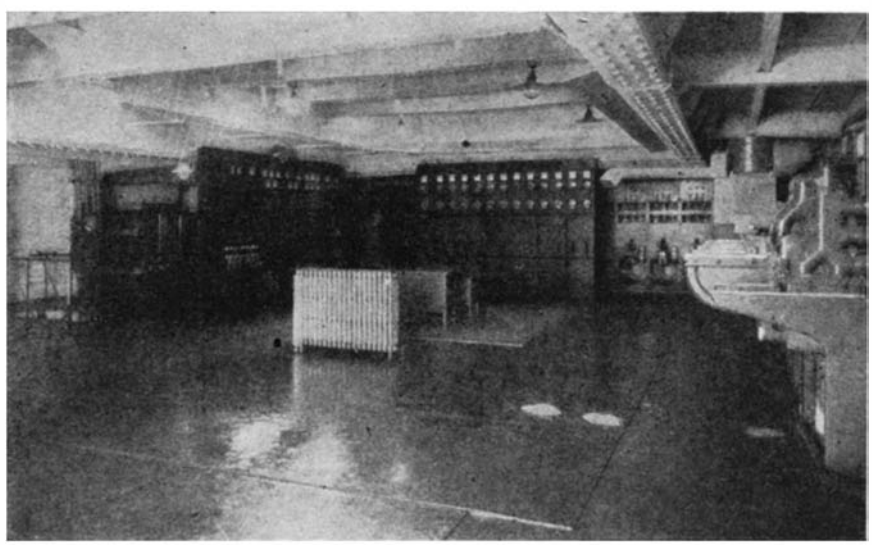
Faced with these conditions, the company has had under consideration for some time the problem of a floating power plant. After an extended investigation the company decided to purchase from the United States Shipping Board the S. S. *Jacona*, a cargo vessel of 7000 tons, 380 feet long, and 53 feet beam. This vessel has now been converted into a floating power plant by the Newport News Shipbuilding and Dry Dock Company who made the necessary changes and installed the equipment.

The propelling equipment, boilers, and engines were removed and foundations constructed to accommodate the new equipment which consists of four boilers and two turbo-generators each rated at 10,000 kilowatts. The maximum capacity of this plant is 20,000 kilowatts.

Practically all the cargo and machinery spaces are occupied by new equipment. Near the forward end of the ship is a cargo space occupied by a donkey boiler and coal bunker. This boiler will be used for heating and operating equipment on the ship when being towed. Following this is another cargo space which constitutes the boiler room. The second deck has been practically removed to make room for the boilers which extend to the main deck. In the space besides the boilers, there are two motor-driven and one turbine-driven boiler feed pumps, two oil pumps, three oil heaters, one oil transfer pump and bilge pump, and numerous boiler meters and instruments.

THE boiler equipment consists of four Babcock and Wilcox marine type boilers equipped with air pre-heaters, inter-deck superheaters, Diamond soot blowers, and oil burners. These boilers will deliver 280,000 pounds of steam per hour at 425 pounds pressure and 250 degrees, Fahrenheit, superheat. Each boiler is equipped with 11 Cuyama burners. The fuel oil is supplied to the burners at 300 pounds pressure and 300 degrees temperature. Two of the boilers are equipped with de-superheating coils. This steam will be used for heating oil and operating auxiliary equipment. The furnace walls consist of a high-grade fire brick and special insulation. There are one stack, and one forced and one induced draft fan for each pair of boilers. The fans are equipped with variable speed motors controlled from the boiler room floor. This boiler plant is designed to be operated at 83 percent efficiency.

Near the center of the ship is a built-in steel oil tank with a capacity of 250,000 gallons, or enough to supply the plant about five days at full capacity. This tank has been subdivided and reconditioned and fitted up with all necessary equipment for measuring and heat-



The switchboard and control room resembles somewhat this part of a similar plant on land, it not being necessary to crowd equipment as is usual on shipboard

ing oil. On the second deck level over the oil tank are the high-pressure heaters and surge tank supplying the boiler feed pumps.

Aft of the oil tank is the old boiler and engine room. This space is occupied by one of the 10,000-kilowatt turbines and its auxiliaries. Next comes a cargo space which is occupied by the second turbine and auxiliaries. Following this is another cargo space near the stern of the ship which constitutes the switchboard room. Switching equipment is located on the second deck and a bank of transformers is mounted below.

THE turbines are General Electric Company's standard power house machines of the very latest design and are of high efficiency. They will operate at 3600 revolutions per minute on 400 pounds pressure and 250 degrees superheat, and will exhaust into surface condensers at one inch absolute back pressure. With these steam conditions, steam consumption of the turbine alone will be approximately 9.4 pounds per kilowatt at full load.

The turbines are direct-connected to the generators which have a closed system of ventilation. Cooling water for the air coolers and oil coolers will be supplied by the main circulating water pump.

The condensing equipment is furnished by the Westinghouse Electric and Manufacturing Company. The condensers are of the single pass type and the tubes are expanded at both ends. Each condenser is suspended on the turbine exhaust flange.

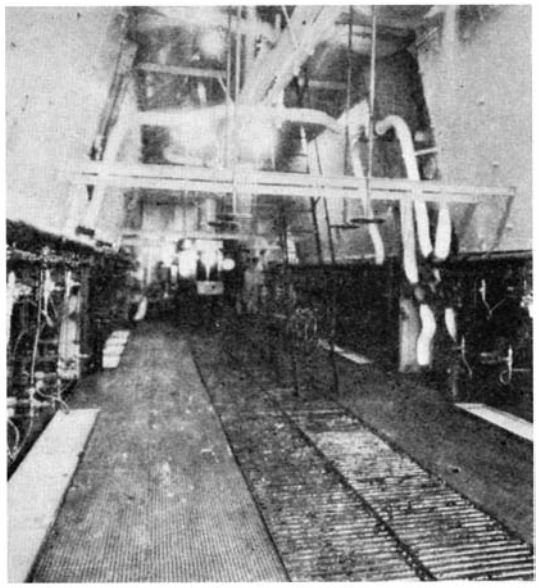
Condenser water connections are arranged on both sides of the ship and the main circulating water tunnel extends athwart-ship so that water may be taken in from either side.

The closed feed water system has been adopted and only the make-up water is being de-aerated. This water is de-aerated by means of a small heater and vent condenser before entering the evaporator. Fresh water will normally be used for make-up but the plant will be prepared to operate with salt water if necessary.

With the exception of a few auxiliaries, the plant is divided into two separate units. Two boilers are arranged to serve each turbine, each unit having an evaporator, low-pressure heater, high-pressure heater, and boiler feed pump, with an auxiliary boiler feed pump so arranged as to serve either system.

The generators are built for either 11,000 volts "Y" or 6600 volts delta. Leads are brought out from each winding and carried to the Allis Chalmers Reyrolle Units where the change-over is made through a plug type carriage unit.

Most of the auxiliaries are motor-driven but there are enough steam-driven units to enable the station to start up if there should be a break in the transmission lines and it became necessary to start the plant without power on the ship.



Looking aft in the boiler room. Fresh water is normally used but salt water may be used

The ship is provided with double bottom tanks for oil and water storage but these tanks will not be used at present as there is no demand for them. The forward and after peak tanks, however, are connected up for service, principally to maintain the trim of the vessel. The bilge, ballast, and oil transfer systems have been reconditioned and modified to suit the arrangement and will be similar to any other ship.

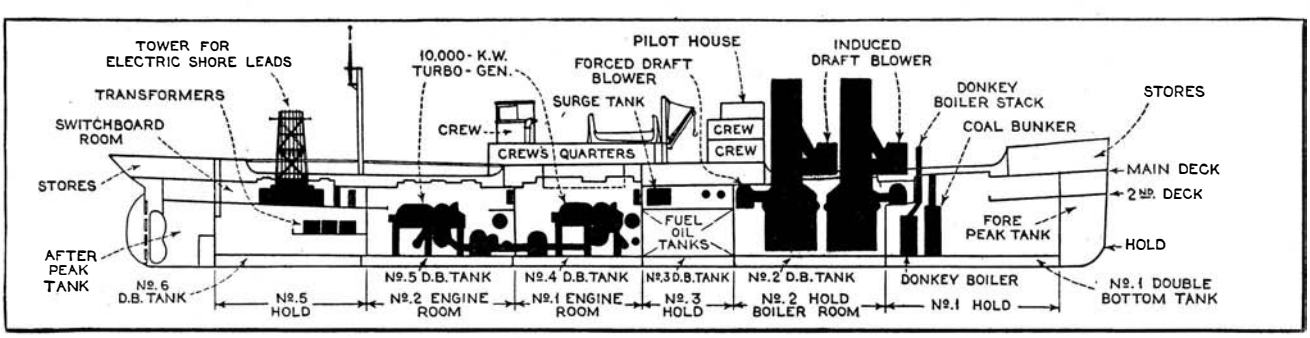
THE crew's quarters forward and aft have not been disturbed, but the midship quarters were reconditioned to accommodate 15 to 20 men when the ship is being towed. One mast was unshipped to provide room for the boiler stacks and the other kept in place fully equipped to assist in handling equipment.

The method of making electrical connections to the shore has been a problem involving considerable study. The arrangement finally decided upon consists of a steel tower on the dock and one on the port side of the ship, built on the main deck about in line with the center of the switchboard room. Arrangement is made to transfer this tower to the opposite side whenever necessary. Two separate three-phase circuits consisting of heavily armored and insulated cable will run up these towers and over a barrel cross-arm structure to the dock tower. A considerable amount of slack will be left in the cable between these towers to compensate for the rise and fall of the tide which normally is about 10 feet, but at times of severe storm may go as high as 18 feet.

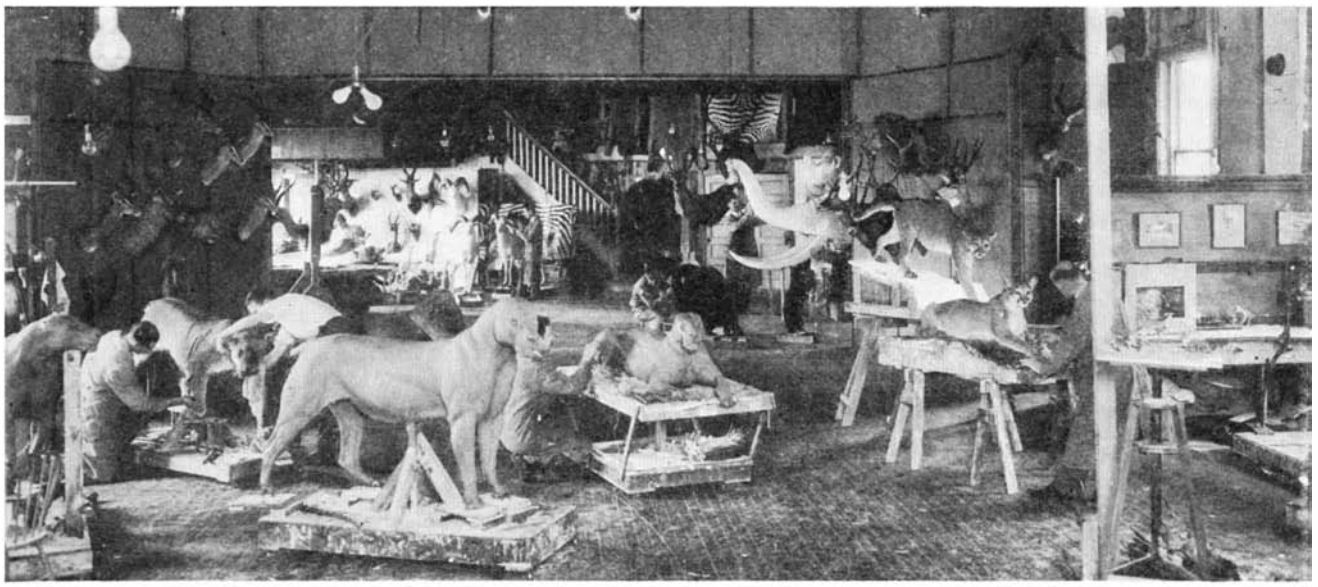
Facilities for berthing have been made at Bucksport, Maine, where a large paper mill is in the course of construction. This paper mill will consume approximately 20,000 horsepower.

As the ship will have no propelling equipment it will be necessary to tow it from place to place as the occasion demands, and water, oil, and electric connections made to existing facilities ashore.

This floating power plant is really a stationary plant placed inside a ship and combined with several marine features. Being the first plant of its kind, there naturally were many problems to work out and these involved considerable study. However, the power company endeavored to make this a thoroughly modern and highly efficient plant in every way, but since it is intended to be more of a utility station and the load factor is indeterminate, they, of course, have not gone to the extreme in efficiency.

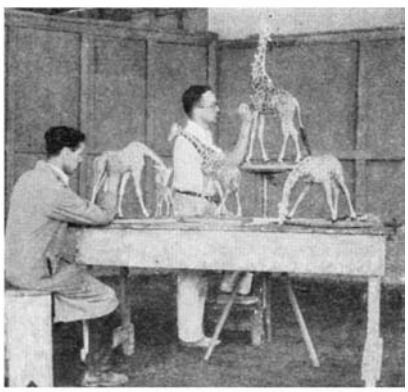


Arrangement of equipment in the converted *Jacona*



A view of a modern studio showing a variety of activities—sculpture and taxidermy

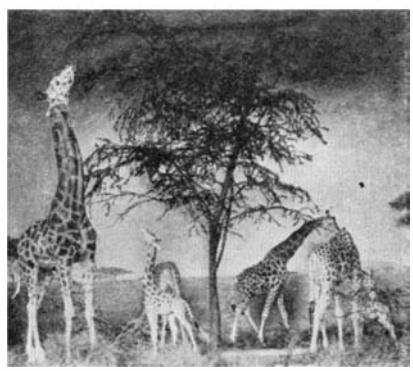
SCULPTURE AND TAXIDERMY JOIN FORCES



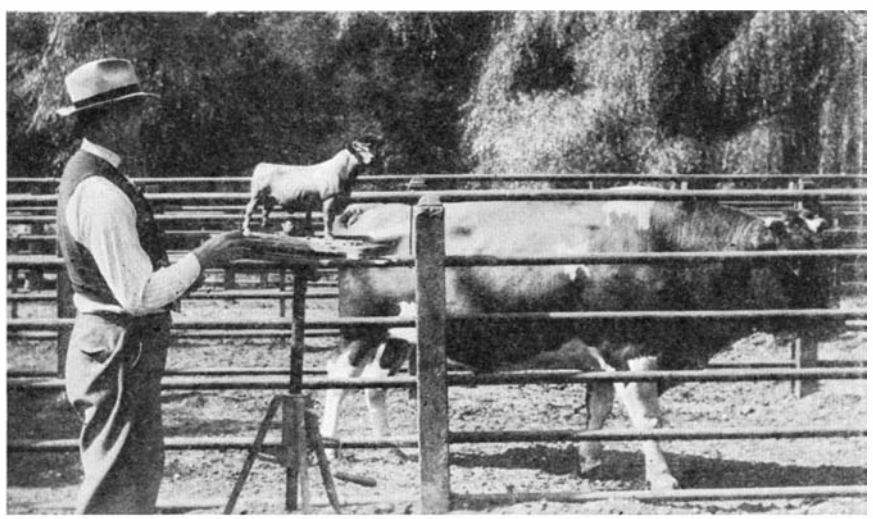
Artists coloring wax figures of giraffes for a miniature museum group. Finished group at the right

NOT far from New York City is a disused moving picture studio where another type of studio work has replaced the old time "slap-stick" comedies of two decades ago. Here the skins of wild animals are transformed into lifelike forms. In one corner an elephant is being mounted for the music room of George Eastman. In another part, miniature groups of animals are being designed and modeled in a new medium for the "friendly museum" that does not possess a deep pocketbook. Such groups are as educational as those of life size and are beloved of children and grown-ups alike. These miniatures cost less than 8 percent as much as the huge groups in which only a rich museum with plenty of space and large resources can indulge. In other words, this studio caters to the "4000" as it were, and not to the "400" which are apt to have their own extensive preparation rooms. However, there are many times when even a great museum like the Field Museum of Natural History is glad to procure, by contract, such a beautiful model or group as is shown on the opposite page.

The zoological art studio we illustrate is that of Jonas Brothers at Yonkers, New York, and one of our editors recently spent an enjoyable morning there selecting some pictures for presentation to our readers.



In the studios, talented young men receive excellent training while actually attacking the problem of art. No better schooling could an artist have for animal sculpture than by surrounding himself with such activities as are found in this studio. Here he gains structural understanding of the various animals and acquaints himself with the characteristics and habitat of the various members of the animal kingdom, under authentic leadership. John Jonas, famous big game hunter and explorer, is president of the studios; Louis Jonas, well known sculptor, is director of museum activities; and Leslie Jonas, mechanical

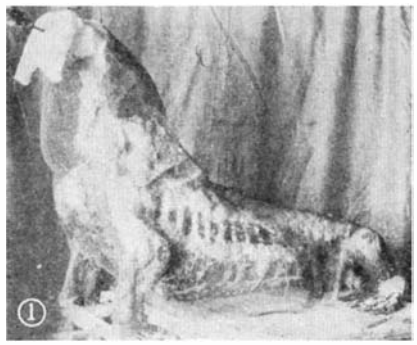


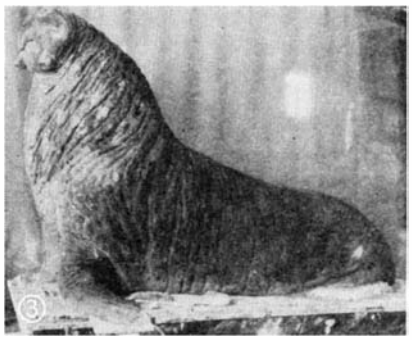
Louis Jonas modeling a Guernsey bull from life. This will be one of a large series of farm animals for the new Museum of Science and Industry at Chicago

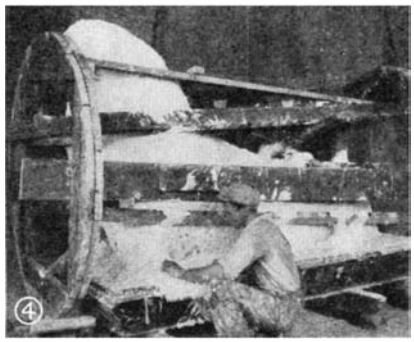
engineer, is in charge of production.

A well organized staff of artists and technicians is constantly engaged in designing and constructing animal and bird groups for natural history museums. The miniature models of mammals are on a scale of ⅙ life size. Many of these mammals are in groups, such as the giraffes illustrated. In all instances careful initial studies are made from nature or from photographs. Motion pictures are a great source of information. With the aid of special projection machinery, the animal's movements, general physical makeup, and physiology can be studied most satisfactorily. Whenever possible, models are made and the casts colored from life.

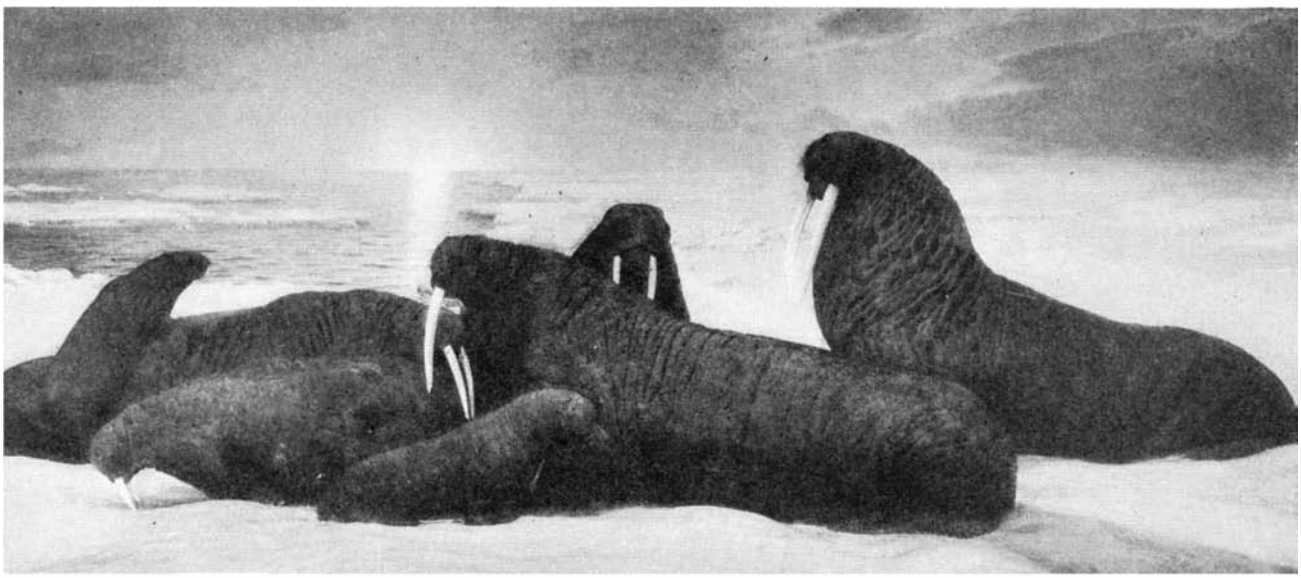
The method of mounting the walrus group is that known as the "Akeley process" which has been further developed and adapted to the mounting of walruses. The skeleton is covered with wire cloth and plaster, forming a shell over which the clay model is made. When the model assumes its general shape and size, it is coated with a soft clay composition and the skin is put on. Now the soft tanned skin is gradually worked into the clay composition until the desired lifelike texture is gained, with all the wrinkles and other fine details brought out. The skin-covered model now is ready for the mold. Plaster about one inch thick is applied directly over the skin and is reinforced with woodwork. This plaster shell holds the skin in its final place. The whole structure is turned upside down and all the skeleton, plaster core, and clay removed. The skin remains in the plaster shell and is reinforced with a durable material about ¼ inch thick. This is now allowed to dry and after several weeks the plaster shell is removed and the skin is there in its lifelike form, permanently reinforced yet light and very durable. The surface of the skin is cleaned, soaked with waterproof material, and then painted. The background is supplied at the museum where the exhibit is to be shown.







1: General shape of walrus formed with wire cloth and plaster over actual skeleton. 2: Skin placed loosely over clay model. 3: The details are worked out by pressing the skin into the soft clay preparatory to making the mold. 4: Reinforcing the plaster mold. 5: Removing the plaster and clay core. Hide remains in mold which is reinforced with permanent material. 6: Removing last piece of mold. *Below:* Group of walruses in the Field Museum of Natural History, Chicago, Ill.



THE FUTURE OF THE ROCKET

By DAVID LASSER
President of the American Interplanetary Society

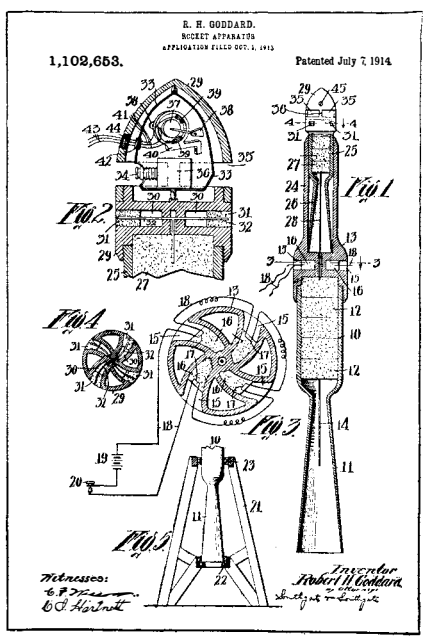
THE accompanying discussion of interplanetary rocket travel may please some, displease others. The proponents of the space rocket have not yet demonstrated its practicability but its opponents cannot demonstrate its impracticability. We shall have to wait and see, in the meantime keeping an open mind. Doubtless some of the students of the subject are rather optimistic and perhaps more enthusiastic than circumstances warrant. Still, one recalls the famous case of the great Newcomb proving that ordinary airplane flight was a physical impossibility and, eight weeks later, the Wright brothers actually flying—another fine-spun theory set at naught by a mere fact. There are enough parallels to this case to make a cautious person still more cautious about predicting the impossibility of interplanetary rocket travel.

—The Editor.

IN simplest terms, the rocket consists of a tube in which there is a chamber open at one end to the outside. In this chamber fuel, such as smokeless powder, is burned. The gases of combustion thus formed exert a high pressure in every direction. Their pressures on the side walls of the chamber balance each other, but the pressure parallel to the chamber causes two things to occur. The gases press upon the end wall of the chamber and, conversely they tend to rush out of the chamber through a nozzle into the open. Due to these pressures, caused by the tendency of the gases to expand, a force is exerted on the end wall, which pushes the rocket ahead.

This action does not depend on the medium, such as air, outside the rocket. In fact, the operation of the rocket is helped rather than hindered in a vacuum. Although the power obtained at the tail of the rocket may not be so great in a vacuum as in air, because in a vacuum the gases tend to expand and escape more quickly and thus lose their energy more rapidly, the reduction in head resistance, due to the absence of air, more than outweighs this factor. The air resistance against any moving body increases directly as the square of the speed. Thus the rocket is peculiarly fitted for operation at high altitudes or in open space where presumably there is an almost complete vacuum.

There are several other conditions that govern and limit the rocket's field of application. The experiments of Goddard, Oberth, and others, have demonstrated that the rocket operates at its greatest efficiency when the gases of combustion flow out of the exhaust nozzle at the greatest speed. Goddard found in his experiments that when, for example, the speed of expulsion of the gases is about 1000 feet per second, the



Drawing from Professor Goddard's original patent on a duplex rocket

efficiency of the fuels—the obtained percentage of their latent chemical energy—is about 2 percent. When he obtained a speed of expulsion of 7000 to 8000 feet per second, the efficiency was between 55 and 65 percent. In other words, with greater speeds of expulsion of the gases, the efficiency rises very rapidly. Furthermore, the work of these experimenters has revealed that the efficiency is greatest when the speed of the rocket approaches the expulsion speed of the gases. From this it is easily seen that the rocket is a means of transportation whose efficiency is best developed at very high speeds compared with those to which we are accustomed.

Some of the attempted uses of the rocket doubtless are doomed to prove failures, while others may achieve a success that will astonish even the most optimistic rocket enthusiasts of today. The early efforts of Max Valier and Fritz von Opel, German experimenters, were directed toward the utilization of the rocket principle on the motor car and the airplane. Because the airplane could not be driven safely at speeds greater than 400 miles per hour, and the practical motor car was limited to about 100 miles per hour—due in both cases to the enormous friction of the air encountered at such high speeds—these experimenters soon realized that the field of the rocket was destined for other than terrestrial transportation. As has been stated, at speeds much lower than the expulsion speed of the gases, the efficiency of the rocket decreases very rapidly. Between such speeds, therefore, as 400 miles per hour, which may be the limiting speed of the airplane, and upward of 3000 miles per hour, at which the rocket must travel for a reasonable efficiency, there exists a wide gap.

WE are forced, then, to view the rocket as an instrument which can operate safely at speeds approximating 3000 miles per hour, in mediums offering little resistance to its passage. Four such fields are open: first, for terrestrial transportation at high altitudes; second, for the observation torpedo; third, for the establishment and operation of a station in space; and fourth, for extensive travels into outer space and possibly to other planets.

Colonel Lindbergh has stated recently that future long distance flying will be done at high altitudes, say at 25,000 feet; for only then can an airplane be freed from the terrors of storm, sleet, fog, and snow, and be rid of the resistance of the denser, lower air. Yet the airplane is not a high-altitude machine. Its propellers must secure their traction by cutting through the air, its wings must be supported by the air, and the motor needs oxygen for its operation. To play the rôle that Colonel Lindbergh assigns to the airplane, nothing is better fitted than the rocket. With it, long distance flights become not only possible but necessary. As Max Valier has shown, a rocket ship equipped with wings could leave a Berlin airport, climb to a 40-mile altitude, and after a horizontal flight over the Atlantic

Ocean, glide slowly down to New York —all in one hour. At the 40-mile level the resistance of the air is so small, probably not more than one hundredth of what it is at sea level, that a speed of 3000 miles per hour is easily obtainable. Valier has shown that such a craft, carrying passengers, mail, or valuable express, need not have greater power than an airplane to do an equivalent job.

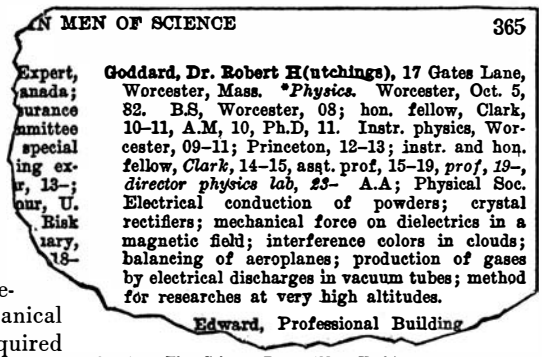
Here, then, is one important field for the rocket, a field to which its peculiarities perfectly adapt it. And as has been pointed out, it is only for long distance trips at a high altitude that the rocket can thus be utilized.

The present efforts of Dr. Goddard and the Advisory Committee assisting him under a liberal grant of funds by Daniel Guggenheim, are directed toward the perfection of what might be known as an "observation torpedo," a rocket carrying various devices for measuring temperature and pressure; for taking samples of air; and for photography. The torpedo will be sent unmanned to a high altitude. When the power of the rocket's upward flight is exhausted, the devices will perform their work, a parachute will spring from the cap of the rocket and allow it to descend gently to earth. These mechanical eyes can be sent aloft as often as required to any predetermined height, not only to gather weather information invaluable to aviation and commerce, but also more general information of value to science.

BUT the observation torpedo has its limitation—it is a costly process to send these rockets aloft continually, especially when the area to be observed is so great. Otherwise, the particular data obtained will be of only local and transitory value. What has been proposed to serve to supplement the purposes of the observation torpedo is the "station in space." This conception we owe to Hermann Oberth of Mediasch, Germany.

Herr Oberth proposes that we take advantage of the dual forces of gravitation and centrifugal force to send a rocket aloft which shall circle continually around the earth. Rising to a height of about 500 miles, equipped with all manner of observation devices, the rocket will acquire a speed of some five miles per second parallel to the earth's surface and then, with power shut off, it will continue to circle the earth indefinitely, unless destroyed. From this "station," which will encircle the earth every two hours, a scientist-observer will watch cloud movements, observe the stars, note changes in the sun with their resultant effect on terrestrial weather, radio communication and other electric phenomena; and gather valued information.

The observer or observers in this "station in space" will maintain communication with the earth by radio or, if that is not possible, by light signals. Relief and supplies will be furnished by an auxiliary rocket sent from the earth. As many stations may be established as desired, each, of course, covering a circumferential segment of the terrestrial sphere. Such studies of outer space as are made possible by the observation torpedo and the "station in space" must of course precede attempts to conquer outer space and make a journey to the moon or to some other planet. Only by a precise knowledge of the conditions existing in free space (temperature, pressure of atmosphere, if any, existence and field of activity of meteors and cosmic rays) can man plan to build a ship capable of making an interplanetary journey and to protect himself against adversity.


N MEN OF SCIENCE 365

Expert, anada; urance mmittee special ing ex- r, 13–; our, U. Risk iary, 18–

Goddard, Dr. Robert H(utchings), 17 Gates Lane, Worcester, Mass. *Physics. Worcester, Oct. 5, 82. B.S, Worcester, 08; hon. fellow, Clark, 10–11, A.M, 10, Ph.D, 11. Instr. physics, Worcester, 09–11; Princeton, 12–13; instr. and hon. fellow, *Clark*, 14–15, asst. prof, 15–19, *prof, 19–, director physics lab, 23–* A.A; Physical Soc. Electrical conduction of powders; crystal rectifiers; mechanical force on dielectrics in a magnetic field; interference colors in clouds; balancing of aeroplanes; production of gases by electrical discharges in vacuum tubes; method for researches at very high altitudes.

Edward, Professional Building

Courtesy The Science Press (New York)

For such an ambitious trip as the latter, the rocket is the only means thus far devised. The properties of the rocket which would fit it for high altitude transportation and for extra-terrestrial observations, also would fit it for long journeys to other worlds. The speed of nearly seven miles per second necessary to escape the gravitational attraction of the earth is well within reason, and a solution is possible by the use of the detachable rocket.

In the detachable rocket the space ship will have attached to its tail, in railroad car order, two, three, or more separate rocket motors. When the ship leaves the earth the last or tail rocket (which naturally is the largest) will be put into operation and bring the rocket up to a predetermined speed, say two miles per second, before it is uncoupled and by means of a parachute allowed to drift back to earth. The rocket remaining at the end is now operated and the speed of the ship is increased to four miles per second before its fuel charge in turn is exhausted. It, too, is uncoupled; and so on, until only the ship proper and a non-detachable rocket are left. Before the last remaining fuel is exhausted, the rocket already has a speed sufficient for it to escape the earth and on a predetermined course to travel to another planetary body.


Bachrach

Professor Goddard and biographical record in "American Men of Science"

Some of those who admit the possibility of a rocket ship traveling, say, to the moon, assert that no return for the ship is possible—for fuel can not be carried for the round trip. Even if this were true, in the light of fuels now available, that would not of itself place a barrier against an interplanetary journey. Granted that funds for the construction of rockets were available, and that a trip to the moon were contemplated, perhaps a dozen small rockets could first be dispatched, each carrying, in addition to the fuel and supplies for its own trip to the moon, a small additional amount. These rockets would all land in the same lunar neighborhood and when the main rocket arrived it would gather the surplus fuels from the small rockets, for its return trip. The small rockets would remain on the moon or else be salvaged.

FREQUENTLY I am asked, "Granting that a trip to the moon is possible: how then can your space travelers exist on that airless, waterless globe; and how can they return to earth?" These questions are fair, and they demand an answer. However, I can point out only the scientific principles; I can not give an engineering blueprint of the answer, for the particular answer must depend, very largely, on discoveries which must first be made on the nature of extra-terrestrial space, and on further research of the moon. The 200-inch telescope now being constructed may, for example, upset our present notions of the nature of the lunar surface.

For existence on the moon, where there is no air—no pressure to equalize that which our bodies are accustomed to on earth, namely, 14.7 pounds per square inch, and no water vapor—artificial equipment obviously is neces-

Fritz von Opel, the German manufacturer and rocket car experimenter, with Frau von Opel

sary. A form of equipment which would provide all three necessities could very well be a rigid diving suit used by deep-sea divers. The weight of the equipment need not be a handicap; in fact it would be an advantage. Since the gravitational pull on the moon's surface is only one sixth that on the earth's surface, a terrestrial being must have some extra weight to ballast himself on the moon in order to walk or move about without discomfort. A suit made of almost any metal, flexible enough to permit bodily movement and provide an equalizing pressure of 14.7 pounds per square inch against the body, might serve. Artificial air with the proper amount of oxygen would be kept in the space flyer and a form of gas mask in the space suit would be filled with it each day.

I have not counted on replenishment of supplies from the moon but, even assuming that there is no pure oxygen or water on it, there is no reason to assume that salts and mineral rocks can not be broken down to provide oxygen and water. The first trips made to the moon will be merely journeys to provide a quick inspection of lunar conditions, with a rapid return to earth. Only after these conditions have been determined in full can a more extended stay, to reap some of the advantages of interplanetary travel, be made.

Another serious obstacle to existence on the moon is the extreme temperatures prevailing. During the lunar day, which lasts two weeks, a space traveler would be exposed to the full solar heat; and during the two-week lunar night he would have to exist at an extremely low temperature.

If the space suit were double walled, with a vacuum between the walls, body temperature might be preserved to a certain extent. The space ship also should be double walled and provide its own heating system for the long cold nights. For relief from the heat of the sun, advantage might be taken of the shade offered by the deep lunar craters, or a migration to the "terminator" of the lunar surface where the sun was just above the horizon. Here, a more or less equable temperature should prevail and, by keeping step with the comparatively slow movement of the moon in relation to the sun, the space ship could be kept continually near the dividing line between day and night.

