conception and inexperienced *personnel*, will do good work, we have no doubt; for it is the saving grace of our American navy, that its officers are apt in utilizing brief experience, fertile in expedients, and bold in execution of a task before them.

THE GREAT VIENNA TELESCOPE.[1]

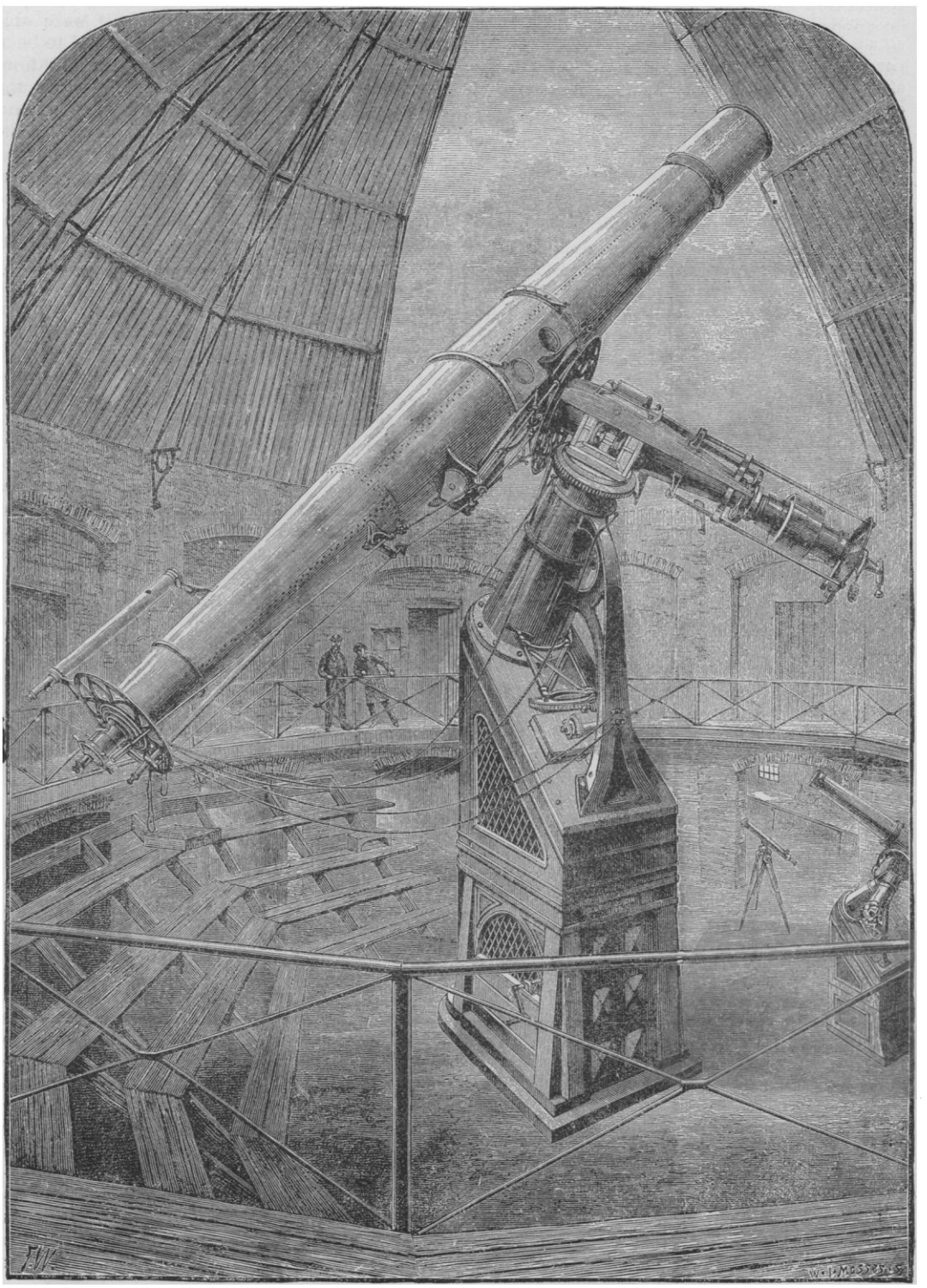
AMONG the instruments which I have examined, that to which most interest now attaches is the great telescope recently completed for the Imperial observatory at Vienna by Howard Grubb of Dublin. It is the largest refracting telescope in actual use at the present time, being of one inch greater aperture than that of the Naval observatory at Washington. The contract was made with Mr. Grubb in 1875; but, owing to difficulties in procuring glass disks of the necessary size and purity, it was not completed until 1881. Further delays occurred in mounting, so that it was scarcely ready for actual work at the time of my visit in April last. I made as critical and careful examination of its working as was possible during the unfavorable weather which prevailed at Vienna at that time. My examination was principally in the nature of a comparison of its working with that of the Washington telescope.

