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REPORT ON MARS, NO. 29.

By WILLIAM H. PICKERING.

INTRODUCTION.

The apparition of Mars in 1922 was noteworthy in that at the time when the planet was nearest to the earth, on June 18, it was nearly as far south of the equator as it is possible for it to be. It was then in declination —26°.1, or 2°.7 south of the ecliptic. While it was then nearer to us than it had been for thirteen years, yet its southerly position greatly interfered with the work of all the northern observers. Although I had requested aid to the extent of only a few hours time from all of the great southern observatories, yet oddly enough we did not receive a single observation of this remarkably favorable apparition from any station south of the equator. This total lack of interest among the professional astronomers well illustrates one of the difficulties with which the compiler of Martian information has to contend. The opposition occurred on June 10, diameter of the planet 20″.30. On account mainly of the eccentricity of its orbit, it was nearest to us eight days later, an unusual amount. Its diameter then reached 20″.53. At opposition the solar longitude ⊙ was 171°.26, corresponding to the Martian Date of September 21, which is 15 days before its equinox.

The designations, location, and equipment of the various observers who reported are as follows:

M. Dr. M. Maggini, Catania, Sicily. 13-inch refractor by Merz. Magnification 430 and 600. Seeing on Standard Scale ranging from 9 to 11.

P. Professor W. H. Pickering, Mandeville, Jamaica, B. W. I. 11-inch refractor by Clark. Magnification 330 and 430. Seeing on Standard Scale ranging from 6 to 10.

D. Professor A. E. Douglass, Tucson, Arizona. 8-inch refractor by Clark. Magnification 175 and 350. Seeing on Standard Scale 7 to 8.

W. L. J. Wilson, Esq., Nashville, Tennessee. 11-inch reflector by himself. Magnification 250 to 400. Seeing on Standard Scale 6 to 8.

R. P. M. Ryves, Esq., Teneriffe, Canary Islands. 10-inch reflector by With. Magnification 210 and 300. Seeing on Standard Scale 3 to 7, but sometimes momentarily reaching 10.

N. K. Nakamura, Esq., Kyoto, Japan. 7-inch refractor by Zeiss and 4-inch by Heyde. Magnification 230 and 130. Seeing on personal scale 5 to 8.

PLATE I.

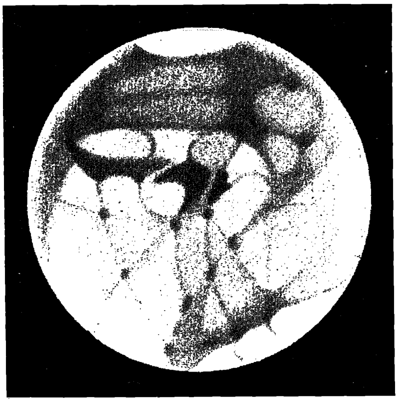

Fig. 1
Maggini 0° A

Fig. 2
Pickering 354° A

Fig. 5
Maggini 58° B

Fig. 6
Pickering 58° B

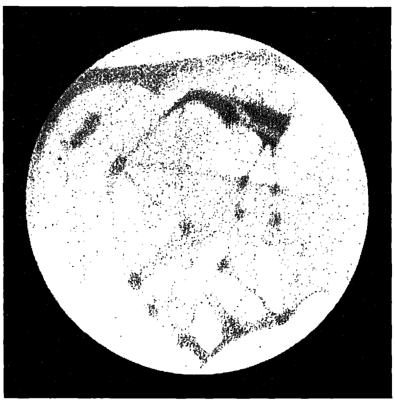

Fig. 9
Maggini 127° C

Fig. 10
Pickering 120° C

DRAWINGS OF MARS IN 1922.

POPULAR ASTRONOMY, No. 323.

PLATE II.

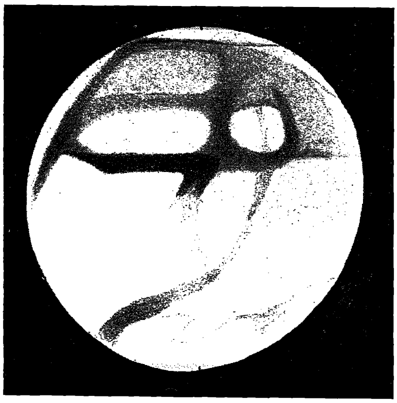

Fig. 3
Pickering 3° A

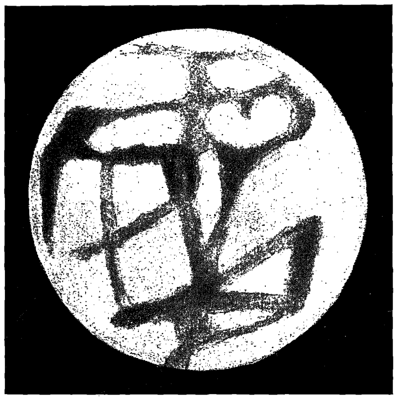

Fig. 4
Douglass 2° A

Fig. 7
Pickering 57° B

Fig. 8
Douglass 67° B

Fig. 11
Pickering 119° C

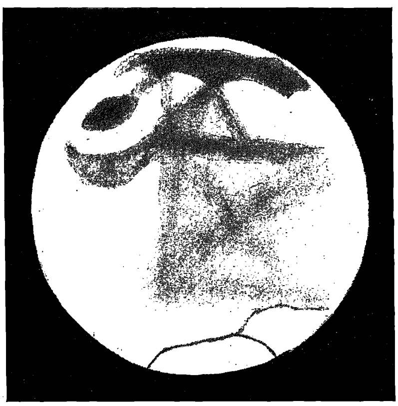

Fig. 12
Douglass 124° C

DRAWINGS OF MARS IN 1922.

S. R. Schofield, Esq., Kobe, Japan. 8.5-inch reflector by Calver. Magnification 235 to 395. Seeing on Standard Scale 6 to 9.

G. H. J. Gramatzki, Esq., Berlin, Germany. 6-inch reflector by himself. Magnification 140 to 270. Seeing on Standard Scale 7 to 7.5.

P. Professor W. H. Pickering in 1890 at Cambridge, Mass. 12-inch refractor by Clark. Magnification believed to be about 350 and seeing probably about 6.

TABLE I.

Fundamental Data of the Figures.

