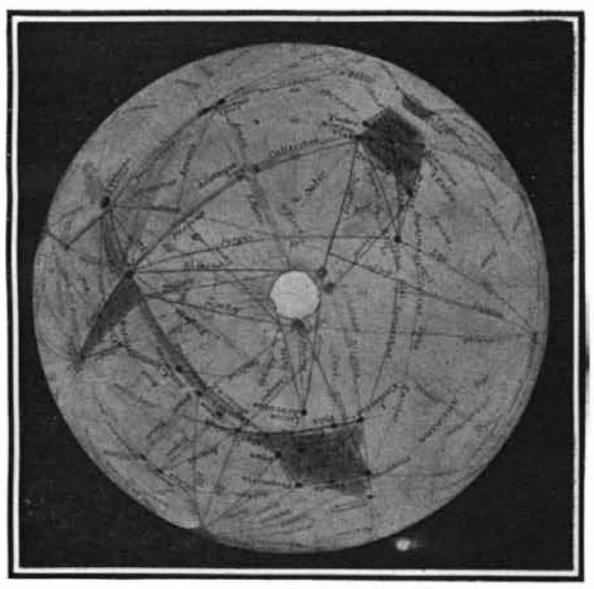
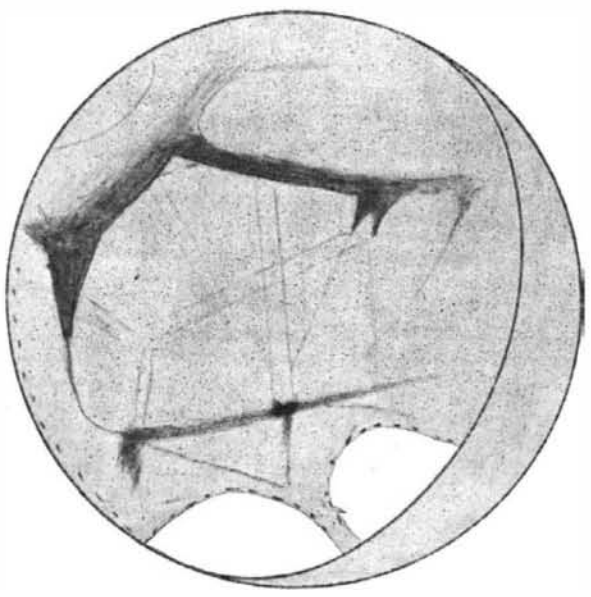
THE RIDDLE OF MARS.*

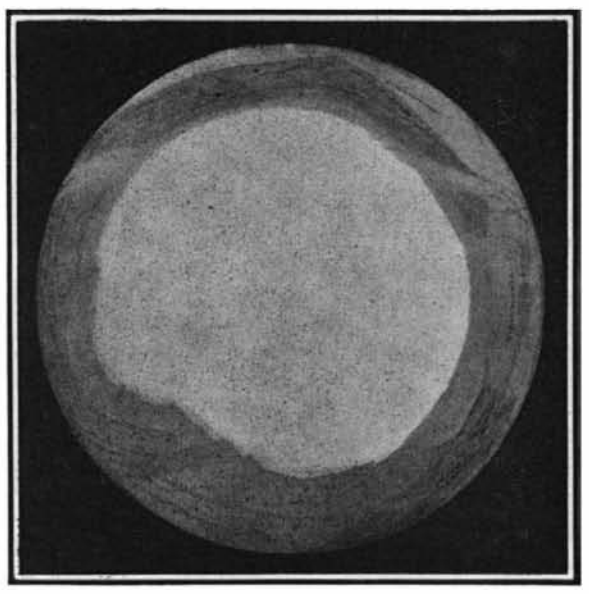
Whether or not astronomers agree with Prof. Lowell's Martian theories, it cannot be denied that he has been by far the most indefatigable observer of our planetary neighbor. His studies have been elaborate and painstaking, and have involved not only the expenditure of years of time, but the erection of a private observatory in an atmosphere peculiarly fitted for his work. Based upon this foundation, any book of his on the subject deserves somewhat more consideration than the passing review which usually falls to the lot of a popular exposition of an important scientific investigation.