General character of mounting. — In its main features the telescope is mounted on the same general principle with that at Washington. Both of these instruments are counterpoised on the German plan. The tubes of both are of steel. The rapid motion in declination is by means of a rope attached to the two ends of the tube, and that in right ascension by a system of wheel-work. The clockwork is in the pier below the instrument. The leading points of difference are, that the mounting of the Vienna telescope is much larger, stronger, and heavier in all its parts; that the contrivances for making use of it are more numerous; that an elaborate system of friction-rollers in declination is provided, the Washington telescope having none; and that a more convenient system of illuminating the field and the divisions on the several circles has been adopted.

Ease of motion. — In moving the Vienna telescope, one is at first struck with the fact that mere weight is a serious drawback; but when the motion is once commenced, the movement in right ascension is almost as easy as in the Washington telescope. It is, however, very different in declination. For reasons which neither Dr. Weiss nor myself were able to perceive, the friction-rollers seemed to be of no benefit in easing the motion in declination, which was much more difficult than in the Washington telescope, and, in fact, quite a task upon the strength of the observer at the eye-piece. The quick motion for setting in right ascension is made below the end of the polar axis by turning a steel steering-wheel. This appliance is in every way inferior to the system at Washington, where the same motion is effected by an endless rope hung over a grooved wheel, which the observer turns hand over hand. By this motion the observer at the Washington telescope can make the required motion without taking his eyes from the telescope or the vernier, and without giving any thought to the motion of his hands. But the handles of the steering-wheel are much less convenient to take hold of than a rope; and, if the motion is at all rapid, the operator must be on the alert lest the steel handles strike his knuckles in the attempt to take hold of them without looking. The necessity of care in this respect makes the motion slow and laborious.

Clock-motion. — On the system of the Messrs. Clark, applied in the Washington telescope, the screw which turns the sector does not take hold of the circumference of the latter directly, but gears into a complete wheel, the axis of which is connected with the arc of the sector by a pair of brass or steel bands. By this arrangement the toothed wheel makes a nearly complete revolution while the sector is moving through its arc; and the effect of the small unavoidable irregularities in the working of the screw is diminished in the ratio of the arc of the sector to the circumference of the wheel. Whatever advantages this arrangement may have in small instruments, I think that in large ones they are more than counterbalanced by the evils arising from the elasticity of the band, combined with the changes of friction, the action of the wind, and other forces acting to vary the uniform motion of the telescope. Owing to this elasticity, the effect of the wind or of any slight pressure by the observer on the eye-piece is many times greater in the Washington than in the Vienna instrument. But it did not appear to me that the firmness of the connection in the latter instrument between the support of the turning-screw and the tube of the telescope was as great as supposed by those who lay stress on large and stable mountings. I found that, by a simple pressure of the thumb-nail upon the eye-piece of the

[1] Extract from a report to the secretary of the navy on recent improvements in astronomical instruments, by SIMON NEWCOMB.



