MESSRS.

T. COOKE & SONS'

(LIMITED)

Illustrated Catalogue

(HOME EDITION)

OF

Surveying Instruments,

ETC.

Separate Catalogues of Astronomical and Drawing Instruments, and Drawing Paper may be had on application.

1907.

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A.B.C. Code, 4th Edition.

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THE prices quoted in this Catalogue are for goods delivered at Buckingham Works, York, unless the goods are in stock at the London Office of the Company, No. 14, Great Chapel Street, Westminster, in which case delivery can be taken there if preferred.

Should any article ordered be out of stock, it will be supplied with the least possible delay.

Messrs. Cooke & Sons have had considerable experience in supplying complete outfits to Engineers, Surveyors, Explorers, Prospectors, Miners, and others, and will be pleased to advise any such as to the choice of the most suitable instruments and apparatus for any special purpose. They can, and do frequently, supply a large variety of other goods in addition to those here catalogued, and will obtain to order anything that may be required on receipt of full particulars.

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Messrs. Cooke & Sons employ at their South African Branch, 18, Strand Street, Cape Town, a staff of workmen specially trained in their factory at York, England, capable of effecting Repairs and Adjustments to any class of instrument in the shortest possible time.

THEODOLITES.

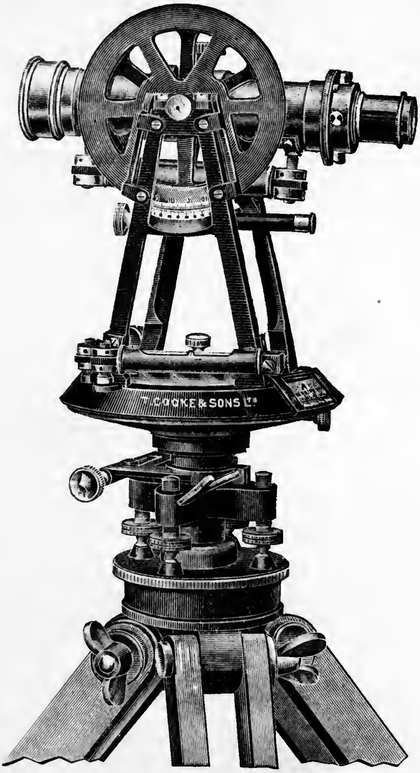


Fig. 1

Mountain Theodolite.

(*Shown with 4-Screw Adjustment*).

No.

1. **MOUNTAIN THEODOLITE**, of lightest possible construction, with open pattern standards, horizontal circle 4-in. dia., reading by two verniers to 1′; glass protecting covers to verniers. Vertical circle 3-in. dia., fitted with metal guard, and reading by vernier to 1′. Level on telescope and two others on plate. Telescope of ·875-in. aperture and 5-in. focal length; two Ramsden eye-pieces, powers 10 and 15 (or one erecting eye-piece, power 12 if preferred). Circular compass with 2½-in. needle. Two suncaps, sunshade, hand magnifier, plumb-bob, screw-drivers and levers. Supplied with three levelling screws unless four are specially desired. Packed in a mahogany case with shoulder strap. Framed telescopic tripod, 5 ft. long when open, 3 ft. when closed. Weight of instrument, under 4 lbs.; box and accessories, 4½ lbs.; tripod stand, 5½ lbs. ... ... £27 0s. 0d.

Theodolites.

No.

2. **4-Inch TRANSIT THEODOLITE,** of light construction, with open pattern standards, circles divided on silver to 30′, and reading by verniers, two to each circle, to 1′. Telescope with object-glass 1-in. aperture and 7·6-in. focal length. Three levelling screws, high and low power eyepieces, two suncaps, sunshade, trough compass and plumb-bob. Packed in a mahogany case, fitted with a leather shoulder strap. Light tripod stand of framed (or solid) pattern £30 0s. 0d.

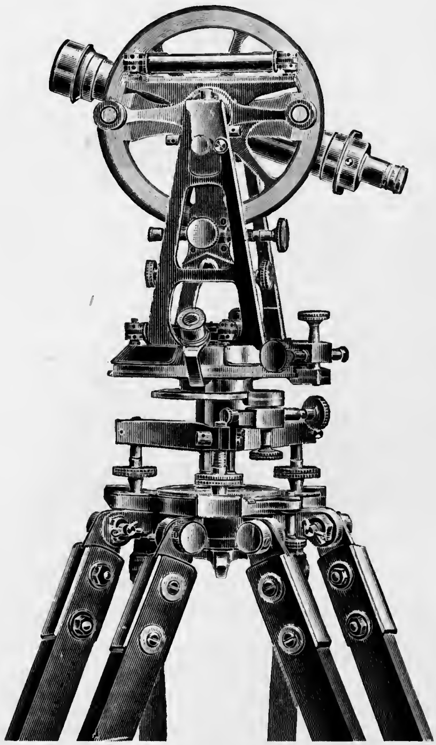


Fig. 2.

4. **5-Inch TRANSIT THEODOLITE,** with open pattern standards, circles divided on silver to 20′, and reading by verniers, two to each circle, to 30″, (or to 20″ if so desired). Telescope with object-glass 1·125-in. aperture and 8-in. focal length. Three levelling screws, high and low power eye-pieces, two suncaps, sunshade, trough compass and plumb-bob. Packed in a mahogany case, fitted with a leather shoulder strap. Tripod stand of framed (or solid) pattern, with centering arrangement and locking plate ... ... £33 0s. 0d.

Theodolites.

No.

5. **5-Inch TRANSIT THEODOLITE,** as above, but with object-glass 1·35-in. aperture and 10-in. focal length ... ... £35 0s. 0d.

6. **5-Inch TRANSIT THEODOLITE,** as above, but with extra large telescope, having object glass 1·6-in. aperture and 12-in. focal length ... ... £38 0s. 0d.

7. **5-Inch TRANSIT THEODOLITE,** as No. 4, but without vertical circle (Railway pattern) ... ... £30 0s. 0d.

8. **5-Inch TRANSIT THEODOLITE,** as No. 5, but without vertical circle (Railway pattern) ... ... £32 0s. 0d.

9. **6-Inch TRANSIT THEODOLITE,** divided to 20′ and reading to 20″. Object-glass 1·35-in. aperture and 10-in. focal length. Tripod stand of framed pattern with centering arrangement. Accessories as to No. 4. Packed in two cases, fitted with leather shoulder straps ... ... £38 0s. 0d.

10. **6-Inch TRANSIT THEODOLITE,** as No. 9, but with object-glass 1·6-in. aperture and 12-in. focal length ... ... £40 0s. 0d.

11. **6-Inch TRANSIT THEODOLITE,** as above, but with extra large telescope, having object glass 1·8-in. aperture and 13-in. focal length ... ... £43 0s. 0d.

12. **6-Inch TRANSIT THEODOLITE,** as No. 9, but without vertical circle (Railway pattern). Packed in one case, fitted with leather shoulder strap ... . £34 0s. 0d.

13. **6-Inch TRANSIT THEODOLITE,** as No. 10, but without vertical circle (Railway pattern) ... ... £36 0s. 0d.

14. **7-Inch TRANSIT THEODOLITE,** as No. 9, but divided to 15′ and reading by three verniers to horizontal and two to vertical circle to 15″. Telescope with object-glass 1·6-in. aperture and 12-in. focal length. No centering arrangement included. Packed in two cases, fitted with leather shoulder straps ... £45 0s. 0d.

15. **8-Inch TRANSIT THEODOLITE,** as No. 14, but of heavier construction. Circles divided to 10′, and reading by three verniers to horizontal and two to vertical circle to 10″. Telescope with object glass 1·8-in. aperture and 13-in. focal length. Packed in two cases, fitted with leather shoulder straps ... ... £55 0s. 0d.

16. **10-Inch TRANSIT THEODOLITE,** Specification according to requirements.

For particulars of the Adjustments, etc., of these Theodolites see page 85.

Theodolites.

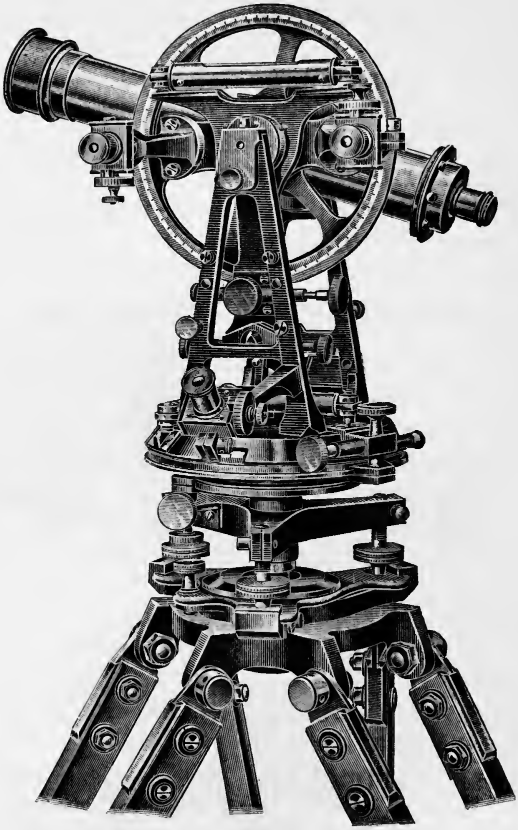


Fig. 3.

