



CATALOGUE LIBRARY

*Catalogue*  
of

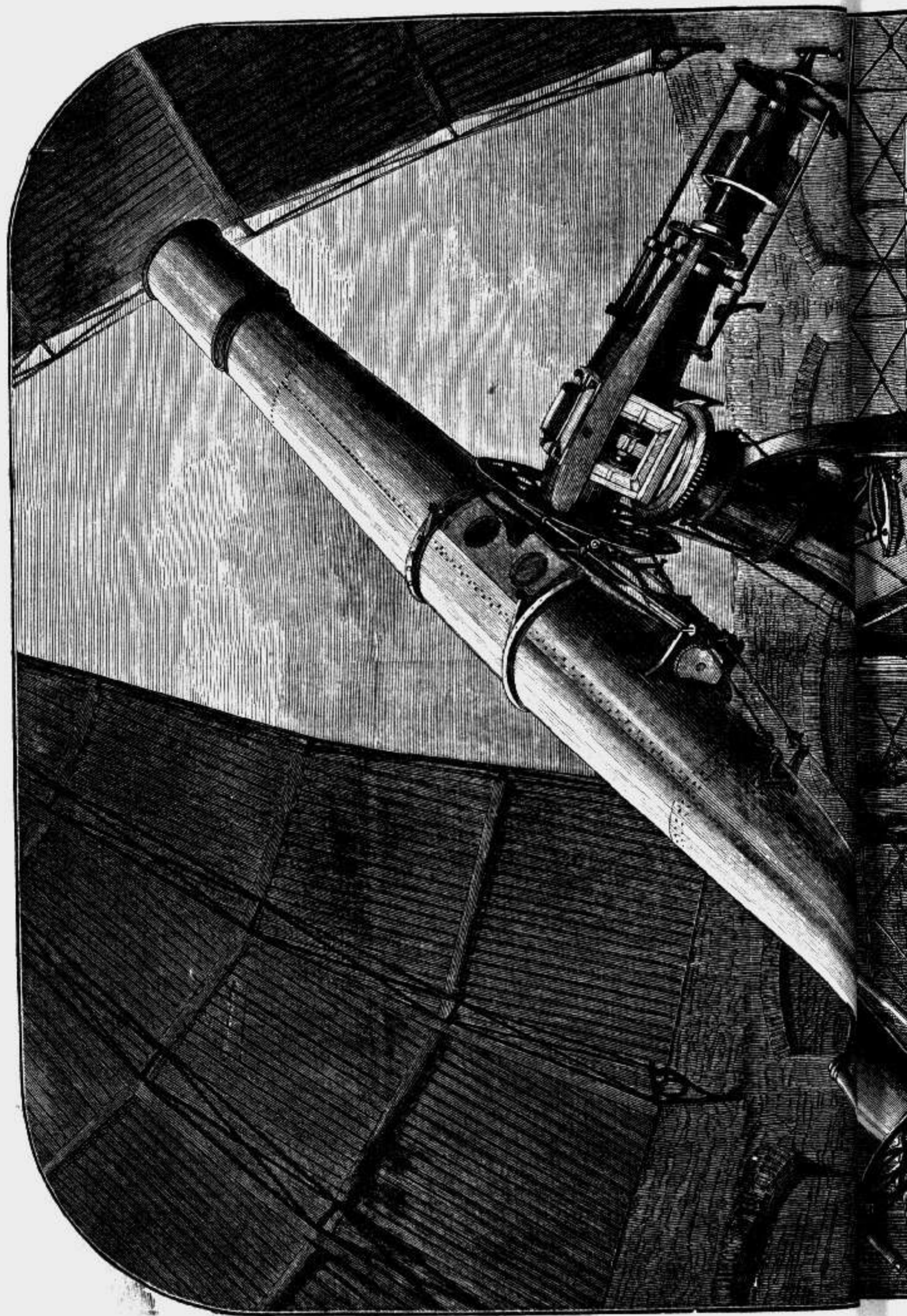
NOV 17 1931

REFERENCE

*Astronomical*  
and  
*Observatories,*  
of

*Sir Howard Grubb,*  
*Dublin.*

1888.







**GREAT EQUATORIAL FOR THE NEW OBSERVATORY, VIENNA.**

*27 INCHES APERTURE.*

CONSTRUCTED BY SIR HOWARD GRUBB, DUBLIN.

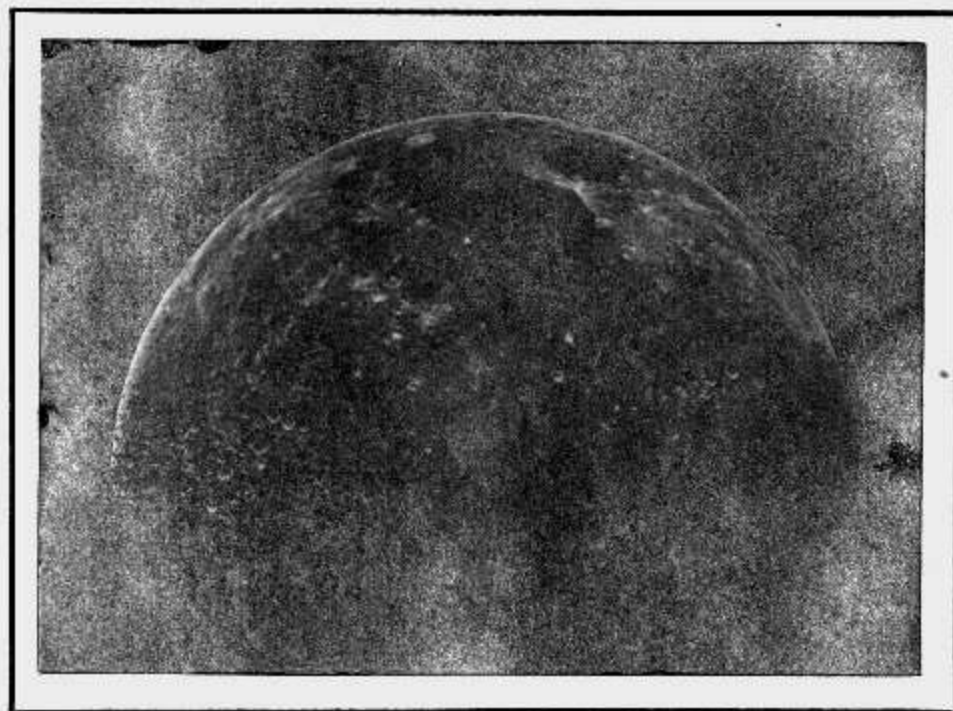
Copied, by permission, from the *Illustrated London News*, 1881.

522.100  
G7i  
1888

AN  
❖ ILLUSTRATED CATALOGUE ❖  
OF  
ASTRONOMICAL ❖ INSTRUMENTS,  
OBSERVATORIES, ETC.

Manufactured by  
SIR HOWARD GRUBB,

*Fellow of the Royal Society of London; Fellow of the Royal Astronomical Society of London; Honorary Master of Engineering, University of Dublin; Honorary Member of the Institute of Civil Engineers, Ireland; Cunningham Gold Medallist, Royal Irish Academy; Late Vice-President of the Liverpool Astronomical Society; Vice-President Photographic Society of Ireland; etc., etc.*



Photographed by the Great Melbourne Telescope.

ASTRONOMICAL INSTRUMENT WORKS: RATHMINES, DUBLIN.

London Agency: Messrs. WATSON & SONS, 313, High Holborn.

1888.

WATSON & SONS  
11 19  
LIBRARIES

SIR HOWARD GRUBB,

*Astronomical Instrument Maker  
and Contractor*

TO THE

BRITISH, COLONIAL, & FOREIGN GOVERNMENTS.

**CONTRACT TERMS.**

IN the case of orders of £100 and upwards payment is required in instalments—one-third with order, one-third when work is well advanced, and one-third on completion.

Every facility is given by SIR HOWARD GRUBB to have all optical work thoroughly tested before leaving his establishment, either by the purchaser or any person the purchaser may depute to act as his agent.

Packing and delivery on rail or steamboat in Dublin is charged 5 per cent. on mechanical work and 2½ per cent. on optical work.

For the convenience of customers residing in England, SIR HOWARD GRUBB has appointed MESSRS. WATSON & SONS, of 313, High Holborn, as agents for the sale of his Astronomical Instruments. A few patterns of his smaller instruments can generally be seen in their showroom.



# Sir Howard Grubb

HAS WITHIN THE LAST FEW YEARS EXECUTED IMPORTANT  
ASTRONOMICAL WORK FOR

## THE GOVERNMENTS OF

AUSTRIA, BELGIUM, CHINA, GERMANY, INDIA, ITALY, MEXICO, RUSSIA, SPAIN,  
SOUTH AUSTRALIA, VICTORIA, AND GREAT BRITAIN (ADMIRALTY, INDIA  
OFFICE, OFFICE OF WORKS, ETC.).

ALSO FOR

## THE UNIVERSITIES OF

OXFORD, DUBLIN, QUEEN'S, GÖTTINGEN, AND MANY IN AMERICA.

ALSO FOR

THE ROYAL SOCIETY, ROYAL ASTRONOMICAL SOCIETY, ASTRONOMICAL SOCIETY  
OF LIVERPOOL, ROYAL DUBLIN SOCIETY, ROYAL IRISH ACADEMY, INSTITUTE  
OF ROYAL ARTILLERY, ETC.

And for the following as well as many other observatories :—

## IN GREAT BRITAIN.

GREENWICH; DR. HUGGINS, DUBLIN; EDINBURGH, ARMAGH, CORK, MARKREE,  
DUN ECHT; MR. CHAMBERS, EASTBOURNE; SIR HENRY THOMPSON, HAMPTON;  
MR. ROBERTS, LIVERPOOL; MR. McCLEAN, TUNBRIDGE; MR. COOKE, GOMERSAL;  
MR. LOCKYER, MAJOR MAXWELL, MAJOR REMINGTON, AND MR. WILSON,  
WESTMEATH.

## IN THE COLONIES.

SYDNEY, MELBOURNE, CASTLEMAINE, WELLINGTON, N.Z., CAPETOWN, DURBAN,  
TRANSVAAL, BOMBAY, MADRAS.

## IN AMERICA.

YALE COLLEGE, FRANKLIN COLLEGE, PRINCETOWN; LICK OBSERVATORY, SAN  
FRANCISCO; TEXAS, GEORGETOWN, S.A.; CARACAS, SANTIAGO, CHAPULTEPEC,  
TACUBAYA (MEXICO), HAVANNAH.

ALSO IN

VIENNA, BERLIN (POTSDAM), DRESDEN, GÖTTINGEN, BRUSSELS, LIEGE, LOUVAIN,  
MOSCOW, KASAN (SIBERIA), ROME, CONSTANTINOPLE, CADIZ, SAN FERNANDO,  
PEKIN, NAPLES, ACI REALE (SICILY).

# SIR HOWARD GRUBB'S

## TELESCOPIC OBJECTIVES.

\*\*\*\*\*

The superiority of these Objectives—now universally acknowledged in Great Britain, Germany, and America—has induced imitations. SIR HOWARD GRUBB, therefore, desires to recommend that no Objectives purporting to be of his make be purchased indirectly, except accompanied by a letter of identification from himself.

The Cells of all these Objectives, up to and including those of eight inches diameter, are of brass, and above that size of cast iron or cast steel, the expansive properties of these metals approaching more nearly that of the glass.

The foci of these Objectives are generally from twelve (for small sizes) apertures to sixteen apertures. Special foci, however (within moderate limits), can be ordered without incurring much additional expense.

+-----+

### PRICES OF OBJECTIVES AND CELLS.

Diameter. Inches.	£		Diameter. Inches.	£
3	12	+	12	380
4	21	+	15	650
5	35	+	18	1,000
6	55	+	20	1,400
7	80	+	25	2,000
8	110	+	27	2,600
9	160	+	28	3,000
10	220	+		

No larger sizes than twenty-eight inches have yet been made, but estimates can be given for Objectives up to thirty-six inches aperture.

