THE ECLIPSE.

Best Opportunity for Sun Study to Occur this Century.

Time and Track of the Sun's Total Obscuration.

DIAGRAMS EXPLAINED.

The Rose-Red Chromosphere and the Corona.

SOLAR CHEMISTRY.

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ECLIPSE EXPEDITIONS AND PREPARATIONS.

The Novel Instrument for Attacking the Great Solar Problem.

A Foreglimpse of the Earth's "Dies Iræ."

The present year will be memorable in the annals of astronomy. Besides the great transit of Venus the phenomenon of a total solar eclipse—probably the most favorable that can take place during this century—are among the celestial events toward which scientific attention has been eagerly directed. There are many grave problems of solar physics which, from time immemorial, have been under discussion, that can find solution only in spectroscopic examination of the eclipsed sun. Although the coming eclipse is not so rare and so exciting an occurrence as the recent transit there are peculiar circumstances which invest it with unusual interest and importance.

One of these is the fact that it will be observable only at a small number of land stations, and these lie mostly in the Indo-Chinese peninsula, within the little Kingdom of Siam. In this ancient nationality court astrologers and prognosticators have been long employed at trivial remuneration, and formerly were severely castigated on the failure of their predictions. By the roughest and crudest methods the Siamese astronomers-royal have been in the habit of calculating eclipses. And to them, we may well imagine, the greater scientific perfection of their European brethren, coming in their midst with the most magnificent and modern machinery of the star gazer, will be an event more impressive than the eclipse itself. Although the phenomenon soon to be observed is now among civilized nations one of scientific interest rather than popular terror, it has by no means lost its influence on the uneducated masses of men. Before astronomy had made known the cause of eclipses, their occurrence was regarded as indicating fearful deviations from the ordinary course of nature. In the first year of the Peloponnesian war, when the Athenian fleet was ready to sail, a solar eclipse would have demoralized his men and marred his expedition, had not Pericles, its commander, been able to explain the mystery. Eighteen years later an army, composed mainly of the same highly cultured and intellectual Athenian element, was lost from failing to move, at a critical moment, because terrified by an unexplained lunar eclipse. History has preserved the instructive incident of how Columbus, sorely pressed by famine, relieved his wants and secured the fruits of his celebrated voyage by threatening the Indians that the moon, then riding in serene majesty through the heavens, would be darkened on a certain day if they did not succor him. But while the alarm now excited by eclipses is confined to the untutored and unthinking, the many welcome such phenomena and the world's science is marshalling for new and more brilliant conquests in the domain of astronomic discovery.

THE COMING ECLIPSE

of the sun will occur on the 5th of April next. The central eclipse begins on the earth a little southwest of Cape Agulhas (South Africa), in longitude 99 deg. 19 min. 7 sec. east from Washington, and in south latitude 35 deg. 30 min., at 11h. 44m. Washington mean time. The first contact thus barely escapes the southern extremity of Africa and the central line, along which the shadow of the moon (interposed between the earth and sun) advances, runs from southwest to northeast. Its track is now almost entirely oceanic, passing southeast of Madagascar and not quite grazing its southeastern extremity. Thence also missing Mauritius, where an able body of observers could take the field, it flits rapidly onward, crossing the Equator in about longitude 166 deg. east from Washington, or about 89 deg. east from Greenwich. It then strikes (Fig. 1) through the Nicobar islands, in the southern part of the Bay of Bengal, and sweeps across Tenasserim, Siam and Anam, passing out into the China Sea and finally making its last contact on the open bosom of the Pacific a little northeast of the Ladrone Islands. The point of this last contact is about 147 deg. east of Greenwich, in latitude 21 deg. 12 min. north, and occurs at about 15h. 12m., Washington mean time.

