HOW MAN'S MESSENGER OUTRAN THE MOON.

IT came about on this wise — rather complexly.

Sun and moon, types and wires,— astronomy, journalism, and telegraphy, — all were concerned in the contest.

But first, how can any one be certain that the moon really moves at all? We see her in the nocturnal sky, apparently at rest relatively to the stars about her, all seeming to drift together towards the west. After watching for an hour or two, it becomes evident that she has moved easterly among these stars; but the motion cannot be seen in the sky — only the result of it is evidenced in a change of her place.

A few rough observations suffice to show that the moon moves over her own breadth in about sixty minutes; and, as we know that her diameter is about one-quarter that of the earth, it follows that the moon's actual motion in her circumterrestrial path is in the neighborhood of two thousand miles in each hour of time. This velocity is somewhat greater than that of projectiles from the best rifled guns; but these can often be seen throughout their whole flight. Evidently the moon's motion, also, is not too great to be seen. And it can be seen if all conditions favor the observer.

Averaging a period of some decades, there are in three years two opportunities when this spectacle may be seen: they occur only at such times as the moon passes between the earth and the sun and causes a total solar eclipse. But even then it is not strictly correct to say that the moon can be seen traveling through space.

At the time of such an eclipse, however, the moon's dark shadow sweeps over the earth with nearly the same velocity as the moon herself travels; and it is this swiftly flying shadow which the alert observer may see.[1]

This imposing spectacle has frequently been beheld, but rarely unless from an elevation commanding a vast extent. Often, however, expert observers fail to see the almost tangible shadow, even when specially on the lookout for it.

Not strange is it, therefore, that different eyes report so impressive a phenomenon differently. To some the shadow seen in the distance resembled a dark storm upon the horizon. Some saw the shadow "visible in the air"; one speaks of its "gliding swiftly up over the heavens"; while another likens its passage to the "lifting of a dark curtain."

Those who have taken pains to note its color do not generally call it black, but deep violet, or dark brown. One describes it as a "wall of fog," another as a "vaporous shadow," a third says it was "like neither shadow nor vapor," while no less careful observers than Winnecke and Lady Airy speak of the shadow as "appearing like smoke."

From their stations high above the valley of the Ebro, over which it swept, members of the Himalaya Expedition of 1860 had exceptional opportunities for watching the approach and recession of the shadow. Many observers saw it. "When the critical moment was at hand," says one, "the darkness, sweeping over a landscape twenty or thirty miles in extent and advancing right at me, was in the highest degree sublime and imposing." Then and on other occasions it was very distinctly seen.

So much for the appearance of the shadow; but more interesting here is its speed.

While observers generally remark the "frightful velocity" with which it travels, President Hill of Harvard, in Illinois in 1869, found the transit of the shadow much slower, and more majestic and beautiful than he had been led to expect. "A sweeping upward and eastward of a dense violet shadow," are his words.

General Abbot, ascending Mount Ætna in 1870, wrote: "At an elevation of 7500 feet I was overtaken by the shadow, which swept with great rapidity over us, darkening the gloom to an awe-inspiring degree."

One of the best opportunities in more recent years for witnessing this spectacle fell to the lot of a small party of observers who clambered to the summit of Mount Santa Lucia in California in 1880. The track of the eclipse that year was similar to that of last January, only lying farther to the south; and the shadow

1 While the shadow is sweeping easterly across the globe, the earth itself by turning on its axis carries along the observer in the same direction; so that at the equator the velocity of the shadow relative to the observer may be reduced a half.

swept in from the Pacific Ocean, trailing over this mountain, which is nearly 6000 feet high and only a few miles from the coast. The skies were clear, and there could be no mistake. Among the astronomers were Professor Frisby of Washington and Professor Davidson of San Francisco. From this elevated spot all the observers saw the shadow advancing over the ocean as a dark brown area on its surface. However, it had not, says Professor Davidson, "the density and impressiveness of the shadow I saw in Alaska in 1869, coming down the valley of the Chilkaht, when it was visible on the flanks of the mountains and against the snow gorges."