Fig.	Obs.	Aper.	Magn.	Seeing	1922	Reg.	Long.	ΔLong.	Lat.	Diam.	⊙	M. D.
							°	°	°	″	°	
1	M	12.8	430, 600	11	July 2	A	0	0	+9.0	19.9	183.7	Sept. 42
2	P	11	430	6,8	June 2	"	354	— 6	4.1	19.7	167.0	" 13
3	"	"	"	9	July 9	"	3	+ 3	9.6	19.2	187.8	" 49
4	D	8	350	7,8	July 9	"	2	+ 2	9.6	19.2	187.8	" 49
5	M	12.8	430, 600	10	June 25	B	58	— 2	8.2	20.4	179.7	" 35
6	P	11	430	9	June 30	"	58	— 2	8.8	20.0	182.6	" 40
7	"	"	430, 330	10	Aug. 8	"	57	— 3	8.2	15.4	205.7	Oct. 22
8	D	8	175, 350	7	July 4	"	67	+ 7	9.2	19.7	184.9	Sept. 44
9	M	12.8	430	10	June 15	C	127	+ 7	6.5	20.5	174.0	" 25
10	P	11	430, 330	9,8	June 23	"	120	0	7.9	20.4	178.6	" 33
11	"	"	"	9	Aug. 2	"	119	— 1	8.9	16.1	202.0	Oct. 16
12	D	8	350	7,8	June 29	"	124	+ 4	8.7	20.1	182.0	Sept. 39
13	M	12.8	430	9	June 12	D	177	— 3	5.9	20.4	172.4	" 23
14	P	11	"	9	June 17	"	180	0	6.8	20.5	175.2	" 27
15	"	"	"	9,6	July 29	"	180	0	9.3	16.7	199.6	Oct. 12
16	D	8	175	8	June 18	"	196	+16	7.0	20.5	175.7	Sept. 28
17	M	12.8	430, 600	11	July 9	E	253	+13	9.6	19.2	187.8	" 49
18	P	11	430	10	June 14	"	240	0	6.3	20.5	173.5	" 25
19	"	"	430, 330	7	July 21	"	235	— 5	9.7	17.7	194.8	Oct. 4
20	D	8	175, 350	8	June 15	"	235	— 5	6.5	20.5	174.0	Sept. 25
21	M	12.8	430, 600	11	July 6	F	300	0	9.4	19.5	186.0	" 46
22	P	11	430	7,9	June 4	"	299	— 1	4.4	19.9	168.0	" 15
23	"	"	"	10,9	July 13	"	294	— 6	9.7	18.7	190.1	" 53
24	D	8	350	7,8	June 10	"	287	—13	5.5	20.3	171.3	" 21
25	W	11	250, 400	5,6	July 10	A	338	—22	9.6	19.1	188.4	" 50
26	"	"	" "	6	July 9	B	27	—33	9.6	19.2	187.8	" 49
27	"	"	" "	7,8	July 1	C	97	—23	8.9	20.0	183.2	" 41
28	"	"	" "	6	June 26	D	145	—35	8.3	20.3	180.3	" 36
29	"	"	" "	6	June 16	E	209	—31	6.7	20.5	174.6	" 26
30	"	"	" "	7,8	June 15	F	263	—37	6.5	20.5	174.1	" 26
31	R	10.2	300	5,6	Aug. 8	A	6	+ 6	8.2	15.4	205.7	Oct. 22
32	"	"	"	—	June 29	B	60	0	8.7	20.1	182.0	Sept. 39
33	"	"	210	5	July 28	C	120	0	9.3	16.8	199.0	Oct. 11
34	"	"	"	3,4	July 23	D	188	+ 8	9.6	17.5	196.0	" 6
35	"	"	—	—	July 15	E	239	— 1	9.7	18.5	191.3	Sept. 55
36	"	"	210, 300	7	July 7	F	295	— 5	9.4	19.4	186.6	" 47
37	G	6	220	7	June 22	B	62	+ 2	7.7	20.5	178.0	" 32
38	"	"	140	7,5	May 29	F	305	+ 5	3.4	19.2	164.7	" 9
39	S	8.5	235, 310	8	June 11	B	58	— 2	5.7	20.3	171.8	" 21
40	"	"	245, 395	6,8	June 30	E	240	0	8.8	20.0	182.6	" 40
41	N	4	130	5	June 24	E	265	+25	8.0	20.4	179.1	" 34
42	"	7	230	5	June 25	F	325	+25	8.2	20.4	179.6	" 35
					1890							
43	P	12	350±	6±	June 28	A	1	+ 1	14	17.8	176.4	" 30
44	"	"	"	"	June 20	B	58	— 2	14	18.5	172.1	" 22
45	"	"	"	"	June 15	C	107	—13	13	18.9	169.3	" 17
46	"	"	"	"	July 14	D	194	+14	14	16.0	185.7	" 45
47	"	"	"	"	July 11	E	222	—18	14	16.4	184.0	" 42
48	"	"	"	"	May 25	F	300	0	9	18.8	157.9	Aug. 53

Description of the Drawings.

In Table I is given a statement of the main facts relating to the various drawings. The table is arranged as in previous Reports, the successive columns giving the number of the figure, the designation of the observer, the aperture of his instrument, the magnifications employed, the seeing on the Standard Scale, which is described in Report No. **9**, the date of the drawing, the region depicted, the longitude of the central meridian, its deviation from the desired standard, the latitude of the center of the disk, the angular diameter of the planet, the longitude of the sun as seen from Mars, and the corresponding Martian Date taken from Report No. **10**. The average date of the drawings was June 29, or 19 days after the opposition. This is about the usual interval, and coincides with that obtained at the previous apparition.

According to the plan adopted in the earlier Reports, the drawings of the principal observers are so arranged that all in the same horizontal row shall represent approximately the same longitude on the planet. In the vertical columns the longitudes are intended to differ by just 60°, beginning with longitude 0°. Thus six views of the planet are shown by each observer, covering the whole visible surface. The six regions are indicated by the letters **A**, **B**, **C**, **D**, **E**, and **F**. The other drawings are arranged on separate pages, and no further explanation of them is necessary.

The Work of the Different Observers.

We regret the absence this year of all the British observers excepting Mr. Ryves and Mr. Schofield from our list of contributors, but since the altitude of Mars when on the meridian as seen from London was only 12°.4, it is quite natural that little could be done there. Usually nearly half of our observations come from the British Isles. The two gentlemen mentioned observed in foreign countries. Curiously enough however, we have this year an enthusiastic and painstaking German observer in Berlin, who sent us three sketches, two of which we reproduce, because they appear to us to be extremely good, considering that the altitude of the planet as seen from that station never exceeded 12°, and in Figure 37 could not have been over 11°. He even detected 6 of the more prominent canals, and only drew one that was not confirmed, and probably was not there. He employed a 6-inch reflector made by himself, which it is believed was as large an instrument as the seeing at that altitude would have borne.

The next most northern observer was Dr. Maggini at Catania, Sicily, latitude 37°.5. That he should have seen as many canals as are indicated in Tables II and III, including six double ones, with an altitude of Mars never exceeding 26°.5 is certainly surprising. The large number of canals, and also of lakes which he saw (see Tables III and VI) which could not be confirmed by other observers better located, is of course regrettable, nevertheless he saw many canals which others did confirm. We never attempt to observe the planet ourselves at a lower altitude than 35°. Our latitude is 18°, giving us at this opposition a maximum altitude for the planet of 46°. The latitudes of four of the other observers ranged between 32° and 36°.