To give a clearer idea of the phenomenon in question the diagram Fig. 2 is presented. Although it is partly self-explanatory and graphically shows the

PHYSICAL PHENOMENA OF THE ECLIPSE,

it may be well to notice the conditions under which such an obscuration of the sun occurs. The eclipse of the sun is caused by the interposition of the moon between the earth and the sun, and when the conical shadow which the interposed moon projects behind her in space reaches the earth, the points of the terrestrial surface on which it falls are completely deprived of solar light and involved in total darkness. Those parts of the earth covered by the moon's penumbra are, however, shrouded in but partial darkness because from these parts only a portion of the light from the solar disk is intercepted. According to the relative positions of the sun, moon and earth, a variety of solar eclipses is presented. If the apparent diameter of the moon happens to be greater than that of the sun, the obscuration of the great luminary will be total, as in the approaching phenomenon to be observed in Siam. If the moon's apparent diameter be smaller than that of the sun a luminous ring, formed by the unobscured portion of the solar disk, is visible, and the eclipse is then annular—an instance which will occur and be observable at Washington on the 28th of next September. If the moon's centre is not exactly upon a straight line joining the sun's and the earth's centre, the solar disk can, of course, be but partially concealed and the eclipse is partial; but when the centres of the three orbs lie on the same straight line, the result is a central eclipse. The greatest possible excess of the lunar above the solar diameter, as seen by a terrestrial observer, is only two minutes of a degree, so that the greatest eclipse that can ever or anywhere occur can last only as long as it takes the moon to pass over about two minutes in her orbit, or about four minutes of our time. In such a case the moon's shadow covers only a spot about 180 miles broad, though the penumbra (or partial shadow) may then darken a circular spot on the earth's surface having a diameter of nearly 4,900 miles.

In figure 2 the sun's centre (S) is seen to be in a straight line with the moon's centre (M) and the earth's centre (E), and the reader is supposed to be looking down on the earth's northern hemisphere. The earth (marked E) is rotating on its axis, and, at the same time, revolving in its orbit around the sun in the direction (O T), and the moon is revolving in its orbit around the earth in the direction (L N). On the latter's coming in conjunction with the sun and earth the solar rays, striking from W toward A are intercepted by the lunar crust, as also are the rays striking from V toward B. The dark shadow, or umbra, included between the letters A, B, C, D, is thus formed somewhat in the shape of a truncated cone, the base of which rests on the nearer lunar hemisphere. On either side of the umbra, or full shadow, is the penumbra P, P, covering a much larger area of the earth's surface, extending from F to G, but only with a partial eclipse of the solar light. In Figure 2 the moon is represented as near her perigee, or point of greatest nearness to the earth, which actually and exactly occurs on the 6th of next April. Were she then to be in her apogee, or at that part of her orbit most remote from the earth, her conical shadow would terminate in a point above the surface of the earth and there would be no total eclipse, the observers in Siam seeing only a luminous ring or annular eclipse. As it is, being near her perigee, the shadow reaches the earth, shrouding in dense darkness an elliptical space about or exceeding one hundred miles in breadth, and this travels, as we have seen, with the motion of the moon itself, with great rapidity.

THE LAND TRACK OF THE ECLIPSE.

The chart (Fig. 1.) exhibits the geography of the regions through which the central line of the eclipse passes. From this diagram will be seen the prominent points at which observations will be taken. These are the island of Camorta, in the Nicobar group, the island of Bentinck, near the mainland of British Burmah, or Tenasserim Province, Mergui and Tenasserim, towns of the latter province, some point south of Bankok, and on the eastern side of the Indo-Chinese Peninsula, Hué, the capital of Anam. At Kaikul, in Camorta Island, the totality lasts 4m. 27s, the sun being at an altitude of 70 degrees. At Bentinck Island the totality lasts 4m. 17s.; at Mergui, 4m. 6s.; at Tenasserim, 3m. 57s.; at Bankok, 3m. 59s., the sun ranging at an altitude of from 60 to 65 degrees. Within these four minutes of the sun in eclipse, by the aid of spectrum photography, it is believed as much knowledge can be gained as ordinary solar observation would give in as many years.

We have seen that the interposition of the moon between the earth and sun acts as a celestial dam to intercept the vast flood of solar light, and that the consequence is the dark cone-shaped shadow of our satellite. But, while the latter serves the purpose of a transient dam, it cannot intercept the glare or radiance of the solar atmosphere—itself a luminous flame enveloping the sun and rising hundreds of thousands of miles above the fiery crust of that orb. The flaming atmosphere of the sun emits light which, during the eclipse, bursting over the interposed lunar barrier, reaches the eye and instrument of the eclipse observer; and it is this light which spectrum analysis so eagerly interrogates, in order to ascertain the

CHEMICAL CONSTITUTION OF THE SUN.

