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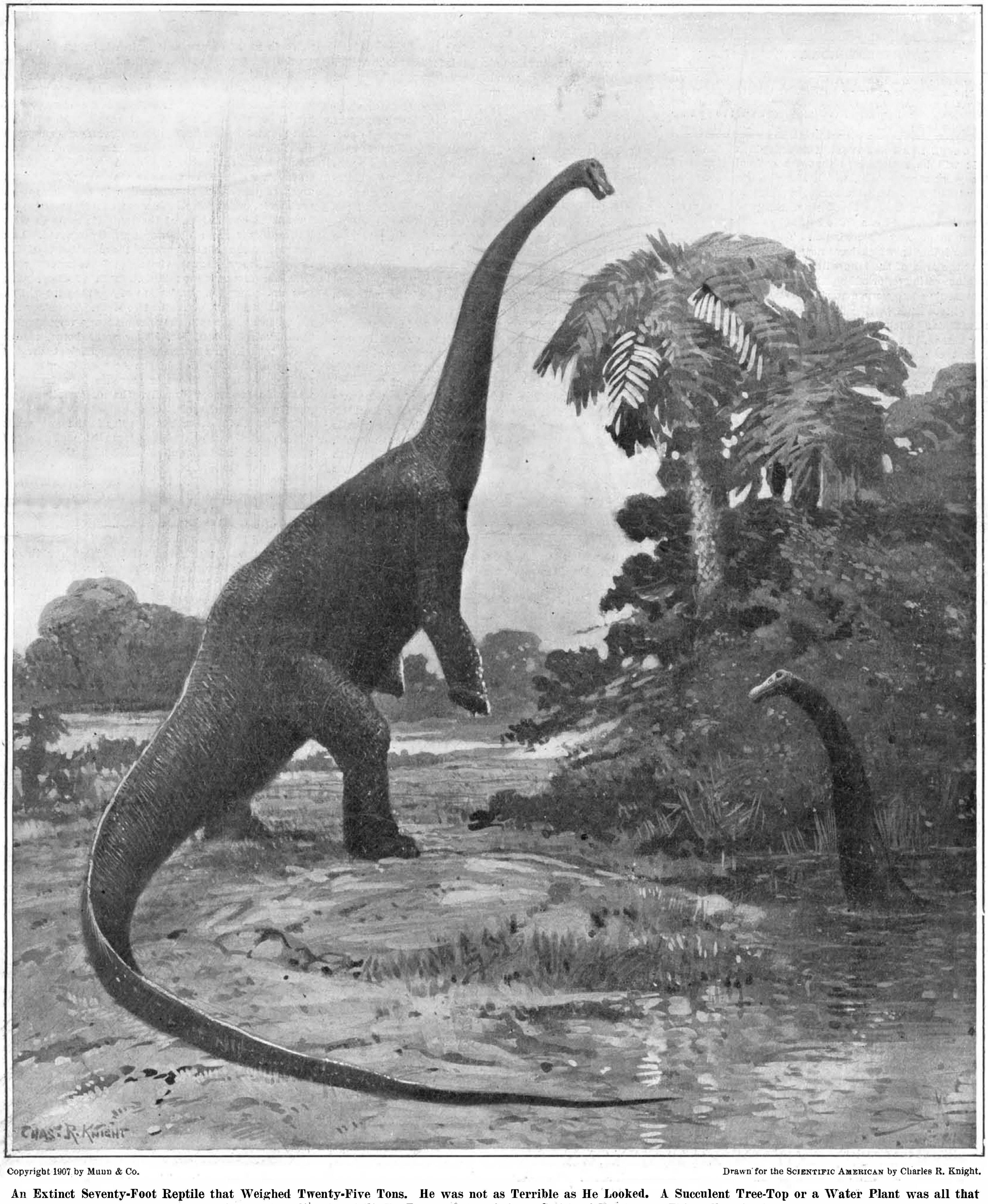

Drawn for the SCIENTIFIC AMERICAN by Charles R. Knight.

An Extinct Seventy-Foot Reptile that Weighed Twenty-Five Tons. He was not as Terrible as He Looked. A Succulent Tree-Top or a Water Plant was all that He Cared to Munch. Still, He Resented Attack by a Swish of His Heavy, Thirty-Foot Tail.

DIPLODOCUS RESTORED. THE LARGEST CREATURE THAT EVER ROAMED THE EARTH.—[See page 491.]

SCIENTIFIC AMERICAN

ESTABLISHED 1845

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, JUNE 15, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

GATUN LAKE IS DOUBLE THE ESTIMATED SIZE.

It will be remembered that the estimated area of the great storage lake, which is to be formed by the construction of the Gatun dam, was 110 square miles. This calculation was based upon the preliminary reconnaissances of the area to be flooded, and was understood to be only approximate. The detailed surveys of the Isthmus, which have now been completed, show that the area of the lake will be more than double the original estimate, or 225 square miles. The larger lake represents some very material advantages in favor of the 85-foot high level canal as now being constructed, advantages which will be felt both in the wet and the dry season. In the first place, the lake will have sufficient capacity to receive and retain all the flood waters, even those of such heavy floods as occurred in December of last year; and secondly, it will be possible to handle this water with considerably less fluctuation in the canal level. It is estimated that the increased lake area will double the amount of water that will be impounded in the lake at the commencement of the dry season. The statistics of past years show that, even in years of extremely small rainfall, the run-off from the area draining into the lake amounts, during the rainy season, to 7,200 cubic feet per second; and this will be sufficient to raise the level of the lake the 4 feet which it will be lowered during the dry season: It is true that because of the increased area of the lake, the evaporation will be double what it would have been from a lake of only 110 square miles area; but since the total supply impounded will also be doubled, it is estimated that, after deducting the loss by evaporation, there will be sufficient water available for fifty-six lockages a day, instead of twenty-six, which was the number estimated as available with the smaller lake.

SAN FRANCISCO EARTHQUAKE AND ENGINEERING CONSTRUCTION.

In view of the important lessons which could be gathered from a professional study of the San Francisco earthquake, the American Society of Civil Engineers arranged for an investigation by the local association of its members. The report of this committee, as read at a recent meeting of the Society, is one of the most valuable documents of its kind ever presented. Although it deals with every branch of construction affected by the earthquake that comes within the province of the engineer, the most important section of the report is that which concerns the construction of buildings.

The report opens with the statement that the stresses set up in a building shaken by an earthquake are similar to those which are occasioned in a truss by the action of a live load. Since the intensity of the shock is not known, the amount of stress cannot be determined, or predicted. The shock may range from a mere tremor to one of sufficient violence to entirely wreck any building. Moreover, should the earth-slip take place immediately below a building, it would necessarily be wrecked. It is reassuring, however, to learn that the committee are of the opinion that any building, designed with a system of bracing sufficient to withstand a wind pressure of 30 pounds per square foot, which is the standard unit of pressure adopted today for tall buildings, roofs, bridges, and similar framed structures, will resist the stresses caused by a shock of an intensity equal to that of the recent San Francisco earthquake. To meet these stresses the prime requisite of the structure is elasticity, or the ability to return to its original form after distortion. This elasticity allows the building to receive and absorb the motion of the earth by the compression or extension, as the case may be, of its steel frame, where a more rigid structure, such as one built entirely of masonry, would be ruptured. A building with a timber or steel frame meets the requirement satisfactorily, as does also, with exceptions in certain details, a building of reinforced concrete. But buildings of stone, brick, or block construction, with horizontal mortar joints, fail entirely to meet this prime requisite of elasticity.

The exception noted above in the case of concrete-and-steel buildings relates to the lack of steel reinforcement in the upper flange of concrete girders and floor beams, and to the absence, or inadequacy, of knee-bracing at the junction of girders with vertical columns. Diagonal bracing cannot be used in modern office buildings to any large extent because of its interference with window space. Its place is taken by gusset-plate knee-braces and portal braces in the steel frame. These, however, induce heavy bending moments in the columns and girders. But since in many cases, the bending stresses will be in the reverse of those produced by the floor load, they call for extra material in the top flanges. Now the concrete floor beams as a rule, have no steel reinforcement near the plane of the upper face; and it was shown in the recent earthquake that failure occurred on this account. Furthermore, great stresses occur at points where the girders join the columns, especially in the lower floors of tall buildings; and here, also, reinforced concrete construction, as now designed, is weak. These deficiencies can, however, be overcome by proper design. The committee is of the opinion that the steel frame building offers the best solution of the problem; but that the reinforced concrete building, if proper modifications be introduced, is a satisfactory form of construction; and that a well-built timber frame building is also proof against destruction by earthquake.

FLUID COMPRESSION FOR STEEL RAILS.

According to the testimony of some of the railroads which have been most troubled with broken rails during the past winter, the principal cause of fracture has been the existence in the rail of pipes, or cavities carried over from the ingot during the process of manufacture. The piping is due chiefly to the contraction of the metal from the center to the sides of the ingot during cooling. Other harmful effects of cooling are crystallization and segregation. One of the most effective methods of preventing or reducing these evils is to subject the metal, while it is cooling in the mold, to heavy pressure by what is known as the Whitworth system. The latest application of this principle has been made at the steel works of St. Etienne, France, where a new method, called the Harmet process, has been tried with remarkable results. An illustrated description of the plant will be found in the current issue of the SUPPLEMENT. Briefly stated, it consists in compressing the ingot during solidification by wire-drawing. Use is made of a tapered ingot mold, smaller at the top than at the bottom, into which a hydraulic plunger which forms the bottom of the mold is forced upward, compressing the steel, as it solidifies, into the contracted tapered portion forming the upper three-fourths of the mold.

So successful has fluid compression proved that practically all of the highest grades of steel that are made in large quantities, such as those used for armor-plate, guns, and marine shafting, are made by this process. Generally speaking, fluid compression is used in connection with the open-hearth process, the Bessemer process being reserved for the manufacture of the cheaper grades of steel in which the highest qualities are not supposed to be so necessary. To this grade, unfortunately, steel rails are supposed to belong, although the experience had this winter with the use of Bessemer rails has proved that the present methods of manufacture are unequal to the production of rails that will stand up to their work. There is no question that ultimately rails will have to be made by the open-hearth process; but for some years to come the demand will be so much greater than the capacity of the open-hearth furnaces, that Bessemer rails must continue to be made on a very large, though gradually diminishing scale.

There is no question, however, that the quality of the Bessemer rails could be greatly improved by the introduction of some form of fluid compression; for by its use it would be possible to get rid of much of the segregation and all of the piping, the latter being, as we have observed above, the most frequent cause of rail failure. The Harmet process, as developed at St. Etienne, is designed to forestall the development of defects in the ingot during cooling. The formation of the pipe is due to the fact that the shrinkage of the central mass toward the outer shell of the ingot leaves hollows in the center. The wire-drawing effect induced by forcing the cooling metal up into the tapered portion of the mold, has the effect of closing the already cooled external shell of the ingot, inward upon the central mass, and causing it to close in at a rate somewhat quicker than that at which the volume of the metal diminishes. The process has already engaged the attention of the Ordnance Department of the United States army, and we believe that its introduction into the rail mills of this country would go a long way toward the solution of the present problem of broken rails.

SIR BENJAMIN BAKER.

The recent death of Sir Benjamin Baker has attracted attention which is as widespread as the fame of the great engineering works with which he was connected. Everyone who has heard of the Forth bridge and the Assouan dam is more or less familiar with the name of this distinguished engineer, for, although his professional work covered an exceedingly wide field in both civil and mechanical engineering, it is with the two great structures above mentioned that his name will be most honorably identified.

As an engineer, Mr. Baker exhibited a happy combination of the theoretical and the experimental, with a leaning, both by instinct and practice, toward the latter. His pre-eminently successful life proves that there is no necessary antagonism between the highly specialized finesse of the academician and the experimental and practical methods of the man in the field. His knowledge of the theory of his profession was ample, as is shown by the fact that he was responsible for the skeleton design, the strain-sheet calculations, and the elaborate investigations of wind-pressure of the great Forth bridge. He was gifted with an uncommon share of that originality of method and independence of tradition which enter into the make-up of the world's great engineers. He was prolific in experiments—experiments, many of which were curiously crude and humble in comparison of the majestic scale to which the results were to be subsequently applied. Thus, our esteeemed contemporary, the Engineer, of London, relates a characteristic incident in connection with the discussion on the strength of dams, which was started by the publication of the theories of Pearson and Atcherley, a year or two since. The story runs that, after going into the whole theory very carefully with Prof. Pearson, Mr. Baker went home, made a mold, and having commandeered sufficient domestic jelly, modeled a section of the Assouan dam, and submitting his model to water pressure in a trough, he was able to study, broadly, the deformation on a greatly magnified scale.

The merit of the Forth bridge lies in the comparative novelty of the type and the magnitude of the scale upon which it was applied. To bridge the two main channels of the Firth of Forth, each wider than the East River at the Brooklyn bridge, it was necessary to devise some method of building the structure without the use of falsework or scaffolding, and the cantilever, of course, was the type of bridge that lent itself most readily to these conditions. The least dimensions, however, which could be adopted for the two spans, was 1,710 feet, which was more than twice the span of the only large existing cantilever, the Sukkur bridge, in India, and was 115 feet longer than the Brooklyn bridge, at that time the longest suspension bridge in existence. The problem, however, was enormously complicated by the fact that the recent collapse of the Tay bridge had resulted in the passing of a law by the British government, demanding that a unit pressure of not less than 56 pounds per square foot be employed in estimating the wind pressure, and determining the size of the members of future railway bridges in Great Britain. That was twenty-five years ago, and bridge engineers are well aware to-day that 56 pounds is just about twice as much as is necessary in large bridges of this character. Sir Benjamin Baker, however, was confronted by the requirement, and it can be readily understood that the wind stresses, figured on this basis, became the most important elements of stress in the whole structure, and rendered it extremely heavy and costly. The work was taken in hand, and pushed through to completion without a single hitch in seven years' time and at a cost of about twelve and a half million dollars. During the progress of the work Mr. Baker carried out a series of experiments to determine the nature and amount of wind pressure encountered by long-span bridges, and his results have been widely accepted and have formed the basis of later wind calculations.

Mr. Baker was engaged on that other great engineering work, the Assouan dam, built for the irrigation water supply of Egypt, as consulting engineer. Like the Forth bridge, this is the largest structure of its kind, the masonry dam being a mile and a quarter in length, and the lake, which extends back 143 miles up the Nile Valley, impounding 1,165,000,000 cubic meters of water. Five years were allowed for the completion of the work, but as the result of that harmonious collaboration of engineer and contractor which is common in British works, it was pushed through with such speed, that it was completed in one year less than the contract time.

Outside of these two works, Mr. Baker was associated with the Blackwall tunnel and the Tower bridge, London. He was intimately connected with many important railway works; he was one of the lay members of the Ordnance Committee; one of the original members of the Engineering Standards Committee of the

Institute of Civil Engineers; and was also chairman of their Committee on Bridges and General Building Construction.

For his successful completion of the Forth bridge, Mr. Baker was made a knight commander, and for his connection with the Assouan dam he was made a K. C. B. He was a fellow of the Royal Society, a past president of the Institution of Civil Engineers, and the recipient of honorary degrees from the universities of Edinburgh, Cambridge, and Dublin.

THE TRANSIT OF MERCURY IN 1907.

BY FREDERIC R. HONEY, TRINITY COLLEGE.

The transit of a planet across the sun's disk, apart from any astronomical significance, is always a matter of interest even to the most casual observer of the heavens. It affords an excellent opportunity for verifying the reliability of the science by which we are informed in advance of the precise moment when the transit will occur; and at the same time it is possible to compare measurements which in themselves are beyond the comprehension of the human mind.

On November 14 of this year, a tiny speck will traverse a chord of the sun's disk. This speck will represent a planet whose diameter is a little over three thousand miles.

Reference was made by the writer to the transit of Mercury in a recent article in the SCIENTIFIC AMERICAN,* and the position of the planet relative to the earth was shown in the plot. The orbit of Mercury was projected upon the plane of the ecliptic, and conjunctions were correctly indicated; but there was nothing said about the position of the planet relative to the plane of the ecliptic.

If this page be placed in a horizontal position, it may be regarded as representing this plane, which is that of the earth's orbit (Fig. 1). To obtain a clear understanding of Mercury's orbit, whose obliquity and eccentricity are greater than those of any of the planets, that part which is represented by the heavy line may be described as above the plane of the ecliptic, while that represented by the fine line, as below that plane.

The points N and N', where the orbit pierces the plane of the ecliptic, are respectively the ascending and descending nodes. Moving in the direction of the arrow at the point N the planet passes from the space below to that above the plane of the ecliptic. At N' the passage is made in the opposite direction.

If the plane of Mercury's orbit coincided with that of the earth, a transit across the sun's disk would occur at each inferior conjunction; but on account of the great obliquity of his orbit, Mercury usually appears to pass above or below the sun, according as he is in that part of his orbit which is above or below the plane of the ecliptic. It is possible for a transit to occur only when Mercury is at or very near one of the nodes, N or N', i. e., when he is at or very near the plane of the ecliptic.

An edge view of the orbits of the earth and Mercury, looking in the direction of the arrow A, is shown by the straight lines (Fig. 2), the angle between them being the inclination of the plane of the planet's orbit to that of the ecliptic (= 7 deg.).

In Figs. 1 and 2 the sun is represented by the small circle, whose diameter is correctly proportioned to the diameters of the orbits of the planets. Since the diameter of the sun is more than 100 times that of the earth, and 286 times that of Mercury, on the scale of the accompanying plot the planets are represented by points. If we suppose the earth at the point marked March 18, and Mercury at the same date, the latter as seen by an observer on the earth will appear to be projected in space in the direction of the dotted line, i.e., above the sun. If the earth is at the point marked July 25, and Mercury at the same date, he will be projected below the sun.

Now the earth may be situated at any point in its orbit, and Mercury at any point in his orbit, and the relative positions of the planets will determine the apparent position of Mercury relative to the sun as seen from the earth.

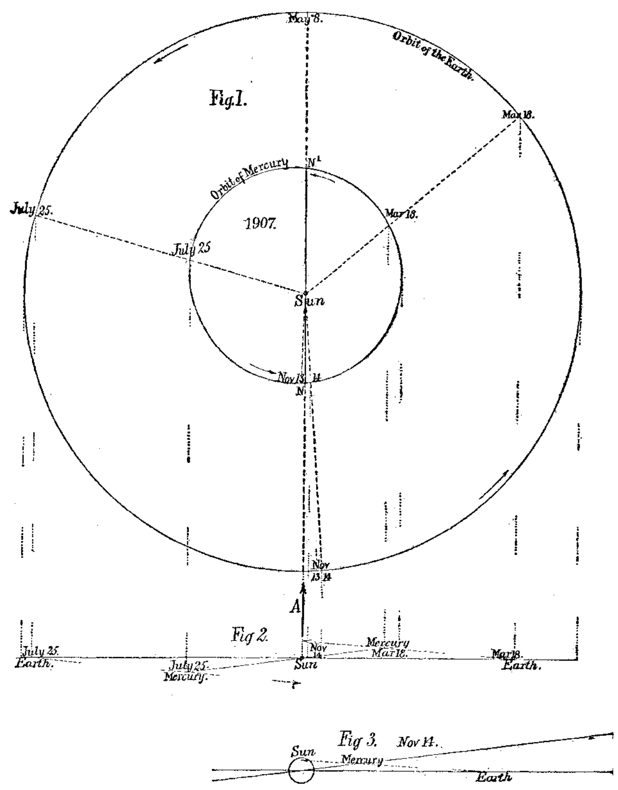
In order that a transit may occur, the sun, the earth, and Mercury must (in Fig. 2) be at or very near the intersection of the orbits. This intersection, shown by a point, is the line NN' ("the line of nodes"). This line is the intersection of the plane of the planet's orbit with the plane of the ecliptic.

A perspective drawing of the orbits of the planets (Fig. 4) will assist the reader in realizing their position relative to each other and the sun.

Fig. 3 is an enlarged edge view showing the positions of the earth, Mercury, and the sun at the time of the transit. The arrow indicates the position of Mercury projected on the sun as seen from the earth.

The first inferior conjunction this year occurred on March 18, when the planet (Figs. 1, 2, and 4) appeared as shown above the sun; the second inferior conjunction will occur on July 25, when the planet will appear below the sun; and the third and last on November 14, when the transit will occur. Mercury will have just passed the ascending node, i.e., he will be a little above the plane of the ecliptic, and the path of the transit will therefore be projected above the sun's center. Mercury will be approaching perihelion and traveling at the rate of about six degrees a day, or about six times as fast as the earth (angular velocity), and on the 14th will overtake the earth just in time for a transit.

The positions of the earth and Mercury are shown



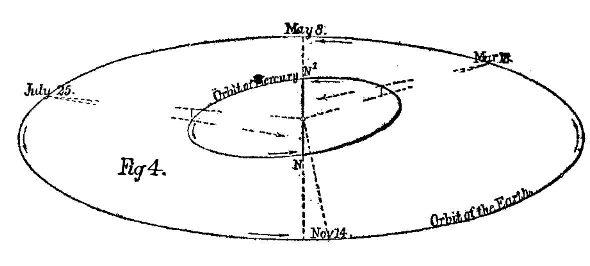
THE ORBITS OF MERCURY AND THE EARTH ABOUT THE SUN, SHOWING THEIR RELATION WITH REFERENCE TO THE ECLIPTIC.

for the 13th and 14th, indicating to the eye the proportion between the distances traversed by the planets in a single day. Mercury will pass the ascending node on the 13th.

Since the line of nodes produced intersects the earth's orbit at points where the earth is always found in May or November, transits of Mercury can occur during those months only. Intervals between the transits are ascertained by determining an approximate common multiple of the periods of the earth and Mercury. The earth's period is 365.2564 days; and Mercury's 87.96926 days. The number of days in the year multiplied by seven and divided by Mercury's period,

thus: $\frac{365.2564 \times 7}{87.96926} = 29.06$, shows that after an interval of seven years, during which Mercury will make twenty-nine revolutions around the sun, there is a possibility of another transit. If the number of days in the year be multiplied by 13 and divided by Mercury's period, thus: $\frac{365.2564 \times 13}{87.96926} = 53.98$, it shows that after an interval of thirteen years, during which Mercury will make fifty-four revolutions, there is a probability of another transit. If the number of days in the year be multiplied by 46 and divided by Mercury's period, thus: $\frac{365.2564 \times 46}{87.96926} = 190.99$, it appears that after an interval of forty-six years, during which Mercury will make 191 revolutions, it is certain that a transit will occur.

The last transit was in November, 1894, i.e., thirteen years ago; and the years of the November transits for this century are as follows: 1907, 1914, 1927, 1940, 1953, 1960, 1973, 1986, and 1999. If the intervals between these dates be noted they will appear as follows, 7, 13, 13, 13, 7, 13, 13, 13. The predominant interval is thirteen years in groups of three, followed by an interval of seven years. The sum of any four consecutive intervals is 46 years, i.e., a transit always occurs after that interval of time.



A PERSPECTIVE VIEW OF THE ORBITS OF THE EARTH AND MERCURY.

* "Morning and Evening Stars," February 9, 1907.

THE TWO-HUNDRED-MILE AUTOMOBILE ENDURANCE TEST OF THE NEW YORK MOTOR CLUB.