TRANSIT THEODOLITES WITH MICROMETERS.

No.

17. **5-Inch TRANSIT THEODOLITE,** with open pattern standards, horizontal circle divided to 10′, and reading by two micrometer microscopes to 10″; vertical circle divided to 20′, and reading by two verniers to 30″. Telescope with object-glass 1·35-in. aperture and 10-in. focal length. High and low power eye-pieces, two suncaps, sunshade, trough compass and plumb-bob. Packed in two mahogany cases, fitted with leather shoulder straps. Tripod stand of framed pattern, with centering arrangement ... £40 0s. 0d.

18. **5-Inch TRANSIT THEODOLITE,** as No. 17, but with micrometer microscopes to both circles, and reading to 10″ ... £45 0s. 0d.

19. **6-Inch TRANSIT THEODOLITE,** as No. 17, but with vertical circle reading by two verniers to 20″, and having telescope with object glass 1·6-in. aperture and 12-in. focal length ... ... £45 0s. 0d.

20. **6-Inch TRANSIT THEODOLITE,** as above, but with micrometer microscopes to both circles, and reading to 10″ ... £50 0s. 0d.

No. **Theodolites.**

21. **8-Inch TRANSIT THEODOLITE,** as No. 20, but of heavier construction, divided to 5′, and reading by three micrometer microscopes to horizontal, and two to vertical circle to 5″, with additional pointer microscopes for reading the figures. Telescope with object glass 1·8-in. aperture and 13-in. focal length. No centering arrangement included ... ... £75 0s. 0d.

22. **10-Inch TRANSIT THEODOLITE,** as No. 21, but reading to 2″ of arc by either circle, and having telescope with object glass 2·0-in. aperture and about 16-in. focal length ... ... £120 0s. 0d.

23. **12-Inch TRANSIT THEODOLITE,** Specification according to requirements.

Estimates given for Theodolites of Special Design or of Larger Size.

EVEREST THEODOLITES.

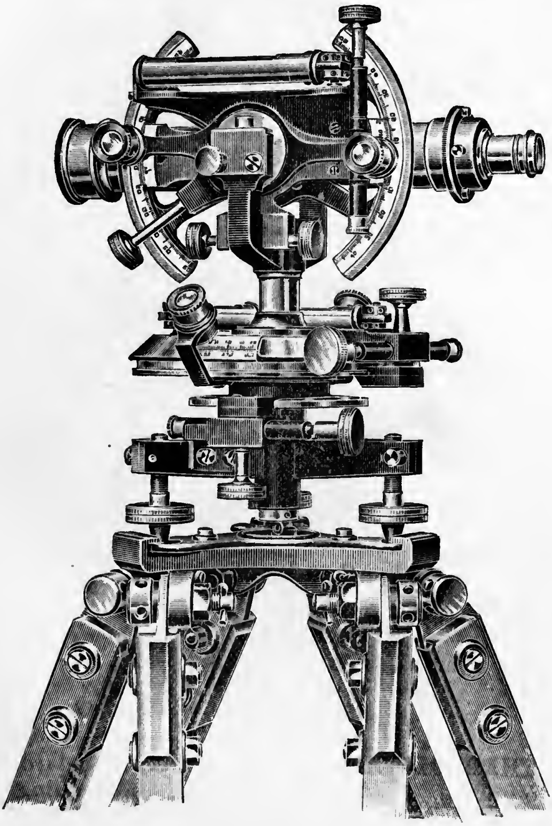


Fig. 4

Everest Theodolite.—(*Shown without Centering Arrangement as No. 28.*)

26. **5-Inch EVEREST THEODOLITE,** divided to 20′ and reading to 30″. Telescope with object glass 1·125-in. aperture and 8-in. focal length. Three screws and locking plate, circles and verniers read by simple microscopes, with high and low power eye-pieces, two caps, sunshade, trough compass and plumb-bob. Packed in a mahogany case, fitted with leather shoulder strap. Tripod stand of framed pattern, with centering arrangement ... ... £31 0s. 0d.

No. **Theodolites.**

27. **6-Inch EVEREST THEODOLITE,** as No. 26, but reading to 20″, and having telescope with object glass 1·35-in. aperture and 10-in. focal length ... ... £36 0s. 0d.

28. **7-Inch EVEREST THEODOLITE,** as above, but reading to 15″, and having telescope with object glass 1·6-in. aperture and 12-in. focal length. No centering arrangement included. Packed in two cases ... ... £42 0s. 0d.

29. **8-Inch EVEREST THEODOLITE,** as No. 28, but reading to 10″, and having telescope with object glass 1·8-in. aperture and 13-in. focal length ... ... £50 0s. 0d.

AMERICAN PATTERN THEODOLITES.

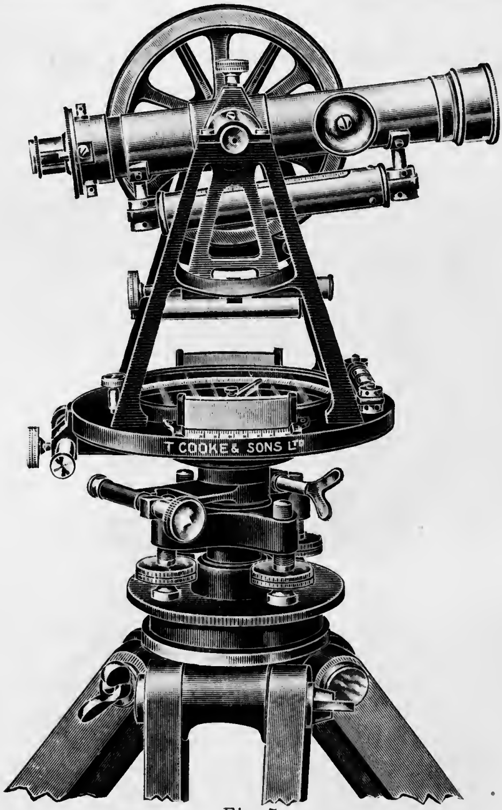


Fig. 5.

30. **TRANSIT THEODOLITE,** with open pattern standards, flat horizontal circle of 6-in. dia., graduated on silver, and reading by two double verniers to 20″; Glass protecting covers to verniers. Vertical circle, 5-in. dia., fitted with metal guard, graduated on silver, and reading by one double vernier to 20″. Long level on telescope and two levels on plate. Telescope of 1·125-in. aperture and 8-in. focal length, two Ramsden eye-pieces, powers 16 and 24, (or one erecting eye-piece, power 20, if preferred). Four levelling screws and shifting centre. Circular compass with needle 4-in. long, two suncaps, sun-shade, and plumb-bob, screwdrivers and levers. Packed in a mahogany case, with shoulder strap. Framed tripod ... ... £35 0s. 0d.

31. If with fixed microscopes for reading the verniers ... £36 0s. 0d.

Theodolites.

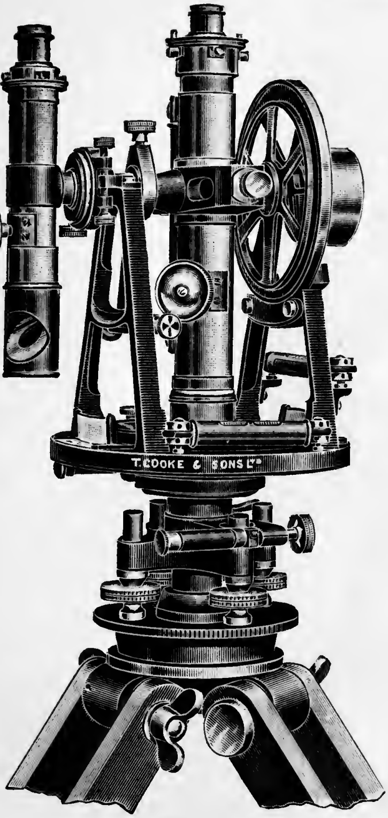


Fig. 6.

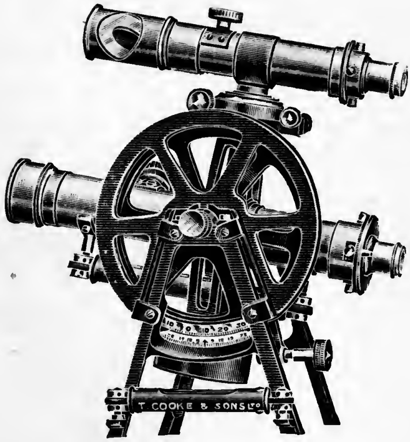


Fig. 7.