For the return to earth, one method already has been pointed out: sending a number of auxiliary rockets each carrying a surplus of fuel for the return journey of the main rocket. The amount of fuel necessary, of course, would be much less than for the journey to the moon, for on the return, on leaving the moon, the space ship need combat a gravitational pull only one sixth of that of the earth. Furthermore, the earth itself would begin to aid the space ship when it had traveled only about 24,000 miles from the moon. Thus, the escape from the moon to the earth would need considerably less than one fiftieth of the power required for the earth-moon trip. The return trip need not, then, cause serious difficulties, for if no space ship can be designed that can carry one fiftieth of its fuel as reserve, a trip to the moon would be sheer suicide in any event.

The answers given here are merely suggestions of the ultimate solutions. It is enough to say that the basic scientific principles involved are sound.

THE application of man's ingenuity, and his use of the manifold resources of nature in extending the power and use of the rocket, has but begun. As the skepticism of the world gradually dissolves and more and more experimenters are attracted to the possibilities of making original contributions to this new art, our control over the rocket should be extended geometrically.

I foresee, being steadily leveled under the assault of determined and far-visioned technicians, the problems of the finding of new and more powerful fuels, the control of these fuels, and the question of the stabilization of the rocket in flight.

If we are not to be appalled by the difficulties in harnessing the giant that slumbers in the rocket, it can open up a new era of our conquest over nature; we must decide whether the game is worth the candle. My own answer is an emphatic "yes!" In any event, the rocket is here to stay. It has a field of usefulness given to no other instrument, and by the intensive exploitation of its usefulness the ultimate conquest of space should prove possible.

nennt man günstigste Geschwindigkeit und hat für sie den Ausdruck:

$$\ln\left(\frac{m_r+m_{aa}}{m_r}\right)=\ln(1+q_0)=$$

$$=\frac{1}{c}\left[\bar{v}_1-\bar{v}_0+2g\left[\left(\frac{c}{g}+\frac{H}{c}\right)\ln\frac{\bar{v}-\frac{2gH}{c}}{\bar{v}_0-\frac{2gH}{c}}-\frac{c}{g}\ln\frac{\bar{v}}{\bar{v}_0}\right]\right] \quad (94)$$

wo bedeuten: $\bar{v}_1$ günstigste Geschwindigkeit am Ende der Antriebsperiode, d. h. wenn $m_a = 0$ und $q_t = 1$, $\bar{v}_0$ günstigste Geschwindigkeit am Anfang des Antriebes (beim Anfang des Fluges wird natürlich $V < \bar{v}_0$), $\bar{v}$ günstigste Geschwindigkeit für eine bestimmte Stelle, H Höhe gleich etwa 7500 m und g = Const. (= 9,81 m/sek²) und die anderen Buchstaben die übliche Bedeutung haben. Dabei können folgende drei Fälle eintreten:

$$\left.\begin{array}{l}\bar{v}_0\ c<2g\sqrt{H}\\ \bar{v}_0\ c=2g\sqrt{H}\\ \bar{v}_0\ c>2g\sqrt{H}\end{array}\right\} \quad (95)$$

From A. B. Scherschevsky, Die Rakete.
C.J.E. Volckmann Nachf. G.m.b.H. Berlin-Charlottenburg

ET POSSIBILITÉ DES VOYAGES INTERPLANETAIRES 51

La pression qui règne en tête est

$$p_m=\frac{M}{S}\frac{d^2H}{dt^2}=\frac{M}{S}A\zeta_0 z_0'^2 e^{-2A(e^{-z}-e^{-z_0})-z} \quad (204)$$

la pression à l'altitude z considérée est

$$p=p_0e^{-z}\ , \quad (205)$$

de telle sorte que le rapport de compression est

$$\frac{p_m}{p}=\frac{M}{Sp_0}A\zeta_0 z_0'^2 e^{-2A(e^{-z}-e^{-z_0})}=\frac{k\cdot\mu_0}{p_0}w_0^2e^{-2A(e^{-z}-e^{-z_0})} \quad (206)$$

or, quand z est très grand, cette valeur se réduit à

$$\frac{p_m}{p}=\frac{k\cdot\mu_0}{p_0}w_0^2 \quad (207)$$

et la température atteinte par ce gaz comprimé instantanément est

$$T=T_{amb}\left[\frac{k\cdot\mu_0}{p_0}w_0^2\right]^{\frac{\gamma-1}{\gamma}} \quad (208)$$

c'est naturellement la formule qui a déjà été trouvée pour le cas général.

From R. Esnault-Pelterie, L'Exploration par Fusees.
La Société Astronomique de France, Paris

Typical pages from foreign technical treatises on rocket flight, showing that physicists, engineers, and mathematicians have given more serious attention to the technical problems involved than many realize. This is especially true of the Germans and French, in whose languages a large literature on the subject exists, and who are ahead of us in rocketry

SCIENTIFIC PROGRESS IN 1930

Alarms—True and False

THE editor frequently is asked to "name the most significant scientific event of the previous year." This he cannot do. Nobody can. True, it is possible, often by following the line of least effort or perhaps, being motivated by some journalistic aim, to name and recompense with a prize *an* event in science which after so short a lapse of time has the outward appearance of being the most outstanding —if only one which has made a big noise in the newspapers. But future historians alone will be in a position to select *the* most significant scientific event of 1930 or any year.

Who, for example, could and would have selected as early as the following winter the most significant scientific event of 1831, Faraday's research on induction? Only many years later was this simple little experiment clearly seen to have been the progenitor of the world's whole 90-billion-dollar electrical industry. How many, on the other hand, if foolhardy enough to engage in this premature picking pastime, would be likely to select discoveries destined later to be regarded as "false alarms"?

Thoughtful persons will not seriously make this attempt.

We publish this month a part of the annual *Science Service* summary of the past year's happenings in the world of science, pointing out however that, if the past provides a criterion, only a fraction of these researches later will turn out to have afforded major contributions to knowledge. As time elapses and a maturer viewpoint thus is gained, we shall endeavor—as we always do—to present carefully weighed accounts of those few scientific discoveries which, after running at least the first gauntlet, are seen to be candidates of major importance.—*The Editor*

Aeronautics

The highest altitude ever reached by man was attained by Lieut. Apollo Soucek, naval flyer, when he climbed to 43,166 feet, more than eight miles.

The difficult east-west crossing of the Atlantic was successfully made by Captain Dieudonné Coste and Maurice Bellonte in the *Question Mark*, flying from Paris to New York in 37 hours, 18 minutes.

An expanding rubber leading edge for airplane wings, called "airplane overshoes," to prevent the formation of ice on the wings, was invented by Dr. William C. Geer, of Cornell University.

Captain Frank M. Hawks took just 12 hours, 25 minutes, 3 seconds to cross the continent from Los Angeles to Valley Stream, Long Island, setting a new record; the time included three stops of 15 minutes each.

The world's largest airplane, the German *DO-X*, made successfully its first long distance flights.

A new refueling endurance flight record was set by Forest O'Brine and Dale Jackson in the *Greater St. Louis* at 647 hours, 28 minutes, 30 seconds.

The Curtis Tanager, with its automatic wing slots and floating ailerons, won the 100,000-dollar prize of the Guggenheim Safe Aircraft Competition.

The world record for duration without refueling was established by two Italian flyers, U. Maddalena and F. Cecconi, at 67 hours and 13 minutes; they also made the record for distance in closed circuit, 5088.27 miles.

Dr. Hugo Junkers completed and put into operation his huge flying wing, a plane carrying more than three tons, with a cruising range of 2000 miles, in which space for engines and passengers, cargo and fuel is made an integral part of the wing.

An unofficial world record for a duration flight in an engineless plane, was made by Jack Barstow at Point Loma in California, when he glided for 15 hours, 13 minutes in a sailplane.

The large British airship *R-101* was destroyed by explosion in a storm in France.

The first attempt to come to earth on a glider launched from an airship, was successful when Lieut. R. S. Barnaby descended from the airship *Los Angeles*.

With a flight from Ireland to the United States, Capt. Charles Kingsford-Smith and crew in the *Southern Cross* completed a trip around the world.

A non-stop flight of 3400 miles from Cardington, England, to Montreal, Canada, was made by the airship, *R-100*.

An unofficial world speed record for airships was set by the *R-100* at 81.5 m.p.h.

Photographs taken at a distance of 270 miles from the subject by Capt. A. W. Stevens in an Army plane set a new record in long distance aerial photography.

The women's altitude record was set by Miss Elinor Smith, 18 years old, at 27,418 feet, more than five miles.

Captain Wolfgang von Gronau and three companions made the first east-west seaplane crossing of the Atlantic by way of Iceland and Greenland.

The first woman's solo flight from England to Australia was accomplished by Miss Amy Johnson.

A world's speed record for women was established by Miss Amelia Earhart at the speed of 181.157 miles per hour.

An 1800-mile air line, from Ft. McMurray near Edmonton, Alberta, to Aklavik on the Arctic Ocean, was put in operation.

Anthropology and Archeology

An elaborate system of canals built by Indian engineers in Arizona about 1200 A.D. was photographed and surveyed by an airplane expedition directed by Neil M. Judd, archeologist of the United States National Museum.

In an almost inaccessible region of the Kuskokwim River, Dr. Ales Hrdlicka, of the Smithsonian Institution, found 3000 living Eskimos belonging to the old, original type, quite unlike the present race of Eskimo.

Evidence that the Maya understood the false perspective was found at Uxmal buildings by the Tulane University Expedition; additional buildings and 19 important date stones were discovered at Uxmal.

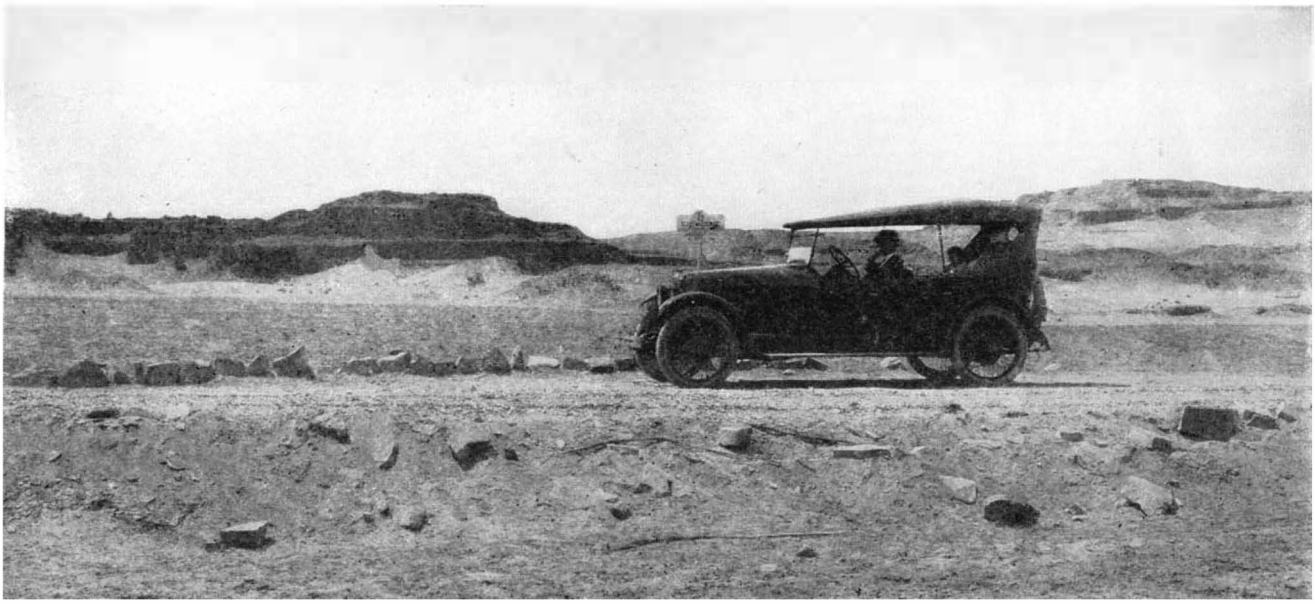
Highly accurate predictions of eclipses of the sun and the moon were made by the Mayan Indians eight centuries before Christ, Dr. Herbert J. Spinden, of the Brooklyn Museum, discovered.

Clearance of ancient ruins in Rome continued, with the removal of modern buildings to display the old buildings to better advantage.

Evidence of 1000 years of Biblical history, from 1600 B.C. to 587 B.C., was found in a single mound at Tell Beit Misrim, in Judah, it was reported by Prof. William F. Albright.

Indian artifacts lying under a layer of ground sloth refuse were found by

(*Please turn to page* 209)



A modern motor car at the ruins of ancient Pachakamak. The temple is 15 miles inland from Lima, Peru

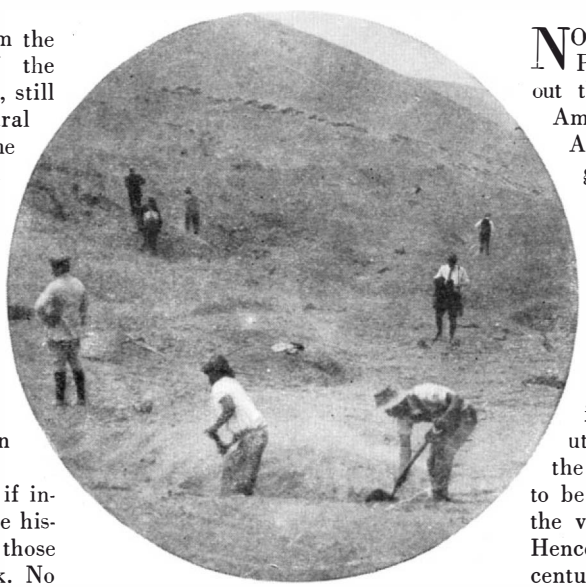
THE MECCA OF ANCIENT AMERICA

By A. HYATT VERRILL

COVERING hundreds of acres of the desert that stretches from the sea to the Andean foothills, bisected by the modern motor highway from Lima, 15 miles distant, to Pisco, are the ruins of the ancient city of Pacha-Kamak. Everywhere are the massive walls of adobe bricks, the crumbling remains of great palaces, storehouses, and public buildings, the cubicles that mark rows of houses, the extensive plazas and ball courts, the public baths, and the shops, shrines, and market-stalls. Everywhere one may trace the once-busy streets, the broad highways, the narrow paved lanes.

A little apart, and isolated from the other ruins, is the temple of the *Mamakunas* or Virgins of the Sun, still well preserved with its lofty central altar, its cells that once housed the sacred virgins, its hallways and stairs, and its oddly Egyptian-like niches within which, in the long-forgotten past, stood magnificent images or idols ablaze with gold and jewels. And, dominating all, covering the summit of an immense artificial hill, is the vast temple of Pachakamak, the supreme god, the Creator, the Almighty of the Incan and pre-Incan races.

No ruins in all South America, if indeed in the New World, hold more historic and romantic interest than those of this holy city of Pachakamak. No one can say when the city was first established, no man even can guess at its age. It may be five thousand, ten thousand years old; but we know that, centuries before the days of the first Inca, Pachakamak was an ancient city; that it was a sacred spot, a holy city, the Mecca of the South American races; and that, from far and near, from points as far distant as Colombia and the Argentine, pilgrims journeyed to this Mecca of ancient America to worship at its temple, to pass their last hours within its sacred precincts, and to be buried in its consecrated ground. So firmly established had its sacred character become, so reverenced its temple and its shrines, that the Incas made no attempt to suppress the ancient rites and religions that were followed at Pachakamak, and instead of forcing the people to adopt the Incan faith and worship *Inti*, the Sun-God, they erected their own Temple-of-the-Sun on a hill adjacent to that of the temple of Pachakamak. Hence the city became a Mecca for the people of the Incan faith as well as for the others, and the immeasurably ancient god of the pre-Incas and *Inti*, the Sun-God, were worshipped side by side.



Mining for mummies near the temple in the great ruined city of Peru

NOT only did the people come to Pachakamak to worship; throughout the length and breadth of South America—even in far distant Central America—the image of the supreme god was credited with working miracles and of curing the crippled and the ill. Men and women barely able to crawl up the temple stairs, or so weak with illness or with injuries that they were carried by others, emerged from the holy presence strong, whole, and well. In addition, the image of the god was believed to utter oracles and prophecies, while the faithful desired nothing more than to be interred in the sacred ground of the vast cemeteries about the temple. Hence it is no wonder that through centuries—thousands of years—the desert sands about Pachakamak should have become a vast necropolis literally

filled with the mummified bodies of the dead, and that the temple and its shrines should have been enriched by the gifts and offerings of pilgrims until it was reputed—and no doubt rightly—to have contained a greater treasure than even the famed Temple-of-the-Sun at Cuzco, the Incan capital. In fact, it was the stories of the wealth of Pachakamak that lured Pizarro to Peru, for tales of its riches in gold, silver and precious stones had spread northward to Panama and beyond.

Façade of the temple. An idol stood on the top of each bastion and the niches below held others. The walls were ten to 80 feet thick

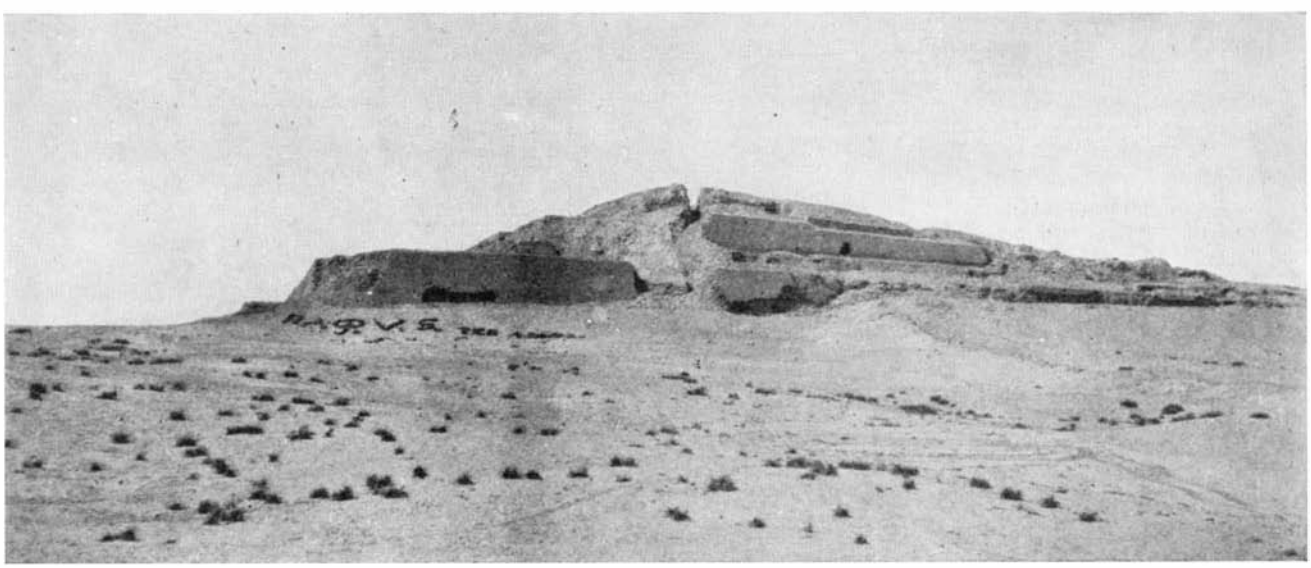
A grand and imposing sight the famous temple must have presented before the days of the conquest. And almost incalculable must have been the time and labor devoted to its construction. The hill upon which it stood, a miniature mountain, was built entirely by hand, of adobe bricks and faced with squared blocks of stone. How many centuries went into the making of this gigantic mound, how many men toiled and labored at it, how many millions of bricks and stones went into its construction, are beyond computation. But the probability is that it was erected gradually, little by little, through countless centuries.

UPWARD from the base—more than two miles in circumference—a flagged stone ramp extended in a spiral. At every turn was a shrine or small temple and a short flight of stone steps that led to the next turn. As the pilgrims and worshippers ascended the huge mound they stopped at each of these spots to pray and make offerings. Everywhere rose the massive stone-faced walls, sloping inward toward their tops, rising in tiers like a modern "zoned" skyscraper, and everywhere covered with red or yellow stucco and elaborate frescoes.

Along the topmost wall bordering the last portion of the ramp, facing the Pacific, was a line of immense stone statues rising above niches in which were smaller images of wood covered with plates of gold. At the very summit of the temple was a huge rectangular level court or plaza surrounded by ornately sculptured walls with niches in which were more than one hundred sacred and symbolic figures gleaming with gold and silver and ablaze with gems.

In the center rose the holy of holies, the most sacred of shrines in all the New World, a small rectangular structure of stuccoed and frescoed stone, containing the idol or image of the almighty Pachakamak, Creator of Heaven and Earth, Ruler of the Universe—a wooden image of gigantic size so laden with gold and precious stones that it was scarcely visible. The timbers and woodwork, as well as the doors to the various shrines, were of hardwood fastened together with gold nails, and the massive portals of Pachakamak's shrine were completely covered with magnificent mosaic work of turquoise, mother-of-pearl, rock crystal, coral and semi-precious stones.

When the ruthless, destructive Spaniards under Hernando Pizarro reached Pachakamak—having been sent from Cajamarca by Pizarro in order to secure the treasures that were to form a portion of Atahualpa's ransom—they found little of value in the temple. Word of their coming had been carried to the city, and the priests of the temple had hurriedly stripped the idols and images of all precious metals and precious stones and secreted them. To be sure, the idols and images were still there, the magnificent mosaic work adorned the doors, and the Dons found a few bits of gold and two or three emeralds that had been dropped by the priests and overlooked. Still the Spaniards did not return empty-handed. Having torn down and destroyed every image, idol, and statue they could find, after erecting a cross upon the temple's top they piously proceeded to torture the priests in an effort to force them to reveal the hiding place of the temple's riches. In this they were partially successful. One priest, unable to withstand the agonies imposed by his inhuman captors, told of a horde of silver in a storehouse



Another view of the temple, showing one of the cuts made by the treasure seekers. A syndicate was formed for the exploitation of the imagined "buried treasure" beneath the great structure and it has been ruthlessly damaged by their acts

(which still stands) and of gold and silver buried near the temple. But though this treasure was in itself a fortune—so great was the quantity of silver that the Dons shod their horses with that metal—yet it is believed to have been but a drop in a bucket as compared with the riches that had been hastily removed and which never have been found. One of the Spaniards also discovered the gold nails in the woodwork, and when the latter had been burned and the precious spikes had been raked from the ashes, they were found to weigh 32,000 ounces—roughly half a million dollars in value.

Remains of a fifteen-foot stairway to the shrine of the temple—sadly damaged by the vandals

From that day Pachakamak was doomed. Deprived of their most venerated deity, with much of their temple and their city wantonly destroyed, and with alien men and an alien faith established in the ancient, holy city, the natives deserted it. As no more pilgrims journeyed over deserts and mountains, through torrid jungles and over arid plains to worship at the desecrated shrine, Pachakamak soon became but a memory of the past, a dead and ruined city tenanted only by the soft-winged burrowing owls, the soaring black vultures, and the desert rats. The thatched roofs of the buildings decayed, fell in and vanished in impalpable dust; the adobe walls, uncared for, exposed to the elements, crumbled and fell apart; the Spaniards tore down the temple walls and used the cut stones to build their tawdry dwellings in the neighboring valley of Lurin, and where once were green, tilled fields and gardens the desert drifted in until today the ruins of the city stand in a glaring, barren waste of sand. Alone with its countless dead the forsaken city lay silent in the shadow of its once magnificent temple, an accusing monument to the ruthless destructiveness of the Spaniards.

BUT even the dead could not be left in peace. Everywhere men dug where, for thousands of years, the bodies of the faithful had been laid to rest, because gold and silver sometimes were buried with the corpses. Ruthlessly the cotton-wrapped mummy-bundles were dragged from the graves, feverishly the cloths, the priceless textiles and the garments were torn from the shrivelled, desiccated bodies and these, torn limb from limb, were scattered about, tossed aside, trodden underfoot. Treasure seekers, archeologists, curio hunters and tourists—all have played their part until there is scarcely a square yard of the sand in or about Pachakamak that has not been turned over. In many places the desert looks as though it had been exposed to shell fire. Everywhere are the great pits, the crater-like depressions where graves have been excavated, and everywhere are the skulls and bones, the human hair, the fragments of textiles, and the broken pottery that have been disinterred and cast aside. In many places the skulls form veritable windrows, and one can scarcely move anywhere without treading at every step upon human remains.

Bad as this was, the worst was yet to come. Up to the past year the great temple upon its artificial hill had remained almost intact. To an extent, time and the elements had left their marks upon it. Most of the frescoes and much of the stucco had disappeared, little of the sculptured stone and adobe remained, and vandals had scribbled their names and had painted advertisements upon it in places. But the walls still stood, solid, massive, impressive. The ramp could still be traced and afforded a pathway to the summit, and one could trace the outlines and details of the shrines and visualize it as it was in its heyday. The stairways were as perfect as on that day when Hernando Pizarro, sword in hand, dashed past the protesting priests and, bursting into the sacred cubicle, with characteristic bigotry hurled the venerated god over the temple walls.

Within the past year this most famous and most historic relic of Peru's ancient civilization, the temple itself, nearly 1800 by 1500 feet in dimensions, has fallen to the insatiable lust for gold that still fills the hearts and minds of many of the descendants of the Spanish conquerors. Some charlatan claimed to possess an ancient document telling of vast treasure buried beneath the temple. A syndicate was formed and a gang of men was put to work tearing it down, undermining its walls, destroying the stone facings and tunneling into the hill itself.

IN vain were the protests of those interested in preserving this magnificent relic of the Incas and pre-Incas. Soon great gaps appeared in the ancient walls, columns and stairways that were ancient when Pompeii was built, fell crashing in clouds of dust down the hillside, and shrines were reduced to piles of débris. It is the greatest pity that the money and the energy expended in this destruction was not devoted to reconstruction, that the government of Peru did not realize the inestimable historic and scientific value of preserving the temple for all time.

The saddest part of this wanton destruction is that the destroyers will have accomplished nothing aside from the destruction of the temple. No gold, no treasure will reward them, for it is beyond the bounds of reason or of credibility to suppose that valuables would have been concealed under the temple in the heart of that stupendous pile of adobe bricks. To have done so would have been practically impossible without leaving obvious traces, and had there been such traces the avaricious and keen-eyed Spaniards would have seen them and would have left no stone upon another until they had unearthed the hidden treasure.

The temple of the Virgins of the Sun at Pachakamak. No one knows who first built the city whose bottom layers, many yards beneath, have not been excavated

Courtesy California Fish and Game Commission

A "stair-case" of pools, known as a fish ladder, around the end of a dam

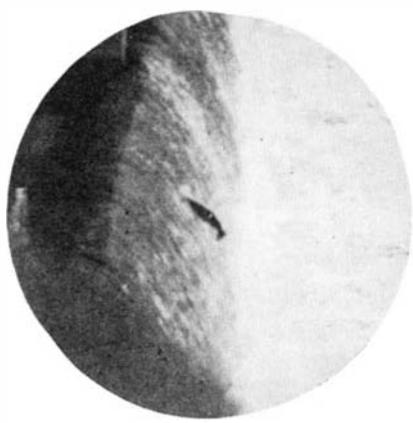
MIGRATING FISH 'CLIMB' FISH LADDERS

By CHARLES W. GEIGER

ONE of the interesting features of hundreds of power and irrigation dams on the rivers and streams of California are the fishways or fish ladders which are built for the purpose of aiding migrating fish on their journey to spawning areas to pass dams in the streams. Fishways, or ladders, generally consist of a series of pools, rising like steps from near the downstream base of a dam to the crest, the water flowing through the pools in an even amount. The migrating fish jump out of the water, clearing the flow of water from one pool upward to the next. Here they usually rest for a short time before attempting to make the jump to the next pool above. These fish often jump to a height of four or five feet and cover a horizontal distance of six to eight feet.

IN the great majority of California streams, the fish ascend the streams during the spawning season to reach their natural and most favorable breeding places. They also move from one part of the stream to another in search of food, as well as to adapt themselves to temperature conditions. During the fall and winter the fish descend to the lower reaches of the large rivers that drain the Sacramento, San Joaquin, Kings, Kern, Kaweah, Tule, Klamath, Eel, and other river basins. If their movements are obstructed by dams, the natural propagation is seriously affected. Their movements to the upper reaches of the streams when the temperature rises are also prevented by dams which do not have fishways.

The work of maintaining efficient fishways over dams becomes more important as the number of dams being built by the hydro plants and irrigationists increases. Maintenance of efficient fishways in California is carried out by the Bureau of Hydraulics of the California Fish and Game Commission. This Bureau, now in charge of Mr. John Spencer, was formed by the Commission in June, 1926. For the first seven months the Bureau of Hydraulics was concerned with fishway and fish screen installations, but early in 1927 pollution control, or prevention of pollution, of public waters was added, and at the present time the Bureau is considered one of the most important departments of the Fish and Game Commission. Fishways are inspected periodically by deputies of the Commission.



Striking photograph illustrating the height a fish can leap over falls

California law states that fish ladders shall be constructed when, in the judgement of the Commission, one is required or, in lieu thereof, a hatchery may be constructed or fry planted. The practical working out of these provisions is that many of the owners of the high dams escape their obligations to the state and do nothing for fish life or its perpetuation, except as the reservoir formed may be of aid. This is brought about due to the fact that fish ladders, as far as present information goes, may be installed on dams only up to about 60 or 70 feet in height; hence dams beyond these heights are not provided with fish ladders, and hatchery construction must be resorted to or fry planted as covered by the law. After the owner of the dam constructs a hatchery it is turned over to the state, and the Commission takes care of its operation and maintenance.

THE highest dam in California over which fish pass by means of the fish ladder, is the San Clemente, which is 70 feet high. The fish ladder built at this dam consists of some 35 concrete pools each pool above the first being about two feet higher than the preceding one. Fish ladders are usually con-

structed of concrete or wood, redwood or pine being used in many instances.

Unless water is to be passed by a dam to maintain fish life below, it is not always necessary to have a fish ladder in continual operation. It is essential, however, that a ladder shall be in operation at all times during fish migrations. Some streams in California are dry in the summer months, yet in the fall, winter, and spring these streams do much to promote fish life, for fish ascend, spawn, and hatch and the fry returns before the stream becomes dry. Dams on such streams require fish ladders as well as do those on streams that flow continually.

A fishway of considerable importance is that of the Anderson-Cottonwood Irrigation District on the Sacramento River at Redding. This dam had formed a barrier to migrating salmon and steelhead for seven years and only a small number of fish had succeeded in passing. A change in the plan came as the result of a harmonious conference, and construction of the fishway followed. Now the migrating salmon and steelhead easily pass upstream. An effective barrier to migrating fish can stop the run up that stream and in a few years make the stream above practically barren of migrating fish. The recent installation of three fishways on dams on coast streams in Mendocino County, opened up a large area which had been closed for many years to spawning fish.

IN all cases of fish ladder construction, an effort is made to have the entrance to the ladder as close to the base of the dam as possible, picking out the side of the stream that the fish generally use. This is because they sometimes seem to prefer one side of the stream rather than the other. The entrance to the ladder, however, and all pools of the ladder, should be free from any overpour of the dam. The trout will search more thoroughly than the salmon to find the ladder. Therefore if the Commission is designing one for steelhead and other forms of trout they do not have to comply so closely to this principle of locating the entrance close to the base of the dam. Salmon usually come to a dam and do not, generally speaking, drop downstream afterwards; hence the entrance to the fish ladder must be in such a position that it can be readily found.

Courtesy California Fish and Game Commission

Rotary fish screen on an irrigation ditch and, at far end of dam, a three-jump fish ladder

The type of fish ladder generally used is the pool type and has been found successful when properly installed. Due consideration must be given to all factors, such as size of pool in proportion to the size of the fish, amount of water in the pool, amount of water passing through, width of port, and height of the jump or difference in elevation between the pools.

The usual sizes for pools are four feet by six feet and six feet by eight feet, although for large fish, such as the larger salmon, pools have been made of considerably larger size. The openings from one pool to another are generally all on line, that is, they are not zigzag, or staggered from one side to another, although departures are made from this straight line whenever it is found necessary. The pools may be in line or may, by taking advantage of natural conditions both for economy and practicability, wind back and forth across the slope but changes of direction are to be avoided as much as possible.

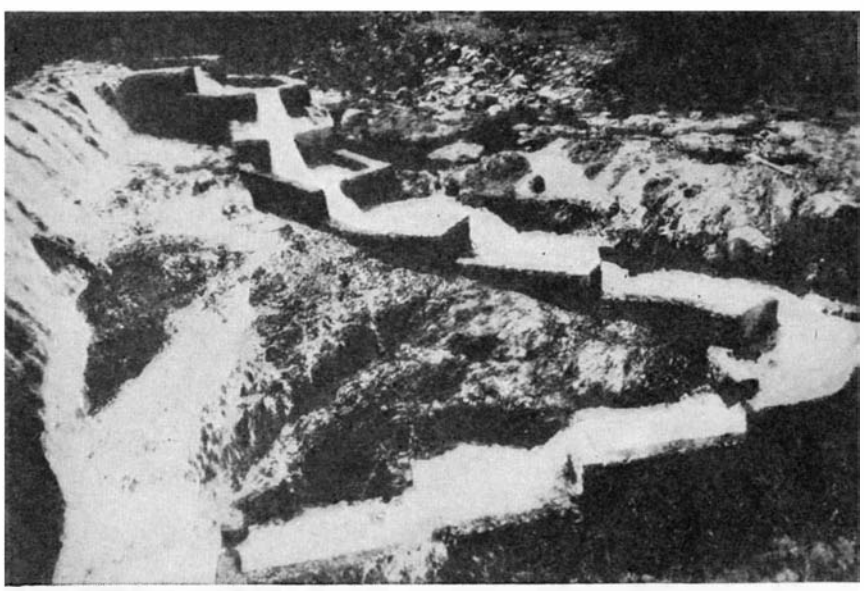
The difference in elevation between the pools or jumps does not run over 2½ feet and decreases to one foot or less. These differences in elevation are determined by the weight of the fish, the amount of water, and often by the obstacles overcome before reaching the ladder. If it is thought that the fish have used considerable energy in the upstream migration, then an effort is made to have the jumps in the ladder as small as possible.

ALL pools are designed to have a depth of at least two feet so that the fish may rest. The largest size of the pools is in the direction of the jump, and the pools are protected either by high walls or by wire mesh so that fish, if they do not jump straight, can not get out of the pool. The ports or openings from one pool to the next are figured to have a lip of not over six inches in width and an effort is made to have the lip similar to the crest of a weir, as it has been found that when lips are wide the results are not as satisfactory.

The amount of water running through a fish ladder is of importance. There can be too much water and also too little. This can be determined by observing the actions of the fish. Too turbulent a condition is not advisable although sufficient water should come through so that fish will be attracted.

Fish screens are as necessary to preserve fish life as fish ladders are necessary to help fish in their upstream migration. If the young salmon in their migration down stream are permitted to pass into irrigation ditches and thence on to the land where they would die, or if they are permitted to pass through the turbines of power plants where they would be killed, the future supply of salmon in that particular river would be destroyed. To prevent such destruction fish screens are used. Experience has shown that the largest canals can be screened without decreasing the flow of water.

The work of fish screen installation



Courtesy California Fish and Game Commission

Sometimes it is necessary to zig-zag the fish ladder up the incline around the end of a dam as shown in this illustration. Overflow from dam shows at the left

in California is carried out under provisions of the Penal Code which, in general, state that when, in the judgment and opinion of the Fish and Game Commission, a fish screen is required to be installed in a ditch, tailrace, or a tunnel, the Commission may order one built, specifying location, type, size, and, in fact, all the details which are necessary for its construction.