The first real endurance test that has been held in the vicinity of the eastern metropolis in some time was run under the auspices of the New York Motor Club on Thursday, the 6th inst. In two respects at least this run was particularly difficult. In the first place the distance was over 200 miles, or nearly double what is considered a good day's run; and secondly the roads for the last 50 miles were in an extremely muddy condition owing to recent rain as well as to a rain storm which occurred during the latter part of the test. In fact, muddy roads were traversed nearly the entire distance, save for stretches of macadam met with now and then.

Out of 27 cars that left New York soon after 6 A. M., none arrived at Albany via Poughkeepsie, Great Barrington and Pittsfield, Mass., within the 12 hours that was allowed them. Deducting the 40-minute stop at Great Barrington for lunch, the first half-dozen cars to arrive—a 40-horse-power Lozier, a 24-horse-power Corbin, a 30-horse-power Haynes, a 50-horse-power Welch, a 16-horse-power Reo, and a 30-horse-power Stoddard-Dayton—made the 208 miles at an average speed of 19.2, 20.07, 19.2, 19.08, 17.21, and 16.36 miles an hour, respectively. Altogether, 18 machines reached Albany before midnight. No car had a perfect score at the finish, though at Amenia (the half-way point) two of the air-cooled Corbin cars, an Aerocar, a Lozier, Welch, Haynes, Pope-Toledo, Reo, and White had no marks against them. At Great Barrington (138 miles) five cars still had perfect scores, but from there on the rain and mud were too much for the best of cars, so that all had lost some points by the time Chatham was reached. The 30-horse-power Haynes touring runabout was the only car to arrive at Albany ahead of time. Despite the bad roads, it made the 20-mile run from Chatham in one minute less than its schedule and thereby lost 2 points. This car had a perfect score at Pittsfield, but it lost 18 points in traversing the abominable, narrow, and rutty roads of mud and clay between that place and Chatham. A 24-horse-power air-cooled Corbin touring car came the nearest of any to making a perfect run. It lost 5 points at Great Barrington and 4 at Chatham. Another car of the same make had 116 points charged against it, while a third Corbin touring runabout was struck by an interurban electric car at a dangerous crossing on a long down grade near Albany, one of its passengers being killed outright and the other and the driver being seriously injured. This needless sacrifice of life was caused by the automobile coming upon an unprotected crossing at high speed and without knowing that there was any such dangerous spot. It seems as if the officials conducting a tour or test should see that the contestants are suitably warned of such traps as these in the future. Furthermore, the trolley company should be compelled by law either to protect such crossings by a flagman or gates, or else to bring their cars to a full stop before allowing them to cross the highway. Such railroad crossings are equally dangerous whether the cars are run by electricity or steam.

An analysis of the results shows that 17 touring cars and 10 touring runabouts started, and 13 touring cars and 5 runabouts finished before 11 P. M.

PENALIZATION OF CARS THAT FINISHED.

Class A, Touring Cars. Class B, Runabouts.

Position.	Class.	Car.	Penalization.	Points Lost for Being Ahead of Time
1	A	Corbin	9	....
2	A	Lozier	18	....
3	B	Haynes	20	2
4	A	Welch	24	....
5	A	Reo	46	....
6	B	Stoddard-Dayton	50	....
7	A	Berliet	79	....
8	A	Mitchell	103	....
9	B	Premier	106	20
10	A	Corbin	116	....
11	A	Pope-Hartford	131	....
12	A	Darracq	148	....
13	A	Dragon	153	....
14	B	Continental	190	16
15	B	Stearns	207	74
16	A	Knox	222	....
17	A	White	229	....
18	A	Frayer-Miller	300	6

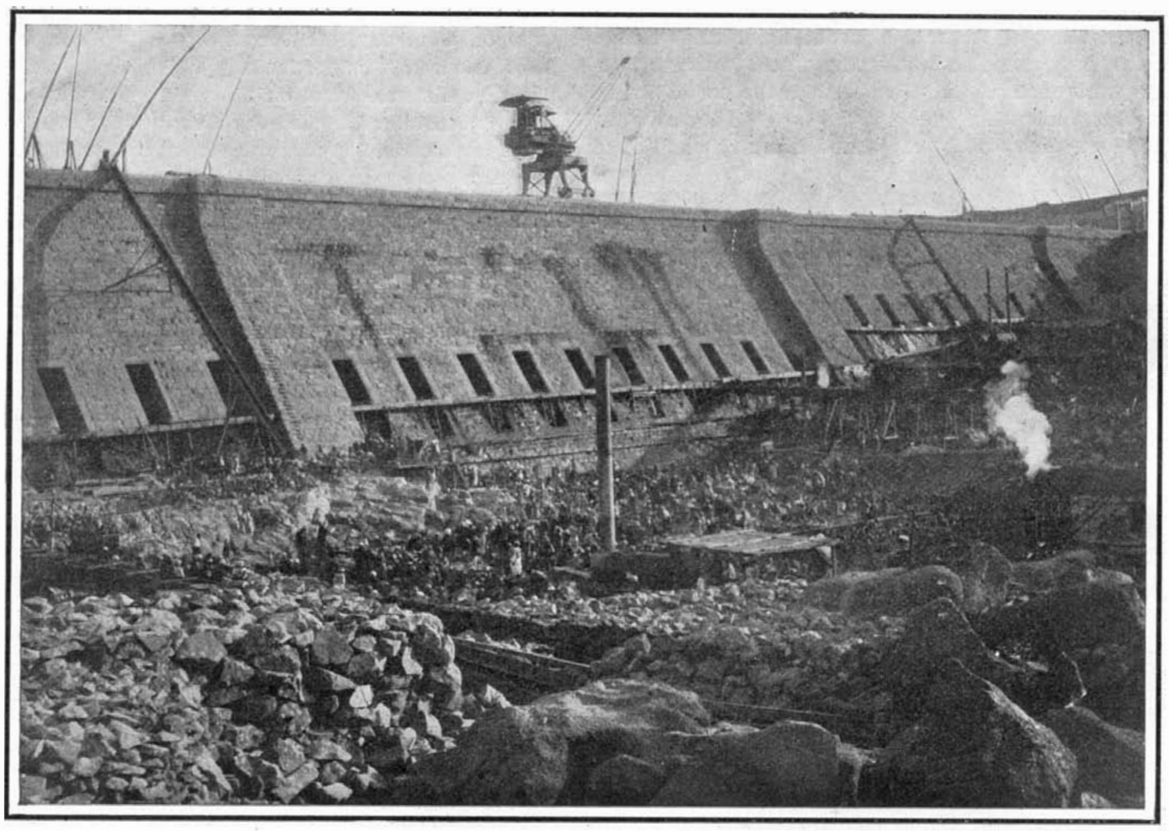
Water softening reactions are notoriously delicate, a fact emphasized by the experience with the softening method at Oberlin, Ohio, last summer. The process of softening followed there was described in this journal on October 7, 1905, the water being treated in two settling basins. During last August it was discovered that if all the chemicals for the day were put into one-half the water and the other half was allowed to flow into the first basin without chemicals, there would be no caustic alkalinity in the water after mingling and treatment and the magnesium would be reduced from 22 to 1.5 parts per million. It had previously been impracticable to remove so much magnesium, as the caustic alkalinity would rise too high.—Engineering Record.

THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

BY OUR LONDON CORRESPONDENT.

One of the greatest difficulties with which the engineers of the Egyptian Irrigation Department have had to contend in regard to the impounding and distribution of the water of the Nile by the barrage at Assouan, has been in connection with the severe and extensive erosion of the river bed below the works by the scouring action of the water released through the sluices. The river bed, though of rock formation, is of a most friable character, and the great pressure and high velocity of the water pouring through the sluices rapidly cleaned out the natural lines of cleavage in the rock, with the result that in a short space of time huge masses of rock were disintegrated, and either eroded away completely or carried farther downstream. The result was that huge holes were left in the river bed of considerable depth, many of these fissures extending below the level of the foundations of the dam. A short time ago we reproduced in these pages a photograph of a typical bowlder weighing several tons, that had been so dislodged and thrown upon one side.

Owing to the severity and extensive continuance of this action, which might have possibly impaired the stability of the barrage itself, an elaborate scheme of protective work became imperative. As a result of the investigations that were conducted, the most satisfactory solution of the problem was conceded to be the construction of a heavy talus or apron in masonry, extending from the foot of the dam to a point some distance downstream, at which the water had lost the greater part of its scouring and eroding violence. Work was started upon the section of the river bed facing the set No. 16 sluices, and immediately this section was finished, the river was diverted from the east to the west side. By this means one half of the river bed was left dry, the whole of the supply passing through the sets of sluices 9 to 18. The western and central channels were then "sadded" off, so that operations could be carried out upon the facings to sluices, sets 1 to 8. The water within this inclosed area between the sadd and the dam was then pumped out, leaving the river bed quite dry. At this juncture, the late Sir Benjamin Baker visited the barrage, and in view of the crumbling nature of the river bed, not only approved of the projected protective works, but advocated their being carried out upon a more extensive scale than originally intended; which advice was duly accepted.

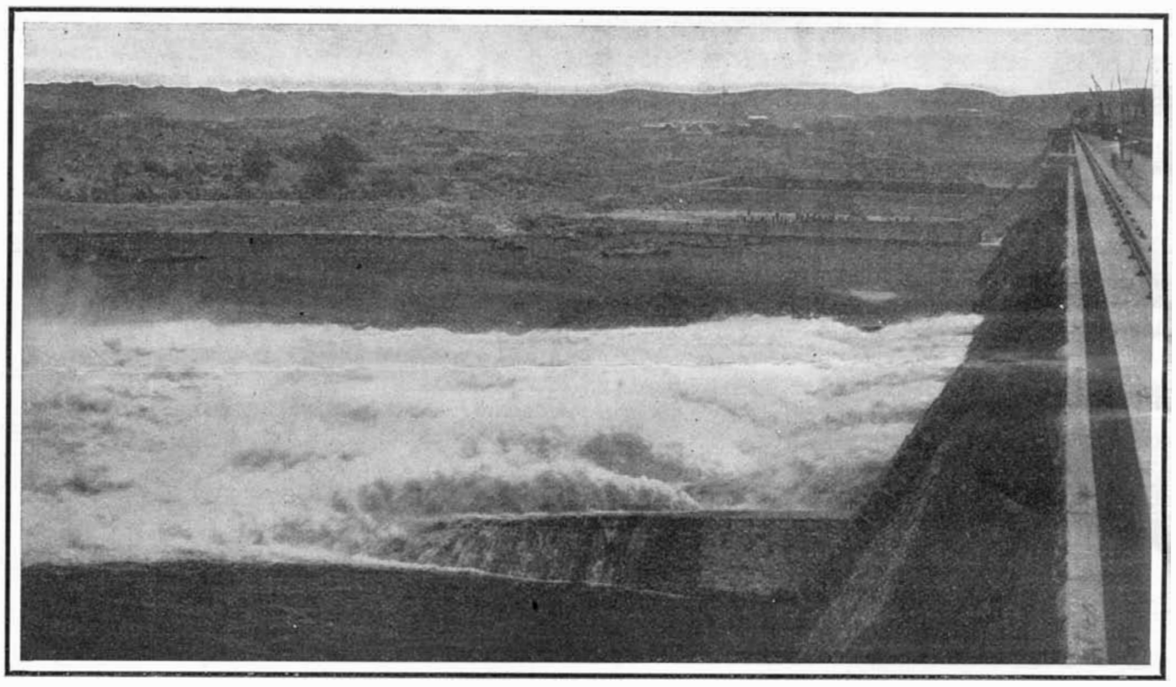


Excavating 390,000 Cubic Yards of Loose Rock and Gravel from the River Bed, Preparatory to Building the Masonry Apron.

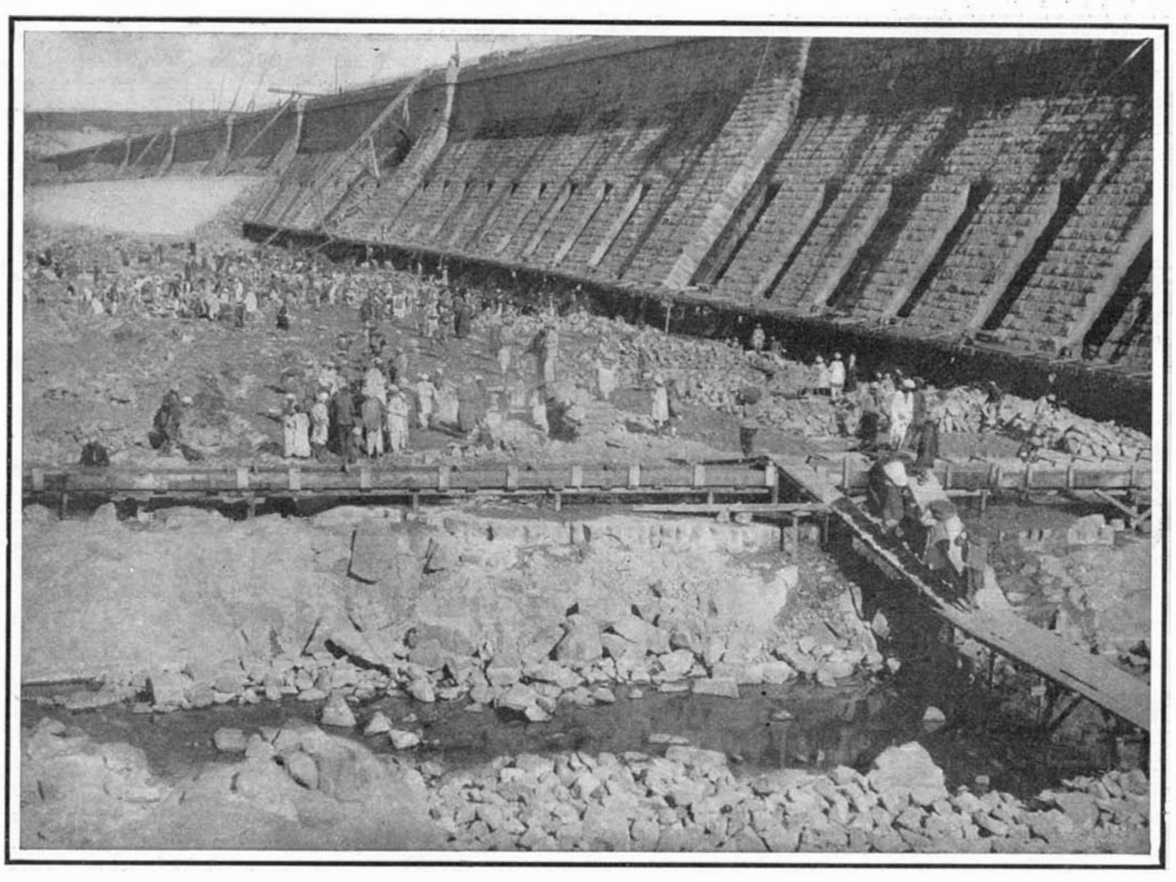
Note in foreground huge masses of rock torn from river bed by the rush of water from the sluices.

The work was done by large squads of men, ranging in number from 2,000 to 7,000, after pumping operations were completed, who were employed upon the river bed in removing the loosened bowlders and the large accumulations of gravel into which the rock had been pulverized by the water. Upon the removal of all the loose ballast, the river bed was thoroughly examined, and all faulty or bad rock was blasted out. This operation entailed in places some very heavy work, the excavation being carried to great depths.

The whole of these depressions and cavities had then to be filled up with masonry of a heavy and solid nature, the work being continued up to the lip of the sluices, from which the apron had a steady and suitable gradient to carry away the water to a point about 200 feet downstream, where the masonry joined the natural rock level. For the most part, the filling-in was effected with rubble masonry set in 4 to 1 cement mortar. At these points, however, where the talus was more than 10 feet in thickness, the proportion of cement mortar was made 6 to 1.



Testing a Portion of the New Protecting Apron Below the Dam. Note the Violence With Which the Water Rushes Through the Sluiceways.



Building Up the Excavated River Bed With 405,000 Cubic Yards of Solid Rock Masonry Paved With a Granite Facing, Which Is Carried Up to the Lips of the Sluices, as Shown.

THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

The whole of this masonry was then faced with squared, fine-grained, granite blocks. These blocks were 15¾ inches deep, with heading courses in four sets, 31½ inches deep, and they were all laid in a 2 to 1 cement mortar. Altogether, the total area of facing completed for the sluices sets 1 to 8 amounted to approximately 290,630 square feet. A comprehensive idea of the magnitude of the task involved in the carrying out of the protective work may be had from the fact that the building of the talus across one-half of the barrage entailed the building of 517,350 cubic feet of sadds, the excavation of 1,818,671 cubic feet of soft ballast, and 3,566,254 cubic feet of rock. For filling up 1,165,362 cubic feet of rock and 3,135,494 cubic feet of rubble masonry were used. There was 288,937 square feet of facework and 53,820 square feet of pointing.

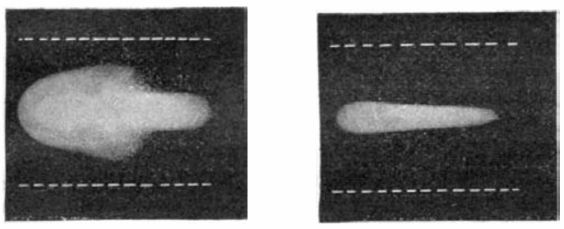
When the work was completed the apron was subjected to test, the water pressure at first being comparatively slight, and the head being gradually increased until the maximum was attained. At intervals, the various sets of sluices were shut off, so that the effect, if any, of the heavy impact of the water flowing through might be ascertained, and in order to repoint up immediately any joints that might have been washed out in the first instance owing to defective construction. Out of the whole 290,630 square feet of talus completed in the first half of the work, only about 1,000 square feet failed to resist the maximum head of water that could be delivered upon it; and in view of the enormous area so covered, the failure of this small portion, considering that native labor was employed, was not surprising. Owing to the lateness of the season, the point at which the failure occurred could not be reached until the following

(Continued on page 490.)

BALL LIGHTNING.

BY PROF. JOHN TROWBRIDGE, HARVARD UNIVERSITY.

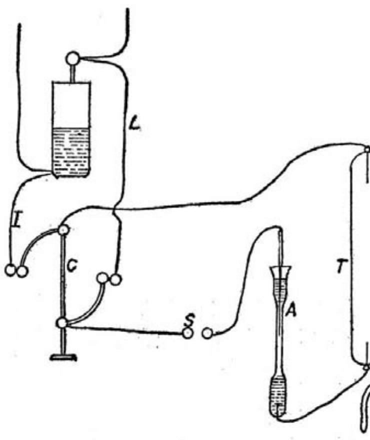
There is still much skepticism in the minds of many people in regard to the so-called phenomenon of ball lightning. We hear of strange luminous masses, which travel so slowly that one can easily follow their passage across a room or witness their perching on this object and that. It must be remembered, however, that there are not many persons who are in a sufficiently stable and philosophical frame of mind in a thunder storm to be trustworthy observers; and there may be a hypnotic state induced by repeated fearful shock which tends to states of hallucination.



PHOTOGRAPHS OF ARTIFICIAL BALL LIGHTNING.

A very exhaustive paper on the phenomena of electrical storms has been written by Toepler, who has done so much to perfect the electrical machine. (Annalen der Physik, 1900, vol. 2, p. 560.) He gives considerable space to a consideration of ball lightning, and evidently considers that there is reliable evidence of its existence.

It does not seem impossible, therefore, to produce electrical discharges by the powerful sources of electricity now at our command, which should resemble the slowly-moving effects that have been observed in thunder storms. The most notable attempt to reproduce such effects was made by Prof. Righi, the distinguished Italian physicist. His experiments are described in a memoir presented to the Royal Academy of Sciences of Bologna, with the title "New Researches upon Electric Sparks, Constituting Luminous Masses which Move Slowly."



Circuits of Righi's Apparatus.

Prof. Righi used a large plate electrical machine, driven by one-quarter of a horse-power, to charge a large condenser. This condenser was then discharged through a great resistance of distilled water and a glass tube filled with rarefied nitrogen. The diagram shows the disposition of his apparatus. *C* is a reversing key, which enabled him to discharge from the outside or the inside of the condenser. *S* is a spark gap. *A* is a tube of distilled water. *T* is a tube of rarefied nitrogen.

I have repeated Rhigi's experiments, using, instead of the discharges from large condensers, the current from a storage battery of 20,000 cells without the interposition of a spark gap, and I have obtained slow-moving luminous effects such as are described in Rhigi's memoir. These luminous masses move slowly from the anode toward the cathode with increasing strength of current, and retreat to the cathode with decreasing strength of current. A striking fact is this: the movement is toward the cathode when the pressure of air is suddenly increased in the discharge tube. The method was as follows: The electrical resistance was running water. At the base of the reservoir, the water issued through a glass tube ½ inch in diameter. A wire introduced in this tube could be pushed in and out, thus modifying the resistance. This high resistance was found highly satisfactory for this form of experimentation; for it did not heat, whereas graphite resistances developed a large amount of heat under the effect of the powerful electric current.

The slow movement of the luminous masses was shown best in tubes of two inches internal diameter. The photographs show the typical forms of such luminous masses. It will be noticed that the ends of the masses are curved, as if the center of the luminous mass constituted an anode, the interval between the luminous masses acting like cathode spaces.

I believe that the slow movements of electrical discharges produced in this manner are due to ionization, and that ball lightning is a similar ionization produced in rarefied channels of air formed during the thunder storm. One can conceive of a non-luminous condition of ionization pervading the space between the terminals of the battery in a wide tube at a comparatively high pressure of the gas in the tube. The positive carriers of electricity are not restrained or held back by the swifter-moving carriers, which cannot manifest their energy in a limited free path. On a sudden increase of pressure luminous clouds emerge from the anode. This phenomenon seems to indicate a greater proportional falling off in the energy of the negative carriers. The cloud of collision between the two moves slowly to the cathode, the conductivity of the gas changing under the difference of electric stress in the tube.

From the time of Benjamin Franklin down to the invention of the step-up transformer, our views of lightning gathered from electrical machines have been extremely limited. Even to-day one sees frequently in print the assertion that the quantity of electricity in an ordinary lightning discharge is small. My experience with the large number of storage batteries I possess makes me realize the extreme fallaciousness of this assertion. A very large quantity of current can pass over the path opened by even a short spark. This is also true of sparks six feet long, which manifest very little resistance, and which can open a path to discharges which can melt metallic rods an inch in diameter. During thunder storms discharges have often occurred which have melted lightning conductors of this diameter. The phenomena of ball lightning must result from a great quantity of electricity, which manifests itself by slow ionization of rarefied air.

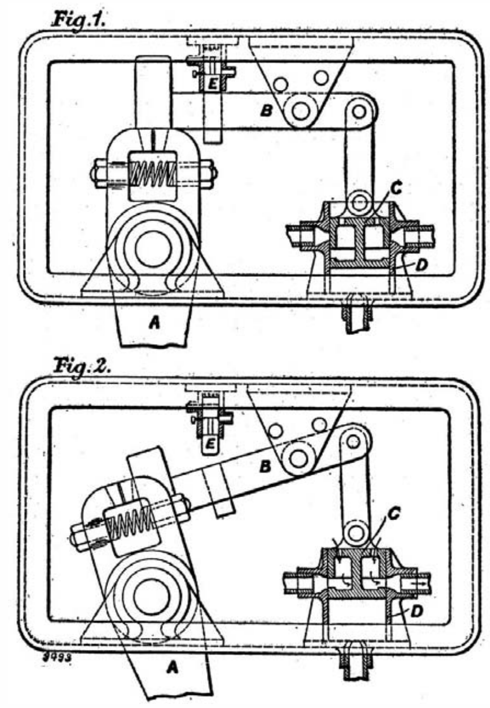
A NEW SIGNALING MACHINE SYSTEM FOR THE AUTOMATIC CONTROL OF RAILROAD TRAINS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

There have recently been carried out at the Stoke-on-Trent junction of the North Staffordshire Railroad of England, tests and demonstrations with a new system of automatically controlling railroad trains. This method which has been evolved by Mr. Thomas E. Raymond Phillips, of Liverpool, follows original lines, and possesses several ingenious and novel features which render it distinctly different from other devices that have been contrived to insure the absolutely safe control of railroad operation.