32. **MINING TRANSIT THEODOLITE,** as American pattern No. 30, but with additional telescope of ·875-in. aperture and 5-in. focal length, interchangeable on side and top of the main telescope by means of screwed extensions on end and centre of telescope axis, giving a clear vertical sight downwards in either position. Diaphragm fitted with one cross line, which is horizontal when the telescope is on the side, and vertical when on the top of large telescope. The former allows angles of depression to be measured, which by reason of the interference of the horizontal limb cannot be obtained by the large telescope. Slow-motion adjustment and clamp for setting the single cross wire of the interchangeable telescope in the same plane as the line of collimation of the large telescope. The surveyor by this method has the advantage of making his own adjustment, and does not rely upon a fixed adjustment of the makers, the continued accuracy of which in this particular case it would be impossible to retain. One Ramsden eye-piece, power 14, fitted with prism attachment for convenience in vertical sighting. Reflectors to fit on object ends of both telescopes for illumination of lines. Counterpoise to supplementary telescope in either position. Dust guards to levelling screws. Packed in a mahogany case with shoulder strap. Telescopic tripod of framed pattern ... £43 0s. 0d.

TACHEOMETERS.

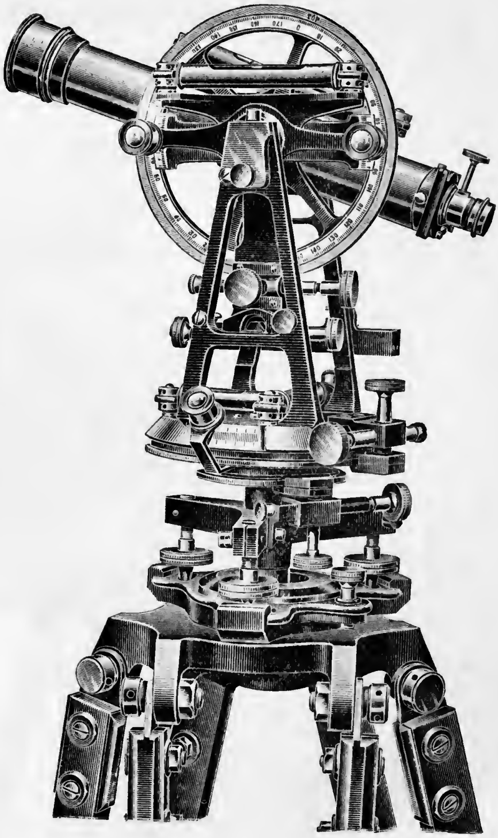


Fig. 8.

33. **4-Inch TACHEOMETER**, with open pattern standards, circles divided either to 30′ reading to 1′, or centesimally to 50′ reading to 1′. Telescope with object glass 1·125-in. aperture, 8-in. focal length, and anallatic lens. Bubble on telescope as well as on vernier arms. Three screws and locking plate, high and low power eye-pieces, two suncaps, sunshade, trough compass and plumb-bob. Packed in a mahogany case, fitted with leather shoulder strap. Light mahogany tripod stand of solid pattern, without centering arrangement ... £32 0s. 0d.

34. **4-Inch TACHEOMETER**, as above, but with light telescopic tripod stand ... ... £33 0s. 0d.

35. **5-Inch TACHEOMETER**, as No. 33, but reading to 30″, or centesimally to 1′. Telescope with object glass 1·35-in. aperture, 10-in. focal length, and anallatic lens. Tripod stand of framed or solid pattern, with centering arrangement ... ... £36 0s. 0d.

36. **6-Inch TACHEOMETER**, as above, but reading to 20″, or centesimally to 1′, and by estimation to 0·5′. Telescope with object glass 1·6-in. aperture, 12-in. focal length, and anallatic lens. Packed in two cases, fitted with shoulder straps. Tripod stand of framed pattern, with centering arrangement ... ... £41 0s. 0d.

37. **Kew Certificate to any Theodolite or Tacheometer 16/- and upwards, according to size.**

For further information concerning Tacheometers see page 88.

Extras and Additions to Theodolites and Tacheometers.

No.		One Case. Best Solid.	One Case. With Felt Lining.	Two Cases. Best Solid.	Two Cases. With Felt Lining.
	LEATHER CASES—	£ s. d.	£ s. d.	£ s. d.	£ s. d.
38.	For 3-in. Instrument ...	1 5 0	1 14 0	—	—
39.	,, 4 ,, ,, ...	1 10 0	2 0 0	—	—
40.	,, 5 ,, ,, ...	1 13 0	2 5 0	2 10 0	3 5 0
41.	,, 6 ,, ,, ...	1 16 0	2 10 0	2 17 0	3 15 0
42.	,, 7 ,, ,, ...	—	—	3 5 0	4 7 0
43.	,, 8 ,, ,, ...	—	—	3 13 0	5 0 0
44.	,, 10 ,, ,, ...	—	—	4 15 0	6 7 0
45.	Canvas and leather bound case for tripod ...		...	...	1 10 0
46.	,, ,, ,, ,, cap ,, ,, head		...	...	0 7 6
47.	Solid leather ,, ,, ,, ,,		...	...	0 15 0

Centering Head to Solid Pattern Tripod.

Fig. 9.

Telescopic Tripod with Centering Head.

Fig. 10.

Tripods.

Extras, etc.

No.		Non-Centering.	Centering.
49.	**TRIPOD STAND** of light pattern, for Mountain Theodolite	2 15 0	—
50.	DITTO of solid round pattern for Mountain, and of framed or solid round pattern for 4-in. Theodolite	3 5 0	4 10 0
51.	DITTO telescopic	4 0 0	5 5 0
52.	DITTO of framed or solid round pattern for 5-in. and 6-in. Theodolites	3 5 0	4 15 0
53.	DITTO telescopic	5 0 0	6 10 0
54.	DITTO of framed pattern for 7-in. and 8-in. Theodolites	4 5 0	6 5 0
55.	DITTO of framed pattern for 10-in. Theodolite	4 10 0	—

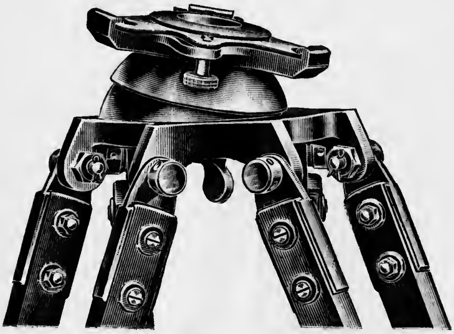


Fig. 11.

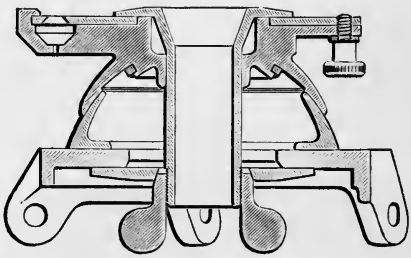


Fig. 12.

57. Centering and levelling arrangement to stand of 5-in. or 6-in. instruments. *Figs.* 11 *and* 12 ... ... £3 0s. 0d.

An allowance of £1 10s. 0d. will be made when the ordinary centering arrangement is already included.

The prices quoted for centering arrangements are to new instruments only; when supplied to old instruments an extra charge will be incurred for fitting.

No.		£ s. d.
59.	**ILLUMINATED AXIS** 35/-, **and STRIDING LEVEL** 15/-, to 5-in. or 6-in. instruments	2 10 0
60.	DITTO 40/- ditto, 20/-, to 7-in. or 8-in. instruments ...	3 0 0
61.	DITTO 50/- ditto, 30/-, to 10-in. instruments	4 0 0
62.	**DIAGONAL EYE-PIECE,** with swivel socket	1 15 0
63.	**EYE-PIECES,** Ramsden, high or low power	0 12 6
64.	DITTO erecting	1 7 6
65.	**SUNCAPS,** each	0 3 0

Extras, etc.

	BUBBLES—	Small Plate.	Large Plate.	Azimuth, Telescope, or Striding Level.
66.	For Mountain & 4-in. Instruments	4/-	6/	8/-
67.	,, 5-in. ,,	4/-	6/-	8/-
68.	,, 6-in. and 7-in. ,,	6/-	8/-	10/-
69.	,, 8-in. ,,	6/-	10/-	14/-
70.	,, 10-in. ,,	8/-	12/-	18/-

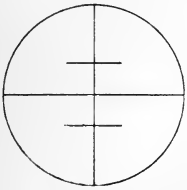


Fig. 13.

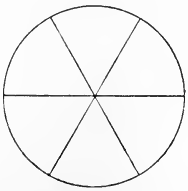


Fig. 14.

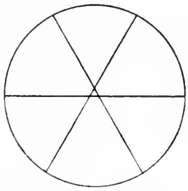


Fig. 15.

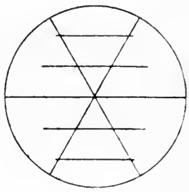


Fig. 16.

Diaphragms for Theodolites and Tacheometers.

These are of parallel glass and the lines are ruled with a fine diamond; (Spider lines can be had if preferred at the same prices).

Fig. 13 shows a simple + (as adopted by the India Office) with the addition of stadia lines, 1 in 100 or any other ratio desired.

Fig. 14 is a pattern frequently supplied, and

Fig. 15 is an improvement upon it in which no more than two lines cross at any one point, thus offering the minimum of obscurity.

Fig. 16 is the standard pattern for tacheometers, the stadia lines being 1 in 50 and 1 in 100, but 1 in 100 and 1 in 200, or any other ratios can be ruled to order.