The North Polar Cap of Mars.



The Double Canals of Mars.



The South Polar Cap of Mars.

In the first place, Prof. Lowell is a staunch believer in the habitability of Mars. His conclusions, reached after a minute study of the puzzling surface markings of the planet, are based on a wealth of ingenious reasoning that cannot but appeal to the romantically inclined. In the following brief paragraphs we have endeavored to present in succinct form the theory which Prof. Lowell has formulated, and the plausible arguments he has advanced to uphold that theory.

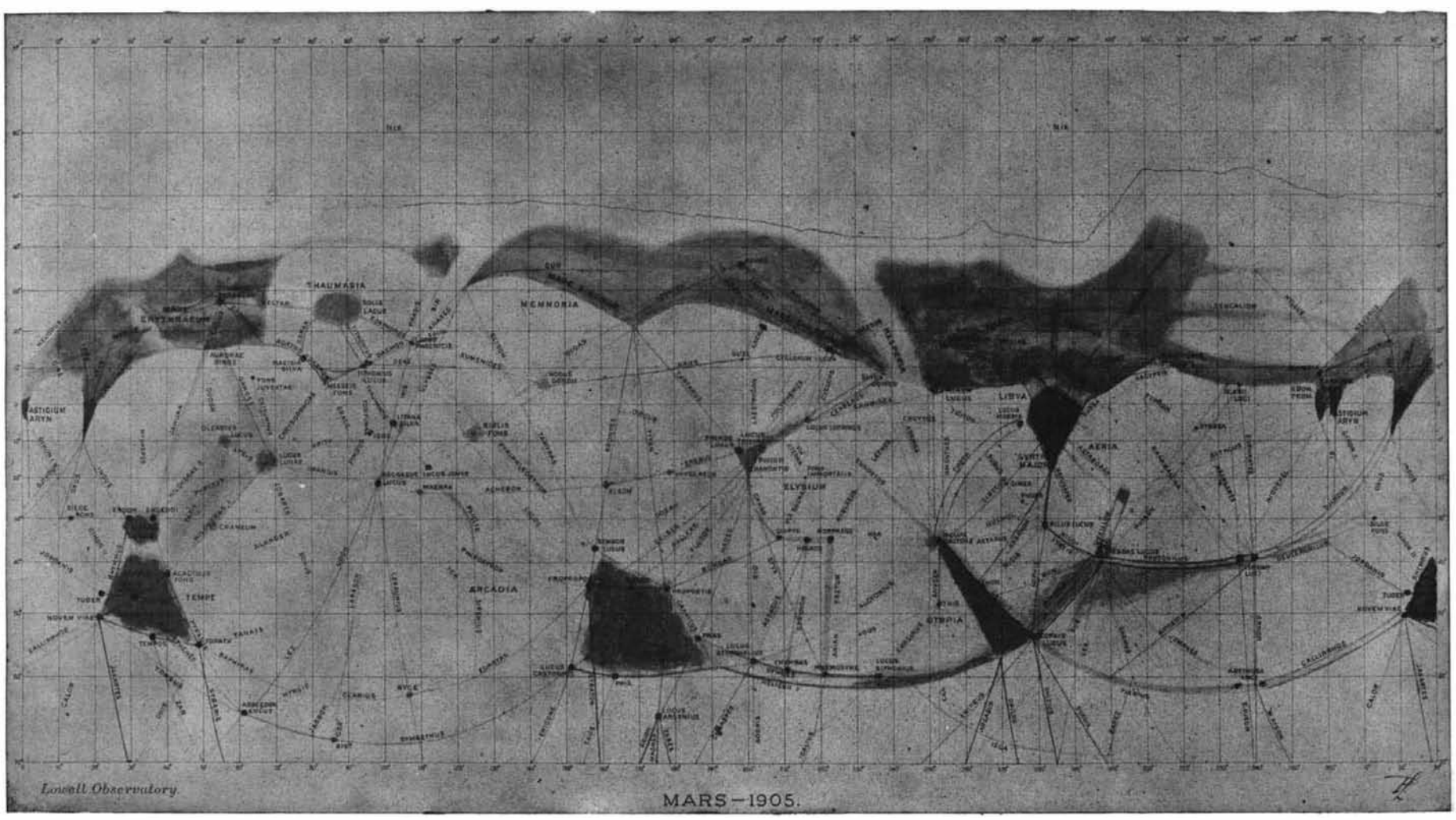
Viewed through a telescope, Mars appears as a disk crowned with white spots and covered with blue-green and reddish ocher patches. Upon the fluctuations of these markings Prof. Lowell bases his conclusions of the habitability of the planet. Most prominent of all the markings are the white spots that cap the poles. They are the most important evidence of the planet's constantly changing condition, for they come and go just as our own polar snows wax and wane. In the depth of winter they stretch over much more than the polar regions, extending down to 60 degrees and even to 50 degrees of latitude north or south as the case may be, then dwindling until, by midsummer, they extend only 5 or 6 degrees across. A three-inch glass is sufficient to disclose these modifications. It was early surmised that Martian caps must be composed of ice and snow, a theory which Prof. Lowell substantiates by pointing out that as the Martian cap melts it is surrounded by a deep blue band, which keeps pace with the shrinking cap and is clearly the product of its disintegration. This ribbon of blue conclusively shows that not gas but water is the substance of which the caps are composed.