Ryves obtained a very good series of drawings from the island of Teneriffe in the Canaries, latitude 28°, with his 10-inch reflector, which he took there for that purpose. Maximum altitude of the planet 36°. The island lies some 300 miles south of Madeira, whence Green with a 13-inch reflector in 1877 obtained his classic series of drawings. Incidentally it may be remarked that Ryves saw a good deal more detail than Green, but had of course the great advantage of knowing that the canals were there, which Green did not. He states that his altitude was 7700 feet, and that he was located on dry volcanic ash. There was considerable wind from the northwest. Only about two nights per month were cloudy during his stay. Cumulus clouds were almost constantly seen below him. The seeing was "characterized by general unsteadiness, with frequent but brief moments of marvelously good definition". The numbers in Table I do not, he says, give a fair idea of his best moments.

Wilson also obtained some excellent drawings from his station in Nashville, Tennessee. Unfortunately all of them differed so greatly from the required Martian longitudes, in which drawings were secured by the other observers, that comparison with their work is unsatisfactory. The drawings are very useful however for statistical purposes, and for this reason we have reproduced all six of them. We have received drawings from two observers in Japan. They had rather small instruments, but their work appears to have been done with care, and is of additional value coming from a terrestrial longitude which permitted them to observe the different Martian longitudes at a time when they were invisible to European and American observers.

In connection with the fact that no southern observatory obtained any observations of Mars whatever, as far as we are aware, and that many of the usual northern observers were excluded by their high latitudes, it may be mentioned that as it turned out, this was by far the most interesting and instructive apparition that we have observed hitherto. Nor do I exclude in this comparison the somewhat nearer one of 1924. The reason for this appears to be that in 1922 Mars was in a portion of its orbit where rapid seasonal surface changes were very marked, and some of the things that were observed to actually occur are extremely difficult to explain. No matter how diligent the observers, at no single observatory can they expect to see even one-third of all the interesting rapid changes that occur during any given apparition. It is therefore the more to be regretted that no accurate observations appear to have been secured at any station south of our own.

Between May 19 and 26, ⊙ 159°.3 to 163°.0, corresponding to early September on Mars, the surface of the planet was densely clouded, so that the appearance of even the most prominent details was transformed, the dark regions being outlined only in part by the deserts, and in part by Martian clouds. What detail could be seen was extremely faint and hazy, the haze covering the equatorial regions rather than the extreme north or south. Only short sections of the canals surrounding Elysium were visible, Lunae was extensive but very faint, while the outlines of Thaumasia were in large part covered by cloud, giving it a very unusual apparent shape. Owing for the most part to unfavorable terrestrial weather conditions which not infrequently occur in our rainy seasons, no observations were secured here between May 9 and 19, nor between May 26 and June 2. The Martian cloudy spell may therefore have lasted three weeks, but we are only sure that it lasted one.

In order to illustrate the more striking changes in the markings themselves, and also their development, as well as the disappearance of some of the canals, we have given two series of drawings that were secured here in the period extending from June 2 to August 8. It will be remembered that the planet was nearest to us on June 18, so that in the nearest drawing made in the second set it was more remote than in the most distant drawing made in the first. By referring to Table III in the third and fourth columns, it will be seen that in the drawings made while the planet was near us only 41 canals were seen, while in those made when the planet was more remote 48 were visible. Of these latter, 5 were detected which were not confirmed elsewhere, probably because they had developed too late to be found in the drawings by the other observers, which were all made earlier in the apparition. Only 30 canals were common to the two sets. Similar results were obtained with the lakes.

The reader should fully appreciate the fact that the differences between these two series are not due to bad drawing. They are given for the very reason that they do differ so strikingly from one another, and to illustrate the marked changes that occur at this season of the Martian year. Usually drawings made in successive months by the same observer resemble one another very closely. In the present case Figure 2 differs markedly from Figure 3. The latter was drawn on the same night as Figure 4 by Douglass, and a week later than Figure 1 by Maggini. It resembles these two drawings much more than does Figure 2, which was drawn five weeks earlier, before the detail had developed. On the other hand Figure 22 resembles Figure 24 by Douglass, while Figure 23 resembles Figure 21 by Maggini. The two former were drawn about a week apart, and the two latter a month later, also a week apart. A difference between the maria in Figures 10 and 11 is due to the fact that in the latter the region of Titanum was concealed by terminator cloud. Titanum itself was clearly visible the previous night, so that the change in this case is only apparent, not real.

These rapidly changing appearances will perhaps best illustrate to the reader why Martian observers find the planet so interesting to sketch, whenever it is near us, and why a comparison of its meteorol-

PLATE III.

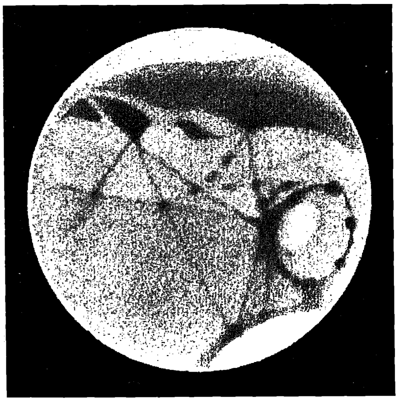

Fig. 13
Maggini 177° D

Fig. 14
Pickering 180° D

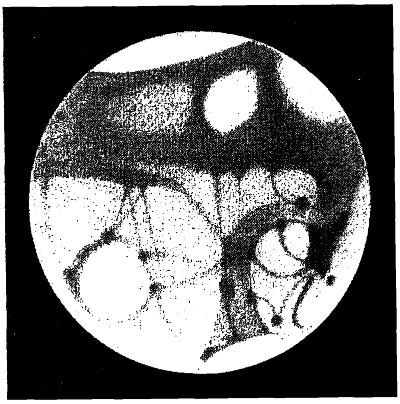

Fig. 17
Maggini 253° E

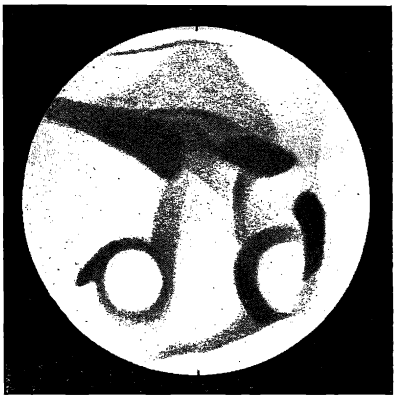

Fig. 18
Pickering 240° E

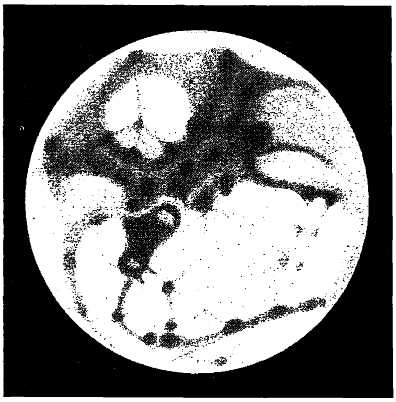

Fig. 21
Maggini 300° F

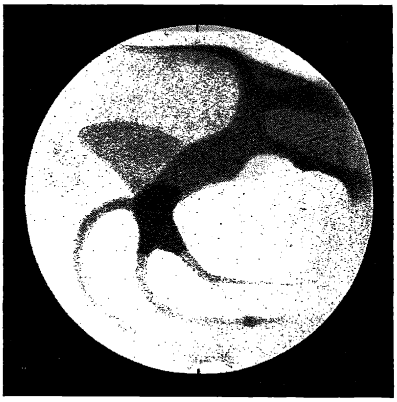

Fig. 22
Pickering 299° F

DRAWINGS OF MARS IN 1922.