No.		£	s.	d.
72.	**DIAPHRAGMS,** ordinary, parallel glass	0	5	0
73.	Ditto special or stadia lines	0	7	6
74.	**GUN-METAL BLOCK,** with dove-tailed slide and adjusting screws, for carrying glass diaphragm	0	7	6
78.	**SOLAR ATTACHMENT** to 5-in. or 6-in. instruments, having extra large telescopes	12	0	0
79.	Ditto to 7-in. or 8-in. instruments	15	0	0
80.	**GRADIENTER ATTACHMENT** to 5-in. or 6-in. instruments; to either circle	1	10	0
81.	**WALL PLATE,** for use on masonry pillar, or elsewhere, in place of tripod	0	12	6
82.	**PLUMB-BOBS,** gun-metal, with steel point and silk cord, 8 oz., 3/6; 12 oz., 4/6; 16 oz.	0	6	0
83.	Ditto cheaper quality, small, without cord	0	2	0
84.	Ditto plain steel, with hardened point, without cord ...	0	1	0
85.	**TROUGH COMPASS,** for 5-in. or 6-in instruments	0	15	0
86.	**CIRCULAR COMPASS** in lieu of trough compass	1	10	0

Extras, etc.

Fig. 17.

No.		£	s.	d.
	DIAGONAL REFLECTOR, fitting on O.G. end of telescope :—			
87.	For 5-in. and 6-in. instruments ...	0	7	6
88.	For 7-in. and 8-in. ,, ...	0	10	0
	EXTRA BUBBLE in tube, fitted on telescope :—			
89.	To 5-in. and 6-in. instruments ...	1	5	0
90.	To 7-in. and 8-in. ,, ...	1	10	0
91.	**SHORT FOCUSSING ARRANGEMENT** by means of a slit rendering it possible to take sights much within the usual minimum distance ...	0	10	0
92.	**LEVELLING SCREWS**, each ...	0	2	6
93.	**LEATHER SHOULDER STRAP** ...	0	3	6
94.	**STRAPS** for solid round pattern tripod ...	0	1	6
95.	**INSTRUMENT OIL**, per bottle ...	0	1	6

DIAGRAMS, BOOKS, TABLES, Etc.

99.	**GILLMAN'S PATENT DIAGRAM**, for the rapid reduction of Tacheometer readings (360° or 400°) ...	0	7	6
100.	**STEWART'S COPYRIGHT DIAGRAM**, giving the horizontal distance and the vertical height direct, without any calculation (360° and 400°) ...	0	7	6
101.	**CUARTERO'S TABLES** (400°) ...	1	1	0
102.	**JORDAN'S TABLES** (360°) ...	0	12	6
103.	**BEAZELEY'S TABLES** of Railway Curves, on cards ...	0	4	0
104.	**FIELD BOOK**, size 7-in. by 4¼-in., ruled two centre lines only, bound red basil, with elastic band ...	0	1	6
105.	Ditto ruled faint lines and centre line ...	0	2	0
106.	Ditto size 8¼-in. by 5-in. ...	0	2	6
107.	Ditto as No. 104, but of cheaper make, half bound cloth	0	1	0
108.	**LEVELLING BOOK**, size 7½-in. by 4¾-in., ruled and headed, bound red basil, with round corners ...	0	2	0
109.	Ditto of cheaper make, half bound cloth ...	0	1	6
110.	**TACHEOMETER BOOK**, as level book No. 108 ...	0	2	0
111.	**SECTIONAL RULED NOTE BOOK**, oblong, ⅛-in. or $\frac{1}{10}$-in. square ruling, 100 leaves, bound limp roan, with elastic band, size 6¼-in. by 4-in. ...	0	2	6
112.	Ditto size 7¾-in. by 5-in. ...	0	3	6

SCIENTIFIC AND ENGINEERING BOOKS.

The Electrical Engineer's Pocket Book	*Kempe*	0	5	0
Electrical Engineering for Electric Light Students	*Slingo & Broker*	0	12	0
Standard Wiring for Electric Light and Power ...	*Harrison*	0	4	6
"The Electrician" Wireman's Pocket Book	*Raphael*	0	5	0
Engineer's Year Book	*Kempe*	0	8	0
Land Area Computation made easy (Amsler's Planimeter)	*Codd*	0	0	6
Railroad Spiral (Theory of Transition Curve)... ...	*Searles*	0	6	6
Handbook Street Railroad Location	*Brookes*	0	6	6
Engineer's Field Book	*Shunk*	0	10	6
African Pilot (Part 3 South)	—	0	5	0
Railway Track and Trackwork	*Tratman*	0	12	6
Surveying with the Tacheometer	*Kennedy*	0	10	6
Economic Theory of the Location of Railways ...	*Wellington*	1	1	0
Practical Surveying	*Usill*	0	7	6
Curve Tables	*Kronkhi*	0	5	0
Treatise on Surveying (2 vols.) ea.	*Gillespie*	0	10	6
Do. ,, ,, ...	*Middleton & Chadwick*	0	10	6
The Steam Engine...	*Ewing*	0	15	0
Civil Engineer's Pocket Book	*Trautwine*	1	1	0
Engineering Formulæ Pocket Book	*Molesworth*	0	6	0
Engineers' Tables in celluloid case	*Hurst*	0	1	6
Mathematical Tables	*Chambers*	0	4	6
Curve Tables	*Kennedy & Hackwood*	0	2	6
Astronomy for Everybody	*Newcome*	0	7	6
Navigation and Nautical Astronomy	*Martin*	0	18	0
Electric Traction Pocket Book	*Dawson*	0	17	6
Fergusson's Percentage Theodolite with examples ...	*Fergusson*	0	0	6
Nautical Almanac	—	0	2	6
On the Aneroid and Meteorological Instruments ...	*Cooke*	0	0	6
Land Area Tables	*Codd*	0	3	6
Half-hours with the Microscope	*Lankester*	0	2	6
The Aneroid Barometer, how to use it	—	0	0	6

FERGUSSON'S PERCENTAGE SURVEYING CIRCLE.

PLATE No.1.

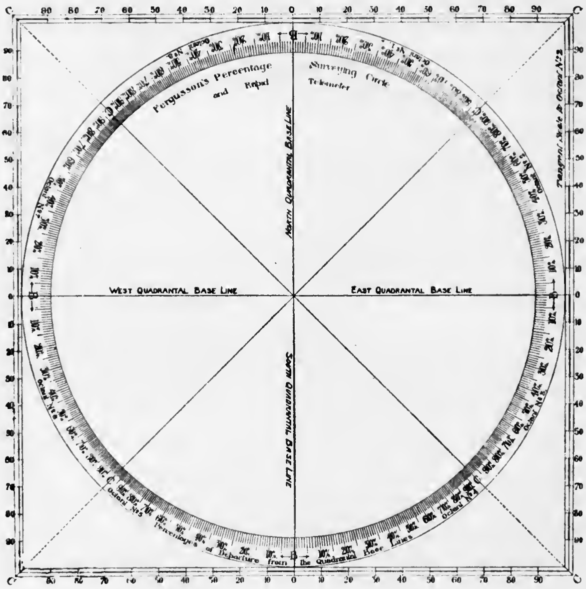


Fig. 18.

FERGUSSON'S PERCENTAGE SURVEYING CIRCLE is shown in *Fig.* 18, which illustrates the method of forming *Fergusson's Percentage Unit of Angular Measurement.*

Fig. 18 does not shew the degree divisions, which are either marked on a separate concentric circle, or a single circle may be used, one half being divided in Percentages and the other half in Degrees.

ADVANTAGES OF THE PERCENTAGE CIRCLE.

It is a telemeter circle in azimuth and altitude, because every division subtends $\frac{1}{100}$ of the base-line.

It does away with Traverse Tables, as the length of the departure is expressed by the *number of the angle;* thus, the departure in an angle read as 12 %, at a point along the base-line 320 feet from the vertex is simply 12 per cent. of 320 feet or 38·4 feet.

Without tables, the distance, level, latitude and departure of a station can be got in the field, and curves of any radius may be ranged instantly. This cannot be done by any other instrument divided in degrees only.

Fergusson's Percentage Unit is easier to work in than the degree, as it does away with tables and trigonometrical formulæ.

When Fergusson's Surveying Circle is attached to a compass or other surveying instrument in place of the ordinary dial or circle divided only into degrees, the instrument is at once converted into a telemeter or range finder, and may be read either in units of degree or in percentage divisions, as desired. Problems which would be difficult to solve by trigonometrical formulæ, when angles are read in degrees, are calculated with ease and rapidity by simple arithmetic, and can often be solved mentally, when the angles are read in percentage units.

When a percentage angle is bisected, the half nearer the base-line contains fewer percentage units, or divisions, than the half of the same angle, which is farther from the base-line; thus :—

Take for example, a course of 1,000 feet long, bearing North 80 per cent. East ; when the angle of 80 per cent. is bisected, the half of the angle adjacent to the base-line, contains 35·055 divisions, and the other half of this angle farther from the base-line, contains 44·945 divisions. These two numbers express the ratio which the length of the 1,000 feet course (North 80 per cent. East) bears to the quadrantal-base-line running due North ; so every 44·945 feet along the course will contain 35·055 feet of Northing along the quadrantal-base-line.