In 1860, Mr. Warren de la Rue and the Italian astronomer Father Secchi were enabled, by photographs of the eclipsed sun, to satisfy themselves that the strange red prominences seen round the moon during the total eclipse were not of lunar origin, but belonged to the solar atmosphere. This settled a question that had been in dispute for a century and a half, and paved the way for solving the kindred and higher problem of the nature and composition of the solar atmosphere, or, more strictly speaking, the red prominences and the corona. The

RED PROMINENCES,

it will be borne in mind, lie within and make up mainly the comparatively shallow part of the sun's atmosphere i. e. the part which lies immediately above the solar crust, or photosphere. This part of the sun's envelope is known also as the chromosphere, or colored sphere, and may be compared to the lower stratum of the earth's atmosphere. But comparatively shallow as it is, the prominences shoot up sometimes 70,000 miles, in the shape of a cone, or cimeter, and are of various colors, deep red, pink and rich carmine and scarlet. Enormous as the chromosphere is, it is, however, but a thin ligament to the sun, as compared with the outer layer of its atmosphere, designated as

THE CORONA,

which may be likened to the upper atmosphere of the earth, stretching indefinitely outward into space, far beyond the reach of instrumental observation or even mathematical computation. The corona, as intimated, is separated from the photosphere, or light orb of the sun—the orb visible to the naked eye—by the intervening chromosphere, and, as its spectra can also be photographed during an eclipse, the utmost interest attaches to its chemical constitution. Before the eclipse of 1868 occurred—an event ever memorable in the history of astronomy—Kirchoff, by means of the newly-invented spectroscope, had, approximately, discovered the elements of these solar atmospheres, and when the manifold eclipse observations of that year were maturely discussed they sustained his views generally. The result showed that the chromosphere, surrounding the bright, round, solar disk that we see every day, is an envelope composed mainly of glowing hydrogen gas, into which are irequently injected from the body of the burning sun (or photosphere) be neath it and upon which it rests, magnesium, sodium, and occasionally iron and the other heavy metals. The "bright lines" observed on the 18th of August, 1868, told, unmistakably, that the "red flames" or "red prominences," forming the chromosphere, were built up of glowing or incandescent vapor, generated in the ever-fiery breast of the great luminary. But now the question was,

WHAT IS THE CORONA?

This halo of light, outside the prominence-envelope or chromosphere, was the object of intense interest in the next eclipse of 1869, during which the American observers, who had it all to themselves, made numerous and splendid photographs of the corona. In modern science, as in modern war, success has become largely conditioned by the instrumental perfectness of the apparatus used in the field. The needle gun and the rifled cannon have not been more decisive of modern battles than the spectroscope had been of modern astronomic assaults upon the great problems of solar and stellar physics. Between the eclipses of 1868 and 1869, Mr. Lockyer, by the use of improved spectroscopic apparatus, had been able, without the presence of an eclipse, and by mere laboratory researches to verify the results of the observations of 1868; and hence the observations of 1869 were confined mostly to the examination of the corona. The American observations of that year were not conclusive, but they were of very great significance. This magic circle of silvery whiteness, concentric with the solar orb, and forming a halo round the moon during the total eclipse, was shown to be self-luminous and in the main belonging to the sun, and not merely an optical phenomenon caused by the combined action of the sun's rays, the moon and the earth's atmosphere. A faint, continuous spectrum, free from dark lines, but crossed by two or three bright lines told the important story that the corona, like the red prominence-envelope, is also probably of a gaseous nature, forming a widely diffused atmosphere around the sun. Especially was the theory, previously held, that the corona may be due to a lunar atmosphere, entirely dissipated by the American observations, since, had the theory been true, the coronal spectrum should have shown Frauenhofer's dark lines, which was not the case. The conclusion reached by the American observers was then, in brief, that the corona is a highly rarefied, self-luminous atmosphere of the sun, probably composed of the incandescent vapor of iron, at a temperature exceeding 4,500 degrees Fahrenheit. But the great question was not yet settled, and in 1870 another eclipse was observed in the Mediterranean with greater but indecisive success in the determination of the coronal constitution. Dark rays called rifts and streamers were seen in the coronal band, and from the indications some astronomers confidently concluded that a part of it was due to the glare of different layers of solar atmosphere. Another important advance was made in the next eclipse of 1871, when the corona was well photographed. It was now established beyond doubt that it is a solar appendage, whose outer light is stronger in the violet and ultra violet parts of the spectrum than elsewhere, and that above the hydrogen envelope, fainter and cooler hydrogen exists. The chromosphere below was, therefore, proved to be a layer of brighter hydrogen and other vapors. Since the eclipse of 1871 a special investigation of the solar atmosphere has been progressing under the auspices of Professor C. A. Young, conducted at times at an elevation of 9,000 feet in the Rocky Mountains, where the air is so transparent that many celestial objects, small and obscure when viewed from near the sea level, become greatly magnified and more perceptible. Professor Young has found that the vapor of the metal calcium, distinguishable only in a very clear atmosphere, is often present with magnesium in the sun's chromosphere. Hydrogen and the metals of the alkalis and alkaline earths, metals of the iron class, and the presence of such metals as zinc, aluminium and lead have been spectroscopically indicated by these high mountain observations.