Can man's fleet messenger, the telegraph, outstrip this rushing shadow? And will any advantage result if it can?

Evidently the odds are largely in favor of the electric messenger, as the actual speed is many thousand-fold greater than the motion of the moon. But while the moon moves steadily onward, telegraphic dispatches are often subject to sundry and irregular detentions; so that there may well be doubt as to which may outstrip the other when both are matched together on the racecourse of space, as it were. If the telegraph can win the race, many possible benefits appear on slight consideration.

These trails of the lunar shadow across the terrestrial landscape are usually more than a hundred miles broad, and their length often exceeds five thousand miles.

It is apparent that the eclipse cannot be total at the same time everywhere along this track; as the moon journeys eastward, its shadow following it, the eclipse may be total near the west end of the trail more than two hours (world time) before it becomes total near the eastern extremity.

If the astronomers near both ends of the shadow-track are in telegraphic communication, these may become moments of supreme significance.

An important observation, a discovery possibly, may be made by an observer whom the shadow first meets; it may be months, perhaps years, before another eclipse will happen with all conditions favorable for the verification of that discovery. But if the telegraph is called in as an adjunct, new light may be available at once, and without waiting for another eclipse. By telegraphing the nature of the observation eastward to a fellow-observer, the discovery may be confirmed forthwith, or the observation, if doubtful, may be rejected.

More than a decade has elapsed since I first brought this novel project to the notice of astronomers. This was during the eclipse of 1878, when the moon's shadow swept southeasterly across Wyoming and Texas. Professor Newcomb observed the eclipse in the former Territory, and my own station was in the latter State. Intra-Mercurian planets were then favorite search-objects, and we had concluded an arrangement with the telegraph company to forward any message from the northern station to the southern one with all possible dispatch. But no opportunity appeared for the practical test on this occasion.

Four years later a case not wholly supposititious arose. The astronomers who went to Egypt in 1882, to observe the total eclipse in May of that year, took a photograph of the region surrounding the sun. To their great surprise, on developing the negative, a faint comet made its appearance alongside the corona. This object had never been seen before, nor has it ever been seen since; consequently nothing is known of the size and figure of its orbit, or of its position, or whether the comet will ever return to the sun again or not.

But it is easy to see how the telegraph may render important service on a similar occasion in the future. By telegraphing eastward to an astronomer where to find it, an observation of the comet two or three hours later may readily furnish data sufficient to indicate where to look for the stranger as it recedes from the sun. Subsequent observations thus may enable the astronomer to determine all the elements of its orbit with precision.

Any one acquainted with the conditions of this duplex problem of astronomy and telegraphy will at once recognize the practicability of the project of telegraphing ahead of the moon; and this was demonstrated upon occasion of the total eclipse on New Year's Day.

The engraving gives a glimpse of celestial perspective, so conventionalized as to come within page limits. Here are the sun and its corona, the moon and the earth. On the latter the artist has rolled back the cloud curtain to give all observers a clear view of the eclipse.

The track of total eclipse is shown as a darkened area crossing the Pacific Ocean, and curving northward from California to Manitoba.

To lessen the artist's difficulties, and to heighten the pictorial effect, our engraving shows sun and moon standing nearly over that region of the earth where the eclipse was visible. Had it been possible to represent these bodies correctly, the line joining the centers of the sun and moon would have been a tangent to the earth's surface at that point in the British Possessions where the eclipse-trail ends. This line thus becomes less and less inclined to totality-path as the end of it is approached;

consequently the apparent velocity of the shadow is all the time increasing until it leaves the earth. Over the plains of Manitoba its speed was no less than five times that of a rifle-shot.

The curvature of the eclipse-track is partly due to the curved surface on which it is projected, and partly to the earth's axial turning as the lunar shadow sweeps over it.

As shown in the engraving, the total eclipse was visible in the eastern part of California, the shadow having just passed over the point occupied by the Harvard University Observatory party. This point was Willows, California, and the artist has represented it in direct telegraphic connection with New York.