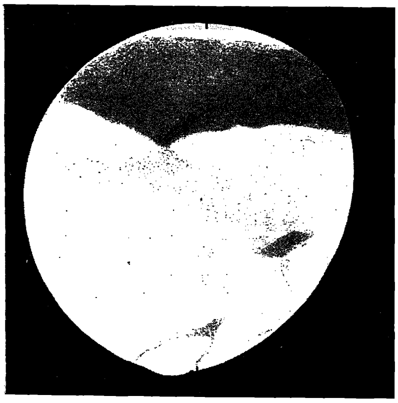

Fig. 15
Pickering 180° **D**

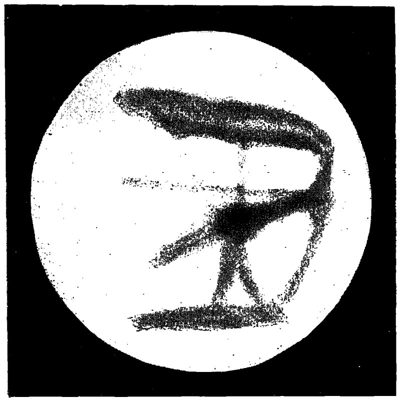

Fig. 16
Douglass 196° **D**

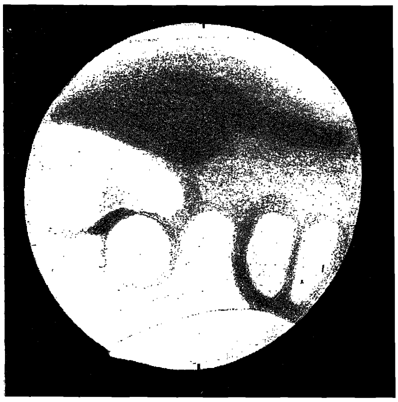

Fig. 19
Pickering 240° **E**

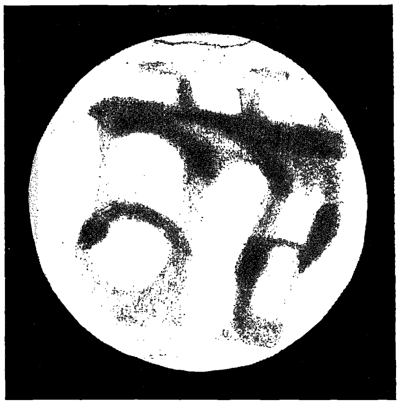

Fig. 20
Douglass 235° **E**

Fig. 23
Pickering 294° **F**

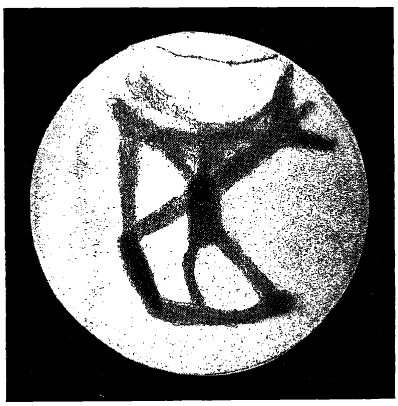

Fig. 24
Douglass 287° **F**

DRAWINGS OF MARS IN 1922.

ogy and vegetable life with our own offers such a fascinating field for research. These exceptionally cloudy spells and rapid changes of detail are found to occur just before, and at the time of the Martian equinoxes, both spring and autumn. Then also the canals are fewest, being least developed. At these times the northerly winds of the planetary circulation give place to the southerly ones and *vice versa.* In other words then the vernal polar cap begins to melt, and transfer its moisture across the surface of the planet towards the autumnal one, which soon after begins to form.

While just preceding the summer solstice of the southern hemisphere, which we passed in 1924, when the diameter of the planet was over 25″, more canals were visible than at the equinoxes, yet it is during the summer solstice of the northern hemisphere and before it, when the diameter scarcely exceeds 15″ that the most conspicuous canals are visible. Then is the time when the amateur, furnished with a small telescope, can most readily see them. Indeed in February, 1916, when the diameter was less than 14″, both Thoth and Nilosyrtis were clearly seen here with a 3-inch aperture (Report No. **15**, 4).

Finally, in describing the various drawings included in this paper, I may refer to the last series represented, which consists of a set of drawings, never before published, that the writer made in Cambridge, Mass., with a 12-inch refractor in the year 1890. In that year the position of the planet in its orbit as indicated by the solar longitudes ⊙ was nearly the same as in 1922. Figure 43 resembles Figure 2 of the first set of our later drawings perhaps rather more nearly than it does Figure 3 of the second set. Oddly enough, considering the poor seeing in Cambridge, it shows more canals than either of them, thus illustrating the fact that seasons on Mars differ in this respect. Figure 44 most resembles Figure 7 of the second set, while Figure 45 is more like Figure 10 of the first. Figure 46 most resembles Figure 15 of the second set, and again shows many more canals, but probably owing to atmospheric conditions, is I am afraid not a very good representation of the shape of the detail that was really visible at that time. Figure 47 bears little resemblance to either Figures 18 or 19, but curiously enough looks much more like Mr. Wilson's Figure 29, drawn with about the same central meridian. Evidently he and I saw things very much alike in these two different years. Figure 48 looks little like any drawing of the Syrtis Major made of late years, but when we compare it with Figure 22, as distinguished from Figure 23, and consider that the larger loop in all three figures is identical, we see that the two earlier ones clearly represent a transition stage not long maintained, and therefore seldom seen. Ryves also shows it in Figure 36, and Douglass to a certain extent in Figure 24. The others seem to have missed it. It is thought that these three series of drawings, made by the same observer, at the same Martian season, and at an extreme interval of 32 years, may have some interest, and are perhaps unique. The early ones represent the best results of 32 nights of observation. The planet only reached an altitude at Cambridge that year of 25° at opposition, so that we see that even in New England, where we get perhaps the worst seeing in the United States, if not in the civilized world, the canals of Mars can occasionally be seen, and drawn with some accuracy. In an earlier paper I once expressed doubt as to their visibility from Cambridge, but by Table III we see that 34 were detected there, which is really not a bad record at all, and of these, 29 were confirmed in 1922. I may perhaps add that at that time I was unfamiliar with Schiaparelli's maps, although the existence of the canals was of course well known to me.

Description of the More Important Changes.