Ineffective screening of an irrigation ditch was responsible for this loss in fish life

Two general types of screen installation are used in California, namely, the rotary, self-propelled type, and the stationary, parallel bar type. The rotary type consists of a steel shaft to which there is attached a circular frame which supports mesh of one-half inch by six inches, with boards or paddles set on the inside which furnish the motive power for its rotation. This screen is set in a box of supports for the entire width to be screened. To pass the trash that may come down, or to remove the moss, it is set up from four to eight inches from the bottom of the ditch and this space is protected by a board set on hinges, fastened to the bottom of the ditch and connected by rods to a spring, so that when the pressure of the trash becomes more than the tension of the spring, the board, or draper, will drop down sufficiently to pass this trash and then come back into place. On the top of this board is a section of canvas or rubber belting which lightly touches the wheel as it rotates and thus removes leaves and moss from the rotating screen.

THIS general type is used because it is not patented, and while there are patented screens that may be better, yet it is not policy for the Fish and Game Commission to order in a patented screen unless the diverter of water so desires it.

Among successful fish screens devised by various individual inventors is a self-cleaning fish screen, a recent invention of Francis Cuttle of Riverside, California. Originally designed for the removal of trash from canals it is also an effective fish screen. Its motive power is derived from a current water wheel and as its mechanism is geared to run slowly, it has great power. This enables the machine to remove with ease large objects from the stream in which it operates. Under test with two men on the teeth that lift the trash from the water and with others on the crossbars, the machine has handled the extra weight without any appreciable lowering of its speed. This type meets most of the objections against their installation held by diverters of water.

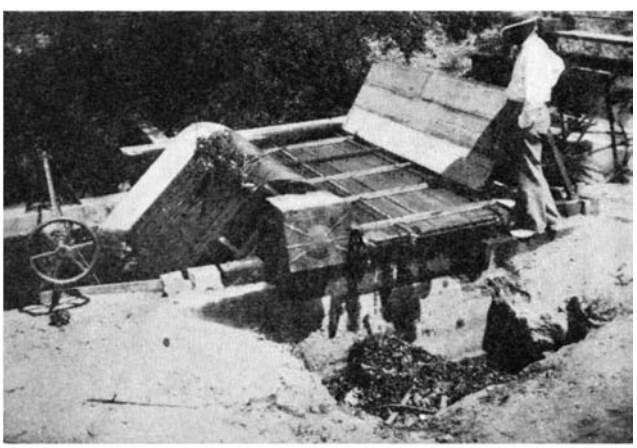
The upright rack for catching the trash consists of steel bars, bent on a curve at the upper end, and held in place to a cross bar at the upper and lower ends. The teeth for removing the trash are attached to a shaft which, in turn, is attached to sprocket chains actuated by a shaft attached to a spur shaft driven by the water wheel. Spacing of the bars may be arranged as required. The trash is deposited on a cross-carrier by the teeth which are then withdrawn by an upset arrangement at each end. The teeth disappear under the bar to reappear at the bottom on the next round. The carrier deposits all debris at one side of the canal.

Naturally the length of the bars and width of rack of the water wheel will vary with different canals, but the gears, teeth, upset devices, and in fact, everything but the length of the bars and width of the water wheel will be of one design. The speed is regulated by the size of the sprocket wheels on the shaft of the water wheel and the spur shaft. Usually this speed is about one complete revolution of the teeth every two minutes but this may be varied at will. As the speed is very slow, the working parts will wear but little.

The usual stationary parallel bar screens used in California are built in sections and placed at an angle to the direction of the flow—the greater the angle the better. These stationary parallel bar screens are a refinement of what is commonly known as a grizzly, or rack. There are variations of this type of screen in that some are made to rotate, and some have a self-cleaning device, such as the Cuttle device just described, the power being furnished either by the water itself or by a motor. For these bars the spacing is seldom less than ½-inch and when placed properly in the stream offer no appreciable interference with the flow of water.

The stationary type of screen is, in general, considerably cheaper to install, in proportion to the area to be screened, than the rotary type, and is more commonly used for the larger ditches, while the rotary screen is considered more suitable for small ditches.

A VERY effective self-cleaning screen rack has been in use at the Empire Gold Mine in California for many years, which can also be used as an effective fish screen. This device was home-made and is shown in one of the accompanying photos. The trash rack, or grizzly, is spaced to stop trash and fish and the automatic trash cleaning device consists of a series of bars which are fastened to sprocket chains which are driven by an undershot water wheel.



Self-cleaning fish screen devised by Mr. Cuttle. Trash on the rack is about to be discharged on to the cross carrier

The effective self-cleaning fish screen which has been in successful operation for years at the Empire Gold Mine

FLYING TO FIND OIL

By MILTON WRIGHT

"FRANK HAWKS and I were flying low—just about a hundred feet up—examining the ground for rock strata that might give a clue to a likely place to sink an oil well, when suddenly we heard a burst of sound that reminded us of the old days in the War. Crack! Crack! Crack! There must have been twenty repeating rifles pumping away at us from the woods. How we longed for a good 112-pound bomb to drop on them. We couldn't charge them, for they were protected by the trees. The only thing for us was to head back for Tampico. We reported the attack, a company of soldiers was sent out to the place we described, and we understand quite a pretty little battle followed with half a dozen bandits and eight or nine soldiers being killed. We didn't see the fight, however; we were more interested in our job of helping to find oil lands."

IT was Lieutenant Robert Alfred Smith speaking, killing time as he waited for the regular weekly get-together of the famous organization of Quiet Birdmen of which he is a member. Smith, who happens to be chief of the Oblique Division of Fairchild Aerial Surveys, has spent more time in the air making oblique pictures than any man who ever flew. He probably also has made more maps from the air than any man living, but he hesitates to admit it. He thinks it just possible that there may be one or two fellows in the army who have done more map making than he has. Altogether he has more than 2000 flying hours to his credit, 1000 of them with a camera.

"But why did these Mexicans start shooting at you?" we wanted to know. "Did they take you for Federal soldiers scouting their position, or did they think you were carrying a payroll they could rob you of?"

"No," he replied. "They were just trying to raise a little hell. Mexican bandits are like that. Just as a small boy will throw a stone at a bird, one of these chaps will throw his rifle butt to his shoulder and blaze away at any airplane that happens to fly within his range. There is nothing personal about it, you know; they merely are trying out their marksmanship with a moving target. Once I was flying over what I thought might be a new oil field, minding my own business, when a man on horseback began firing at me. Fortunately, it was nice open country, with no trees about, so I was able to swing around and aim my plane directly at him. If he hadn't tumbled from his horse and lain flat on the ground in the nick of time, I'd have got him. The few shots he sent after me didn't worry me. He was entitled to them after the fright I had given him."

"But how do you locate oil from the air?" we queried.

Lieutenant Smith has probably made more maps from the air than anyone else in the business today

"With a camera. Of course, I don't pretend to be a geologist; to know the air and the ground is about all that ought to be expected of one small head, without having to know what's under the ground, too. But making maps for oil companies, as we do, we get to know quite a bit about oil-bearing indications.

"Here's the way it works. An oil company has a vast area in which it hopes to strike oil at some point. I go up in a plane, sitting in the back with an aerial camera. The first thing to do is map the ground on a small scale. This we do from a height of about four miles. We fly along one edge of the area to be mapped, taking vertical snapshots as we go. When we reach the end of the track we fly back again a little farther in. Then we double back again, and so on, hour after hour and sometimes day after day, until we have covered every foot of the ground. I've covered as much as two thousand square miles in a day. This was flying at an altitude of 16,000 feet.

"Now we come down and develop our pictures. Each one overlaps the one beside it by 50 percent and the one in front and behind it by 60 percent. We cut the developed prints and put them together, making a mosaic. We look at the prints through a stereoscope.

"You remember the stereoscope that nearly every home used to have for the benefit of the children? You put two views of the same scene in the wire frame at the back and looked through two pieces of glass and saw the view in three dimensions, the trees and rocks and houses standing out in bold relief. That's exactly the way the geologist's stereoscope works. He sees the contours of the whole landscape, here the rocks jutting up, there the tall trees, there a deep ravine or a shallow one. Especially is the geologist interested in river beds, extinct river beds even more than present ones, and in hill crests.

"WE pick out a certain sector that seems most likely and map that on a larger scale. Then we go over the larger maps and the geologist goes in with ground guides to look for suitable outcroppings. The geologist notes the slope downward of the rock strata here and its upward slope farther along. By skillful calculation he estimates where the crown or lowest point is. If there is a pool of oil to be found, it will be in the vicinity of the crown. The spot determined, down goes the boring and up comes the oil—maybe. Sometimes she gushes only salt water."

"How much oil land can you show with one exposure of your camera?"

"As much as you want. It depends upon how high you fly. Suppose you want a map on a scale of 800 feet to the inch, and the lens of your camera is 12 inches from the negative. You multiply 800 by 12 and get 9600. That's the height you fly at—9600 feet. Simple, isn't it? Just multiply the scale you want by the distance from lens to film and you get the height you have to fly."

"How frequently do you have to snap your pictures?"

"That's something you can't calculate until you are up. It depends upon both the height and the wind velocity. Generally we use a view finder to determine how much we are drifting. Flying at a fair rate of speed I should say that you would have to expose your film about every thirty seconds or so. But the wind has a lot to do with it. I have found

myself flying with all the power I had directly in the teeth of the wind and actually drifting backwards. This meant that the wind was blowing against me at a speed of well over a hundred miles an hour."

Getting into his present work was more or less of an accident with Smith. He served with the Royal Flying Corps in France until 1917. In 1918 he served as army instructor in the British Isles, specializing in air photography. When the war was over he was sent to Camp Borden to teach in the Royal Canadian Air Force. Completing his tour of duty in 1922, he started back to England, but stopped off in New York to see the sights. By way of paying a social call, he dropped in at the office of Fairchild Aerial Surveys.

"YOU'RE just the man we're looking for," they cried, welcoming him with open arms. "We're commissioned to make a map of the city of Newark. Stay over a few days and do it for us."

"That's the way it started," Smith told us. "When I had the Newark job finished there was a big tract of oil land to be surveyed. It would only be a week or so. Then there were some mining properties in the northwest. And so it has been going. What with one flying job crowding on the heels of another, I found myself flying every day and I haven't made that trip to England yet. This flying business certainly keeps a man busy. When Commander Byrd was making his plans for the South Pole expedition, I completed arrangements to go with him to do all the air photography. There was so much work to be done up here in North America, however, surveying oil lands, timber tracts, mining properties, real estate developments and what not, that I had to call it off."

"Do oil companies use planes to any great extent?" we asked.

"Sure. They use planes not only to locate the place to drill and to take in supplies while construction work is going on, but after the wells are in operation they transport the payrolls by air. A large part of the work of the Compania Mexicana de Aviacion, for example, is done for the oil companies. The payroll boys often have some hard flying to do. To get to Mexico City, for illustration, you have to fly over an eleven thousand foot mountain range. Generally, I've had to climb up through the clouds to get there. The payroll is usually delivered by dropping the sack containing it in a marked circle on the ground; thus the pilot does not have to land. One time one of the military guards at a camp tried to catch the sack. He was of no more use to the army for three months.

"There is an element of danger, too, in carrying payrolls of oil companies in Mexico. One day one of the pilots flying to a camp with the payroll saw the circle on the ground and a group of armed men standing about. He was going to land, for his engine wasn't running as smoothly as he could wish, when one of the men took a shot at him. He swooped up again and streaked back to Tampico. A group of bandits had driven off the soldiers and were waiting for the payroll. That happens every once in a while.

"Such things, of course, don't occur every day. What bothers us more than anything else in oil development work are clouds and winds. To make a survey on a large scale you have to fly pretty high. It is a fact not generally known that no matter how hard the wind is blowing down near the ground, it is always blowing west above 15,000 feet, and it blows hard; sometimes its speed is over a hundred miles an hour.

Copyright Fairchild Aerial Camera Corp.

The stereoscope supplies the "third dimension," bringing out contours

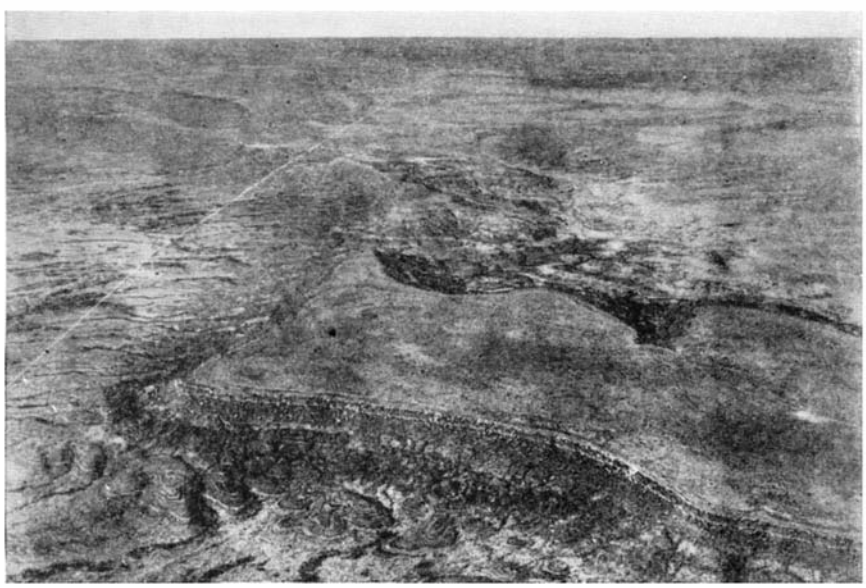
"The only days we can make surveys are days when cumulus clouds—those high, piled up, puffy ones—are not in the air. Cumulus clouds float along at a height of 5000 feet. Sometimes you can see thunder storms rising up from the clouds to a height of 13,000 or 14,000 feet. At such a time you weave your way in and out between the storms. Such storms, you know, don't start operations until they are 13,000 to 15,000 feet up.

"In surveys we have two kinds of difficulty resulting from cumulus clouds. The clouds pass between your ship and the ground when you are making large scale maps, and, of course, you can't see through the clouds. On the other hand, when you are making oblique pictures the clouds cast shadows on the ground that show up in your pictures and are likely to obscure the very rock formation you are most anxious to study.

"CLOUDS and wind, however, in spite of the trouble they sometimes cause us, are very helpful indeed. They tell us just what conditions to expect in the air. We know that a wind from the northwest will bring a fine day, generally with the cumulus clouds that mean ideal survey weather—after they have cleared. A wind from the north will bring a fine day, generally without clouds. A wind from the southwest will bring thunder storms with cumulus clouds, especially in the summer time. Winds from the east usually bring rain in most parts of the United States."

"And where do you get your biggest thrill in all this survey work?"

"The biggest thrill lies in getting a job well done. You fly over an area that is practically unknown. This incident or that comes up, but your mind is set on getting an accurate picture of the terrain that will show you oil indications. You develop your prints and piece them together. You see promising rock strata. There is your thrill."



An aerial view of typical oil country. The outcroppings that show encourage the geologist to study farther. A boring is being made in the lower right corner

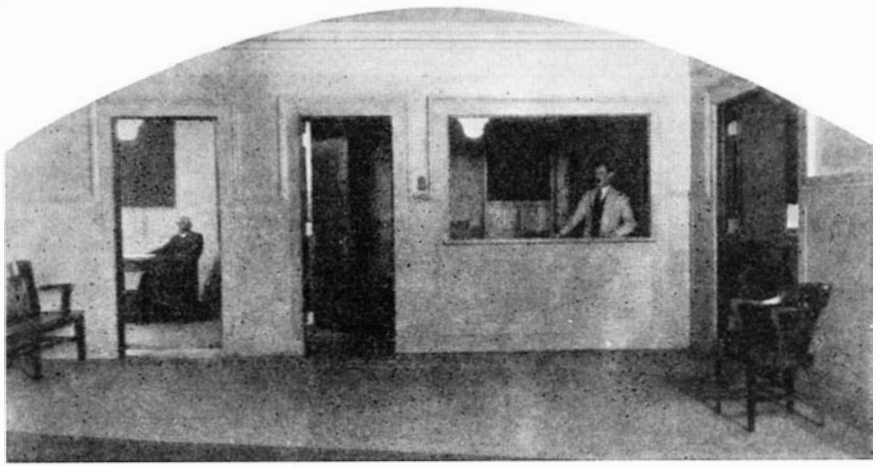
SAFEGUARDING SOCIETY

By ALBERT A. HOPKINS

BACK of the orderly processes of law as we generally know them, stands an agency more powerful than this law, though it is a part thereof. Be a man politically powerful, wealthy, of highest social standing or be he a poor bum in the street, if he dies under suspicious or not readily explainable circumstances, the coroner must be notified before the body can be touched. In this particular the coroner has authority over every other branch of civic government. If the situation warrants it, the body is removed to the morgue, the protective features and social importance of which are so little understood or, as is often the case, so greatly misunderstood.

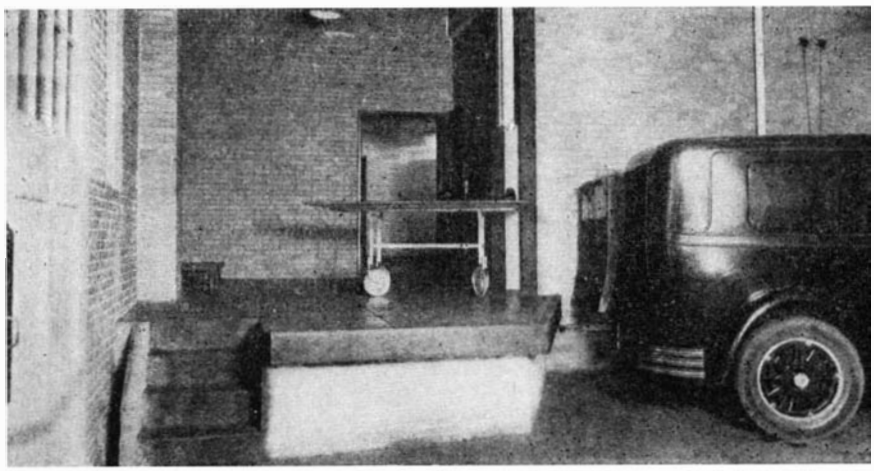
The coroner's office is an ancient one; in olden times the one holding it was a local agent of the king and had many duties to perform other than those relating to deaths. Now, however, with the progress of civilization the problems of sudden death have become complicated and it requires many of the resources of science to help solve them. It is to the interest of the family as well as to the state that a reasonable investigation of death is made where there may be involved a question of reputation, of property, of insurance, of personal satisfaction. In many cases there are in the offing suspicions of crime.

The writer recently paid a visit to Philadelphia, Pennsylvania, to see the remarkable work done by Dr. W. S. Wadsworth, who is the author of the standard work on post mortems, and who is an authority on the construction of morgues. Now at last he has been able to build a structure that embodies ideas gained through years of experience. Asked as to "why a morgue?"

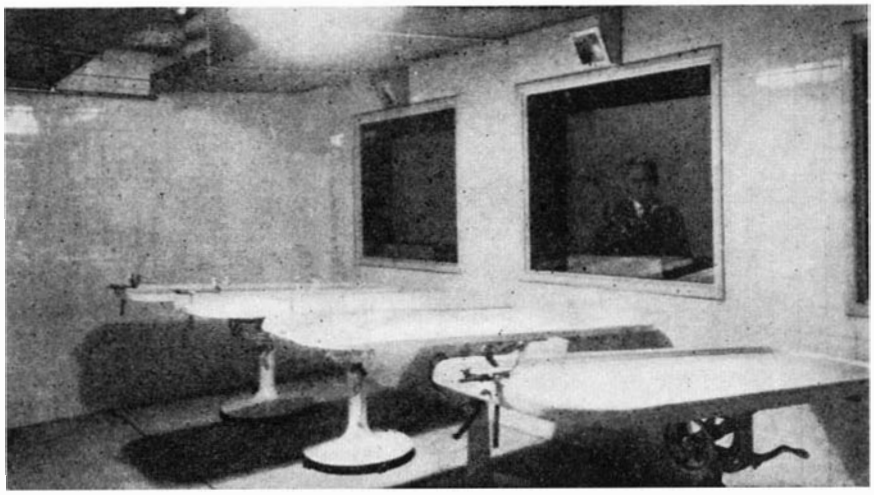


Above: **This looks more like a hotel office than the entrance to a morgue**

Right: **The person is transferred, in private, from the police wagon to truck**



The enclosed yard is like a garage and can accommodate many vehicles



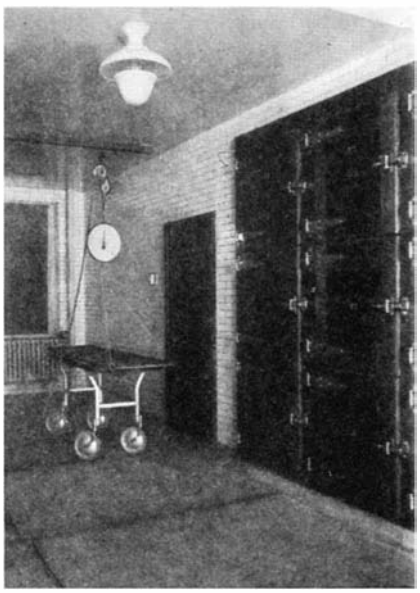
Where the public can view unknown persons who rest on inclined slabs in a refrigerated chamber. Only interested persons may gain access to this room

Dr. Wadsworth responded as follows:

"In every large city there are many sudden deaths. A limited number of these are clear cases of collapse of a vital organ—most often the heart—but some are not clear at the time and may not become so after a careful study of the person's past. The rapid increase of death by street traffic has greatly enlarged the number of investigations. Travelers form a considerable part of this problem. Of course, many cases are rushed to the hospitals but few of these have facilities or personnel for what follows. Some cases can be cleared up very quickly; but where the persons are unknown, or strangers, or where the conditions must be studied to see whether there are any grounds for suspicion, or where a crime is evident, there must be a delay and most large cities have found it not only desirable but necessary to provide a centrally located place for the reception and care of such cases.

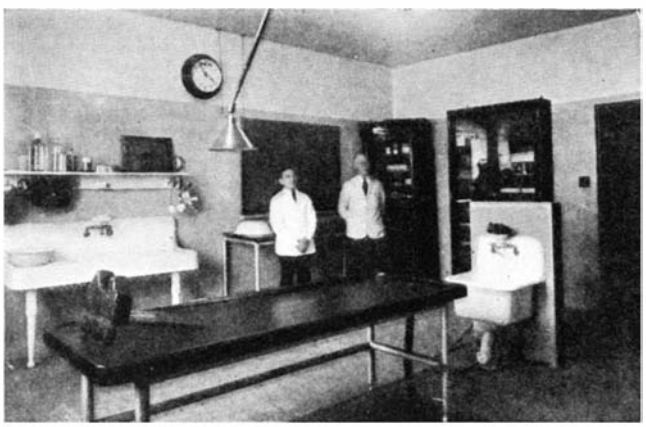
"These places are generally called 'morgues.' The term is somewhat harsh in sound and has gathered to itself an unsavory reputation. The time is well within the memory of those living when there was hardly a respectable morgue in the country. Indeed, hospital mortuaries and the average undertaker's quarters were equally bad, but these showed improvement before any could be noted in the municipal establishments. It has been only within the last few years that the large cities have awakened to the necessity of providing suitable establishments for this work. This awakening has spread rapidly. While Philadelphia was not the first in the field, the machinery was started some years ago and the preparation of plans and the construction occupied several years. So much care was exercised throughout that we deem the result of general interest. Before developing the plan certain ideals were outlined. Every case was to be treated in such a way that the nearest friend and closest relative would have no added pain."

Above: **Showing receiving method of transfer from the ward carriage to the crypts. Note the metal trays on floor.** *Right:* **Crypts and scale**

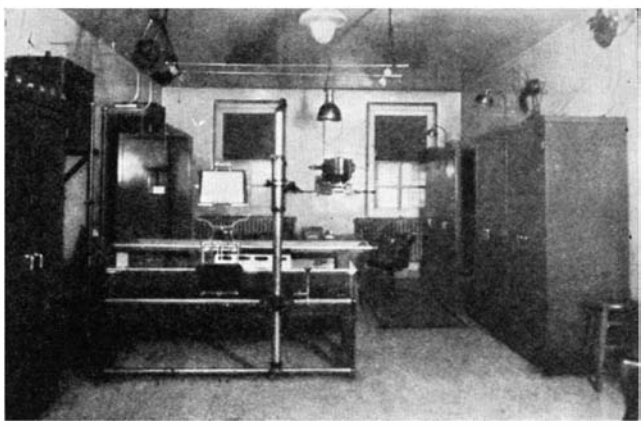


The "zero room" is separated from the crypts by an isolating air lock

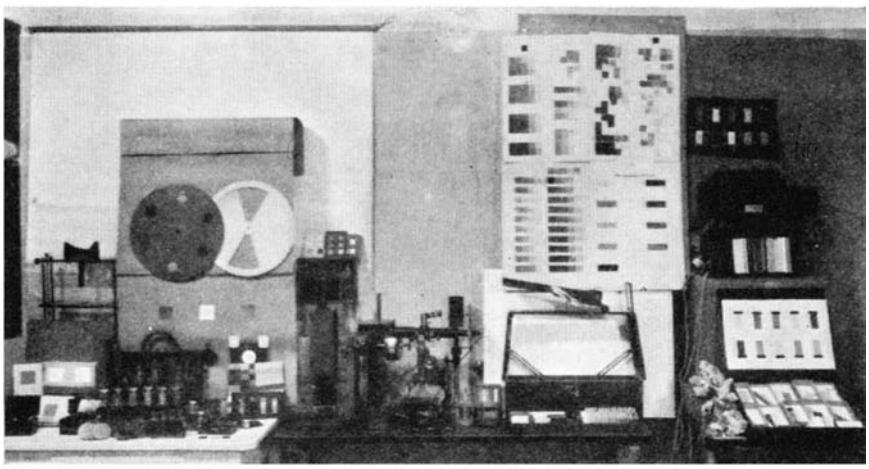
THERE is nothing about the Philadelphia morgue to suggest its purpose; it might well be a building devoted to any welfare purposes. The visitor enters the door, and finds himself in a room somewhat resembling the office of a small hotel. Here visitors and those having business to transact make known their desires. The day of the morgue as an attraction for the curious has passed away all over the world. If the visitor's purpose is to identify a friend or relative and no record is on file, the visitor is taken down a hall, which is



Operating rooms are used for post-mortem examinations and investigations. Every room is individually ventilated



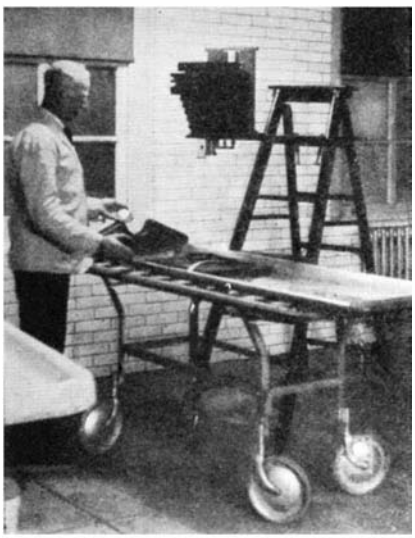
The X-ray room is elaborately equipped to make X-ray pictures which are valuable in many medico-legal cases



The analysis of color is carried on in a special laboratory which contains novel pieces of apparatus and charts. Color of organs is best tested with color screens

really an air-lock, and is permitted to view the unidentified bodies which rest on modern sanitary slabs. This chamber, like all the others for preserving the dead, is refrigerated, there being two refrigerating plants in the basement.

Dr. Wadsworth spent much time in designing the rear block or storage section so that it would be simple, sanitary, cleanable, thoroughly ventilated, well lighted, free from insects and what he calls all sorts of "architectural jokers." The construction of the individual crypts required the co-operation of the manufacturers, contractors, architects, and those in charge of the planning, since no similar structure was available as a model. Directly on arrival in the large yard, cases are placed on wheel stretchers and sent immediately into a cold chamber where ample provision is made for disinfecting and preserving clothing.

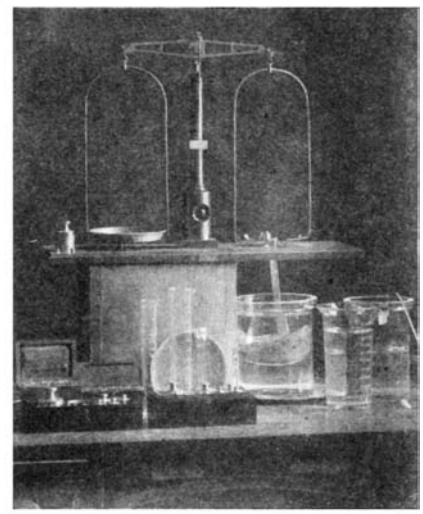


Photographing a subject is rendered easy by the vertical camera

THE ventilation is by individual fans with separate flues in each room. There are 10 of these and they can be put in operation when and where needed. The central hall with skylight ventilator is actually an airlock so that no sound or odor can reach the front portion of the building. Off this open the X-ray and the photographic laboratory where photographs can be made by various arrangements of the camera. There are also operating rooms where important medico-legal work is carried on, for the question of color of an organ or tissue is often very valuable and, with a set of standard colors which is to be found here, any one of these can be accurately analyzed.

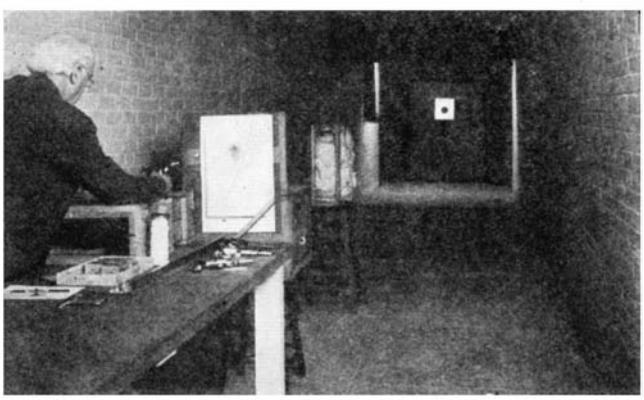
Access to the chemical laboratory is also gained from this hall. When it comes to cases of poisoning, the skilled toxicologist is able to render most valuable aid. Dr. Wadsworth has one of the finest card catalogues in the world relating to cases of poisoning.

In some cities, in New York for example, ballistic work is done under the direction of police officers, but the net result is the same whether done by a coroner's physician or by a detective, assuming the same technical skill in each instance. Dr. Wadsworth's firearms laboratory is magnificently equipped with comparison microscopes, binocular microscopes, and a complete photo-micrographic outfit. In the basement is a range for testing firearms. One of our illustrations shows the doctor himself firing a bullet at a cotton target so that the tell-tale marks will not be effaced. Then the bullet from the suspected gun may be compared in the laboratory with a fatal bullet. Of course the cartridge shell often gives as valuable evidence as does the bullet. (See the SCIENTIFIC AMERICAN for October and December, 1930. *Editor.*)



Finding the specific gravity of organs by weighing in air and water

It has remained for estheticism to place the morgue, conceived and developed as a bulwark of society, on the high plane of our best hospital service, as indeed they rank equally high in importance to the community.



Dr. Wadsworth making revolver tests in the rifle range in basement. Note effects of powder recorded on screen

The ballistic testing room has scientific apparatus of all kinds for use in fatal and test bullet and shell comparison

FROM THE ARCHEOLOGIST'S NOTE BOOK

A "Melian" Terra-cotta Relief

THE Museum has just acquired one of the rare so-called "Melian" terra-cotta reliefs (some are said to have been found at Melos) of the first half of the 5th Century, B.C. It is only 7⅜ inches high and the width of the plinth is practically 11 inches. The subject represents the "Return of Odysseus." To the right is Odysseus, scantily clothed in the guise of a beggar leaning on his stick. He is grasping the arm of his wife Penelope who does not recognize him. She is in the attitude of mourning. Behind her is her son Telemachos, starting back in surprise at the sight of his father. The whole epic of the return of Odysseus to his home is thus brought before us, not in any one particular incident as told in the "Odyssey," but in Greek fashion as an integral whole.

Ink Tablets Afford Plastic Medium

THOSE who prefer Chinese ink rather than the liquid article often feel keen regret at having to spoil the exquisitely engraved sticks or tablets by rubbing them up with water on a slab. While a liquid ink is primarily the problem of the chemist, an ink in solid form becomes, after the manufacturing process has been perfected, a plastic medium of importance to the designer and engraver. The best engravers in China were commissioned to make the molds. Some of the cakes and sticks were not intended to be made into liquid ink and were so marked. The various themes include practically everything that is likely to interest the Chinese scholar. The book of designs of two of the most famous makers are veritable cyclopedias of Chinese art themes. The Museum has just acquired 64 pieces. Some of the examples show palaces which have been destroyed.

Chinese ink tablets afford a plastic medium of use to the designer

The Remodeling of Rome

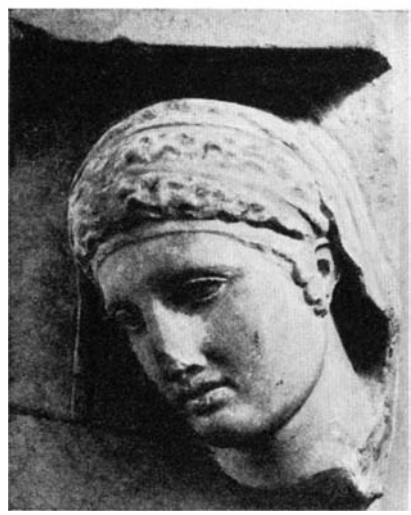
PROBABLY the enthusiastic archeologist would like to see all Rome excavated. He is getting his wish only in spots but these spots are all important. Rome, however, is a forward looking city teeming with life and must have improvements. Fortunately, modern traffic problems have become so acute and the older parts of the city have become so congested and unsanitary that a drastic overhaul was necessary, involving a great system of town planning. New streets are being laid out or broadened, slums have been wiped out, and all these activities have been carried on with due respect for archeological interests. The Mussolini government is greatly to be commended for backing archeological exploration so splendidly in Rome, Pompeii, Herculaneum, and Ostia.

All photos courtesy Metropolitan Museum of Art

A terra-cotta relief, Fifth Century, B.C., shows the return of Odysseus

Head from Greek Gravestone

AT the recent sale of the Lansdowne Collection in London the Metropolitan Museum of Art acquired the famous Lansdowne stele. It is a fragment of a Greek gravestone with the head of a woman and the upper portion of the pediment, the head practically life size and in excellent preservation. It belonged to a great monument of the Phidian school. It teaches us better than many words what we mean by Greek idealism, the serene beauty which, to the Greeks of the 5th Century, B.C., constituted the aim in art. The effect of idealization is obtained not only by the selection of a noble type but by the large, simple modeling. The work is free from the expressive distortions of modern art; the Greeks idealized nature, but did not transgress it. Frequent wettings were required to remove the London soot with which the surface was coated, revealing the warm yellow Pentelic marble. The fragment has had a long history having been mentioned as far back as 1837. It was shown in London in 1904 in the memorable exhibition of Greek art.



A beautiful Greek head of warm yellow Pentelic marble from a gravestone—end of Fifth Century B.C.

An ancient Egyptian "vanity" box has eight compartments for ointment vases and space for the mirror

"LARGEST METEORITE SEEN TO FALL"

By CHARLES CLAYTON WYLIE
Associate Professor of Astronomy, University of Iowa

AT about 4:08 A.M. on the morning of February 17, 1930 a brilliant meteor appeared over southern Indiana, first attracting attention when nearly in the zenith for persons living near Evansville. It fell to the southwest, following approximately the direction of the Ohio River, crossed southeastern Missouri, and at a height of about ten miles, near Paragould, Arkansas, it burst into three main pieces. The velocity of these smaller pieces was checked rapidly by the dense lower atmosphere, and the brightness diminished so that the largest piece became invisible at a height of about five miles. The bursting and disappearance of the meteor, as seen from a distance of 75 miles, was similar to the bursting of a big rocket, and so was the disappearance of the sparks.

Following the disappearance of these "sparks," the larger stones continued their fall as dark bodies, two at least reaching the earth as meteorites. One, whose weight was determined as 820 pounds, went down in clay soil a little more than eight feet, and is the largest meteorite for which the date of fall is known. A second stone, weighing about 80 pounds, was also recovered.

