

found in ventilating the tubes, *i.e.* making it of some open-work construction, in order that the air may pass through and across and remove currents of differing tem-

peratures. This difficulty is not felt with refractors; but, curious to say, in the largest refractor at present in existence (the Washington 26-inch), Prof. Newcomb informs

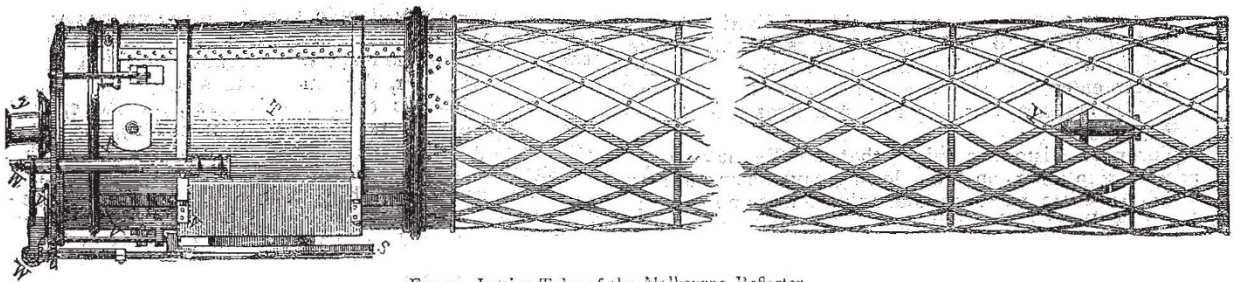


FIG 9.—Lattice Tube of the Melbourne Reflector.

me that considerable inconvenience is felt sometimes from the outside of the object-glass cooling down more quickly in the evening than the inside, which produces a decided effect on the spherical aberration, and injures temporarily the otherwise fine definition. He consequently recommends the use of lattice or ventilated tubes for very large refractors. If this be found necessary, this advantage of the refractor vanishes."

But there is another nice point concerning this larger aperture which has to be considered.

We may set out with observing that the light-grasping power of the reflector varies as the square of the aperture multiplied by a certain fraction representing the proportion of the amount of reflected light to that of the total incident rays. On the other hand the power of the refractor varies as the square of the aperture multiplied by a certain fraction representing the proportion of transmitted light to that of the total incident rays. Now in the case of the reflector the reflecting power of each unit of surface is constant whatever be the size of the mirror, but in that of the refractor the transmitting power decreases with the thickness of the glass, rendered requisite by increased size. Although for small apertures the transmitting power of the refractor is greater than the reflecting power of the reflector, still it is obvious that on increasing the size a stage must be at last reached when the two rivals become equal to each other. This limit has been estimated by Dr. Robinson to be 35'435 inches, a size not yet reached by our opticians by some ten inches, but object-glasses are increasing inch by inch, and it would be rash to say that this size cannot be reached within perhaps the lifetime of our present workers. However this may be we can say with safety that up to the present limit of size produced, refractors have the advantage in light-grasping power, and it is also a question whether with increase of thickness in the glass there will not be such an increase in the purity of material and polish as to keep the loss by transmission at its present value. Any one who has a Tully and a Cooke object-glass, by placing them side by side on a clean sheet of paper, will be able to see how our modern opticians have already reduced the loss by transmission.

The next point worthy of attention is the question of permanence of optical qualities. Here the refractor undoubtedly has the advantage. It is true

that the flint glass of some object-glasses, chiefly those produced in Germany, gets attacked by a sort of tarnish, still that is not the case generally, while on the other hand, metallic mirrors often become considerably dimmed after a few months of use, the air of a town seeming to be fatal to them, and although repolishing is not a matter of any great difficulty in the hands of the maker, still it is a serious drawback to be obliged to return mirrors for this purpose. There are, however, some exceptions to this, for there are many small mirrors in existence whose polish is good after many years of continuous use, just as on the other hand there are many object-glasses whose polish has suffered in a few years, but these are exceptions to the rule. The same remarks apply to the silvered glass reflectors, for although the silvering of small mirrors is not a difficult process, the matter becomes exceedingly difficult with large surfaces, and indeed at present large discs of glass, say of four or six feet diameter, can rarely be produced. If, however, a process should be discovered of manufacturing these discs satisfactorily and of silvering them, there are objections to them on the grounds of the bad conductivity of glass, whereby changes of temperature alter the curvature, and there is also a great tendency for dew to be deposited on the surface.