Professor Young's mountain observations were taken in the summer of 1872, at Sherman, the summit of the Union Pacific Railroad. He found the unclouded sky exquisitely transparent, and multitudes of stars invisible at lower levels were conspicuous. The spectroscope worked to great advantage, and he found 278 bright lines in the chromosphere, with occasional glimpses of very many more. Sulphur, strontium and cerium were pretty conclusively shown to be constituents of the solar atmosphere, and probably erbium, zinc, iridium and other similar metals. His advantages of observation from this eminence were so encouraging that this astronomer concluded the power of the glasses was increased by twenty-five per cent, and that it might make a difference of years and decades in the advance of astronomy if her new artillery opened its attack upon the heavens from the mountain top instead of the plain.

THE CORONAL ATMOSPHERE,

as Janssen proposed to call it, was then conclusively shown in 1871 to contain hydrogen gas at a lower density than in the chromosphere, and that astronomer's observations went to prove that in the upper atmosphere of the sun there are solid and liquid particles reflecting the sunlight from below, as vapory vesicles of cloud or as smoke. The extreme tenuity of this outer halo may be illustrated by the fact that comets have frequently passed very near and through it, and yet, notwithstanding the lightness of their mass, they have never fallen into the sun. This tenuous cosmical matter, emanating from the solar furnaces and composed of volatilized metals, indigenous in the solar crust, is by no means in repose, but ceaselessly agitated by solar storms and eruptions from beneath. The red flames or protuberances, which carry the hydrogen to the enormous heights of the coronal atmosphere, are peculiarly influential in disturbing it, and may be supposed to exert an influence analogous to that of a great volcanic eruption upon the terrestrial atmosphere. The enormous rapidity and violence of discharges from these

SOLAR ETNAS

have been startlingly stated by Professor Young. During the autumn of 1870 he witnessed a prominence streaming out from the sun, nearly vertically, to the height of 90,000 miles, as determined by a time observation. Though at first very brilliant, in thirty minutes it had faded away, leaving only a few wisps of cloud. On the 7th of September the same year, he saw and recorded an immense solar cloud 100,000 miles long and 54,000 miles high. Having been temporarily interrupted in his work, upon his return to it within half an hour he was astounded to find the whole thing literally blown to shreds by an inconceivable uprush from beneath. Before his interruption, he had measured the altitude of a part of this prominence and found it had attained 200,000 miles above the solar surface. The velocity of ascent he computed was 166 miles a second or nearly 10,000 miles a minute. When we reflect upon such observed phenomena and others witnessed by European astronomers, in which prominences some 40,000 miles high have been shattered to atoms in ten minutes, we get some faint conception of the velocity and force of

SOLAR WINDS AND STORMS.