Here was located the most complete collection of photographic apparatus ever brought to bear upon a solar eclipse: cameras for photographing the corona on every scale, from the largest to the smallest, spectroscopes for a thorough analysis of the coronal light, photometers for measuring its intensity, a large telescope for photographing all the stars in the neighborhood of the sun, so as to detect the suspected Intra-Mercurian planet, together with a great variety of accessory apparatus.

The immediate reporting of the eclipse observations at Willows and elsewhere was a matter of great scientific interest to astronomers in both hemispheres. It could not, however, be successfully accomplished without very careful pre-arrangement with the observers themselves; and the enterprise of the "New York Herald" was accordingly invoked in executing the plans which I had elaborated.

First, a complete list of the instruments of every observer, and the work he purposed to do with them, must be prepared. Weather probabilities were everywhere very unsatisfactory, there was a possibility of all degrees of success or failure. Accordingly the problem was to arrange for each station a cipher code, which should include, as minutely as possible, all the likely combinations of instruments, weather, and results on eclipse-day.

About one hundred words were found sufficient to embrace the complete cipher. A part of the code for Willows is given here:

Africa.	Perfectly clear throughout the whole eclipse.
Alaska.	Perfectly clear during totality.
Belgium.	Clear sky for the partial phases, but cloudy for totality.
Bolivia.	Entirely cloudy throughout the whole eclipse.
Brazil.	Observed all the contacts.
Bremen.	Observed three of the contacts.
Ceylon.	Made observations on the shadow-bands.
Chili.	Observed lines of the reversing layer visually.
China.	The corona showed great detail.
Cork.	Obtained 40–50 negatives during totality.
Corsica.	Obtained 50–60 negatives during totality.
Crimea.	Obtained 60–70 negatives during totality.
Cuba.	Observed a comet.

And so on through a great variety of detail, not the least of which was the capability of the cipher to indicate with sufficient accuracy the position of any Intra-Mercurian planet which the photographs might disclose.

Between twenty and thirty codes had been prepared on a like plan for as many stations, and the observers were instructed to report the results of their work in cipher at the earliest available moment, employing the ordinary telegraphic facilities.

In rehearsing the programme it occurred to me that in receiving so many cipher dispatches great delays were at least possible; and that through no fault of the telegraph company. In only a single way could the arrangements be improved: were a special wire available in direct circuit from New York to the eclipse-stations in turn, our chances of success would surely be bettered, not only in gathering the eclipse reports, but also in proving the practicability of telegraphing ahead of the moon.

I outlined my plans to the Western Union Telegraph Company, and asked for the use of a special wire to the more important eclipse-stations, for the purpose of immediate and rapid communication of the observations. To this request the general manager of the company acceded very heartily.

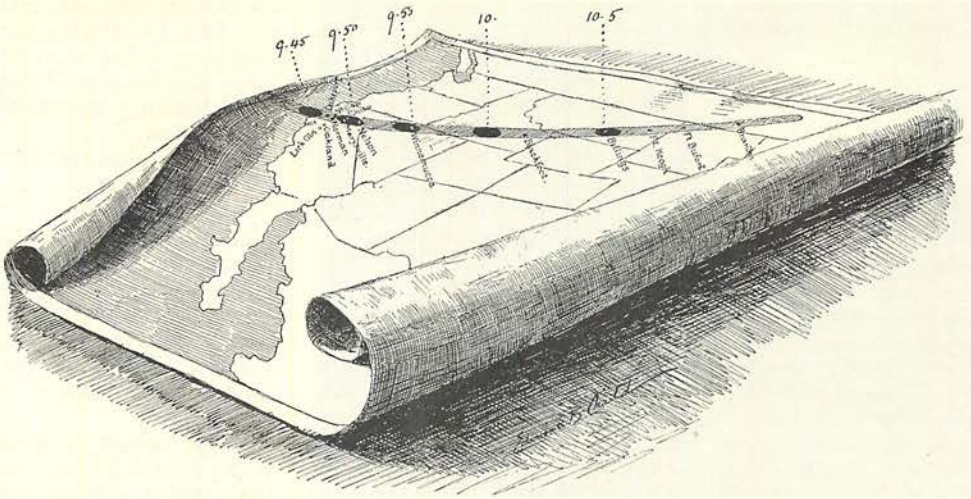
A New York-San Francisco wire was placed at my disposal, and a loop, as the telegrapher calls it, or branch wire, was let across Broadway from the Western Union building to the editorial rooms of the "Herald."