Vienna telescope, the pointing in right ascension could be changed by a number of seconds, so as to throw an object entirely away from the wire. The main question is, however, the steadiness of motion when no pressure whatever is applied by the observer or the wind; and, so far, I have found no large telescope which is entirely satisfactory. The Vienna telescope was not supplied with a micrometer at the time of my examination, so that I could not test its motion as thoroughly as I wished to; but, by bringing the planet Uranus in the edge of the field, I found that there was constantly an irregular movement in right ascension, the amount of which I estimated as between one and two seconds of arc. This movement had no regular period, and therefore did not seem to be connected with any defect in the figure or motion of the screw. Its irregular period, if I may use the term, varied from the smallest appreciable amount to two or three seconds of time. Its most probable cause seemed to be the irregular friction of the motion in right ascension, and especially of the friction-rollers, by which the polar axis is supported at its lower end. A similar irregularity is noticed in the Washington telescope; but I think it is decidedly less than in the Vienna one, provided that no strong wind is blowing on the instrument.

Arrangement of sector. — In Mr. Grubb's large telescope an attempt is made to give greater stability to the screw by having its axis immovably fixed to supports in the massive base of the telescope, which renders it incapable of any motion except that of turning. The screw cannot, therefore, be unlocked from the sector, as in the instruments by other makers. When the sector reaches the end of its motion, it is to be turned back by giving a rapid backward motion to the screw itself, for which special apparatus is provided. From what I have already said, I am of opinion that this arrangement offers no advantage to compensate for the trouble which it causes the observer.

Slow motion. — The slow motion in right ascension in the Vienna telescope is endless, instead of being confined between narrow limits, as in that at Washington. This is a decided improvement, saving the observer much loss of time from the motion running out.

Illumination. — The apparatus for illuminating the field of the micrometer was not in perfect order at the time of my visit, so that I need not report upon it in this connection. It is in its general character similar to the system adopted by the Messrs. Repsold, of which I shall speak hereafter. The illumination of the divisions of both circles leaves nothing to be desired.

Minor points. — In the preceding I have indicated what may be considered fundamental points affecting the use of the instrument. There are, however, several minor points which are of almost equal importance, so far as the practical use of the instrument is concerned. As the instrument now stands, the drawback which strikes me most was the absence of any rough setting, either in right ascension or declination, and the impossibility of seeing, even approximately, the pointing in declination, except when the observer is at the eye-piece. This, when combined with the great force necessary to move the telescope in declination, makes its pointing a difficult and troublesome operation. The observer must first set the telescope by pure guess-work. He has then to mount to the eye-piece, wherever it may be, look into the microscope, and note the reading of the circle. He has then to withdraw his eye, and, by considerable muscular exertion, to make another guess, which he can test by again reading the circle. Thus the pointing is to be made by a series of trials, which are so troublesome that I found the observers were in the habit of mounting to the top of the clyinder in the dome, and finding the pointing in declination by moving the telescope around the horizon.

I remark, in this connection, that the Washington telescope has a coarse setting, which the observer can read from any point below the telescope with the aid of an opera-glass.

Objective. — The proper figuring of a great objective so as to give the best possible image of a celestial object is justly considered the most difficult task in the construction of a large telescope: especial interest, therefore, attaches to Mr. Grubb's success with the objective. The atmospheric conditions were very unfavorable to the finest tests, but I succeeded in making such examination as the circumstances admitted on three evenings. On the first trial the image was found to be distorted, owing to want of adjustment of the glass itself. This was soon corrected by Director Weiss. On the second trial I found a well-marked spherical aberration, which seemed, however, to be very regular from centre to circumference. But there had been a fall of temperature, and the dome had been opened but a short time, — circumstances under which the Washington telescope always exhibited the same phenomenon. On the third evening the dome had been opened long enough to nearly equalize

the temperatures. So far as I could judge, the character of the image was perfect, there being no appearance of those rings of different focal lengths which are commonly seen in large objectives. As I had not used a large telescope for some eight years, I could not feel that my judgment was an entirely critical one; but I am persuaded, that, if any defects exist, they are so minute as not to interfere in the slightest with the finest performance of the instrument.

I have been led by the examination above described, combined with some experience in the use of the Washington telescope, to some conclusions respecting the most appropriate features in the mounting of an instrument of the largest size. They may here be enumerated for the consideration of those engaged in constructions of this kind.