It is strongly urged by many distinguished scientists that these outbursts of solar energy have their correspondent agitations in the bosom of of the earth's atmospheric ocean. The sun spot period of maximum number and activity, it is claimed, has been shown to correspond with the years of maximum frequency and fury of terrestrial cyclones, showing an intimate connection between our own and the sun's meteorology. Mr. Charles Meldrum, of the storm-beaten island of Mauritius in the tropical belt of the Indian Ocean, has collated an immense number of meteorological and hurricane statistics and compared them with sun spots. He is quite confident that there exists a physical and casual connection between the two phenomena, and he has gone so far as to assert that the whole question of cyclones is a question of solar activity—"many sun spots, many hurricanes; few sun spots, few hurricanes." Whether this generalization be well founded or premature, it is plausible enough to scientific men generally to invest the study of solar phenomena with a novel and utilitarian interest which a purely philosophical inquiry might lack. As a meteorological dogma it will, no doubt, be rejected by the majority of meteorologists, seeing that terrestrial tornadoes are easily accounted for by those periodic alternations of heat and cold, dryness and humidity, high and low barometric pressures, caused by the sun's apparent motion with respect to the earth's equator. But there can scarcely be a question that the sun's varying activity, its vicissitudes of heat and electricity, its eruptive phenomena, within and beyond the chromospheric envelope, do modify the climate of all parts of the solar system. When it becomes possible to ascertain the number and magnitude of the forces at work in the sun and upon its exterior (but not till then), is it likely that the meteorology of our planet will be intelligently connected with that of the sun. This remark, however, can hardly apply to the intercommunication of magnetic indications. The best authorities seem to agree that the greatest

MAGNETIC DISTURBANCES

in the earth's atmosphere are due to terrestrial, and not to solar or cosmical, agency. But various observations attest, that great solar paroxysms correspond with the magnetic storms registered, photographically, by the magnetic instruments at Greenwich, and this correspondence is almost perfect as to time. It is, therefore, probable that every outburst of the sun receives a response from the earth, and that the magnetic impulse is propagated from the one to the other, with the velocity of light. This fact evinces the value of continuous and combined magnetic and sun-spot studies.

THE MOMENT OF TOTALITY.

In the diagram of a total solar eclipse (Figure 3) we have the chief solar phenomena graphically delineated. The dark central body represents the eclipsed sun, at the moment of totality, when the moon comes directly between the earth and the sun. The chromosphere is marked as a very shallow, ill defined envelope around the solar disk, as seen December 22, 1870, at Syracuse, by Captain G. L. Tupman, R. M. A. This quasi-envelope has an irregular demarcation on its exterior edge, presenting a serrated, billowy, uneven surface, heaved up somewhat on its southern side (or upper side as it appears in the diagram). The letters N., S., E., W., show the north, south, east and west limbs of the sun at the moment of total eclipse. The photosphere lies under the chromospheric envelope and is not represented at this stage of the eclipse. The corona is the self-luminous and extensive band or halo of thin solar atmosphere outside of the chromosphere. The red flames or protuberances of the chromosphere, of course, cannot be shown on the diagram, but their relative place as to the corona and the photosphere can easily be understood.

We have now given an outline of the many recent and latest discoveries in the domain of solar physics, enriched, as it has been, but only by slow and fragmentary additions, at a lavish expenditure of toil, study and material resources. It only remains to inquire how the knowledge now had can be augmented through the approaching eclipse observations.

THE PREPARATIONS FOR OBSERVING

the April eclipse are hardly yet mature; but, without such unfortunate weather as was experienced in 1870, the Siam expedition will be likely to secure the best photographic records ever yet obtained. Strange to say, the prospective credit of the April work, whatever it may be, will belong, not to the Europeans, but to the King of Siam, who has taken the initiative in inviting astronomers to his dominions and providing for their entertainment while there. On the 9th of last October His Siamese Majesty, through his private secretary, Bhashakarawangse, extended this courtesy to the Royal Astronomical and Royal Societies and to any astronomers they might accredit to him, for the purpose of utilizing the coming opportunity. Other letters to other societies and to friendly governments have, we believe, been addressed. The English government has appropriated about $5,000 to defray the expenses of its own eclipse expedition and to provide the suitable apparatus, so as to secure the fruit which has been so long ripening and is now ready to drop into the hands of science. The time intervening before the eclipse comes off is short; but the Nicobar and Siam stations can be reached by fast steamers from Calcutta or Galle, connecting with the Mediterranean steamships navigating via the Suez Canal.