\*\*\*\*\*

### Dr. H. C. VOGEL'S opinion of the Objective of the Great Vienna Refractor.

(*Publicationem des Astrophysikalischen Observatorium zu Potsdam, Vol. IV., p. 7.*)

"In the spring months (1883), when there were several consecutive days of exquisitely clear weather, I got the impression that the object glass was rather good, but that the images, as regards sharpness, were not to be compared with those of middle-sized instruments, and on leaving Vienna I had formed the opinion that the difficulties of producing so large Objectives had not been quite surmounted, and that the advantages of large object glasses principally consisted in the amount of light, through which much detail would be revealed (though not with the sharpness of middle-sized instruments), which by a smaller amount of light would quite escape the eye of the observer.

"But by my observations in September this opinion was completely upset. I have acknowledged that the Vienna Objective, as regards the precision of the image, leaves nothing to be desired, and that it was only from want of taking the state of the air properly into account that I had formed my former opinion. I have with advantage, on splendidly-clear evenings in September, used a power of 1,000, and even of 1,500, and perceived the fine details of planetary discs with admirable sharpness. The images of bright stars were of perfect regularity, and the central part of the diffraction disc was so remarkably small that it may be expected that the instrument would also be very suited for observing double stars."

SIR HOWARD GRUBB having devoted a considerable amount of attention to the above during the past year, is now prepared to furnish Objectives corrected according to the conditions laid down at the Paris International Astronomical Congress of 1887, and capable of giving good definition over a large field.

4-inch	...	...	...	£18	9-inch	...	...	...	£140
5-inch	...	...	...	30	10-inch	...	...	...	200
6-inch	...	...	...	48	12-inch	...	...	...	340
7-inch	...	...	...	70	13·1-inch	...	...	...	400
8-inch	...	...	...	100					

**Note**—That these Objectives are useless for Visual Observations.

Useable either for Visual or Photographic purposes.

The preparation of this form of Objective is more troublesome, and therefore the prices are somewhat higher, but for Amateurs who desire to prosecute this branch of Astronomy, and who do not wish to incur the expense of a second Telescope this form will be found very valuable.

4-inch	...	...	...	£25	9-inch	...	...	...	£180
5-inch	...	...	...	40	10-inch	...	...	...	250
6-inch	...	...	...	60	12-inch	...	...	...	420
7-inch	...	...	...	95	13'1-inch (Standard size)				500
8-inch	...	...	...	125					

**Foci from 5 to 10 Diameters.**

Diameter.		Silver on Glass.		Speculum Metal.		Diameter.		Silver on Glass.		Speculum Metal.	
9-inch	...	...	£15	...	£20	24-inch	...	...	£180	...	£200
12-inch	...	...	36	...	48	36-inch	...	...	350	...	400
15-inch	...	...	72	...	90	48-inch	...	...	700	...	750
18-inch	...	...	100	...	120						

No larger sizes than 48-inch have as yet been made, but estimates for larger sizes can be obtained on application.



## →\* SMALL INSTRUMENTS. \*←

(SUITABLE FOR UNIVERSITY STUDENTS.)

At the request of several University Professors SIR HOWARD GRUBB has undertaken to produce a few instruments for Students' use, in which all unnecessary finish and elaboration is dispensed with, and the most rigid economy practised in all stages of preparation; particular attention being only paid to the optical parts, and such few mechanical parts as are absolutely necessary in order to do justice to the optical parts.

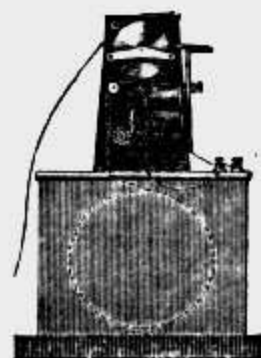
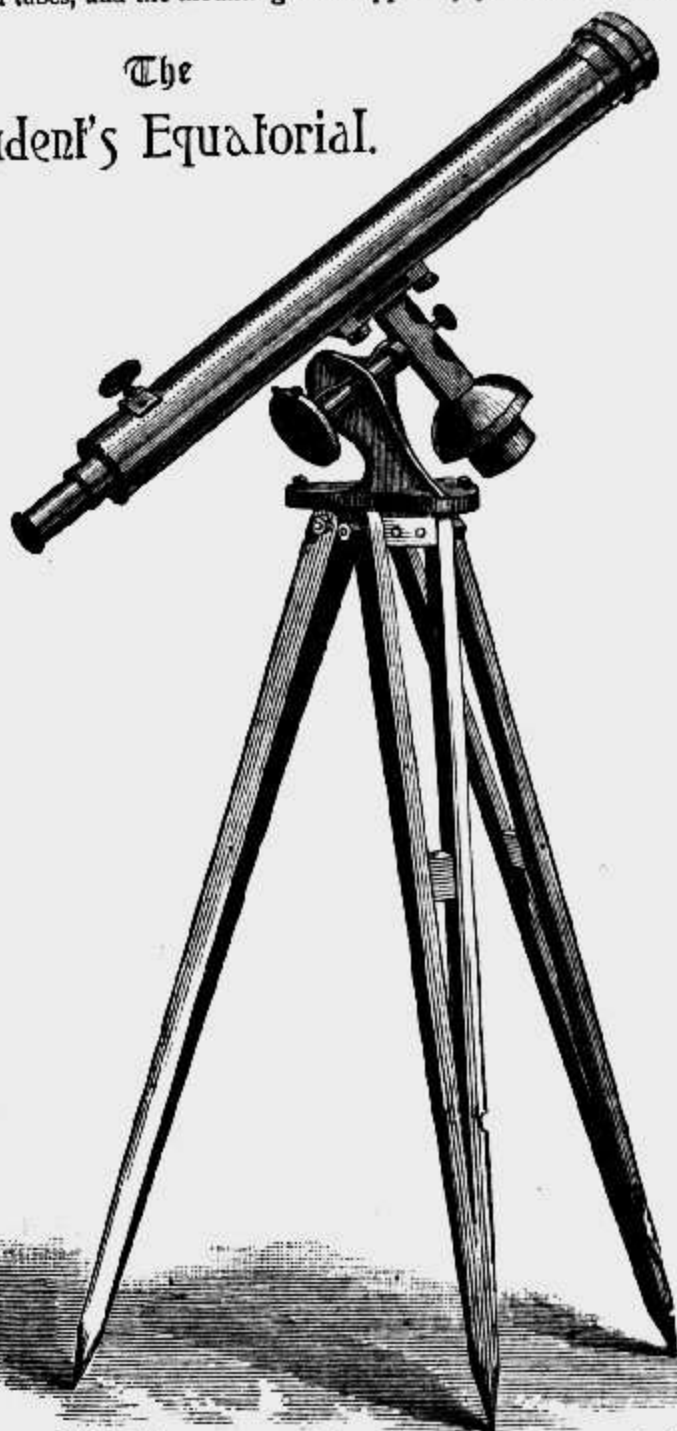
To carry out the above requirements, the mechanical parts are made for the most part of malleable and cast iron, and the divisions of the circles are on cardboard discs, which, being printed from an accurately-engraved plate, are considerably more reliable than inferior dividing on metal, and can be easily replaced when required. The Telescopes are in brass, nickel-plated, or japanned tubes, and the mountings are supplied japanned or otherwise finished as desired.

### The Student's Equatorial.



#### STUDENT'S TRANSIT INSTRUMENT,

As above, aperture  $1\frac{1}{2}$  inch, divided setting circle, striding level, adjustments in altitude and azimuth, mahogany case for telescope and level, and tin cover to protect mounting when not in use. This allows mounting to be erected permanently in open air, the telescope being placed in position only when required for use ... .. £12



#### STUDENT'S CHRONO- GRAPH,

Morse Type, recording observations on paper ribbon, the one pen recording the seconds from clock and transit of star; as used in American observatories ... £8 8s.

Two-cell Leclanche battery for working above, 18/-

3-inch Student's Equatorial Telescope, as above, with two astronomical eyepieces, sun glasses, and tripod stand; the telescope and eyepieces packed in mahogany case ... ..	£22 10 0
The following parts of above Equatorial can be had separately at the following prices:—	
3-inch Equatorial complete, but without mahogany case or tripod stand ... ..	£18 0 0
Unmounted Telescope, with two eyepieces ... ..	12 0 0
Equatorial Head, without tripod ... ..	8 0 0
A similar Telescope to above, of 2½-inch aperture, without tripod or mahogany case ... ..	£14 0 0
<b>COMPLETE STUDENT'S OBSERVATORY.</b>	
3-inch Equatorial, Transit Instrument, and Chronograph, as above ... ..	£42 0 0
Wooden Observatory, 8 feet square, with sliding roof ... ..	15 0 0

The Prices on this page include packing and delivery in London.

# Small and Portable Equatorials.

## CLASS B.

UP TO 5-INCH APERTURE.

### A LIGHT PORTABLE EQUATORIAL

on Metal Pillar, with circles divided on gun metal, slow motions, and clamps of improved construction, adjustments for latitude and azimuth, and finder telescope, 3 negative eyepieces, Hooks-joint handle, etc.

#### PRICES.

4-inch Telescope	. £52 10 0
4½-inch Telescope	. 63 0 0
5-inch Telescope	. 73 10 0

### THE SAME INSTRUMENT

Supplied with clockwork (frictional governor), and differential hour circles, etc.

#### PRICES.

4-inch Telescope	. £63 0 0
4½-inch Telescope	. 73 10 0
5-inch Telescope	. 84 0 0

**WOODEN OBSERVATORY,** 12 feet square, with sliding roof, for use with the above instrument, £21.

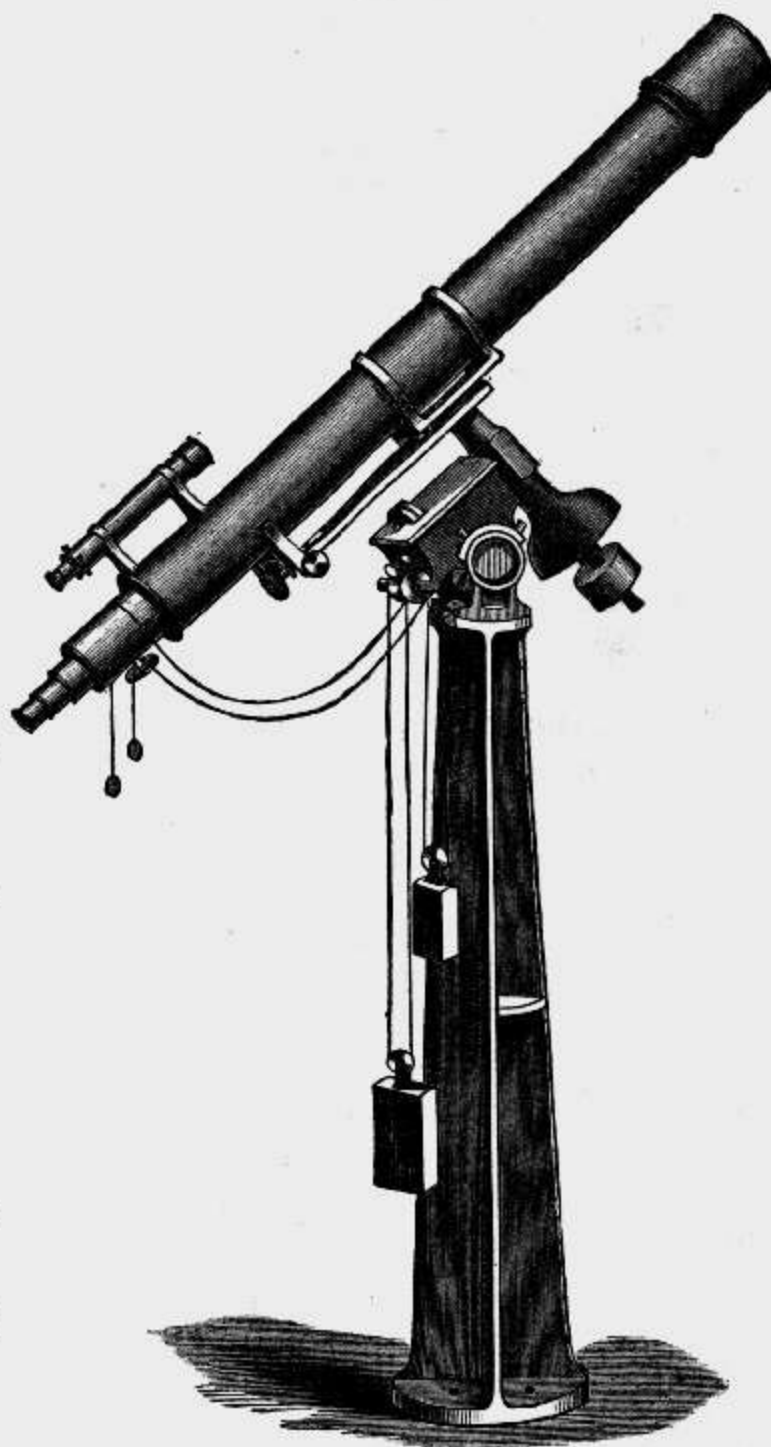
*The Prices on this page include Packing and Delivery in London.*

## SIR HOWARD GRUBB'S NEW BINOCULAR TELESCOPE

As exhibited in Manchester Exhibition, with prismatic erecting eyepieces (see page 17), especially adapted for terrestrial observations.