In general the observers made few remarks on their observations. Professor Douglass mentions the conspicuous white area that appeared south of Margaritifer on July 9. He states that it had moved northward on the 10th, and had then nearly disappeared. Mr. Ryves says "Amongst the most interesting features I should specially mention the shape of Syrtis Major." To this we have just referred. He further mentions "the prominent canal running down the 240th meridian (Aethiops?), the prominence of Solis Lacus which I saw disconnected from Sinus Aurorae, the brilliant white spot in about 340°, —60°, on July 8 and 9, strength of the Nepenthes system, and of that of Trivium Charontis, Cerberus." Mr. Wilson records that Amenthes was first visible June 15, and not on June 11. He mentions a dark chocolate-colored spot in longitude 46°, latitude —35°, visible on July 6. This spot was not seen here, nor was any noticed near that place on July 7 or 8, but on July 9 a round dark area appeared near longitude 15° latitude —25°, which shortly developed into a conspicuous white spot. Our own observations of this spot, and of certain other markings visible at this apparition, are so detailed and extensive that they must be deferred until our next report.

Before closing this section however, a few words may be said regarding certain cloud formations which were observed, projecting beyond the limb and terminator from the northern polar cap (See Figures 7, 11, 15, and 19). Such projections appear only at rare intervals. They were first seen on the terminator in 1892, under similar conditions to those of the present apparition, both at the Lick Observatory and at Arequipa. At the latter station we also saw projections on the limb, and measured their height, with our 13-inch telescope. It is recorded that they "attained an altitude of at least 20 miles" (*Astronomy and Astrophysics,* 1892, **11**, 849). No limb projections have been seen from that day until this apparition, as far as the writer is aware. The first one that we saw in 1922 appeared on June 22, 23, and 24, north of Elysium, ⊙ 178°.0 to 179°.2, corresponding Martian Dates September 32, 33, and 34. The next one appeared July 10, and after that they were visible on practically every favorable night until August 16, ⊙ 210°.5, Martian Date October 30, after which no more were seen. They were recorded on 17 nights in all. None of the other observers mention them, but it is possible that they may have been seen elsewhere.

The two highest appeared on June 22 and July 10, and each projected 0″.25 ± 0″.05 above the limb, as measured by means of our Scale of Projections. The principle of this scale is described in Report No. 7. These measures were corroborated by drawings made at the time. It was concluded further that an altitude of less than 0″.1 would be likely to pass unnoticed. Reducing these measurements to miles, we find that they correspond to altitudes of 50 and 55 miles respectively. These results seem very high, but it is thought that they cannot be much reduced, for the projections were very conspicuous, as is shown in the figures. They rarely equalled 2″ in length, and always appeared over the polar cap, and usually near its southern border. Their latitude ranged from 45° to 80°, but in the latter case the cloud was apparently seen across the cap. Four different projections, or about one-third of them, originated near longitude 220°, south of Elysium. The others were scattered fairly uniformly around the pole. At the previous apparition in 1920 Mars was too remote at the proper season for us to detect them. In 1924 the planet was near us, but none were seen.

On account of the small value of the surface gravity on Mars, clouds in a similar atmosphere would rise to 2.6 times the height that they would with us. Now our thunder-storm clouds sometimes reach an altitude of 7 miles. Under similar conditions on Mars they would rise to 18 miles. Under different conditions, which may well obtain there, less dense clouds might very well rise to the heights that we have recorded. This would seem to imply however a much more dense and extensive atmosphere than has heretofore been generally assumed, possibly one fully as dense as our own.

The northern polar cap itself was very small in May, but increased rapidly to a maximum in early July, corresponding to the end of the Martian September. It then had a radius of practically 45°. Its disappearance was fully as rapid, and by September 20, Martian Date November 9, its radius was reduced to 10°. After that it again increased, disappearing and reappearing throughout the remainder of the year. Its brightness ranged from 7 to 9, never reaching 10. The tops of the projecting clouds were the brightest portions, thus indicating greater freedom from the absorption of the surrounding atmosphere, at that considerable elevation. On account of its comparative faintness, and of its striking and rapid changes in size and shape, it is believed that this cap was composed entirely of cloud. A very similar cap was observed in 1920, when it reached its maximum size on the Martian Date September 36. It disappeared finally on the Martian November 3.

PLATE V.

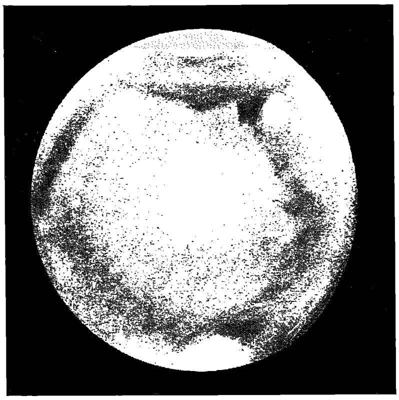

Fig. 25
Wilson 338° A

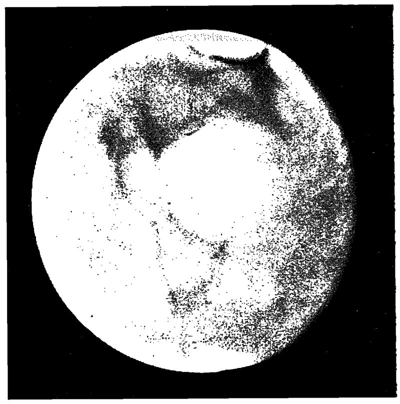

Fig. 26
Wilson 27° B

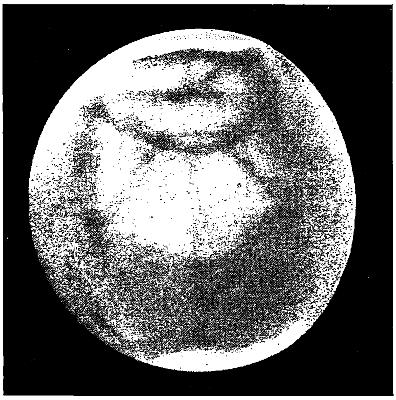

Fig. 27
Wilson 97° C

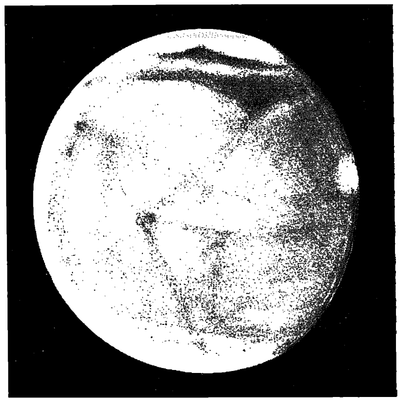

Fig. 28
Wilson 145° D

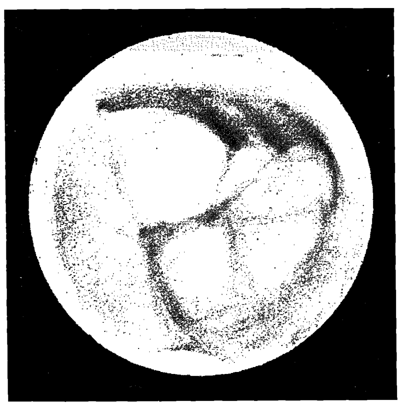

Fig. 29
Wilson 209° E

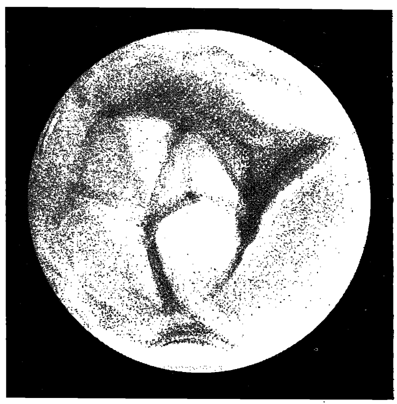

Fig. 30
Wilson 263° F

DRAWINGS OF MARS IN 1922.