From San Francisco every California station was within easy telegraphic reach, and our wire thus extended by direct circuit to each eclipse-station in turn. From the editorial rooms of the "Herald" I was in immediate communication with the observers at any eclipse-station which I chose to call.

As previously intimated, I had arranged with the Harvard astronomers at Willows to receive their message first and with the utmost dispatch, purposing to test the practicability of outstripping the moon in its motion through space.

Shortly before five o'clock in the afternoon the dispatches began to come in. Of course we have to allow for a slight delay in reporting, owing to the fact that the observers at the various stations were some rods distant from the local telegraph office, and that it would take a few minutes after the eclipse was over to prepare the suitable message from the cipher code.

On the astronomer's table were a large map and a chronometer. The latter indicated exact



THE TRACK OF THE ECLIPSE JANUARY 1, 1889. SHADED ELLIPSES SHOW POSITION OF SHADOW CONE AT INTERVALS OF FIVE MINUTES, GREENWICH TIME.

Greenwich time, and the former showed the correct position of the moon's shadow at the beginning of every minute by the chronometer. In this way it was possible for me to follow readily the precise phase of the eclipse at every station. About the rooms and accessible for immediate use were arranged the cipher codes pertaining to the several stations, and other papers necessary in preparing the reports for the press.

In a sketch here reproduced from the map is shown the eclipse-track, with the position of the moon's shadow at intervals of five minutes of Greenwich time. Also the same map shows the location of many of the observers who had been requested to send their reports for publication in the "Herald."

The eclipse was to become total at Willows at 9h. 48m. Greenwich time.[1] Our direct wire had been fully tested an hour before.

At about 9h. 30m. the operator there was called up and asked the state of the weather. He replied that it was already getting quite dark, that the sky was perfectly clear towards the south-west, and that there was no cloud anywhere near the sun. We therefore (in New York, 3000 miles away) knew what capital opportunities awaited the Harvard astronomers, even before they had themselves made the observations.

The moon's shadow then lay out on the Pacific Ocean. Rapidly it rushed along, the total phase came on at Willows, the sun's corona flashed out for nearly two minutes and then disappeared. Totality was over at 9h. 50m. and the shadow swept swiftly eastward, affording other astronomers a brief glimpse of the sun's surroundings.

After a short interval, Mr. Pickering, the chief of the Harvard party, had come to the telegraph office at Willows and had begun to send a dispatch announcing the general success of the entire expedition. The first three words of the cipher dispatch — *Alaska, China, Corsica* — came hurriedly over the line, then the circuit of our wire was lost!

Meanwhile the moon was getting a long way the start in the race — the eclipse was already total in Idaho.

The break in our long line was soon located somewhere between Utah and California, but more than half an hour elapsed before the circuit was reëstablished and the remainder of the dispatch could be received.