With pair of 4-inch Objectives,	£60 0 0.
With pair of 5-inch Objectives,	90 0 0.
With pair of 6-inch Objectives,	130 0 0.

Tripod,	£6 6 0 extra.
Tripod,	6 6 0 extra.
Tripod,	8 8 0 extra.



# — Small and Portable Equatorials. —

## CLASS B\*.

4 TO 8-INCH APERTURE.

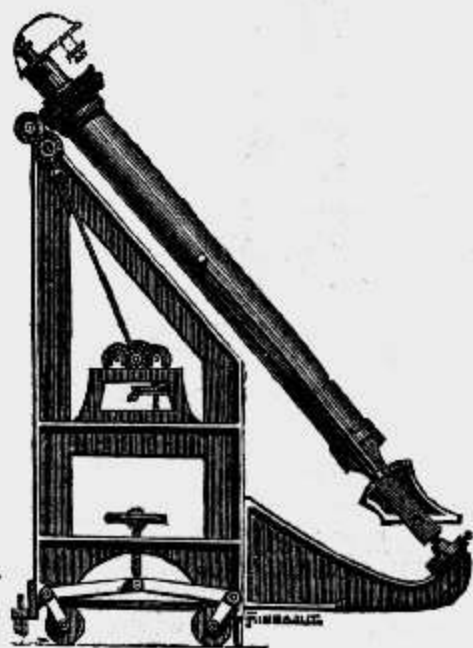


Of more solid and substantial construction than Class B, and with larger circles and superior clockwork. Hour and declination circles divided on gun metal; hour circle read by one vernier in usual manner, declination circle read by two opposite verniers. Rack and pinion eye-end, improved clamp and slow motion. Clockwork of best construction, not including control, see page 17; means of adjusting clock-rate accurately and conveniently, etc.; adjustment in altitude and azimuth to an almost unlimited extent; all the slow motion and clamping arrangements available from eye-end of Telescope; four negative eyepieces, finder, etc.



Price, with 4-inch Telescope	. £90
Price, with 5-inch Telescope	. 130
Price, with 6-inch Telescope	. 180

## NEW FORM OF SIDEROSTATIC TELESCOPE.



Complete with four-inch Objective and corresponding plane mirror, clockwork, etc., etc., £90.



A most convenient form of instrument for star-gazing purposes. The Objective and Mirror (when in use) are outside the Observatory; the eyepiece inside. All the advantages of good definition due to working in open air are thus obtained, combined with the utmost degree of personal comfort to the observer himself, situated in the interior of the building. For full description of this instrument, see paper by Sir Howard Grubb in Proceedings Royal Dublin Society.



# \* PORTABLE \* EQUATORIALS. \*

## CLASS C.

FOR

REFRACTING TELESCOPES of 6 to 10 INCHES APERTURE,

AS SUPPLIED TO THE

*Belgium Government, for Texas and Santiago Transit Expeditions;**Spanish Government, for Havanah;**Mexican Government, for Chapultepec; H.M. Lords of  
Admiralty, for Capetown;**New Observatory, Durban; Government Observatory at Sydney;*AND MANY PRIVATE OBSERVATORIES IN ENGLAND, BELGIUM,SOUTH AFRICA, AUSTRALIA, TURKEY, ETC.


---

Price, with 6-inch Telescope	£240
„ 7-inch „	330
„ 8-inch „	475
„ 9-inch „	660
„ 10-inch „	800

---

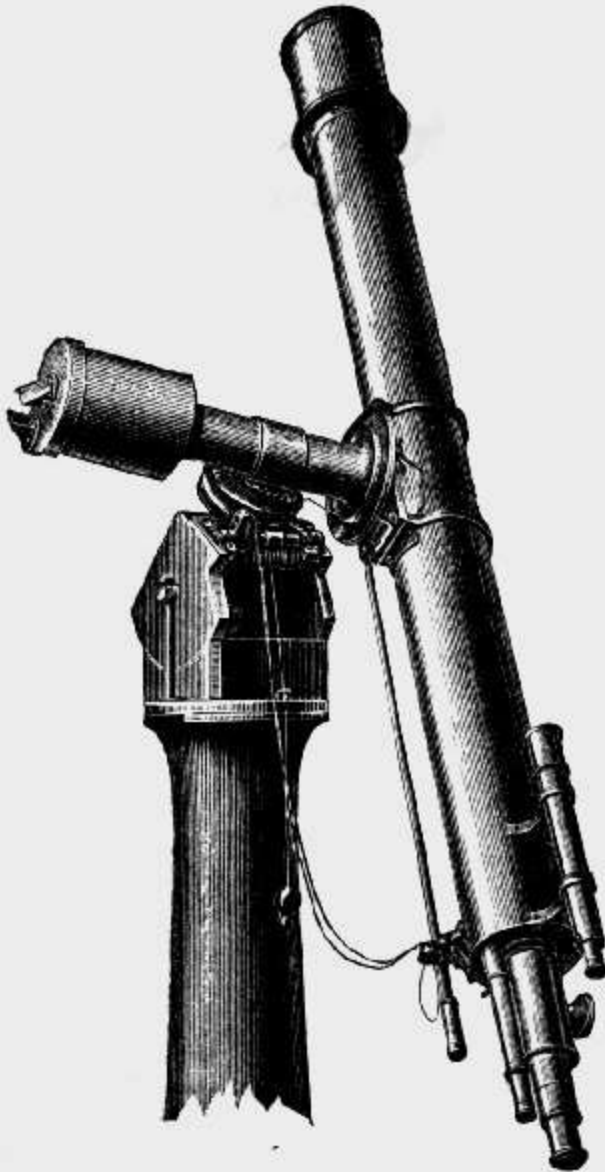
### THE SPECIFICATION \* \* \* \* \*

of above very efficient form of instrument includes two right ascension and one declination circle, divided on silver to such graduation as purchaser desires; right ascension circles arranged for differential readings; declination circle read by two opposite verniers, one of which can be viewed from eye-end of telescope by microscope; bright field illumination for micrometer; transparent position circle; breech piece and eye-end of SIR HOWARD GRUBB'S improved form, as described at the Brighton Meeting of the British Association, containing quick and slow motion for position angle, clamping arrangement, etc.; SIR HOWARD GRUBB'S improved clamps and slow motion, as described at the Glasgow Meeting of the British Association, 1876; clockwork of best construction (not including control [see page 17]); means of adjusting clock-rate accurately and conveniently, maintaining power, etc.; quick motion in right ascension for setting telescope while reading right ascension circles; adjustments for latitude and azimuth; all the slow motions and clamping arrangements, and the reading of one vernier of the declination circle, available from the eye-end of telescope; four negative eyepieces, finders, etc., etc.

New electric illumination arrangements fitted to above Telescopes, if desired, at an extra cost of from £10 to £25 (including batteries).



## The Clampless Equatorial.



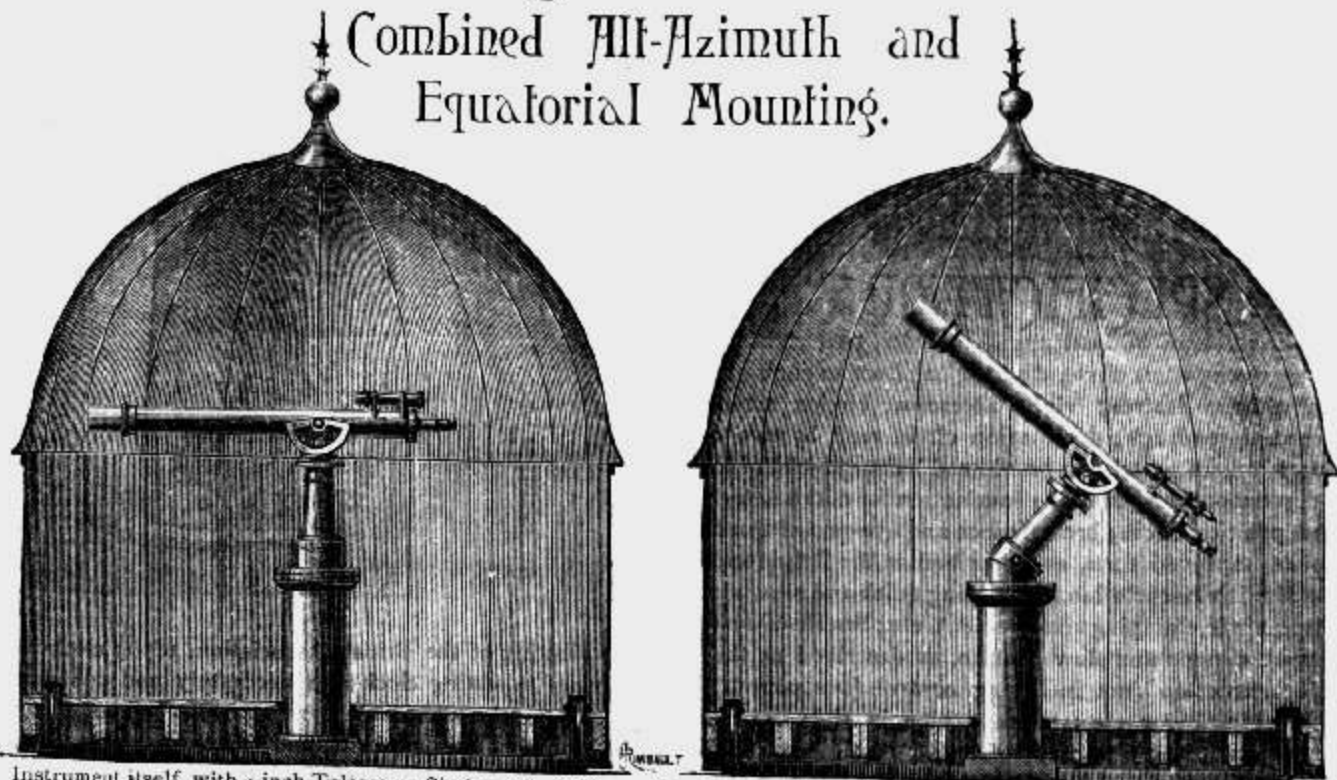
This form is probably more convenient than any other for small instruments. The polar axis is enclosed in an outer case or "sleeve," to which the driving circle is attached. The telescope therefore is entirely free at any time to be moved for setting purposes (without unclamping), but immediately on being released it partakes of the movements of the outer sleeve, which is carried by the clockwork, and in which it (the polar axis) rests. The declination axis is similarly mounted, so that slow or quick motions are available without any clamp.