If the caps melt, they must clearly pass into a gas, which means that Mars must have an atmosphere. That atmosphere, it is safe to conclude, is composed primarily of water vapor. Corroborative evidence of the presence of Martian air is shown by the existence of clouds, rare though they may be. Other evidence is afforded in the limb light, a phenomenon which may be described as a brilliant obliteration near the edge of the disk, an obliteration which suggests a veil drawn between us and the planet, and which can be caused only by air or haze. Evidence has also been gathered of the existence of a twilight, which would indicate the presence of a thin high air more rarefied than prevails on our highest mountain peaks. That the atmosphere must be thin is proven by the uninterrupted view of the Martian disk in all zones.

Of the blue-green and reddish ocher patches to which reference has been made, it may be stated in a general way that of the two the reddish-ocher tint predominates, occupying as it does, five-eighths of the disk. Early in the history of Martian observation the blue patches were taken for seas, and received names in keeping with the conception. Thus, we have the Sea of Serenity, the Sea of Vapors, and the like. The initial doubt of their watery nature was cast by their change in aspect, a change first noticed by Schiaparelli. The *coup de grace* to the old belief was given when Pickering and Douglass found that the dark areas were traversed by permanent lines. If the blue-green areas are not seas, what are they? According to Prof. Lowell, only vegetation can account for their singular fluctuations. He finds that in their color (blue-green) the dark areas exactly typify the distant look of our own forests. If the changes are vegetal, they must occur at the proper season of the planet's year. Generally speaking, it may be said that certain regions pass from ocher to blue-green in a few weeks at a season corresponding with the Martian spring. Conversely, the blue-green regions are converted into ocher with the coming of autumn. Mars owes its fiery tint to the great ocher stretches. Land the ocher regions have generally been taken for, and land they undoubtedly are. Indeed, they seem to be nothing but deserts. Their pure salmon hue is characteristic of the Sahara desert and of the desert of northern Arizona.

By far the most distinctive surface markings of the planet Mars are the curious streaks originally discovered by Schiaparelli and called by him "canali." They suggest a spider's web overspreading the disk of Mars. So geometric are the lines that Schiaparelli said of them, they seem to have been laid down by rule and compass. Moreover, the lines run straight throughout their course for the most part, and where they are not straight they are symmetrically curved. Equally striking is the uniform width of each line

* Mars and Its Canals. By Percival Lowell. Illustrated. The Macmillan Company. New York and London, 1907. Octavo. Pp. 393.