With regard to the general suitability for observatory work this depends upon the kind of work required, whether for measuring positions, as in the case of the transit instrument, where permanency of mounting is of great importance, or for physical astronomy, when a steady image for a time only is required. For the first purpose the refractor has decidedly the advantage, as the object-glass can be fixed very nearly immovably in its cell, whereas its rival must of necessity, at least with present appliances, have a small, yet in comparison considerable, motion.

The difficulty of mounting mirrors, even of large size, has now been got over very perfectly. This difficulty does not occur in the mounting of object-glasses of sizes at present in use, but when we come to deal with lenses of some thirty inches diameter, the present simple method will in all probability be found insufficient, but we anticipate that one will be adopted which will allow the permanent position of the object-glass to be retained.

J. NORMAN LOCKYER

(To be continued.)

OUR ASTRONOMICAL COLUMN

THE COMET OF 1106.—In Mr. Williams's account of the object observed by the Chinese in this year, and called a comet by Ma Twan Lin, we find the following note:—"This appears to have been a large meteor, as it seems to have been seen for a short time only." It is probable that the author had not compared Pingré's

description of the motion of the comet, which was certainly observed in Europe early in the year, or he would have seen that in all likelihood, notwithstanding Ma Twan Lin's account reads as if it referred to a temporary phenomenon, the Chinese really observed the bright comet recorded by the European historians. We are told that in the fifth year of the epoch Tsung Ning, on day Woo Seuh of the first moon (1106, Feb. 10) a

comet appeared in the west; it was like a great Pei Kow (a kind of measure). The luminous envelope was scattered; it appeared like a broken-up star. It was sixty cubits in length and three cubits in breadth. Its direction was to the north-east; it passed through Kwei, Lew, Wei, Maou, and Peih, which are sidereal divisions determined according to Biot by the stars β Andromedæ, β Arietis, α Muscæ, η Tauri, and ϵ Tauri respectively. "It then entered into the clouds, and was no more seen." Gaubil's manuscript, used by Pingré, assigns precisely the same course.

European historians relate that on February 4 (or according to others on the following day) a star was seen which was distant from the sun only "a foot and a half;" Matthew Paris and Matthew of Westminster call this star a comet. On February 7 a comet, properly so called, was discovered in Palestine in "that part of the sky where the sun sets in winter," its ray had "the whiteness of snow," and extended to the commencement of the sign Gemini, below the constellation Orion. As Pingré points out the comet must at this time have had a south latitude, and, considering the sun's position, could not be less advanced than 10° or 12° of Pisces to have been seen in the evening after sunset. The comet subsequently passed by west to north-west, the tail directed to that part of the sky between the north and the east; the comet was visible until the middle of the night, and "shone during twenty-five days in the same manner at the same hour;" as one writer states, it had a real motion from west to east. The length of the comet's appearance is variously given; an eye-witness says that the most piercing sight could hardly distinguish it after fifty days, and a manuscript consulted by Pingré, in the Bibliothèque de Sainte-Geneviève, of the thirteenth century at latest, mentions fifty-six days for the duration of visibility.

The comet of 1106 long attracted attention from the circumstance of Halley having identified it as the famous comet of 1680, an idea which was first disputed by Dunthorne, on the authority of a manuscript preserved in one of the College libraries at Cambridge, which gives the comet's track from the beginning of the sign Pisces (on February 7 as Dunthorne reads) in the order of the signs to the commencement of Cancer, which agrees closely with the path recorded by the Chinese. He considered that this track "quite overbalanced the probability of the identity of the comet with that of 1680"—and this view has been confirmed by subsequent calculation. Again, when astronomers were searching for earlier accounts which might refer to the great comet of 1843, first detected at noon-day on the date of its perihelion passage, this comet of 1106 was fixed upon by MM. Laugier and Mauvais, as probably identical with it, several of the circumstances mentioned above being overlooked by them, particularly the fact of the comet having been observed so long in the northern part of the heavens, where it is impossible that the comet of 1843 could be located.