The instrument figured in cut (described in *Engineering* of December 30th, 1887,) is most completely fitted up, with electric illumination to all verniers and a reader enabling the observer to read the right ascension and declination circles from eye-end, the electric lamp lighting up automatically when reader is brought into position.

Price for above instrument complete, with a 4-inch

Telescope	...	...	...	...	...	£100
Ditto	ditto	ditto	5-inch Telescope	...	...	£140
An instrument on similar principle, but without the reading and illumination arrangements above mentioned, with a 4-inch Telescope						
Ditto	ditto	ditto	5-inch Telescope	...	...	£80
						£120

## Combined Alt-Azimuth and Equatorial Mounting.



Instrument itself, with 4-inch Telescope, Circles, etc., £60. Complete, with Revolving Dome, Observatory and Flooring, £90.  
A convenient form of "Smeaton's Block," capable of being changed from Alt-azimuth to Equatorial, or *vice versa*, in a few seconds by simply revolving pillar 180°, on stand. Very suitable for Coast Observatories. The whole Observatory and floor revolves on wheels.

# ✧ GRUBB'S STANDARD EQUATORIALS. ✧

AS SUPPLIED TO THE OBSERVATORIES OF—

TULSE HILL (DR. HUGGINS).  
 OXFORD (REV. PROFESSOR PRITCHARD).  
 DRESDEN.  
 DUN ECHT (EARL CRAWFORD AND BALCARRES).  
 DUNSINK (DR. BALL).  
 ARMAGH (DR. DREYER).  
 MAGHULL, LIVERPOOL.  
 CARACAS, VENEZUELA.



VIENNA (DIR. VON LITTROW AND DR. WEISS.)  
 BERLIN, POTSDAM (DR. H. C. VOGEL).  
 CORK.  
 YALE COLLEGE, U.S.  
 CHAPULTEPEC } MEXICO.  
 TACUBAYA }  
 BOMBAY.

AND

\* Many \* Private \* Observatories ; \*

AND OF THE FORM AND CONSTRUCTION OF THAT WHICH OBTAINED THE  
**GOLD MEDAL**

*At the late Paris Exhibition, and the Cunningham Gold Medal of the Royal Irish Academy.*

See page 13.

THE application of Equatorial Telescopes to the various branches of physical research has necessitated the adoption of numerous new contrivances of a labour-saving nature, and a large increase to the various matters of detail applicable for one purpose or another. As the prices of Equatorials depend to a very large extent on the amount of refinement and detail expended on them, SIR HOWARD GRUBB has, for convenience sake, in the Price List, etc., page 12, divided Refracting Equatorials into two classes—A and B. A expresses the most elaborate and perfect construction, B the simplest and least elaborate. The workmanship of both, so far as it goes, is equally perfect. It is to be understood that purchasers can obtain any of the particular appliances mentioned without the others. They have been classified into the two groups for simplicity sake, and to avoid a complex Price List of small details.

---

**FOR SPECIFICATIONS, SEE PAGE 12.**

---

**FROM "ENGINEERING," OCTOBER 10, 1879.**

"Among the many beautiful objects which formed the splendid collection of scientific apparatus in the Paris Exhibition of 1878, there was none which surpassed in interest the fine Equatorial Telescope exhibited by MR. HOWARD GRUBB, F.R.S., of Dublin, and of which we publish above a perspective view."

"The name of MR. HOWARD GRUBB is now a sufficient guarantee that the perfection of workmanship with which the whole instrument is carried out is in every respect worthy of its original and beautiful design, and we must congratulate him upon having so grand an opportunity of showing to what further refinement and perfection modern mechanical science can save the valuable time of the astronomical observer as that which he has before him in the completion of the largest Equatorial Refractor in the world, which will before long be at the disposal of the Austrian Government."



# GRUBB'S STANDARD EQUATORIALS—(Continued).

(SEE OPPOSITE PAGE).

## SPECIFICATION A.

**I**NCLUDES two right ascension and one declination circle of as large size as practicable, divided on silver to such graduation as the purchaser desires; first right ascension circle read by two opposite verniers in the usual manner, second right ascension circle read by one vernier and bent microscope from eye of telescope, declination circle read by two verniers and microscope from eye-end of telescope. Dark and bright fields of micrometer, and the verniers of right ascension and declination circles illuminated by electric lamps. Transparent position circle also illuminated by electric lamp. Eye-end and breech piece of SIR HOWARD GRUBB'S improved form, as described at the Brighton Meeting of the British Association, containing quick and slow motions for position angle, clamping arrangements, etc., etc. SIR HOWARD GRUBB'S improved clamps and slow motions, as described at the Glasgow Meeting of the British Association, 1876; clockwork of best construction (not including control [see page 17]), with GRUBB'S frictional governor; means of adjusting clock-rate accurately and conveniently; maintaining power; lunar wheels for instantaneously changing to lunar rate (in sizes of twelve inches and over the internal anti-fractional arrangements of the late MR. THOS. GRUBB, F.R.S., are introduced); quick motion in right ascension for setting telescope while reading right ascension circle; adjustments for latitude and azimuth to a small extent, sufficient to allow for inaccuracy in laying the pier; all the slow motions, clamping arrangements, and reading of all circles available from the eye-end of the telescope; six negative eyepieces; micrometer (page 16), with six positive eyepieces; finder or finders, etc., etc. Barlow lens, batteries, etc. Electric current carried by insulated circles and wipers through the various axes.

## SPECIFICATION B.

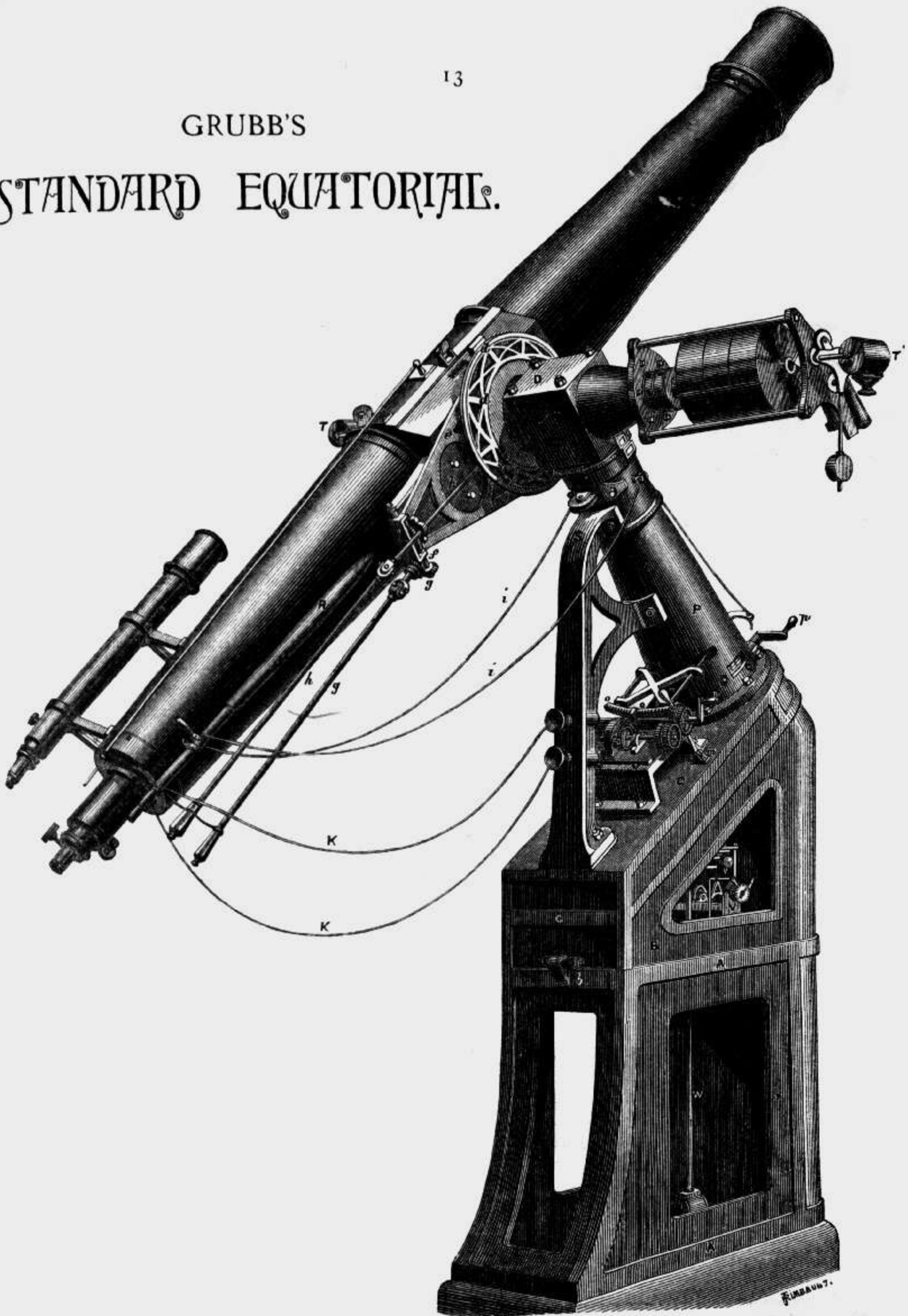
**I**NCLUDES one right ascension and one declination circle, divided on gun metal to such graduation as purchaser desires; right ascension circle read by one or two verniers in the usual manner; declination circle read by two opposite verniers, one of which can be viewed from eye-end of telescope by microscope; bright field illumination for micrometer; breech piece and eye-end, containing quick and slow motion for position angle, clamping arrangement, etc.; SIR HOWARD GRUBB'S improved clamps and slow motion, as described at the Glasgow Meeting of the British Association, 1876; clockwork of best construction (not including control [see page 17]); means of adjusting clock-rate accurately and conveniently, maintaining power, etc. (in larger sizes lunar wheels for instantaneously changing to lunar rate, and internal anti-fractional arrangements of the late MR. THOS. GRUBB, F.R.S., are introduced); quick motion in right ascension for setting telescope while reading right ascension circles; adjustments for latitude and azimuth to a small extent, sufficient to allow for inaccuracy in laying the pier; all the slow motions and clamping arrangements, and the reading of one vernier of the declination circle, available from the eye-end of telescope; four negative eyepieces; finders, etc., etc.

## Price List of Equatorially-Mounted Refractors.

Diameter of Objectives.	See Specification A.	See Specification B.
7	£550	£470
8	650	550
10	950	800
12	1,300	1,100
15	1,800	1,500
18	2,600	2,200
21	3,500	2,800
24	5,000	...
27	7,000	...

It may be understood that these prices can be considerably modified by circumstances. For instance, in all of the sizes up to fifteen inches the equatorial quoted for each size would very well carry a size above. The prices quoted above are for the *very best and most suitable* sizes and proportions.

# GRUBB'S STANDARD EQUATORIAL.



Copied, by permission, from "Engineering."

# EQUATORIALS

Specially constructed for the International Photographic Survey of the Heavens.



**D**URING the year 1887 SIR HOWARD GRUBB has devoted considerable attention to the production of instruments suitable for the International Photographic Survey of the heavens, and has now in process of construction for the British, Colonial, and Mexican Governments, and for the Universities of Oxford and Queen's College of Ireland, instruments of the class figured on this page.

The chief peculiarities of these instruments are—

- 1st. Specially corrected objective (see page 5).
- 2nd. New system of equipoise, by which the *entire weight* of the moving parts are transferred to the *base* of the stand.
- 3rd. An entirely new arrangement of clockwork and electric control (partly on Dr. Gill's and partly on Sir Howard Grubb's latest principle), by which the error of the driving gear is reduced to  $\frac{1}{8}$  of a second for the whole period of exposure (about 1 hour).

To ensure the extraordinary accuracy required in the production of these instruments, it has been necessary to construct some new machinery which is now (January 1888) just complete, and SIR HOWARD GRUBB expects that with the aid of this machinery, and by using exceptional precautions, these Equatorials, when complete, will more than fulfil the required condition.