POPULAR ASTRONOMY, No. 323.

PLATE VI.

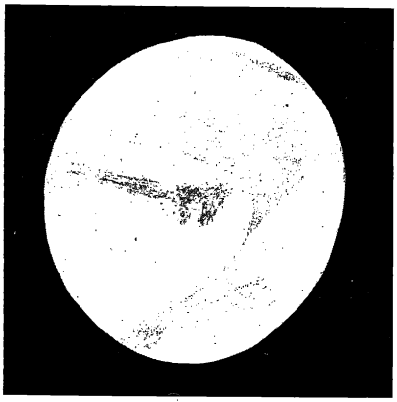

Fig. 31
Ryves 6° A

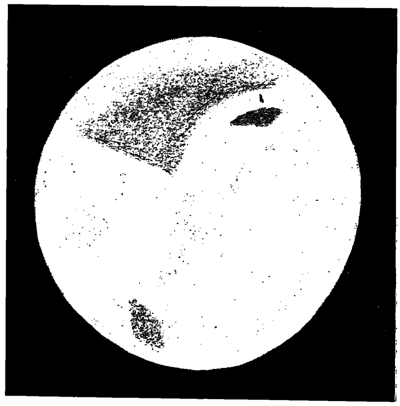

Fig. 32
Ryves 60° B

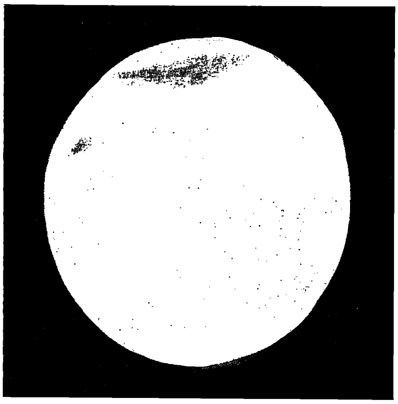

Fig. 33
Ryves 120° C

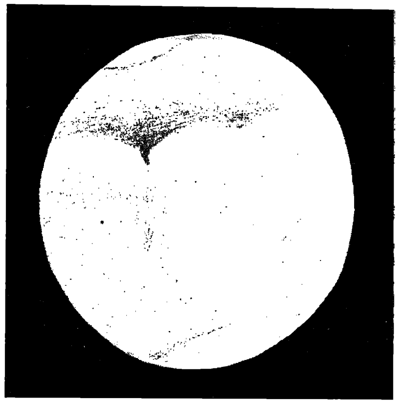

Fig. 34
Ryves 188° D

Fig. 35
Ryves 239° E

Fig. 36
Ryves 295° F

DRAWINGS OF MARS IN 1922.

Statistics of the Canals and Lakes.

In Table II the canals seen by the different observers are arranged in alphabetical order, the headings of the ten following columns give the abbreviations of the observers' names, and the columns themselves give the letters which indicate on which drawings the canals are to be found. These letters are given in Table I, and also under the drawings themselves. In the last column is given the number of observers, including only the first six through Ryves, who saw each canal. In some cases no canal is found on our standard map which can be identi-

TABLE II.

Canals Identified in the Drawings.

No.	Canals	M	P	P	D	W	R	N	S	G	P	Obs.
1	Abalos				B							1
2	Acampsis L			C								1
3	Acheron	C			C							2
4	Aesacus	D									E	1
5	Aethiops	E	E		E	F	E	E				5
6	Alcyonius		E		E	E	E	E				4
7	Alpheus	F										1
8	Ambrosia L	B				C						2
9	Amenthes	E	E		EF	EF	F	E				5
10	Anian	D			E						E	2
11	Araxes	BC	C	C	C	C	C					6
12	Arius D	E										1
13	Aroeris	F										1
14	Astaboras	F	F	F	F		F					5
15	Astusapes	F		EF								2
16	Ausonium				F	F						2
17	Avernus	D										1
18	Baetis	B	B									2
19	Bathys D				C	C						2
20	Bias L '09	F										1
21	Boreas		D		D						DE	2
22	Boreosyrtis										F	0
23	Brontes	C		D		DE	D				D	4
24	Cadmus	F										1
25	Callirrhoe		A		A							2
26	Cantabras D	A										1
27	Casius	EF	F	EF							F	3
28	Catarrhactus L	B	C	BC								3
29	Cerberus	DE	DE	DE	DE	E	DE		E		DE	6
30	Ceraunius		C			CD						2
31	Chaos	DE	DE	E	E	E	E		E		E	6
32	Chrysorrhoas	B		BC	B	C	B				C	5
33	Cliter L '09	C										1
34	Coprates D	B	BC	BC	B	C				B		5
35	Cyclops				D	E			C		E	2
36	Daemon L	B	BC	BC	BC	C	BC					6
37	Daradax L	A										1
38	Dardanus	A				B	B					3
39	Dargamanes (*d*) L	B										1
40	Deuteronilus	F	AF	ABF	A	A	A	F			A	6
41	Diagon (*d*) L				F							1
42	Djihoun L										A	0
43	Doseron (*d*) L				F	F						2
44	Erebus				D	D		E			DE	2
45	Eumenides	CD	D	C	C	D						5

TABLE II.—CONTINUED.

CANALS IDENTIFIED IN THE DRAWINGS.

No.	Canals	M	P	P	D	W	R	N	S	G	P	Obs.
46	Eunostos	DE	E	E	E	E	E	E	E		E	6
47	Euphrates	AF			A			F			A	2
48	Euripus				E							1
49	Evenus					D						1
50	Fortuna	B				C						2
51	Galaxias				D							1
52	Ganges	B		B	B	BC	B		B	B	B	5
53	Gehon	A		A	A	AB		F			A	4
54	Gigas	CD	C		C	CD						4
55	Gyndes	D	E			D	DE		E			4
56	Hades	D			D	D						3
57	Heliconius	E					E		E			2
58	Hephaestus	E										1
59	Hyblaeus	DE	E	E	E	E	E	E	E		E	6
60	Hydaspes	A										1
61	Hydraotes	B										1
62	Iaxartes	A				B						2
63	Ich L			C								1
64	Indus	AB	B	B	B			F		B	A	4
65	Iris	C		C	C	D						4
66	Issedon	B		B	B							3
67	Ister D	F		F				F				2
68	Jamuna	B										1
69	Japhyx L					F						1
70	Jordanis				A							1
71	Kedron P		B		BC	C						3
72	Laestrigon	D			DE		D				DE	3
73	Lethes		E	E								2
74	Lycus					D						1
75	Marne P				D		D		E			2
76	Nar L			F							E	1
77	Nasamon	EF	E	E	EF			EF				4
78	Nectar	B	BC	BC	B	C			B		BC	5
79	Nepenthes	EF	EF	E	EF	F	EF				F	6
80	Neudrus	A			A							2
81	Nicenus D	E										1
82	Nilokeras	AB	B	BC	B		B			B	B	5
83	Nilosyrtis	EF	F	EF	EF	F	F	EF	E	F	AF	6
84	Nilus	B								B		1
85	Orcus	D	D	DE		DE						4
86	Orontes	A										1
87	Orosines (*d*) L				F	F						2
88	Oxus	A	A	A	A	B	A	F				6
89	Pactolus	E	E	E		EF					E	4
90	Pallas D					F						1
91	Pandora	AF	A	AF	AF					F		4
92	Peneus	F										1
93	Perseus L	C										1
94	Phasis				C							1
95	Protonilus	F	AF	F	F		F	EF			AF	5
96	Pyriphlegethon	C	D	C		CD						4
97	Sados L			F								1
98	Sirenius	C		C								2
99	Siris	A				B						2
100	Sitacus	AF		A	A			F			A	3
101	Styx	DE	DE	DE	DE	E	DE		E		DE	6
102	Tanais	A			B						C	2
103	Tartarus	DE	D	D	D	DE					D	5
104	Thoth	EF	EF	EF	EF	EF	EF	E	E		F	6

