

carried. A still larger Brillié truck, which was run on gasoline at an average speed of 10.37 miles an hour, had a consumption of 0.11 liter per ton-kilometer (0.046 gallon per ton-mile) of load carried. The consumption of alcohol was thus shown to be somewhat greater per ton-kilometer of useful load carried than when gasoline was used.

HOW ECLIPSES OCCUR.

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In the endeavor to obtain a clear understanding of how eclipses occur, it is necessary to know the form of the moon's path in space, which is the resultant of two motions, viz., that of her orbital motion round the earth, and of the revolution of the latter round the sun.

The popular conceptions of this path are frequently erroneous, and are illustrated in Figs. 1 and 2. The piece *a* rotating about the fixed center *S*, which represents the sun, carries a disk *b* which rotates round the center *E*, representing the earth.

On the periphery of this disk is a point *M*, representing the moon, which revolves round *E*, and describes the moon's path. In Fig. 2 this curve forms a loop, due to the rapid rotation of the disk as compared with the angular motion of *a*.

Fig. 1 represents the curve when the disk rotates more slowly; and *M* describes a sinuous path which crosses and recrosses the earth's orbit. This approaches more nearly the form of the moon's path; but it differs very widely from the true one, because in the illustration the radii of the orbits, and the relative orbital velocities of the earth and moon, are not

M' and *M''* represent two views when the center of the moon is in the plane of the ecliptic, i.e., when she is at one of her nodes. The earth and moon are shown at *M'* by concentric circles; while the distance from *M'* to *M''* measures the mean radius of the moon's orbit. The shadow area is inclosed by the dotted lines drawn from the circumference of the sun's disk tangent to the earth, and indicates the limit within which a total or partial eclipse may occur.

When the moon is at or near *M''*, the eclipse is total; when at *M'''*, partial; and at *M''''* no eclipse occurs.

The moon at each of the dates August 4 to 20 (Fig. 3) is at the extremity of the radius of the circle representing her orbit, and her revolution round the earth is shown until she reaches her position on August 20. Connecting these points, the dotted line represents her path which is below the plane of the ecliptic.

A partial eclipse of the sun occurs on August 19, when the earth, the moon, and the sun (Fig. 3) are again in the same straight line.

The diameter of the sun is 866,400 miles; dividing this by 389—the length of the earth's mean distance

in terms of the moon's mean orbit radius— $\frac{866400}{389} = 2,227$.

A disk 2,227 miles in diameter would eclipse the sun. The moon's diameter is 2,162 miles. Therefore, under these conditions, if the three bodies were in the same straight line, we should have an "annular" eclipse of the sun, shown at Fig. 5; the larger circle representing the sun, and the smaller one the moon.