The siderostats to be employed by the English have been constructed by Messrs. Cook & Sons, of York, who, it is said, have improved upon the original model of the inventor. The arrangements are no doubt already perfected, and the expeditionary parties on their way to Calcutta.

The French government will be represented by an expedition under control of M. Janssen, the well known astronomer, whose probable destination is Hué. In a very recent letter to the French Academy of Sciences, Mr. Lockyer, of England, writes that the English observations, in the Nicobar Islands and Siam, will be directed mainly "to the spectra of the chromosphere and the coronal atmosphere, with the principal view to determine the chemical constitution of the latter." The same line of inquiry will probably be followed by the French observers.

The latest European intelligence from those interested in the eclipse observations states that Dr. Vogel, the well known Berlin astronomer, will join the outgoing astronomers at Suez and Dr. Janssen at Singapore. The Italians are also to be represented by Professor Tachini, who is already in Calcutta, ready to move to the eclipse stations. The British expedition sailed from Southampton on the 11th of February, in the Peninsular and Oriental Company's steamer Surat, for Galle and Singapore. It is, we understand, a matter of regret to American astronomers that, Congress having made no provision for the United States to take part in the eclipse expeditions, no organized party can be despatched hence in time for the important event. But the fullest preparations and instrumental equipments have gone forth with the European scientists, and all the circumstances are auspicious.

But, among all the circumstances which lend importance and give promise of success never before attained, to the forthcoming eclipse observations, is the proposed application of the new instrument.

THE SIDEROSTAT.

It has been well and beautifully remarked that the barometer "has brought in sight a new country, and has enriched science, not only with new facts, but new principles." The same eulogium may aptly serve to characterize the destined utility of the siderostat. Grand as the results have been, which have been developed by the use of spectrum photography, the latter application is of very limited value unless combined with such an instrument as the siderostat, which is, doubtless, to effect a great revolution in astronomical observation. The coming eclipse is to be the object of its novel and special attack, and the prospect is very exhilarating to astronomers.

The siderostat was devised to enable the observer to escape the inconvenience and often the impossibility of changing his position to follow the eye-piece of his telescope, when turned upon the moving sun or star. With the best telescopic mountings and arrangements which have heretofore been employed, the observer is put frequently in the most uncomfortable positions, and his work subjected to those errors irreparable from the nervous handling of his glasses at the exciting and critical moment of the eclipse. The ingenious scientist, Foucault, the perfecter of the siderostat, aimed to give the equatorial the power of making the entire heavens pass before the observer without his having to disturb himself or to displace the instrument. The siderostat, as arranged by him, is, therefore, a telescope fixed horizontally in an invariable position, before which a plane mirror brings successively the various points of the sky. The whole rests on a brass stand, supported by three screws, with two levels and a regulating azimuth movement. The plane mirror is carried by a horizontal axis on the top of two vertical supports, which revolve round a centre, the movement being perfectly effected by small wheels at the foot of the supports. By the employment of a

CLOCKWORK MOVEMENT,

the isochronous regulator of Foucault, placed at the foot of the instrument, communicates to the plane mirror a motion sensibly equal to the diurnal motion, so that the heavenly bodies maintain invariable positions in the field of the horizontal telescope, in front of the apparatus directed toward the mirror. This clock movement, which has been applied to equatorials, is perfectly regular, and won for its inventor the grand prize in the mechanical arts at the Universal Exhibition of 1867. The apparatus gives perfect steadiness in experiments for measuring the position of spectrum lines and of the displacement of the lines by means of large fixed spectroscopes. Its adaptability has been tested during the recent photographic experiments in connection with the transit of Venus, and with the greatest ease it combines with the observing telescope the apparatus necessary for the work of celestial photography for photometric researches. The complete instrument, telescope and siderostat, placed in the plane of the meridian, may also be regarded as a meridian instrument, so that it is, perhaps, the most powerful weapon of modern astronomy; and, when desired, spectroscopes and photographic apparatus can be attached to the eye-piece of the telescope, of a size even larger than the telescope itself.

