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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 to-day 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.

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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.

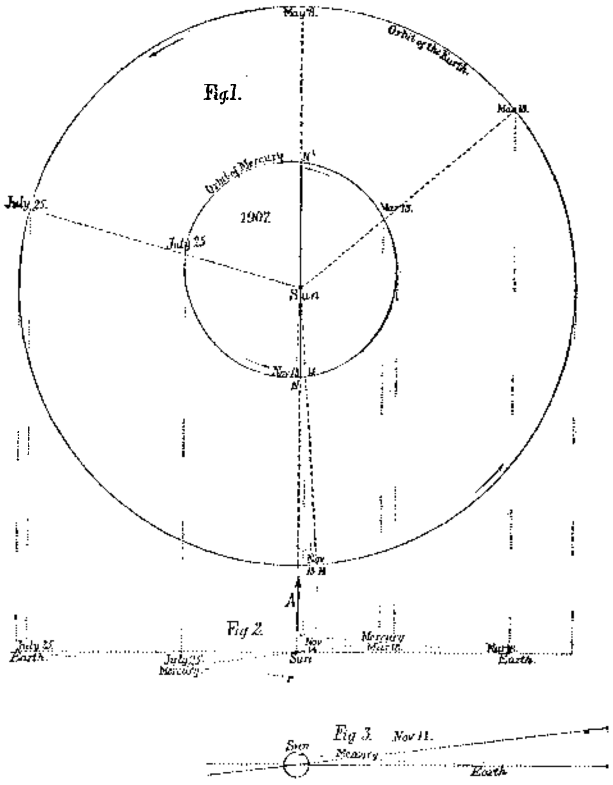
In order that a transit may occur, the sun, the earth, and Mercury must (in Fig. 2) be at or very near the intersection of the orbits. This intersection, shown by a point, is the line *N N'* ("the line of nodes"). This line is the intersection of the plane of the planet's orbit with the plane of the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



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

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.

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

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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.

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