## PRICES.

For 6-inch Equatorial complete	...	£500
8-inch                   "                   "	...	700
10-inch               "               "	...	900
12-inch               "               "	...	1200
13.1-inch, Standard size	...	1400



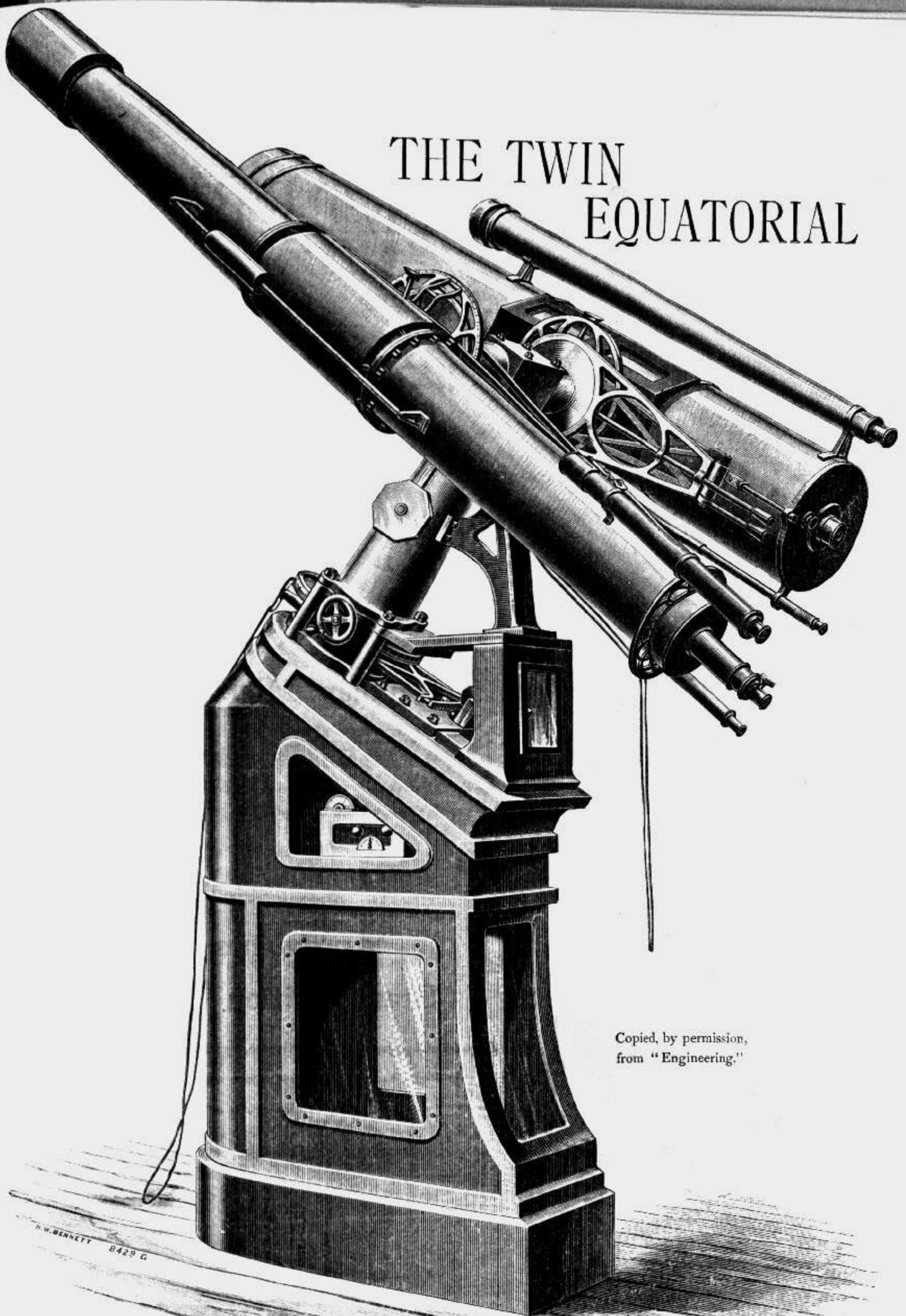
# TWIN TELESCOPES.

(See opposite page.)

For the convenience of some who desire to use two Telescopes of different sizes or different forms, SIR HOWARD GRUBB has constructed the "*Twin*" form of Equatorial, as used by Dr. Huggins and Mr. Roberts, and as exhibited in the late Manchester Exhibition. The motion of each Telescope is quite independent of the other. This construction is fully described in "*Engineering*" of Dec. 16, 1887.



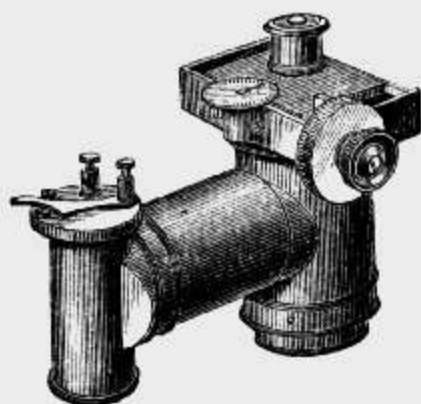
# THE TWIN EQUATORIAL



Copied, by permission,  
from "Engineering."

# ✧ MICROMETERS. ✧

## Unifilar Micrometer.



Of new construction, with electric arrangement for bright and dark field illuminations, complete in itself, attachable to any Refracting Telescope.

### PRICES.

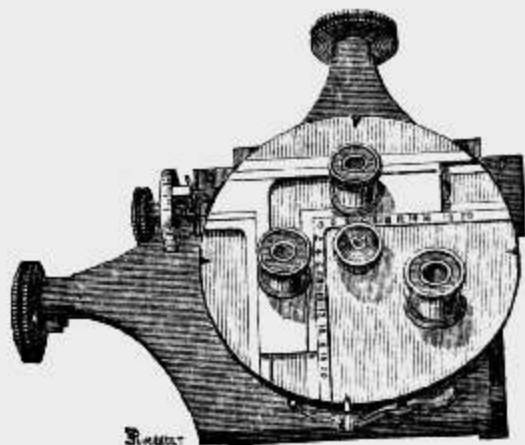
Unifilar Micrometer, in mahogany box, three eyepieces ...	£7 7 0
Illumination arrangement, with electric lamp ...	5 5 0
Battery for same ...	3 3 0
	<u>£15 15 0</u>

## Bifilar Micrometer.



Of SIR HOWARD GRUBB'S usual construction, as described in the "Encyclopædia Britannica," mahogany box, five eyepieces, £21.

## Duplex Micrometer.



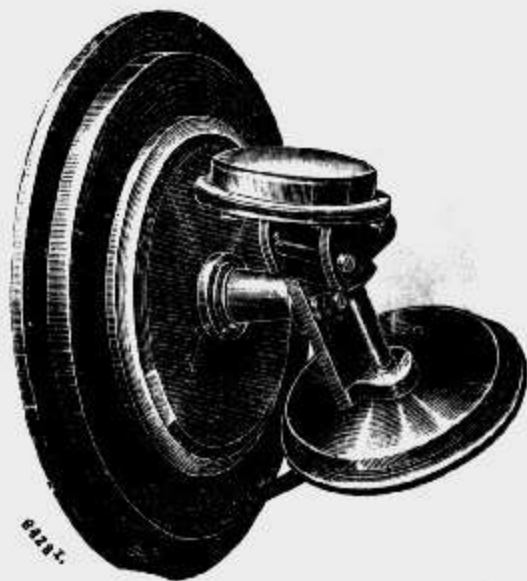
For large angular measurements. For full description see Proceedings Royal Dublin Society, and Professor Pritchard's papers.

Price ...	£25 0 0
Double Slipping Piece ...	8 0 0
	<u>£33 0 0</u>

Large size, as made for the "Lick" Observatory, £84.

## GRUBB'S

## Star Position Finder.



A most useful adjunct to any Telescope, by which readings can be taken in Right Ascension and Declination without reference to the hour or Declination circles of instrument.

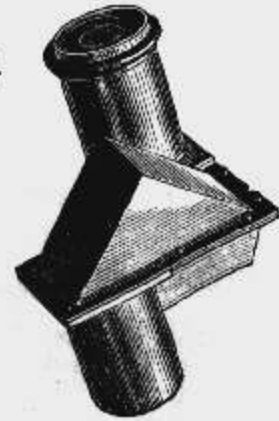
Price according to size, etc., from £12.

# MISCELLANEOUS APPARATUS.

## NEW FORM OF TERRESTRIAL OR ERECTING EYEPIECE,

Giving very much larger field than the ordinary form.

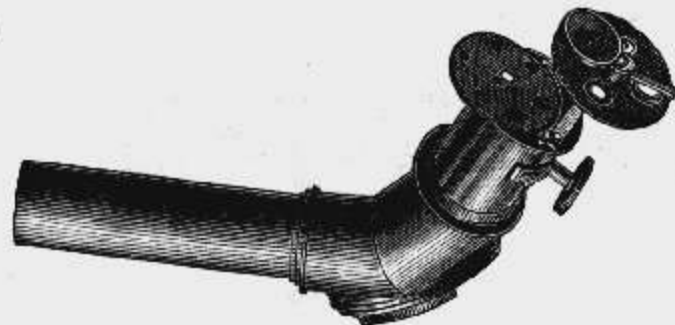
Price £5 5 0



## COMBINED POLARIZING AND "DAWES" SOLAR EYEPIECE.

Avoiding the necessity of using dark glass.

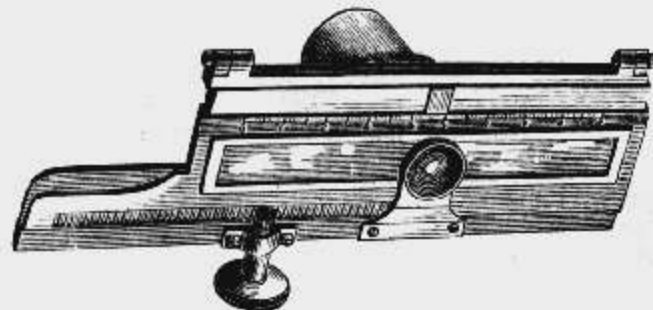
Price £8 8 0



## WEDGE PHOTOMETERS.

For full particulars see Professor Pritchard's papers.

Price £8 8 0



## GRUBB'S SIDEREAL CLOCKS.

Simple form, with zinc and wood pendulum ... £25 0 0

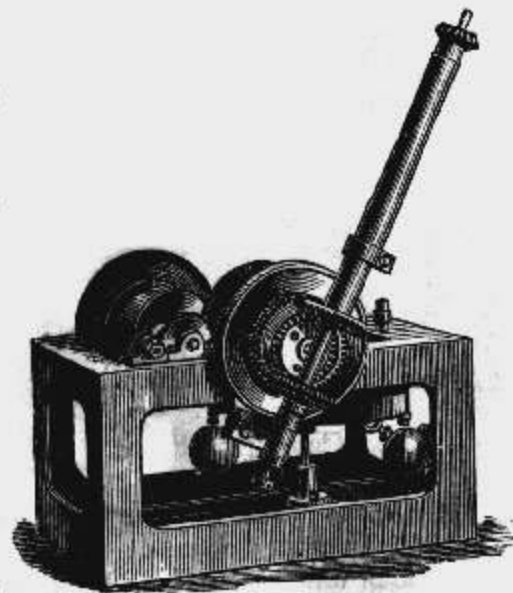
Best make, with mercury pendulum and jewelled  
bearings... .. 75 0 0

## GRUBB'S CLOCKWORK.

With Frictional Governors. Price according to size.

## GRUBB'S ELECTRIC CONTROL.

Adapted to same. Price according to size, from £15 to £25.