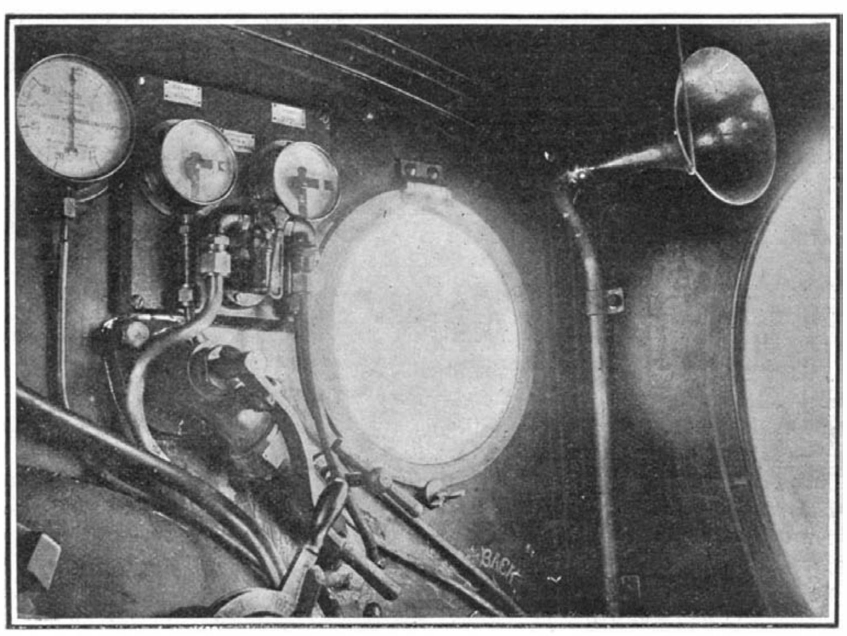
Briefly, the invention may be described as a system whereby the engineer of the locomotive is supplied in his cab with a visual repetition of the signal of the semaphore, "danger" or "line clear," combined with an arrangement for further drawing his attention to the conditions prevailing, should the visual signs be overlooked, by the blowing of the engine siren or whistle, and the gradual application of the brakes. But not only is the locomotive engineer thus informed of the condition of his road, but the signalman in his cabin is similarly protected, there being a dial showing the position of the semaphore assisted by the ringing of a bell, which continues until the signalman releases the stopped train, so that it is impossible for any accident to occur unless the visual and audible warnings are deliberately neglected.

The apparatus is divided into two essential sections —that carried on the locomotive, and a second installed upon the railroad track, the latter being in connection with both the semaphore and the signal cabin. In the cab of the locomotive are fitted two small semaphore indicators corresponding to the "distant" and "home" signals respectively, pneumatically operated, and showing whether the line is clear or otherwise. There is a vacuum reservoir, to which these two indicators are connected by gages, together with two other control pipes—one leading to the engine siren or whistle, and the other to the vacuum brake pipe of the train. This vacuum reservoir is normally in connection with the semaphore gages in the cab, so that the arms are kept depressed, i. e., in "clear" line position. The actuating mechanism is carried in a casing fixed to the front of the locomotive, and placed slightly to one side of the center line. There is a vertical lever *A* of the scissor-leg type, with the limbs held tightly together so as to form one member. Upon the upper end of this lever rests the weighted end of a horizontal lever *B* which, at its opposite end, is connected to a hollow piston *C*. By coming into contact with the rigid section of the apparatus fixed on the track, the lever *A* is pushed over, thereby permitting the horizontal lever *B* to drop at the weighted end. In this action the hollow piston *C* is lifted, and in rising the latter brings ports in the piston *C* into coincidence with ports in the cylinder *D*. The falling of the lever *B* permits air to enter the gage of the indicating semaphore in the engine cab, lifting the arm to the danger position, so that it corresponds with the railroad signal. Simultaneously the locomotive siren is brought into action, and continues sounding until the engineer attends to his brakes, though meanwhile the apparatus has, by the falling of the piston valve *E*, admitted air to the brake pipe of the train, so that speed is gradually decreased. In the operation of the apparatus in connection with the "home" signal, which necessitates immediate action on the part of the engineer in pulling up the train, the three functions are appreciably accelerated, especially in regard to the automatic application of the brakes. In passing the "distant" signal, when the arm is at danger, rapid retardation of the train is not generally requisite, so that the automatic application of the brakes is not so powerful, but yet at the same time sufficient to attract the attention of the engineer. In the case of

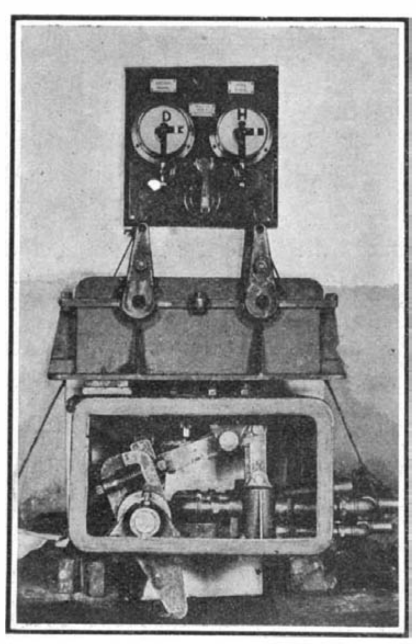


Mechanism Carried on Engine.

Fig. 1.—Normal position of apparatus. Fig. 2.—Position after lever A has struck trigger on track, showing rising of piston C, operating engine indicator, siren and brakes simultaneously.



Semaphore Indicators and Siren Installed in Engine Cab.



Indicators and Actuating Mechanism Carried by Locomotive.

A NEW SIGNALING MACHINE SYSTEM FOR THE AUTOMATIC CONTROL OF RAILROAD TRAINS.

the "home" section of the apparatus coming into action, the "distant" part of the mechanism is similarly operated, so that the two semaphores within the cab have their arms set at danger, as in ordinary railroad signaling work.

The track mechanism consists of trippers comprising balanced pendulums swinging in cases, there being sets of trippers for home and distant signals, and each working in conjunction with its respective striker on the locomotive. These trippers are placed to one side of the road, so as to clear coupling chains, hooks, etc., carried on the rolling stock. These trippers are connected with the semaphores, and should the latter be at "danger" position they project upward, the upper parts being struck by the projecting levers of the locomotive mechanism. If the line is "clear" and the semaphore arm depressed, in setting the latter the signalman also draws the trippers down clear of the strikers on the engine.

The track part of the apparatus is electrically connected to the signal cabin, these connections being of a simple character, so as to be as immune from breakdown as possible. In the signal cabin is a dial with a repeater, which indicates whether the semaphore arm is set "clear" or at "danger" positions, and if the apparatus from some cause or another breaks down, the record "out of order" is indicated. In connection with this dial is the electric bell, which continues ringing after an operation until the signalman releases the train out of his section. It will thus be realized that it is impossible for a signalman to forget that a train is blocked at one of the signals in his section even though he be prevented from seeing, owing to thick or foggy weather.

To reset the apparatus on the locomotive, the engineer simply turns a three-way cock, which renews the vacuum in *D* under the piston *C*, thereby causing the horizontal lever *B* and the vertical striker *A* to revert to their normal or set position, the arms of the semaphore indicator being depressed to the "line clear" position, and the blowing of the whistle stopped thereby. In the event of any part of the mechanism suddenly failing through breakage, the piston *C* immediately rises, drawing the engineer's attention to the fact that something is amiss. Similarly, in the event of the striker becoming fractured by the force of an abnormally hard blow against the triggers on the track, or the lower point becoming so worn under repeated contacts as to miss striking, the same effect results. In this case the spring, which is compressed between the upper ends of the scissor limbs of the vertical striking lever, forces the two members open, with the result that the weighted end of the lever *B* falls between the two opened parts, and cannot be removed until the broken striker is replaced.

At first sight it may appear that the risk of breakage, which is always existent in signaling systems depending upon the contact of a striker with a tripper, constitutes an inherent weakness of the Phillips invention, inasmuch as when, say, a striker breaks, the locomotive engineer would be liable to frequent false indications, and the application of the brakes when in reality the line is quite clear. Such, however, is not the case. The integral parts of the apparatus are all standardized, and any fractured part can be replaced in a few seconds. In the event of a breakage occurring in the engine mechanism, the indicating semaphore arms immediately rise to "danger," the siren sounds, and the brakes are applied as already mentioned. The engineer would then, after seeing that the line is actually clear, though his apparatus indicates the reverse state of affairs, endeavor to remedy the wrong reading by setting the apparatus with the three-way cock provided for the purpose. But the handle of this three-way cock is painted and shaped like an ordinary semaphore arm, so that although the engineer would reset his indicating semaphore arms to "line clear" position, the handle of the three-way cock would remain at "danger" position. Thus the apparatus would show two different readings, and from this the engineer would immediately realize that the apparatus was at fault, would stop his train, and ascertain the defect. Should he ignore the divergent readings, he would be running against "danger signals." Before an engineer actually gets the "line clear" position, the brakes must first be released, the gage indicators must show line "clear," and the handle of the controlling or resetting three-way cock must show the same reading. False indications are thus impossible. For the past two years the appliance has been in daily use upon a stretch of the North Staffordshire Railroad, and never on a single occasion has the slightest breakage occurred to either the engine or track portions of the apparatus, nor has a solitary instance of failure to act been recorded. In fact, owing to the unique success of the system, it was removed to the important and busy junction at Stoke-on-Trent, where it is subjected to far heavier and rougher usage. On this system so far the highest speed at which the train has passed over the apparatus has been 45 miles per hour, at which speed the apparatus has withstood the shocks of contacts remarkably well; and though the working parts have been in use for two years, no appreciable signs of wear are perceptible. The removal of this particular installation to a busy junction has imposed a supreme test upon the invention, since the trains travel at high speeds over a network of crossovers and switches, in negotiation of which under such conditions considerable oscillations and vibrations are produced.

The electrical connections of the tripper, and those running to the signal cabin repeater, are so arranged that so long as the trippers remain either at the "danger" or "line clear" positions the circuit is closed, the indicators in the cabin being held up by magnets. Directly the tripper arm is struck by the lever on the engine the circuit is automatically opened, thereby causing the indicator to fall, and thus showing whether the tripper acted upon is either the "distant" or "home" signal. In the act of falling the indicator also closes a local circuit, causing the bell to ring, and this action continues until the indicator is restored to its position by means of a plunger provided for the purpose in the repeater. In the tripper the wire connecting the contacts is carried over the top of the arm internally, so that in the event of the arm being broken the conductor is also broken, thereby cutting off the current, and thus the indicator pointer within the signal cabin falls to its middle position, marked "out of order." The bell, however, is set in action and continues ringing until the tripper is repaired. In this it will thus be seen the signal operator is duly warned of the failure of the apparatus, and cannot in the event of an accident to the train in his section attribute the cause thereof to the failure of the apparatus.

The invention is also so devised that the locomotive engineer can apply his brakes without causing any movement of the semaphore indicator within his cab, or by the pulling of the communication cord extending throughout the train. This end is assured by means of a check valve, which is placed between the braking pipe of the train and the reservoir, which works in conjunction with the indicators in the cab of the engine.

THE PROTECTIVE WORKS OF THE ASSOUAN DAM.

(*Continued from page 488.*)

year, when it was replaced and the second half of the river bed similarly treated.

The whole task has now been successfully completed; there being a granite and masonry apron stretching from one side of the river to the other, from the lips of the sluices to points ranging from 100 feet to 200 feet downstream, according to the conditions prevailing. So efficient have the earlier sections of the apron proved in resisting the heavy impact of the water rushing through the sluices that no doubt is entertained as to the permanence of this work. The apron will necessitate but little attention beyond periodical examination, and the possible renewal of the pointing.

Sir William Garstin, the well-known irrigation engineer and adviser to the Egyptian Ministry of Public Works, who has been closely identified with the barrage since its inception, considers that the completion of this protective masonry apron has completely removed any apprehensions that might have prevailed concerning the stability of the barrage itself. The construction of the apron, which was carried out by the Irrigation Department's engineers under Mr. Macdonald, the resident engineer, is a remarkable feat considering the difficulties that had to be surmounted both in the use of native labor, and in the short space of time available for the completion of the undertaking.

It is due to the thorough nature of the work that the raising of the barrage itself is considered to be feasible and is now being pushed forward with all speed. This work in itself will be a remarkable one. The extension is not to be built immediately upon the old work; but the whole cross section of the dam is to be increased from top to bottom. There will be a space of about 8 inches between the old and the new walls, which will be connected by steel ties, the intervening space being subsequently filled with cement grouting, and the whole structure thus converted into one homogeneous whole. The total cost of building the masonry apron has approximated $1,500,000.

Official Meteorological Summary, New York, N. Y., May, 1907.

Atmospheric pressure: Highest, 30.33; lowest, 29.70; mean, 30.00. Temperature: Highest, 83; date, 14th; lowest, 36; date, 12th; mean of warmest day, 70; date, 19th; coolest day, 44; date, 12th; mean of maximum for the month, 62.8; mean of minimum, 47.8; absolute mean, 55.3; normal, 59.7; deficiency compared with mean of 37 years, —4.4. Warmest mean temperature of May, 65, in 1880. Coldest mean, 54, in 1882. Absolute maximum and minimum of this month of 37 years, 95 and 34. Average daily deficiency since January 1, —1.8. Precipitation: 4.08; greatest in 24 hours, 1.10; date, 16th and 17th; average of this month for 37 years, 3.18. Excess, +0.90. Accumulated deficiency since January 1, —0.58. Greatest precipitation, 7.01, in 1901; least, 0.33, in 1903. Wind: Prevailing direction, N. W.; total movement, 8,683 miles; average hourly velocity, 11.7; maximum velocity, 48 miles per hour. Weather: Clear days, 9; cloudy, 10; partly cloudy, 12; on which 0.01 inch, or more, of precipitation occurred, 12. Thunderstorms, 10th, 11th, 16th, 19th, 20th, 27th. Frost, light, 5th, 12th. Remarks: Coldest May with the exception of May, 1882, in 37 years.

Santos Dumont's Airship No. 16.

Santos Dumont is not only engaged in perfecting his new aeroplane which we already had occasion to mention, but is also constructing a new airship which has some interesting points. We expect to give a more complete account of the airship, but at present will speak of its leading features. As regards the balloon body, it is one of the smallest in cubic contents that has ever been constructed, seeing that it gages but 99 cubic meters (349.7 cubic feet), but on the contrary it is to carry a light-weight motor of no less than 50 horse-power. No doubt it will be able to reach a high speed under these conditions. The balloon envelope is of varished Japan silk, and the total length of the balloon, which is a very long cigar shape, is 21 meters (68.9 feet). The surface is 151 square meters (1,625 square feet). The main balloon contains a ballonet which measures 2 meters (6.6 feet) in diameter. There is a single propeller which is mounted upon the light framework below the balloon body. The propeller is mounted direct upon the motor shaft and is 2.05 meters (6.76 feet) in diameter with a pitch of 1.70 meters (5.8 feet). In front of the propeller and attached to the framework is a movable plane formed of a frame covered with canvas which measures 3 meters (9.8 feet) in length across the balloon and 0.50 meter (1.64 feet) in width. Toward the rear is placed a second and similar plane which is 4 meters (13.1 feet) in length and 1.20 meters (3.9 feet) wide. Behind it lies the rudder, which is formed of a circular frame and is 2 meters (6.6 feet) in diameter. The aeronaut will be seated on a simple bicycle saddle, which is suspended, as is also the mechanical part, to a frame made of light steel tubes placed vertically and fixed from a bamboo pole, the latter being held just under the balloon body. The center of resistance is placed as nearly as possible in coincidence with the center of traction. As the propeller is mounted quite near the balloon, it will almost touch it when it is running. Good protection is afforded to the motor by a wire gauze covering which surrounds the carbureter, thus avoiding any risk of fire to the gas escaping from the balloon. The new airship is to be known as the "Santos Dumont No. 16," and it is now in construction at the shed which had been erected again at Neuilly near the Bois de Boulogne. To the same shed is soon to be brought the new aeroplane "No. 14." Its sustaining planes have been modified since the last accident it had at St. Cyr.

The Current Supplement.

The highlands east of the Jordan River are strewn with ruins marking the rise and fall of successive civilizations. The strangest and most beautiful of these ancient ruins is the Rock City of Petra, described in the current Supplement, No. 1641. Dr. Franklin E. Hoskins writes most interestingly on the old town. Exceptionally handsome illustrations accompany his description. An important article on the compression of steel ingots by wire drawing, with cuts, is given. Mr. Hall's excellent paper on artificial fertilizers is continued. W. F. Badgley tells us something on the shape of molecules. By far the most valuable article in the Supplement to the amateur is undoubtedly Mr. E. F. Lake's description of how a 5-horse-power stationary gas engine can be built at home. He describes clearly and simply how each part is made and what metal must be used. The usual notes will be found in their accustomed places.

Consumption of Pulp Wood in 1906.

The Census Bureau has prepared a preliminary report on the consumption of pulp wood in the United States for the calendar year ended December 31, 1906, which shows that during that period 3,646,693 cords were used, as compared with 3,192,123 cords utilized in the previous year. This is an increase of 454,570 cords. The principal wood used in 1906 was domestic spruce, of which 1,785,680 cords were consumed. Classified according to methods of reducing into pulp, the mechanical process took 1,197,780 cords; the sulphite process, 1,944,136 cords, and the soda process, 504,777 cords. The figures cover the operations of 250 mills in 1906 and 237 in 1905.

A new 72-inch plate mill at the Homestead works of the Carnegie Steel Company has been put in operation. The mill, it is said, will have a capacity of 60,000 tons annually.

Correspondence.

The Inverted Image Explained.

To the Editor of the SCIENTIFIC AMERICAN:

Under the title "A Curious Illusion," there is published in the SCIENTIFIC AMERICAN of May 25 an article by Gustave Michaud, of the Costa Rica state college, which is presumed to illustrate the manner in which "the nervous element" which upsets the inverted image on the retina may be deceived into overturning an image which by an artifice has been made to paint itself right side up on the retina, so that it will then appear to be upside down.

In this experiment, which is a very pretty one, three, or, for that matter, any convenient number of holes are made in a card with a pin, very close together. A single hole is made in another card. Then, if the card having the number of holes in it is held very close to the eye and an attempt is made to look through the single hole in the other card, held at the proper distance, instead of one hole, as many will be seen as there are holes in the card next to the eye, and the arrangement of these holes will appear to be inverted —that is, if the holes are arranged in a triangle with the apex directly at the top, it will appear to the eye as if standing on its point.

Prof. Michaud says: "The triangle on the retina is arranged just as it is on the card, right side up. The nervous element, however, blindly upsets this image, as it does upset ordinary inverted images, and this gives us the sensation of seeing upset what we know to be erect." If a layman may be pardoned for expressing an opinion, this so-called "nervous element" has absolutely nothing to do with the phenomenon in question, which is easily explainable on purely mechanical lines.

If the experimenter will hold the card with the single hole in it toward the light and rather close to his eyes, both being open and focused for long distance, he will observe two luminous spots instead of the one which he knows to be there, and it may readily be determined that the image which appears at the right belongs to the left eye, and the one at the left belongs to the right eye. This means simply that the eye sees an object in the direction from whence it receives the light emanating from it, and the hole being to the right of the left eye is seen by that eye to the right of the image formed by the right eye, which, as will be noted, is a form of inversion or reversion.

This is all there is to the inversion of the triangle as seen in the experiment, the three portions of the retina which receive the impressions acting with reference to each other precisely as the two eyes do toward themselves. Owing to the greater elevation of the hole at the apex of the triangle the eye receives a pencil of light through it which emanates from a lower point, relatively, than those which pass through the holes at the base of the triangle; hence the image formed on that portion of the retina makes the object appear lower than it does as seen through the latter. The different portions of the retina merely see the object in the direction from whence they receive the light, and the "nervous element" is in no way concerned in the apparent inversion.

It would seem that this simple rule is the true explanation of the much-mooted question as to how the image ordinarily formed on the retina is made to appear right side up when it is actually inverted. The power portion of the retina receives the light from the top of the object, hence sees it in that direction, or right side up, and the same for every other point touched by the image. Accepting this common-sense explanation we have no need for a mysterious "nervous element," which goes about standing inverted images on their feet. The great trouble with this point has been that many people insist on believing, or acting as if they did, that the brain stands back and looks at the image formed on the eye, when nothing of the kind takes place. The eye sees an object in the direction from whence it receives the light, and that to the writer appears to be all there is to it.

Mt. Carmel, Ill., June 3, 1907. D. E. KEEN.

Specific Air Navigation Prizes.

To the Editor of the SCIENTIFIC AMERICAN:

The only rational specification of a proper flying machine that I have yet seen published is that indicated by Mr. Rankin Kennedy, of Glasgow, in the SCIENTIFIC AMERICAN of May 25. It appears to me that any aeroplane dependent alone upon its swift propulsion for maintenance of support, or any machine which cannot by its own contained power "go up, stay up for a time, and come safely down," and moreover maintain its position aloft poised or hovering near one point at will, is in no way the equal of a suitably constructed, gas-buoyed motor airship, which does at the present time these feats with moderate effort and safety to its rider.

The impelled movement of small model machines is also achieved with moderate effort in a variety of ways. Something really superior, and man-bearing, should be required to warrant award of the SCIENTIFIC AMERICAN prize for "flying machines."

Frankfort, N. Y., May 27. CARL E. MYERS.

Wanted—An Army Cooking Stove.

To the Editor of the SCIENTIFIC AMERICAN:

There is need for a contrivance to be used in connection with the oven of a cooking stove as a substitute for the old-time roasting jack, that will properly cook and baste a roast of meat. There are many inventive persons in our country, readers of the SCIENTIFIC AMERICAN, who could doubtless fashion such a machine, and it seems to me that the invention ought to be a profitable one.

My idea of such a contrivance consists essentially of a simple clockwork motor placed outside the oven and firmly attached to the stove or nearby wall, the power to be conveyed to the interior of the oven through a small aperture in the side or back of the oven (not through the oven door) and by a suitable device made to revolve an axis to which is attached two spoons, which in their revolutions scoop up gravy in the baking pan, convey it above the meat, and empty it onto an inclined perforated conduit, that will permit it to drop over the meat and thus baste it, and thus continue till the meat is roasted. The meat is to be laid in the baking pan, and does not revolve. The baking pan to be fashioned so as to have a gutter or rounded channel at one end, where the gravy will accumulate for being dipped up by the spoons. The latter to accurately and easily fit the rounded channel. The bottom of the baking pan to incline toward the gutter, so that the gravy will readily run into it; or the purpose may be accomplished by placing a small piece of iron or other incombustible material under the end opposite the gutter. The inclination need be but slight. The compensation to the inventor would be derived from stove and range manufacturers for the right to use it.