1. I think, that, in order to secure the necessary stiffness with the least weight, the axes should be hollow. The material can then be made comparatively thin. It is true that the greater the friction, the larger the axis; but the mass of metal in the interior of the axis contributes so little to its stiffness that the external diameter will have to be increased very little to secure the same stiffness with the hollow axis as with the solid one.

2. It is not worth while to supply the declination-axis with friction-rollers, unless experiment and research shall show that they can be made more effective than they appear to be in the Vienna instrument.

3. The best quick motion in right ascension is that adopted in the Washington telescope, where the observer pulls an endless rope hand over hand, and can lock and unlock at pleasure the gearing which connects the turning-wheel with the telescope.

4. If, as is probable, the quick motion in declination by means of the loose rope attached to the two ends of the telescope requires too strong a pull, the best method of giving this motion is through a gearing turned by an axis passing centrally through the polar axis, on the Repsold plan; but it is desirable to have this motion made by turning a crank, or pulling a rope, rather than by taking hold of the wheel.

5. Coarse divided wheels should be supplied, so that the observer, while turning the instrument, can constantly see its approximate pointing. It is better if this coarse reading can be made with the naked eye, as is the case with the right-ascension movement in Washington. The declination-circle, being farther from the observer, has to be read with an opera-glass if more than a coarse fraction of a degree is required. By such an arrangement the telescope can always be set by the quick motion so nearly that any object sought shall be in the field of view of the finder. In nine cases out of ten this will be all that is required in practical use. It should never be forgotten that in all quick motions it is very desirable that the observer should be able to keep his eye upon the movements of the telescope itself, so to save him from even a groundless apprehension that something may be going wrong.

6. The slow motion should, if possible, be endless. There is no difficulty in making it so in right ascension: there may be, however, in declination.

7. When the instrument is so large that there is an interval of three feet or more between the centre of the polar axis and the side of the tube, the screw which communicates the clock-movement should be geared into a complete circle rather than into a sector. The use of a metal band to multiply the intervening radius of the wheel offers no advantage, in the case of large instruments, to compensate for the disadvantage of want of stability arising from elasticity of the band and its fastenings.

8. In this connection the question arises of applying the Greenwich system, which consists in setting the hour-wheel so that its position shall correspond to sidereal time, and clamping to it a second wheel corresponding to right ascension. Every practised astronomer is familiar with the trouble in setting an ordinary equatorial, arising from the necessity of having to calculate the constantly varying hour-angle of the object on which he points. With the Greenwich arrangement there is no such trouble. The worm-wheel being once set to sidereal time, the observer has only to set the other one to the constant right ascension of the object. It is true that practical difficulties arise in the usual construction, owing to the fact that the vernier on the gear-wheel will from time to time be on every point of the circle; but this difficulty can, I think, be obviated by appropriate arrangements.

9. A clock-motion which can be kept up by water or other power is greatly preferable to any system which requires an assistant to wind up a weight.

10. The entire practicability of illuminating the divisions of the circle by lamps, and of reading these divisions from the eye-end of the telescope, has been so completely demonstrated, that all large instruments should be supplied with this arrangement.

11. The system of illuminating wires, field-micrometer slit, etc., by a single lamp which

shall be vertical in all positions, has been so perfected by the Repsolds, that it leaves nothing to be desired.

12. The Washington plan of having the whole micrometer-plate, including both fixed and movable wires, moved by a fine screw, offers such a convenience in setting, that it should always be adopted.

13. The old system of having a single finder on that side of the telescope which is opposite the declination-axis becomes very inconvenient in a large instrument, owing to the necessity of setting the slit in the dome, not only to the telescope, but to the finder. The plan adopted in the Vienna telescope, of having two finders, — of which one shall be above, and the other below, the telescope when the latter is in the meridian, — obviates this difficulty, and should always be adopted.

THE AMERICAN AWARDS OF THE GEOLOGICAL SOCIETY OF LONDON.

WE give below the text of the addresses on the occasion of the awards to Dr. Leidy and Mr. Lesquereux at the annual meeting of the Geological society of London in the middle of last month.