Therefore the length of the course being 1,000 feet, the Northing is 781·25 feet, and the departure (or Easting) is 80 per cent. of 781·25 or 625 feet. In this way, the Latitude and departure of a course measured in any direction is immediately established, and the tangent, sine, secant, radius or cosine, can be obtained by using these ratios ; for in an angle of 80 per cent.—

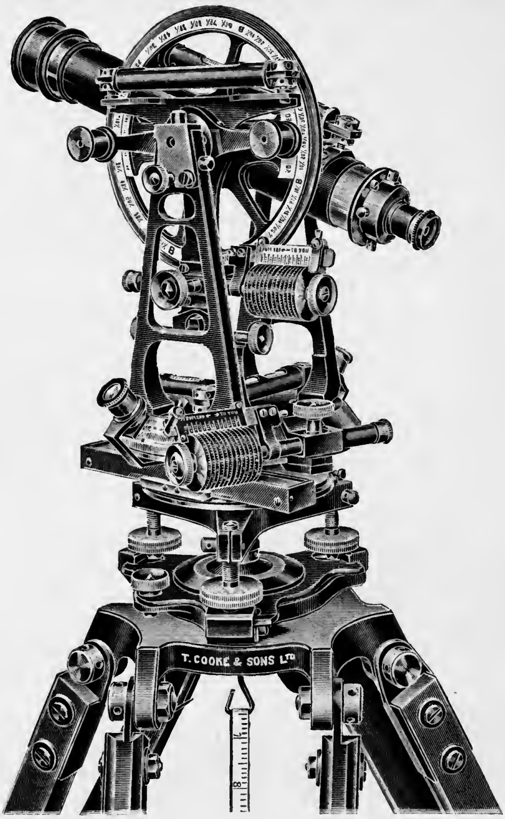
44·945	:	35·055	::	Tan.	:	Sin.
44·945	:	35·055	::	Sec.	:	Rad.
44·945	:	35·055	::	Rad.	:	Cos.

This particular ratio between the percentage units contained in the two halves of a percentage angle is of the greatest importance, and has been described as "a mathematical discovery of great practical value," for herein lies the secret to the solution of all problems in plane trigonometry.

The easiest method of dividing a percentage angle on the instrument is to bisect the equivalent angle in degrees and minutes on the opposite half of the circle with the vernier; and then read the percentage base-half of the angle; this, subtracted from the whole angle, gives the excess half-percentage of the angle, and with these two sets of figures the surveyor can at once get any function he requires arithmetically.

A Pamphlet entitled "Fergusson's Percentage Theodolite, with examples," may be obtained from Messrs. T. Cooke & Sons, Ltd., post free, 1/-

Any of the Theodolites or Tacheometers listed on the preceding pages may be fitted with Fergusson's Percentage Circles at an extra charge.



FERGUSSON'S STANDARD PERCENTAGE THEODOLITE.

119. **FERGUSSON'S STANDARD PERCENTAGE THEODOLITE** (or Surveying Circle), with open pattern standards. Circles 5 inches diameter divided on silver. The horizontal circle is divided into two complete circles of divisions, one degrees and the other percentage units. The vertical circle is divided one half into degrees, the other half into percentage units. Fitted with Fergusson's Tangential Micrometer for reading at sight the unequal percentage divisions in $\frac{1}{100}$-ths, thus affording a closer and easier method of reading small fractions of arc than by means of a vernier. Telescope with object glass 1·35-in. aperture and 10-in. focal length, with stadia lines 1 in 100 and anallatic lens, long level on

telescope, high and low power eye-pieces, two suncaps, trough compass and tape-suspended plumb-bob. Packed in mahogany case fitted with a leather shoulder strap. Tripod of framed pattern with aluminium head, centering arrangement and locking plate ... £45 0s. 0d.

[*Copy.*] THE UNIVERSITY, BIRMINGHAM,
May 2nd, 1905.

Fergusson's Percentage Theodolite.

I have pleasure in stating that I have examined Fergusson's Percentage Theodolite from a point of view of the mathematics involved in its use, and can certify that the claims made on its behalf are justified. It has also been tested practically in the field in the Engineering Department of this University, and has been found extremely convenient in use.

The novelty of the instrument consists of a new method of graduation of the horizontal and vertical circles of a Theodolite. The circles are divided into spaces proportional to the tangents of the angles subtended. The division is complete for each octant, tan 45° being called 100. The new graduation is applied, however, only to one half of each circle, the other halves of the circles being divided into degrees and minutes in the usual manner.

By means of the vertical circle and a graduated levelling staff the length of a course can be found without calculation whether the line of sight be inclined or not.

The length of the course being known, the rectangular coordinates of the course can be obtained immediately from a reading of the horizontal circle.

The length of the course being known, the difference of level between the ends of a course can be read directly from the instrument.

In curve ranging, no tables are required for the determination of the deflexion angle.

The reduction of the results of observations can be carried on simultaneously with the field work without reference to books of tables. Thus all the information about any point on the field can be known whilst the surveyor is on the spot.

For all traverse surveying, especially for a rapid preliminary traverse subject to modification, the instrument possesses distinct advantages over the ordinary Theodolite.

(Signed) R. S. HEATH, M.A., D.Sc.,

Professor of Mathematics.
Vice-Principal of the University.

LEVELS.

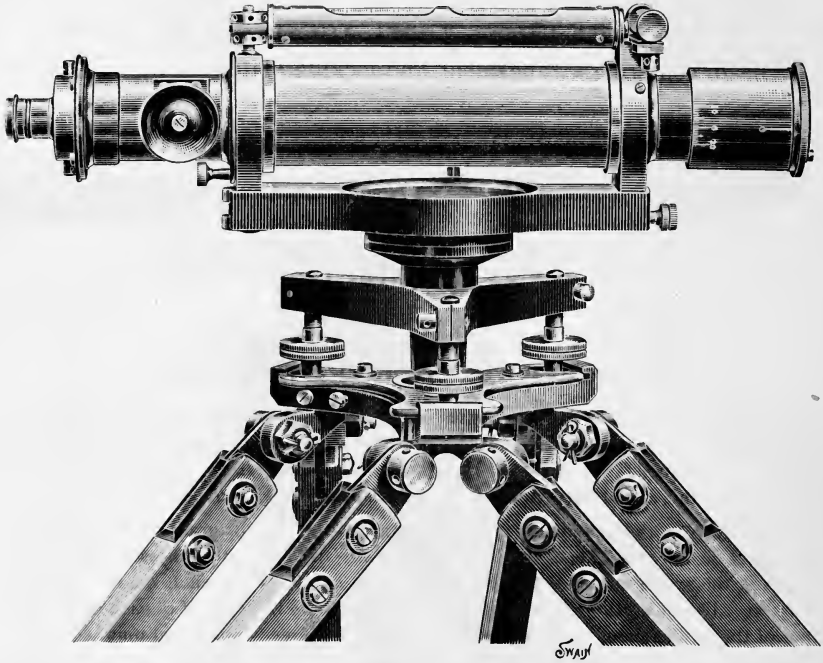


Fig. 19.

COOKE'S PATENT REVERSIBLE LEVEL, with three screws and locking plate, cross bubble, high and low power eye-pieces, etc., packed in a mahogany case, with leather shoulder strap. Tripod stand of solid pattern for 10-in. instruments, of solid or framed pattern for 12-in. and 14-in. instruments, and of framed pattern for the larger sizes. See page 79.

No.	Size.	With compass and prismatic reader.	Without compass.
		£ s. d.	£ s. d.
121	10-in. Cooke's Reversible Level	13 0 0	12 10 0
122	12-in. ,, ,, ,, ...	14 0 0	13 10 0
123	14-in. ,, ,, ,, ...	16 0 0	15 5 0
124	*15-in. ,, ,, ,, ...	18 10 0	—
125	16-in. ,, ,, ,, ...	18 0 0	17 5 0
126	18-in. ,, ,, ,, ...	20 0 0	19 5 0
127	20-in. ,, ,, ,, ...	22 0 0	21 0 0

* With slow motion adjustment, War Office pattern.

Levels.