MARS AND ITS CANALS. A MAP MADE ON MERCATOR'S PROJECTION BY PROF. PERCIVAL LOWELL.

from its beginning to its end. Each line seems like a telegraph wire stretched from point to point. The precise width of the canals is not determinable, although certain comparative measurements made by Prof. Lowell lead him to the conclusion that 15 to 20 miles is the width of the larger of the Martian canals, and 2 or 3 miles that of the more diminutive. The length of the canals is certainly enormous. A length of 2,000 miles is not uncommon. At its terminal each canal meets other canals which have arrived with the same directness from other places. Not two, but three, four, five, and six may gather in a single point. The result is a network which triangulates the surface of the planet. To Prof. Lowell the canals are not fortuitously placed. That lines should thus meet exactly and in numbers at particular points, and only there, shows, in his eyes, that their position is not governed by accident. If very thin rods be thrown haphazard over a surface, the chance that more than two will cross at the same point is vanishingly small. Some law working to an end underlies the position of the Martian canals, according to Prof. Lowell. The departure points of the canals are not scattered haphazard over the surface, but bear general relations to its definite features. The lines emanate from well-marked indentations in the dark regions fitted by natural position for departure points, and are locally dependent upon the general topography of the fundamental features of the surface. For some reason they connect the very points most suggestive of intercommunication.

Puzzling as the straightness of the lines undoubtedly is, still more puzzling is their peculiar habit of doubling, a phenomenon also discovered by Schiaparelli. By means of the finest spider threads that could be secured, micrometric estimates of the distance between the two elements of a double canal were made at Flagstaff in 1905. The typical double canal, the Phison, is roughly speaking, 2,250 miles long; the distance between the centers of the two lines is about 130 miles, and each line is, perhaps, 20 miles in breadth. Bi-lateralism, however, is not a universal trait of the canals. Out of the 400 seen at Flagstaff, only 51 have at any time doubled; that is, one-eighth, roughly, of the whole number observed. In spite of possessing the property of pairing, a canal may not always exhibit it. The proper time is necessary. A canal seen single at one season may double at another. It appears that in some cases certainly, and possibly in all, the dual aspect is not a temporary condition, but a permanent state marked with varying intensity, the fact of "gemination," so called, being confined to a filling out of what is always there in skeleton. When the two lines of a canal differ, it is always the same one that outdoes its fellow in conspicuousness. We may, therefore, call it the original canal, the other being dubbed the duplicate. Prof. Lowell concludes that the phenomenon of variable visibility of double canals is partly seasonal and partly dependent upon the canal's position on the planet.

Seventeen years after the recognition of the canals in the light regions, canals were discovered in the dark regions. These canals left the edge of the blue-green "continents" at the very points where the canals of the light regions entered them, which continuation is highly significant, since it links the two together into a single system, compassing the whole surface of the planet. The canals run at their northern ends into dark spots at the edge of the polar cap. Here we have the end of the whole system, or more properly its origin in the polar snows.

The last phenomena to be considered in enumerating the surface markings of Mars are the so-called oases—dark, round spots toward which the canals converge in groups of three, four, five, and more. Of the spots three kinds may be distinguished: the large, the little, and the less. To the kind called the large belong the greater number of spots so far found upon the disk. According to Lowell's latest determination, the large spots measure from 75 to 100 miles in diameter. They look like sizable black pin heads sharply pronounced against the ocher stretches and even prominent in the midst of the dark areas. They all seem to be round. The little spots are distinguished from the large by being pin points instead of pin heads. They vary from 15 to 25 miles in diameter. The large spots are the places of intersection of the largest and most numerous canals, while the small spots are the terminals of the fainter lines. Hence spots and lines are connected not simply in position, but in size. In the case of a double canal, the spot is exactly embraced between the two arms of the double canal, fitting in snugly between the parallel lines. Many spots lie close together, and may be taken as double oases. Their relation to the canals which run into them is most complicated. No less than seven double canals converge in twin spots. The canals converge to the places occupied by the spots, and do not cross haphazard according to the laws of chance.