The instrumental advantages with which astronomers will study the approaching eclipse, have been maturing since 1860 with great rapidity, and the promised result of the Siam expedition will be the fruit and crown of the work so auspiciously commenced fifteen years ago. The experience now had in photographing celestial objects and in spectrum photography lend an importance to the present undertakings which similar eclipse observations never could have possessed.

THE "AWFUL EVENT."

A total eclipse of the sun is one of the grandest and most awe-inspiring sights it is possible for man to witness. "It is an awful event," says Mr. Lockyer. "One seems in a new world—a world filled with awful sights and strange forebodings, and in which stillness and sadness reign supreme; the voice of man and the cries of animals are hushed; the clouds are full of threatenings and put on unearthly hues; dusky livid or purple or yellowish crimson tones chase each other over the sky, irrespective of the clouds. The very sea is responsive and turns lurid red. All at once the moon's shadow comes sweeping over air and earth and sky with frightful speed. Men look at each other and behold,

AS IT WERE, CORPSES,

and the sun's light is lost." No wonder was it that the great Light Giver of the heavens was worshipped by the Persian followers of Zoroaster, under the symbol of fire, and in the once splendid kingdom of the Peruvian Incas received divine adoration. Well might the poet write in "Manfred":—

Most glorious orb! that wert a worship ere
The mystery of thy making was revealed.

To see this sight blotted out of the heavens still is, and indeed ever must be, appalling; and even the cold-blooded scientist becomes tremulous with nervous emotion. Dreadful as the spectacle is, it appears to be but a faint celestial sign of that yet more dire eclipse—foretold by inspired seers ere the birth of astronomy was celebrated—immortalized in mediæval song:—

Dies Iræ, dies illa
Solvet sæclum in favilla,

which is to come upon the earth, when its history is closed, its destiny consummated, and the "sun shall be darkened, and the moon shall withdraw her shining."

FIG. 1.---THE LAND TRACK OF THE TOTAL ECLIPSE.

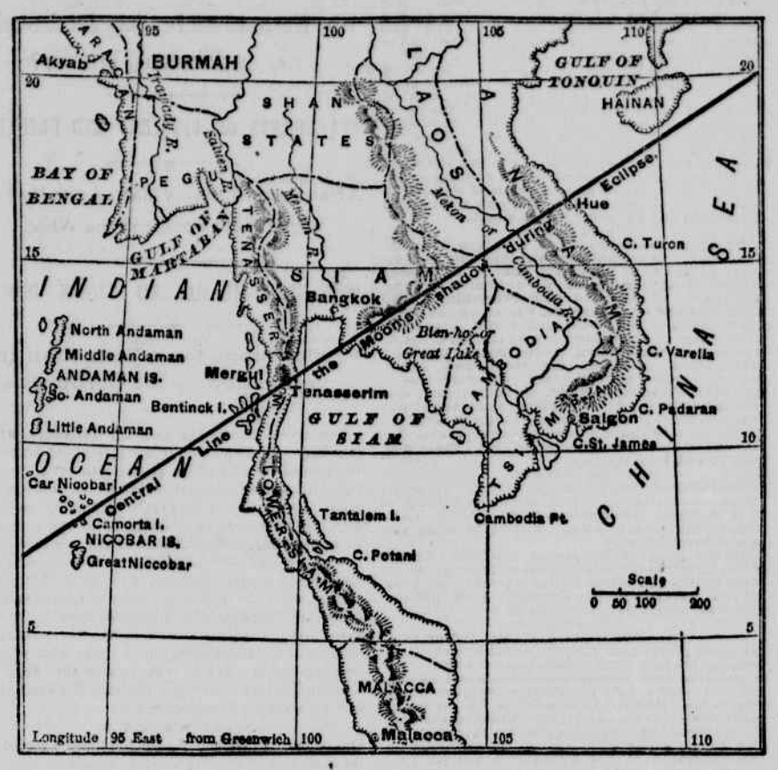

FIG. 2.---THE MOON PASSING BETWEEN THE EARTH AND THE SUN.