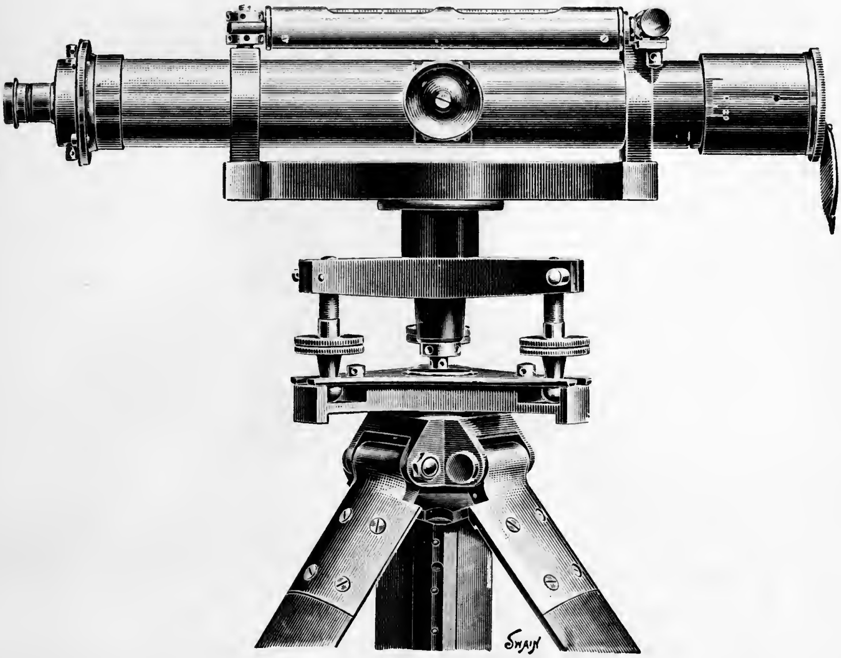


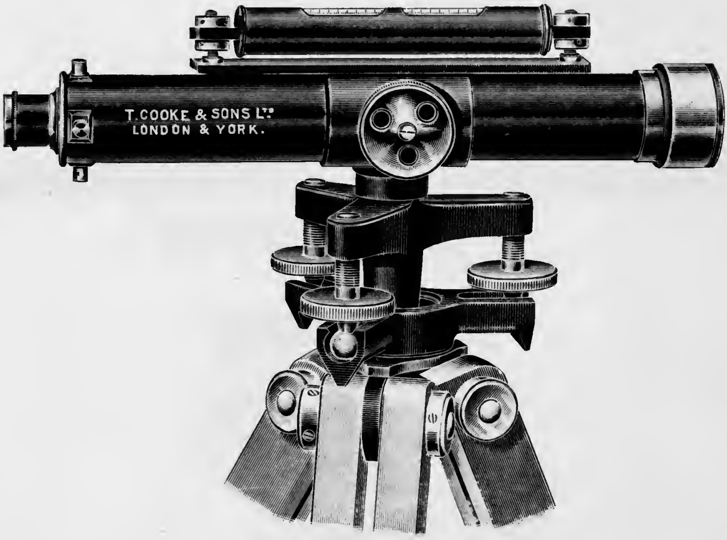
Fig. 20.

Dumpy Level.

DUMPY LEVEL of good construction, with three screws, cross bubble, high and low power eye-pieces, etc. No compass. Packed in mahogany case, fitted with leather shoulder strap. Tripod stand of solid pattern. Made in three sizes only.

No.		£	s.	d.
129.	10-in. Dumpy Level	12	0	0
130.	12-in. ,, ,, ...	13	0	0
131.	14-in. ,, ,, ...	14	0	0

Levels.



133. **BUILDER'S LEVEL,** in one size only, 9-in., a useful and reliable instrument with three screw adjustment and long bubble, packed in a pine case, fitted with leather shoulder strap. Light tripod stand of solid pattern 7 10 0

Bolton's Patent, Cushing's Patent, or Wye Levels, at prices £1 in excess of those quoted for Cooke's Levels.

Extras and Additions to Levels.

No.		Best Solid. £ s. d.	With Felt Lining. £ s. d.
	LEATHER CASES—		
135.	For 10-in. Level	1 3 0	1 14 0
136.	,, 12-in. ,, ...	1 6 0	1 18 0
137.	,, 14-in. ,, ...	1 9 0	2 2 0
138.	,, 15-in. ,, ...	1 11 0	2 4 0
139.	,, 16-in. ,, ...	1 13 0	2 7 0
140.	,, 18-in. ,, ...	1 17 0	2 12 0
141.	,, 20-in. ,, ...	2 2 0	2 18 0
142.	Canvas and leather bound case for tripod		1 10 0
143.	,, ,, ,, ,, cap ,, ,, head		0 7 6
144.	Solid leather ,, ,, ,, ,, ...		0 15 0

Extras, etc.

No.		£	s.	d.
145.	**TRIPOD STAND,** ordinary, for 10-in. level	2	10	0
146.	,, ,, ,, ,, 12-in. or 14-in. do. ...	3	5	0
147.	,, ,, ,, ,, 16-in. or 18-in. do. ...	3	15	0
148.	,, ,, ,, ,, 20-in. do.	5	0	0
149.	,, ,, telescopic, for 10-in. or 12-in. level ...	4	0	0
150.	,, ,, ,, ,, 14-in. do.	4	10	0
151.	**ROUGH LEVELLING ARRANGEMENT** to stand of 12-in., 14-in., or 16-in. level	2	2	0
152.	**SLOW-MOTION ADJUSTMENT** in azimuth to do. ...	1	10	0
153.	**EYE-PIECES,** Ramsden, high or low power	0	12	6
154.	Ditto Erecting	1	7	6

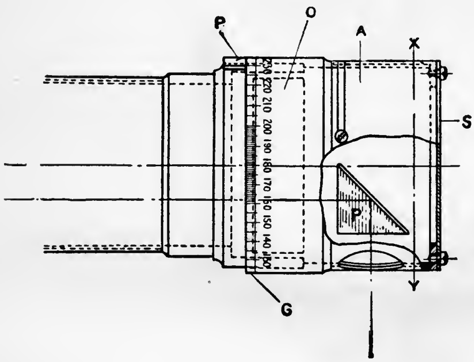


Fig. 21.

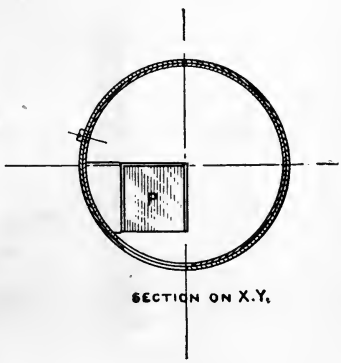


Fig. 22.

155. **DEACON'S PATENT OPTICAL SQUARE ATTACHMENT** can be fitted to any level, and consists of an attachment A, carrying a prism P, for ranging out lines at right angles to the main line, on flat or hilly ground. After closing the shutter S the line of sight is deflected through an angle of 90°, and by revolving the attachment about the object glass O, any points in the vertical plane at right angles to the axis of the telescope, can be brought into focus without altering the position of the level. With the addition of stadia lines to the level tacheometrical readings may be taken in all directions at a single setting up of the instrument. The presence of the prism in no way interferes with the ordinary staff readings ... ... £1 5s. 0d.

Extras, etc.

BUBBLES—

No.		Long.	Cross.
156.	For 9-in. Level	0 5 0	—
157.	,, 10-in. ,, ...	0 6 0	0 2 0
158.	,, 12-in. ,, ...	0 7 0	0 2 0
159.	,, 14-in., 15-in. and 16-in. Levels	0 8 0	0 2 0
160.	,, 18-in. and 20-in. ,, ...	0 12 0	0 3 0

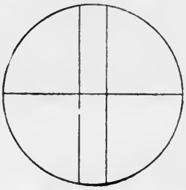


Fig. 24.

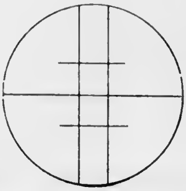


Fig. 25.

161.	**DIAPHRAGMS**, ordinary, parallel glass. *Fig.* 24	0 5 0
162.	DITTO special or stadia lines. *Fig.* 25	0 7 6
163.	**GUN-METAL BLOCK**, with dove-tailed slide and adjusting screws, for carrying glass diaphragm	0 7 6
164.	**LEATHER SHOULDER STRAP**	0 3 6
165.	**LEVELLING SCREWS**, each	0 2 6

MINING DIALS.

Fig. 26.

No.

MINER'S DIAL, of best make, a strong serviceable instrument, very suitable for rapid surveying, with folding sights and circular bubble; Tripod stand, with ball-and-socket joint :—

		£ s. d.
168.	Diameter of box, 6-in.	8 10 0
169.	Ditto, with 5-in. box of aluminium, very light	8 0 0
170.	Divided cover to either of above, giving difference of hypothenuse and base	0 15 0

Mining Dials.

IMPROVED MINER'S DIAL, with semi-circular vertical arc, which can be folded down when not required; Folding sights, two level bubbles, etc.; packed in a mahogany case. Tripod stand with legs jointed in the middle, and ball-and-socket joint.

No.		£	s.	d.
171.	Diameter of box, 5-in.	16	0	0
172.	Ditto 6-in.	19	0	0
173.	Telescope fitted to either of the above, extra	5	5	0
174.	Solid leather case to box of mining dial, 5-in. or 6-in. ...	1	2	0
175.	**BRUNTON-PEARCE POCKET MINING TRANSIT or COMPASS,** 3-in. dia.	5	0	0

POCKET DIALS.

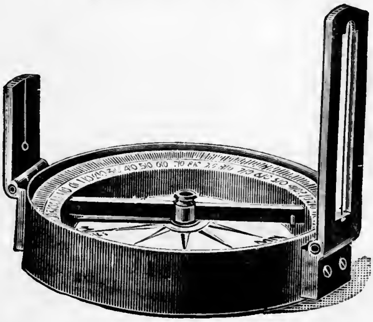


Fig. 27.