THE brilliancy of the meteor is indicated by the fact that, in the vicinity of St. Louis, Missouri, several persons mistook it for an airplane going down in flames, and a night garage superintendent sent his service man to the park to investigate. At the hour of the fall nearly everyone was asleep, but in the vicinity of Paragould practically all were awakened by the detonations and some were awakened from sound sleep in southern Missouri and eastern Tennessee.

Because of the importance of this meteoric fall, observers of the meteor in the three states, Arkansas, Missouri, and Tennessee, have been personally interviewed by the writer, and information from more distant points has been obtained by correspondence. At the time the meteor appeared, two young men from Beech Grove, Arkansas, were going fishing, driving in a wagon. The landscape lighted up, it seemed brighter than day, and looking up they saw a ball of fire come out of the northeast, pass overhead, and disappear at an altitude of about 20° in the southwest. Their impression was that it had burned out and dropped in the field to their right. The team was accustomed to bright automobile lights, and went on without change of pace for about a hundred yards, when a blast as though from an explosion of dynamite frightened both men and horses. The first sharp explosion, which seemed to come from about where the meteor had disappeared, was followed by a roar as though a great tornado was retreating along the path of the meteor. The noise crashed back to overhead in "no time," and on to the northeast more slowly, fading out in the distance in the direction from which the meteor came. At first, the young men were ready to call off the fishing trip and go back home; but when they had quieted the horses and talked things over they decided to go on.

The author and the hole from which the big meteorite was recovered

At Poplar Bluff, Missouri, the night man in charge of the freight yards had just made up a train, when he noticed a brilliant light, like the headlight of a locomotive, moving in the eastern sky. It crossed to the south, burst into three pieces and disappeared. He examined its trail a moment, then walked over to the telephone booth to report his train. He had called up his party, and was talking, when the report of an explosion startled him. His first thought was that something had crashed into the train he had just made up, with perhaps a boiler explosion, so he rushed out of the phone booth, but when outside realized the noise must have come from the meteor.

It is interesting to compare the facts obtained for this meteor with the observations and conclusions of men of science from other well investigated falls, since several of these points are not well known by the educated public in general.

First, two large meteorites were recovered, and there are indications of a third good-sized stone which was not found. A great meteor may scatter stones over an area ten miles long by three miles wide. Much of this area will normally consist of fields, wooded lands, and, in general, country where people will not often be walking. A meteorite weighing a pound or more will normally make a hole deep enough below the surface of the ground, so that it will be unnoticed unless someone happens to pass almost over it. In a field of grain or hay, or in underbrush it might be passed by, even then. The big Paragould meteorite made a hole more than eight feet deep and scattered clods of clay more than 50 yards, in a pasture, but this crater was not noticed for four weeks. By that time a smaller hole would have been filled up by rains, so that in all probability a person would have passed it by.

UNDOUBTEDLY many stones are noticed, or even picked up, which do not find their way into the hands of scientists. Near Paragould we showed a specimen of meteorite to those whom we interviewed. One farmer told us that he had noticed in his pasture a small stone of that appearance, but he had not picked it up. As he was interviewed more than a month after the fall and remembered only approximately where he had seen it, there was no way of ascertaining whether or not he had really seen a small meteorite. Another farmer told us that immediately after the fall of the meteor he had noticed in his pasture a hole which, from his description, was such as a 50-pound stone might have made in striking. He had looked in it and, as he noticed nothing, filled it up.

In investigating another report of a meteoric fall, we were told that a fresh hole with a stone at the bottom had been located in a field, and that the finders

planned to dig up the stone, but the owner of the land would not permit it. Instead he filled up over the stone, and then plowed the field so that no one could locate the place.

These reports probably do not all refer to authentic meteorites, but undoubtedly they illustrate the fate of many which are genuine.

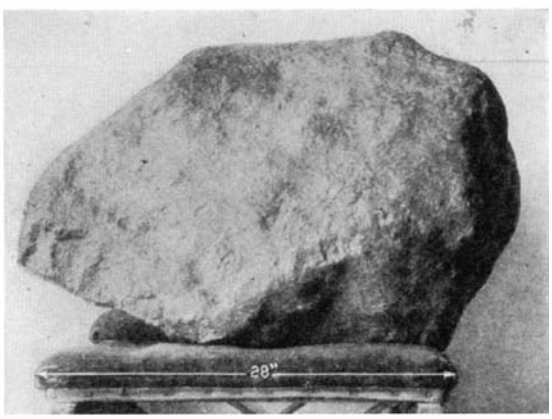
THE ball-of-fire appearance for the Paragould meteor previously mentioned ended at an altitude of five miles and the first meteorite recovered was reported "not hot" when dug up. Von Niessl found 14 miles as the average height of disappearance for 16 meteors from which meteorites were recovered. Since the Paragould meteor furnished us the largest meteorite for which we know the circumstances of fall, we would expect the height of disappearance to be less than that for an average meteoric fall. The assumption of the educated public undoubtedly is that, since a meteor is seen in the upper atmosphere as a ball of fire, any meteorites which fall should also reach the earth as balls of fire. This general impression appeared in a newspaper feature on the Paragould meteor. It was stated that a ball of fire was seen by certain persons to strike the earth in a field, and that when morning came they went to the field and found a hole with a strange looking stone at the bottom. But we know that these people did not see the meteor at all, and from those who did see it we can calculate that it disappeared at a height of five miles.

The direction of fall of the big stone was nearly vertical, the deviation from vertical being indicated by the angle of the hole- about one foot for a hole slightly more than eight feet in depth. The first report on the 80-pound stone was that it had entered the ground at rather a low angle from the southwest. This was the report of the two men who removed the stone from the hole. A competent civil engineer who examined the hole soon after the removal of the stone reported to us that he doubted the accuracy of this first report. From such markings as he could find he suspected that the stone had actually fallen from the northeast, that the dirt had fallen into the hole from the southwest, so that the stone was found to the northeastern side of the hole which the farmer found.

From theoretical considerations it has been computed that whatever the original direction, and whatever the original velocity of a meteor, meteorites near the surface of the earth should fall in an almost vertical direction and with a velocity not greatly in excess of that at which the resistance of the air is balanced by the pull of gravity on the meteorite. It has been observed that stones large enough to make a deep hole fall almost vertically. For example, at Tilden, Illinois, a stone weighing 110 pounds and going down into the earth three feet ten inches deviated six inches from the vertical in that distance. There are several reports of smaller stones striking at a low angle and bouncing a short distance. A seven pound stone falling at Amana was reported to have bounced 30 feet.

In view of the fact that a seemingly very positive report of a stone striking at a low angle was questioned by the first careful investigator examining the hole, it appears that such reports should have complete confirmation before we consider them established. In this instance it appears highly improbable that an 800-pound stone should strike almost vertically, with a slight deviation towards the southwest, and that an 80-pound stone should be thrown back at a low angle toward the northeast. Meteorites contain no explosives and observations indicate that after the bursting the smaller stones fall in a more vertical direction than the larger stones.

The larger stone was found about two miles farther in the direction of travel of the meteor than the smaller stone. This agrees with the facts collected wherever the direction of the travel of the meteor is definitely known. After bursting, the smaller stones fall quite directly to the surface of the earth, while the larger stones can overcome the resistance of the air better and travel a few miles farther before striking the earth.



The largest meteorite seen to fall, the Paragould meteorite, now on exhibit in the Field Museum

The sound of the explosion appeared to come from about the place where the meteor disappeared, and the roar that followed traveled back along the path of the meteor. This effect has also been reported wherever we have the complete information. Meteors travel with a velocity greatly in excess of that of sound and, as the point of bursting is nearer than other parts of the path to those near the point of fall, the explosion is heard first and the roar of the meteor along the more distant portions of its path follows.

The Paragould meteor gave everyone the impression of being very close. At St. Louis, Missouri, as we have said, several thought it was an airplane going down in flames. At Topeka, Kansas, an engineer wired back to Burlingame asking that they look for an airplane which he thought had gone down near that town. At Poplar Bluffs, Missouri, the father of a sick child returning from a doctor's office thought the ball of fire coming out of the east was going to strike him and ran to get out of the way. This is the impression whenever a bright meteor falls. People three or four hundred miles apart will each believe that the meteor has fallen within a mile of their point of observation. For example, several persons in Nebraska thought that the meteor of July 25, 1929, which burst nearly over DeKalb, Illinois, had fallen within a mile of them, and at Williams Bay, Wisconsin, astronomers of long experience felt an impulse to dodge when they saw the brilliant ball.

THE big Paragould meteorite is now on display at the Field Museum in Chicago, as "The largest meteorite seen to fall." We put the museum authorities in touch with the original owner, but it was some time before they succeeded in purchasing the big stone. We were told that it was weighed on good scales as 820 pounds when first removed from the hole. Before it reached the Field Museum a certain amount of it was knocked off at one place, and at that institution its weight was determined as 745 pounds.

Previous to the fall of the Paragould meteor the largest meteorite seen to fall was the 650-pound stone which fell near Knyahinya, Czechoslovakia, on June 9, 1866. The largest stone meteorite known, weighing more than 1200 pounds, fell near Long Island, Kansas. It was broken by striking on a ledge of rock. The date of fall is not known. The largest meteorite now known is an iron one which lies where it fell at Grootfontein, South Africa. (Three photographs of this meteorite were published in SCIENTIFIC AMERICAN, October 1929—*Ed.*) Luyten, of Harvard, visited the locality, and estimated its weight as 50 tons or more. A few other prehistoric masses of iron, accepted as meteoric because of their structure, are much larger than any meteorites for which we know the date and circumstances of fall.

●

A more recent "meteorite," widely noticed in the press, is possibly a fake, and an able authority has promised a discussion of it.—The Editor.

The segregation pool in the core trench of the dam. Trains dumped their loads of earth down the side banks; and powerful pumps on several scows shot streams of water on this loose material, washed it down, and settled it firmly

THE MAMMOTH SALUDA DAM

ON the Saluda River, 10 miles from Columbia, South Carolina, in the Saluda River Hydro-Electric Development is the largest earth dam for electric power purposes in the world. The dam is 208 feet high, nearly a mile and a half long, a quarter of a mile thick at its base and contains 11,000,000 cubic yards of material. The crest is 25 feet wide. It forms a lake which is 41 miles long, 14 miles wide at its widest point, covers approximately 76 square miles of land, and has a shore line of 520 miles. In water holding capacity it is the third largest in the country—93,000,000,000 cubic feet—being surpassed only by the Gouin development, St. Maurice River, Quebec, with a capacity of 160,000,000,000 cubic feet and by Elephant Butte, New Mexico, which has a capacity of 114,911,000,000 cubic feet.

Field work was started in April 1927 and the plant was completed and placed in operation in October, 1930. The installed capacity is 140,000 kilowatts, which will later be increased to 200,000 kilowatts ultimate capacity.

The general scheme of development called for first laying on bed rock, parallel to the river, four penstocks 15 feet in diameter and one concrete arch conduit approximately semi-circular in cross-section, and 48 feet in diameter inside. The penstocks are of plate steel and are completely encased in concrete having a maximum thickness of about four feet. The earth dam was then placed on top of these conduits and they served to take care of the river flow during construction. As the dam progressed and the penstocks were no longer needed for the above purpose, work on the power house was started and the pipes extended to connect with the turbines. The 48-foot arch conduit was continued in use as a by-pass for the water, when necessary, until the work reached a stage where surplus flow could be passed over the regular spillway. This spillway is not a part of the dam proper, but is located on the south bank on bed rock and discharges into an adjoining creek bed.

FOUR concrete intake towers with steel reinforcing, each 30 feet in diameter and 223 feet high, serve the penstocks. A fifth tower, 60 feet outside diameter and 223 feet high, serves the concrete arch conduit and provides for two additional steel penstocks.

At the bottom of each of the smaller intake towers, on the upstream side, are installed trash racks 75 feet high. Inside the racks on the center line of the tower are a pair of Broome roller gates for cutting off the flow of water to the penstock. Each pair of gates is operated by a 234-ton hoist, capable of lifting them with the pressure unbalanced, although as a precaution, a by-pass has been provided for first filling the penstock. The hoist is installed in a brick building on top of the tower.

In the larger tower, which is designed to serve two future penstocks, six gates of similar construction have been placed in openings around its periphery about 100 feet above the base of the tower.

The trash racks around this tower extend upwards 70 feet from the bottom of the gates. Each gate is operated by a 40-ton hoist connected electrically to the hoist diametrically opposite to it.

All the gates can be operated from the power house through remote control. Access to the hoists is by means of a passenger cableway several hundred feet long from the dam to the large tower.

The dam was built in three sections. The upstream and downstream sections were first built across the river bed and valley, like two parallel dams, from hill to hill, a distance of about 1000 feet, then raised until they were about 75 feet high and widened until within about 500 feet of each other. The area between them was then stripped of all sod and loam, and all loose material was removed from the exposed river bed. A core trench was next excavated midway between the two fills and parallel to them about 50 feet wide and 10 feet down to ledge rock or to other impervious material.

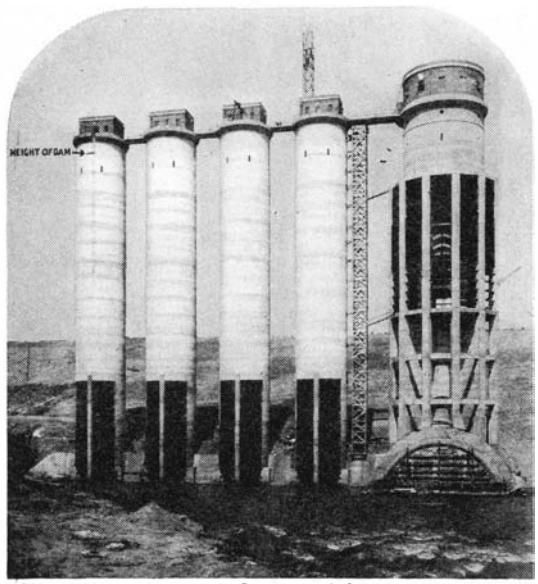
At this stage, the area of the basin between the two fills was pumped full of water to a maximum depth of 25 to 30 feet. The pool so created was known as the "segregation pool." This pool was thereafter maintained by pumping in enough water to take care of evaporation and seepage. On the pool were launched five scows, on each of which was mounted pumping equipment for taking water from the pool to supply a

giant nozzle or monitor, discharging 750 gallons of water per minute at a velocity of 125 feet per second. The streams from these monitors were directed against the banks of the earth fills, washing down the fine material into the pool, where it was deposited to form a dense heart or core for the dam. The work was carried out in such a manner that the middle sixth of the completed dam is composed of densely compacted material, of which at least 65 percent would pass a 100 mesh-per-inch screen.

As the bottom of the pool filled up with fine material the outer earth fills were raised by dumping additional loose earth, the space between these fills narrowing as they went higher, so that the general outline of the section of the completed dam was followed. When within 30 feet of the top these sluicing operations stopped as the pool became too small for the operations.

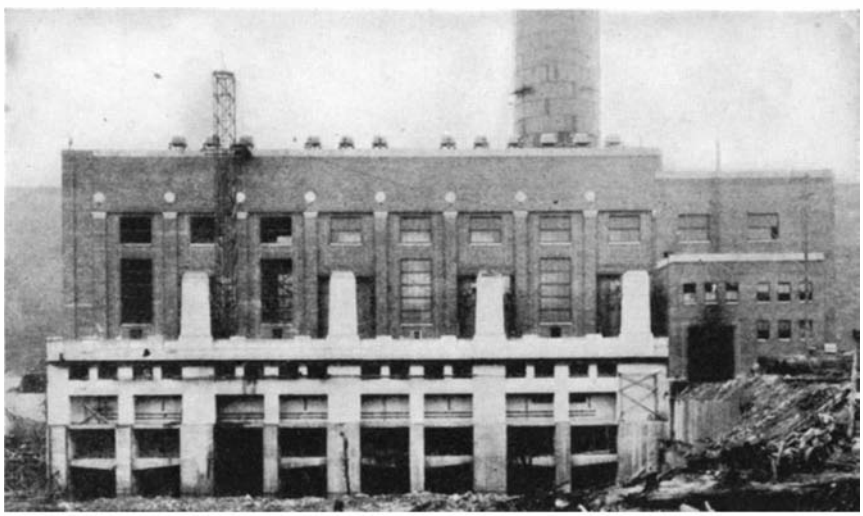
The next section of 10 feet was built by dumping selected materials into the pool. The last 20 feet was built by consolidating selected materials by wetting and rolling, as was also that portion of the core that extended more than 110 feet about the original ground. The maximum width of the core is approximately 350 feet.

The upstream face of the dam from the crest downwards 67 feet was covered with rip-rap varying uniformly in thickness normal to the face of the dam, from one foot at the lower edge to two feet at the top. This rip-rap was composed of either one-man stone or gravel, or a combination of both. On the downstream face of the dam there was planted 100 acres of Bermuda grass to protect the face against future erosion.

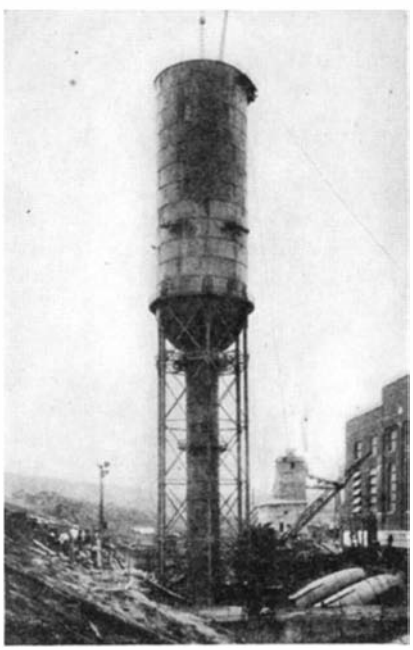


Photographs courtesy W. S. Barstow and Company, Inc.

The four concrete towers that serve the penstocks, and the larger one for the arch conduit



The tailrace of the Saluda power plant shortly before its completion



One of the surge tanks which make possible speed regulation of units

A spillway, equipped with four Tainter gates, each 37 feet 6 inches wide and 25 feet high, was placed across a gully 500 feet from the south side of the dam. The discharge from the spillway enters the river channel about three quarters of a mile below the power house. The spillway can take care of 150,000 cubic feet per second. Under extreme flood conditions the level of the lake will rise no higher than to within seven feet of the crest of the dam.

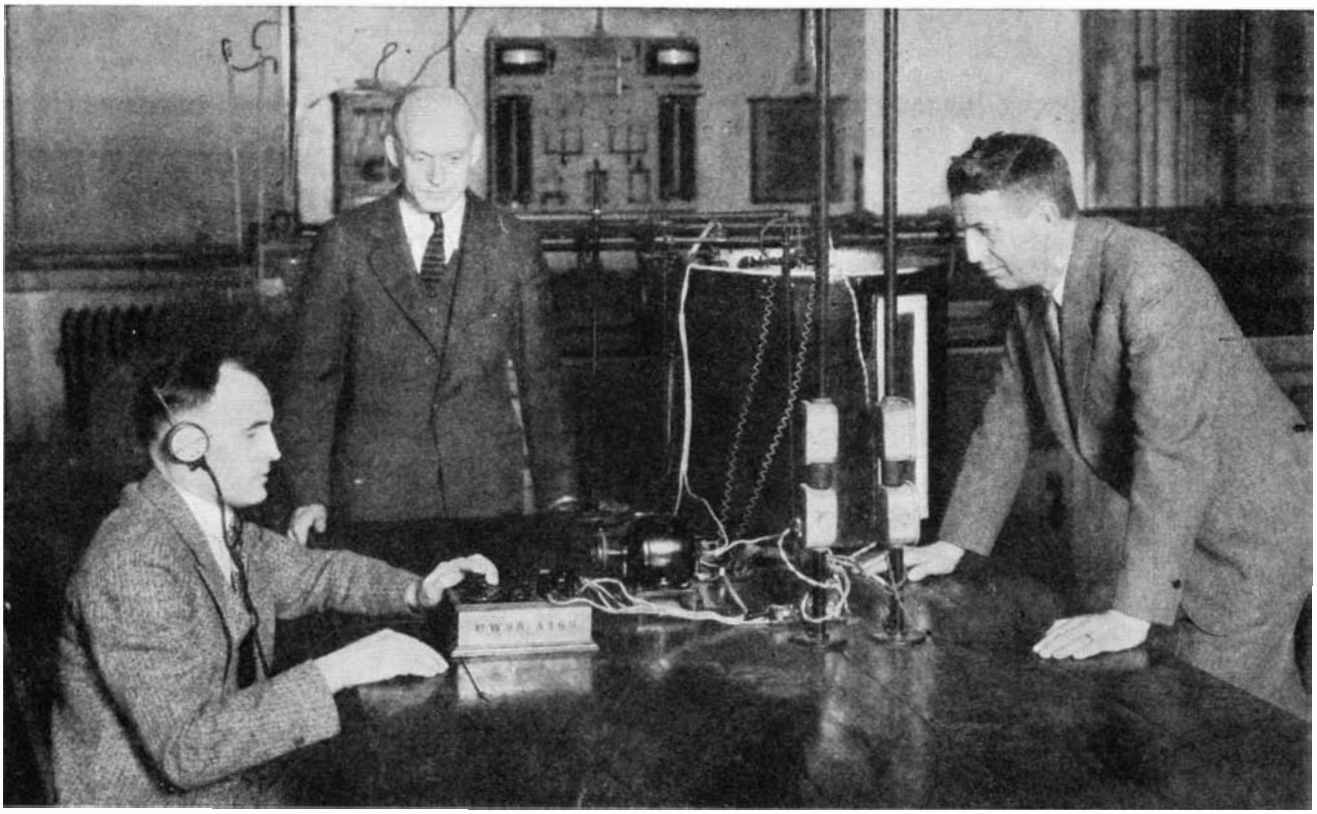
Two surge tanks, 38 feet in diameter and 219 feet in overall height, each having a capacity of about 800,000 gallons of water were erected adjoining the power station to enable speed regulation to be maintained on two of the units. The other two units will not be equipped with surge tanks unless experience shows them to be required.

The penstocks connect to 16-foot diameter, motor operated, butterfly valves at the power house. Each valve has a 24 inch by-pass pipe and motor-operated gate valve which will be used to equalize the pressures on the two sides of the butterfly valve before opening it.

THE turbines are of the vertical shaft, Francis type, each developing 55,650 horsepower at full gate at 180 feet net head rotating at 138.5 revolutions per minute. The scroll cases are of plate steel, and the draft tube is an elbow type tube, with a long horizontal. Each generator has a capacity of 40,625 kilowatts at 0.8 power factor, is wound for 13,800 volts, 3 phase, 60 cycle current, and is equipped with a 250-kilowatt direct-connected exciter and a 35-kilowatt pilot exciter. The generators are of the single bearing, overhung rotor type, having a thrust and steady bearing in the same oil pot beneath the rotor. This construction enables a rotor to be removed and gives access to the windings without disturbing the thrust bearing. It also keeps all oil beneath the rotor and precludes the possibility of leaking oil being thrown into the windings.

Provision has been made for testing the units by the salt velocity method, by piezometers, manometers, and in accordance with the Winter patents. In the first named, salt will be introduced at the intake, and the electrodes are situated between the butterfly valve and the scroll case. The piezometer taps are near the entrance to the scroll cases. This equipment will furnish a means of determining flow of water and losses in penstocks.

The Saluda River Development was built by W. S. Barstow and Company, for the Lexington Water Power Company.



The inventors of the new electrical test which measures the hardiness of plants and helps reduce winter crop losses. From left to right: S. T. Dexter, W. E. Tottingham, and L. F. Graber. This test may have great economic significance

A NEW ADVANCE IN FOOD PRODUCTION

By RENSSELAER SILL

SEARCHING for a way of measuring the ability of plants to withstand the hazards of winter, three Wisconsin scientists have perfected an electrical method for testing hardiness that promises to be of considerable value to agriculture and to unlock research fields only touched upon in the past. The economic importance of such a discovery to American agriculture becomes obvious when it is realized that the hardiness of plants can now be tested with their method in a few minutes, and that severe losses caused by the winter-killing of crops can be reduced.

In the past the ability of plants to resist winter weather was measured simply by planting them in plots and observing how they withstood low temperatures. Naturally, this method required several years. It also slowed up the determination of hardiness, and lengthened out by perhaps three or four years the testing of new varieties of alfalfa, clover, corn, grains, and so on. Perhaps, in the average case, the first winter plants were under observation happened to be exceptionally mild, and the second year extremely severe.

This resulted, of course, in killing all varieties. Then the only recourse would be to re-seed the test plots and start all over again. It was only good luck if the first few winters happened to be of the right severity for experimental purposes, and even then there always was the danger that other factors beside low temperatures might have been partly responsible for winter injury.

THEN, too, with the old method of testing it was almost impossible to discover the precise temperature the plants could withstand with profit to the farmer. It was exceedingly difficult to uncover answers to such questions as the following: Precisely what is the effect of the soil upon winter-killing? How does the storage of food reserves in the roots of plants help them to conquer winter dangers? What provisions does nature make for protecting her plant life during periods of severe cold? Does cloudy weather during the late summer affect the hardiness of plants? A number of other questions of keen interest to farmers and men of science required answers.

Although the new method for testing the hardiness of plants has not answered all these questions, it has succeeded in opening up an angle of approach to their solution. With this method, men of science actually can control the temperature to which the experimental plants are subjected, can measure accurately the effect of low temperatures on different kinds of plants, and can test the hardiness of individual plants in such a way that they will not be destroyed and thus can be used for plant breeding work if desirable.

Like many other discoveries that have helped put farming on a scientific basis and have aided in insuring the world an adequate food supply, the recently discovered method for determining the hardiness of plants is marked by its simplicity. The Babcock test for butterfat, which virtually revolutionized the dairy industry and made it possible to conduct tests on the production of individual cows; the tests for determining the lime and phosphorus requirements of the soil; and the various tests for

some of the plant and animal diseases —these likewise are of outstanding simplicity.

Scientific discoveries, regardless of how evident they may seem and how simple the methods employed in making them may be, do not just happen. So it was with this discovery, which was made in the research laboratories of the University of Wisconsin by S. T. Dexter, a young agricultural chemist, who worked with W. E. Tottingham, another chemist, and L. F. Graber, an agronomist known for his work with alfalfa.

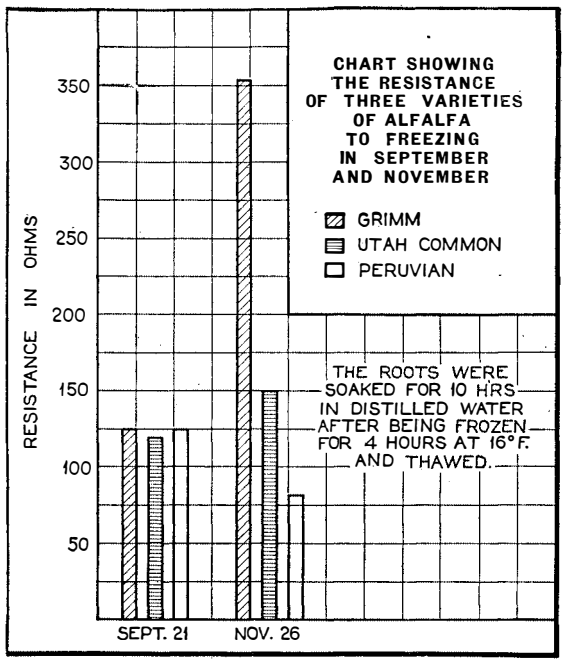
BELIEVING that there must be some chemical differences in plants in the hardened and unhardened condition, these workers set out to determine the precise nature of such differences. The first step was the choice of a suitable plant to work with. Among the many plants that could have been used in the experiment, alfalfa finally was chosen because of its great economic importance to Wisconsin and to American agriculture. Alfalfa is an outstanding hay crop and is a legume. Thus it aids in keeping up the nitrogen supply of the soil. It is rich in minerals and proteins, makes heavy yields, and is an excellent roughage for livestock. Indeed, this crop is responsible to no small extent for the rapid growth of part of the dairy industry and for bringing into cultivation many abandoned farms.

Now it generally is agreed that the injury or killing of plants by cold or any other means involves the disorganization of substances essential for carrying on the life processes. With such disorganization, plant cells lose their capacity to regulate the diffusion of their soluble contents. For example, frozen potatoes upon thawing become soft and mushy, a condition caused by the breaking down of the cells and their contents, which then no longer have the capacity to hold on to the materials which are essential to life. Precisely the same thing happens to plant roots when they are injured by low temperatures.

Upon this basis it was assumed that the extent of plant injury from cold might be related in some way to the loss of stored materials in the roots. These materials include various kinds of minerals which are good conductors of electricity. Such conductors are called electrolytes.

To test the soundness of the hypothesis that the amount of such materials lost from the roots might be related to the extent of frost injury, alfalfa roots of three varieties of known hardiness (Grimm, Utah Common, and Peruvian) were frozen under controlled conditions for various lengths of time and at different stages of growth during the fall months. The diffusion of materials from the roots then was measured.

Through the results of thousands of test plots of these three varieties of alfalfa, scientists already had learned that the Grimm was the hardiest, the Utah Common less able to withstand freezing, and the Peruvian the least hardy. If the experiments checked with these facts laboriously discovered through actual field tests over a long period of time, the new electrical test for hardiness probably would be accurate.



After the roots of the three varieties of alfalfa of known hardiness were frozen they were thawed out and soaked in distilled water for ten hours. Preliminary work had revealed that there was very little diffusion of cell contents after the ten hour period.

The distilled water in which the frozen roots had been soaked was then poured into a conductivity cup, which is simply a small glass cup containing two platinum poles. An electric current was next passed through the liquid. It was found that the roots which were uninjured by freezing did not give up their cell contents and consequently the distilled water offered a high resistance to the current. But the cells of roots which were badly injured by low temperatures gave up salts and thus offered a low resistance because of the electrolytes in the liquid.

By measuring this resistance offered by the water in which the frozen roots of varieties of different degrees of hardiness were soaked, it was relatively simple to determine whether or not the amount of materials lost by the cells was an index to the ability of plants to withstand cold weather. To discover what relationship existed between subsequent growth and the amount of injury from each freezing treatment, 24 plants of each variety were transplanted in soil under greenhouse conditions. In general, the growth of the plants showed a distinct correlation between the loss of materials from the roots and the extent of injury from the freezing treatments.

That different varieties of plants prepare to fight the low temperatures of winter with more thoroughness than do other varieties, also was confirmed by this method of testing the hardiness of alfalfa. Some hardy varieties, such as the Grimm, slow up in growth early in the fall and start storing large reserve supplies of food in their roots, while others, such as the Peruvian, keep growing and store relatively less food materials in their roots and stems. Those varieties that prepare for winter usually survive even severe cold, but those that are caught in their growth period by cold weather are often winter-killed.

THIS fact was discovered by measuring the out-go of materials from the roots of different varieties that were dug and frozen early in September. At this first freezing no varietal differences were found in hardiness, but when the roots were dug out of the ground and frozen during the latter part of October and in November, differences in the ability of varieties to resist cold weather became evident.

Thus, plants go through a hardening process in the fall which prepares some varieties more than others to withstand cold winters. (See chart.) Just what this hardening process is remains unknown, but it is not at all unlikely that the new test for hardiness will be helpful in uncovering the secret that has baffled scientific men for the last half century.

In addition to measuring the hardiness of alfalfa by this electrical method, tests conducted on wheat, apples, raspberries, and other woody plants, indicate that their hardiness also can be measured by the amount of materials lost from their roots. If further research checks these preliminary experiments, facts will be unearthed which may reduce severe winter crop losses, the plant breeder will be able to breed varieties of plants of almost undreamed of hardiness, and it is not altogether visionary to see areas in the northern states producing crops hitherto limited to the south. Indeed, the food-producing areas of the world may feel the effects of such a discovery more than we suspect.

Perhaps the most interesting phase of the electrical test for hardiness in plants is the new research it opens up.

COMPANIONS IN DEPRESSION*

By RAYMOND B. FOSDICK

IF I may put it bluntly, our world is very sick. It is a world which engineers and technologists have created. They have given us radios and telegraph systems and airplanes and automobiles and other marvelous methods of communication and transit. They have given us harvesters and turbines and all sorts of automatic machinery. These gifts have knit the world together into a new kind of unity; they have made possible the organization of production and distribution on a gigantic scale; they have increased the standard of living far beyond even the dreams of our fathers; they have resulted in higher wages, shorter hours, lower prices, and larger profits. And yet I repeat: the world we live in today is very sick.

If anyone doubts this assertion let him feel the pulse and take the temperature of the present situation. All over the world during the past year production has declined, commodity prices have fallen, bankruptcies have increased, agriculture has become chaotic, and the figures of unemployed have mounted with almost unparalleled rapidity.

NOW the awakening has come. We are faced with a stagnation of industry such as we thought would never occur again. Apparently the problem of the machine age is not so much a problem of producing goods as it is of producing buyers. We cannot move our wheat abroad, for there is little demand for it, and consequently the purchasing power of our vast farmer class is paralyzed. Our cotton is rolling up in our ports like gigantic snowdrifts and the price has fallen to an abysmal depth. In copper, steel, motors, merchandising, and a dozen other industries, the story is the same: a drying up of the stream of consumption, a slowing down of production, curtailed output, falling prices, passed dividends, staggered hours of work, half-time work, quarter-time work, no work.

We are not going to be saved from all this by a slogan. Industrial depression cannot be cured by any such shallow approach. The causes lie too deep and are too complex and widespread to be removed by so simple a remedy. With one method or another we shall doubtless effect an improvement in our present situation; but before we begin to think in terms of permanent cure, before we can be sure that whatever amelioration we accomplish is more than temporary, it will be necessary for us to face, more frankly than we have faced, some rather fundamental facts.

The country is full of remedies. But in trying to think our way through the difficulty remember that we are living in a 20th Century, and not an 18th Century, industrial world. The difference between the two needs no elaboration. Our new world is a world of interdependence and solidarity. It is a world that machines have woven together with thousands of criss-crossing threads. It is a world in which the relations between cause and effect have been so lengthened that on any given day the Egyptian planter cannot know what his cotton or sugar is worth until he receives the quotation from Galveston or Cuba. A heavy frost in the Mississippi Valley will affect prices on the Liverpool exchange, and the disturbance will reverberate in Australia and India.

The chain of economic consequence is practically without end. French savings, through the channel of a loan to Argentina or Chile, contribute to the development of German or Belgian industry. Prosperity in Czechoslovakia, by increasing the consumption of chocolate, results in the stimulation of the plantations of Venezuela. This complex play of action and interaction which constitutes our 20th Century industrial civilization could be portrayed in endless illustrations.

MEANWHILE the ports on the world's seaboards continue to grow. Each time a dock is built at Montevideo it is necessary to add a dock at London and at Hamburg. One nation extends its agricultural hinterland while the other increases its hinterland of factories. One nation lends its capital (we Americans have 20 billion dollars in private investments overseas) and the recipient nations in return increase their imports and add to their equipment.

The solidarity of this new world of ours is the result, of course, of specialization. Each country makes its particular contribution, dependent upon its own resources and capacities, to the goods that the world consumes. Italy has no coal or iron; France has no oil; Great Britain must import two thirds of her food supply; the United States is dependent on other countries for tin, silk, nickel, rubber, and many other commodities. The War Department in Washington has listed 30 specific materials which are called strategic because they are essential to the prosecution of war, and because we either do not produce them at all, or can supply them only in quantities insufficient even for peace-time requirements.

A country that could not make a locomotive, an automobile, or an airplane without materials from abroad can scarcely be called self-contained. A country that could not even carry on war without the aid of 30 essential commodities from other nations cannot boast of its national independence. By the same token, a country whose excess wheat and cotton are rotting in fields and storehouses because its foreign market has gone to pieces is not in a position to talk in terms of Washington's Farewell Address.