If the sun should be at his minimum distance from

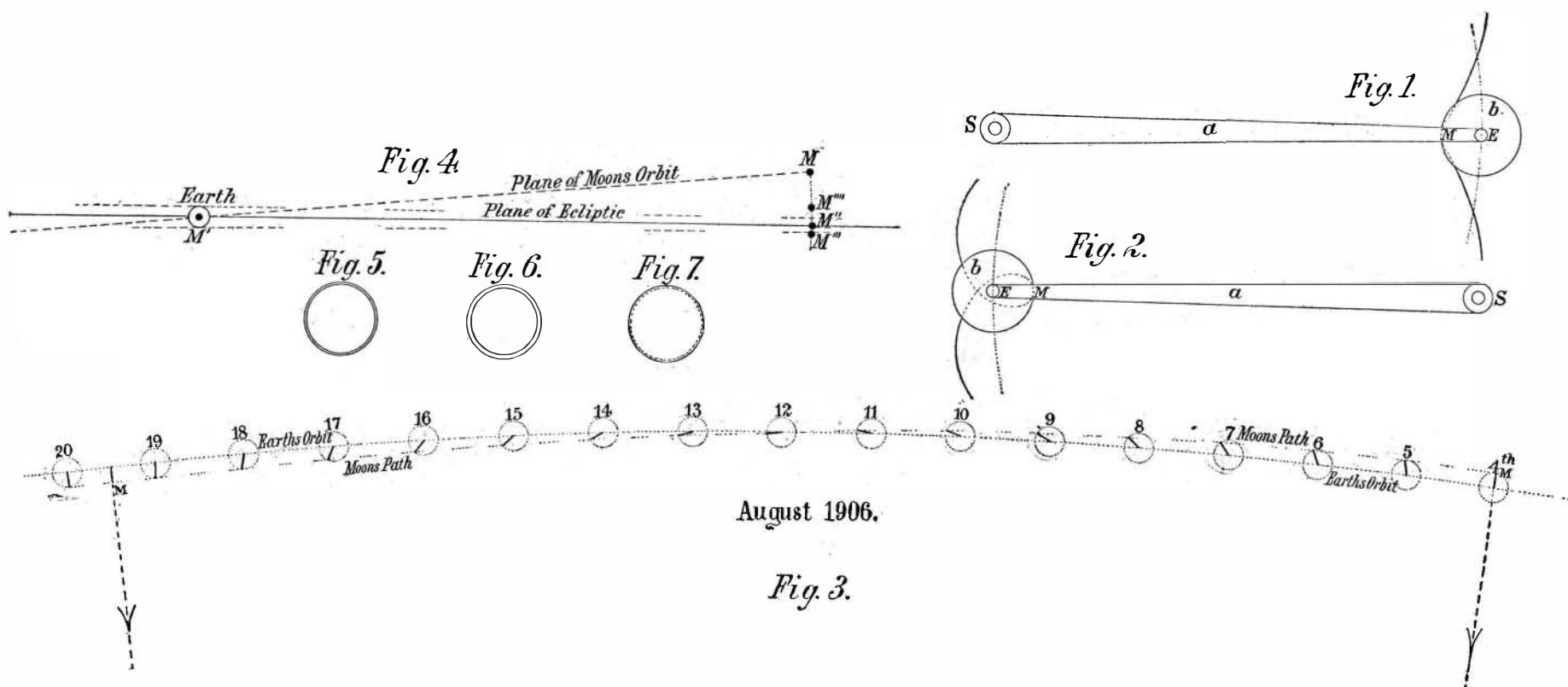
urement equal to three hundred and eighty-nine times this unit.

The sine of 32 deg. = 0.0093. If we multiply this by 108, $0.0093 \times 108 = 1.00$, we discover that a circular disk of one inch diameter placed 108 inches (= 9 feet) from the eye will eclipse the sun or the moon.

Another Alpine Tunnel.

Consul Edward Higgins, of Berne, reports that the legislature of the Canton Berne has accepted the project for a trunk line called the "Lötschberg," with electricity as motor power, to pass through the Bernese Alps and connect at Brig with the Simplon.

This new road will require five and one-half years to build, and necessitates a tunnel $13\frac{1}{2}$ kilometers (kilometer = 0.62137 mile) long out of an entire length of 56 kilometers. The cost will be about \$17,100,000. The steepest gradient will be twenty-seven one-thousandths. It will serve as the most direct means of communication between northern Italy (Milan and Genoa) and the vast district lying to the north and northwest of Switzerland. It will shorten the approach to the Simplon, that now must be reached via Lausanne, and will compete with the Gothard tunnel railroad. In addition to its value as an international trunk line it will prove of vast commercial importance to central Switzerland, and particularly to the Canton and city of Berne, by affording a direct line with the south that now has to be reached by means of the Gothard on the east or through the Simplon, which requires a roundabout deviation via Lausanne on the west. The road that has to be constructed will commence at Frutigen, a town near Spiez, a few miles



HOW ECLIPSES OF THE SUN AND MOON WILL OCCUR IN THE MONTH OF AUGUST.

correctly represented. The mean radii are respectively 92,900,000 and 238,840 miles. Dividing one by the

other, $\frac{92,900,000}{238,840} = 389$; i.e., the earth's mean orbit

radius is three hundred and eighty-nine times as long as the moon's. They are correctly proportioned in Fig. 3, which is a plot of the earth's orbit for about one-half of the month of August, 1906.