In 1894 Prof. Lowell detected a set of markings which have since been seen again. The markings in question consist of triangular nicks in the coast line of what were once thought to be the oceans. The nicks have the general form of carets, such as the markings one makes in checking items down a list. These carets punctuate points where canals are to show, or indicate terminals of those that already exist. In every case one or more canals leave the caret for their long journey down the disk. Difference of altitude, according to Prof. Lowell, is concerned in their constitution. The canal system falls to a lower level at the carets and triangular spots instead of round ones are the result.

Prof. Lowell devotes an entire chapter to the photographing of the canals by Lampland in 1903, a feat for which the photographer deserves all praise, inasmuch as it disposes forever of any theory based upon the supposition that the canals are optical illusions induced by eye-strain or the like.

The canals undergo fluctuations of a periodical nature. Sometimes they disappear temporarily. On occasion canals and whole regions appear to be blotted out. Each canal has its own times and seasons for exposing and concealing itself. Seasonal changes seem the only explanation for the phenomenon. The canals begin to develop after the greatest melting of the polar cap has occurred. This development proceeds down to the equator, and then not stopping there advances up the latitudes of the other hemisphere. In the Arctic region development is arrested as it begins to get cold there, the most northern canals being affected first. A similar wave of evolution occurs from the opposite pole some time before and passes away. To Prof. Lowell, the disappearance is due to the withering of vegetation in the autumn. Similarly, the reappearance of the canals is accounted for by the growth of new vegetation in the spring.

The oases are also subjected to change, and apparently in the same manner as the canals. They grow less evident at a like season of the Martian year, decreasing gradually in size. Like the canals, latitude together with the suitable season of the planet's year are the determining factors of their development. Each polar cap runs through a gamut of change in a Martian year; the canals also complete their cycle of growth and decay in a Martian twelvemonth. The only difference between the two is that each polar cap has but one maximum and one minimum in the course of this time, while most of the canals have two of each, though neither the maxima nor the minima are alike. Not only is the period of the two series of changes the same, but the one follows the other; for the development of the canals does not begin until the melting of the polar cap is well under way. As the polar cap disintegrates it gives rise, as we have seen, to a dark belt of blue-green, which fringes its outer edge and retreats farther as it shrinks. After this belt has been formed, the canals nearest to it proceed to darken, and those a little farther off follow suit, and so the wave of visibility rolls in regular routine down the disk. Here, then, at the outset, we have a chronological connection between the two phenomena; disintegration of the cap after integration of the canals.

The caps are undoubtedly composed of water. The development of the canals may further be ascribed to the unlocking of the polar snows. Considerable time intervenes between the disappearance of the cap and the appearance of the canals. A quickening due to vegetal growth would produce the counterpart of what we see. If we suppose the water accumulated in the cap to percolate toward the equator, starting vegetation in its course, this would explain the increased visibility of the canals, and at the same time the seeming delay by allowing for the time necessary for this vegetation to sprout. This explanation is certainly most satisfactory. The vegetal quickening would pass down the planet's surface, and give rise to what we characterize as seasonal change.

It appears that much at least of the surface of Mars has two seasons of vegetal growth, the one quickened by the north polar cap, the other by the south. How far the polar spheres of action overlap it is not possible at present to tell, as the canals at the last opposition were visible only to 35 degrees south latitude.

If vegetation exists on Mars, as Prof. Lowell would have us believe, we are at once introduced to the probability of life on that planet. The existence of a flora is ground for suspecting a fauna.