178.	**POCKET DIAL,** with raised graduated ring, bar-needle and stop, 3-in. dia.	1	5	0
179.	Ditto with sights reading both ways, and cover, 3-in. dia.	1	10	0
180.	Ditto 4-in. dia.	1	15	0
181.	Ditto 5-in. dia.	2	8	0
182.	Sling leather cases for above, 4/6, 5/6, and 6/6 each.			
183.	Light mahogany tripod stand with ball and socket joint fitted to either of above	1	5	0

CLINOMETER COMPASSES.

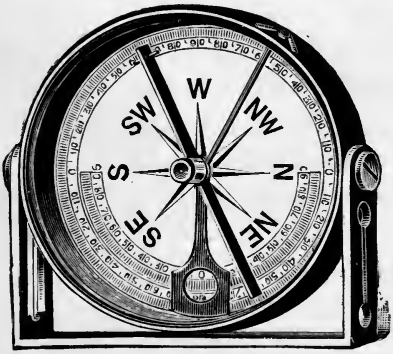


Fig. 28.

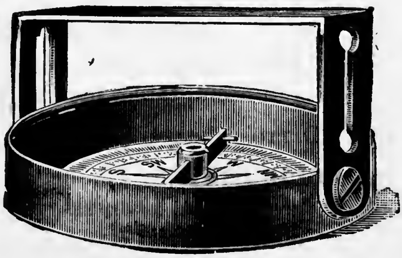


Fig. 29.

186. **CLINOMETER COMPASS,** which may be used as a pocket dial with sights, or as a level or clinometer, reading the dip in degrees or inches per yard. In case complete, 3-in. diameter ... £1 1s. 0d.

187. Ditto 4-in. diameter ... ... £1 5s. 0d.

CLINOMETERS.

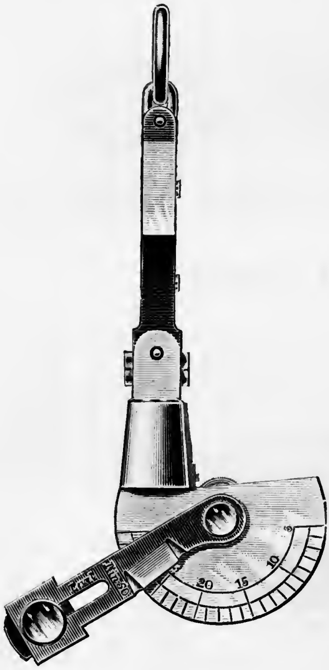


Fig. 30.

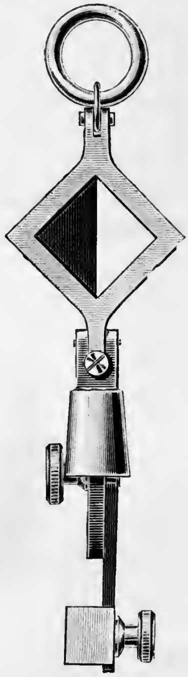


Fig. 31.

De Lisle's Clinometer.

No.		£	s.	d.
189.	**DE LISLE'S CLINOMETER,** for the tracing of roads, etc., marked for levels and gradients up to 1 in 50, fitted in leather case with shoulder strap...	3	3	0
190.	**ROAD-TRACER,** Ceylon pattern, marked rising and falling gradients, with supporting staff and target	4	0	0
191.	**WATKIN'S SERVICE PATTERN CLINOMETER,** in case	2	10	0
192.	**RULE PATTERN CLINOMETER,** 6-in. boxwood, with flush vernier arc, large swing compass, bar needle, and useful tables marked on side, in case...	2	5	0
193.	Ditto cheaper pattern	1	15	0
194.	**CLINOMETER,** gun-metal, with divided arc, two spirit levels, 2-in. compass, folding sights, etc., in case, complete. Tripod stand with ball-and-socket joint.	5	0	0
195.	Ditto in aluminium	5	15	0
196.	**PLATELAYER'S LEVEL,** 12-in., adjustable, giving gradients, in case	1	10	0

Clinometers.

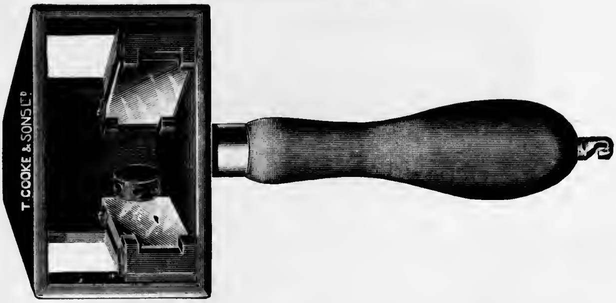


Fig. 32.

		£	s.	d.
197.	**OPTICAL SQUARE,** with adjustment, in solid leather case, with shoulder strap	1	8	0
198.	DITTO double, reflecting 90° simultaneously to both hands, with adjustment, in solid leather case	2	15	0

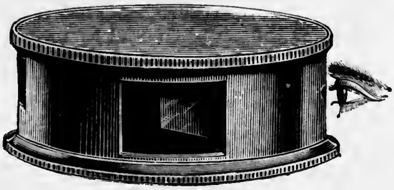


Fig. 33.

200.	**OPTICAL SQUARE** round pattern, in case	1	1	0

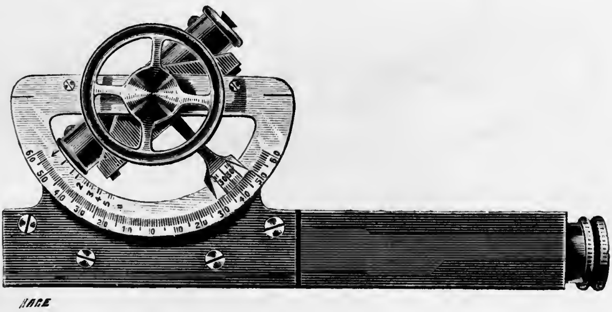


Fig. 34.

202.	**ABNEY'S LEVEL or Clinometer,** 5-in. in case ...	2	0	0
203.	DITTO 7-in. with considerably larger arc.	2	15	0
204.	DITTO 4-in. with fine adjustment by tangent screw, in morocco case	3	10	0

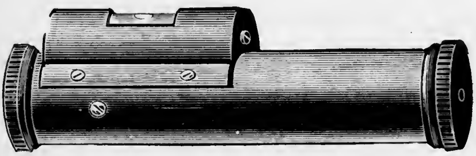


Fig. 35.

205.	**POCKET REFLECTING LEVEL,** with prism, in case ...	0	18	0

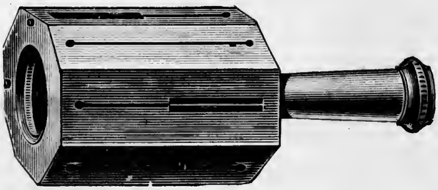


Fig. 36.

206.	**CROSS-STAFF-HEAD**, Octagonal, for setting out angles of 45° or 90°, with compass, packed in a wooden box ...	0	17	0
207.	Ditto without compass, as illustrated	0	10	6
208.	Ditto Cylindrical, with divided circle and screw adjustment, for setting off any angle, with compass	2	0	0
209.	Ditto without compass	1	15	0
210.	Ditto open pattern for right angles only, without compass, in case	0	12	6
211.	**LIGHT TRIPOD STAND** for any cross staff head	0	10	0
212.	**PLAIN STAFF**, iron shod, for ditto	0	3	6

PLANE TABLES.

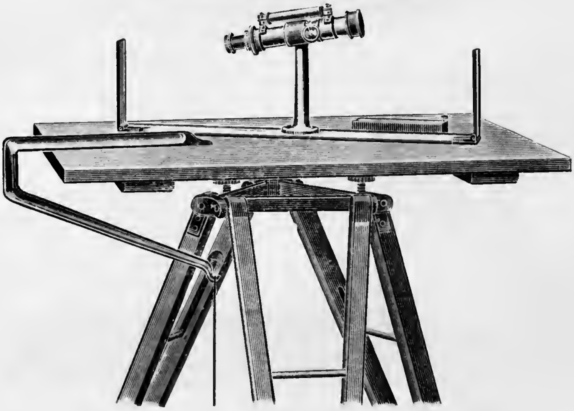


Fig. 37.

213. **PLANE TABLE**, with board 17-in. by 14-in., in canvas case with shoulder straps. Boxwood alidade with folding sights and divided edges, trough-compass and circular spirit level. Tripod stand of framed pattern ... ... £4 0s. 0d.

214. Ditto as above, but fitted with a ball-and-socket joint for quick levelling ... ... £6 0s. 0d.

215. Telescopic Stand for either of the above, extra ... £1 5s. 0d.

216. Ditto with board 23-in. by 16-in., having special means of rapidly stretching and fixing the paper, ball-and-socket levelling arrangement, gun-metal alidade with removable sights. Trough compass and level bubble. Folding tripod stand. The whole packed in a strong case ... ... £8 0s. 0d.

Plane Tables.

217. **PLANE TABLE**, as No. 216, but with three screw levelling arrangement, gun-metal alidade with removable telescope carrying bubble, and removable sights at ends, suspending fork and plumb-bob. Aperture of telescope ·875 in. and power 10. See fig. 37 £11 0s. 0d.