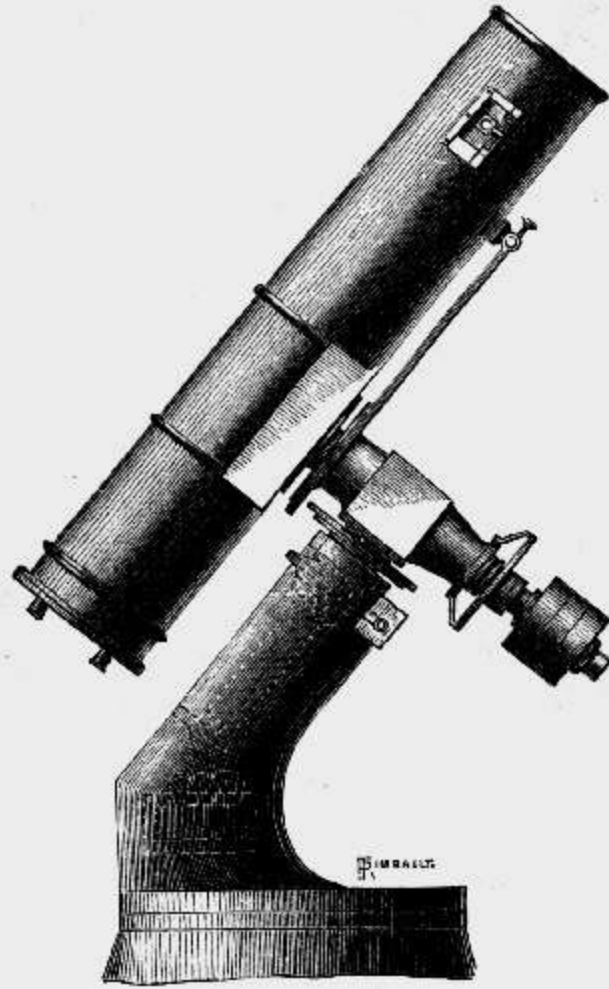




# MISCELLANEOUS APPARATUS.

Negative Eyepieces (ordinary power) ... ..	£0 18 0
"    "    (extra power) ... ..	£1 0 0 to 1 5 0
Positive Eyepieces ... ..	0 16 0 to 0 18 0
Transit Eyepieces ... ..	2 10 0
Terrestrial Eyepieces ... ..	1 5 0
New Form of Prismatic Erecting Eyepiece ... ..	5 5 0
First Surface Reflecting Solar Eyepiece, as used in Transit Expeditions ... ..	2 5 0
Polarizing Solar Eyepiece, with Tourmaline ... ..	5 5 0
Dawes' Solar Eyepiece ... ..	5 5 0
Combined Polarizing and Dawes' Solar Eyepiece (recommended). See page 13 ... ..	8 8 0
Four-Reflection Solar Eyepiece ... ..	10 10 0
Total Reflection Prism Eyepiece, for Zenith Stars ... ..	2 5 0
Combined Total Reflection Prism and First Surface Eyepiece. The Prism capable of revolution and use in either position ... ..	4 4 0
Barlow Lens ... ..	£1 1 0 to 3 3 0
Sliding Wedge, of neutral tint glass, as used in Transit Expeditions ... ..	1 17 6
Pearl Dynameters ... ..	2 10 0
Electric Lamp, mounted with automatic switches ... ..	0 15 0
Batteries for working Electric Lamps ... ..	£1 1 0 to 3 3 0
Electric Illumination applied to Equatorials, in lieu of oil lamps, according to number of lamps required, from... ..	5 5 0
Dr. Huggins' Coronagraph for photographing Corona ... ..	25 0 0
Dr. Stoney's Collimator for adjusting Reflecting Telescopes, complete with electric apparatus ... ..	10 10 0
4 inch Barrel Chronograph, with best clock (not controlled) ... ..	35 0 0
Larger size, as made for Dunsink Observatory, with 2 barrels for 4 hours' work. Seconds 0.4-inch long. Clock of best construction, electrically controlled ... ..	140 0 0

# REFLECTING TELESCOPES.



## Newtonian Reflecting Telescopes.

Mounted on equatorials of general form shown in the above woodcut; with complete circumpolar motion, and having circles divided on gun metal; improved clamps and slow motion; clockwork of best construction; small amount of adjustment for latitude and azimuth, etc.

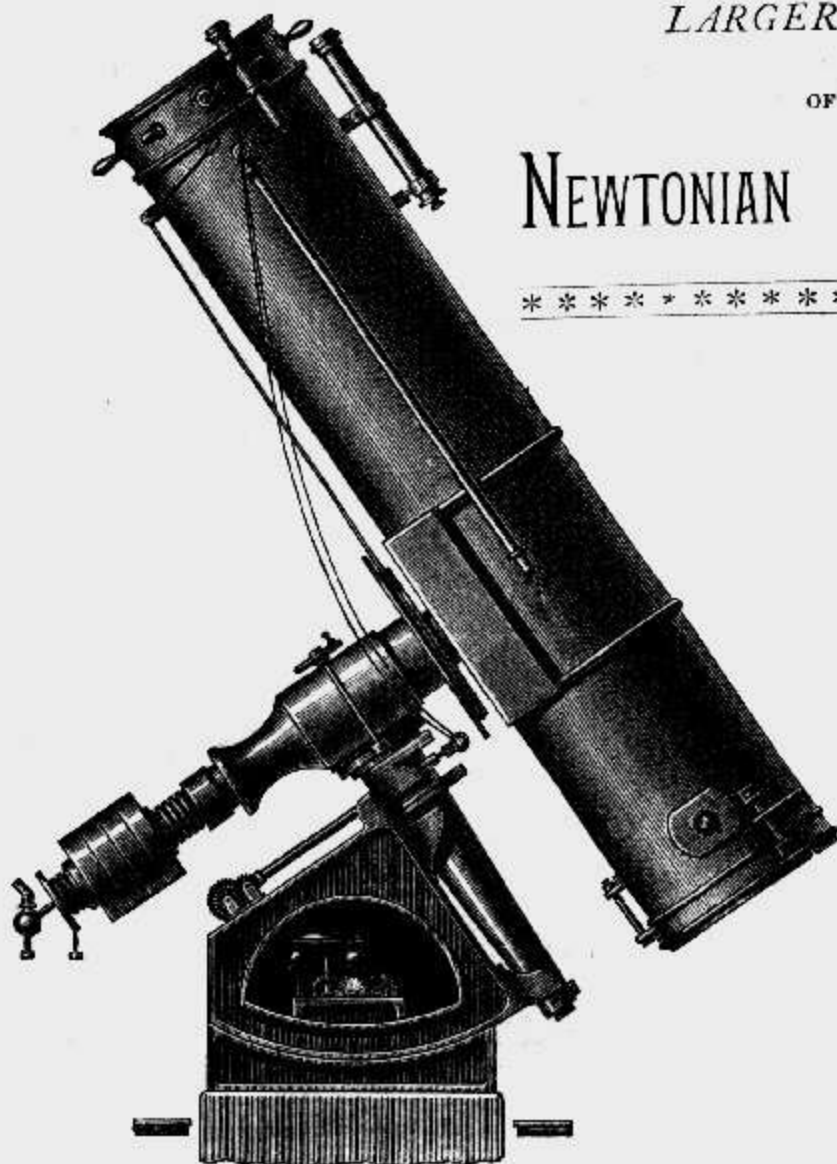
\*\*\*\*\*

### PRICES:

The mirrors of either speculum metal or silvered glass.	With 8-inch Mirror		...	...	...	£120
	„	12-inch	„	...	...	200
	„	15-inch	„	...	...	300
	„	18-inch	„	...	...	450
	„	21-inch	„	...	...	600
	„	24-inch	„	...	...	800

OF

# NEWTONIAN REFLECTOR.



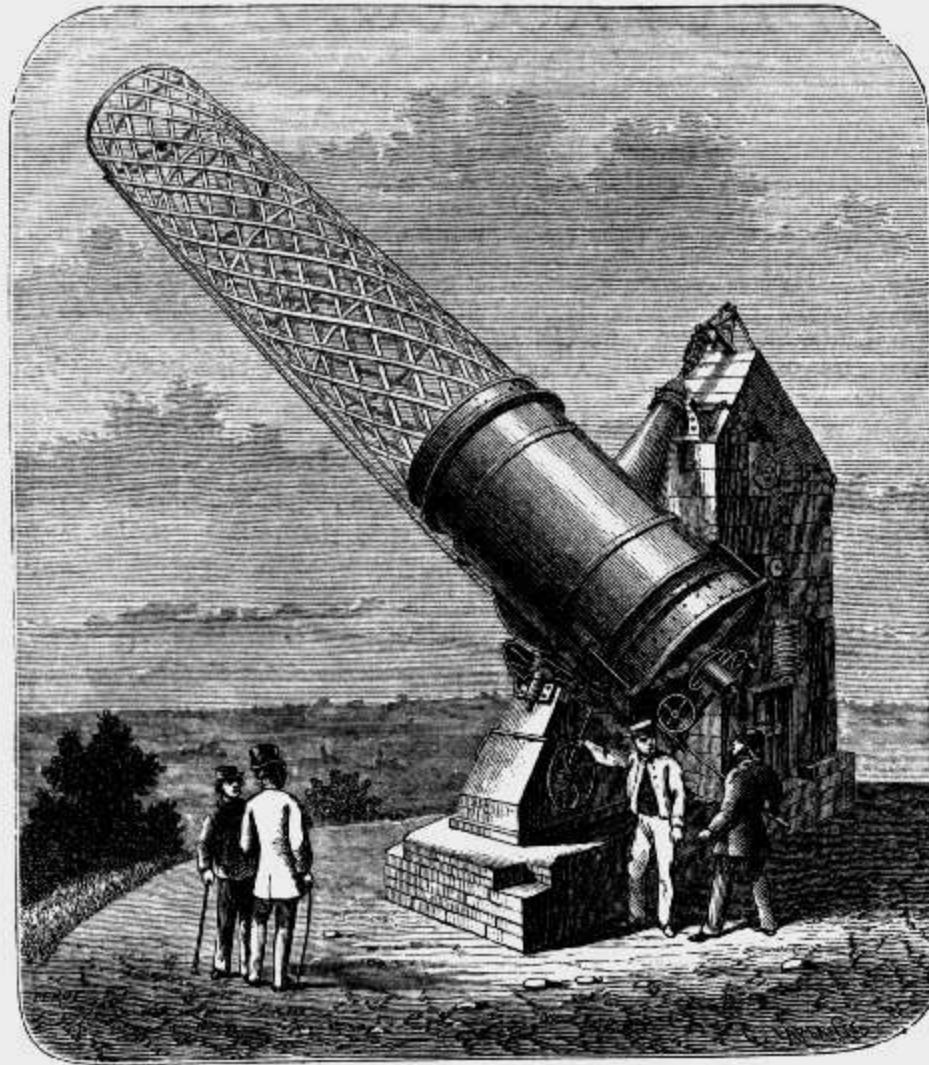
\* Newtonian \* Reflecting \* Telescopes \*

Of more elaborate construction, as figured above, the specifications for which include two right ascension and one declination circle, divided on silver to such graduation as purchaser desires; right ascension circles arranged for differential readings; declination circle read by two opposite verniers, one of which can be viewed from one eye-end of telescope by microscope; bright field illumination for micrometer; SIR HOWARD GRUBB'S improved clamps and slow motion, as described at the Glasgow Meeting of the British Association, 1876; clockwork of best construction (not including control [see page 17]); means of adjusting clock-rate accurately and conveniently, maintaining power, etc. (in larger sizes lunar wheels for instantaneously changing to lunar rate are introduced); quick motion in right ascension for setting telescope while reading right ascension circles; adjustments for latitude and azimuth; all the slow motions and clamping arrangements, and the reading of one vernier of the declination circle available from the eye-end of telescope; four negative eyepieces; finder telescope, revolving hood, etc.