YOU see, do you not, what has happened? In a hundred years, thanks to machines, the rush of trade and finance has trampled down the old geographical frontiers. Everywhere economic forces have broken through old barriers and are seeking common levels. Around the world prosperity and depression keep the same rhythm, and rise and fall together like the ebb and flow of the sea.

Now there is no doubt that there are many things that could be done and are being done here in the United States which would and will improve our internal situation. The revision of our anti-trust laws, as suggested by Mr. Thomas W. Lamont, with their unfortunate consequences in terms of duplication of plant and equipment, might very materially encourage our economic recovery. The repeal of our recently enacted tariff law with its vicious boomerang against our own export trade would undoubtedly help. The establishment of a National Industrial Planning Board, as outlined by Mr. Stuart Chase, which would act as an economic general staff—a fact-gatherer and adviser both for government and industry in relation to every major economic undertaking—might be of great assistance in articulating the development of business and thus meeting the challenge of the Russian formula. Similarly we could and probably should have legislation establishing a national system of employment exchanges, unemployment insurance, advance planning of public works, and other emergency remedies.

The fundamental difficulty with our present situation is that two distinct

*Abstracted from an address delivered before the Carnegie Institute of Technology.

principles are struggling for mastery. In spite of the fact that the economic tides are overflowing the world, we are still trying to maintain our old nationalistic water-tight compartments. Our political conceptions have not caught up with our machines. We still cling to the idea that we can maintain political isolation in a world in which economic isolation has long since gone by the board. Although commerce and trade have far transcended the framework of the nation, we still continue to think about them in terms of absolute national control.

It all comes down to this: we are trying to run a 20th Century industrial world with 18th Century political ideas. The tremendous technical revolution of the last hundred years has as yet made little impression upon our institutions or social beliefs. The United States, for example, continues to live in the intellectual atmosphere of Jeffersonian individualism. Its administrative system is roughly the same as it was in the days of Jackson. Its philosophy of international relations is inherited from Hamilton. It repeats the Declaration of Independence as if nothing had happened since 1776.

IN brief, the United States is trying to live in two different worlds at the same time. A leader in everything that relates to the advance of the technical aspects of economic interdependence, it refuses to face up to the political implications of its own acts. It cannot bring itself to believe that airplanes, five-day boats across the Atlantic, and telegraph systems are fundamentally incompatible with our inherited ideas of national independence. All over the world, in every country, there is this same chasm between the new life and the old ideas, this same obstinate adherence to antiquated political formulas as a solution of modern economic problems.

But let no one imagine that the solution is an easy one. It involves a voluntary curtailment of the field of so-called sovereign rights—a relinquishment to group decision of many matters which hitherto have been considered of exclusively national concern; even more than that, it involves the immense difficulty of securing common agreements between nations whose racial and cultural backgrounds are utterly diverse.

As far as the United States is concerned, a solution along lines of international action will call for a re-orientation of our present point of view and a sharp reversal of our present practice. We shall have to give up our secretly cherished belief that the ultimate test of law and morals lies in an enclosed territory. We shall have to be willing to play our part, not as an onlooker, but as an active participant, in the wider organization of the world community. Whether it is the League of Nations, or the Court of International Justice, or the International Labor Office, or the Bank of International Settlements, or the International Chamber of Commerce, or whatever may be the machinery, official or non-official, by which the overlapping interests of nations are given voice and expression, we must be prepared to make our maximum contribution and carry our full share of the common enterprise.

Raymond B. Fosdick, the author, is, among other things, a well-known lawyer, a trustee of the Rockefeller Foundation, and a member of the American Academy of Political and Social Science. He has a long and notable record of public service, both local and national

The new solution involves the necessity of sitting down with any nation or group of nations to discuss any matter whatever of common concern. More than that, it involves a self-denying ordinance by which we will refrain from action prejudicial to other nations, at least until we have joined them around the conference table in the hope of mutual agreement.

The question of tariff is a case in point. The tariff is not a local issue; it is not even a national issue; it is an international issue which should be handled by some kind of international technique.

In the Tariff Act that was recently passed in Washington, 890 different items were increased, affecting imports from nearly every country in the world. Following the passage of the Act there came from other nations a volume of angry protests and retaliation which has scarcely diminished to this day. The Act was a blow struck by one nation at the economic stability of 60 nations.

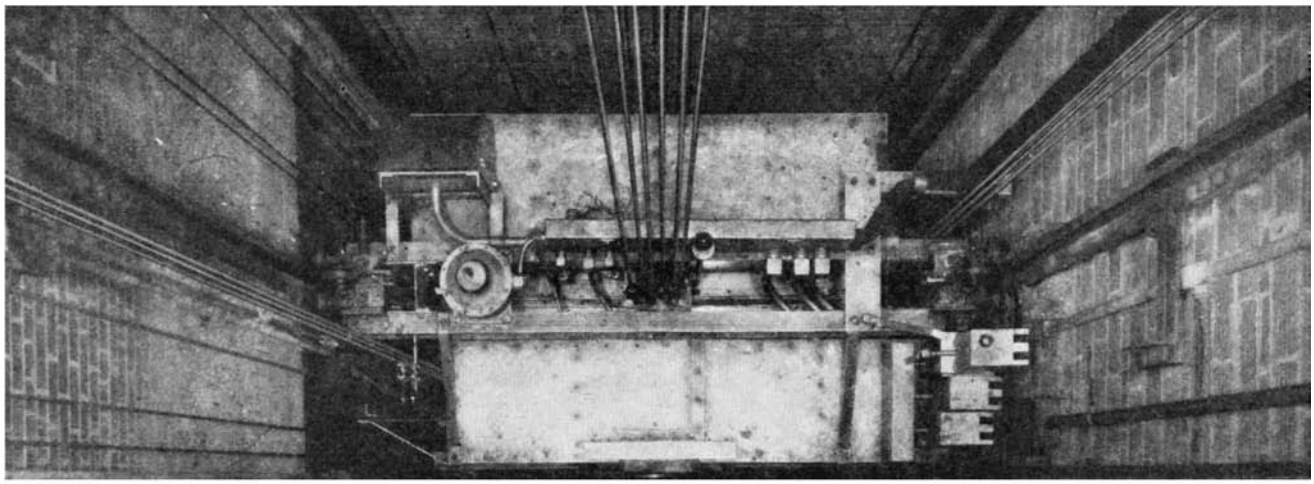
Take the case of Switzerland, for example. The Swiss Republic is to a large extent a nation of watchmakers. She has no natural resources; she imports all her raw materials. She has been shipping to the United States approximately 11,000,000 dollars' worth of watches and watch movements every year. Our new tariff bill closed the doors of many of her factories. A handful of men, sitting around a table in Washington in an atmosphere heavy with ignorance and cigar smoke, crippled the chief industry of a country 3000 miles away.

This is not world order. It is anarchy. Even from the standpoint of our own self-interest it is catastrophe. For Switzerland was buying from us 45,000,000 dollars' worth of goods a year. With her principal industry disorganized, and with the ramifying effect of that collapse upon her own purchasing power, with what funds will she buy from us in the future, even if she now had the desire?

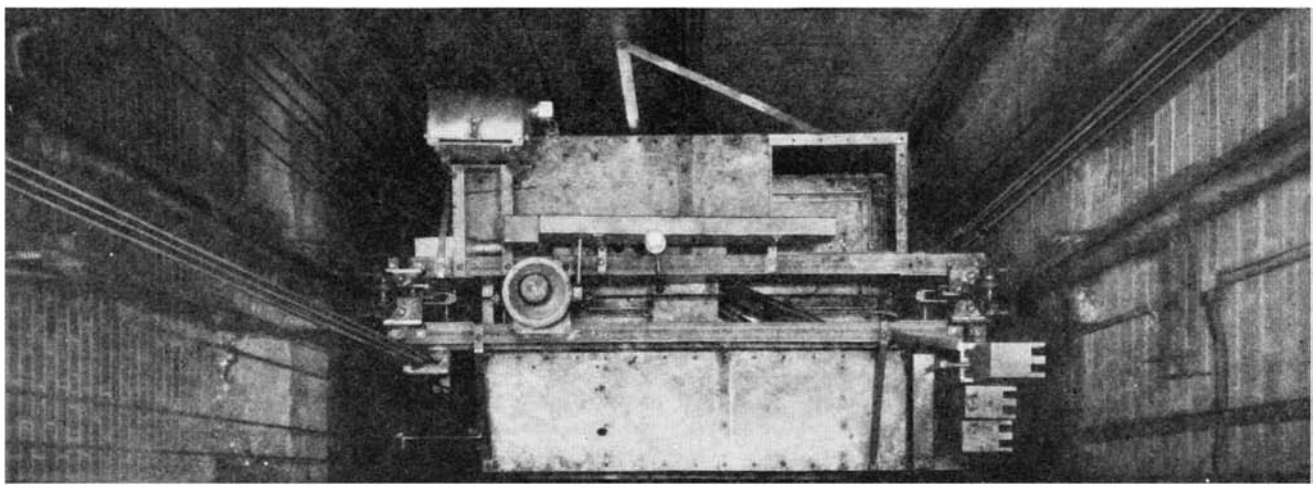
The old doctrine of "Each for himself and God for us all" which Canning enunciated a hundred years ago after the wreck of the Holy Alliance, does not fit into a 20th Century world. A national tariff act, passed in utter disregard of its consequences abroad, is today an anachronism. It is a throwback to an age of savage conquest. The whole question of tariffs belongs in the international field. It is a problem for common counsel and joint consideration.

THIS, then, is the prescription which destiny seems to be writing for our sick world: we must bring our political ideas abreast of our industrial internationalism; we must close the gap which our machines have made between politics and economics. Local remedies may afford temporary relief. Our enormous potential consuming capacity will certainly assist recovery. But the attacks will come again, and, because of the growing complexity of international relationships and the fast developing physical propinquity of peoples, they will come with increasing severity. For some of us the medicine that has been suggested will be bitter. But there seems to be no other method of permanent cure. And the patient is very sick.

In 1927, a World Economic Conference, called by the League of Nations, stated in its report that "it was a mistake to assume that the economic condition of Europe could be so seriously disorganized without affecting the rest of the world." We, here in the United States, did not believe it then. We were at the top of our gait, and the bread lines of Europe were a long way off. Now we know that what they said was true. We are all in this situation together. British, Germans, Spanish, South Americans, Asiatics—we are companions in depression; and we humbly subscribe to that further sentence in the report of the Economic Conference: "Prosperity is not something that can be enjoyed in small compartments."



Above: Looking down on the top of the upper car showing cables attached to the center. Cables for lower car at sides



Below: Top view of lower car showing ropes attached to the outer ends of the sling. Aluminum is largely employed

TWO CARS IN ONE ELEVATOR SHAFT

By H. D. JAMES
Consulting Control Engineer, Westinghouse Elec. & Mfg. Company

RECENT articles have shown that the height of a building is not limited by the mechanical structure and that buildings even a mile high can be built if there is any justification for them. High buildings of the tower construction may be built for advertising purposes, but most buildings are erected as an investment and the vertical transportation problem is the feature which places an economic limit on the height, due to the floor space required for the elevator shaftways. Fifty square feet is a very conservative estimate for the size of an elevator shaftway which we may assume can be rented for four dollars per foot; this multiplied by the number of floors in the building represents a very considerable revenue.

Engineers have been working on this problem and the best solution so far offered is to operate more than one elevator car in the same shaftway. This will reduce the total number of shaftways and release a considerable floor area for revenue purposes.

The Westinghouse Electric & Manufacturing Company have recently completed an elevator installation of this kind in a shaftway attached to their new office building at East Pittsburgh. This is the first installation where two independent elevators are operated in one shaft on a commercial basis. Each elevator car has a capacity of 3000 pounds at 600 feet per minute and is controlled by a full automatic push-button system which stops the cars automatically at the desired point by use of inductor relays. The top car operates from the third to the eleventh floor and the bottom car from the first to the ninth floor.

Obviously both cars should run in the same direction, on a fixed schedule. Nothing can be gained by trying to run the cars in opposite directions except under abnormal conditions. Provision is made in each car to change the control from automatic to hand operation, which will permit slow movement of either car toward the other. This provision is intended to be used only as a matter of safety in case a passenger were caught in the enclosure door or the automatic control did not properly land the car.

When one car is operated in the hatchway, automatic means stop it before it reaches the limits of travel. When two cars are operated in the same hatchway each car becomes the limit of travel for the approaching car and in general the same safety means stop the approaching car before it reaches the limit of its travel.

The floor selectors for both cars are mounted together in the penthouse and attached to a miniature pair of elevators operating in an illuminated hatchway, with ground glass front. Each floor is indicated and all of the parts are to scale so that it is easy to follow the operation of the two cars.

The cars are normally operated on a block system of control similar to the trains in a subway. When one car approaches the other, it is first automatically slowed down and then stopped by means of the same control which is used for its normal operation. The operator in the car has a set of three signal lights. A green light indicates that he can run full speed; an amber light is a caution signal requiring half speed; a red light means stop.

A SET of differential gearing, located at the top of the shaft, is provided with two elements, one of which is attached to each car by means of a steel tape. Automatic devices stop both cars if either steel tape becomes slack. The differential gearing indicates the relative position of the cars and operates to slow-down and stop the approaching car if the block system should fail. The action is selective; the leading car does not have its control interfered with. Every facility is provided for the leading car to clear the block and provide safe running space for the following car. The speed of the approaching car is reduced and the car finally stopped in three stages by the differential gearing.

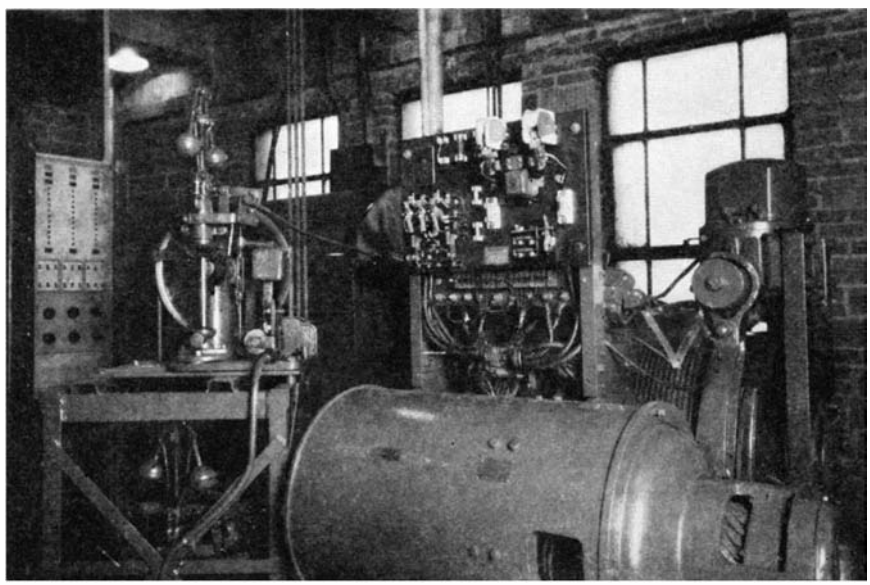
Oil buffers stop the car at either limits of travel in the usual manner. In addition to this, an oil buffer is placed between the two counterweights to prevent shock should the two cars drift together. At the same time a set of emergency switches located between the cars is operated to disconnect the electric power.

The two counterweights are operated on the same set of rails. The upper one is provided with a safety to prevent its dropping on the lower one in the event that the ropes become detached.

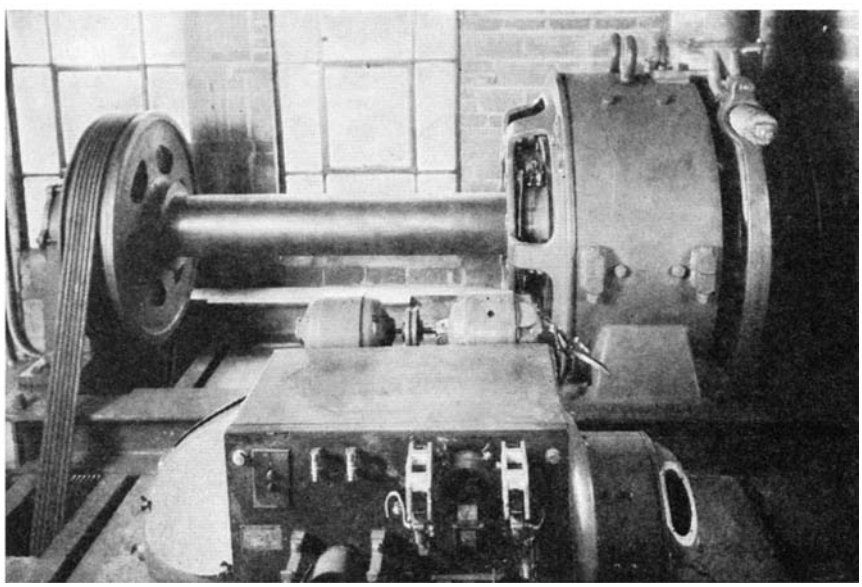
The hoisting cables for the lower car lead down either side of the top car and are attached to the cross beam of the bottom car at either end on opposite sides of the center line passing through the guide rails. The other ends of these hoisting cables are attached to the outer ends of the counterweight. The distance between counterweight rails is approximately the same as between car rails. The top counterweight is attached to the bottom car.

The hoisting ropes are attached to the top car at the center and lead to the bottom counterweight through a slot in the upper counterweight. This arrangement is similar to the old drum machines using a separate car counterbalance.

View of car and control board. Car is made of aluminum and Micarta, reducing weight and running costs. See the text below



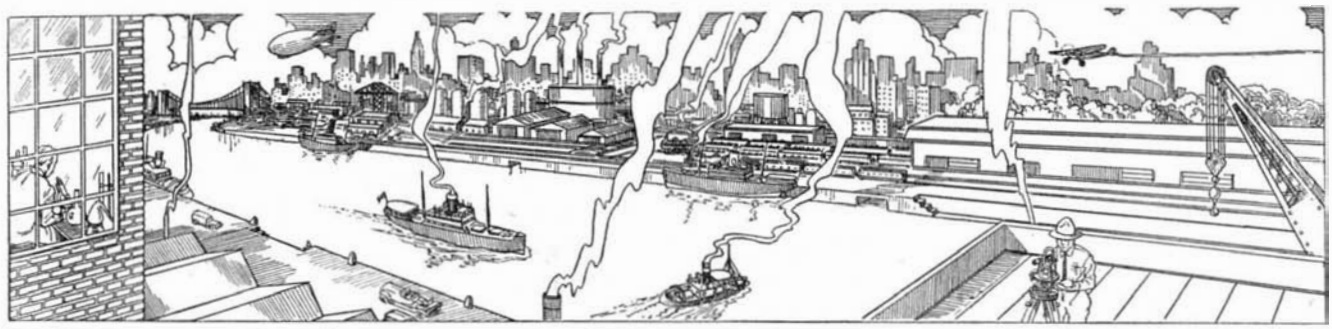
Right: **Lower penthouse holds upper car machine. Lower car cables at the left near the governors**



Below: **Upper penthouse drive for the lower car. Cables at both sides pass upper car in the shaftway**

Aluminum was used wherever the reduced weight improved operation. The car sling and platform framing are made of aluminum. A combination of aluminum and Micarta gives the car enclosure a very unusual and attractive appearance. The saving in weight of the car and sling is considerable. This reduces the power consumption and the stresses on the equipment and supporting structure and therefore improves the service and naturally reduces the cost of operation.

The enclosure doors are made of aluminum with Micarta panels. These doors weigh about half as much as the ordinary steel door and consequently require only half the energy to operate them.



THE SCIENTIFIC AMERICAN DIGEST

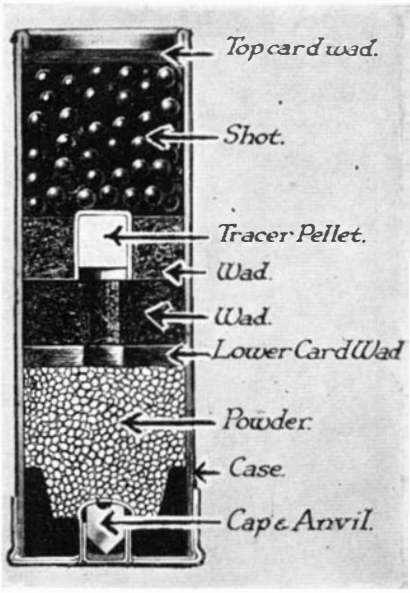
Conducted by F. D. McHUGH

Easy Way to Melt Snow Blanket in Spring

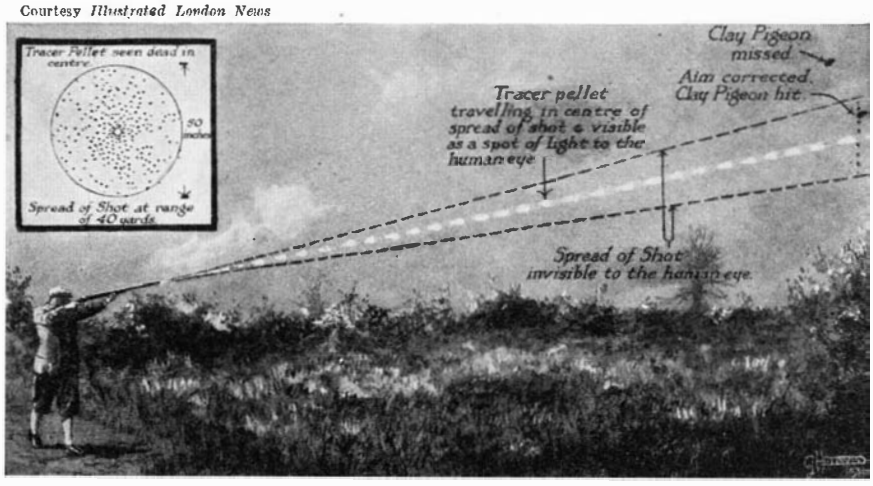
WHEN "winter, lingering, chills the lap of May," foresters of the United States Department of Agriculture sometimes call into play a trick of the trade that puts an end to the unseasonable loitering. In some years it happens that sites chosen for reforestation by planting are ready for seedlings from the forest nursery while the nursery is still buried in snow. By the time the snow in the nursery has melted and the trees are ready for transplanting, the soil in the planting sites may be too dry. The problem in such a case is to melt the snow and advance the working season in the nursery.

The trick is simple—when you know it. It consists in broadcasting fine black soil on the snow over the compartments of the nursery from which planting stock is to be removed first. This soil, because it is black, absorbs considerable heat which would otherwise be reflected from the white snow. This hastens the melting of the snow and enables the workers to get out the planting stock earlier—as much as two weeks earlier in some instances.

This practical and simple application of one of the elementary principles of physical science, as adopted by the Forest Service, may also find other work to do, officials of the department suggest. For example, a similar broadcasting might advance the time when it is possible to work the home garden.



Courtesy *Illustrated London News*



At the left is shown a new shotgun shell which carries a tracer pellet which is ignited by the powder charge thus tracing the trajectory and allowing the sportsman to correct a faulty aim. At right, the tracer shell being used in trapshooting. It is manufactured in England

Diabetes and Sugar Consumption

THE idea that diabetes is caused by eating an excess of sugar is so prevalent that the popular name for the condition is "sugar diabetes." Recent studies made by special investigators of this disease indicate that it is not so much the excess of sugar that does harm to the diabetic as an excess of food generally. Diabetes is inconspicuous among orientals who live largely on cereals. It was, moreover, quite as prevalent in Germany as in the United States at a time when the sugar consumption in the United States was far beyond that of the former country.

A recent survey of the relationship of sugar consumption to diabetes was made by C. A. Mills of the University of Cincinnati. His studies failed to reveal any direct relationship between the consumption of sugar and deaths from diabetes. Some countries with a high consumption of sugar, such as Hawaii and Argentina, had relatively low rates for diabetes, while some countries with a high death rate from diabetes, such as the Netherlands, have a very low sugar consumption.—*M. F.*

Preventing Rust in Water Systems

IN many manufacturing operations, and especially in air conditioning installations, water is sprayed into the air or flowed over open condensing systems. In such cases, the water becomes saturated with oxygen. This condition is just right for causing rust, and rust is the *bete noir* of the engineer and operating man. In most of these systems the water is recirculated with only enough make-up to keep the volume constant.

It has been found that a judicious application of silicate of soda added either by a slow continuous feed or at regular intervals prevents rusting under such conditions. It is not necessary to exercise a very accurate control, though eight parts of silica per million of water will be about right. The action of the silicate is believed to be the formation of a very thin invisible film of silica which interferes with the transfer to the metal of oxygen dissolved in the water. The film must be kept intact by

keeping silicate in the water which would otherwise dissolve the film, and the rusting would merrily proceed.—*A. E. B.*

The Baker's Dough Evaporates

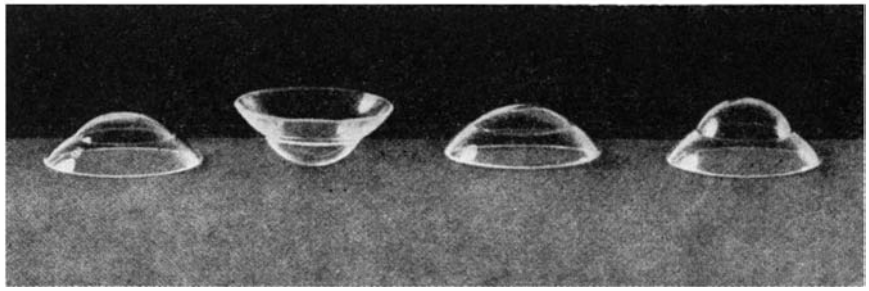
THIS is written just as the Christmas bills are coming in, so the time is appropriate for some data on the evaporation of "dough." We thought our money disappeared with record speed, but now we read of bakers' shops where tons of dough literally evaporate every day.

Loss of weight of dough during fermentation under practical shop conditions has amounted to as much as 6 percent, while the average loss in the plant under good control can be held down to about 0.5 percent. Some weight loss will always take place during fermentation, but large losses due to evaporation may be prevented. P. G. Perrie, writing in *Bakers Weekly*, is authority for these statements. He recommends that materials should be weighed accurately, humidity should be controlled—70 to 75 percent relative humidity in the dough room is desirable—and suitable records should be kept. In one bakery, a five-oven plant, evaporation losses in the dough room were found to be equivalent to 100,000 pounds of dough per year.—*A. E. B.*

Contact Eye-Glasses

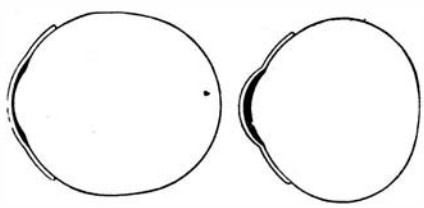
NEW hope for millions who daily are conscious of the "nuisance value" of those cumbersome appliances known as eyeglasses seems to lie behind the recent development of so-called "contact glasses." These are simple little eyeball caps of optical glass, without rims and without bows, in fact without any method of attachment to the human anatomy other than support by the eyelids and adhesion to the eyeball, with which they turn under control.

The very simplicity of the idea will make immediate appeal to persons of scientific and mechanical leaning. The little shells are scarcely larger than one's thumbnail and, being made of glass only one-fiftieth of an inch in thickness they weigh no more than seven grains. One might assume that they would soon be broken, since they are so thin, and do injury to the eye. On the contrary the chances of breakage seem to be extremely small, for the concave cups are situated in a most advantageous position, just the reverse of ordinary eyeglasses which are ideally situated for breakage. In fact, contact glasses partake of the same protection nature affords the eye itself—location in a depression behind the ring formed by the cheek bones below and the brow above.



Four examples of contact glasses ground to different optical prescriptions. These tiny shells—shown approximately full size here—are fitted under the eyelids

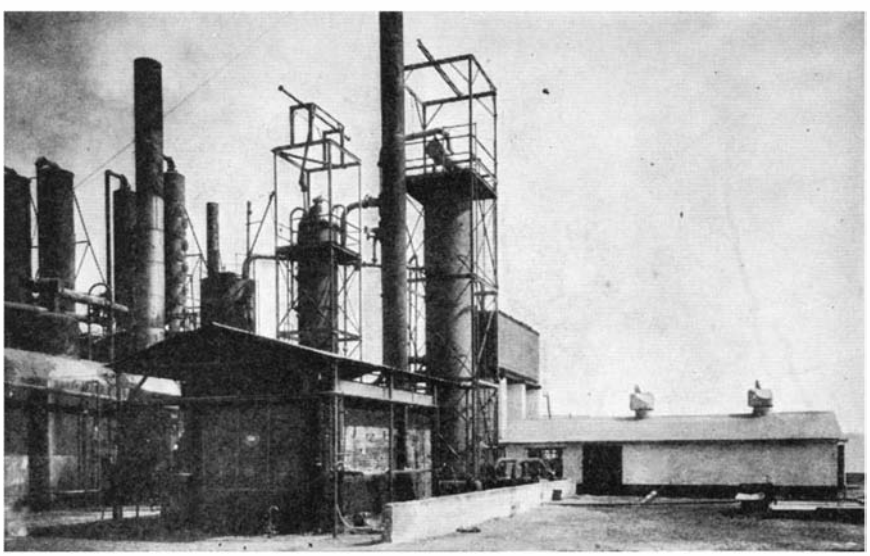
Obviously the curves of the contact glasses must fit the eye of the individual user and this demands no small amount of painstaking when they are fitted. Parts of the eye must be anesthetized and the wearer must expect to make numerous trips to the oculist. Dr. A. Rugg-Gunn describes the necessary technique of fitting in an article in the *Lancet* (London), and makes no attempt to minimize these difficulties which, he says, are "obviously great."



The manner in which the new contact eyeglasses fit the wearer's eye

Before the cups are applied to the eyeball they must be filled with a fluid having a refractive index approximating that of tears. Then as the wearer leans forward they are applied directly to the eye by means of a small rubber vacuum cup temporarily pressed to their outer surface. A little thought of the optical principles involved will reveal the fact that, optically, these artificial outer lenses, because of the liquid held behind them, abolish the effect of the cornea and, since astigmatism occurs in the cornea, they abolish astigmatism while they are worn. Incidentally, they are so thin that they are practically invisible.

With regard to contact glasses there is only one "fly in the ointment" but it appears to be a large fly—they are difficult to fit and, especially if the contact of the marginal part is not uniformly perfect, they are likely to irritate, becoming, as Dr. Rugg-Gunn says, "intolerable." Yet there is so much in the idea which will make appeal to those who have wished for the 10,000th time that all eyeglasses were in Gehenna, that it is hoped the research workers of Carl Zeiss who developed them in refined form will persist until, finally, all those who are forced to wear the conventional form of eyeglasses can celebrate the day these safely can be consigned forever to the ash can.



Semi-commercial plant at East St. Louis where the new Pratt process for making gasoline is being developed. Knockless gasoline has hitherto been obtained only from choice grades of crude oil but the object of this plant is to make gasoline from almost any grade of crude. It is said to produce 300 barrels daily by a vapor-phase cracking process using temperatures up to 1100 degrees, Fahrenheit

Violin Bows Made of Silver Threads

VIOLIN bows, which have been strung with horsehair ever since the Middle Ages at least, may soon have to yield place to a new form of an old material. A German violinist has been experimenting with bows strung with silver wires of hair-like fineness, slightly roughened on their surfaces to set the violin strings vibrating. It is stated that a sensitiveness and brilliance of tone are achieved that excel the effects usually obtained with the old horsehair bows.—*Science Service.*

The Rate of Wound Healing

SOME of the most sensational announcements appearing in recent years have had to do with the use of what is called the electrical knife for surgical operations. One advantage claimed for the electrical knife is the fact that it seals the tissue at the time the cut is made, thereby lessening bleeding. It has also been urged that the wounds made by the electrical knife healed more rapidly than those made by other techniques. In some instances the use of the cutting current with just enough electrical desiccation to control oozing of blood has permitted surgery which formerly could never have been attempted. These instances concern particularly the control of brain surgery, the removal of parts of the liver

The Autogiro in flight in the disturbed air currents over New York City

and spleen and extensive excisions of cancer.

It is the belief of Dr. John D. Ellis that the claims regarding rapid healing following electrical cutting are not warranted. In a series of [illegible]ontrolled studies he found that only 60 [illegible]rcent of electrically produced wounds showed primary healing in comparison [illegible] 97½ percent of primary healing in [illegible] made by the ordinary scalpel. He found, furthermore, that when healing did occur in wounds made by the electrical knife the union was weaker than in corresponding wounds made by the scalpel. The same general results were found in cutting the walls of the stomach and in cutting muscle.—*M. F.*

The Autogiro

SEVERAL requests from readers for authentic information on the "flying windmill," the autogiro, have brought about the decision to devote almost the entire aviation section of the Digest this month to that subject. Professor Klemin has therefore prepared the following description which will answer many of the questions about the autogiro that arise when one first views that ship in flight.—THE EDITOR.

LA CIERVA'S Autogiro, with its remarkable landing properties, its freedom from any tendency to spin, and its long record of successful flights unmarked by a single fatality has aroused wide public interest. No less a personage than Thomas A. Edison has expressed enthusiastic approval after examination of this new type of aircraft at Newark Airport. Our readers may perhaps be interested in a review of its history and present status.

Its History

THE invention of the Autogiro is due entirely to a sheep! In 1918 Juan de la Cierva designed an excellent three-engined bomber for the Spanish Air Force. Flying from one field to another, he saw a sheep directly in his line of landing. He pulled back his stick to avoid the sheep, stalled the airplane, and crashed. So at least we learn from Flight Lieutenant Bonham-Carter of the British Royal Air Force. *Si non è vero, bene trovato.* Cierva spent a sleepless night or two, and determined to build a craft which would not stall. Hence the Autogiro.

In 1920 he first conceived a freely rotating wing as the best means of achieving his purpose.

In the ordinary airplane, loss of forward speed means loss of lift and all its attendant troubles. With a rotating wing, when the craft as a whole is flying at low speed, the rotating blades still have considerable speed and therefore lift. Hence the possibility of very low landing speeds, and almost vertical descent.

The first type of Autogiro tested was fitted with two four-bladed rotors mounted one above the other. The purpose of the two systems rotating in opposite directions was to eliminate the difference in lift existing between the blade going into the wind, and the blade moving away from the wind of forward motion. Probably owing to interference between the two rotor systems and the consequent loss in efficiency, the type was far from being successful.

The second attempt had a single rotor system of three blades, which was set at varying incidences, as it rotated, by a mechanical device, also designed to eliminate the difference in lift and the resulting turning moment. This was an improvement over the first type, but the mechanism proved cumbersome and ineffective.

The third type of Autogiro was fitted with a rotor of five rigid blades, and was the first full sized machine actually to leave the ground. Unfortunately, whenever a rigid rotating system changes its plane of rotation, gyroscopic moments are set up. The gyroscopic moments proved too large to be controlled and this type also had to be abandoned.

Finally Cierva hit on the principle of articulated blades, freely hinged at or near the axis of rotation. In forward flight, as we have stated previously, there is more relative wind speed and hence more lift on the blade advancing into the wind than on the blade receding from the wind. But when the blades are hinged, the advancing blade rises. As it rises, the air strikes it from above and the increase in lift ceases. Equilibrium is established between the weight of the blade, the centrifugal force, and the air forces. Since the weight of the blade is always the same, the lift on either side remains substantially the same. Even if the difference in lift is not entirely eliminated, the freely hinged blades cannot introduce rolling or pitching moments into the body of the machine.

Another great advantage of the hinging of the blades is that gyroscopic moments are eliminated when the aircraft, as a whole, is pitched or rolled.