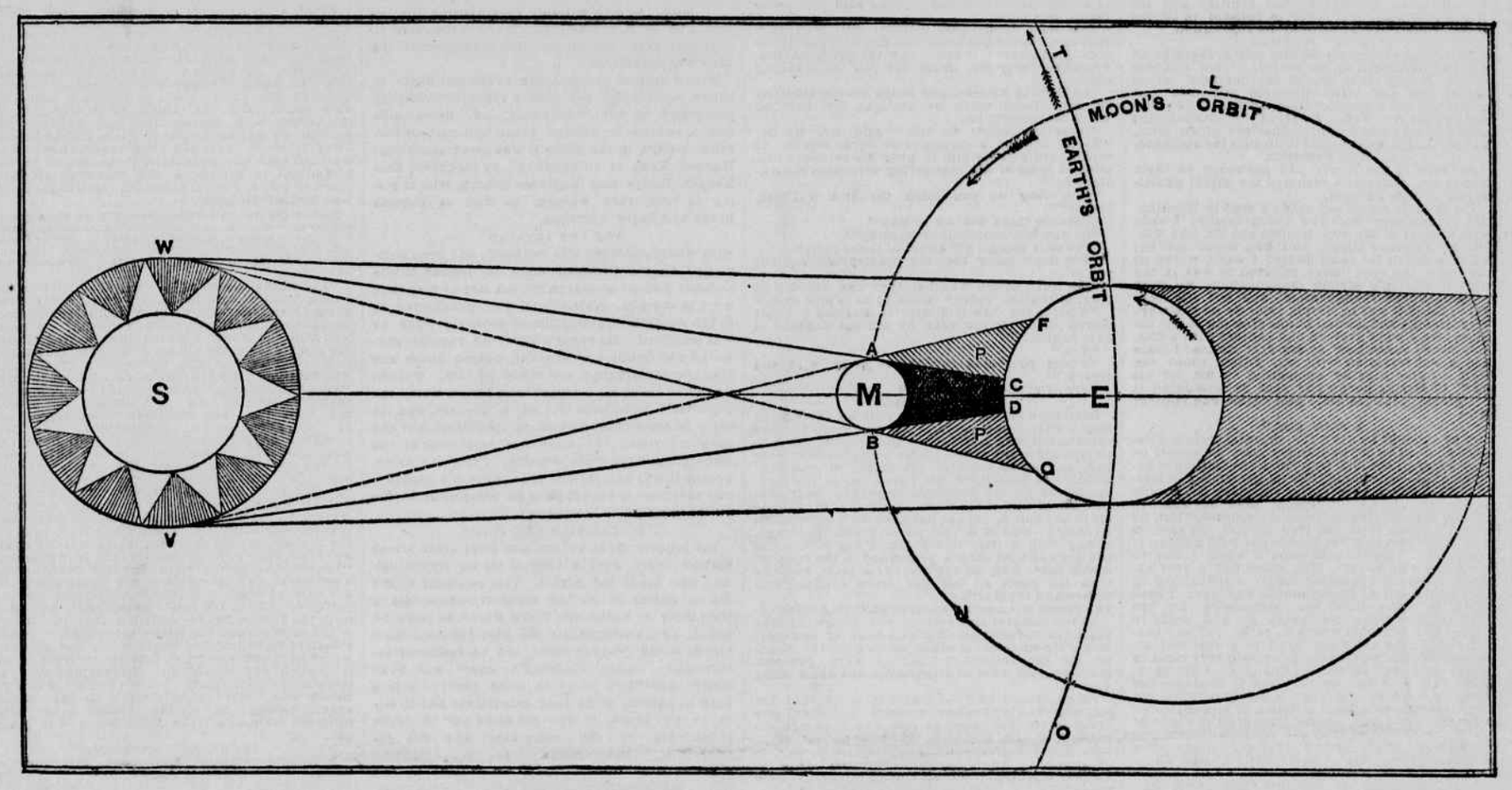

FIG. 3.---THE TOTAL OBSCURATION.