The contrivance, except the clockwork, should allow of being easily taken apart for cleaning and keeping in order. There are now on the market fixtures that pretend to roast meat, but so far as I know, they parboil or stew the meat, and cannot give the flavor of a real roast; indeed, one may say that the taste or flavor of roast meat exists only as a long-ago memory. This would not be so if the cook would place the meat in the baking pan with a little fat for basting, and then honestly baste it at proper intervals, but the cook does not attend to it in this way; for to save this trouble water is used in the baking pan, and the meat is steamed, and not roasted. What is now wanted is a machine that will baste the roast, relieve the cook of an expected but neglected duty, and restore to our tables a form of food known to former generations, and of which the present generation has no knowledge. An inventor, thinking to act on these suggestions, should, if ignorant of cooking, consult an intelligent cook for points to be considered in a perfect roasting appliance. JOHN P. HAWKINS,

Indianapolis, Ind. U. S. Army.

The Skeleton is Mounted in Sections Which Can be Taken Apart and Reassembled.

DIPLODOCUS: THE GREATEST OF ALL EARTHLY CREATURES.

DIPLODOCUS: THE GREATEST OF ALL EARTHLY CREATURES.

BY WALTER BEASLEY.

A splendid 60-foot specimen of the great American dinosaur, Diplodocus, is to have the place of honor in the new Senckenberg Natural History Museum, at Frankfort-on-Main, Germany. For this valuable fossil prize the municipality of Frankfort is indebted to the generosity of Morris K. Jesup, Esq., of New York, president of the American Museum of Natural History, and of Jacob H. Schiff, Esq. Mr. Schiff, as a native of Frankfort, was requested to secure if possible an interesting exhibit from this country, to enrich the new Frankfort institution. Mr. Jesup heard of this appeal and had prepared and mounted at his own expense a diplodocus skeleton from the Museum's collection. The dedication ceremony will take place before a distinguished gathering of scientists and educators, including the German Emperor and Empress. It is probable that Director Herman C. Bumpus will make the official presentation of the diplodocus on behalf of Mr. Jesup.

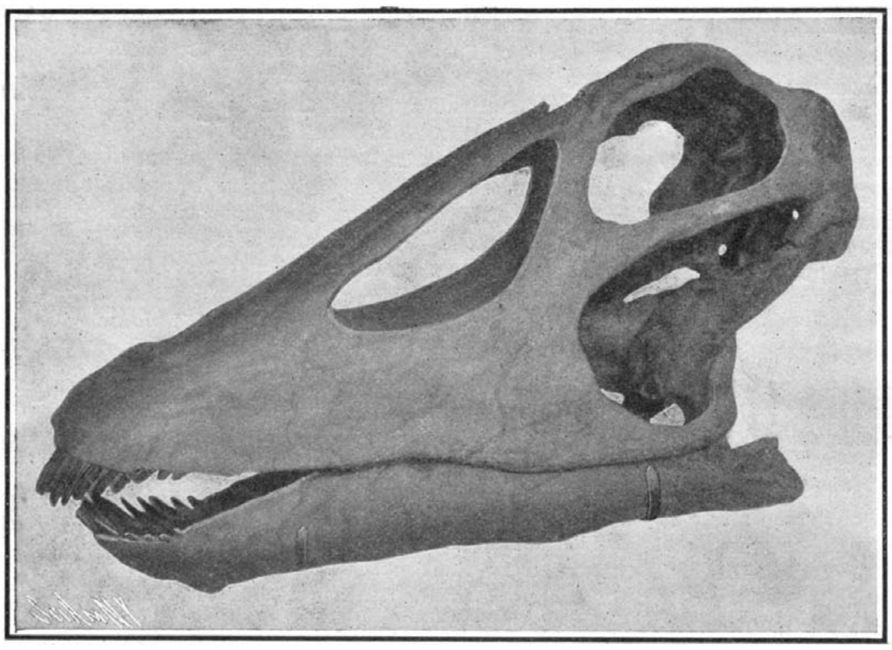
The skeleton was obtained from the famous Bone Cabin Quarry, located near the Medicine Bow River, in south central Wyoming, and was unearthed in 1899 by Dr. W. D. Matthew, the present associate curator, and Mr. P. Kaison, who dug out the greater part of it, comprising the backbone, ribs, and one hind limb, which were found lying on their sides, the bones articulated in their natural position from the middle of the neck to the tenth vertebra of the tail. The ribs of the underside lay in position; those of the upper side were more or less scattered and broken. The hind limb was nearly all in place. A noteworthy feature of the skeleton is that this is the only one of an amphibious dinosaur, in which all the vertebræ of the back region have been found articulated, in individual series, so that their number is entirely certain. It is thus proved beyond question that the creature had an extremely short back with every vertebra bearing a rib. Before the discovery of this specimen much uncertainty and speculation prevailed as to the number of vertebræ.

The other limbs and portions of the feet and tail are supplied from specimens found in the Bone Cabin Quarry and may possibly belong to the present individual. A few of the missing parts are represented in black outline on the slab matrix. The head is cast from a perfect diplodocus skull in the museum.

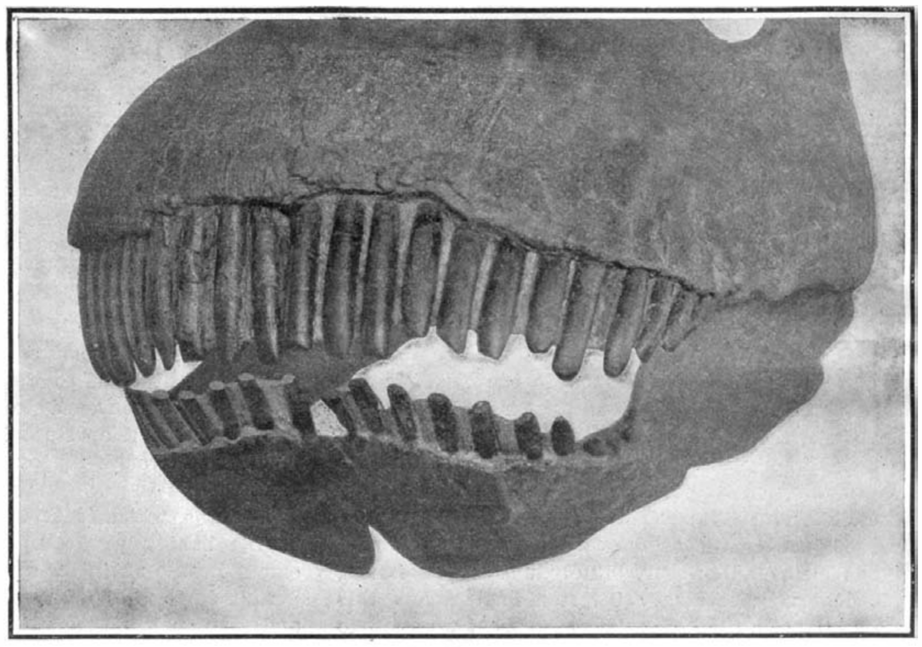
Diplodocus was a giant reptile and one of the largest animals that ever trod the earth, ranging from 60 to 70 feet in length. The animal flourished some eight million years ago during the Jurassic Period and Age of Reptiles. This huge lizard-like creature roamed around the marshes and lived in the inland seas and lakes which, during the Reptilian Era, covered Wyoming and various parts of the Rocky Mountain region. Diplodocus was tall, exceeding in height the largest elephant, with long, slender limbs, 10 feet or more in length, and for its huge bulk was considered to have been remarkably agile. The animal was principally aquatic, though frequenting the land at times. The head was astonishingly small, being but 2 feet long, in proportion to the huge body, the estimated weight of which was 25 tons. Charles R. Knight's restoration, here shown, strikingly portrays the characteristic and approximate life appearance of the animal. The short, rake-like teeth around the front of the mouth were useless for cutting or grinding, and were adapted only for pulling up and tearing off the soft, succulent water-plants and vegetation of the lake bottoms on which it fed. A realistic view of both the small head and rake teeth are shown in the photo here reproduced from a complete skull, now in the American Museum.

Diplodocus is credited with having the longest and largest neck known to any animal, living or extinct. The long, flexible, tapering neck of the present specimen is 15 feet in length; in others it has reached over 20. One of the most remarkable structural features of the animal is the whip-like and powerful tail, 30 feet long, constituting about one-half the length of the body. The tail served the creature both as a propeller, enabling it to swim rapidly through the water, and as a weapon of defense on land and a ready means of rapid escape by water when attacked or pursued by the fierce carnivorous dinosaurs of the land. Another peculiar feature of the enormous tail was that it acted as a lever and balanced and supported the animal when it rose up on all fours and assumed a semi-upright position. A series of four or five of the tail vertebræ are so flattened at the bottom and the lower surfaces as to indicate the supposed resting-point when the creature stood up in a kangaroo-like fashion.

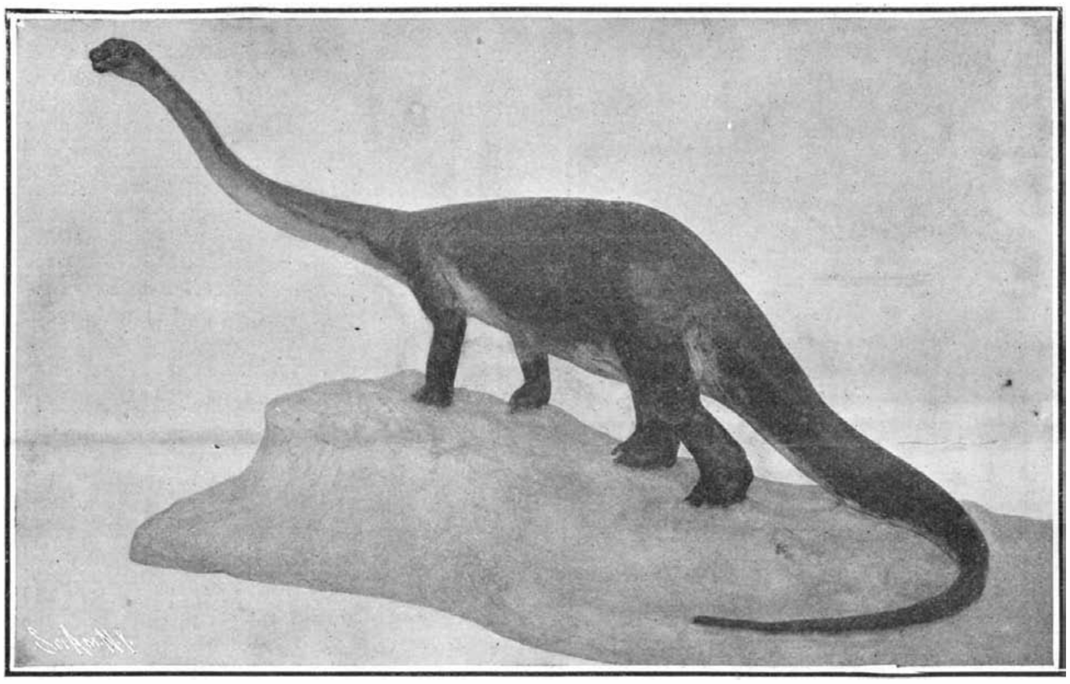
The imposing slab matrix is a wooden framework with a plaster foundation, 56 feet long and 13½ feet high, following the curvature of the spine of the skeleton. This delicate and unique piece of fossil engineering work was built by Mr. Harry Beers, of the museum staff. It is in twenty-five sections, each supporting one or more bones. They are so constructed that they can be assembled and bolted together so as to



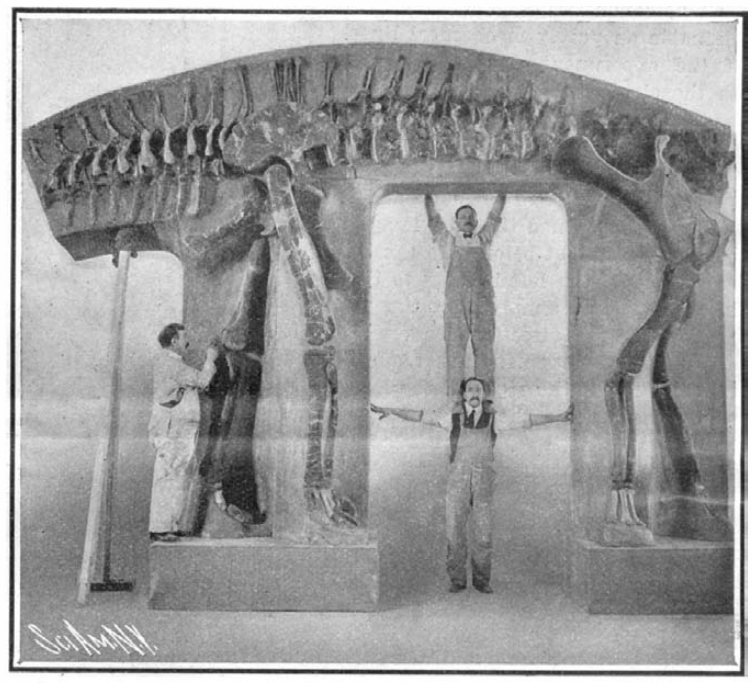
The Two-Foot Head of Diplodocus, Showing the Rake-like Teeth Used for Uprooting the Vegetation of Marshes.



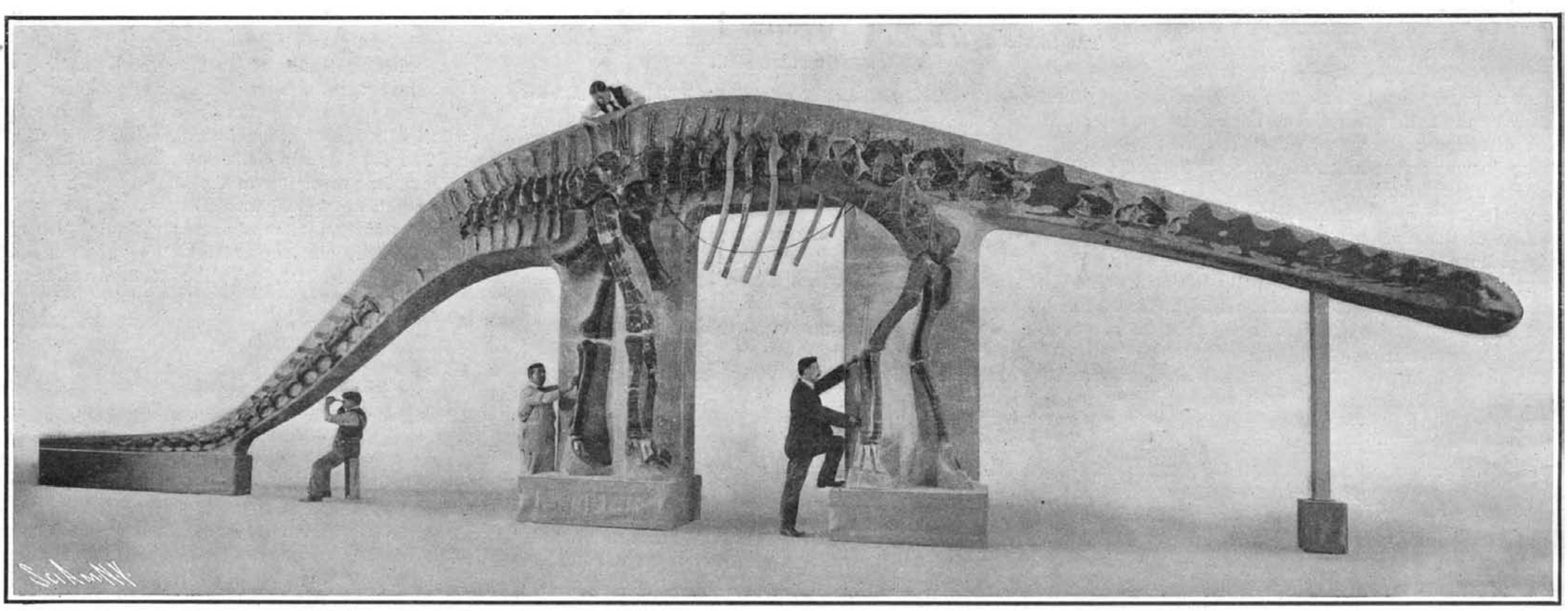
A Front View of the Battery of Blunt Rake Teeth with Which Diplodocus Was Armed.



Restoration of Diplodocus by Charles R. Knight.



Piecing Together Sections of the Great Diplodocus.



Complete View of the 60-Foot Diplodocus Skeleton to be Presented to the City of Frankfort-on-Main.

DIPLODOCUS: THE GREATEST OF ALL EARTHLY CREATURES.

form what appears to be a continuous stone slab, with the skeleton hewn out in bold relief. The sections are framed of kiln-dried spruce logs, screwed together, painted with three coats of asphaltum, to prevent the dampness from swelling or warping the plaster. Three-quarter channel irons are used to form the rests or beds on which the bones are fastened. The wood frames and iron projections are covered with galvanized iron wire mesh and then again with burlap dipped in liquid plaster. On this foundation the plaster matrix was run to the edge of the bones. After the matrix became hard, it was chipped with a stone-cutter's chisel, so that the fossil seems to have been sculptured out of the solid rock. The mounting of the great skeleton was very skillfully accomplished by Mr. Otto Falkenbach, assisted by Mr. Charles Falkenbach, of the paleontological department.

Artificial Sea Water for Keeping Sea Animals and Plants in an Aquarium (according to H. Lachman).—In 50,000 parts of the hardest obtainable well water (i. e., that containing the most lime) dissolve 1,325 parts of chloride of sodium, 100 parts sulphate of magnesia, 30 parts of sulphate of potassium, and 150 parts of chloride of magnesium. These solutions are allowed to clarify by precipitation and are poured off clear. The water must not be used at once, however, but should stand for about three weeks, lightly covered, in a cool place. At the commencement of this period of rest, a few of the algæ (sea weeds) that attach themselves to stones should be placed in the water, to effect its oxygenation. Of such an exactly constituted solution, we can determine the specific gravity, and thereby constantly control the amount of salt in the solution, not only while it is stored, but in the aquarium. Finally, the water is filtered through a clean sponge or through plastic charcoal, and is then ready for use.

THE OCEAN RACE OF TORPEDO-BOAT DESTROYERS.

Although the recent ocean race of six of our largest torpedo-boat destroyers, over a 240-mile course from Sandy Hook to Cape Charles, has not turned out to be as great a fiasco as similar races of this kind that have been held in bygone years in other navies, it can hardly be called a success. The first race of this character, if we remember rightly, took place some twenty years ago, when a large number of torpedo boats were sent at full speed over a course laid up the English Channel; and it served mainly to demonstrate the frailty of these craft and the impossibility of relying upon them for any long-continued speed effort over a lengthy course. Such of the boats as were not crippled in the engine room or boiler room, began to show evidence of structural weakness. The race left no doubt that the torpedo boats of that day were altogether too light for deep-sea duty; and it was partly as the result of this experience that the dimensions and scantling of torpedo craft were increased, and the torpedo boat developed into the dignity of the torpedo-boat destroyer. The increase in size since that date has been steady, the displacement having gone up from 80 or 100 tons to from 300 to 400 tons, while the latest British destroyers are of 500 tons displacement. But even the modern destroyer, with its ample length, beam, and draft, appears to be unable to maintain her full speed for more than a few hours at a stretch. Probably the best work that has been done of late years was the deep-sea service of the Japanese destroyers during the operations at Port Arthur, when these vessels kept the sea, except for occasional visits to a naval rendezvous, through all the stormy months of the winter blockade. It is certain, however, that most of this service was performed at a moderate cruising speed, the occasional runs under full power being only of limited duration.

The division of torpedo boats engaged in this race contained representatives of the best of our destroyers. The latest and probably the most efficient of the six is the "Stewart," whose dimensions may be taken as

TORPEDO BOAT DESTROYERS IN THE SANDY HOOK-CAPE CHARLES RACE.

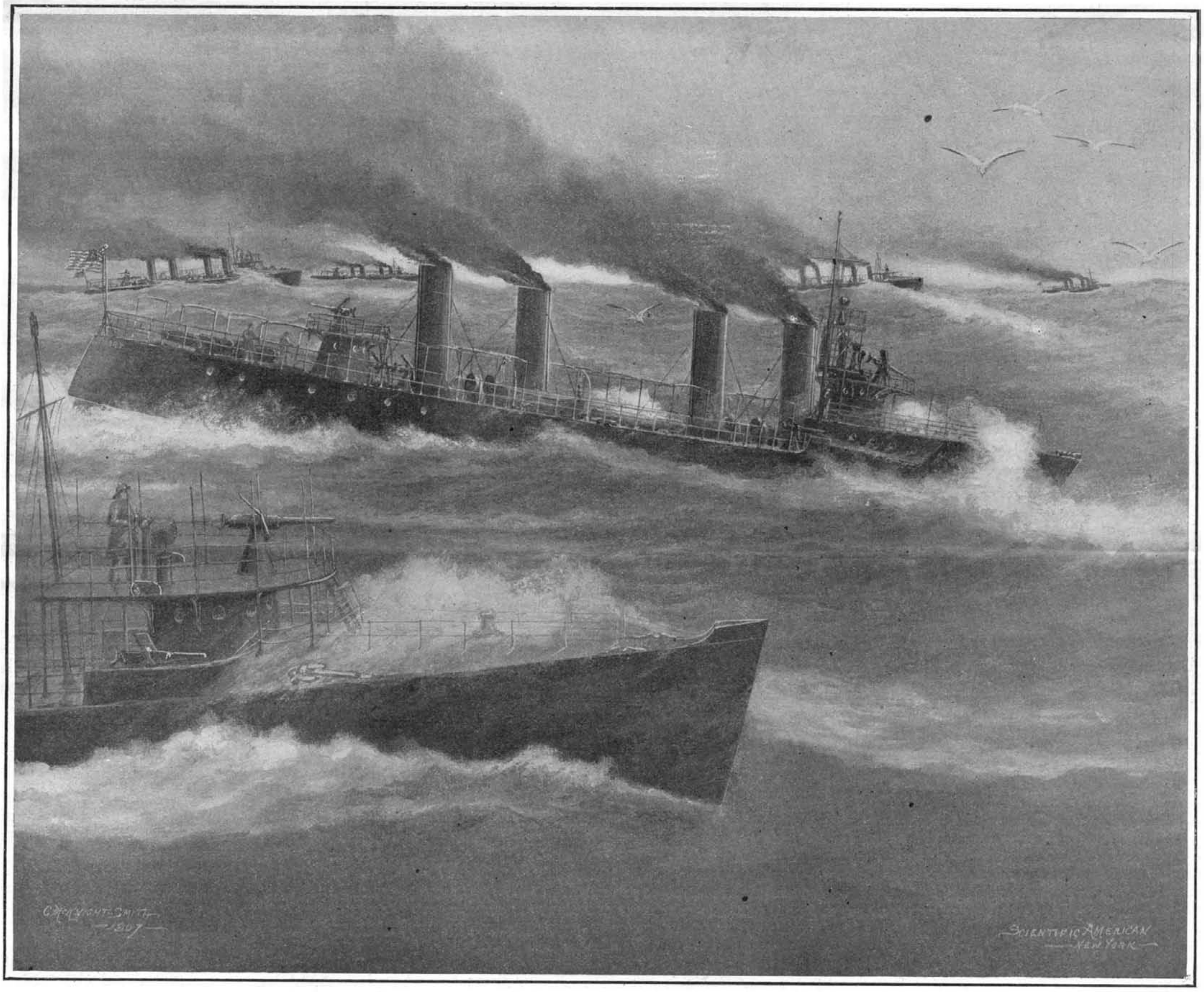
	Length	Beam.	Draft	Displacement on Trial Tons	Maximum Coal Supply Tons	Horse-power	Trial Speed
"Whipple"	248′ 0″	22′ 3½″	6′ 0″	481*	177	8,300	28.24
"Truxton"	248′ 0″	22′ 3½″	6′ 0″	481	177	8,300	29.58
"Worden"	248′ 0″	22′ 3½″	6′ 0″	476	177	8,300	29.86
"Hull"	238′ 9″	23′ 1½″	6′ 0″	449	165	9,119	28.04
"Hopkins"	238′ 9″	23′ 1½″	6′ 0″	467	165	8,456	29.02
"Stewart"	245′ 0″	23′ 1″	6′ 6″	439	184	8,000	29.69

* Beeause of the large amount of stores, ammunition, coal, water, furniture on board, these vessels at the commencement of the race displaced nearly 700 tons,

representative of the sixteen vessels which compose our destroyer fleet. She is 245 feet long; 23 feet 1 inch in beam, and draws 6 feet 6 inches at normal draft. Her displacement on trial was 439 tons, and her trial speed 29.69 knots an hour. The great disparity between the trial speeds of these boats and the speeds which they are able to develop on a sudden order for a run under full power, is to be attributed: First, to the rapid all-round depreciation due to the light construction both of hulls and engines. Secondly, to the fact that, as in the present case, the hulls are frequently foul because of the lengthy absence from drydock; and thirdly, to the fact that in the cruising condition they are so weighted down with ammunition, general stores, coal, water, and the furniture necessary for living accommodation, that they not infrequently displace fully 50 per cent more than they did on trial. Thus, the "Hull," when on trial, stripped for speed, and with just enough water and coal for the occasion, displaced about 450 tons. On crossing the line at Sandy Hook, she displaced about 680 tons. It was for the reasons given above, that naval officers did not expect the vessels to average more than 22 or 23 knots for the whole course.