On carefully weighing the scanty evidence afforded by the records of the time, it appears likely that the elements of the comet of 1106 bore some resemblance to those of the great comet of 1618 (Pingré's third comet), the inclination being smaller.

THE SATELLITES OF MARS.—Both of the newly-discovered satellites of Mars were observed during September with the 12-inch equatorial of the Morrison Observatory, Glasgow, Missouri, by Mr. Pritchett. On September 7 the two satellites could be seen with the planet entirely in the field, and were very distinct when it was shut out of it, and on September 10 and 13, the inner one was easily observed. The outer satellite was again estimated to be of the fourteenth magnitude. The observations of this satellite were made with wires faintly illuminated with a red light; for observations of the inner one the light of the planet sufficed. Unfavour-

able skies prevented any observations in October, though Mr. Pritchett thinks the satellites might have been well followed during that month.

COLOURED DOUBLE STARS.—In Sir John Herschel's seventh catalogue of double stars from the sweeps with the 20-foot reflector is one the position of which identifies it with Σ 724, and the note attached runs thus: "A very curious double star, the small star is very red." The observation belongs to sweep No. 121, for the epoch 1828.05. Struve measured this object in 1829, but says nothing respecting the colours of the components, which he estimated on his scale 8.7 and 10.0. In 1829.85 the angle was 241.5° , and the distance 6.86". Has any one confirmed Sir John Herschel's observation on the colour of the smaller star? The position for 1878.0 is in R.A. 5h. 33m. 30s., N.P.D. $79^\circ 5' 5''$.

In *Memorie dell' Osservatorio del Collegio Romano*, 1857-59, p. 173, Secchi mentions a wide double star, which is called *nova*, and is thus measured:—

1856.63 Pos. $335^\circ 25'$ Dist. $23'' 83$ { Components 7m. and 8m.
A red, B blue.

He has the additional remark, "*Colori superbi.*" This object would appear to be formed by Nos. 3743 and 3744 of Zone + 37° of the *Durchmusterung*; positions for 1855.0:—

	R.A.	h. m. s.	N.P.D.	μ
3743	R.A.	19 58 23.5	N.P.D.	52 4.1
3744	"	19 58 25.5	"	52 4.7

THE TALKING PHONOGRAPH¹

MR. THOMAS A. EDISON recently came into this office, placed a little machine on our desk, turned a crank, and the machine inquired as to our health, asked how we liked the phonograph, informed us that it was well, and bid us a cordial good night. These remarks were not only perfectly audible to ourselves, but to a dozen or more persons gathered around, and they were produced by the aid of no other mechanism than the simple little contrivance explained and illustrated below.

The principle on which the machine operates we

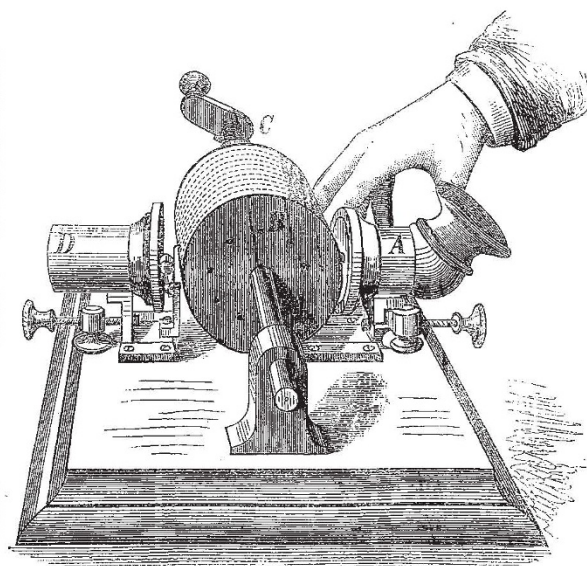


FIG. 1.

recently explained quite fully in announcing the discovery. There is, first, a mouth-piece, A, Fig. 1, across the inner orifice of which is a metal diaphragm, and to the centre of this diaphragm is attached a point, also of metal. B is a

¹ From the *Scientific American* of December 22, 1877.