TABLE II.—Continued.

Canals Identified in the Drawings.

No.	Canals	M	P	P	D	W	R	N	S	G	P	Obs.
105	Titan	D									D	1
106	Triton	E	E			F					F	3
107	Typhonius	F					F					2
108	Uden L	C		C	C							3
109	Udon D	EF										1
110	Xanthus				E							1
111	Anon. *(a)*	A										1
112	Anon. *(b)*	A										1
113	Anon. *(c)*	A										1
114	Anon. *(d)*	A	A									2
115	Anon. *(e)*			C								1
116	Anon. *(f)*				C		C					2
117	Anon. *(g)*					D						1
118	Anon. *(h)*	E										1
119	Anon. *(i)*			F	F							2
120	Anon. *(j)*							F				0
121	Anon. *(k)*		E	F								2
122	Anon. *(l)*			F								1

fied with the ones observed. In such cases the name of the canal is followed by a capital letter, L for Lowell, D for Jarry-Desloges, and P for the writer. The letter L refers to a map in Vol. **3** of the *Annals of the Lowell Observatory,* Plate XI, unless it is followed by '09, in which case it refers to an unpublished map by Lowell based on his observations of 1909. The map by Jarry-Desloges is found in his third volume. Of the two canals named by the writer, Kedron will be found described in Report **17**, 8, and Marne in Report **21**, 7. The (*d*) placed after certain of Lowell's canals indicates that they are found in the dark regions or maria. The twelve canals that were seen and were previously unnamed, may be described as follows:

(a) Preceding Neudros.
(b) Following Neudros.
(c) An east and west canal south of Pandora.
(d) A canal bounding Thymiamata on the south.
(e) A canal extending northwest from Phoenicis, between Iris and Pyriphlegethon.
(f) A canal extending northwest from Sirenum.
(g) A canal between Biblis Fons and Eleon Lacus of Lowell.
(h) A small canal between Casius and Nasamon.
(i) A canal joining Caloe to Nuba.
(j) A canal north of, and parallel to Protonilus.
(k) A canal bounding Hellas on the west.
(l) Its western component.

Information regarding the number of canals recorded by each observer is contained in Table III. When a canal was seen by all six of the first observers we may describe its visibility as 6. When seen by only five of them, its visibility is 5, and so on. The first column of the table records the visibility, and the remaining columns the number of canals of each visibility seen by each observer, and the total number

TABLE III.

THE NUMBER OF CANALS RECORDED.

Obs.	M	P	P	D	W	R	Total	N	S	G	P
6	12	12	12	12	12	12	12	6	7	1	9
5	11	9	9	11	8	7	11	3	2	3	7
4	11	10	10	8	10	3	13	4	1	2	3
3	9	3	5	5	3	2	9	1	0	0	4
2	15	7	7	15	10	4	29	3	3	0	6
1	27	0	5	8	6	0	46	1	0	1	3
0											2
Total	85	41	48	59	49	28	120	18	13	7	34
Confirmed	58	41	43	51	43	28	74	17	13	6	29

seen by all. Thus Maggini and Douglass were the only observers who saw all the canals of visibility 5. The next to last horizontal row of figures gives the total number of canals seen by each observer, and the last row the number of his canals that were confirmed by at least one other person. Thus as in former years Maggini saw a great number of canals, but only 58 of them were confirmed by others. For the other observers the two figures agreed more nearly. At this apparition a total of 74 confirmed canals were seen, showing as was predicted a distinct falling off from the last apparition when 86 were visible.

TABLE IV.

PROPORTION OF THE CANALS VISIBLE TO THE DIFFERENT OBSERVERS.

Vis.	M	P	P	D	W	R	Total	N	S	G	P
6	1.00	1.00	1.00	1.00	1.00	1.00	12	.50	.58	.08	.75
5	1.00	.82	.82	1.00	.73	.64	11	.27	.18	.27	.64
4	.85	.77	.77	.62	.77	.23	13	.31	.08	.15	.23
3	1.00	.33	.56	.56	.33	.22	9	.11	.00	.00	.44
2	.52	.24	.24	.52	.31	.14	29	.10	.10	.00	.21
1	.51	.00	.11	.17	.13	.00	46	.02	.00	.02	.07
Confirmed	.78	.55	.58	.69	.58	.38	74	.24	.18	.09	.39

In Table IV the arrangement is similar to that in Table III, except that instead of giving the total number of canals seen by each observer, it gives the proportion of the total number recorded. These total numbers are given in the eighth column, and are taken directly from Table III. As we descend the columns to fainter and fainter canals, the proportion of the total number seen by each observer should gradually decrease, falling off sharply when he approaches his limit, and this we find in general to be the case, except for Maggini. The limiting visibility for any given observer may be taken as that at which he is able to see only about one-quarter of all the canals of that visibility. Thus for Wilson and the writer it seems to be about 2. This rule obviously does not apply to the observers from Japan and Germany, since only a portion of their drawings could be included. The last horizontal line of the table shows the proportion of confirmed canals that each observer contributed to the final result. It is deduced from the last row of Table III.

PLATE VII.