The recent race was rendered possible by the fact that a squadron of six of our destroyers was under orders to proceed from New York to the naval review at Hampton Roads. Advantage was taken of the opportunity thus presented, to send these vessels down the coast under an order calling for them to make their best speed for the 240 miles. The boats started abreast across an imaginary line drawn from the Sandy Hook lightship at eight thirty-three on the morning of June 6. Each vessel, judging from the blowing off of the safety valves, was carrying a full head of steam, and they were speedily hull down to the observers at the Sandy Hook station. Although the boats were credited with trial speeds of from 28 to nearly 30 knots an hour, it was not anticipated that they would average more than 22 or 23 knots an hour over the whole course. This should have brought them into Hampton Roads at about 6 o'clock the same evening.

The winner of the race was the "Worden," whose time, taken by the American fleet as she passed the Cape Charles light, was seven forty P. M., the elapsed time for the run being eleven hours and seven minutes. This works out at just 21.6 knots average for the whole distance—a rather poor showing for the crack boat of half-a-dozen supposed 28 to 30 knot craft. The "Worden" was being closely pressed by the "Hopkins," when suddenly off Hog Island, the latter broke a propeller strut, and was completely disabled. The propeller, thrashing wildly around, tore a hole in the after compartment, and the "Hopkins" had to signal for assistance. Her after bulkhead held, fortunately, as did her pumps, and with the aid of a line from the "Whipple," she was able to reach Hampton Roads at 8 o'clock on the morning of June 7. It is only fair to state that the "Hopkins" and "Whipple" had averaged a higher speed than 21.6 up to the time of the accident, the "Whipple" slowing down subsequently. The other boats made a pitiful showing, the "Hull" taking 16 hours, the "Stewart" 21 hours, and the "Truxton" 22 hours to cover the 240 knots.



The "Worden," Winner, Average 21.6 Knots. The "Hull" Made 15 Knots; the "Stewart," 11½ Knots; the "Truxton," 11 Knots. The "Hopkins" Was Disabled.

THE 240-MILE OCEAN RACE OF THE TORPEDO-BOAT DESTROYERS.

PRACTICAL TESTS OF THE SCHLICK GYROSTAT FOR SHIPS.

The Schlick gyrostat, or device to diminish the rolling of ships, which was first described about two and a half years ago, was suggested by certain curious phenomena which the inventor had observed in paddle-wheel steamers. One of these is the violent list caused by putting the helm about, which is much greater than can be explained by the centrifugal force due to the turning. In general, paddle steamers roll less than screw steamers and their period of oscillation is longer when the wheels are revolving than when they are at rest. In a seaway a paddle steamer follows a sinuous course which is generally attributed to the alternate raising and lowering of the wheels in rolling. On this theory the depression of the starboard wheel should deflect the bow to port, but, as a matter of fact, the bow turns to starboard.

Schlick came to the conclusion, long ago, that these phenomena are caused by the gyroscopic action of the revolving paddle wheels. When the axis of a rotating wheel is turned by external forces about an axis perpendicular to itself there is produced a couple which tends to cause rotation about a third axis, perpendicular to both of the axes above specified. For example, when the shaft of a paddle steamer is turned in a horizontal plane, by moving the helm and changing the course, a couple comes into play which acts to turn the shaft about a horizontal axis running fore and aft and thus to careen the vessel toward the outside of its curved path.

Conversely, when the shaft is turned about a horizontal axis by the rolling of the ship a couple is produced which acts to twist the vessel around a vertical axis and cause it to deviate from the straight course. But this deviation in turn produces a couple which tends to turn the vessel about its longitudinal axis in a direction opposite to the rolling, which is therefore diminished.

Schlick's gyrostat is a heavy wheel revolving rapidly about a vertical shaft mounted in a frame supported on trunnions which allow it to turn about a horizontal transverse axis so that the shaft of the wheel swings in the vessel's plane of symmetry. As the common center of gravity of the wheel, shaft, and frame is lower than the trunnions the shaft hangs vertical while the vessel is at rest, but it swings fore and aft like a pendulum when the vessel rolls.

The arrangement above described, however, would only lengthen the period of rolling, because part of the energy derived from the waves would be consumed in raising the center of gravity of the apparatus as the shaft is deflected from the vertical position. But when the ship had completed its roll to one side and begun to right itself the potential energy of the raised center of gravity would be expended in increasing the rolling motion from which it had been derived, so that the amplitude of rolling would not be affected by the revolving wheel. The addition of a hydraulic brake makes it possible to check the oscillations of the apparatus and indirectly, through reaction, those of the ship. In other words, the energy taken from the rolling motion during one phase is not restored to it during another, but is converted into heat by the brake, so that the energy of rolling is diminished.

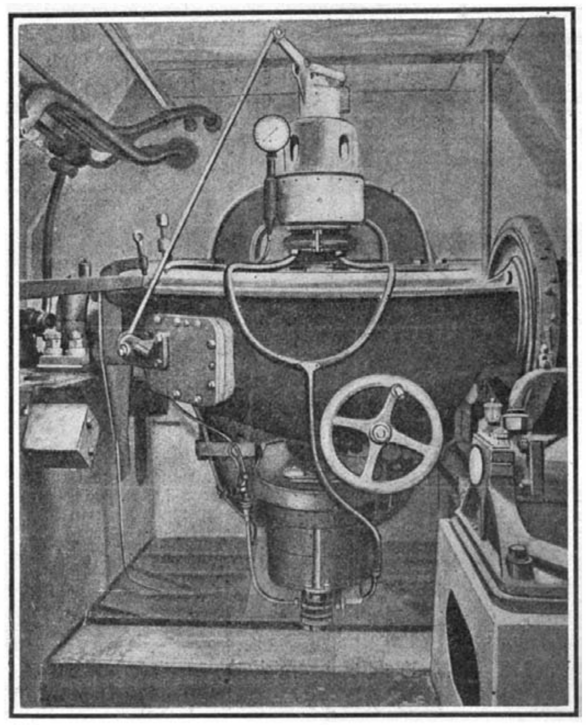
Experiments made with small models were surprisingly successful, yet the inventor hesitated to test the invention on a ship until Prof. Foeppl had reduced the mathematical theory to practical form and proved that an effective gyrostat need not be of impracticable size.

In view of the great expense of the experiment and of the increase in practical difficulties with the size of the vessel, the apparatus was installed on the little "See-Baer," formerly a torpedo boat of the German navy. Her approximate dimensions are as follows:

Length of water line, 35 meters or 115 feet.
Greatest breadth, 3.6 meters or 12 feet.
Draft, 1 meter or 3.3 feet.
Displacement, 57 metric or 63 short tons.
Metacentric height, 0.5 meter or 1.6 feet.
Period of rolling, 4.14 seconds.

The comparatively high metacenter increased the size of the gyrostat needed to check rolling and hence the severity of the test and the value of the results. In order to avoid unknown practical difficulties the gyrostat was designed to run at comparatively low speed and made correspondingly large, according to the following:

Outer diameter of wheel, 1 meter or 3.3 feet.
Weight of wheel, without shaft, 500 kilos or 1,100 pounds.
Velocity of rim, 84 meters or 275 feet per second.
Revolutions per minute, 1,600.



The Schlick Gyrostat in the "See-Baer."

The wheel was a solid block of forged steel. It would have been most convenient, both for installation and for operation, if the wheel had been driven by an electric motor, but as the boat had no electric plant and none could be added without great expense and difficulty Schlick decided to convert the wheel itself into a steam turbine by attaching to its rim rings of reaction surfaces and inclosing it in a shell of cast iron to which were attached the trunnions which permitted it to swing in the median plane of the ship. These trunnions, which rest on ball bearings, are hollow and serve respectively as an inlet and an outlet for steam, like the trunnions of an oscillating reciprocating engine. The lower end of the shaft also rests on ball bearings, which as well as the bearing or guide at the upper end are kept constantly supplied with oil by a chain pump, and cooled by a blast of air from a centrifugal blower. At the upper end is a centrifugal governor which cuts off the steam when the speed exceeds 1,600 revolutions per minute. There is also a device which strikes a gong after each 10 revolutions and thus gives warning of any irregularity in speed. Finally, there are brakes by which the wheel can be stopped quickly in emergencies.

The brakes which control the oscillations of the apparatus are on the port side. They include a band brake connected with a wheel on deck by which the oscillation can be entirely stopped, and a hydraulic cylinder brake. The piston rod of the latter is connected to a tongue on the side of the gyrostat case and its resistance is regulated by a valve which can be operated either from the gyrostat room or the deck.

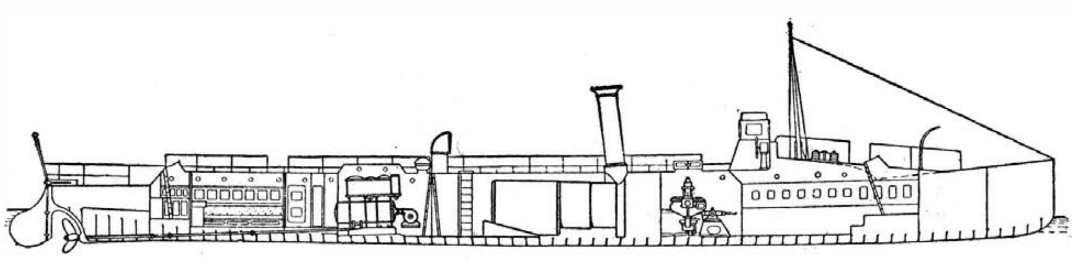
In the first experiments the vessel was towed. The performance of the gyrostat was satisfactory in every respect. Not the slightest vibration or jar was felt and the lubricating and braking devices proved their excellence. Occasionally the speed was increased to 3,000 revolutions per minute. No ill effects followed.

Next, the boat was caused to roll by moving the crew from one side to the other. The time occupied by a double oscillation (from starboard to port and back to starboard) was 4.14 seconds when the gyrostat was at rest and about 6 seconds when it was making 1,600 revolutions per minute. In the latter case the smallness of the oscillations made the observations very difficult.

Then experiments were made to determine the number of oscillations that took place while the amplitude of oscillation decreased from an arbitrary initial value to ½ degree. For this purpose the boat was inclined about 15 degrees by raising one side with a crane and suddenly released. The amplitude was measured with a simple instrument consisting essentially of a heavy wheel, 60 centimeters (2 feet) in diameter, with its axle horizontal and parallel to the axis of the ship, at the level of the center of gravity in the latter, and mounted on ball bearings. The center of gravity of the wheel was a little below the axle and the period of oscillation 20 seconds. The rim of the wheel was graduated in degrees and turned under a fixed pointer, which indicated zero when both the ship and the wheel were at rest. When the ship rolled, the wheel remained at rest, so that the pointer marked the amplitude of the oscillation. The results of the experiments show that the gyrostat has a great damping effect on the oscillations.

The main experiment was the test of the apparatus with the vessel steaming at sea. After several trips which gave no results of value because of the calmness of the sea, experiments were made in the delta of the Elbe, in the following manner:

The gyrostat was driven at normal speed, 1,600 revolutions per minute, but at first its shaft was held vertical (or rather, perpendicular to the deck) by the band brake attached to its case. The rotation of the wheel in this fixed position has no effect on the rolling of the ship. The vessel steamed slowly at right angles to the direction of progression of the waves in order to make the rolling as great as possible, and the amplitude of oscillation was measured with the small graduated wheel described above. On one occasion there was a maximum weather roll of 15 deg. and a maximum lee roll of 25 deg.; on others there were maxima of 15 deg. in each direction. This is pretty violent rolling.

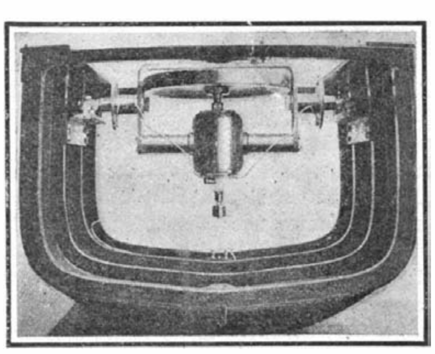


Longitudinal Section of the "See-Baer," Showing Gyrostat Forward.

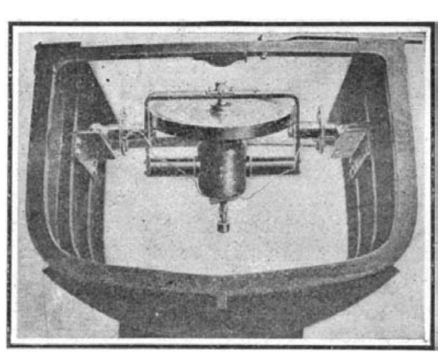
After the rolling had been observed and measured for several minutes the band-brake was cast loose. The gyrostat and its case began to swing violently and the rolling of the vessel was at once reduced to an average amplitude of ½ deg. with an occasional roll of 1 deg. The boat behaved very well, much better, indeed, than when the gyrostat was not acting. The waves appeared to pass under the hull, gently lifting and lowering it without even throwing much spray on the deck. The prediction of nautical experts that the boat would ship heavy seas under the influence of the gyrostat was not fulfilled.

In order to study the effect of lower speeds the revolutions of the gyrostat were reduced to 1,200 per minute. No difference in the effect was observed, but at 1,100 revolutions the damping effect was slightly lessened, and at 800 revolutions the maximum amplitude of rolling attained was 3 deg. With the gyrostat made ineffective by braking deflections of 12 deg. were observed. From this it appears that the gyrostat of the "See-Baer" was much larger than it need have been for a speed of 1,600 revolutions.

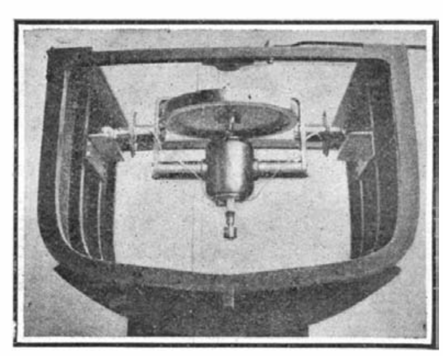
The material for this article is taken from a paper by Dr. Schlick in the Zeitschrift des Vereines deutscher Ingenieure, and the pictures from the Illustrirte Zeitung.



The Gyrostat in Vertical Position.



The Gyrostat Tilted Forward.



The Gyrostat Tilted Backward.

PRACTICAL TESTS OF THE SCHLICK GYROSTAT FOR SHIPS.

A PAIR OF LIMBLESS, SNAKE-LIKE LAMBS.

BY DR. C. R. STOCKARD, COLUMBIA UNIVERSITY.

From the standpoint of the origin of new species or new kinds of animals, a most intensely interesting case is recorded from North Carolina. On the second of last February a lamb without indication of limbs appeared in a flock of sheep on the Tar River Stock Farm in Nash County near Wilson. This lamb is perfect in every other respect, having a well-formed head and body and a long tail, as may be seen by referring to the accompanying photograph of this peculiar sheep.

At first sight one may be led to think that this is merely a case of deformity, or in other words the lamb is a monster, such as occurs every day in one form or another among almost every class of animals. It is well known that young are often born with deformed limbs, and sometimes with their limbs severed from the body, but all such cases are very different from this, for the reasons below.

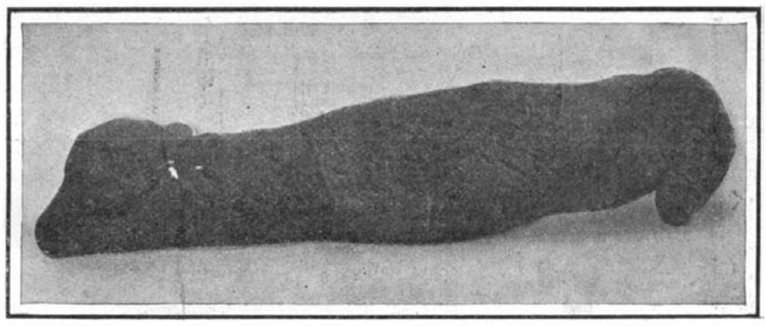
The first and most important reason is that during the latter part of April a second lamb was born on the same farm which was identically like the first, except that it was white instead of black. This one had the same father as the former legless freak but a different mother, both of its parents being white, while the first lamb had a black mother. Monsters or deformed young are usually weak and rarely live, while these lambs are healthy and very vigorous. The first one was fed on milk from a bottle for the first month or two, but is now able to feed on grass just as a normal lamb would.

Such cases as these are what have been termed "sports"; they appear suddenly among a given kind of animal, and breed true to their peculiar form. Darwin knew of a few such cases and recognized that they bred true to their peculiarities, and might even form new kinds of animals. The ones that Darwin recorded were the black japanned peacock, the turnspit dog, and the Ancon ram. The black japanned peacock is a certain peculiarly-marked pea-fowl which sometimes appears in the flocks in England. This "sport" peafowl, although smaller and generally whipped in fights with typical males, thrives and will crowd out the common type within a few generations, since it breeds true to its new characters.

The turnspit dog is the often-seen long-bodied and short-legged kind, which has become a race of dogs in such a manner as the black japanned peacock tends to establish itself.

The Ancon ram was a peculiar long-bodied sheep with short crooked legs born in Massachusetts about 1791. This sheep on account of its awkward shape was unable to climb the low stone fences which were so extensively used in New England. This was, therefore, a very valuable variety in case it should propagate true to its type, and so it did. When this ram was paired with common sheep, many of the offsprings were of the long-bodied, short-legged kind, and from this original father the Ancon race of sheep was produced. These sheep existed in New England for sixty or seventy years, and were then in some way allowed to "run out" or become extinct. Our legless lambs may be said to have carried this short-legged condition to the last degree and have discarded such appendages entirely, lying flat on the ground and being almost unable to move about except for some twisting motions. To the scientist and experimental breeder these lambs without legs are remarkably interesting. The newest and in many ways the most popular idea of to-day regarding the evolution of animals is based on such cases as this. Prof. Bateson in England and Prof. De Vries in Holland are the chief champions of this "Mutation Theory" of evolution, as it is termed. These prominent scientists believe that the various species in the world to-day have arisen from other existing or pre-existing species by sudden changes in form, or that is to say by "sports" or "mutants," such as this legless lamb. These "mutants" when they once appear breed perfectly true, and so establish new varieties or species of animals and plants. Prof. De Vries in his gardens in Amsterdam has succeeded in getting a number of entirely new plants, which establish themselves and continue to breed true from a single original kind, the evening primrose, which was introduced into Europe from America.

The most common cases of "sports" known to all are the albino forms, which suddenly occur among various animals. Many breeding experiments have been conducted with albino mice, to test the manner in which the albino condition is inherited. Albinos and many of these "sport" variations follow what is known as Mendel's law of inheritance, a law first discovered by an Austrian monk, Gregor Mendel, about forty years ago and then forgotten until it was rediscovered in 1900 by three different investigators. The manner in which the law acts may be best illustrated by a concrete case. When a gray mouse is paired with an albino white mouse, all of the young born of this pair will be gray in color like the gray parent, not at all lighter. If these gray offsprings from the gray and white parents are paired among themselves, one out of every four of their offsprings will be a pure albino

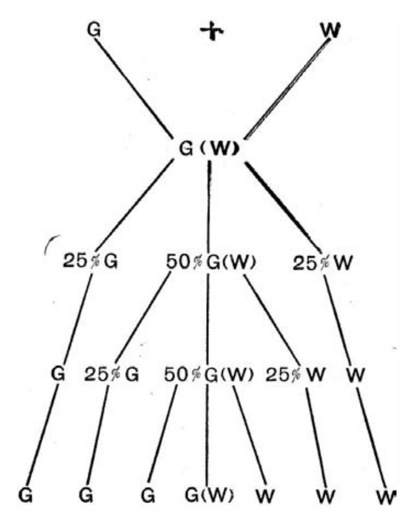


ONE OF A PAIR OF LIMBLESS LAMBS.

This is not the ordinary case of a monster, but of a new variety or "sport," which may be cited as evidence in favor of the new "mutation" theory of the origin of species.

like one of their grandparents, and the other three will be gray like the other grandparent and their own parents. In such a case the gray character is said to be more prepotent than the albino, or is dominant, while the white is recessive. According to Mendel's law, when an animal with a prepotent or dominant character is paired with one having a corresponding character, such as coat color, recessive or less prepotent, the first generation of the young will all show the dominant character only, though the recessive character is contained within them also, as is shown by what happens in the following generation. If the first generation be paired together, one in four of their offsprings will show the recessive character and the other three the dominant.

The way in which Mendel's law acts is made clearer by the accompanying diagram. If we indicate the



gray mouse by G and the white one by W, then when these two are paired their offsprings will be $G(W)$. The W in parentheses indicates that this character, although contained in the mouse, does not show itself externally. Its presence is proven, however, when these $G(W)$ mice are interbred. One-fourth of their offsprings will be pure white mice, one-fourth pure grays, and one-half will be $G(W)$ again (see diagram).

If one of these "apodal sheep" be paired with an ordinary sheep, we may predict that all of the lambs will either be legless or else all have legs. Further, when these offsprings are paired together, one in four will be like one grandparent and three like the other. If the two legless sheep are paired together, all of their lambs will be expected to show the legless condition.

One thus appreciates the practical value of Mendel's law, since by its aid a stock raiser having a breed with two phases of any one character which he wishes to select may know exactly the number of generations required to obtain the pure form he desires, provided the phases of the character are dominant and recessive in their relations.

Zoologists are much interested in these new legless sheep, as they add one more to the very few mutations which are known to be occurring at the present time. A change of one species or form into another is not a common occurrence, and uncounted ages have been necessary to produce the various species of animals and plants that we know to-day. To find such a change when in its beginning gives an opportunity for experimentation along these lines, and may enable the biologist to come nearer the solution of the riddle how the diverse animal population of our planet has come about.