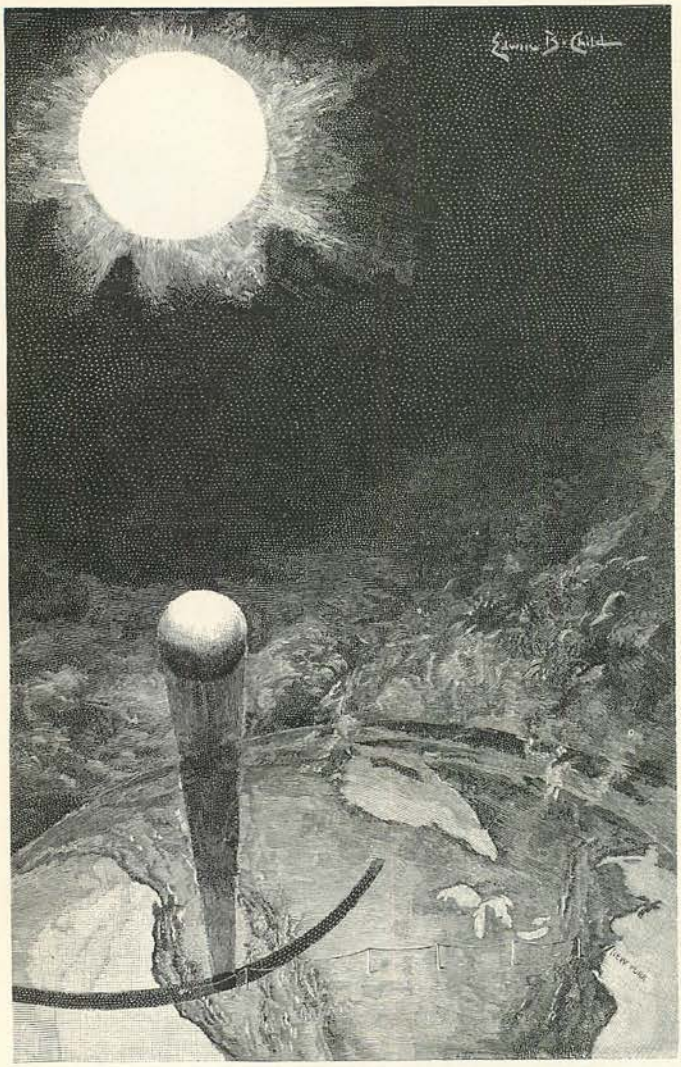
The lunar shadow had meantime advanced over Montana and Dakota and had left the earth entirely, sweeping off again into space. But I was still hopeful that the telegraph might win the race. Had New York been located in the eclipse-path as well as Willows, and both stations symmetrically placed, the total eclipse would have become visible at New York about an hour and a quarter after the shadow had left California.[2]

Thus there was time to spare. Having recovered our wire, Mr. Pickering's message was completed at 10h. 36m., and the stenographer's notes were written out and dispatched to the composing-room six minutes later.

The "copy" was quickly put in type, a proof was pulled, and at 10h. 50m. it was placed in my hands, exactly an hour after the observations had been made at a station nearly 3000 miles away.

[1] This was 4h. 48m. Eastern standard time, and 1h. 48m. Pacific time.

[2] The curvature of the earth reduces the absolute time of transit of the shadow between two widely separated places nearly a half.



THE LUNAR SHADOW.

Had the moon's shadow been advancing from California towards New York, there was still a margin of several minutes before the eclipse could become total at the latter place. In point of fact, while the proof-sheet of the first message was being read the lunar shadow would have been loitering among the Alleghanies.

Man's messenger had thus outrun the moon.

The telegraphic reports of the observations at the other stations were gradually gathered in and put in type, and the forms of the "Herald" were ready for the stereotyper at the proper time, some two hours after midnight.

At 3 o'clock A. M. the European mails closed, and the pouches put on board the *Aller* carried the usual copies for the foreign circulation. Within twenty-four hours after the observations of the eclipse were made by the astronomers near the Pacific coast the results of their work had been telegraphed to the Atlantic sea-board, collated and printed, and the papers were well out on their journey to European readers.

An eclipse-track covering an extensive region accessible by telegraph, costly and delicate instruments and a multitude of trained observers, liberal officials willing to afford every facility of a vast telegraph system, enterprising journalists ready to undertake a unique piece of news-gathering, and withal skies everywhere propitious—these are conditions never before met, and which only the rarest of fortune can completely fulfill.

David P. Todd.

SECURITY.

I KNOW a flower that never need feel dread
Of being picked: the fairest flower of May,
It fears henceforth no stranger's dangerous tread.
Why? Oh, because I picked it yesterday.

A. W. R.