**PRICES:**

The mirrors of either speculum metal or silvered glass.	With 15-inch Mirror	...	...	...	£400
	„ 18-inch „	...	...	...	600
	„ 21-inch „	...	...	...	850
	„ 24-inch „	...	...	...	1,200
	„ 36-inch „	...	...	...	2,000
	„ 48-inch „	...	...	...	4,000





GREAT MELBOURNE TELESCOPE.

Copied, by permission, from "l'Astronomie Pratique," etc., of MM. André and Rayet.



## Cassegrain Reflecting Telescopes.

The smaller sizes up to two feet diameter mounted on equatorials similar to the Standard Refractor, page 12, Specification B. The larger sizes on equatorials similar to great Melbourne Reflector, see above.

### PRICES.

The mirrors of either speculum metal or silvered glass.	With 15-inch Mirror	...	...	...	£300
	„ 18-inch „	...	...	...	500
	„ 21-inch „	...	...	...	700
	„ 24-inch „	...	...	...	1,000
	„ 36-inch „	...	...	...	2,000
	„ 48-inch „	...	...	...	4,000

# SPECTROSCOPES, etc.

**S**IR HOWARD GRUBB having furnished the Spectroscopic equipment for most of his large Equatorial Instruments, is prepared to give designs and estimates for all forms of same.

Two of the instruments most frequently used are figured below; the first, supplied with small prisms, being more especially adapted for solar use; the second, which can be altered in power from 2 to 10 prisms of 60°, is most useful for general work.

For very accurate and constant measures the new form of Spectroscope (as made for Dr. Crookes, F.R.S.) in which the same telescope serves as collimator and for observing, and in which all the mechanical movements are simplified to one single motion round a pivot, is recommended. For all objects, however, whose light is sufficient, the Spectroscopes with diffraction gratings are now preferred, and Sir HOWARD GRUBB is prepared to submit designs and estimates of these suitable for any particular instrument.

## PRICE LIST.

Laboratory Spectroscopes ...	from £10 to £200
A.—Telescopic Spectroscope useable with 1 or 2 compound prisms, equal to nearly 2 or 4 prisms of 60°	15
D.—Large Spectroscope of same form	25

G.—Is a Spectroscope specially adapted for solar work. The principle of its construction is quite novel. It is automatic in action, and the power can be altered from two to four, eight, or twelve prisms, without even taking the eye from the eyepiece. This facility for adjustment of power is found to be of great practical advantage. The whole instrument is very rigid, but light and compact, and when mounted on a solar sweeping arrangement forms the most convenient sun spectroscope yet devised. It will be seen that the observing telescope can always be brought into a convenient position for observing.

## PRICES.

4 and 8 prisms	£32 0 0
2, 4, and 8 „	35 0 0
4, 8, and 12 „	45 0 0
2, 4, 8, and 12 „	48 0 0

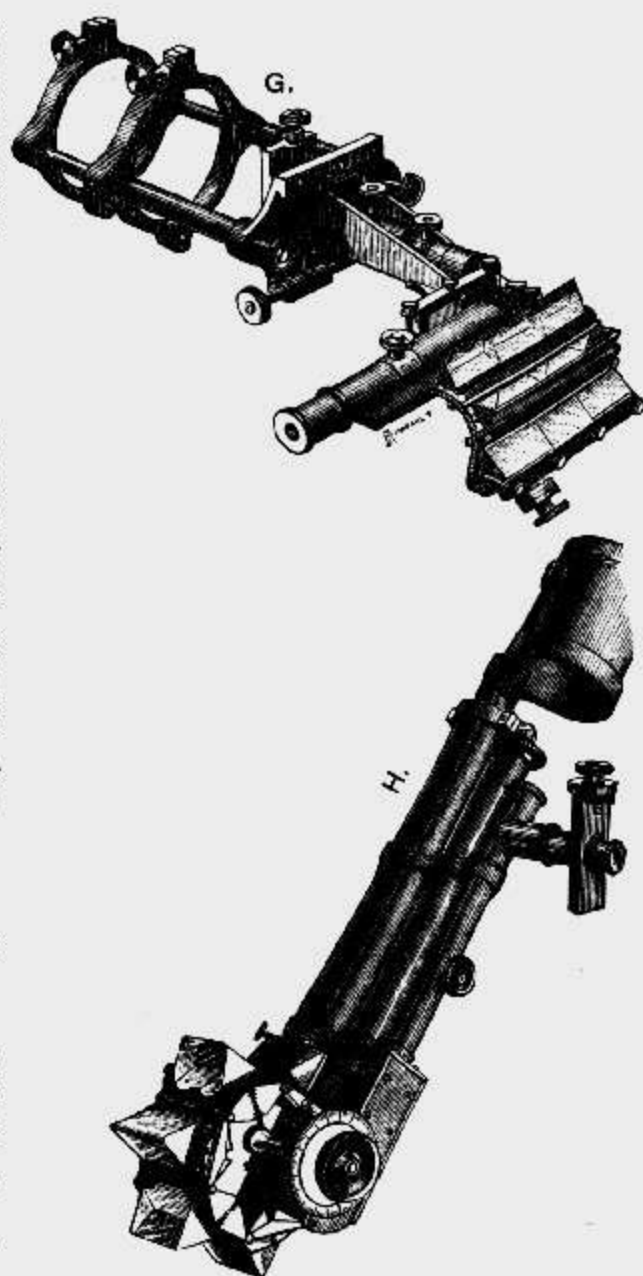
H.—Is a Spectroscope strongly recommended for solar and general work. The first instrument of this form was constructed for Prof. Young, of America, and contained many improvements designed by this well-known physicist. The collimator and observing telescope being parallel, have their objective cells connected together, so that the one motion of pinion head affects the focussing of both simultaneously. The instrument is supplied with two half and four entire prisms of 60° angle, and as the pencil of light traverses twice through, the full power of the spectroscope is = 10 prisms of 60°, while this can be reduced in a moment to 8, 6, 4, or 2, if desired, by altering the position of the last half prism, to which is attached the prism of reflection for sending the ray back to the collimator. This instrument has been supplied to many Continental and Home Observatories, and has been found most efficient for solar and general work.

Price ...	£70 0 0
Equatorial Mounting for same, with Slow Motion in Declination	12 0 0

I.—New form of Spectroscope, in which the one telescope serves both as collimator and observing telescope.

Small size	£20 0 0
Large size	45 0 0

K.—Diffraction Spectroscope, with small Roland's grating ... £15  
Ditto, large size, with 1½-inch Roland's grating ... 25



SOLAR SWEEPING APPARATUS for prominence work to suit particular purposes.

EYEPIECE MICROMETERS for delicate differential measurements.

GRUBB'S STAR-FINDING AND COMPARISON SPECTRUM ARRANGEMENT, applied to slit, if desired.

# Observatories and Observatory Roofs.

## DOMES, DRUMS, SLIDING FLAT ROOFS, AND TRANSIT ROOFS,

AS SUPPLIED TO

GREENWICH.  
VIENNA OBSERVATORY. See p. 26.  
CHAPULTEPEC, MEXICO.  
YALE COLLEGE, U.S.  
CARACAS, S.A.

GÖTTINGEN.  
CAPETOWN.  
NATAL.  
CONSTANTINOPLE.  
EDINBURGH.

BOMBAY.  
CORK.  
ARMAGH.  
TULSE HILL.  
KASAN, SIBERIA.

SIR HOWARD GRUBB having had considerable experience in all forms and sizes of observatory roofs—from small sliding roofs for 4-inch telescopes to the great forty-five feet dome of the Vienna Observatory (see p. 26)—is prepared to furnish estimates for the construction and erection of any form of same.

For small-sized telescopes (even up to ten-inch refractors and fifteen-inch reflectors) the sliding roof is strongly recommended when it is desired to obtain in a very economical way a thoroughly efficient roof, easily managed, and not likely to get out of order. For anything over this size it is desirable, at least in case of refractors, to adopt either the dome or the drum. The dome is, of course, more expensive, but possesses several advantages over the drum, particularly as to appearances and offering less resistance to the wind.

The revolving machinery recommended differs according to the size and weight of the roof. For roofs up to one or one and a half tons a set of grooved wheels running on a wrought or cast-iron plate answers perfectly well, but above this size there is no system so thoroughly satisfactory as the "triple rollers" introduced by the late THOMAS GRUBB, F.R.S., in which the tractive power is reduced to about  $\frac{1}{100}$  of the weight, and which is so constructed that after years of working (or, what is still more trying, years of disuse), no appreciable increase of power is found necessary. As an instance of the effectiveness of this system it may be mentioned that a roof which weighs about four tons, and formerly required ten minutes' hard work for two persons to turn, on being remounted on this system is now easily and without labour revolvable by one person in about one minute. This system has been adopted in the great roofs at Dunsink, Dun Echt, the new forty-three feet roof at Washington, in all of the four observatory roofs for the new Imperial and Royal Observatory at Vienna (of which the largest is forty-five feet external diameter), and at the New Observatory of Tacubaya, Mexico.

Next to this in point of efficiency appears to rank a system of large conical wheels "canted." This is not so expensive as the system mentioned above, and is quite sufficient for domes up to two or three tons weight.

## ELEVATING FLOOR FOR OBSERVATORIES:

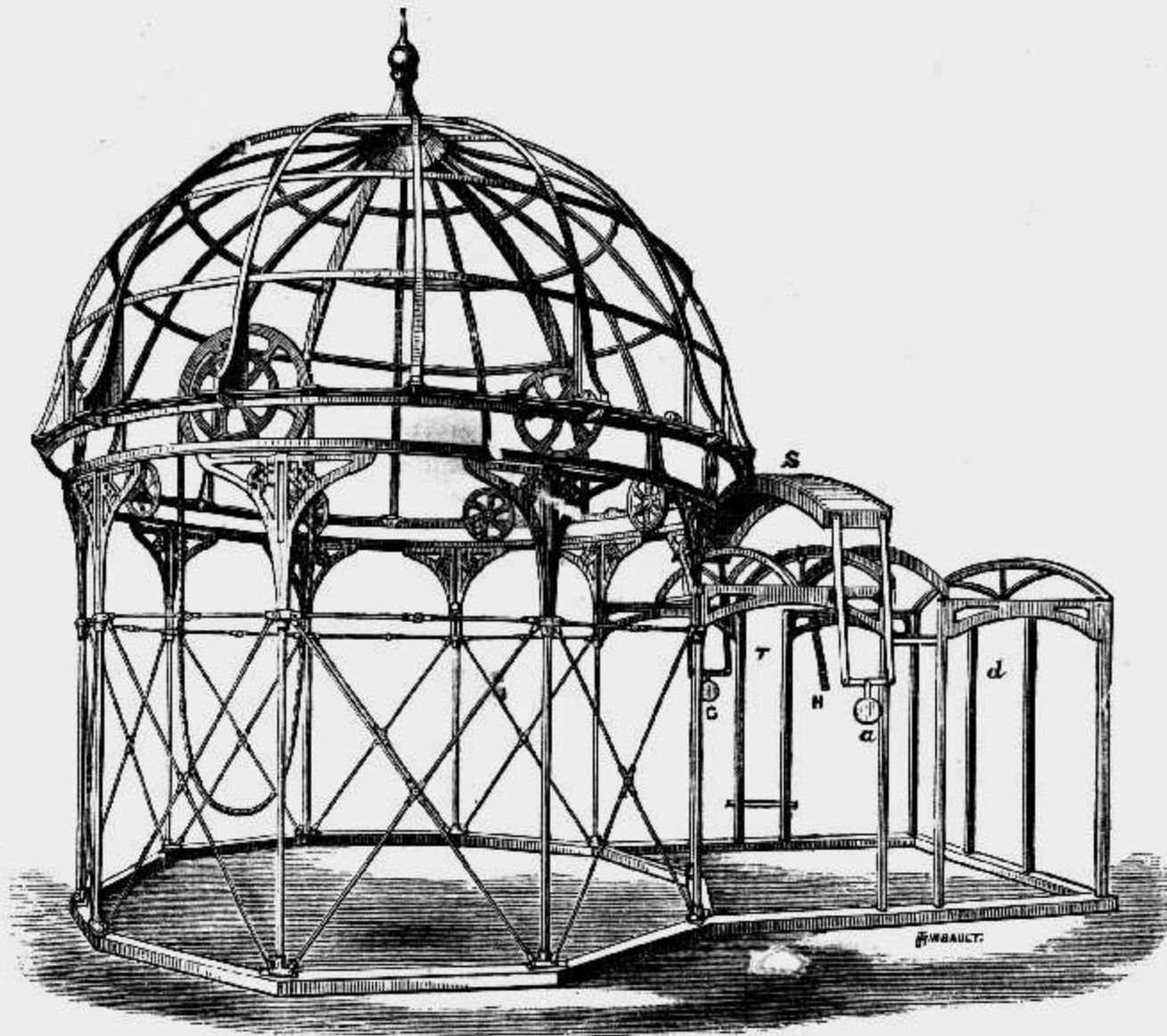
### A SOLUTION OF THE TROUBLESOME QUESTION OF THE OBSERVING CHAIR.