Such a remarkable "apodal sheep" has never before been recorded.

A SUCCESSFUL HYDROPLANE GLIDING BOAT.

We give herewith the design and details of a 15-foot hydroplane gliding boat—"Vida May IV."—which was designed and built by Stearns Brothers, of Bridgeport, Conn., during the fall of 1906, and was intended to be launched during the latter part of February of this year, but which, owing to the heavy ice, was not put overboard until after the middle of March.

This boat has attained a speed of 21.6 miles per hour, which is extremely good, considering her weight and power, for a boat of the gliding type.

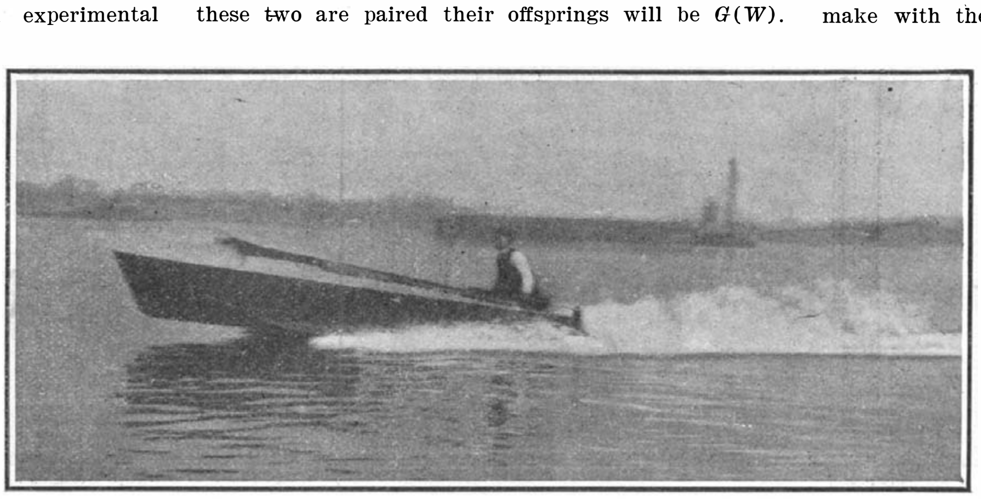
Although built on the gliding principle, the boat is considerably heavier than the European gliders, as it was built to stand a good sea, which is shown by the style of the bow and forebody chosen. Its weight is about 500 pounds, while some of the light gliders recently constructed weigh only 100 pounds. The engine used is also of a heavier type, being a 2-cycle, 2-cylinder, 14-horse-power Cushman marine motor which weighs 350 pounds.

As a comparison, this same engine was in use during last season in a displacement boat, "Vida May III.," of exceedingly fine lines, this displacement boat attaining a speed of 18 miles per hour.

The gliding boat, being heavier in construction, is quite substantial, which is a very necessary point, as a gliding boat is subjected to the severest stresses that any model can stand. One instance is a gliding boat running into a head sea where it pounds. Unless something is done to resist this pounding, as was the case when the designers adopted the form of bow and forebody which is here shown, such a boat is worthless in a sea.

Another instance is a gliding boat running at an angle to a head sea. The sea then strikes under its weather bow, and unless the hull were designed to resist the impact of the waves, they would wrench or twist it out of shape.

In the design of a gliding boat the weight of the structure has been found to be a very detrimental factor as regards speed, for the resistance varies almost directly as the weight. The angle which the planes make with the water line when running is also of great importance, as this angle determines the lifting and retarding forces and the resistance. The retarding force is directly proportional to the angle of inclination of the planes with the water line when the area and speed of the planes remain constant.



A 15-FOOT HYDROPLANE BOAT WHICH MADE 21.6 MILES AN HOUR WITH 14 HORSE-POWER.

The lifting force acting on the planes tending to lift the boat at right angles to the water line, has been found to equal

$$(AV^2C \text{ sine of angle}) \times \text{cosine of angle.}$$

In this formula A = area of planes, V = speed in knots, C = a constant of about 4.

In determining the area of the planes, it has been found that the area of plane necessary to give the right amount of bearing surface at certain speeds is obtained from the formula

$$A = \frac{W}{V^2C \text{ sine of angle} \times \text{cosine of angle}}$$

in which W = weight on plane, V = speed in knots, C = constant as before.

By this formula it can be plainly seen that the area of the plane varies directly as the weight, and inversely as the square of the speed.

A gliding boat when at speed is acting against different conditions than is a displacement boat. For instance, the boat has but little lateral area, and when traveling fast with a beam wind, it is easily blown off its course unless designed to resist the force of the wind.

Another condition realized is when the boat is running at full speed, at which time the downward pressure between the bottom of the boat and the surface of the water is shifted aft toward the stern.

Any slight force acting on the forebody at right angles to the direction of motion of the boat will then easily cause her to steer off.

When the boat is running very slowly, the action is reversed, or the downward pressure between the bottom of the boat and surface of water is shifted forward, which causes the stern to be swung easily when a force is applied. In this boat the rudder is placed on the forward plane, so as to take advantage of the foregoing conditions.

Gliding boats when at speed are practically on the surface, which causes the shaft line to come near the surface.

If the propeller is situated under the aft plane and not far below it, the engine will race as the plane nears the surface.

The cause, apparently, is as follows: The water line at full speed is very short on each plane; therefore the propeller draws a mixture of water and air from under the plane. This mass of water and air, since it has a less density than water, allows the engine to speed up, and the propeller shows very great slip.

By running the propeller a little aft of the stern in deeper water, this trouble is eliminated. Twelve to 14 horse-power is the smallest motor which should be used in a boat of this size to get good results. The weight of the motor should not be greater than 300 to 350 pounds complete. The dimensions of the propeller used on this boat with the 14-horse-power engine are 18 inches diameter and 30 inches pitch. The blades are oval shaped and 4½ inches wide.

For the benefit of those of our readers who would like to build a fast boat of this type, we print in the current SUPPLEMENT the drawings and full directions furnished by the Messrs. Stearns, who are the first Americans we know of to build a really successful hydroplane glider.

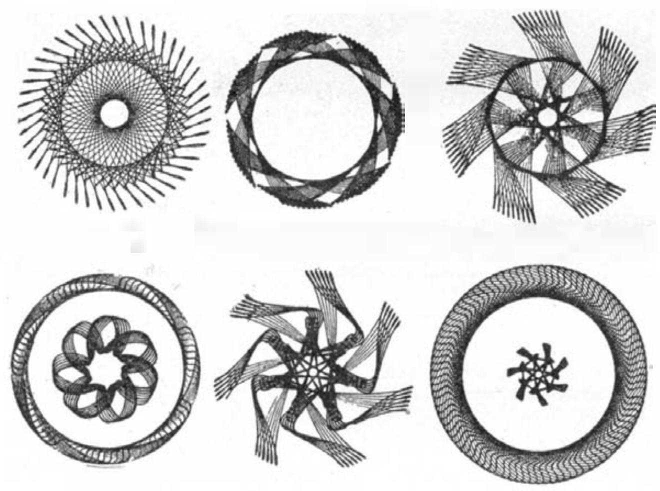
A MECHANICAL TOY WHICH DRAWS GEOMETRICAL DESIGNS.

A notable feature of the Advertisers' Show, recently held in Madison Square Garden, was the exhibition of a rose engine or geometric lathe, at work engraving the intricate tracery of geometric curves by which our paper currency is protected against fraudulent imitation. It was interesting to watch this complicated and expensive machine slowly cutting out with absolute perfection a most beautiful pattern, impossible of exact reproduction on any other machine, or even on the same machine, should the combination of gearing by which the design was produced be lost or forgotten.

Turning away from this exhibition with profound respect for the genius who devised this masterpiece of mechanism, the spectator was confronted with a small toy, extremely simple, and almost crude in design, on which patterns fully as intricate as those of the geometrical lathe were traced in ink with wonderful perfection and celerity. A photograph of this toy with facsimiles of some of the work done by it are reproduced herewith. The device resembles, in a measure, the "Cycloidotrope," which was described about twenty years ago in the SCIENTIFIC AMERICAN (Vol. 53, No. 25); but the construction of the "wondergraph," as the new toy is called, is much simpler and it is capable of tracing a greater variety of patterns.

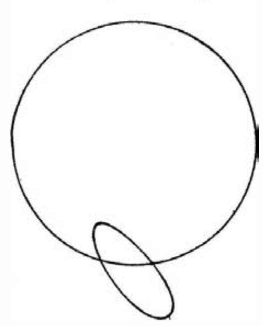
As may be seen in the illustration, the wondergraph comprises three wooden pulleys, about which an endless cord serves as a driving belt. The face of the larger pulley is used as a revolving table over which the pen operates, and is provided with a pair of spring catches that serve to clamp a piece of paper smoothly on the table. The driving pulley is fitted with a small crank handle, by means of which it may be easily turned. The third pulley is carried on an arm which is pivoted to the baseboard, so that the belt may be readily tightened by swinging the arm. A series of holes are formed in the face of this pulley to receive the downwardly-bent end of a rod, whose opposite end rests in one of the notches of a guide rack. The rod carries a pen, the point of which rests on the paper clamped on the revolving table. Now, when the crank is turned the paper is rotated under the pen, and at the same time the pen is oscillated by the small pulley, and this combination of movements results in the drawing of a novel design on the paper. The holes in the pen-oscillating pulley are arranged in a spiral series running from the center to the periphery. If the point of the rod is moved from one hole to another, the design will be changed to a very remarkable extent. Further variation is provided by setting the rod in different guide notches in the rack.

The exact curve described by the pen may be observed by holding the table stationary while turning the pen pulley. It will be noticed that the pen traces a loop or ovoid figure, which is the resultant of the revolving motion of the point of the rod and the sliding motion of the rod in the guide rack. In one of our

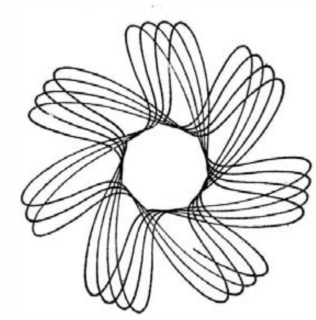


Some Patterns Produced by the Geometrical Toy, Showing the Wide Scope of Its Work.

illustrations we show a typical ovoid curve drawn in this manner. The motion of the paper under the pen is, of course, rotary, and is here represented by a circle. Adjacent to this illustration is a pattern drawn with the pen at the same adjustment, but without holding the table stationary, and represents the resultant of the ovoid curve superposed on the revolving circle.



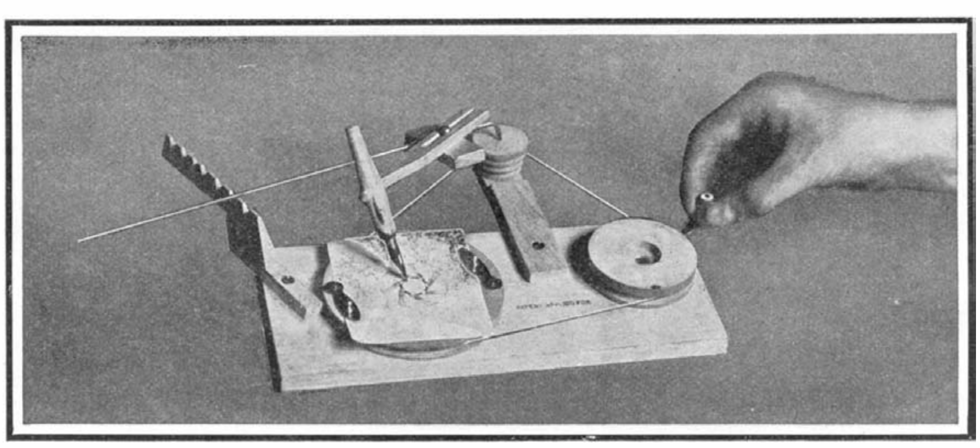
Ovoid Shows Path of Pen. Circle Shows Rotation of Paper.



Design Produced by Combination of the Curves.

Analysis of a Design.

It will be evident that the size of the pen pulley with relation to that of the table bears an important influence on the form of the design. That is, if the two pulleys are geared three to one, the figure will be a three-sided or three-lobed design. In order to permit varying the character of the figure, the peripheral face of the pen-oscillating pulley is tapered, and is formed with three grooves of different diameters.



A MECHANICAL TOY WHICH DRAWS GEOMETRICAL DESIGNS.

Since the pulley is mounted on a pivoted arm, it may be moved to loosen the belt, and the latter may then be shifted from one groove to another, thus changing the gear or the ratio of rotation between the pulley and the revolving table. The best results are obtained when the diameter of the table is not a perfect multiple of the diameter of the pulley, for then the pen, after describing, say, a seven-lobed figure, will not come back to the starting point, but will continue the design at a slight displacement with respect to the original figure. If the operation is sufficiently prolonged, a continuous circular pattern may be formed, as shown in most of the designs here reproduced. The scope of the device is increased by providing a means for adjusting the pen to any angle with the rod, or extending it to any desired distance from the rod; and still another variation is afforded by pivoting the guide rack to the baseboard, so that by swinging the rack to various angles the designs may be further modified. It will be evident that the toy, crude as it may seem, embodies sufficient elements to produce a countless number of combinations, and hence it should prove of endless amusement to children, as the changes produced by slight variations of adjustment are kaleidoscopic in character. Furthermore, a toy of this kind is bound to be instructive to any one.

The Portland Cement Industry.

In the United States the cement industry has prospered to a degree that would seem to justify indulgence in the alleged American propensity to boast. Taking into consideration the brief period that has elapsed since America was entitled to be called a cement-producing country, the record of the industry stands without a parallel. One has merely to recall the fact that 82,000 barrels of Portland cement comprised the output in 1880, and to be told that the estimate for 1906 has been placed at the enormous total of 42,000,000 barrels or more, to be convinced that the development of the industry in this country has been truly marvelous. Certain it is that both the production and use of cement are constantly increasing, and not solely because of great enterprises like the construction of the Panama Canal, the reclamation of deserts, and the rebuilding of cities, but because there is growing appreciation and understanding of the value of cement. The last has operated to give the cement trade a tremendous impetus in the United States. Not only does America easily take first place among the cement-producing and using countries in the world, but so unprecedented is the demand for cement and so thoroughly established is the industry, that no one can safely predict its future magnitude. A potent factor in all this has been the gradual decline in the cost of manufacture and the selling price as compared with the situation of the early nineties. The wide distribution of the industry has been another important consideration. It has afforded the people generally an opportunity to become familiar with the many virtues of cement and concrete construction, and it is now extensively used in communities in which a barrel of cement would have been a novelty a short time ago.

To reflect upon the development of the past few years is to become convinced that, after all, this country has merely crossed the threshold in the evolution of the cement industry. Cement in factory construction may be said to have fairly begun. In the matter of dwellings and kindred structures the field has scarcely been touched. Granting that there can be no further saving effected in the cost of production, no increased competition in manufacture, and that progress in structural methods is about to cease, even so, under present conditions, the use of cement must increase far beyond the present output.

To sum up the situation briefly, America has first and foremost a large home demand. Cement is sold at a reasonable price within the reach of all classes of consumers, but at a price which allows a fair profit to the manufacturer. The consumption of cement is constantly expanding, but the establishment of new factories precludes the probability of exorbitant prices. Viewed from every standpoint the cement industry in this country appears to be on a substantial and wholesome basis.—Robert W. Lesley in the Engineering and Mining Journal.

Platinum $34 an Ounce.

The year 1905 saw a phenomenal rise in the price of platinum and a greatly increased production in the United States. The annual report of the United States Geological Survey on the production of platinum, prepared this year by Mr. F. W. Horton, contains details of exceptional interest. It shows that early in March, 1905, the price of ingot platinum advanced from $19.50 an ounce to $21 an ounce, surpassing gold in value. On April 1, 1905, the price fell to $20.50 and remained firm at this quotation until February 1, 1906, when it jumped to $25 an ounce, where it remained until September 1, 1906, when it leaped to the unprecedented value of $34 an ounce. Mr. Horton's report also shows that the production of platinum in the United States increased from 200 ounces in 1904 to 318 ounces in 1905. This report is published as an advance chapter of the annual volume, "Mineral Resources of the United States, 1905," and is distributed free of charge, on application to the United States Geological Survey.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

SKIRT STAY AND FASTENER.—W. H. REGNER, York, Neb. The device will prevent the skirt from sagging down behind or becoming unfastened, and allows of stooping, sitting or other bodily movements without discomfort owing to its flexibility and lightness. It can be used in connection with the lightest fabrics on account of dividing the strain on the goods. The fastener can also be adjusted to suit different sized persons, and taken apart to enable it to be conveniently sewed into the skirt or unhooked in the case of a very large person, thus permitting the skirt to be easily applied.

TAILOR'S MEASURING APPARATUS.—J. BARNETT, New York, N. Y. This apparatus is intended to be used especially in taking the measurements at the upper part of the body and particularly at the shoulders. While the invention is intended primarily to provide means for taking accurate measurements at the shoulders, it affords means for taking measurements at other points.

Electrical Devices.

INSULATOR-PIN. — L. STEINBERGER, New York, N. Y. This invention produces a supporting member of great strength with a mimimum of material. Renders the supporting stem as near immune as possible from effects of moisture. Makes the stem in parts one encircling the other and firmly anchored thereto. Covers the thread with electrose or other suitable insulating material in order to increase the insulation, and also to enable the thread to be made more exact as to form. Envelops all metallic parts completely with insulating material.

SPIRAL-CORE INSULATOR. — L. STEINBERGER, New York, N. Y. In this patent the invention relates to insulators, Mr. Steinberger's more particular object being to produce a type of insulator suitable for use in various general relations and of peculiar value for leading in cables. Among many other objects one is to provide a type of tubular insulator in which a minimum quantity of material is employed in its construction. This inventor prefers to employ the substance commercially known as "electrose" for the dielectric members.

HIGH-POTENTIAL INSULATOR.—L. STEINBERGER, New York, N. Y. This insulator possesses numerous advantages among which is to provide a hood upon its inner face with a surface of such conformity as to facilitate the dripping of moisture therefrom very rapidly, thereby reducing surface leakage to a minimum. To provide an insulator hood on its under surface with numerous drip points, air-spaces and barriers, in order to further prevent surface leakage and danger of arcing and to increase the general di-electric properties of the insulator. The insulating material employed is preferably the kind known in this art as "electrose." The inventor does not limit himself to the use in every instance of a cement for securing the separate hood to its support.

INSULATOR-PIN.—W. S. LEE, JR., Charlotte, N. C. The inventor's object is to so construct the pin that it will comprise the minimum number of parts so combined as to secure ample strength and durability, and facilitate and expedite line repairs by the ease with which injured or defective insulators may be replaced, and also to secure an economy of cost of such replacing of insulators by reducing in size or amount the part of the pin which has to be discarded.

TELEPHONE-SWITCHBOARD.—J. M. DOSBAUGH, Cedar Vale, Kan. An operator is apprised of a call by the push rod of the station making the calls, this rod springing outward, and that during the time the connection is made between two stations a busy lamp is burning. When a pawl engages a certain tooth and the magnet is energized, this tooth is released and the rod springs back, the point of the pawl engaging a second tooth. The magnet immediately is deënergized, the pawl springs up so that the point releases the second tooth, but a third is immediately engaged so that it cannot get past the pawl until the magnet is again energized.

Of Interest to Farmers.

FURROW PLOW AND ROLLER.—C. E. HOLBROOK, Carson City, Nev. This invention relates to improvements in furrowing or ditching plows and rollers, for irrigation, the object being to provide a device of this character, that will be comparatively light to draw over the ground to form the ditches and to smooth the banks, sides and bottom of the ditches.

Household Utilities.

TRANSOM-LIFTER.—L. C. SMITH, New Orleans, La. The invention pertains to transom lifters such as are used in dwellings and similar places, for controlling the positions of transoms for windows. The object of the invention is to produce a device which can be quickly operated to hold the transom in an open, closed or intermediate position.

SANITARY CUSPIDOR. — A. FISHMANN, New York, N. Y. In this case the principal objects are to provide means whereby an antiseptic liquid can be automatically forced into the interior of a cuspidor, after it has been used, to provide for conveniently cleaning it and to improve it in several other particulars. All parts are easily removable.

Of General Interest.

PAPER-HANGER'S TRIMMER. — E. E. GOBIE, Brattleboro, Vt. A cutter on a table is adapted to be reciprocated in the trimming operation, said table being inlaid at one edge adjacent to the cutter with strips of wood of different color, and provided with a scale in order that the paper may be readily gaged before it is cut. The cutting means, which is provided with a device for insuring a clean cut of the paper, may be removed from the table top and the table folded up in a small compass, making it convenient to carry about.

POST-FORMING DEVICE.—W. E. SNYDER, Lagrange, Ind. Mr. Snyder's invention has reference to improvements in devices for making cementitious fence posts, and has for its object to produce a simple, cheap and efficient device by which cement posts used for fences, mail-boxes, hitching horses, etc., may be quickly and cheaply made.

PROCESS OF MANUFACTURING YEAST.—J. BLUMER, Peekskill, N. Y. The invention pertains to methods of manufacturing yeast in general, and the main object is to supply the yeast plant in process of propagation with a cheap nutriment which is exceedingly rich in soluble nitrogenous substances, thereby enabling the manufacture of a yeast of great leavening power, and also producing a larger yield of yeast.

ATTACHMENT FOR ROLL-PAPER CUTTERS.—F. H. MAASS, Clinton, Iowa. The invention relates to an attachment for cutters such as used in connection with rolls of wrapping paper for cutting small quantities of sheets therefrom. The object is to produce an attachment which may be readily mounted on a roll paper cutter of common construction, the general purpose being to produce an arrangement which will facilitate the drawing out of the paper when a portion of the same is to be detached. While the attachment is for a knife of common form, it will be possible to construct the complete device as one structure, so that the improved device could be shipped in its finished form from the factory.

CARPENTER'S SQUARE.—J. A. MCCLOSKEY, Mount Vernon, N. Y. In this patent for an improved carpenter's square, the inventor has for his object the provision of a means adapted to enable a builder to readily determine from a given pitch the length of common and hip rafters, and the cut of the ends of said rafters.

REINFORCED CONCRETE CONSTRUCTION FOR BUILDINGS AND OTHER STRUCTURES.—G. GEORGENSON and J. E. HENNEN, Fond Du Lac, Wis. An object of the invention is to produce a structure which will sustain to a high degree all kinds of strains or stresses, particularly those incident to unequal settling or heaving, without cracking or dismemberment. It is believed that a building constructed as specified may be raised at one or both ends or sides without injurious consequences, and will retain its shape in all positions.

DUMPING-BODY.—W. R. GOIT, Oklahoma, Oklahoma Ter. The invention is an improvement in dumping bodies such as are in use on dumping wagons, dumping cars and bins. In operation the dumping of the body sections may be so regulated as to distribute the load to the center, to the outside or evenly between the two as may be desired. The invention in its broad features need not be limited to specific features for readjusting the sections to position to receive the load or to the particular means for breaking the props when it is desired to dump.

FURNACE.—A. DUCCO, 36 Via Pio Quinto, Turin, Italy. According to the invention the rotary furnace is provided with a charging device arranged on the roasting chamber itself, and which, at each revolution of the furnace, raises but just the quantity of ore corresponding to the speed of the combustion. With this charging device, air cannot enter into the furnace while charging, nor can the combustion gases developed in the furnace escape.