This fourth type was notably successful. However, lateral control was provided for by tilting the axis of the rotor to the right or left, and this proved impractical. Nevertheless, the fundamentals of success had been determined. The machine was reconstructed or modified 15 times, a better type of lateral con-

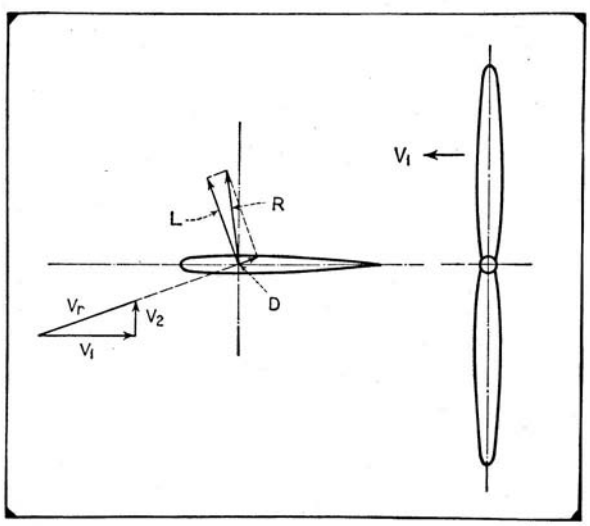


Diagram illustrating the rotor principle

trol was evolved and in January, 1923, a successful flight of about 200 yards was made near Madrid, and subsequently a flight on a closed course at the famous Quatro Vientes Airdrome.

The Principle of the Rotor

PERHAPS the most puzzling thing for the layman to understand is in the principle of auto-rotation of the lifting rotor.

The easiest aspect of the problem is auto-rotation of the rotor in vertical descent. Suppose we have a blade as shown in the appended sketch, rotating in the direction shown. There is an air velocity relative to the blade, due to its rotation, of amount V_1. There is also an air velocity relative to the blade, due to the descent, of amount V_2. The resultant of these two velocities, Vr, strikes the symmetrical blade at an angle. The lift, L, of the blade is always perpendicular to the resultant wind velocity. Therefore, the lift has a forward component, which overcomes the drag, D, and keeps the blade in rotation.

Similar considerations of a somewhat more complicated character explain how the blade is kept in rotation in forward flight.

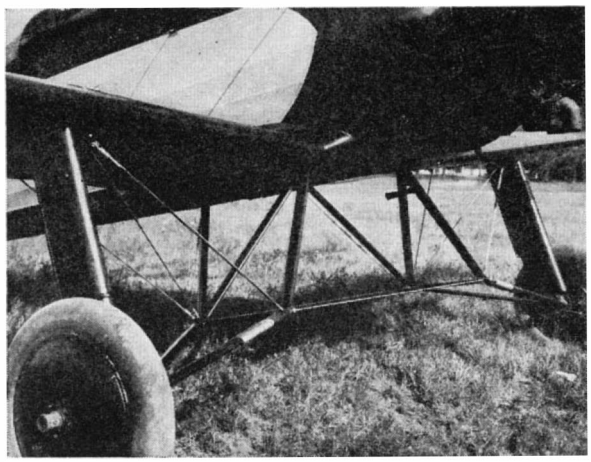
There is no application of power to the axis of rotation. Once the Autogiro has started on the ground, and the "windmill" has been set in motion, rotation continues.

Autogiro and Airplane Compared

IN Cierva's opinion the Autogiros recently produced have no better performance than the equivalent conventional airplanes. In fact they have a little less speed and a little less climb than the best equivalent airplanes. Nevertheless he considers them better flying machines. Summarizing comparative performances, he states: "Top speed, 5 to 10 percent less. Rate of climb, 20 percent less. Minimum horizontal speed, 50 percent less. The take-off since the introduction of the deflector tail is better. The landing qualities are so well known that it is hardly necessary for me to mention them. In any case I want to state that the present day Autogiro can, with proper handling, be landed in perfectly still air, with no run at all after touching the ground. In steep descent of about 45 degrees the vertical speed of the latest machines is not more than 12 to 13 feet per second."

Airplane exponents argue that the wide speed range of the Autogiro can be met by the use of slots and flaps applied to the conventional wing; that the greater average speed of the blades as compared with the speed of the fixed wing means always higher drag, and therefore less efficiency and top speed; that the Autogiro will never be able to compete with the refined transport airplane in load carrying capacity and general performance. Still Cierva and his American licensee, Harold F. Pitcairn, have cogent arguments and tests in rebuttal of these hostile views.

Autogiro landing at low speed. The demonstration was spectacular because of the barrier of trees



This close-up of the landing gear shows the exceptionally wide tread, long travel, and novel design

The Modern Autogiro

WE are indebted to the Pitcairn-Cierva Autogiro Company for an excellent collection of photographs which illustrate the construction of the Autogiro as it is to-day.

Let us examine the photograph of the Autogiro flying comfortably over the disturbed air of Manhattan. There are four long thin blades in rotation above the craft. This characteristic rotor system furnishes approximately 80 percent of the lift at high forward speed and 100 percent in vertical descent. It consists of a set of four hinged blades mounted on a hub which rotates on ball thrust bearings set on a pylon structure above the fuselage. These blades rotate freely under the aerodynamic pressure of the wind produced by the general movement of the craft. The rotor is designed to revolve about an axis approximately perpendicular to the longitudinal axis of the machine. The speed of rotation for any given system is defined by its design and is practically constant for all flying conditions. The rotational speed of the rotors varies from 120 to 150 revolutions per minute.

We have already explained the function of the articulation of the blades. The Pitcairn Company explains its action as follows: "When the Autogiro is in flight the rotating blades are subjected to two major and opposed loads brought about by natural forces. Under the action of lift the blades have a tendency to rise, since they are free to move about the hinge at the roots. This tendency to rise is overcome by the centrifugal force of rotation acting at right angles to the lift force. The equilibrium of the two forces results in the rotor system coning slightly in flight." This coning is quite apparent in the photographs.

With reference to the details of the rotor system we note that the rotor system revolves on three ball bearings, any two of which are designed to take the full load. Each blade is joined by a universal joint to the forging which constitutes the rotor-head. This construction permits flapping upward and downward, and a movement of one blade with respect to the other, but prohibits any change in the angle of incidence of individual blades. The hinges which form this universal joint are plain journal bearings. "Droop" cables prevent the blades from falling when centrifugal force is absent. Immediately below the rotor-head may be seen the drive shaft and over-running clutch of the mechanical starter which brings the rotor to its speed of 120 revolutions per minute before take-off of the machine.

The starter derives its power directly from the engine crank through a manually operated clutch, and brings the rotor up to speed in less than half a minute. In flight it is completely disengaged and has no connection whatsoever with the rotation of the blades. A simple braking arrangement similar to the familiar wheel brake stops the movement of the rotor after the Autogiro has landed.

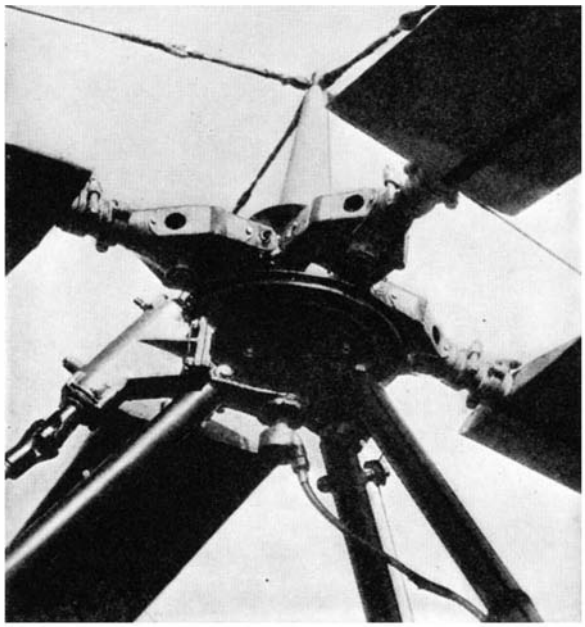
In some of the new machines built by Cierva, the tail itself is made to act as a self-starter. The tail is raised, the slip-stream of the propeller is deflected upwards and the rotary blades are forced in turn to a flapping movement which is transformed by aerodynamic reaction into circular motion.

Two small fixed wings with upturned wing tips provide lateral stability and serve also the purpose of carrying the ailerons and for providing a convenient mounting for the wide under-carriage.

In the 13½ foot spread of this unusual landing gear, a novel arrangement of streamlined wires in tension and cabane struts in compression is used. The struts transmit landing loads to the base of the triangular stub axles to which the wheels are attached and landing stresses, after being transmitted through oleo-pneumatic shock struts, are taken through the heavy wires in tension to the bottom of the cabane struts. Although the appearance of this under-carriage is that of great strength, it is nevertheless designed for 25 percent less loading than would be necessary with an airplane of equivalent weight.

The Future: Some Opinions

OPINION as to the future of the Autogiro is still very divided among experts. But the Autogiro has made many friends among unprejudiced aeronautical men. Captain Richard Depew, a noted pilot and connected with the Fairchild Airplane



A close-up of the doubly articulated blade system, the starter drive, and supporting "droop" cables

Manufacturing Company has put himself on record as follows:

"It is my opinion that the Autogiro can be flown by any reasonably good pilot without any difficulty whatsoever. Furthermore I believe that a novice could learn to fly the Autogiro more easily than an airplane. . . . My impression is that the Autogiro can do anything reasonable that an airplane can do, plus a great deal more than any airplane can do in the way of flying and descending at very low air speeds. To an airplane pilot, it is a great thrill to sit in the Autogiro and almost hover over a spot at ridiculously low air speeds, and still have the machine climbing under perfect control. The ease of controlling and the responsiveness of the controls at exceedingly low speeds are astonishing to one accustomed to flying an airplane."

Thomas A. Edison at the Newark Airport is reported to have said, "That's the answer, that's the answer."

Thomas Carrol, formerly chief test pilot for the N. A. C. A. has also an encouraging view: "Development of all mediums of mechanical transport has always waited upon the invention of devices that could successfully check and control the great speeds of which they were potentially capable. Railroad trains could travel at high speeds long before commercial train schedules reflected those speeds. The Westinghouse Air Brake made possible the safe speeds now attained on the railroads. Four-wheel brakes have done much the same for the motor car. The Autogiro is the first heavier-than-air craft to embody in its design this ability to check its own speed. Incidentally this one factor gives an amazing sense of security while flying this machine."

Our own view would be that the Autogiro will not supplant the exceedingly fast and efficient transport airplane, but that it will nevertheless occupy a definite place in the general plan of heavier-than-air flying, and that it may have extraordinary possibilities of usefulness in the realm of private flying. The skill, energy and perseverance of Cierva himself, of Harold Pitcairn and his engineer Larsen, of Kellett, Le Page, and MacClarren, associated in another American group, are guarantees that nothing technical or experimental will be left undone to secure the ultimate possibilities of the Autogiro.—A. K.

Crashes Due to Vapor Locks

ONE of the commonest causes of accident is failure of the engine immediately after the airplane leaves the ground. Such accidents have been known to occur when the plane and the engine were in perfect condition before the start of the flight, and when both ground and flying personnel had the best possible qualifications.

In several instances, the subsequent investigation showed that the dual ignition of the engine was in perfect condition and could not possibly be blamed. The carbureters were of the two or three jet type and were in no way clogged. The tanks contained ample gasoline. The valves, gearing, and other mechanical parts of the engine were functioning perfectly. The engines had been tested at full throttle prior to the take-off.

Wherein then lay the cause of the mysterious failure of the power plant?

Mr. E. Curran, writing in *Aviation Engineering*, seems to have solved the mystery of these extraordinary and unpleasant failures. An investigation of eight forced landings immediately after the take-off showed that there was one common feature in all the cases involved: namely, gravity feed with a tank placed in the wing with a comparatively long pipe from the wing tank to the carbureter and a shut-off cock situated near the tank.

Mr. Curran diagnosed the trouble as follows: When the shut-off cock is closed on landing, the pipe from the wing tank to the carbureter is emptied of gasoline and is filled with air or vapor. When the cock is open, the gasoline in the tank does not immediately expel the air or gasoline vapor in the long pipe. The presence of this air or vapor retards the flow of gasoline in an otherwise perfectly satisfactory system. Therefore soon after the plane leaves the ground insufficient fuel is fed to the carbureter, the engine fails, and the plane has to make a forced landing. This conclusion has been checked by systematic and careful test.

The remedy is simple. The shut-off cock should be placed as near as possible to the carbureter. In this way the long gasoline line is always full of fuel and the danger of vapor lock or retardation of flow is removed.

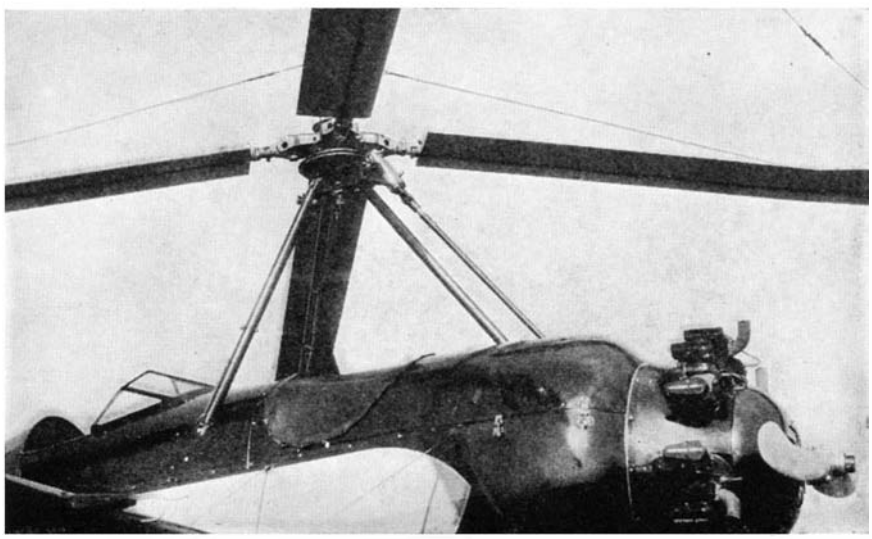
Airplane designers have spent a great deal of time and ingenuity in avoiding difficulties due to engine failure on the climb. Here is a simple idea which is likely to eliminate such cause of accident in a great measure. This bears out once again our opinion that the safety of the airplane is not merely a question of stability or aerodynamics but also of care and thought in a multiplicity of small details.—*A. K.*

Modern Metallurgy and Cosmetics of Ancients

IT has more than once been alleged, says *Chemical Age*, that it was to the use of cosmetics of mineral origin that, in prehistoric times, the discovery of the art of smelting metals was due. The legend runs that some irate husband in the distant past made a bonfire of his wife's "beauty box" and thereby reduced its metallic contents "in contact with carbon" with the result that metal products were subsequently discovered amongst the ashes of the connubial hearth.

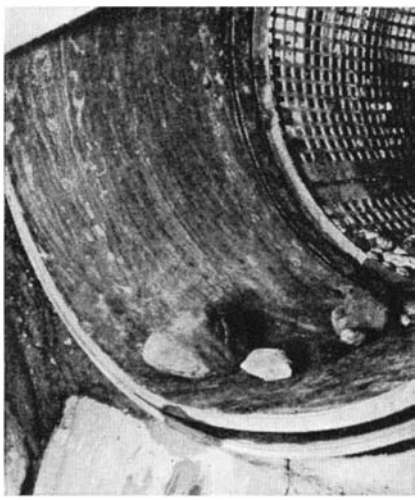
The use of mineral powders as toilet adjuncts is, of course, extremely ancient, and color is lent to the hoary legend by some recent discoveries made by Professor Dart, of the Witwatersrand University in Northern Rhodesia. Near Broken Hill there was found the remains of an ancient manganese mine, the first of its kind to be discovered, and it can hardly be imagined that the deposits were worked for their metallurgical value.

Dr. Dart tells us, as other scientists have told us before, that manganese, in the form of the black crystalline pyrolusite, was used for dusting the hair, in ancient times, just as red ochre was used for imparting the fashionable tint to the skin,



The mounting of the blades on their pylon above the fuselage

and powdered green malachite was used, mixed with unguents, for painting the eyelids. To this list may be added antimony compounds, such as the sulfide, used as a depilatory, while many other instances will occur to those familiar with the composition



A screen in a gravel plant armored with a thin, tough lining of rubber

of the cosmetics of the modern beauty shop. It may well be that to the accidental or purposeful burning of some of these that the origin of the art of metallurgy in ancient times is to be ascribed.—*A. E. B.*

Diet and the Teeth

SKULLS of ancient Egyptians reveal the same type of decay of the teeth that is seen in modern individuals. For many years it has been believed that the appearance of dental decay is associated with general ill health. The pathologists who have studied the condition believe that caries of the teeth are due to the dissolving of the mineral salts of the teeth in certain areas. This breaking down has been alleged to be caused by the actions of bacteria, by changes in the chemistry of the saliva, by disturbances of the glands of internal secretion, and by a bad diet. In most instances, the dental decay occurs between the ages of seven and twenty. Quite recently investigators in the University of Wisconsin noted that the prevalence of dental decay was much less among children given adequate diets than in those that were on deficient diets.

Drs. Bunting, Hadley, Jay, and Hard therefore determined to compare the relative influences of antiseptic mouth washes, varied diets, and combinations of these. The people studied lived in institutions supported by the state and could therefore be quite satisfactorily followed. In two groups a satisfactory diet was used, except for the elimination of sugar. In these diets milk, green vegetables, and fruit were prominent. Moreover, an antiseptic mouth wash was used daily. At the end of the period of observation, caries was found to be active in approximately 5 percent, while 80 percent were relatively free from the disorder.

In a third group, antiseptics were used in the mouth, but control of the diet was not attempted. After nine months, 50 percent had caries and only 25 percent were free. In the fourth group the diet was good but not ideal and the mouth wash was omitted. After a year 75 percent were normal and only 6 percent showed active caries. The fifth group had merely an ordinary diet with no attempt to provide the essentials and no attempt to carry out mouth antisepsis. In this group, 18 percent were free, while 49 percent showed active caries.

The general impression from these studies is that diet is of far more importance than any other factor in the control of caries. In the three groups in which milk, fruit, and green vegetables were prominent, progress of dental decay was either greatly diminished or entirely prevented, and these results were obtained whether antiseptic mouth washes were used or not. It is, of course, quite possible that the effect of the improved diets was due to mechanical action in chewing as much as to any change in the general chemistry of the body. This point merits further study.—*M. F.*

Rubber Armor Protects Steel

WHEN the rubber chemists of the B. F. Goodrich Company discovered a method for attaching a rubber lining to a metal surface, they presented a new and valuable material to the chemical engineer for use in the vats, tanks, pipes, pumps, and so forth, in which he handles corrosive liquids. The rubber lining effectively resists the action of acids which would soon eat through the steel. Now this process of attaching a rubber surface to metal has been perfected to a degree which encourages its use to resist abrasion in some of the most severe service conditions imaginable.

One of our photographs shows the exit end of a large screen used in a gravel plant. The sharp rocks would soon wear away the rotating steel cylinder, but since it has been lined with rubber, the wear is seemingly negligible.

Another illustration shows an application of rubber to the chutes and baffle plates of a big dredge. The residents of Edgewood formerly complained about the noise the dredges made, so it was on the baffles that rubber was first used. The rubber-covered baffle plates last about a year. A steel plate usually lasts five or six weeks. The part of the chute extending up into the air has been in service about three years and the rubber looks as good as new. However, it isn't used as much as the first section. The first section, down which gravel is rolling lasts a year as compared with five or six weeks for bare steel lining.—*A. E. B.*

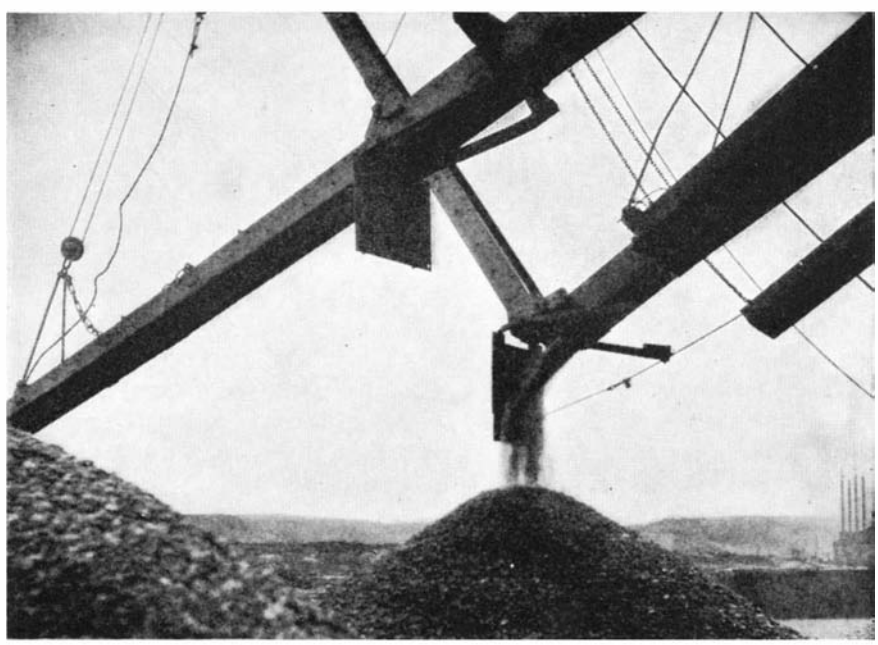
Copper in Oyster Farming

THERE is no more important event in the life history of the oyster or in the successful operation of oyster farming than that which marks the attachment or cementing of the microscopic larval oyster to submerged objects such as old shells, gravel, and brush.

This process of attachment or setting, which must be successfully completed for the survival of the oyster, has been found to depend upon the presence of an infinitesimal amount of copper in the water.

Setting has been produced in solutions containing as little as one part copper to 50,000,000 parts of sea water and proceeds with greater rapidity as the salinity of the water is decreased. The beneficial and stimulative value of minute amounts of copper must not, however, be construed to indicate that trade wastes containing this metal are helpful in the least, as the greater amount which they contain has been found to have a poisonous effect on the larvae, causing death in a very short time. It is also apparent that trade wastes of an alkaline character would precipitate from the river water its normal content of copper and thus deprive the oyster of this essential element for setting and transformation into the adult stage.

In an effort to find some chemical which would be effective and at the same time practical for the elimination of starfish from the oyster beds, copper sulfate has been found to meet the requirements. This substance may be dragged over the beds in bags at the beginning of flood tide and as little as 15 ounces in 2000 gallons of water will kill the adult starfish upon exposure of only a few minutes. Small starfish are

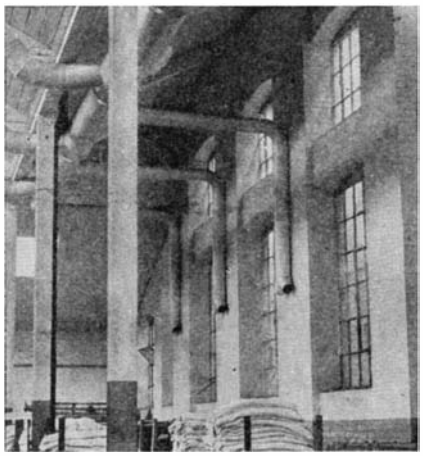


Rubber covered baffle plates which last about a year replace steel plate baffles which last only five or six weeks at the end of these gravel chutes of dredges

killed by exposure to solutions of 12 to 16 ounces in 10,000 gallons of water. The interesting feature of this poison is that it is not toxic to oysters or marine fish and is soon precipitated entirely out of the sea water.—H. F. PRYTHERCH, in *The United States Daily*.

Control of Condensation on Factory Walls

CONDENSED water from walls, ceilings, and windows always carries with it material of a damaging character. Practically no factory work room can be kept in such a high state of cleanliness that the condensed water which may drop from these



Warm air blown against inside of exterior walls reduces condensation

surfaces is clean and undefiled. Relatively high humidity which leads to condensation of water on walls is created as a result of processes of manufacture such as are found in dye houses, laundries, pulp mills, and so forth.

There are two effective ways of preventing such condensation—by increasing the temperatures of the surfaces where the condensation takes place, and by controlling the moisture content of the air. An excellent and not too expensive method to prevent condensation is shown in the accompanying photograph. In this system ventilating pipes carry moderately hot air blasts to the pilasters between windows and also to the skylight where condensation is usually most serious and from which the drip is likely to be directly upon materials in process of manufacture.

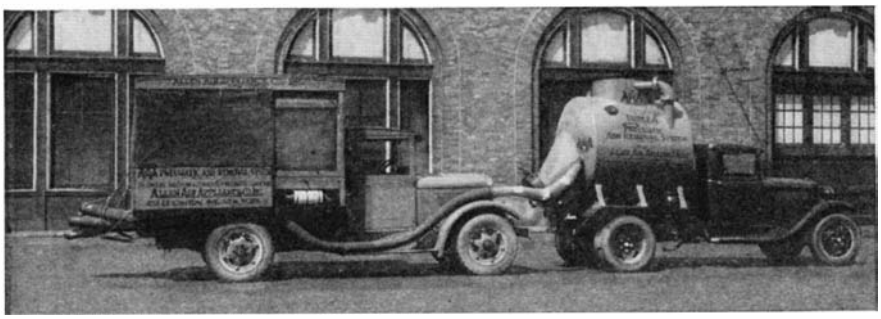
Aluminum Cooking Utensils

PERSISTENT assertions that the use of aluminum cooking utensils is injurious to health caused the federal bureau of health in Germany to conduct a careful inquiry. Experiments were made on animals extending over many months and human beings were tested with comparatively large doses of aluminum. In none of these were any serious disturbances of health noted.

It was found that the metal contained in the compound does not enter the body fluid by the intestines, but is carried off with the excretions. In more than a year of experimentation it was found that the amount of aluminum in the blood, the urine, the organs, and the tissues was merely the usual

amount, regardless of the fact that increased amounts of aluminum were taken into the body. These studies confirmed the original investigations made in 1893.

In the United States a determined campaign has been carried on largely by commercial interests to discredit the use of aluminum cooking utensils. The charge has been made that aluminum received in the body in this way is the cause of cancer and of all sorts of gastro-intestinal disturbances. The new investigation is proof again of the utter baselessness of such charges.—*M. F.*



The two trucks of the dustless ash handling system described here. The one in the rear contains the air filters and the motor which creates a vacuum

Paint Metal in the Afternoon

IF you're planning to do any painting on metal surfaces, exposed to the weather, wait until afternoon. That is the advice of Mr. Ulick R. Evans, of Cambridge University, who recently addressed the Society of Chemical Industry. The rusting of iron, he said, is not a direct oxidization process; indeed, the invisible oxide film produced by the direct action of air on stainless steel protects it against corrosion. On ordinary steel the corresponding invisible film gives no protection, unless an oxidizing agent is present to repair the skin as soon as a break-down occurs. That is why red lead is used on structural steel.

In the absence of such substances, steel corrodes when wet. Electric currents pass between the anodic places where the skin is in bad repair, and the cathodic places where it is in good repair. Most paint vehicles, whether linseed oil or nitrocellulose, absorb some water, and unless the lowest coat includes some anti-corrosive substance, attack occurs when the painted iron or steel is wetted.

At Cambridge and other places they have demonstrated that paint applied in the afternoon wears far better than painting done at sunrise, which had shut in an invisible moisture film usually present early in the day. Salt, if shut in under paint, as at a seaside place, draws in water and causes rapid failure.—*A. E. B.*

Dustless Ash Handling

IN these days when there is so much talk about the injurious effects of dust and noise on the populations of our larger cities, the news of a new and entirely practical method of removing ashes noiselessly and dustlessly will be hailed by all.

No longer will it be necessary for unsightly ash-cans to appear on the sidewalks of our cities; and the clouds of dust and ashes scattered over our streets, to say nothing of passing pedestrians and automobiles, may now be a thing of the past.

There may now be seen in New York City a new and patented system which, by means of a powerful suction, carries the ashes from the basements of buildings through a hose or pipe line directly to an air-tight steel receptacle mounted on a motor truck for carting away. The passing pedestrian would not even know that ashes were being collected if the operation of the system were not explained to him.

Even when fully loaded no ashes can be blown from the truck as it passes through the streets because the ashes are contained in an hermetically sealed tank.

The ash handling system above referred to has been developed by Mr. F. C. Allen, Jr., a pneumatic engineer, at 452 Lexington Avenue, New York City, under a basic patent controlled by Mr. Charles L. Tolford. Mr. Allen is President of the Allen Air Appliance Company, Inc.

The apparatus involves the use of two motor trucks. On one is mounted a 75 horsepower Continental motor operating a multi-stage "Triple-A" vacuum producer, together with two large dust filters.

On the other truck is mounted a large steel receptacle into which the ashes are drawn. This is known as the "ash dump unit" while the truck containing the engine and vacuum producer is known as the "power unit."

When filled with ashes, the ash dump unit is driven away to the point where the ashes are to be dumped and another empty ash dump unit takes its place, so that there is no loss of time and the system is in constant operation with the power unit going from one building to another.

Where the system is to be permanently used a pipe line is installed extending from the ash pit to the sidewalk. When ashes are to be removed, the truck therefore makes a quick connection to the pipe line at the sidewalk level and the ashes are drawn up into the truck at a rapid rate, it being possible by the method to load ashes at the rate of one ash-can every 30 seconds.

Bleaching of Paper Pulp Accelerated by Irradiation

A SWEDISH chemist, H. E. Wahlberg, has found that the chemical process of bleaching vegetable fibers with chlorine or hypochlorite for the manufacture of paper is furthered very substantially by being carried out under ultra-violet light. The direct bleaching effect of the light plays an unimportant part. The effect of the irradiation is almost exclusively of a catalytic nature.

If the bleaching liquid is irradiated alone, it will be decomposed; however, if the liquid immediately after the irradiation is brought into contact with bleachable materials, the bleaching will take place a little more quickly. A slight increase in the rate of bleaching can be observed if the bleachable materials are irradiated before the treatment. A surprisingly high effect is obtained, however, when the bleaching liquid and the materials are irradiated jointly during the bleaching process. The effect is increased further by a high concentration of the bleaching substance.

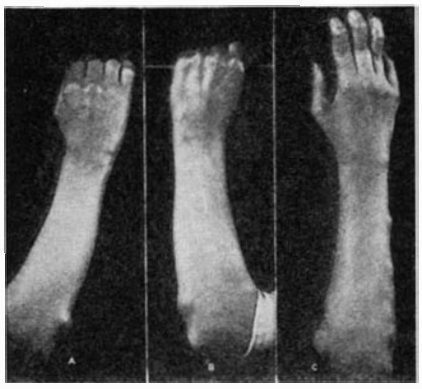
The advantages of this procedure are that the time required for complete bleaching can be considerably reduced and at the same time the process can be carried out at a lower temperature.—*A. E. B.*

Rheumatic Nodules

PEOPLE with chronic rheumatism not infrequently develop nodules under the skin. These nodules are conceived by many investigators as being one of the most im-

The ash dump unit which, when filled with ashes, is driven away to the dumping ground. Another dump unit takes its place so there is no loss of time

portant signs in this disease. They have been described over many centuries. Apparently some 20 percent of people with chronic arthritis have nodules of this character. They are usually associated with rheumatic fever, most frequently seen on the back of the forearm but also on the



Subcutaneous nodules in rheumatic arthritis. Note the typical "rheumatoid" deformity of hand at right

hands, knees, and scalp. The nodules develop slowly and last for several years, although they may come and go within a period of a few months. Seldom do they cause any inconvenience, except the annoyance of their presence.—*M. F.*

Photographic Films of the Andrée Expedition

AFTER 33 years without the slightest knowledge of the fate of Salomon August Andrée's expedition which attempted to reach the North Pole in a balloon, the world was thrilled and shocked last August with the news that his final camp with his diary, much of his equipment, and certain human remains had been found on White Island. Their balloon had landed on the ice July 14, 1897 and the expedition had wandered for weeks before finally succumbing to the rigors of the Arctic.

The fact that undeveloped photographic films, found in the ice with the remains, were later developed into recognizable pictures, thus giving the world visual evidence of the hardships suffered by the expedition, will surprise most people who realize the necessity, even today, of having films developed within a year or two after their purchase. The Andrée films were enclosed in copper containers but were thoroughly water-soaked nevertheless. It was only recently learned that they were manufactured by the Eastman Kodak Company, of Rochester, New York. Late in October the Kodak Company received word that the negatives had been developed, with successful results, by Professor Hertzberg, a Swedish photographic scientist.

The Arctic temperatures at which the film remained while it waited 33 years for discovery and development are understood to be largely responsible for the preservation of the pictures, since it is known that cold retards chemical action within film, provided that humidity is low. The Andrée material, produced about eight years after the company had begun to market transparent film, was manufactured at a time when experiments to yield large quantities of film of uniform quality were at their height.

In 1896, according to the Eastman Kodak

Company's records, the 100,000th Kodak was made and film and photographic paper were being manufactured at the rate of between 300 and 400 miles monthly. Film base, at that time, was still made by pouring the fluid nitrocellulose "dope" onto long glass tables to dry. It was not for several years that the continuous drum system for manufacturing the emulsion support, now in use at Kodak Park, was made practicable. Although the latter method improved the uniformity of the film base, the company, by the time the Andrée film was manufactured, had advanced the art of making sensitive emulsions to a high plane.

Recovery of Andrée's pictures increased the similarity of the discovery of Andrée's party to that of Scott, the British officer who reached the South Pole in 1913 only to perish with his companions in a blizzard that obstructed his return. Photographic film, also made by the Eastman Kodak Company, and developed the better part of a year after the death of the British party gave the world a posthumous photographic record of that expedition's struggles.

Unique Sulfur Mining Process

ENORMOUS quantities of sulfur exist in the earth's crust. It has been estimated that sulfur constitutes .06 to 1 percent, but a large part of the world reserves can not be estimated with precision. Such estimates vary from 56,000,000 to 121,000,000 metric tons, according to the United States Bureau of Mines.

The Texas Gulf Sulfur Company is the world's largest producer of sulfur. Second largest is The Texas Corporation. These two companies produced 2,363,389 long tons last year—nearly 80 percent of the world production. The accompanying photographs show some of the interesting operations of these companies.

Sulfur is mined by forcing superheated water down into wells where the hot water melts the sulfur so the liquid can be pumped to the surface. A six-inch pipe line carries the hot water down to the sulfur beds; inside this pipe is a three-inch line through which the sulfur rises to the surface; inside the three-inch pipe is a one-inch pipe which carries compressed air at 500 pounds pressure which forces the sulfur up to the storage vats. It is then poured out into a "vat" with wooden sides where it solidifies as it cools. A few inches each day is added to the surface of the "vat" until the block of solid sulfur is about 40 feet high. The wooden sides are then torn away, leaving a great block of the yellow sulfur, from which shipments are blasted as required.—*A. E. B.*

Asphalt-Aluminum Paint

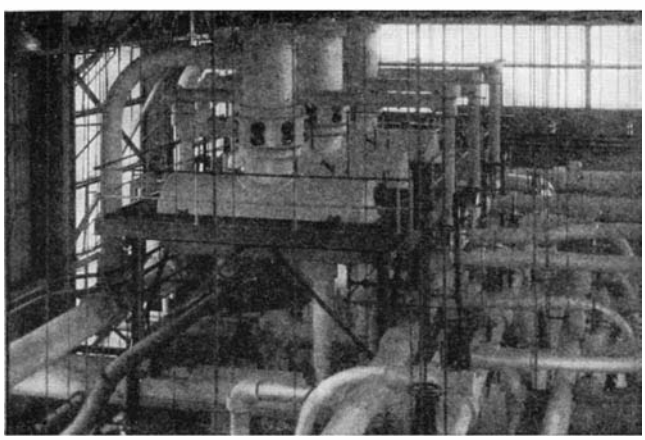
ASPHALT dispersed in a volatile solvent, plus flake aluminum, constitutes a new asphalt-base paint recently put on the market. The flake aluminum is prepared by stamping after which it is polished. A thin film of solvent-repelling polishing agent, which remains on the aluminum flakes, causes them to work their way to the outer surface of the applied coating before the asphalt begins to harden. The finish is, therefore, bright and highly reflecting, having at the same time great covering power and long life, according to the manufacturers.