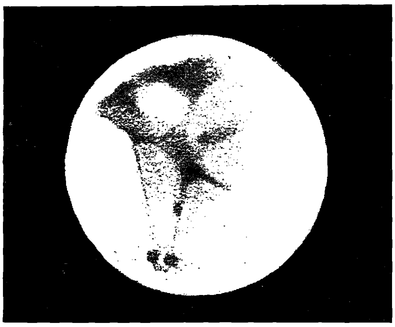

Fig. 37
Gramatzki 62° B

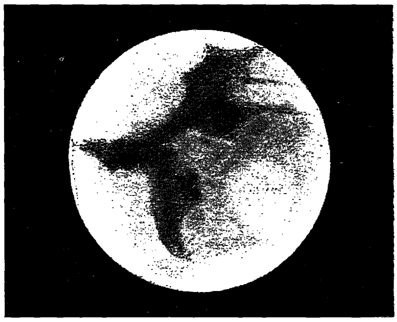

Fig. 38
Gramatzki 305° F

Fig. 39
Schofield 58° B

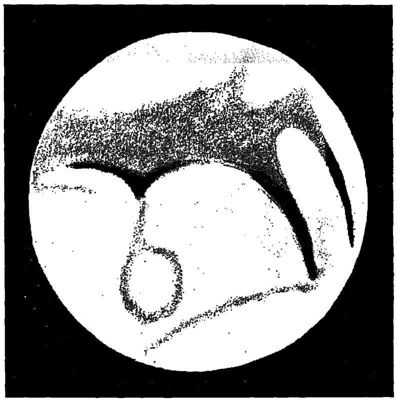

Fig. 40
Schofield 240° E

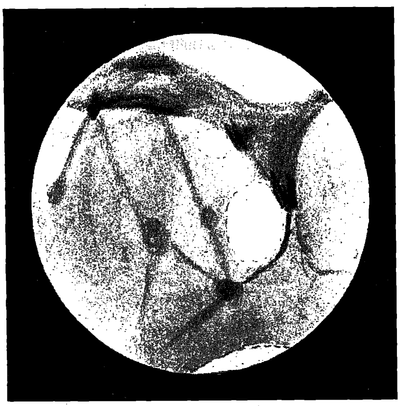

Fig. 41
Nakamura 265° E

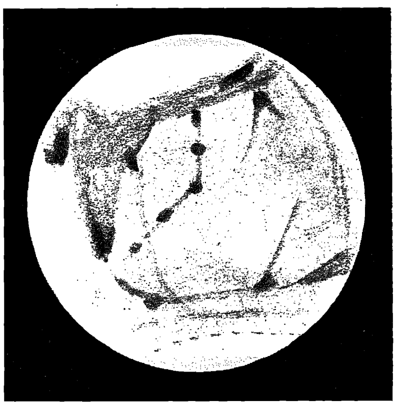

Fig. 42
Nakamura 325° F

DRAWINGS OF MARS IN 1922.

PLATE VIII.

Fig. 43
Pickering 1° A

Fig. 44
Pickering 58° B

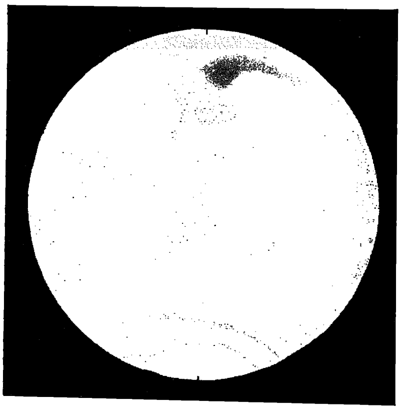

Fig. 45
Pickering 107° C

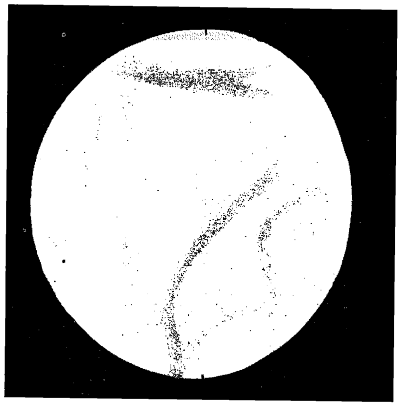

Fig. 46
Pickering 194° D

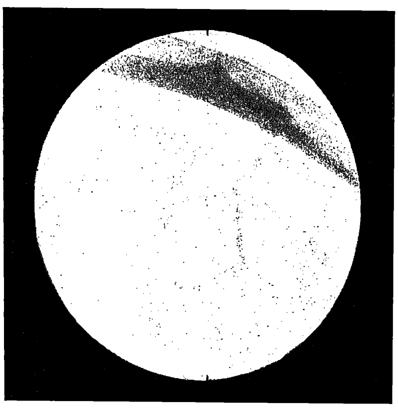

Fig. 47
Pickering 222° E

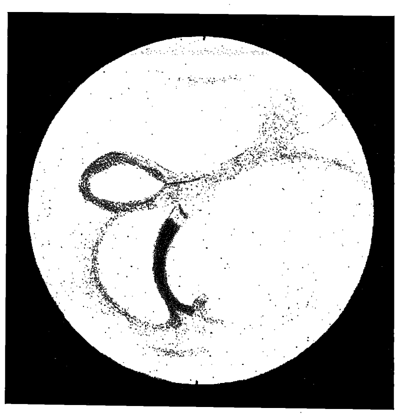

Fig. 48
Pickering 300° F

DRAWINGS OF MARS IN 1890.

TABLE V.

LAKES IDENTIFIED IN THE DRAWINGS.

No.	Lakes	M	P	P	D	W	R	N	S	G	P	Obs.
1	Acadenus L	A										1
2	Acidalius L	A		B								2
3	Ascraeus	C		C		C						3
4	Biblis L	C				D						2
5	Byce L					C						1
6	Castorius					D						1
7	Casuentus L	E				F						2
8	Charontis	DE	DE	DE	DE	DE						5
9	Caloe	F					F	F			F	2
10	Eleon L					D						1
11	Hecatis L					E						1
12	Ismenius	F	AF		AF		A	F				4
13	Juventae	B	B									2
14	Labeatis									B		0
15	Lunae	B		C		C				B		3
16	Maeisia L	B		C		C						3
17	Major L					F						1
18	Messeis L	B	B									2
19	Minor L	E				F						2
20	Moeris	EF				F						2
21	Niliacus					B						1
22	Nadus D	D		C		C						3
23	Nilus L	F										1
24	Novem L	A				B						2
25	Nuba	EF						E				1
26	Oxia	A										1
27	Pambotis	DE				E						2
28	Phoenicis	BC	BC	C	CD							4
29	Propontis		D	D								2
30	Protei L	A		B								2
31	Scotitus L	E										1
32	Semnon L	CD										1
33	Siloe L	A						F				1
34	Sirbonis	A						F				1
35	Tithonius L	B										1
36	Triton	EF				EF		E				2
37	Triviae L	DE										1
38	Utopia	CD										1
39	Anon. *(a)*	C		C								2
40	Anon. *(b)*	C	C									2

TABLE VI.

THE NUMBER OF LAKES RECORDED.

Obs.	M	P	P	D	W	R	Total	N	S	G	P
5	1	1	1	1	1						
4	2	2	1	2		1	2	1			
3	4		4		4		4			1	
2	14	5	4		7	1	15	2			2
1	11				6		17	3			
0										1	
Total	32	8	10	3	18	2	39	6	0	2	1
Confirmed	21	8	10	3	12	2	22	3	0	1	1

Tables V, VI, and VII for the Martian lakes are arranged precisely like the three for the canals. The only anonymous lakes entered in the tables are two that were confirmed, drawn by Maggini and the writer. His other numerous anonymous unconfirmed lakes need not be consid-