EMBROIDERY IN DIVERS' CORDS.—FRANCIA BAUDENON, Vorey, Haute-Loire, France. This invention relates to a mode of support for the applications of embroideries in divers cords, known in France as "*plumetis-express.*" To carry out the purpose, the application is pasted onto a sheet of paper and the sheet is perforated, or partially, or wholly, cut away on a line along the inner contours of the design. Thus, the application is firmly held in shape, for it is connected by the whole of its outer contour to a sheet of paper to keep its shape; furthermore, difficulty of tearing the paper away along inner contours is done away with. Tearing of the paper away along outer contours may again be facilitated by previous perforations.

Machines and Mechanical Devices.

EARTH-SCRAPING MACHINE.—W. RANDALL and J. RANDALL, Marysville, Wash. The improvement refers to earth scraping and dredging machines in which the cutting or scraping edge is automatically removed or raised from the ground when the scraper is filled, and in which the material may be automatically ejected from the scraper when it reaches the point at which it is desired to dump the material. The scraper is provided with novel steering means.

WAVE-MOTOR.—J. W. NEAL, Kealia, Ter. of Hawaii. In this case the invention relates to improvements in wave motors, the object being to provide a wave motor of comparatively simple construction, that will respond quickly and with even motion to any degree of wave movement, and providing power for machinery on land.

MEASURING-PUMP. — T. HENTGEN, New York, N. Y. The invention relates to soda fountains and particularly to pumps for faucets designed to discharge from a receiver syrups used in soda water, and has for its objects to provide means adapted to enable a reciprocating pump to retain the liquid that has once passed therein, and to measure and discharge a pre-determined quantity of syrup from a receptacle at each stroke of the pump.

STAMP-MILL.—G. COON, Mount Vernon, Wash. It is intended that the invention should be used especially in the preparation of concentrates from gold ores, and its use contemplates the employment of the wet process. The object is to produce a mill which will consume little power but which will be efficient in operation Further to construct parts in section, which may be readily transported through mountainous regions by pack-mules or similar means, and there assembled or erected for operation.

LOOSE-LEAF BINDER.—F. H. CRUMP, Los Angeles, Cal. The object of the inventor is to provide means for securing the two backs to be easily and quickly separated for the insertion of new leaves or removal of leaves, while the book remains open on the desk, and without the use of a key.

SEWING-MACHINE GAGE.—D. DANTZIG, New York, N. Y., and J. BONOWITZ, Philadelphia, Pa. The invention refers to sewing machine attachments, and one purpose of the invention is to provide a gage particularly adapted for accurately indicating the required space between double rows of stitching on coats, for example, insuring the rows of stitching being the same distance apart on each garment until the gage is otherwise set.

CAN-SEAMING MACHINE.—E. P. DATOW, New Orleans, La. The machine is adapted for use in connection with any type of pierced cylindrical tin-ware, as for example it is designed to seam on the ends of coffee, baking-powder, fruit, fish, meat and all other cylindrical cans, dippers, pails, pots and all manner of cylindrical pieced vessels, as well as any cylindrical utensils or package made from one or more than one piece of sheet metal.

ECCENTRIC.—R. M. CLARK, Webb City, Mo. The invention pertains to improvements in eccentrics, and more particularly to means whereby the eccentric may be placed from its bearings, or removing any pulley or wheel already secured to the shaft. The object is to provide means whereby the eccentric may be separated into a plurality of parts and these rigidly secured together after having been separately applied to the shaft.

Prime Movers and Their Accessories.

INJECTOR.—W. H. WINKS, Baltimore, Md. In the operation of supplying water to a boiler by means of an injector and in the "break" in the passage of the water from the tank to the boiler there are disadvantages, which the present inventor obviates by providing a tank connected with an overflow pipe of the injector, the tank being arranged on the foot board of the locomotive, although the tank might be arranged at any other convenient point.

AUTOMATIC STOP FOR PISTONS.—E. C. THORSCHMIDT, New York, N. Y. The invention has reference to improvements in automatic stops for pistons actuated by steam or water pressure, the invention being particularly adapted for use in connection with power hammers; the object being to provide a simple means to cushion a piston when near the end of its stroke.

INTERNAL-COMBUSTION ENGINE. — F. MOREY, Scrafford, W. Va. This invention is an internal combustion engine of the type in which the reciprocation of a piston or pistons is converted into the rotation of a shaft by means of a drum having a continuous encircling cam groove, and a roller journaled upon a pin attached to the piston and engaging the groove. A pair of co-axial two cycle cylinders act upon a piston or connected piston heads so that two impulses are imparted at each revolution.

Railways and Their Accessories.

RAILROAD-TIE.—R. L. BOWER, Blandburg, Pa. In this patent the improvement relates to metallic ties, and its object is to provide a new and improved railroad tie which is simple, durable and strong in construction, practically indestructible, and sufficiently elastic to slightly yield according to the load.

Pertaining to Vehicles.

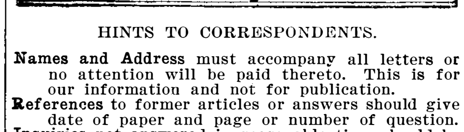
STAND FOR MOTOR-CYCLES, ETC.—J. J. HANSEL, Muskegon, Mich. The rear axle of the cycle is backed into the opening of a casting and a lever swung rearwardly and downwardly, thereby forcing the upper end of the lifting rod upwardly against the steps of the cycle, thus raising the rear wheel of same off the floor, allowing a pawl to engage the rack. The cycle will be held off the floor, whereupon it may be tested, repaired, etc.

SLED-PROPELLER.—J. J. HANSEL, Muskegon, Mich. This invention may be characterized as an attachment to automobiles, employing front and rear sets of sled runners, with a suitable frame connecting the front and rear sled runner, through means of supporting springs, and further, as employing peculiar propeller wheels, adapted to be driven by the automobile or other engine, or by manual means obvious to the skilled in the art.

DUMPING DEVICE FOR VEHICLES.—M. I. TUTTLE, Fort Morgan, Col. One object of the invention is to provide a device which is tilted into position to allow the load upon the vehicle to slide from the same, by weight of the loaded vehicle, while the weight of the unloaded returns the tilting platform to its normal position through the change of position of the center of gravity of the vehicle when loaded and unloaded.

DRAFT ATTACHMENT FOR VEHICLES.—J. M. SUDDUTH, Manhattan, Kan. The invention pertains to a draft device especially adapted for use where a team of horses is employed, and the purpose is to provide an economic arrangement that will draw equally from each side of the center of the axle, and which will effectually prevent the tongue or pole from having a whipping action, and which will also render the draft exceedingly easy.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.



HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

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(10555) P. E. J. asks: When the elements cæsium and rubidium are placed in water they decompose it with the liberation of H, which takes fire, but does Cs give the flame a blue color, or Rb a red? In nearly all books on chemistry I find that the element erbium has never been isolated. On looking through Merck's Index, 1896, a catalogue of nearly every chemical known, I find it thus: "Erbium (E) metal, dark gray powder." Also tell me if this element is not like didymium, which has been split into different elements? A. Cæsium was named from the blue lines which its flame gives in the spectrum, of which there are two. The word cæsium means skyblue. Rubidium in a similar way gives two dark red lines. The word rubidium means dark red. Both are from the Latin.—With reference to erbium, Remsen's "College Chemistry" says: "A final statement cannot be made as yet. It is even questionable whether it is an element."

(10556) J. D. asks: Will you kindly tell me how and what preparation is used in sticking pictures on glass so that it will not blister? Most of the art stores have for sale pictures that they call "medallions," which appear to be a piece of glass pasted over the front of a picture. I have endeavored to do this, and have wet my picture and coated the glass with a thin coating of thin white glue and also paste, and also with library paste. It looks very well while it is moist, especially after I have rubbed all the air bubbles out, but after it dries it appears flaky in places, as if the picture did not stick to the glass. I have also tried putting the picture on under water, thinking by this means to keep the air from getting between the picture and the glass. A. According to the Werkstatt, clean the inner hollow side of the glass thoroughly, pour on gelatine dissolved in boiling water, lay the picture on and pour on gelatine again, so that everything swims. Then neatly remove what is superfluous, so that no blisters result, and allow to dry. The following recipe is said to be still better: Gelatine, 16 parts (weight); glycerine, 1 part (weight); water, 32 parts (weight); methylic alcohol, 12 parts (weight). The mixture is prepared by causing the gelatine to swell in water, then dissolving it with the use of moderate heat, adding the glycerine, stirring thoroughly, and pouring the whole in a thin stream into the alcohol.

(10557) The I. L. & S. Co. ask: Can you furnish us the formula for a dry powder chemical fire extinguisher, such as is used to throw on fire to extinguish? A. 1. Alum 24 per cent, ammonium sulphate 52 per cent, ferrous sulphate 4 per cent. 2. Common salt 60 per cent, sal-ammoniac 60 per cent, sodium bicarbonate 80 per cent. 3. Sal-ammoniac 100 per cent, sodium sulphate 60 per cent, sodium bicarbonate 40 per cent.

(10558) J. H. writes: Will you please inform me who manufactures the gas ignition pellet for sale? Also what the ingredients are, and in what proportion they are mixed, and how fastened to the mantles which render them self-igniting mantles? A. There is only one substance within our knowledge which can be heated by a stream of gas striking it, so that it will ignite the gas. That substance is spongy platinum. It is used in the Döbereiner lamp, where a stream of hydrogen impinges on a platinum sponge. Platinum in this form is capable of absorbing 800 times its volume of oxygen, which does not enter into combination with it, but is simply condensed into its pores, and is available for combination with other bodies.

(10559) M. H. N. asks: If a raceway measures 2 feet 6 inches deep and 5 feet 8 inches wide, and water flows at the rate of 60 feet per minute, what is the flow per hour, and what is the probable amount of horse-power obtainable from a head of 18 feet? A. A flow of water 2 feet 6 inches deep by 5 feet 8 inches wide at the rate of 60 feet per minute, at a head of 18 feet, is, theoretically, equal to 28.9 horse-power. About 75 or 80 per cent of this could be utilized commercially by a turbine, if the flow of water and head remain constant.

(10560) J. N. R. says: You will do me quite a favor if you will solve the following problem for me: Supposing we have a vessel with a hole in the bottom into which fits a hollow tube closed at both ends and six inches long. We will say this tube fits the hole so that no water could leak through, yet works with perfect ease. Now say we should put into this vessel four inches of water; what would the result be if the tube weighed one-fifth the weight of the water? Would the tube rise, or would it go through, or would it remain stationary? Have submitted this problem to several very "learned" men in this city, but none of them seem to "have time" to work it. They all say they *could* do it if they just had time. By solving the above for me and explaining why, you will confer a great favor. A. If the hole in the bottom of your vessel is round and smooth, and the hollow tube fits it perfectly and without friction, as you say, the tube will fall through the hole, whether there is water in the vessel or not, and it will take just the same force to hold it up when the vessel is full of water as when it is empty. The reason for this is that water exerts a buoyant effect on bodies which are immersed in it, causing an upward pressure on the bottom of them. If your tube is so protected by the hole in the bottom of the vessel that the water cannot get underneath, it can have no buoyant effect. If you fill your vessel sufficiently full of water to have the water cover the upper end of the tube, the water will exert a downward pressure on the top of the tube, which should be added to the weight of the tube, in order to get the total force with which it tends to slide through the hole.

(10561) J. W. H. says: Will you kindly tell me how to rid a house of cockroaches? A. Some years ago we had a cockroach powder analyzed and found it to consist of powdered borax 90 per cent; corn starch 10 per cent, and a little coloring matter. We think this will answer your purpose.

(10562) W. F. N. writes: I wish to elevate 125 miner's inches of water 18 feet, and have a waste flume 30 feet long, 6 feet wide, 12 inches of water deep, running 20 feet in 4 seconds. What is the best way to do this? There is no fall at end of flume, and I wish to utilize the power the water gives. Would it be best to put in an undershot wheel with lifting buckets in each side, or an undershot wheel and work a centrifugal pump or any other kind of pump that is best adapted to the work? A. The flow of waste water in your flume, at the rate of 20 feet in four seconds, corresponds to only about 3-100 of one horse-power. This would lift only about 8-10 of one cubic foot of water to a height of 18 feet per minute, if it could all be utilized. The amount of power available is so small that we do not consider it at all practicable to attempt to use it. A gas engine and a centrifugal pump would probably be your most feasible plan.

(10563) J. N. P. says: Please answer the following questions: 1. How is the horse-power of a river estimated, when the depth, breadth, and fall per mile are known? A. The horse-power of a river is estimated by first finding the number of cubic feet of water that flow per minute when the river is at its lowest. This may be obtained by multiplying by the average velocity of the water per minute. This velocity may be determined approximately by timing rods loaded at one end as they float down stream. It is next necessary to ascertain what head or fall is available for a waterwheel, in case the river is dammed or canals built. The horse-power equals the number of cubic feet per minute multiplied by 62.4, multiplied by the available fall in feet and this product divided by 33,000. 2. How is the horse-power of a pipe estimated when the size of the pipe and the quantity of water delivered per minute are known? A. The horse-power of the pipe is estimated by multiplying the number of cubic feet of water per minute in the pipe by 62.4, multiplying this by the head in feet, and dividing this product by 33,000.

(10564) A. P. says: Will you kindly inform me which is the best way to can sweet corn for further use so it will not spoil, such as the canning factories do? A. Among fruits, etc., green corn is one of the most difficult to preserve by canning. The following is the method in use by many of the large canning establishments: The corn, after removing from the cob, is filled into the clean cans so as to leave no air spaces. These are placed in a large oven or other air-tight vessel, and subjected to hot steam under pressure. The harder the corn, the longer the exposure required to cure it; it is said that in some cases as much as eight hours is requisite, but usually much less than this. A large vessel of boiling water, in which the cans are immersed, may be used instead of the steam oven, but is not so effective. On removal from the oven or water bath, as the case may be, each can (they must be filled to the cover with fruit) has the cap with a very small hole tapped in its center immediately soldered on. As soon thereafter as the can stops blowing, as the escape of steam and air through the vent is termed, the hole is quickly soldered. This must be done before the air begins to enter. Other fruit is cured and canned in like manner; tomatoes rarely require longer than fifteen to twenty minutes steam curing. Where the pits are left in fruit, a longer time is requisite to completely destroy all fermentative germs.

(10565) A. V. B. says: 1. Theoretically what are the most favorable conditions for obtaining the greatest efficiency compound steam engines? A. Theoretically, the highest efficiency with a compound steam engine can be obtained with the highest possible boiler pressure and the most perfect vacuum attainable, and the cut-off in both cylinders arranged so that the steam in each case expands down to the back pressure line. Practical considerations, however, and the influence of the condensation of the steam in the cylinders, materially alter the last half of this statement in practice, and the steam is seldom expanded more than from two to three or three and a half times its original volume in each cylinder of the compound engine. 2. For given stroke, what should be proportionate diameter of cylinders? A. There is no fixed rule governing the proportioning of the diameters of the cylinders of either simple or compound engines. Practice and the judgment of engineers differ widely on this point. You can get a good idea of the proportions that are used in common practice by going over the files of any of the leading power journals and noting the comparative sizes of the cylinders given for the different engines that are described. By making a calculation of such figures from them, you obtain the best rule for cylinder proportions which it is possible to formulate with the present state of our knowledge. 3. Is there any rule for proportioning stroke and diameters of cylinders for given rate of piston speed. A. The piston speed does not materially influence the cylinder proportions, other things being equal, and high piston speed is favorable to good economy, and the best engines have a piston speed varying according to their size and design from 600 feet per minute to 700 or 750 per minute 4. Which do you consider the best type of compound engine now operating on the different railways? A. The experience with compound locomotives has been too short for engineers to decide definitely which is the best type. With stationary engines, the cross compound Corliss engine is conceded to be the most economical. 5. What are the difficulties to be overcome in adapting the compound engine to the locomotive? These answers to be based on the performance of a two-cylinder compound or one high and one low pressure cylinder. Any information along these lines not covered by questions asked will be appreciated. Please give comparative performance of simple and compound engines, same power working under same conditions, relative to cost of performance, consumption of fuel, etc. A. The difficulties that have to be overcome with the compound locomotive are: First, the difficulty in starting on grade or under heavy load. Second, equalizing the work on the two sides of the engine under all conditions of load. Third, the balancing of the reciprocating parts. Fourth, the difficulty of simultaneously varying the cut-off in the two cylinders in such a way as to get the same effect as is obtained by shortening the cut-off in the simple cylinder. Fifth, the increased danger of breakdowns, due to the more complicated mechanism and the difficulty of getting engineers who can intelligently operate and care for the compound engine. With stationary engines a gain of nearly 40 to 50 per cent may be obtained by compounding. With locomotives the decreased fuel consumption is not quite so great, 35 per cent being perhaps an average figure.

(10566) H. E. C. writes: I am seeking information concerning wagons. I feel quite sure that some experiments have been made relative to the size of wheels, size of axle skein proper, location of load, etc., but I am unable to find such matter in published form. I need the information in preparation of an article for an agricultural paper upon farm wagons. Can you help me out in any way? A. Theoretically, the larger the wheel and the smaller the axle the less the friction. Practical considerations of strength and convenience therefore govern the determining of the sizes of wheels and axles used. As a rule, larger wheels are used on the rear axles of wagons. Therefore, a load can be drawn more easily if it is placed near or over the rear axles. The wagon also steers more readily if the load on the front axle is small. These are the only points governing the location of the load. In Vol. XIV., page 1014, of the Transactions of the American Society of Mechanical Engineers, you will find an article by Thomas H. Brigg on the haulage of horses, which may interest you.

NEW BOOKS, ETC.

The Food and Drugs Act. June 30, 1906. A Study with Text of the Act, Annotated, the Rules and Regulations for the Enforcement of the Act, Food Inspection Decisions, and Official Food Standards. By Arthur P. Greeley. Washington, D. C.: John Byrne & Co. 8vo.; cloth; 176 pages. Price, $1.50.

No act has had such a far-reaching effect as the "Food and Drugs Act," and of no other act has the interpretation been so often sought. This volume fills the need for a work embodying a discussion of the law and a description of its provisions. Chapter I contains a treatment of the "General Purposes and Scope of the Act"; Chapter II. "Procedure under the Act," and Chapter III. "Articles to which the Act Applies." Chapter IV. deals with "Adulteration," and Chapter V. with "Mishandling," Chapter VI. discusses "The Guaranty" in its different phases. The last chapter, Chapter VII., consists of miscellaneous notes on the enforcement of the act; stock in hand; labels and similar subjects. The Appendix gives the Standards of Purity for Food Products, as well as much valuable information. The style of the book is clear and the arrangement of the topics convenient.

The Handy World Atlas and Gazetteer. New York: Frederick Warne Co. 16mo.; cloth; 160 pages, 120 maps. Price, 45 cents postpaid.

A small and convenient atlas consisting of a collection of remarkably clear maps, and an alphabetical list of geographical names with their locations.

The Design of Walls, Bins, and Grain Elevators. By Milo S. Ketchum. New York: The Engineering News Publishing Company. 8vo.; cloth; 393 pages, 260 illustrations in the text, and two folding plates. Price, $4.

With the improved methods of handling grain and other granular materials, it has become necessary to design bins on economical lines. While the problem of bin design differs from the design of retaining walls in many ways, a thorough knowledge of the theory of the retaining wall is necessary to a correct understanding of the problem. Probably no subject with which the civil engineer has to deal has evoked so much discussion as the design of retaining walls. One class of writers has evolved elaborate mathematical theories, while another class has approached the subject from the empirical side. Many of the mathematical enthusiasts have failed to appreciate actual conditions of the wall and filling; while most of the "rule of thumb" writers show an entire lack of knowledge of the fundamental theories underlying a theoretical discussion of the subject. Mr. Ketchum has based his discussion on "Rankine's Theory" in which the filling is assumed to consist of an incompressible, homogeneous, granular mass, without cohesion, in which the particles are held together by friction. Although by no means perfect, this theory gives a working basis on which a system of design can be raised which is quite as scientific as most of those followed in engineering. The discussion is given in three parts: Part I. The Design of Retaining Walls. Part II. The Design of Coal Bins, Ore Bins, etc. Part III. The Design of Grain Bins and Elevators.

The Engineering Index for 1906. Compiled from The Engineering Index published monthly in the Engineering Magazine during 1906. New York: The Engineering Magazine, 1907. 8vo.; pp. 395. Price, $2.

The present volume follows closely upon the appearance of Volume IV., recently reviewed in these columns, and practically brings the Index down one year closer to date, as it contains entries which appeared in the monthly installment published in the Engineering Magazine down to the beginning of 1907. This "Annual" retains the classification used in the magazine for the benefit of the specialist who desires to see current literature on this subject assembled in a limited space. While the annual issue does not, of necessity, preclude the publication five years hence of any quinquennial volume on the same model as the others, it is hoped by the publishers that it may prove to be a more serviceable arrangement to the majority of readers. Further, its prompt appearance year by year, while the literature it records is still fresh and timely, may make it superior to the larger volume in serving the interests both of its readers and of the publishers of the technical journals indexed. The Index covers 250 technical and engineering journals in six different languages, about one-quarter of the periodicals indexed being in languages other than English. In every case a brief abstract is given, showing the scope and purport of the article, and in many instances this is sufficient for the purpose of the investigator without further reference.

Birdcraft. A Field Book of Two Hundred Song, Game, and Water Birds. By Mabel Osgood Wright. With 80 full-page plates by Louis Agassiz Fuertes. New York: The Macmillan Company. 12mo.; cloth; 317 pages. Price, $2.

The study of birds is a charming amusement which is within the possibility of every-one, live where he may. Scarcely a spot is to be found in which there is no bird life, or which is not within easy distance of a locality in which bird life abounds. Our great cities, with their parks and museums, afford quite as great opportunities as the country for carrying on this pursuit.

"Birdcraft" contains the very information that all but the most technical students desire. It presents in very attractive form the habits of all the birds of this region, as well, of course, as their names and descriptions. The volume is attractively bound and conveniently assembled.

Outlines of Industrial Chemistry. A Text-book for Students. By Frank Hall Thorp, Ph.D. Second Edition. Revised and Enlarged and Including a Chapter on Metallurgy by Charles D. Demond, S.B. New York: The Macmillan Company, 1907. 12mo.; 602 pages, 116 cuts; cloth, $3.75.

This book furnishes an elementary course in industrial chemistry which may serve as a groundwork for an extended study of the subject. It describes the more important chemical processes, but with somewhat less detail than would be fitting in a larger work. In spite of the number of excellent works on metallurgy already in existence, this subject has been given a place, owing to the needs of certain colleges and technical schools. The subject of the coal-tar colors, however, has been condensed to the briefest outline, since it is always included in courses on organic chemistry. The treatment of the various subjects is clear and concise and the ground covered very extensive. An excellent idea of how chemical industries are carried on can be gained from this book, even by the layman.

INDEX OF INVENTIONS

For which Letters Patent of the United States were Issued for the Week Ending June 4, 1907.

AND EACH BEARING THAT DATE

[See note at end of list about copies of these patents.]