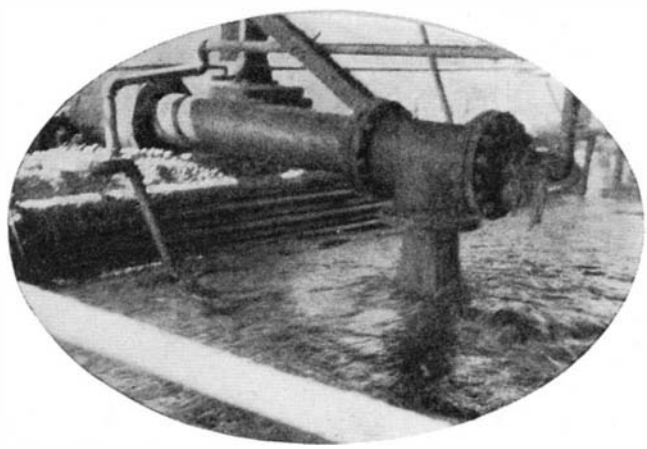
It is claimed that one coat of this material ordinarily will suffice, regardless of the previous color of the wood, metal, or other material to which the paint is applied. The material is also said to be very efficient as a priming coat for other paints. It is recommended for both interior and exterior work and is said to be particularly effective in reducing evaporation from metal tanks, due to its reflectivity. Its resistance against corrosive atmospheres is said to be excellent. —*A. E. B.*

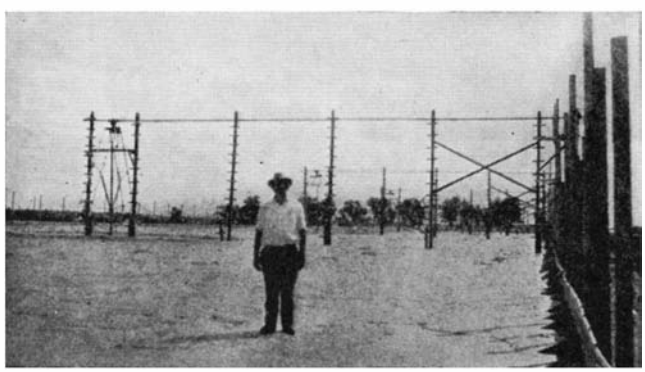
Cosmic Rays and Cancer

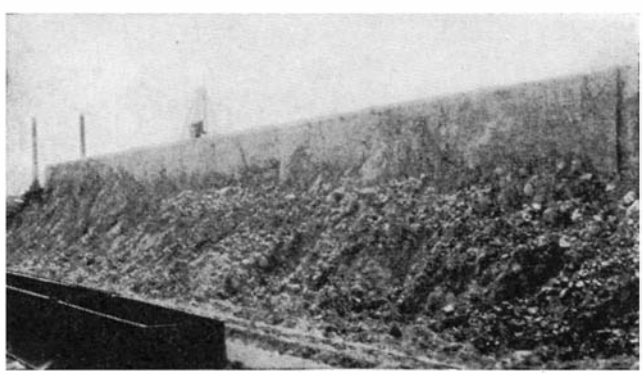
SO great is the field of cancer and we have so little actual knowledge as to its causation that almost any one's suggestion may be given a certain amount of credence. In an editorial in the newly established *American Journal of Cancer*, Dr. Francis Carter Wood has some interesting remarks on cosmic rays and cancer. He points out that sometimes a banker's views on medicine or art afford an evening's delight to the initiated, but that sometimes the productions of a scientist's imagination bring to mind the famous moon hoax of the New York *Sun*.

Prof. John Joly of Trinity College, Dublin, suggested in June, 1930, that a diminution in the strength of the cosmic rays may have something to do with the increased rate in cancer. The cosmic rays have been thoroughly investigated. They come to the earth from a great distance, and they resemble X rays and gamma rays of radium in that they can penetrate thick layers of matter without losing much of their energy. In this regard they are the most powerful rays known, for, after passing through 200 feet of water, 2 percent remain. Millikan estimates their energy to be about one tenth of that reaching the earth from the light radiation of stars. Professor Joly's notion is that these cosmic rays cause increase in cancer because









Water is superheated in the Cochrane jet heaters at upper left and forced into the ground where it melts the sulfur. The upper right picture shows molten sulfur pouring into a vat after being forced to the surface. *Lower left:* On top of a vat of solidified sulfur. *Lower right:* Another vat, which contained 650,000 tons of sulfur, after walls had been torn down

they are diminishing at present and that formerly they were sufficient in amount to exert a controlling influence on cancer growth.

In the November number of *Forum*, Professor Joly went much further. He assumes that an enormous increase in cancer has taken place, that cosmic rays in the past may have had destructive effects on cancer, and similar extraordinary assumptions.

Doctor Wood points out that any radiation which would have the slightest effect on a cancer cell would also affect the rest of the body by destroying all the white cells of the blood which are more sensitive to radiation than any cancer cell. The fact that the population of the world has increased steadily indicates that such rays could probably never have been very powerful since man's beginning on earth. Furthermore, statisticians know that the recorded increase in cancer is nearly, if not entirely, due to the improved diagnosis of the internal types of cancer. Most of the increase in cancer is in the form of cancer of the internal organs and in older people. Cancer is essentially a disease of old age and there are many more old people now than there used to be.

Hence it is not at all necessary to consider seriously the suggestions of Professor Joly. The pity is merely that a man of his scientific position in the field of geology should cast discredit on that field by venturing an extraordinary hypothesis in a field in which he has no standing. If Oliver Lodge had avoided spiritualism, and if other authorities in their own fields would let scientific medicine alone, the practitioners of that art and science would be enabled to avoid much of the wastage of time they now incur in contradicting unsubstantiated theories.—*M. F.*

Exercise in Disease

THE ancient Greeks emphasized a certain amount of exercise for keeping a human being in a healthful condition. Exercise, like every other form of treatment of disease, can be overdone. A special report made to the Council on Physical Therapy of the American Medical Association by Dr. J. S. Coulter and C. O. Molander distinguishes therapeutic exercise, or exercise used in the treatment of disease, from the ordinary exercise that is taken for the improvement of health.

In passive exercise, the patient lies still while the attendant moves the various muscles of the body. The doctors emphasize the fact that the spasm of a muscle during such exercise should be an indication for the operator to stop immediately. One of the chief uses of passive exercise is to restore motion to limbs that have contracted. For this purpose, it is pointed out that one movement of the limb through its fullest range is better than a series of movements within a shorter range. By making one or more motions of the limb through its fullest range, it is possible to produce gradually an increase in the range of movement. A dislocated or fractured limb is usually contracted and fixed in position. One of the chief aims of passive motion is to maintain suppleness and in this way to prevent contractures.

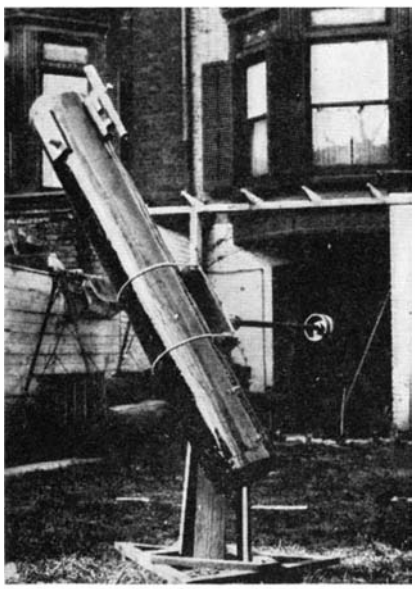
However, exercise by passive motion is not the same thing as stretching of a

(*Please turn to page* 205)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

"WE got through the grinding, polishing, and figuring without any trouble at all," R. S. Mudge, 856 Park Place, Brooklyn, New York, writes with reference to a telescope made by himself and two others, Joseph Rebold and Raymond Paul,



Mudge-Rebold-Paul telescope

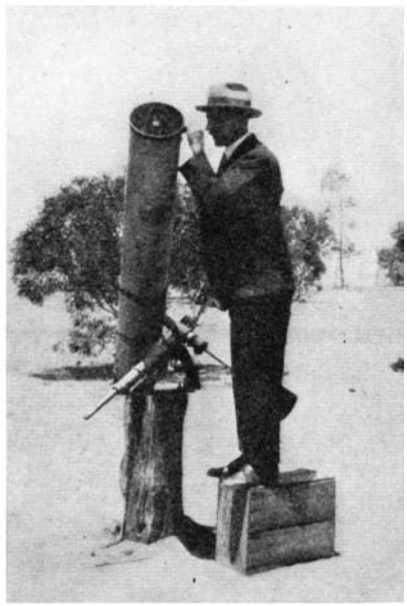
"but the silvering nearly stumped us. We tried it at least a dozen times without success, using grain alcohol; and then we tried rubbing alcohol and hit it the first time."

The Mudge-Rebold-Paul telescope is a six-inch and the dingbat attached to it, which shows in the photograph, is an extemporized camera for taking sun photographs.

W. LUTGE, Pinnaroo, South Australia, also had a little trouble but he "got there" just the same. "My telescope," he writes, "has an eight-inch mirror and I ground and polished three mirrors before I succeeded. No. 1 was broken by a fall, No. 2 cracked due to an icy draught when hot. (This is exactly what happened to Brashear on his first job, as told in his autobiography. —*Ed.*) I polished the third mirror on an HCF lap which I found much quicker than the pitch laps I tried first. I found the Foucault test difficult at first but at all times most interesting.

"We have an Astronomical Society in Melbourne and a few of the members are telescope makers. Most Australians, like myself, had considered that making an efficient telescope was outside the scope of the average person. I consider the instruction book 'Amateur Telescope Making' wonderful. I would be willing to help any Australian amateurs who might wish it. My telescope gives beautiful views of the moon, belts of Jupiter, rings of Saturn, and many double stars and star clusters visible in the southern hemisphere."

"THIS is a real alley telescope." So says Henry Kramer, 4338 North Fort Street, Detroit, Michigan, in describing his "coal scuttle" reflector. "But it, too, 'gits thar just the same'," he adds. "There are no details on such maps and photographs of the moon as are in the libraries of Detroit which can not be located with this eight-inch reflector,



Made in Australia

The Detroit coal-scuttle mounting with its assisted apple-tree pedestal

as crude as the set-up is. The HCF lap is far superior to the pitch lap; it worked faster and was so adaptable that any kind of variation for correction could be had. There was no need of the bootlegger's services, as the rubbing alcohols, Alcorub and Alcol, were all right and silvering was easy. It is just possible that a new planet will be discovered (?) any night now, as we are blazing away with a Kodak trying to make a photo, though no one has profited so far except Mr. Eastman."

Mr. Kramer's attachment, a coal scuttle with its bottom knocked out, is for excluding stray light from houses and street lamps, also for discouraging the activities of stray fingers which seem to have a fatal attraction for one's nicely polished mirror.

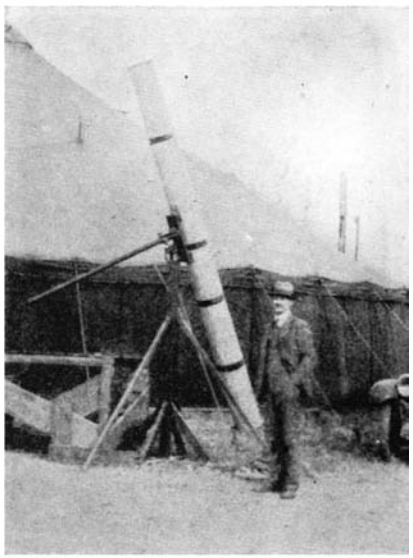
"AS I live in a small furnished room, and have no access to tools, I was forced to attempt something light, portable, and easy to make." So says John Ortueta, 222 East 11th Street, New York City, who continues: "The telescope shown in the photograph was made mostly with tools and materials bought in the ten-cent stores. It is similar in principle to the one shown in 'Amateur Telescope Making' on page 29. It consists of a mahogany box open at one side, containing the five-inch mirror. When not in use the box stores the prism and eyepieces behind a small lock. The main column is of wood and is jointed and adjustable. The whole thing folds into as small a space as a camera, yet is easy to assemble and weighs less than ten pounds. It is equipped with slow motion and a finder."

C. D. FREEMAN, Care E. P. Maxted, R.4, Caldwell, Idaho, uses his telescope "in connection with a series of lectures on astronomy," and, he adds, "thou-

M. Ortueta and folding reflector

sands of people have had the privilege of looking through it." His mounting is constructed of pipe fittings and the eyepiece is on the polar axis. The mirror is a ten-inch and the rather elongated tube is quite impressive.

WORD has been received from Miami that Professor G. W. Ritchey arrived there from Paris with the Ritchey-Chrétien telescope he expects to use in making a



Freeman's long tube mounting

study of the seeing conditions in that locality. With him is G. H. Lutz who has cast a 36-inch Stellite mirror which Professor Ritchey also expects to figure and test. The newspapers have given the impression that a very large observatory was about to be built in Miami. Perhaps this is a bit "previous," as it never is wise to expend large sums in this manner until the local seeing has been well tested. The Ritchey-Chrétien telescope is a modified Cassegrainian having mirror curves which do away with the distortion of out-of-axis images, giving a flat field.

WHEN Brother-amateur-telescope-maker Clyde W. Tombaugh, after diligent search, spotted the image of the planet Pluto on a plate at the Lowell Observatory, where his diligence and enthusiasm had won him a job some time previously, there was a certain tendency to minimize his contribution. Some said he merely happened to be the one to look over the plate and it was stated by one astronomer that Tombaugh was no more the discoverer of Pluto than the seaman at the masthead of Columbus' ship was the discoverer of America because he happened to see its shoreline first. Tombaugh's modesty and good taste kept him entirely clear of controversy and now, as so often happens in science, honor pursues him who runs away from it (just as it usually avoids him who runs after it). The Royal Astronomical Society, the association of professional astronomers of Great Britain, has just awarded Tombaugh the Jackson-Gwilt Medal of that society. Other telescope makers who aspire to gold medals may be encouraged by the thought that there are other worlds to conquer, there being no assurance that Pluto is the last planet in the solar system.

CURRENT BULLETIN BRIEFS

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

How to Repair and Refinish Furniture describes the use of a crack filler and a remover for ground-in dirt. *Savogran Company, Boston, Mass.—Gratis.*

Design in Industry is a publication giving a digest of new literature relating to the subject. Critical notes and prices are given. *Non-residents of Newark, N. J., are put on the mailing list for 25 cents to cover postage. Newark Public Library, Newark, N. J.*

Nickel Alloy Steel Forgings (Nickel Steel Data and Applications No. 17) by Charles McKnight gives the salient facts relating to these important alloy steels. *The International Nickel Co., 67 Wall St., New York, N. Y.—Gratis.*

The Piped Fuel Bucaboo (Reprinted from *Railway Age*, Dec. 13, 1930) by C. V. Beck holds that coal is the most economical fuel in all important coal-consuming areas. *International Carriers, Ltd., 120 Broadway, New York.—Gratis.*

Railroad Equities, a survey by John W. Barringer, III, gives much valuable information about natural gas, coal, and fuel oil. The fuel statistics are equated to common bases. *International Carriers, Ltd., 120 Broadway, New York.—Gratis.*

Archæological Explorations in Peru—Part II. The Northern Coast (Anthropology, Memoirs, Vol. II. No. 2) by A. L. Kroeber describes the first Marshall Field Archæological Expedition to Peru. *Field Museum of Natural History, Chicago, Ill.—$1.50, postage extra.*

One Month in Southern California and What Will It Cost gives a travel program for an entire month. There are also details as to the cost of each day. Certainly breakfasts at 40 cents, luncheons at 50 cents, and dinners at 85 cents sound good. The average expense per day, including sight-seeing, figures out $7.17. *All-Year Club of Southern California, Ltd., 1151 South Broadway, Los Angeles, California.—Gratis.*

City Noise (Report of the Commission appointed by Shirley W. Wynne, Commissioner of Health, to study noise in New York City and to develop means of abating it) by Edward F. Brown, E. B. Dennis, Jr., Jean Henry, and G. Edward Pendray, is a monumental treatise on a most important subject. It is a book of 308 pages which is sent free to interested persons. Address *Edward F. Brown, Director, Noise Abatement Commission, 505 Pearl St., New York.*

M-S-A First Aid Materials (Catalogue No. 7A-2) is an excellent catalogue dealing with first aid material put up in very usable form.—*Mine Safety Appliance Co., Pittsburgh, Pa.—Gratis.*

Flora of the Yucatan (Botanical Series, Field Museum of Natural History, Publication 279, Vol. III) by Paul C. Standley, is a splendid monograph of 492 pages which only a great institution of learning would be justified in publishing.—*Field Museum of Natural History, Chicago, Ill.—$2.00, (postage extra).*

Note on the Electrical Resistance of Contacts Between Nuts and Bolts (Research Paper No. 227, Reprint from Bureau of Standards, Journal of Research Vol. 5, September, 1930) by Frank Wenner, G. W. Nusbaum, and B. C. Cruikshanks, describes researches on the electrical conductivity of Dardelet threaded connections. *Dardelet Threadlock Corporation, 120 Broadway, New York.—Gratis.*

Greek-Roman Treasures of German Museums, edited by Karl Kiesel and Ernest O. Thiele, is a beautifully printed pamphlet giving a complete index of German museums which have notable Greek-Roman treasures. *Terramare Office, Wilhelm-Strasse 23, Berlin S. W. 48, Germany.—Send two International Reply Coupons obtainable at any post office.*

Music in Germany is a delightful little pamphlet giving information as to music centers, music schools, and recent musical literature. It is one of a series of most informing pamphlets on phases of culture in Germany. *Terramare Office, Music Department, Wilhelm-Strasse 23, Berlin, S. W. 48, Germany. Remit two International Reply Coupons which can be obtained at any post office.*

Profitable Farm Management and Sale by C. J. Cassen, President, Farmer's National Company which is now managing 603 farms comprising 228,683 acres. A perusal of this book will benefit almost any farmer. *Farmer's National Company, 1708 Farnam St., Omaha, Neb.—50 cents.*

A Mint in New York (Numismatic Notes and Monographs No. 45) by Bauman L. Belden gives an account of why New York did not get a mint but did get an assay office which in time obtained a new building; the old façade is now a part of the American Wing of the Metropolitan Museum. *The American Numismatic Society, Broadway at 156th St., New York, N. Y.—50 cents.*

Parachute Supplement, Air Commerce Regulations (Aeronautics Bulletin No. 7-D, United States Department of Commerce, Aeronautics Branch). *U. S. Dept. of Commerce, Aeronautics Branch.—Gratis.*

Our Defective Calendar. E. K. Eason of Dublin has written a study of some aspects of the problem, more especially in support of the retention of 12 months in a fixed calendar. *Eason & Son, Ltd., Dublin, Irish Free State.—1 shilling.*

Rate of Growth of Second Growth Southern Pines in Full Stands (Circular 124-C, United States Department of Agriculture) by R. D. Forbes and Daniel Bruce. The authors think that growing new timber is the only way to keep the pine industry of the south from "going back." *Office of Information, U. S. Department of Agriculture, Washington, D. C.—Gratis.*

Calculating Waterfowl Abundance on the Basis of Banding Returns (Circular No. 118, United States Department of Agriculture) by Frederick C. Lincoln suggests what seems to be a reliable method of calculating the fluctuations in the numbers of waterfowl. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Rat Proofing Buildings and Premises (Farmer's Bulletin No. 1638, U. S. Department of Agriculture) by James Silver, W. E. Crouch, and M. C. Betts gives the best method of rat proofing in structures of all kinds. The diagrams are very clear. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Minerals and International Relations (No. 266 of International Conciliation) by Sir Thomas H. Holland, Vice-Chancellor and Principal of the University of Edinburgh deals with the international relationship of minerals and international movement of mineral products in peace and war. *Carnegie Endowment for International Peace, 44 Portland Street, Worcester, Mass.—5 cents.*

Gluing Wood in Aircraft Manufacture (Technical Bulletin No. 205, United States Department of Agriculture) by T. R. Truax is an elaborately illustrated monograph which will be of use to any person who uses glue in any form. It gives formulas for glues which are patented but which are for the free use of the people of the United States. *Superintendent of Documents, Washington, D. C.—25 cents (money order).*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 201)

contracture or adhesion. The purpose of stretching is to loosen contracted ligaments, muscles, or adhesions. The untrained operator is likely to attempt such stretching before inflammation has subsided. It is well established that stretching should never be attempted until the inflammation around the joint or in the joint has disappeared. In order to stretch a limb that has contracted, it is necessary to pull slowly and steadily with gradually increasing weights. Whenever soreness or pain develops, it is safer to stop the motion and to apply heat and permit resting until the pain and soreness have disappeared. Pain that disappears within an hour after the treatment is usually not serious.

In active exercise the patient himself produces the motion with or without the supervision of the operator. Active motion may involve the use of apparatus, such as pulleys or weights. They may be free motions of the arms or they may be resistive motion, in which the muscles push against resistance of various kinds. Far too often, a patient is told merely to exercise an arm or a leg. Little can be accomplished that is of value by this method. The only way to get proper results is to direct the nature of the exercise toward a definite purpose. It is customary in such cases either for the physician or his assistant to watch the work or else to give written instructions so that it will be carried on in a definite manner.—*M. F.*

FINE-GRAIN SUGAR PRODUCED

IN order to provide granulated sugar that will dissolve quickly in iced drinks, sugar refiners have experimented with various methods of reducing the grain size. The latest method of attaining this fine grain sugar, known as the Varnau-Wayne process, is now in commercial operation in Texas.

The new process is a radical departure from customary practice for finely granulated sugar. It starts with a syrup of much lower density. A practically grain-free syrup is obtained by evaporating in a series of vacuum pans and finally in a finishing pan. This concentrated syrup is then chilled suddenly by squirting it as a mist or thin film into an air or vacuum chamber, giving an instantaneous super-saturation effect and causing minute crystals to form at once. The method produces a new type of extremely fine-grained sugar, readily soluble, and very pure. The process is continuous and nearly automatic, so that most of the personal factor is eliminated. Thus the product is more uniform than with vacuum-pan methods.

When you buy a two-pound box of this sugar at the store, you may notice that the box is larger than a two-pound box of ordinary granulated sugar. Do not be misled, however, for the difference in size is merely due to the fact that the new type of sugar bulks larger per pound than the old.—*A. E. B.*

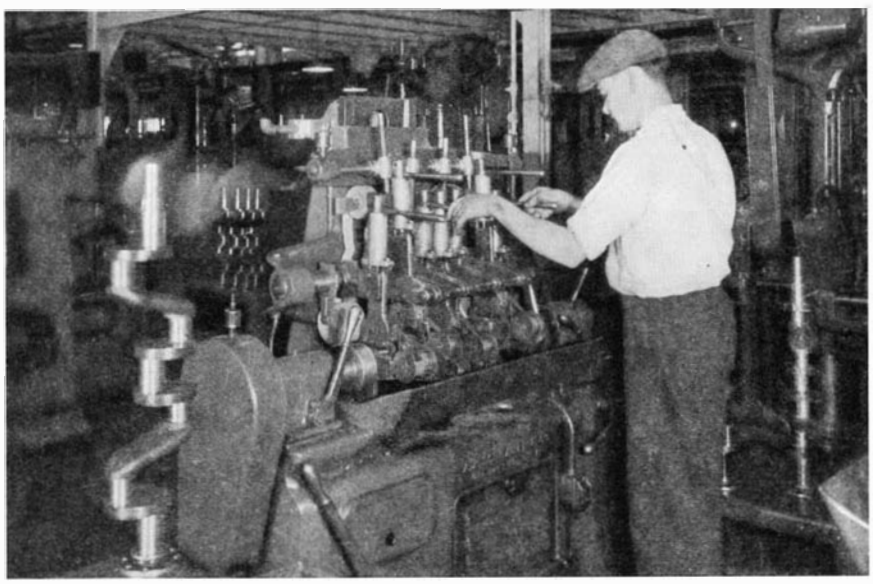
Polishing Seven Bearings In One Operation

BEARINGS of the Ford crankshaft are being polished to a much finer degree as the result of the development of machines that finish all seven main and connecting-rod bearings in a single operation.

After the crankshaft has received its final grinding and has been statically and dynamically balanced it is placed in a specially built lapping machine which has seven arms—one for each bearing. Each arm holds six very fine lapping stones or hones which clamp around the bearings under heavy pressure. The shaft is rotated and also oscillated until no roughness from the grinding operations remains.

To insure an absolutely smooth and bright finish, the shaft is then placed in a similar machine which holds an extra fine polishing paper instead of the lapping stones. Again it is rotated and oscillated, after which the bearings are cleaned and inspected.

This process gives the bearings a mirror-like smoothness which reduces friction and makes easier the breaking-in period of the car. The polishing paper used in the second machine is fed automatically so that there



This ingenious machine polishes all seven of the main and connecting rod bearings of the Ford crankshaft in a single operation, thus obtaining uniformity

is a fresh supply for each crankshaft. This, with the oscillating motion, permits a more uniform finish than was possible under the old method of polishing each bearing separately on a revolving wheel.

Self-Vulcanizing Rubber Compound

RESURFACING rubberized material, or lining metal equipment with soft rubber is possible with a new rubber compound known as "Covulc," made by the Hitchcock Company, 48 Pearl Street, Boston, Massachusetts. This is a soft, plastic rubber compound made in various colors, which is applied to a surface in the form of a paste, and rapidly vulcanizes itself when exposed to the air. After vulcanizing it is said to remain soft and flexible during its life.

The material is available also in the form of sheets already vulcanized to a fabric or wire-mesh base. In this form, it may be cut to any size desired, for lining chutes and hoppers. Either form is easily applied, according to the manufacturer. For example, in repairing a conveyor belt, the cleaned belt is brushed with a special cleaning fluid and coated with a rubber solution. Then the plastic rubber is applied with a spatula or putty knife and smoothed with a glass roller. The material is reported to vulcanize sufficiently in about three hours, and under hot and dry conditions in even less time—*A. E. B.*

A Stationary-Head Engine

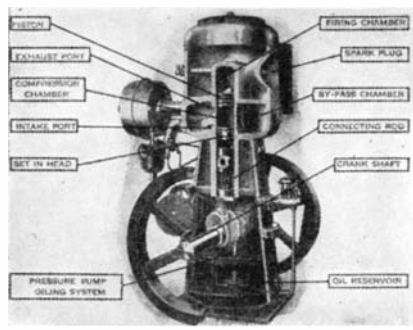
A TWO-STROKE gasoline engine that is claimed to eliminate objectionable features of the conventional type of engine, both two-stroke and four-stroke, has been perfected by the Scott Two-Stroke Motor Company, of Kansas City, Missouri.

Perhaps the most unusual feature of this new engine is the stationary piston, or set-in head which effectively seals the firing chamber against leakage of gasoline into the crankcase and cushions the strokes of the moving piston. The latter is hollow, or rather, it takes the form of a sleeve which slides between the stationary head and the cylinder wall. The motor is termed a piston valve engine because of the port arrangement of the moving piston and the cylinder. It fires with every revolution of the crankshaft.

There are in reality two chambers in the cylinder. The lower chamber inside the hollow piston is the suction and supply chamber while the upper one is the compressing and firing chamber; and both handle gasoline. This unique design eliminates all crankcase gasoline and crankcase compression or displacement, thus doing away, it is claimed, with the basic faults of two-stroke engine design. It also creates a positive measured action for each charge without leakage or adulteration of fuel.

An accompanying illustration shows clearly the unique piston design, performing function of piston, sleeve, and valve in one moving part. It also shows the elimination of such parts as valves, valve springs, tappets, triggers, rollers, push rods, rocker arms, cam shaft, and cam shaft gears.

It is expected that this motor will be seen



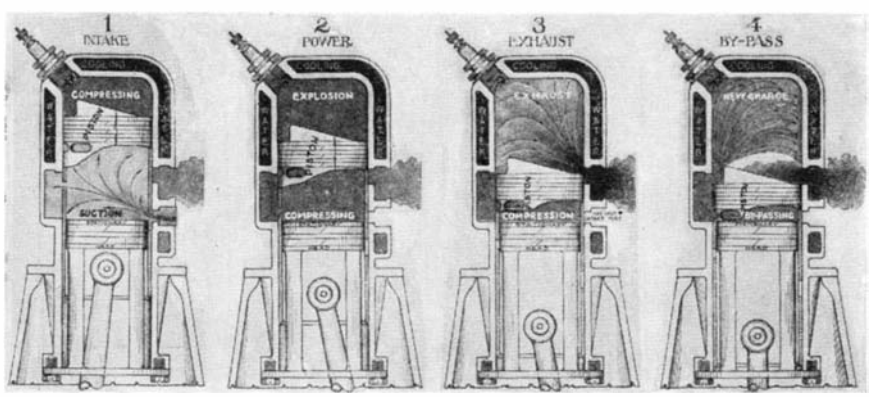
Cut-away drawing of the two-stroke, stationary-head gasoline engine

in the air in the very near future. This company has now designed, and is ready to manufacture a small two-cylinder motor for use in power gliders. It will be 48 horsepower, air-cooled, and the weight will be 80 pounds. Also, a four-cylinder, 100 horsepower; a six-cylinder, 150 horsepower; and an eight-cylinder, 250 horsepower engine will be made.

The Flow of Milk

THE establishment of the important fact that an infant does better on mother's milk than on any other food substance has caused investigators to devote considerable attention to measures for increasing the flow of milk or for stimulation in instances in which it seems to be relatively absent. Careful studies have shown that nervous shock and the emotional states and environment of the mother will affect the flow of milk. It is generally believed that substances secreted into the blood of the mother from various glandular organs stimulate the enlargement of the breast and the flow of milk, but the evidence is contradictory and certainly not conclusive.

Studies recently made by Icie Macy and her colleagues in the Children's Hospital in Detroit seem to indicate that suckling by



The cycle of operation of the stationary-head engine described above

the child is not necessary for the stimulation and continuance of heavy milk flow in women, since frequent and thorough stripping of the breast by hand or by the use of pumping devices brings about a ready and large flow of milk. An instance is known in which a woman produced as much as six quarts of milk in one day and was able to nurse from one to seven babies for a period of 51 weeks. In the cases of the mothers tested in Detroit, the average daily output of milk from the sixth week through the 14th month was two and one half quarts a day. One mother produced three quarts, another two and one half, and another only one and one half. Apparently the removal of the milk from the breast encourages secretion, whereas accumulation of the milk discourages it.—*M. F.*

CHEMICAL CAULKING FOR CONCRETE OR MASONRY

THERE has recently been developed, in Germany, a chemical process for caulking and strengthening deteriorated masonry. It consists of forcing two different chemical solutions into the rock or masonry to be strengthened. The rock, masonry, or concrete is first impregnated with silicic acid solution. The second solution is then sprayed into it, causing a chemical reaction. This procedure is more advantageous than proofing with cement slurry, since the solutions enter into the finest pores and hair-like cracks of the structure to be proofed. It can be applied to any depth, the solutions being forced in at any desired pressure. It is reported that this treatment has been successful in preventing the inflow of water in mine shafts and in strengthening masonry loosened by the action of the water.—*A. E. B.*

Electrolytic Metal Cleaning

A NEW and promising process for cleaning metal surfaces by electrolysis has been patented recently and is said to be free from the disadvantages heretofore associated with electrochemical cleaning—pitting, corrosion and embrittlement. As described in *Chemical and Metallurgical Engineering*, the new process would seem an improvement also over sand blasting, scratch brushing, and tumbling.

A special feature of the Bullard-Dunn process, as it is called, is the use of a metallic film which is deposited on the metal to be cleaned the instant each particle of scale is removed. So that the metal may be completely protected from attack by the bath, the film is itself a metal, resistant to the bath, such as lead, tin, or zinc.

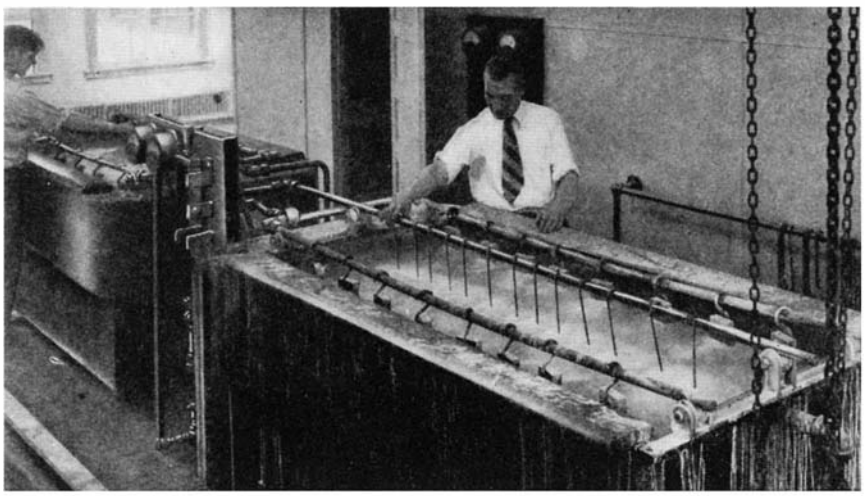
The process is extremely simple in operation. Equipment includes two steam-heated, ventilated tanks, and two wash tanks. The acid tank is lined with lead or rubber and the caustic tank is made of iron. Anodes are made of whatever metal—as, for example, lead—is to be used for the protective film; or if metal salts are to be added directly to the bath, the anodes are of carbon. The cathodes in any case are the objects to be cleaned. The current supply is six volts direct current.

Solution for an acid bath using lead anodes contains a few ounces each of sulfuric acid, hydrochloric acid, and common salt per gallon of water. The caustic solution contains a small quantity of tri-sodium phosphate, soda ash, and caustic soda. The acid bath is operated at about 150 degrees, and the caustic bath at about 200 degrees Fahrenheit.

If the piece of metal to be cleaned is covered with dirt and grease, as well as scale, it is first suspended as the cathode in the caustic tank. Between the action of the solution and the electrolytically released hydrogen, which evolves on the metal surface, the dirt is very quickly removed. After a hot water wash, the piece is suspended as the cathode in the acid tank, where, assuming that the protecting film is to be lead, action is roughly as follows:

Ionic hydrogen, resulting principally from the dissociation of water, migrates to the cathode and, losing its charge in contact with the metal underneath the oxide scale, is evolved in minute bubbles of molecular hydrogen. The hydrogen, in expanding, pries off the scale, bit by bit, and bubbles to the surface. And as soon as any bit of metal is exposed, lead-ion deposits on it as a thin, adherent, protective film.

This prying and coating action goes on continuously until all of the scale has been removed. All of the action is very rapid and takes ordinarily only a few minutes even for a large object. The several advantages of the process, such as complete protection for the parts treated, excellent cleaning even in such hard-to-get-at places as the roots of threads, its low cost of operation, and its foolproof character, would seem to make it a most attractive possibility for many metal industries.—*A. E. B.*



Greasy, rusty, scaly metal parts are made "good as new" electrolytically

OUR POINT OF VIEW

(*Continued from page* 157)

among the Hindu and Moslem delegates and the willingness of the Princes of the independent Indian States to join the proposed federation, brought about the agreement.

After the tentative agreement is legalized the difficulties of putting these changes into operation in India will be great, and Mr. MacDonald has selected as the successor of Lord Irwin, the present Governor General of Canada, Lord Willingdon. The English press is practically unanimous in approving this selection, and the rest of the world will wish the new Viceroy well, for the removal of the present unrest in India will do much to decrease the present depression in world trade.

Panama Joins the Insurgents

THE Panamanians could not resist the impulse to indulge in the revolutions recently so prevalent in Latin America and have overthrown the government of President Arosemena. During the brief hostilities a few natives were killed and wounded; one American, Mr. H. F. Ayers, a newspaper correspondent, was mortally wounded. There were many indications of dissatisfaction with the Government prior to its overthrow, but few observers believed the insurgents would dare forcibly to overthrow the government in the presence of our army garrisons in the Canal Zone.

We realize the difficult situations that have confronted the State Department in this unprecedented series of Latin American revolutions, and without the complete information in the possession of our Government, we will not express an opinion but we wonder if the time is not at hand when we should at least assist in preserving order in Panama and Cuba.