The president handed the Lyell medal to Prof. W. H. Flower, F.R.S., for transmission to Dr. Joseph Leidy, F.M.G.S., and addressed him as follows: —

PROFESSOR FLOWER, — The council has bestowed on Dr. J. Leidy the Lyell medal, with a sum of twenty-five pounds, in recognition of his valuable contributions to paleontology, especially as regards his investigations on the fossil Mammalia of Nebraska, and the Sauria of the United States of America. These vast, and, in comparison with our own country, but little explored, territories have for some years past yielded a harvest of fossil vertebrate remains of exceeding richness, of which we have no example here. How well this harvest is being garnered by our trans-Atlantic *confrères* the flood of memoirs published by them during the last quarter of a century bears witness. Amongst these scientific laborers in the paleontological harvest-field, Dr. J. Leidy has held a foremost place. Careful in observing, accurate in recording, cautious in inferring, his work has the high merit which trustworthiness always imparts. The well-nigh astounding number of papers written by him between 1845 and 1873 (amounting to a hundred and eighty-seven), his reports on the 'Extinct vertebrate fauna of the western territories,' his 'Synopsis of the extinct Mammalia of North America,' and his 'Cretaceous reptiles of the United States,' testify to the fertility of his pen.

Professor Flower, in reply, said: — Mr. President, as I have profited so deeply by Dr. Leidy's paleontological writings, and also have the pleasure of his personal friendship, I was much gratified by his request, communicated to me by telegraph a few days ago, that I would represent him on this occasion, and receive from your hands the award which the council has so worthily bestowed. By the same means of communication, he mentions the interesting incident, that it was by Sir Charles Lyell's advice, given to him in Philadelphia about thirty years ago, that he was induced to abandon the study of medicine and take up paleontology. A letter which I understand Dr. Leidy has written, in which he doubtless has expressed his own thanks to you, has not yet reached me; but I am quite sure that this recognition of his valuable labors in that marvellously fruitful field of discovery, the extinct vertebrate fauna of North America, will be greatly appreciated by him and by his fellow-countrymen, by whom he is so justly esteemed.

The following is the letter from Dr. Leidy, mentioned by Professor Flower: —

PHILADELPHIA, PENN., 1302 FILBERT STREET,
Feb. 7, 1884.

MY DEAR SIR, — I have just this minute received your note of Jan. 25, and hasten to reply, that there may be no delay in my answer, for the anniversary meeting of Feb. 15. I was equally surprised and delighted at the action of the council of the Geological society in awarding to me the Lyell medal and its accompaniment. Such approbation of my services I regard as rich compensation, added to the pleasure derived from my labors. I must add that I feel as if Sir Charles Lyell himself was expressing satisfaction, in consideration of my having complied with his wish, when thirty years ago, in my own home here, he said he hoped I would devote my time to paleontology instead of medicine.

Please present to the Geological society my warmest thanks for the honor it has conferred upon me. I have written to Prof. W. H. Flower, asking him to receive the award on my account.

With sincere regard,

JOSEPH LEIDY.

MR. WARINGTON W. SMYTH,
For. sec. Geol. soc.

In handing to Professor Seeley, F.R.S., a second portion of the proceeds of the Barlow-Jameson fund for transmission to Professor Leo Lesquereux, F.C.G.S., the president spoke as follows: —

PROFESSOR SEELEY, — The council has awarded to Professor Leo Lesquereux the sum of twenty pounds from the proceeds of the Barlow-Jameson fund, in recognition of the value of his researches into the paleobotany of North America, and to aid him in further investigations of a similar kind. Professor Lesquereux's 'Contributions to the fossil cretaceous and tertiary flora of the western territories,' published in the 'Reports of the U. S. geological survey,' are works which, for their matter, typography, and illustrations, leave nothing to desire. In transmitting this award to Professor Lesquereux, you will convey to him the hopes of the council that it may assist him in prosecuting further investigations in the difficult branch of research in which he has already accomplished so much.

Professor Seeley, in reply, said: — Mr. President, I