Accounting device, credit, M. E. Gibson.... 855,767
Acid concentrating apparatus, sulfuric, A. Gaillard 856,048
Adding machine, A. R. Jennings.... 856,157
Aerial vessels, sustaining device for, I. Gruber 855,945
Agricultural implement, W. J. Orr.... 855,902
Agriculutral machine, T. J. Thorp.... 855,596
Air brake locking device, Orange & Bowers 855,863
Air compressor, L. B. Cousans.... 855,697
Air cooling and humidfying apparatus, Minto & Kelly 855,719
Alarm lock, Miller & Kunzinger.... 855,469
Alloys, heat treatments of steel, J. Churchward 855,756
Alternator, self-exciting, L. J. Le Pontois 855,713
Anchor for airships, D. Thomas.... 856,003
Anesthetics, apparatus for administering, F. V. Brooking.... 855,931
Automobile and other vehicle, A. C. Heath 855,776
Automobile horn, A. E. Stump et al.... 856,001
Automobile shock reducer, W. Grothe.... 856,053
Autombile stop, automatic, C. O. Lambert.. 855,711
Automobiles, chain driving gear case for, F. Charron 855,878
Awning, J. C. Knabeschuh 855,579
Awning, T. H. Rees.... 855,668
Axes, pivoted nail claw for, W. L. Marble. 855,859
Axle box dust guard, R. Purdie.... 855,666
Bag lock, L. B. Prahar.... 855,974
Bagasse furnace, F. F. Willems.... 856,011
Baling press, E. Rhodovi.... 855,669
Bar. See Grate bar.
Battery, B. B. Downs 855,880
Battery plates, making storage, W. L. Silvey 855,991
Bearing for electrical and other instruments, jeweled, J. Wennstrom 856,007
Bedclothes clamp, A. Grandjean.... 856,052
Bee smoker, F. Danzenbaker 856,133
Beer cooler, triple pipe, W. Griesser.... 856,140
Beer cooling or heating apparatus, E. A. Appell 856,015
Bell, electric, M. Plato 855,729
Bell hammer, C. E. Gierding.... 855,701
Belts, tension regulating means for, F. D. Mercer 855,899
Bench back attaching bracket, A. J. Schoenecke 855,817
Bicycles and motor cycles, attachment for, T. W. Razoux 855,979
Bicycles and the like, locking apparatus to prevent theft and unauthorized use of, T. B. Janssen 855,854
Bisulfite liquor, apparatus for making, N. Heath 856,195
Block system, C. C. & J. Harper.... 855,571
Blower, pressure, A. Mathis.... 856,171
Blower, turbine-driven, A. C. E. Rateau.. 855,809
Boats, life-saving device for, J. Husser.... 855,890
Boats, means for recovering submarine, E. Oswald 856,096
Boiler, H. Del Mar.... 855,446
Boiler flue cleaner, Eichelberger & Hibner.. 855,563
Boiler furnace, steam, P. R. Kime.... 855,642
Boiler support, C. H. Foster.... 855,453
Book, loose leaf, H. I. Seddon.... 855,988
Book or pad, manifolding, A. F. Staples... 855,997

How to Construct An Independent Interrupter

In Scientific American Supplement, **1615**, A. Frederick Collins describes fully and clearly with the help of good drawings how an independent multiple interrupter may be constructed for a large induction coil.

This article should be read in connection with Mr. Collins' article in Scientific American Supplement, **1605**, "**How to Construct a 100-Mile Wireless Telegraph Outfit.**"

Each Supplement costs 10 cents; 20 cents for the two. Order from your newsdealer or from

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Bosom stretcher and holder, J. Konsel..... 855,789
Bottle, T. Taylor.......................... 856,002
Bottle holder, J. Van Hall................ 856,114
Bottle machines, plunger for, R. Johns.... 856,067
Bottle, non-refillable, M. A. Brown....... 855,690
Bottle, non-refillable, J. D. Mitchill..... 855,800
Bottle stopper, A. Westlake............... 855,917
Bottle washer, H. C. Vogel................ 855,912
Bottles, jars, and other receptacles, closure for, J. V. Hull 855,782
Bottling machine, C. W. Elliott........... 856,135
Box, S. Bachmann 855,746
Brace and stretcher, combined, W. Johnson. 855,641
Brake head and shoe, C. P. Smith.......... 856,186
Brake mechanism, ratchet, J. M. Bosenbury 855,876
Brake shoe, J. J. Tatum................... 856,188
Brewing material, T. B. Wagner............ 855,599
Brickmaking machine, E. L. Martin......... 855,716
Brush lock feeding appliance, Rehfuss & Buch 855,811
Brush drilling and tufting machine, Rehfuss & Buch 855,810
Brush for bottle washing machines, P. Boch 856,191
Brush, fountain, E. S. Current............ 855,758
Brush handle socket, A. J. Warren......... 855,600
Buckle, E. N. Humphrey.................... 855,637
Buckle sleeve, D. A. Huffman.............. 855,459
Buckle strap, reinforcing, A. S. Blowers.. 855,750
Buffing roll, P. Bacigalupo 855,922
Buggy top supporter, A. M. Walter......... 855,680
Buggy tops, joint for folding, H. H. Robinson 855,864
Building block, composite, J. Muir........ 856,176
Building block, interlocking, A. B. Nichols 855,657
Building construction, D. G. Hadley....... 855,704
Building construction, Stransky & Riley... 856,000
Burglar alarm, electric, B. J. Cizkovsky.. 856,132
Button, O. L. Henerlau.................... 855,575
Button turning machinery, S. O. McMaster. 855,901
Cabinet, O. R. Hunt....................... 856,155
Cable hanger, C. L. Peirce, Jr............ 856,099
Cables into conduits, apparatus for feeding, E. J. Hutchins 855,952
Cage, D. W. Jones 855,784
Calcium carbid, producing, E. F. Price, 855,476, 856,477
Cam, B. M. W. Hanson...................... 855,773
Camera stand, P. V. W. Welsh.............. 855,825
Can nozzle, safety, W. H. McNutt.......... 855,525
Candies, dipping frame for coating, P. Panoulias 855,804
Car, combination metal and wood, E. I. Dodds 855,839
Car construction, E. I. Dodds............. 855,838
Car controlling device, motor, H. L. Hooke. 855,780
Car door operating mechanism, gondola, E. I. Dodds 855,837
Car draft rigging, freight, H. C. Stickel.. 855,998
Car fender, I. H. Caliga.................. 855,558
Car fender, S. Concannon.................. 855,938
Car, motor, W. D. Hawk.................... 855,572
Car, railway dumping, E. I. Dodds......... 855,840
Car replacer, W. F. Brann................. 856,192
Car window, E. S. Buckman................. 855,933
Cars, electropneumatic braking device for railway, R. Wikander 856,010
Carbureter, F. E. Henabray 855,574
Carbureter, L. B. Gaylor.................. 855,764
Card grinding machine, J. F. Lehman....... 856,072
Cards, playing, H. C. Ward................ 855,681
Carding machine, S. Cordingley 856,031
Carpenter's tool, W. T. Bubb.............. 855,834
Carpet beater, R. J. Green................ 856,139
Cartridge, G. E. Loeble................... 855,958
Case. See Ticket case.
Cash and parcel carrier, J. L. Baldwin.... 856,189
Casket handle, J. Waddell................. 855,544
Ceiling construction, L. L. Sagendorph.... 855,816
Cellulose, nitrating, A. Voigt............ 855,869
Cement block molding apparatus, J. B. Talbot 855,822
Cement composition and making the same, A. Thoma 855,868
Cement or concrete construction, armored, G. Ajello 856,013
Centrifugal machine, B. Ljungstrom 855,580
Centrifugal machine, T. H. Miller......... 855,718
Chair, J. E. Hanger....................... 856,058
Chair seat frames, corner brace for, W. P. Heberger 855,777
Chart exhibitor, A. W. Howell............. 855,636
Chimney top cowl, J. W. Kayser............ 855,710
Chuck, drill and like clamping, J. Albrecht 855,829
Chuck, lathe, H. A. Hillenbrand........... 855,456
Churn, J. Smith 856,187
Cigar and tobacco moistener, E. L. Buxbaum 855,615
Cigarette, J. Cavargna 856,030
Clamp, Shear & Rhodabarger................ 855,989
Cleaning implement, H. G. Lykken.......... 856,168
Clevis, plow, M. C. Adkins................ 855,740
Clock, repeating alarm, W. S. Hawthorne... 855,775
Cloth, etc., apparatus for doubling, J. Fish. 855,881
Cloth, treating, S. Hermann 855,708
Clothes press and wardrobe, J. L. Gideon.. 855,628
Clover hullers, stone and grit separator for, C. M. Follett 855,625
Clutch, W. R. McKeen, Jr.................. 855,524
Clutch, C. W. Sponsel..................... 855,867
Clutch, P. E. Welton...................... 855,915
Clutch device for automobiles, C. E. Carpenter 855,501
Clutch, friction, C. C. Jacobs, reissue... 12,657
Clutch means for intermittently rotating a reciprocating part, White & Duryea... 855,683
Coat hook, J. Patterson................... 855,586
Cock, gage, A. Fredrikson................. 856,047
Coffee urn, D. O. Dowe.................... 855,842
Collar, D. J. Kelly 856,069
Combustion generating apparatus, continuous, E. P. Noyes 855,726
Commutator grinder, Bryant & Bery......... 855,877
Compasses, G. Schoenner 855,592
Compo board and producing same, J. E. Lappen 855,792
Concrete forms, apparatus for raising, Folwell & Sinks 855,452
Concrete steel suspension arch, E. J. Schauwecker 855,986
Concrete tie, M. E. Woodbury 856,125
Conduit, G. Russell 855,985
Coop or crate, O. J. La Bauve............. 855,790
Corn, apparatus for heading Kafir, T. H. Sparks 855,819
Corn drill, W. Kirn 855,787
Cotton chopper, S. Stallinge 855,995
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Cotton chopper and cultivator, combined, R. H. Purnell 855,977
Cotton chopping and corn hoeing machine, combined, J. Jackson 855,639
Cotton picker, J. B. Neil 856,178
Counter, E. T. Willson.................... 855,827
Counting board, A. J. Dunn................ 856,041
Crossing gate, automatic, R. D. Page...... 855,660
Crusher and pulverizer, M. F. Williams, reissue 12,659
Cue rest, G. F. Williamson 855,684
Cultivator shovels, adjustable clamp for, J. W. St. John 855,487
Cup. See Drinking cup.
Current generator, constant, C. P. Steinmetz 855,484, 855,485
Curtain fixture, C. L. Hopkins............ 855,781
Curtain raiser and controller, E. Harris.. 856,144
Curtain stretcher, H. E. Southworth....... 855,908
Curtain support, side, W. B. Pearson...... 855,970
Curtain suspension device, T. Ludwig...... 856,076
Cuspidor cleaner, O. Kerouse.............. 856,160
Cut-off, automatic, H. Price.............. 855,808
Cutting block, G. E. Daniels 855,940
Damper mechanism, H. A. Starr............. 856,107
Dental fillings, inlays, and crowns, manufacturing fusible, J. N. Crouse.......... 856,034
Dentimeter, J. Bode 855,875
Detinning, C. E. Acker.................... 855,491
Dial holder, O. Ohlson.................... 856,092
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Dish washing machine, J. A. Hamelback..... 855,570
Disinfection, process of, F. Duret........ 855,942
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Display rack; seed, L. L. Morse........... 855,862
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Escapement, O. Ohlson 856,091
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Eyeglasses, E. B. Meyrowitz............... 856,080
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Feed trough, automatic, C. W. Griswold.... 855,568
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Feed water heater, W. Griesser 856,141
Felly and tire, auxiliary, C. Buckland ... 856,027
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Fire extinguisher, H. M. Gillett.......... 856,050
Fire lighter, H. P. Vogel................. 855,488
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Fly trap, Brugel & Passmann............... 856,128
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Fuel, artificial, B. H. Reed 856,101
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Furniture and piano polishing composition, J. R. Fitzgerald 855,451
Furniture, combination, Margolin & Karron 855,520
Furniture, knockdown, W. R. Dean.......... 856,036
Gage, G. W. McLaughlin 855,964
Game, F. M. Greer 855,455
Game, D. C. Pingrey 855,728
Game apparatus, J. W. Wallace............. 856,118
Garment form, A. L. Traviss............... 856,004
Garment holder, S. Levy................... 855,956
Garment supporter, Raymond & Jensen....... 855,529
Garment supporter clasp, B. E. G. Noble... 855,802
Gas burner safety device, A. A. Churchill.. 855,936
Gas generating apparatus, acetylene, A. C. Einstein 855,843
Gas generator, I. N. Enright.............. 855,699
Gas generator, acetylene, P. O. Hays...... 856,148
Gas generator furnace, L. Bemelmans....... 855,749
Gas lighter attachment, W. Roche.......... 855,531
Gas mantles, producing self lighting, F. W. Mayer 855,798
Gas producer, A. de Galocsy et al..855,845, 856,137
Gas washing and cooling apparatus, H. L. Doherty 855,448
Gases or of gas and air for illuminating purposes, apparatus for producing mixtures of, H. L. Karger................ 855,953
Gate, J. M. Higbe 855,948
Gate, E. J. A. Rice....................... 855,980
Gearing, friction, A. O. Carman 855,500
Gearing, worm, A. T. Collier.............. 855,937
Glass and similar articles in place, device for holding, C. C. Roth................ 855,813
Glass mold, D. D. Hughey 856,154
Glove sustainer, L. L. Brown.............. 855,833
Gold washer, B. J. Jayne.................. 855,640
Governor, engine, S. S. Hall.............. 856,056
Governor, explosive engine, N. Young...... 855,490
Grain grader, G. H. Rich 855,981
Grain sampler, H. M. Gray 855,849
Grate, H. A. Smith 855,538
Grate, Margolin & Karron 855,795
Grate bar, H. Truesdell 855,823
Grating, F. E. Canda 856,130, 856,131
Grease cup, F. G. Hunter.................. 855,889
Grinder, J. N. & N. J. Lisk............... 856,167
Guano distributer, R. W. Starling......... 855,593
Gun stock, F. Balson...................... 856,016
Guns, fluid recoil brake for, Motz & Muller 856,174
Hammer, claw, O. E. Palmer................ 856,097
Hammer, drop, C. Prott.................... 855,976
Hammer, power, O. B. Reynolds............. 855,730
Harness hook, C. A. Leonard............... 855,464
Harrow, J. E. Wheaton..................... 856,009
Harrow and cultivator, S. G. Calaway...... 856,028
Harvester needle, S. Smith 855,539
Harvesters and similar machines, cutting mechanism for, H. H. Kryger.............. 855,645
Harvesting threshers, combined cutting knife and distributer for, W. Maloney.. 855,519
Hasp, J. C Griffin 855,566
Hat and coat rack, Rose & Brady........... 855,732
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Hay rake, horse, G. W. Bacon.............. 855,686
Head rest, A. H. Brown.................... 856,025
Heat radiating ring, I. S. Barnett........ 855,687
Heater, T. G. Palmer...................... 855,904
Heater, H. F. Langenhop................... 855,955
Hinge, M. A. Tieck........................ 856,112
Hinge, four-way gate, C. W. Westerberg.... 856,008
Hitching strap clamp, Skinner & Myers..... 855,675
Hook. See Coat hook.
Horn support, V. H. Rapke................. 855,978
Horseshoe calk, A. Smith.................. 855,534
Horseshoe calk, W. Merrick 855,717
Horseshoe machine, A. Smith............... 855,535
Horseshoe nail clencher, J. N. Doss....... 855,505

Horseshoes, apparatus for rolling billets in the manufacture of machine-made, A. Smith 855,533
Hot air engine, O. Ringbom 856,102
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Lacing the uppers of shoes, machine for, Paine & Winkley 855,969
Ladder, step, W. F. Stevens 856,108
Ladder, step, P. F. Wagner 856,116
Ladder, truck, T. Haines 855,771
Lamp, alcohol, C. Halstead 856,142
Lamp burner, W. A. Blauvelt 856,021
Lamp cap, incubator, J. T. Molloy 855,523
Lamp shade, F. Baumer 856,190
Lamps, globe closure for electric arc, E. Bonnet 855,926
Lamps, machine for basing incandescent, W. R. Burrows 856,129
Landside, A. A. Hughes 856,153
Lantern, tubular, A. T. Bishop 855,443
Lantern, tubular, Bishop & McCann 855,612
Latch, J. W. Pettijohn 855,662
Latches, tail stock for wood turning, O. Larson 855,858
Leather splitting machine, A. F. Hertig 855,576
Lifting apparatus, L. R. Shelden 855,990
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Locomotives, signal indicating device for, F. v. Zeppelin 855,920
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Loom picker stick check, J. B. Bernier 855,873
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Loom shuttle, Lacroix & Cunniff 855,791
Looms, drawing hook for warp threads in weaving, K. Mattausch 855,521
Looping machines, needle arm for, R. W. Gorm y 855,847
Louver, H. W. Waldmire 856,117
Lubricating device, F. Meisel 855,467
Lubricators, automatic drainage attachment for, J. C. Hubbard 856,151, 856,152
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Mattress making machine, C. W. White 855,737
Measuring apparatus, construction of, M. Gehle 855,846
Measuring instrument, H. Roost 855,865
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Meat-treating apparatus, J. Cunning 855,618
Mechanical movement, J. Y. Porter 855,973
Medical appliance, A. C. Heath 855,573
Medicine receptacle, F. J. Russell 855,984
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Mill. See Roller mill.
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Motor controlling device, Mittelstrass & Franz 855,470
Motor speed controlling mechanism, explosive, J. A. Miller 855,582
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Mower, lawn, L. Pederson 855,587
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Nail clipper, M. Prochaska 855,665
Nail extractor, H. H. Mattocks 855,522
Nailing or riveting machine, J. M. Gimson et al. 855,454
Navigation, P. L. T. Heroult 855,510
Nipple attachment for points, E. Skelton 855,992
Nurling cylinders, apparatus for, E. J. O'Brien 855,658
Nut, axle, W. L. Pounds 855,664
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Nut lock, G. W. Darling 855,698
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Nut lock, C. C. Halgren 855,946
Oil burner, L. A. Blubaugh 855,688
Oil burner, G. Larsen 855,857
Oil cake trimmer, Dion & Belanger 855,836
Oiler, mechanical, C. R. Radcliffe 856,180, 856,181
Ore distributer, P. Argall 855,744
Ore distributer, radial, P. Argall 855,745
Ores, dressing, O. Witt 856,124
Package, C. P. Mitchell 856,173
Packing, metallic, G. D. Rollins 856,103
Pail clamp, J. P. Stenstrom 855,540
Pail, collapsible, J. L. Morrison 855,963
Painting, making a design, E. D. Roberts, Jr. 855,812
Paper feeding mechanism, C. Williams 856,122
Paper marbling machine, J. W. Newbery 855,474
Pavement and making the same, Sinek & Blome 856,105
Peat collecting machines, tubular conveyer for, W. A. Milne 855,651
Peeling machine, vegetable, H. Robinson 855,481
Pen, fountain, M. W. Moore 856,082
Phonograph, Aylsworth & Dyer 855,604
Phonograph, Durand & Aiken 855,622
Phonograph blanks, making, J. L. Aylsworth 855,557
Phonograph recorder and reproducer, E. L. Aiken 855,828
Phonograph records, making duplicate, J. W. Aylsworth 855,553, 855,554, 855,605
Phonograph reproducer, L. Devineau 856,038
Phonographic records, composition for, J. W. Aylsworth 855,552
Photographic film holder, A. Schalek 855,591
Photometer, C. H. Williams 855,548
Piano, automatic, R. A. Rodesch 855,671, 855,672
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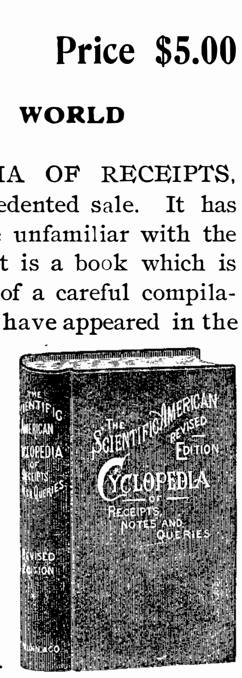

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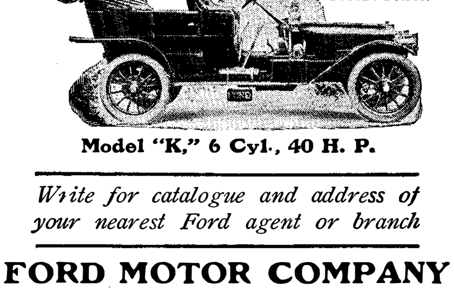

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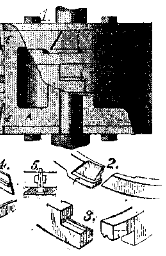

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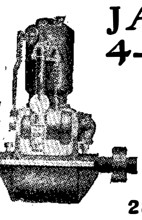

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"Truman's English Fever Cure," for a fever cure, J. G. Truman 13,587
"Uneeda Weeda," for cigars, cheroots, cigarettes, and smoking tobacco, Haase-Schaid Cigar Co. 13,576
"Useeit," for toilet paper, John Hoberg Co. 13,596
"Vevo," for massage cream, Mosco Mfg. Co. 13,582
"White Rabbit," for toilet tissue, John Hoberg Co. 13,594

PRINTS.

"Coat Chart," for men's and boys' coats, Ed. V. Price & Co. 2,014
"College Brand Hats," for hats, Samuel Mundheim Co. 2,012
"Exhibiting Tailor," for men's and boys' coats, Ed. V. Price & Co. 2,015
"Gordon Furs," for furs, Seiter & Kappes Lithographing Co. 2,023
"Greeting Tailor," for men's and boys' coats, vests, and trousers, Ed. V. Price & Co.. 2,020
"Lemp Extra Pale," for beer, Wm. J. Lemp Brewing Co. 2,009
"Life Saver," for beer, Falls City Brewing Co. 2,008
"Magnesium Candles," for fireworks, Erste Thuringer Christbaumschmuck-Fabrik Gebr. Weinrich 2,025
"Measurements Chart," for men's and boys' coats and vests, Ed. V. Price & Co. 2,021
"Men's and Boys' Apparel," for men's and boys' apparel, H. C. Lytton 2,022
"Our Clerk," for men's and boys' coats, vests, and trousers, Ed. V. Price & Co. ... 2,016
"Our President," for men's and boys' coats, vests, and trousers, Ed. V. Price & Co.. 2,018
"Our Salesman," for men's and boys' coats, vests, and trousers, Ed. V. Price & Co.. 2,019
"Pressing Tailor," for men's and boys' coats, vests, and trousers, Ed. V. Price & Co.. 2,017
"Seven-Up," for lubricants, L. Mendel 2,010
"The Knox," for automobiles, L. P. Breining 2,026
"Twinco Stamping Works," for stamped metal goods, Empire State Engineering Co. 2,024
"Vest Chart," for men's and boys' vests, Ed. V. Price & Co. 2,013
"Wheel and Tangent Backs. Bicycle Playing Cards," for playing cards, United States Playing Card Co. 2,011

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., 361 Broadway, New York.

SEALED PROPOSALS.

PROPOSALS FOR PLUMBING AND CONCRETE WORK. Office of the Constructing Quartermaster, Fort Bliss, Texas, June 1st, 1907. Sealed proposals in duplicate will be received at this office, until 12 M. o'clock, July 1st, 1907, and then opened, for alterations in two Lavatory Buildings, at this Post. Alterations consist of removing present fixtures, relaying concrete floors, and furnishing and installing Plumbing and Heating fixtures. Applications for plans should be accompanied by a signed receipt to insure the safe return of the same, and should be addressed to "The Constructing Quartermaster, Fort Bliss, Texas."