The Bank of International Settlements

ALREADY the functions of this latest institution in world banking are expanding, and under the able management of its American president, Mr. Gates W. McGarrah, we may expect it to continue to enlarge its field. At present the founder members own stock as follows: Banking groups in the United States and Japan, 8 percent each; Bank of England, Bank of France, Bank of Italy, Bank of Belgium, and the Reich Bank, 8 percent each; and they elect 16 of the 25 directors. These members have allotted 2 percent of stock to banks, mostly state banks, in each of the following states: Holland, Sweden, Switzerland, Denmark, Austria, Hungary, Poland, Czechoslovakia, Rumania, Greece, Bulgaria, Finland, and Danzig, their interests being represented by nine directors. The remaining 18 percent of stock will be issued to states like Spain and Jugoslavia when they put their banking and currency systems in order, and request to join.

The capital stock is only 20,000,000 dollars, yet on December 1, 1930, its resources were over 360,000,000 dollars. The bank has been extremely conservative in investing its resources so that they can be quickly liquidated.

In addition to acting as Trustee of Reparations, the bank has endeavored to assist Germany in her recent financial crisis by purchasing reichmarks; and has made certain advances to Eastern states whose interest rates were considered excessive. The bank endeavors to level out rates of exchange between various states by transferring capital from markets of low interest to those of high interest.

The bank authorities are now considering whether it shall be made a clearing house for private international payments. Unquestionably that would be a useful and profitable international banking function, but such action would almost certainly cut into the profits of national banks specializing in foreign exchange, create jealousy, and perhaps lead to its eventual abolition. As stated previously in these columns, we believe this bank is destined to be an extremely useful agent for international trade, unless it is choked in its infancy by jealous national banks or extinguished in some future world war, before provision can be made for its preservation. The fostering parents of this promising infant should not develop it too rapidly, or selfish and short-sighted financial interests may strangle it.

China—Customs—Abolition of "Likin"

THE world powers only recently granted China a measure of control over her import duties on condition that "Likin," the tax levied by Chinese provincial authorities on goods as they pass from province to province, be abolished. At least two provinces, one of them Shantung, is continuing the old interior tax in addition to the increased customs paid at the seaports.

The Nanking Government is unable to prevent these local imposts, largely because it is financially unable to maintain an adequate army to enforce its edicts. The long-continued refusal of the world powers to permit import taxes sufficient to support the central government is one of the fundamental causes of the present condition.

President Chiang Kai-shek and Marshal Chang Hsueh-Liang, over-lord of Manchuria, are apparently still working together, and their co-operation continues to be the brightest hope of China. Marshal Chang needs 20,000,000 Mexican dollars, to equip his army and rehabilitate North China. Finance Minister Soong has not yet approved the flotation of this loan. If some assurance could be given that the money would be honestly and efficiently expended, this loan could easily be obtained in Canada, the United Kingdom, or the United States. The authority of the Nanking Government could be gradually extended into the interior with the well equipped army that the loan would make possible; and probably order could be restored in China. As the desire of the great powers to retain China as a dumping ground for their surplus manufactures was one of the fundamental causes of the continued weakness of the Central Government, they should be willing to take some financial risks in an effort to rehabilitate China. Desperate situations require desperate remedies, and only strong and helpful measures can improve the conditions in China. We have long been a disinterested friend of China. We should support the measures suggested by Senator Pittman and Premier Bennett, and in doing so we shall probably help ourselves as well as the Chinese.

PROGRESS IN 1930

(*Continued from page* 167)

M. R. Harrington of the Southwest Museum, and were widely regarded as important evidence regarding early American inhabitants.

The oldest known culture in the world, originated by the so-called "Japhethite" peoples of nearer Asia, was reported by Prof. E. A. Speiser of the University of Pennsylvania.

A temple built by Nebuchadnezzar and other discoveries were made at Ur of the Chaldees by the expedition of the University of Pennsylvania Museum and the British Museum.

Meteorological balloons were first used in aerial photography of archeological excavations by the Megiddo Expedition of the Oriental Institute clearing the mound of ancient Armageddon in Palestine.

A tomb containing mummies of two Egyptian princesses was examined by the expedition of the Metropolitan Museum of Art, and a fine copy of the Book of the Dead was brought to America.

The greatest collection of Ptolemaic mummies ever found in one tomb was unearthed in a mastabah, or flat-topped tomb structure, at Meydum, the great national burying ground of the aristocracy of ancient Egypt.

The discovery of a tomb, called the largest private tomb found in Egypt, was made near the Sphinx at Giza by Prof. Selim Hassan Effendi of the Egyptian University.

A second skull of *Sinanthropus* was recovered from material taken out of the limestone caves at Choukoutien, about 40 miles from where the original "Peking Man" skull was found in 1929.

Astronomy

A new planet, the first to be discovered since 1845, was found photographically with a 13-inch telescope at Lowell Observatory in approximately the place predicted by the late Prof. Percival Lowell, founder of the observatory, who died in 1916. The planet, which is farther from the sun than any other yet discovered, was later named Pluto.

Inter-stellar space, especially in the plane of the Milky Way, is not transparent, but filled with diffuse material that absorbs a considerable amount of light from distant stars, thus making the previous estimates of their distances too large, it was indicated by researches of Dr. R. J. Trumpler, of the Lick Observatory, supported by independent work of Dr. Piet van de Kamp, of the Leander McCormick Observatory.

A faint group of nebulae was found to be apparently speeding away from the earth at the rate of 7200 miles a second, the highest astronomical speed yet recorded, by studies of Dr. Edwin P. Hubble and Milton L. Humason of Mt. Wilson Observatory; but it is supposed that the effect is really an illusion, due to curvature of space.

Many stars are spinning at the rate of 40 miles a second, 150 times the speed of the earth at the equator, it was discovered by a new method developed by Dr. Otto Struve of the Yerkes Observatory in collaboration with a Russian astronomer, Dr. G. Shajn.

An unusually large display of Leonid meteors was visible on the early morning of November 17, suggesting the possibility of a brilliant shower in November 1932, 1933, or 1934.

The theory that stars have a structure similar to that of an egg, a dense yolk in the center, surrounded by a lighter material, was advanced by Prof. E. A. Milne, Oxford University, England.

A new theory of the construction of the universe, that it constitutes a huge system made by the condensation of a loose swarm of smaller clusters of stars which were originally like the mysterious spiral nebulae, was proposed by Dr. Harlow Shapley, Director, Harvard College Observatory.

The surface of the moon is apparently covered with volcanic ash, researches conducted by Dr. B. Lyot of the Paris Observatory indicate.

The theory that the earth may have a comet-like tail sometimes visible as a faint patch of light called by astronomers the "Gegenschein," was advanced by Dr. E. O. Hulburt, of the United States Naval Research Laboratory.

The length of Neptune's day was found by Dr. J. H. Moore of Lick Observatory to be about 16 hours.

A new 50-foot interferometer, a giant instrument for the measurement of the diameter of stars through the interference of reflected light waves, was completed at Mt. Wilson Observatory in California.

Arsenic and germanium are both present in some meteorites that fall to the earth, it was discovered by Dr. Jacob Papish and Zaida M. Hanford, Cornell University chemists.

America's first planetarium in which the observer may at will see a fascimile of the heavens as they look at any time and from any place, was opened on May 10 at Chicago.

The discovery of seven comets was announced during the year, though one was not confirmed and another was a return of a periodic visitor. The first and fourth were discovered by Drs. Schwassman and Wachmann, of the Hamburg Observatory, Germany, though the former was independently found by L. C. Peltier, an amateur astronomer of Delphos, Ohio. The second was discovered by Beyer, also at Hamburg; the third by Wilk, of Cracow, Poland; the fifth by D. L. Forbes, of Rondebosch, South Africa; the sixth was the re-discovery of Tempel's second comet by Dr. George van Biesbroeck, of the Yerkes Observatory and the seventh was by Nakamura, of the Kyoto Imperial University, in Japan. Efforts of American astronomers to find Nakamura's comet, which Japanese dispatches said had been observed by Sibata, of the same observatory, were unsuccessful, however.

Chemistry

The existence of rotating molecules in solid compounds was reported by Prof. Linus Pauling, of the California Institute of Technology, and Dr. Sterling B. Hendricks, of the Fixed Nitrogen Laboratory, United States Department of Agriculture; this discovery has an important bearing on the heat capacities of solids.

The chemical puzzle of the structure of the crystal of the silicates was solved by William L. Bragg, Victoria University of Manchester, England, and Professor Linus

Pauling, of the California Institute of Technology.

A new gas for use in electric refrigerators, non-poisonous and non-inflammable, which is a compound of carbon, chlorine, and fluorine, was the invention of Thomas Midgley, Jr.

Carotin, the stuff that makes some foods yellow, is important for nutrition as well as the green chlorophyl, because vitamin A is associated with this color in vegetables, butter, and egg yolk, it was discovered by S. M. Hauge and J. F. Trost of the Purdue University Agricultural Experiment Station.

Bacteria obtained from brewer's malt may now be pressed into the service of the chemist to eat away the cell walls of plant tissue and liberate the vegetable oil, according to a method developed by John Woods Beckman, Oakland industrial chemist.

A device for removing carbon monoxide from the exhaust gases of an automobile by means of a catalyst was demonstrated by the inventor, Dr. J. C. W. Frazer of Johns Hopkins University.

The richest source of helium yet discovered, a natural gas in southeastern Colorado containing 7 percent of helium, was reported by F. F. Hintze, of the University of Utah.

Crystals of rubber were obtained for the first time in the chemical laboratories of the U. S. Bureau of Standards.

Engineering

After a third attempt, Prof. Georges Claude was successful in obtaining power from the temperature difference in the ocean water at the surface and in the depths of the tropical seas off the Cuban coast.

The two longest steel arches in the world were closed; the Kill Van Kull bridge at New York with a 1675-foot span and the Sydney harbor bridge, Australia, with a 1650-foot span.

Final work was done on the new Welland canal, a mammoth structure built by Canada to pass sea-going lake grain vessels up and down the 326.5-foot difference in elevation between Lake Erie and Lake Ontario.

Plans were made and bonds authorized for the 35,000,000-dollar Golden Gate Bridge at San Francisco, the center suspension span of which will be 4200 feet, the longest in the world.

The Detroit-Windsor vehicular tunnel, connecting Canada and the United States beneath the Detroit river, was opened to traffic.

A severely streamlined railway car driven by a 400 horsepower airplane engine and propeller sped more than 100 miles per hour on a straight track in Germany.

The world's longest concrete arch bridge was built at Brest, France, with three spans, each of 612 feet.

The *Europa*, new German ocean liner, entered service and became speed queen of the North Atlantic by bettering the record of her sister ship, the *Bremen*.

Chicago's Merchandise Mart, said to be the largest building in the world, was completed.

The highest bridge in the world, carrying a highway 1260 feet above the Arkansas River, was completed over the Royal Gorge near Canon City, Colorado.

A radio telephone service was installed between New York and Buenos Aires, making possible the connection by radio phone of four continents—North America, South America, Europe, and Africa.

The first completely welded ocean-going cargo vessel was launched at Charleston, South Carolina.

A new field gun mount, enabling a 75-millimeter cannon to be trained at any point in a complete circle and elevated to any angle up to the vertical, was developed by the United States Army.

Progress in the design of windowless buildings lighted and ventilated entirely by artificial means was made and plans were announced for the construction of a 1,500,000-dollar windowless factory at Fitchburg, Massachusetts.

The United States Patent Office issued 49,599 patents and accepted 117,790 applications during the fiscal year ending in June.

The world's first metal base highway was laid as an experiment in Illinois.

Photographic films taken by the Andrée polar balloon expedition more than 30 years ago were found with the explorers' remains and developed and printed successfully in spite of deterioration by age and exposure to the elements.

Physics

The theory that the sun is lighted like a giant electric bulb by electricity under pressure of 10,000,000 volts flowing from inside the sun and heating its atmosphere to incandescence, was advanced by Dr. Ross Gunn, United States Naval Research Laboratory.

A new theory of the universe, assuming that it is non-static and consisting of matter dissipating through radiation, was propounded by Dr. Richard C. Tolman, of the California Institute of Technology.

The theory that cosmic rays are not rays at all but high-velocity particles was advanced by two German physicists, Dr. Walter Bothe of Berlin and Dr. Werner Kolhoerster of Potsdam, as a result of experiments they have conducted with a specially built adaptation of the electron counter, but researches of Dr. R. A. Millikan on the intensity of cosmic rays near the north magnetic pole provided evidence against the theory.

The theory that cosmic rays consist of high-velocity particles, like tiny bullets, was supported by experiments conducted by Dr. L. F. Curtis of the United States Bureau of Standards in which he used two electron counters.

A clock which will set itself in response to radio time signals was developed by H. C. Roters and H. L. Paulding of the Stevens Institute of Technology.

A new type of clock controlled electrically by a vibrating crystal, thus dispensing with a pendulum, was developed under the direction of Dr. W. A. Marrison, of the Bell Telephone Laboratories.

A moulded compound, including silicon carbide or Carborundum, which has the quality of preventing the flow of electricity at low voltages while allowing it to pass at high potentials, was developed at the laboratories of the General Electric Company.

A film phonograph capable of playing for two hours from a 400-foot reel of motion picture sound film was perfected by Dr. C. H. Hewlett, engineer of the General Electric Company.

Electric current direct from sunlight was made possible through the invention by Dr. B. Lange, of the Kaiser Wilhelm Institute for Silicate Investigation, of a new type of cell containing copper oxide between two layers of metallic copper.

Dr. Ernest O. Lawrence of the University of California, with his associate, Dr. N. E. Edlefsen, devised a method for increasing the speed and energy of the protons or hearts of hydrogen atoms so that it may be possible when the method is further perfected to use them as atomic projectiles for smashing the hearts of other atoms, transmuting them into other substances or releasing enormous quantities of atomic energy.

The final value for the most accurate measurement ever made of the constant of gravitation was announced after seven years work by Dr. Paul Heyl, physicist of the United States Bureau of Standards, to be the fraction 6.670 over 100,000,000.

Artificial gamma rays, which may take the place of radium in the treatment of cancer, are produced by a giant vacuum tube operating at 700,000 volts, at the California Institute of Technology.

An electric photo flash-lamp, a German invention, for taking flashlight photographs without noise or smoke was introduced in the United States, the light being made by aluminum foil ignited electrically in a bulb full of oxygen.

Recognitions and Awards

For his researches on light, particularly the discovery that monochromatic light when scattered by shining on certain transparent substances is partly changed to other colors, Sir Chandrasekhara Venkata Raman, professor of physics at the University of Calcutta, was awarded the Nobel Prize in physics.

The 1930 Nobel Prize in medicine was awarded to Dr. Karl Landsteiner of the Rockefeller Institute of Medical Research for the discovery that human blood is of four different types and that blood of one type does not always mix with blood of another type.

The Nobel Prize in chemistry was awarded to Prof. Hans Fischer of Munich for his achievement in the laboratory production of hemin, one of the components of hemoglobin, the red coloring matter of blood.

The Daniel Guggenheim gold medal for notable achievement in aeronautics was awarded to Dr. Ludwig Prandtl, professor at the University of Göttingen, Germany, for "pioneer and creative work in the theory of aerodynamics."

The distinguished flying cross of the Navy was given to all members of the Alaskan Aerial Survey Expedition which mapped nearly 13,000 square miles of wild country during 1926.

The Collier trophy for the outstanding contribution to aviation was given to the National Advisory Committee for Aeronautics for its cowling for radial air-cooled engines.

Dr. George H. Whipple of the University of Rochester and Dr. George R. Minot of Harvard University Medical School shared the first 10,000-dollar *Popular Science* annual award given in recognition of their discovery of a successful treatment of pernicious anemia by the liver diet.

The Harmon Trophy for the outstanding achievement in aeronautics was awarded to Carl B. Eielson who piloted Sir George Hubert Wilkins across the Arctic.

The Perkin medal was awarded to the late Dr. Herbert H. Dow, president of the Dow Chemical Company, for his developments of improvements in the production of chlorine, bromine, magnesium, and other chemicals.

The James Douglas Medal of the American Institute of Mining and Metallurgical Engineers was awarded this year to John V. N. Dorr, president of the Dorr Company, for "his invention of apparatus and achievement in developing and improving hydrometallurgical practice."

The National Academy of Sciences' public welfare medal was given posthumously to Stephen T. Mather, organizer of the United States National Park Service.

The National Academy of Sciences' Daniel Giraud Elliot Gold Medal was awarded to Dr. Henry Fairfield Osborn of the American Museum of Natural History in recognition of his scientific monograph describing the ancient titanotheres, a prehistoric creature somewhat resembling the rhinoceros.

A gold medal and accompanying annuity of from 100 dollars to 500 dollars to be given government workers for scientific achievements was proposed in a bill before Congress.

The William H. Nichols Medal for 1930 was presented by the New York Section of the American Chemical Society to Samuel E. Sheppard of the Eastman Kodak Company for his "outstanding achievement in the chemistry of photography."

The Willard Gibbs medal was awarded to Dr. Irving Langmuir for "fundamental work on atomic hydrogen and on surface relations and also on electrical discharge phenomena; also for his contributions of great importance to nearly all branches of physical chemistry, including high vacuum technique, electronics, thermochemistry and catalysis, and lastly for his presentation of a theory of atomic structure."

The John Fritz Medal was awarded Rear Admiral Watson Taylor, U. S. N., retired, for his engineering achievements, the most notable of which is his utilization of the bow wave in ship propulsion.

The Edison Medal of the American Institute of Electrical Engineers was awarded to Prof. Charles F. Scott of Yale for his pioneering work in electric transmission.

The Franklin Medal, awarded by the Franklin Institute, was given this year to Sir William Bragg, director of the Royal Institution of Great Britain.

In recognition of his demonstration that protons act like waves, Prof. Arthur J. Dempster, of the University of Chicago, was awarded the 1000-dollar prize given annually by the American Association for the Advancement of Science.

The Hoover Medal was awarded for the first time, the first recipient being President Herbert Hoover.

The American Pharmaceutical Association gave its Ebert Prize for 1930 to Marvin R. Thompson of the University of Maryland for his work on the pharmacology of ergot.

Dr. R. R. Spencer of the United States Public Health Service was awarded the American Medical Association's gold medal for original work in preparation of a vaccine for Rocky Mountain spotted fever.

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Member of the New York Bar
Registered Patent Attorney

Scarlet Fever Toxin Patent Sustained

OF far reaching importance to public welfare and the health of children of this country is the invention of Drs. George F. Dick and Gladys H. Dick, of Evanston, Illinois, for scarlet fever toxin and antitoxin and process for producing the same, the patent on which was involved in a patent infringement suit brought by the patentees against Lederle Antitoxin Laboratories. Not only did the patentees make a meritorious invention, but the fruits of their discovery have been placed under the control of the Scarlet Fever Committee, Inc., of Chicago, a humanitarian institution, for the benefit of the public in general.

The patent describes the process for producing a toxin product and an antitoxin product, and claims covering the process and the toxin and antitoxin products were held to be valid and infringed.

The toxin product described in the claims of the patent as a sterile toxin specific, is injected into the arms of children to determine whether the children are susceptible to scarlet fever. The antitoxin specific is injected to render the children immune to the disease. The process consists in isolating hemolytic streptococci specific to scarlet fever, growing them in a suitable medium, and obtaining a sterile toxin product therefrom; thereafter injecting an animal with the sterile toxin product, and obtaining therefrom a serum containing antitoxin specific.

The court remarked in the decision in the foregoing case that placing the control of the patent in the Scarlet Fever Committee, Inc., so as to dedicate the invention to the benefit of the country, was the utmost manifestation the patentees could make of their desire to serve mankind and to live up to the ideals of their profession.

Patent Specification Ordered Revised

THE following statement by Commissioner of Patents Robertson concerns patent No. 1772175, issued to a Mr. Arbuckle.

"Applicant petitions from the Examiner's requirement to cancel the words 'and I desire, therefore, to claim the invention broadly,' appearing in the last sentence of the specification, which reads as follows:

" 'Many other modifications may be resorted to without departing from the spirit of the invention, and I desire, therefore, to claim the invention broadly, limited only by the scope of the appended claims.'

"The Examiner in the office actions merely required the elimination of the phrase in question on the authority of Ex parte Champ, 114 O. G. 1827, and Ex parte Eldon, 83 O. G. 748. In his statement he points out that the broader claims have all been cancelled in response to rejection on the art, which he states is very close to the structure here disclosed. He further argues that since the interpretation of a patent is for the courts it is thought that the applicant can not give any directions as to how the court would exercise its discretion.

"The applicant argues that the language is unobjectionable, since he is simply intending to show that it was his intention to use the terms in the claims in as broad a sense as possible and that the language objected to is within the ruling in Ex parte Jansson, 120 O. G. 2126.

"In that case, in passing upon an objection to the statement that the applicant wishes to be understood that he does not desire to be limited to the exact details of construction shown, the Commissioner stated that, in case of any doubt as to the meaning of the terms, the intent of the applicant in so using them might become material.

"Obviously, however, a statement should not appear in a patent that applicant desires 'to claim the invention broadly as well as specifically,' if no broad claims have been allowed, and in view of the art applicant has been restricted to specific claims, since the patentee would not then be claiming the invention broadly.

"The particular statement of this application that applicant desires to claim 'the invention broadly, limited only by the scope of the appended claims,' would likewise seem to be objectionable, all the broad claims having been rejected and canceled, as indicating that applicant was claiming the invention more broadly than the claims themselves indicated. On the other hand, even if the language could be construed as a statement that it was desired that the terms of the claims be broadly construed, it would still be objectionable if only limited claims were allowed."

The petition is denied.

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

Request Review in Gas Device Case

A PETITION has been filed in the Supreme Court of the United States asking the court to review the case of Pratt et al. v. Weeks, Nos. 536 and 537, involving an unpatented device that allegedly enables a motor car to run 400 miles on one gallon of gasoline.

In addition to the gas-saving device, there is also involved an unpatented formula for a motor fuel, allegedly costing one cent per gallon to produce and claimed to be 60 percent more effective than commercial gasoline generally in use.

According to the petition, Nathaniel P. Pratt and George L. Pratt, the petitioners, entered into a contract with Charles J. Weeks, the inventor, for the organization of a corporation to exploit the inventions commercially. The contract provided for the payment of sums aggregating more than 1,000,000 dollars to Mr. Weeks with controlling interest in the corporation to rest with him. In return he was to disclose the inventions to be patented.

It is claimed that Messrs. Pratt paid in excess of 32,000 dollars under this agreement but that Mr. Weeks has declined to make any disclosures. Suit was instituted, the breach of the contract alleged, and damages were stated "in excess of 10,000,000 dollars." Judgment against Mr. Weeks was obtained in the trial court, but the Circuit Court of Appeals for the Fifth Circuit reversed its verdict.

Ornamental Design Not A Trademark

THE Converse Rubber Company, of Malden, Massachusetts, is not entitled to register, under the Act of 1905, as a trademark for rubber boots and shoes, a mark described as consisting of "a narrow external white band around the upper edge of the article of footwear," according to a ruling handed down by the Patent Office.

The ground of the decision is that the mark is nothing more than an ornamental design and would not function as a trademark.

In his decision, the First Assistant Commissioner, after noting the examiner's statement that it was common practice to place an ornamental band on boots and shoes but that he had cited no references to show that, called attention to certain design patents and stated that in view thereof it must be held that the conclusion of the examiner that the alleged mark was merely an ornamental border was correct.

He further stated that in view of the citation of new references a rehearing would be granted if request therefore was made within the limit of appeal.

"Worthless" Patent Yields $22,249,999

THE sale for more than 22,000,000 dollars of an oil "cracking" patent long regarded as worthless recently restored Mrs. Lolita Sheldon Armour to the commanding position in American finance once held by her husband, the late J. Ogden Armour.

The news that Mrs. Armour and a number of other persons suddenly had acquired unexpected millions became known when the Shell Union Oil Corporation and the

Standard Oil Company of California announced purchasing the Universal Oil Products Company for 22,249,999 dollars. Mrs. Armour owned 400 of the 1000 shares of Universal Products and will receive 8,216,558 dollars.

Included in the sale was the Dubbs "cracking" process for producing gasoline. P. C. Dubbs of Chicago, who invented the "cracking" process, which Armour backed for several years without success, will receive 3,582,045 dollars of the money derived from the sale, it was said.

Gem Advertising Curbed

IMITATIONS of diamonds are not to be labeled "Diamond," according to an order of the Federal Trade Commission to Frank W. Alter of Chicago, trading as Alter and Company, and Egyptian Gem Company.

Alter, who sells jewelry such as rings and stickpins to dealers for resale as well as directly to the public, is ordered specifically to cease and desist from using or conspiring with others to use the word "Diamond" and the words "stands the tests of fire and the acid bath," or words having substantially the same meaning in the advertising or labeling of stones or imitations which are not diamonds.

The Commission's order also forbids the representation of prices which are in excess of the regular prices as being the regular prices, and from representing postage or charges for postage, packing and shipping, to be more than they really are.

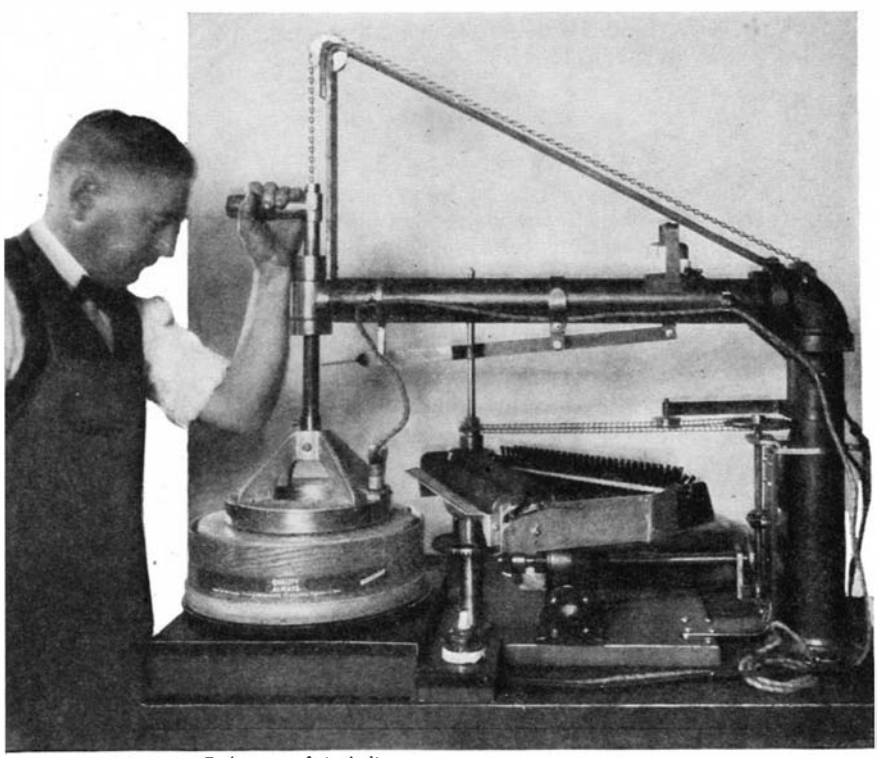
Instead of being set with diamonds or other precious stones, the goods sold by Alter contained pieces of glass, facet cut, or mined stones of small value, or imitations.

Alter caused to be printed coupons describing the spurious articles as diamond rings and diamond stickpins, and certificates guaranteeing this jewelry for certain periods or that a replacement would be made by the respondent.

The respondent then sold the rings and stickpins to traveling salesmen, whose addresses are unknown, among others, to one C. P. Mosert, knowing that they would offer the jewelry for sale to the public in connection with the coupons and certificates, and the respondent, under the trade name Egyptian Gem Company, participated in the sale of the jewelry by the traveling salesmen under the terms of the certificates of guarantee.

Under the guarantee the respondent offered to replace the jewelry if it became tarnished; provided amounts varying from 25 to 35 cents were sent him for postage and packing, although the postage actually did not amount to more than two or three cents, and postage and packing together did not exceed five or six cents.

The regular and reasonable price of the rings and stickpins at retail was from 15 to 25 cents and the alleged replacements were really sales of rings at the regular and reasonable prices and were not bona fide replacements. In the coupons the rings and stickpins were represented to be of regular value or price of from three dollars to $6.50.



Courtesy United States Department of Agriculture

In order to meet market demands for officially stamped products, the Bureau of Agricultural Economics of the Department of Agriculture has devised the cheese branding machine shown above. Until recently, the Bureau states, there has been no practical method of legibly and permanently branding cheese after it has been paraffined. The machine shown has been put into use by the State Department of Wisconsin. It is described by the Bureau as follows: In this machine, metal letters for printing the brand into the paraffin are designed and placed to form 12 segments of a ring. Each segment is independently movable so that the face of the stamp can adapt itself to the contour of the cheese. The branding face is electrically heated and thermostatically controlled. The heated type face sinks into the paraffin, allowing the specially made, non-drying, oil-soluble ink to go down into the paraffin. When the brand face is removed, the melted paraffin flows into the depressions made by the letters, thus sealing the brand mark below the surface of the wax. There are a revolving brush and two ink rollers which clean and ink the stamp after each operation

Tax Refunds on Patents

IN computing the amount of a refund on account of over-payments of income and profits taxes for 1913 to 1918 the market value of patents on March 1, 1913, and not their cost, should have been used in determining depreciation allowance, the District Court for the Eastern District of New York has held. This increased the depreciation allowance and hence the amount of the refund, the opinion explained.

In 1925 the Commissioner redetermined the company's 1919 tax by allowing depreciation for patents. This meant a decrease in invested capital for the years 1913-1918 and a corresponding increase in tax for those years, the court pointed out. When such a change is made in invested capital, however, the 1926 act provides that the income and profits taxes shall also be adjusted. In making that adjustment the market value of patents on March 1, 1913, should have been used, the opinion held, overruling the Government's contention that the adjustment should be made only for profits taxes, and that since the cost of the patents was used in redetermining invested capital, the same figure should be used in ascertaining the overpayment of profits taxes.

Publication of Trademarks

IN order that trademarks and trade names may not become generic in character and thus lose their value to their owner, the words composing such marks should, when appearing in print, be capitalized or quoted. The editors of SCIENTIFIC AMERICAN exercise all possible care to see that this rule is adhered to, but even then a name will slip by once in awhile all in small letters. Two examples that have occurred in the past are Dry-Ice and Carborundum. We offer our apologies to the owners of these marks and hasten to make such restitution of prestige as this note carries.

Geographical Mark Refused

IT was recently held by Assistant Commissioner Moore that the California Perfume Company, Inc., of New York, N. Y. and Kansas City, Mo., is not entitled to register the term "Avon" as a trademark for tooth brushes since this term is geographical.

In his decision, after stating that the word in question is the name of a village in New York, one in Ohio, and a town in Massachusetts, the Assistant Commissioner said:

"The law of trademarks (Act of February 20, 1905) specifically provides that a mark consisting of a mere geographical name or term shall not be registered.

"The reason for the law is that every manufacturer or dealer doing business in any town or village having the name Avon would have the right to appropriate such name to his goods."

BOOKS SELECTED BY THE EDITORS

FUNDAMENTALS OF GENERATORS AND MOTORS—
By F. E. Austin

BY a careful analysis of the component efficiencies the author develops these studies to bring out the commercial or financial efficiencies of generators and motors as a basis upon which to predicate a design which will meet the necessary qualifications for a particular service. Explicit diagrams connote the entire text of 108 pages which is as concise and abbreviated as clarity will allow. A mighty handy little work to have available for the understanding and design of fundamental electrical movers.—$2.65 postpaid.

GENERAL ELEMENTARY BOTANY—
By Elmer Campbell, Ph.D., Transylvania College

INTENDED to give a fundamental prospective of the plant world for introductory study, this work discusses practical problems fully, such as plant uses, weed values—of which the author has made a special study—nutrition, morphology, environment, and reproduction. Then are given plant development and taxonomy of seed-plants which comprise the major portion of the text. A clear and orderly development materially aiding reference and study yet pointing to further advancement should such be the desire of the reader.—$3.20 postpaid.

EXPERIMENTS IN ATOMIC SCIENCE FOR THE AMATEUR—*By James L. Clifford*

REAL practical instructions by means of which, with the expenditure of ten dollars for cheap impure radium salts and a few added pennies for simple apparatus, mostly homemade, the amateur may perform some of the most notable experiments in atomic physics—make radiographs as the Curies did, render alpha and beta rays visible (C. T. R. Wilson experiment), make and use electroscopes and ultra-violet arcs, measure the photo-electric effect and so on. Any boy between 15 and 115 years of age can have more fun and learn more in this manner than he could by spending an equal number of evenings at any other common indoor sport. —$1.65 postpaid.—*A. G. I.*

AMBER TO AMPERES—*By Ernest Greenwood*

A POPULAR story or scientific history of the development of electricity and its many applications from the earliest experiments to our own times. Though nicely produced on fine heavy paper and well bound, this book suffers from a most unusual fault. Samples of the text, read as a tour-de-force, indicate that the account deserves commendation, and it therefore is a pity that the type is so large and heavy it is difficult to read, thus creating a marked physical disability.—$4.20 postpaid.—*A. G. I.*

THE AMERICAN LEVIATHAN—
By Charles A. and William Beard

WRITTEN in fluent and most readable style, this volume of 824 pages unites politics, government, and technology as reflected in the federal system of the United States, with emphasis on the newer functions created under the pressures of the so-called machine age. It is for the general reader, who desires to obtain the inter-relationship of the various functions of government as shown by the events which have recently transpired. Most judicial and scholarly in tone, the exceedingly ample index makes it a reference invaluable for a comprehension of our times, economically and socially.—$5.20 postpaid.

THE DYNAMIC UNIVERSE—
By James Mackaye, Dartmouth College

A 300-PAGE exposition of a new hypothesis concerning a "super-penetrating ethereal radiation" which the author believes causes repulsion and attraction in the universe. This hypothesis, when made public at a meeting of scientific men some time ago, received rather more attention from the newspapers than from qualified physicists.—$3.70 postpaid.—*A. G. I.*

THE LURE AND LORE OF ARCHEOLOGY—
By Ralph V. Magoffin, Pres. Archeological League of America

THE author has compressed a vast amount of interest into the 107 pages of this little book, which covers as fully as possible in that short space an account of all the archeological research of the past few decades. A reader who, after finishing this account, did not discover himself broken out with the red rash of an archeological itch would be thick skinned indeed.—$1.15 postpaid.—*A. G. I.*

JANES' FIGHTING SHIPS 1930

ACKNOWLEDGED to be the only complete encyclopedia of all the navies of the world and containing over 3000 photographs and other illustrations. A complete record of naval progress throughout the world, each year this work is eagerly greeted for it invariably contains information which is not elsewhere obtainable. This year the data concerning cruisers is particularly interesting because of the sharp discussion about this type and the lack of general authentic details. The invaluable reference which should be shelved each year.—$13.00 postpaid.

JANES' ALL THE WORLD'S AIRCRAFT 1930
By C. G. Gray and Leonard Bridgman, Eds.

KNOWN as the official reference book for world aviation, this is a compendium divided into parts on civil, service, commercial divisions, aero-engines, and airships. Of large format, 8¼ x 13½, the profusion of illustrations are therefore large and clear, showing details which are often lost in reproduction. The most thorough and conclusive work of its kind published, the data being checked to the fall of 1930. An indispensable reference for everyone connected with the industry.—$13.00 postpaid.

A BOY SCOUT WITH BYRD—*By Paul Sipla*

NOTHING could be a finer endorsement of this book than Admiral Byrd's foreword which he wrote without reading the manuscript. You will enjoy the roguery of "Pete," the pep of "Belle"—for they were real companions and helpers even in their small canine way. Which is by way of saying that this is a he-boy's account of a marvellous adventure, told with simplicity and directness that gives a zest to the text throughout. The epic of Antarctic achievement will surely include this straight shooting sidelight.—$1.90 postpaid.

FROM RECENT PUBLICATIONS

FIVE YEARS IN TURKEY—
By Liman von Sanders, Gen'l, German Army

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