From the standpoint of any planet, the evidence of animal existence must be difficult to detect. Not until the creatures have reached a certain stage in evolution will their presence become perceptible; and not then directly, but by their handiwork. When the animal has learned to dominate nature, he will betray his existence. If we could view the earth from a distance of 35,000,000 miles, the distance which separates Mars from us during this month of July, we should know ourselves by our geometrical design. The great wheat fields of Kansas and Dakota, fields turning in hue for miles with the rhythmic procession of the seasons, would impress us. On Mars we find ourselves confronted in the canals and oases by precisely the appearance which the planet should show if it is an inhabited world. Here in these straight lines and rounding spots we have spread out our centers of effort and our lines of communication; for the oases are clearly ganglia to which the canals play the part of gulfs. The strange geometric arrangement proves inexplicable on any other hypothesis. Dearth of water is the key to the character of the canals. The only available water on Mars is that coming from the semi-annual melting at the one or the other cap of snow. Vegetation cannot start until this water reaches it. Consequently, though the sun be ready, vegetation must wait on the coming of the water, and starting from near the pole, proceeds equatorward. As a planet ages it loses its oceans, and gradually its whole water supply. Life upon its surface is confronted by a growing scarcity of this essential to existence. That is the condition of Mars. If there are intelligent beings on Mars, they must find some means of conducting the scant supply of water from the poles to the centers of population. Such signs of conscious interference with nature Prof. Lowell finds in the canals. The canals are drawn with such mathematical precision that to him they seem designed for the purpose.

In support of this theory he argues that the positions of the canals with regard to the main features of the disk are remarkable. The lines not only leave important geodetic points, but they travel directly to equally salient ones. Oases are found only at junctions of the canals, which, in Prof. Lowell's opinion, proves that they are the terminal points of the canals.

Most remarkable is the system which the canals form. They are most wonderfully inter-connected. The system covers the whole surface of the planet, dark areas and light areas alike, in a way that renders impossible the supposition that any natural force produced the canals. The system, after meshing the surface in its entirety, runs straight into the polar caps. To Prof. Lowell it is an irrigation system whose aim is the tapping of the snow caps for the water there released, and then its distribution over the Martian disk.

Savage Eyesight.

Many people believe, because they have read in books, that the sight of the Indians was extraordinarily keen, and that they were able to descry objects at a greater distance than was possible for white men. This is an error, if the assertion is to be taken without qualification. All savages have eyes trained to see those things that are necessary to their preservation—game and enemies. Their sight is not by nature more acute than that of the white man, but in some respects it was better trained. The whites who lived among the Indians and were compelled to defend themselves against their enemies saw just as far as their enemies. It may be affirmed as a general principle that there is nothing a civilized man cannot do better than a savage. The latter uses his reason to aid his instinct; the former makes his instinct subservient to his reason. It is well known that sailors are able to discern objects at sea at a greater distance than landsmen, but we have to do here with a faculty that any one can acquire. The Indians did just what the whites who lived among them did who subsisted on game and were obliged to be on the constant lookout for enemies. Both had acquired not merely the power to discern objects, but also training in the interpretation of the signification of those objects that came within visible range. It is probable, for reasons given above, that not only the Indians as well as all tribes living on the same social level, but also the backwoodsmen, retained their sight to a more advanced age than is now generally the case; but that the eye of the former was naturally more powerful than that of the present generation or that of men in general is unsupported by trustworthy evidence. There is no doubt that a child born with normal eyes in one of our large cities can see objects just as far off and define them just as accurately with proper training as a person who never saw a dozen houses together. It is well known, too, that what are sometimes called the lower senses—touch, taste, and smell—are often of extraordinary acuteness in civilized man as the result of training. If, therefore, any of the senses of our urban population is feebler than that of the dwellers in the rural districts, it is not due to an inherent weakness, but to improper or injudicious use.—Dr. C. W. Super in the Popular Science Monthly.

An experimental railroad for testing signaling devices, materials used in track construction and different types of motor cars for railroad use, has been built by the railway department of the German government. The road is double-tracked and is oval-shaped, having a length of 5,760 feet. The straight track is about 800 feet long.—Engineering Record.

Photographing the Canals of Mars.

Prof. Percival Lowell, Director of the Lowell Observatory at Flagstaff, Ariz., has telegraphed as follows to the Harvard College Observatory: "Todd of the Lowell expedition to the Andes cables Mars canals photographed there by Slipher."