The position of the earth on August 4 and the dates that follow is the center of the circle the circumference of which represents the moon's orbit drawn to the same scale. The moon *M* is situated at the extremity of the radius of the circle. The earth, moving at the rate of eighteen and a half miles a second, travels each day a distance of about one million six hundred thousand miles, or three and a third times the diameter of the moon's orbit, while the latter, moving in her orbit at the rate of about five-eighths of a mile a second, revolves round the earth daily at an average of a little over 13 deg.

The relative positions of the sun, the earth, and the moon are shown for August 4, the date of a total eclipse of the moon. The sun is situated in the direction of the arrow, the earth at the center of the circle, and the moon at *M*. They are in the same straight line. If we place this page in a horizontal position, and regard it as representing the plane of the ecliptic—i.e., the plane which passes through the centers of the sun and earth—the moon must be in or near the plane of the ecliptic, that it may be possible for an eclipse to occur.

This will be evident by referring to Fig. 4, which shows the plane of the ecliptic, the plane of the moon's orbit, and the earth and the moon *M*.

the earth, and the moon at her maximum distance, Fig. 6 would represent their apparent relative diameters—a more pronounced annular eclipse.

If the moon were at her minimum distance, and the sun at his maximum distance, Fig. 7 would show their apparent dimensions; the larger circle representing the moon, and the smaller one the sun—a total eclipse of the sun.

The moon's center will be in the plane of the ecliptic on August 18 (the ascending node) before the three bodies are in the same straight line as shown at *M* on the 19th.

Therefore it cannot be a "central" eclipse on that day. If the earth's orbit were plotted to include the date July 21, when another partial eclipse of the sun occurred, we should have an exhibit of the moon's path somewhat similar to that of Fig. 3. This has been omitted for lack of space.

The sun subtends on the average an angle of about thirty-two minutes, with a variation of about half a minute during the year. This is due to the varying distance between the earth and the sun, which amounts to about three million miles.

The moon subtends an average angle of about thirty-one and a half minutes, with a variation of about two minutes. These variations are exhibited in Figs. 5, 6, and 7.

To obtain some conception of the relative dimensions of the sun, the earth, and the moon, and the distances that separate them, it should be noted that the diameter of the sun—which is one hundred and nine times that of the earth—if drawn to the same scale as Fig. 4, would be equal to three and five-eighths times the distance between the earth and the moon ($= M' M''$); and the sun's distance would be represented by a meas-

from the lake of Thun, which is in direct communication with the towns of Thun and Pontarlier and with the cities of Berne and Basel. It will merge into the Simplon at Brig and virtually form the completion of that great project. The distance from Frutigen to Brig will be 56 kilometers, from Spiez to Brig 71 kilometers, and from Berne to Brig 113 kilometers. From an international standpoint Paris will be 15 miles nearer the cities of Italy than via the new Lausanne-Simplon tunnel route and about 100 miles nearer than via Gothard. From Calais northern Italy can be reached with 52 miles less travel than by Lausanne, through the Simplon.

A federal concession was granted covering the Lötschberg in 1891 and amended in 1897. The Canton has turned over its concession to a syndicate, and the cost will be borne by issuing subvention shares, \$4,000,000; preferred shares, \$4,600,000; 4 per cent first-mortgage bonds, \$5,600,000; and $4\frac{1}{2}$ per cent second mortgage bonds, \$2,900,000, or a total of \$17,100,000. The subvention shares will receive no interest until the road is in working order, but the preferred shares will be paid 4 per cent interest during the period of construction. The Canton Berne participates by the purchase of \$3,300,000 subvention shares. The syndicate is composed of Swiss and French banks. It is expected that ultimately the Swiss federal railways will buy the Lötschberg. The work will commence at once.

A 12-horse-power four-cylindred petrol motor in America recently ran 87 miles on two gallons of petrol. The weight of the car was 1,500 pounds. Another car identically the same only ran 57 miles on the same allowance of fuel.