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.

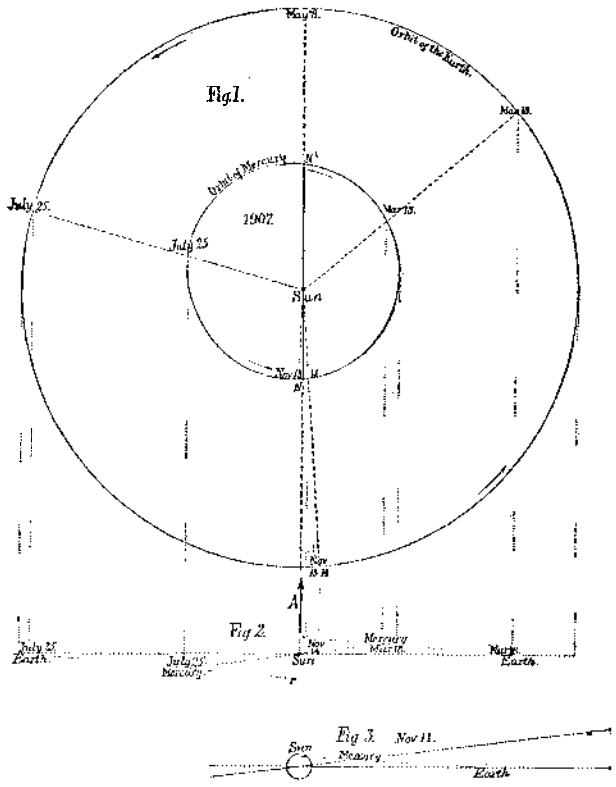
In order that a transit may occur, the sun, the earth, and Mercury must (in Fig. 2) be at or very near the intersection of the orbits. This intersection, shown by a point, is the line NN' ("the line of nodes"). This line is the intersection of the plane of the planet's orbit with the plane of the ecliptic.

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

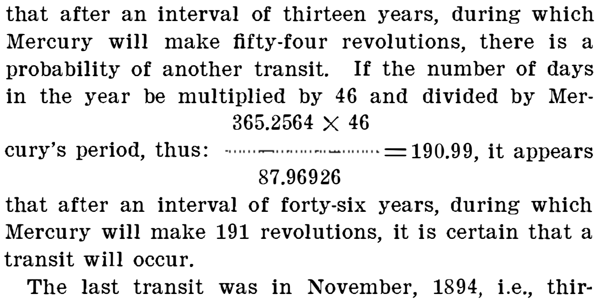


THE ORBITS OF MERCURY AND THE EARTH ABOUT THE SUN, SHOWING THEIR RELATION WITH REFERENCE TO THE ECLIPTIC.

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., thir-



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

teen 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.

* "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.