SIR HOWARD GRUBB desires to intimate that the principle of the Elevating Floor, which he designed specially for the Lick Observatory in California, and which has been adopted by the Trustees of that institution, is equally applicable to small as well as large observatories, and that he is prepared to furnish designs for same, applicable to any particular case.



# COMPLETE IRON FRAMEWORK FOR OBSERVATORY.

EQUATORIAL AND TRANSIT ROOMS.



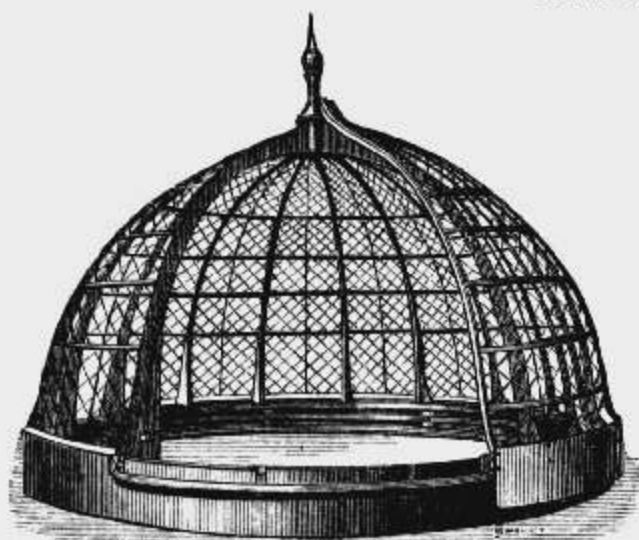
As supplied for Durban Observatory, Constantinople, Armagh, etc. ; complete, with Transit Room, etc. (not including covering)	...	...	...	...	...	...	...	...	£180	0	0
Of stronger and more substantial construction, with cast iron pillars, etc., as constructed for Cape Town Observatory	...	...	...	...	...	...	...	...	400	0	0

## SIR HOWARD GRUBB'S NEW FORM OF TRANSIT SHUTTER.

See above figure at S, and description in Proceedings of Royal Dublin Society. Estimates on application.

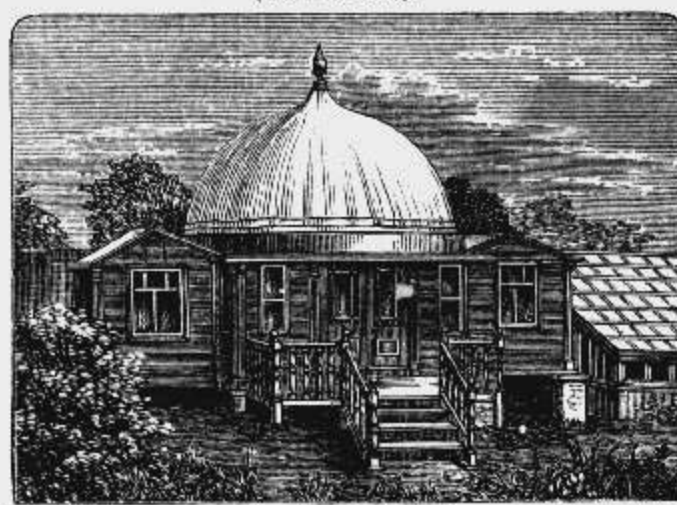
# TYPE OF SMALL PRIVATE OBSERVATORY.

FRAMING OF 15-FEET ROOF.



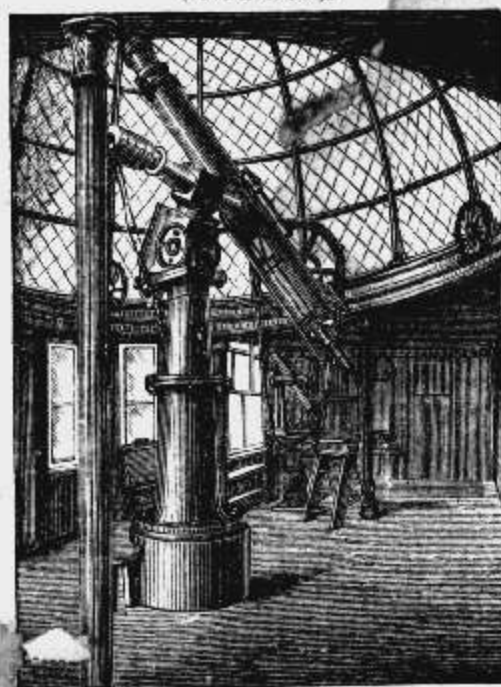
15-foot Dome, ready for reception of canvas covering.

(EXTERIOR).



Springfield Observatory Gomersal, 15-foot Dome, covered with canvas.

(INTERIOR).



15-foot Dome, Springfield Observatory, Gomersal.

## Approximate Prices of various Forms of Observatory Roofs.

	12	15	18	20	24	30	36	45
Wooden Observatory, with sliding roof, covered with zinc	£ 21	£ 25	£ ...	£ ...	£ ...	£ ...	£ ...	£ ...
Iron frame, covered with wood sliding roof, covered with wood and zinc	£ 25	£ 35	£ ...	£ ...	£ ...	£ ...	£ ...	£ ...
Iron Drum Roof, covered with wood, revolving on simple rollers	£ 50	£ 80	£ 120	£ ...	£ ...	£ ...	£ ...	£ ...
Iron-framed Dome, as above, covered with wire and canvas, revolving on simple grooved rollers	£ 65	£ 100	£ 150	£ 200	£ ...	£ ...	£ ...	£ ...
Iron-framed Dome, as above, covered with wire work and canvas, revolving on "canted" rollers and planed wall-plate	£ 90	£ 120	£ 180	£ 240	£ 330	£ 500	£ ...	£ ...
Ditto ditto covered with papier maché	£ ...	£ 150	£ 200	£ 280	£ 380	£ 550	£ ...	£ ...
Ditto ditto covered with wood and copper	£ ...	£ ...	£ ...	£ 330	£ 500	£ 700	£ ...	£ ...
Ditto ditto covered with wood and copper, and revolving on best triple roller system	£ ...	£ ...	£ ...	£ 420	£ 600	£ 860	£ ...	£ ...
Ditto ditto covered with iron plate	£ ...	£ ...	£ ...	£ ...	£ 500	£ 800	£ 1200	£ 2000

## New Astronomical Observatory of the Queen's College, Cork.



THIS observatory has been erected for the instruction of the students of the Queen's College, Cork. It is supplied with a dome (see page 25), a new form of transit shutter (see page 24), an eight-inch equatorial of the standard form, a siderostatic telescope (page 8), and a transit circle on a new principle, sidereal clocks, normal pendulum, and electric control system, etc., etc., the whole instrumental equipment being from SIR HOWARD GRUBB'S establishment.

## New Imperial and Royal

## Observatory at Vienna.

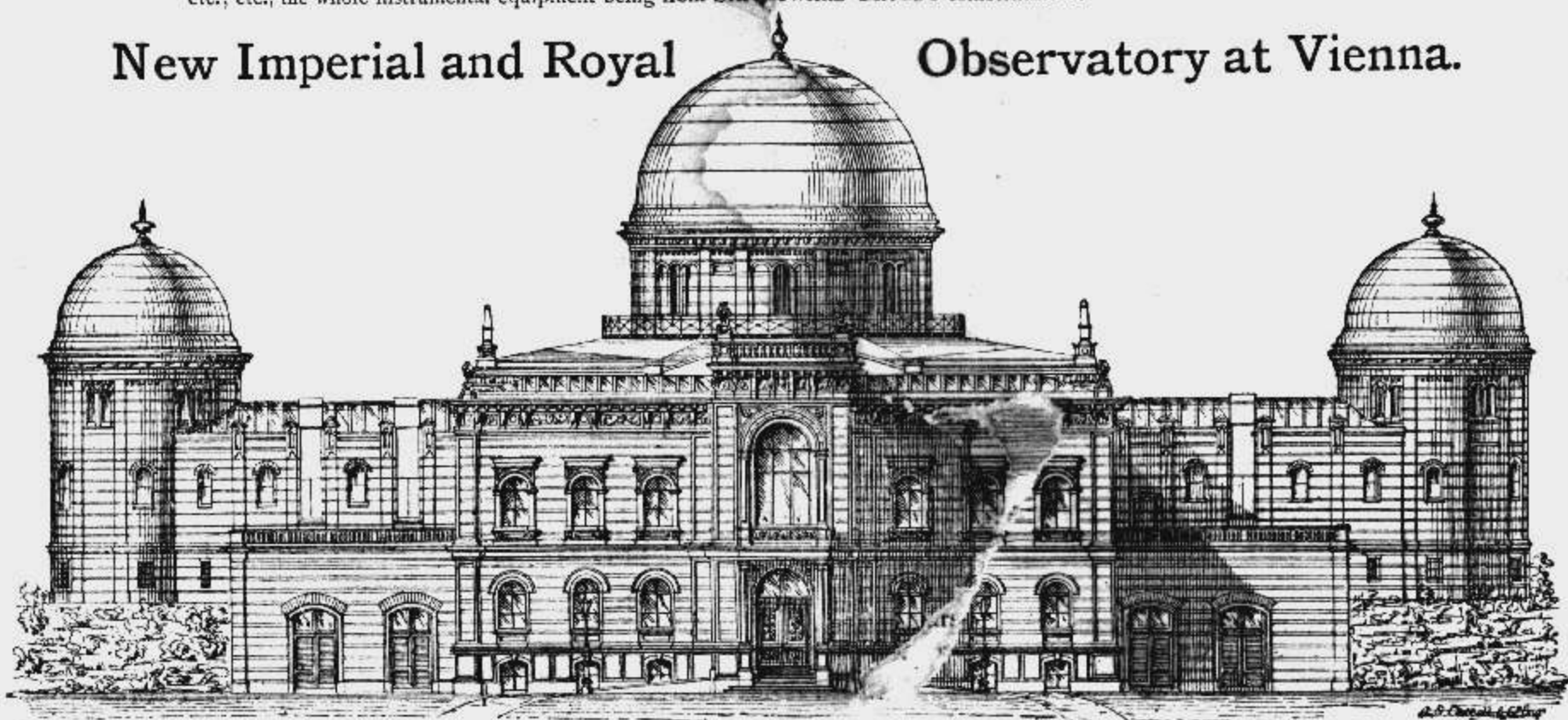


Fig 7

Copied, by permission, from *Engineering*.

THIS magnificent building, erected from the plans of M. F. Fillner, under the direction of the late Director von Littrow, has now been completed. The main building measures 330 feet from north to south, and 240 feet from east to west, and is supplied with three of SIR HOWARD GRUBB'S domes of 27 feet diameter, and one of 45. This last dome, which is entirely of steel, and carried on SIR HOWARD GRUBB'S system of live rollers, covers the great 27-inch equatorial.

For description of this equatorial see numbers of *Engineering* for 1880 and 1881 containing description of instruments and domes.