218. DITTO with board 24 in. by 18 in., having slow-motion adjustment in azimuth and clamp, centering arrangement, three screws for levelling, and special means of rapidly stretching and fixing the paper. Gun-metal alidade with removable telescope carrying bubble and removable sights at ends. Square aluminium plate carrying 3 in. circular compass and cross-bubbles, suspending fork and plumb-bob. Aperture of telescope 1·125 in. and power 16. Folding tripod stand. The whole packed in a strong case ... ... £13 10s. 0d.

219. DITTO as No. 218, but with board 26 in. by 21 in., and telescope of 1·35-in. aperture, power 20, and stadia lines. Strong tripod stand of framed pattern, not adjustable or folding, and not packed in case £16 10s. 0d.

220. Vertical Circle with slow-motion adjustment to either of the last two, extra £2 0s. 0d.

221. DITTO as No. 219, but with board 30 in. by 24 in., or to suit requirements. Anallatic lens to telescope and vertical circle with slow motion adjustment. Aperture of telescope 1·35-in. and power 25 £20 0s. 0d.

222. Canvas and leather-bound case to any tripod, extra £1 0s. 0d.

223. ,, ,, ,, cap to any tripod head, extra £0 7s. 6d.

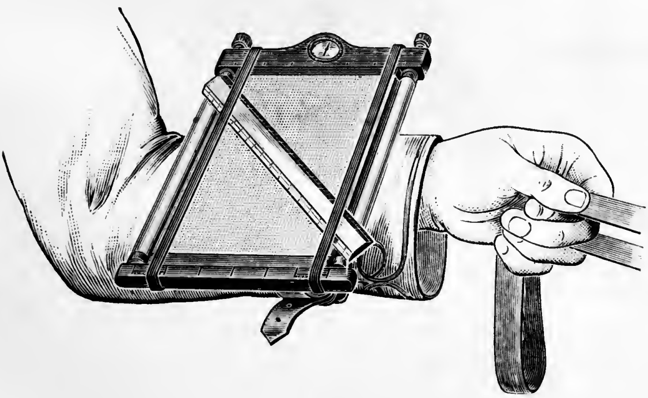


Fig. 38.

225. **CAVALRY SKETCHING BOARD** (for use on horseback), with brass rollers for carrying the paper, bar-needle compass, wrist-strap and straight-edge ... ... £1 15s. 0d.

In consequence of the War Office Regulations, which prohibit the sale of Government Pattern Instruments without permission, we neither illustrate nor describe the different patterns of Rangefinders, Mekometers, Heliographs, Gun-sights, etc., made by us. We are prepared, however, to apply for the necessary permission, and to quote for any of these instruments, on application.

T. COOKE & SONS, LTD.

HELIOTROPES.

HELIOTROPE, as used on the Indian Surveys, consisting of a mirror carried in a frame, and mounted on a tribrach, with rack motions for turning about both vertical and horizontal axes. Fitted in a box which is made to be used as a stand.

			£	s.	d.
237.	With 4-in. mirror	each	6	0	0
238.	,, 6-in. ,, ...	,,	8	0	0
239.	,, 9-in. ,, ...	,,	11	0	0

PRISMATIC COMPASSES.

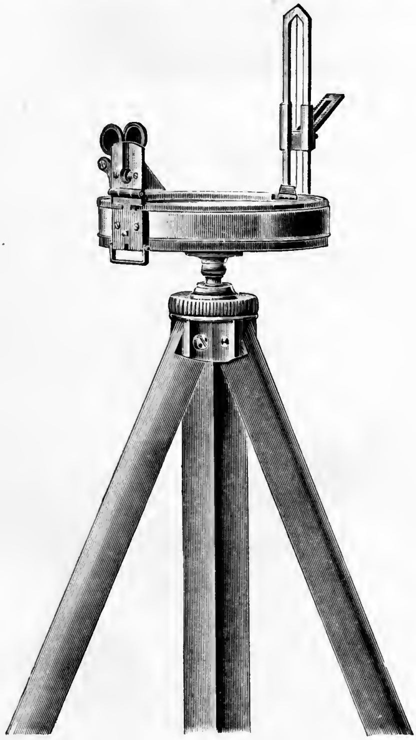


Fig. 40.

PRISMATIC COMPASS, with graduated aluminium ring, shades, and mirror, fitted in a solid leather case, with shoulder strap. Light mahogany tripod stand with ball-and-socket joint.

No.		£	s.	d.
241.	3-in. diameter of ring, divided to 1°	4	0	0
242.	3½-in. ,, ,, ,, ,, ...	4	10	0
243.	4-in. ,, ,, ,, 30′	5	0	0
244.	4½-in. ,, ,, ,, ,, ...	5	10	0
245.	5-in. ,, ,, ,, ,, ...	6	0	0
246.	6-in. ,, ,, ,, ,, ...	7	0	0
247.	If without tripod stand, 25/- less.			

Prismatic Compasses.

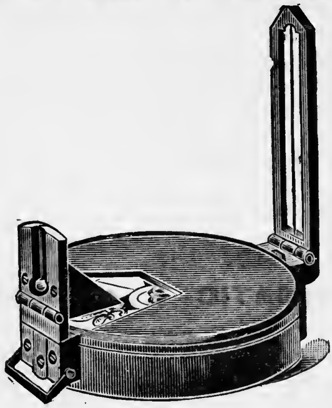


Fig. 41.

No.		£	s.	d.
249.	**Hutchinson's Military pattern,** with card dial, 2½-in. dia. in leather sling case	2	0	0
250.	DITTO 3½-in. dia.	2	10	0
251.	**Major Verner's Service Pattern,** luminous, in leather sling case	2	15	0
252.	**Barker's Combined Prismatic Compass and Altitude Instrument,** 3-in. dia., in solid leather sling case ...	4	4	0
253.	DITTO smaller	3	3	0
254.	**NIGHT MARCHING COMPASS,** with graduated aluminium dial and luminous centre, in bronzed case, with sight in lid	1	3	0
255.	**BARKER'S NIGHT MARCHING COMPASS**	1	1	0
256.	**MAJOR LEIGH'S LUMINOUS** „	1	14	0

Fig. 42.

		£	s.	d.
257.	**SERVICE PATTERN PRISMATIC COMPASS,** Mark V., with hinged lid, $2\frac{1}{8}$-in. dia. and sighting line. In sling leather case	3	15	0

MAGNETIC COMPASSES.

Fig. 43.

Fig. 44.

POCKET MAGNETIC COMPASS, in gilt or nickel case with stop, enamelled dial, open face, best bar needle and agate cap, in morocco case.

No.		£	s.	d.
260.	1⅜-in. diameter	0	10	0
261.	1¾-in. ,, ...	0	11	0
262.	2-in. ,, ...	0	12	0

Ditto with Singer's patent pearl dial and agate cap, in morocco case.

263.	1⅜-in. diameter	0	10	0
264.	1¾-in. ,, ...	0	11	0
265.	2-in. ,, ...	0	12	0

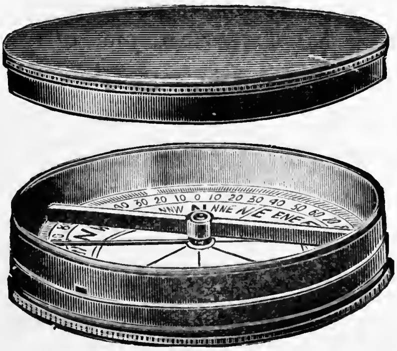


Fig. 45.

Pocket Magnetic Compass in brass case.

Magnetic Compasses.

POCKET MAGNETIC COMPASS, in brass case, with lid and stop, bar needle and agate cap. See Fig. 45.

		With card dial.	With silvered metal dial.
267.	$1\frac{3}{8}$-in. dia.	0 4 0	0 5 0
268.	$1\frac{3}{4}$-in. "	0 4 6	0 5 6
269.	2-in. "	0 5 0	0 6 0
270.	$2\frac{1}{4}$-in. "	0 5 6	0 6 6
271.	$2\frac{1}{2}$-in. "	0 6 0	0 7 3
272.	$2\frac{3}{4}$-in. "	0 6 6	0 8 0
273.	3-in. "	0 7 0	0 9 0

274. Ditto Royal Geographical Society's pattern, 2-in. dia., with aluminium or pearl dial, in gun-metal and leather cases 1 1 0

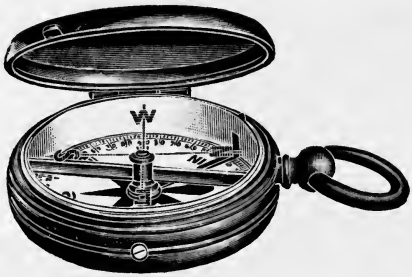


Fig. 46.

		$1\frac{1}{2}$-in.	$1\frac{3}{4}$-in.	2-in.
275.	**BRONZE HUNTER COMPASS,** with bar needle	13/-	15/-	17/-
276.	Ditto with Singer pearl dial	14/-	16/-	18/-

277. Ditto with bar needle, combined with sundial 0 18 0

278. **BOAT COMPASS,** in mahogany case, 3-in., 9/-; 4-in., 11/-; 6-in., 15/-

279. **POCKET GIMBAL COMPASS,** in leather case 1 2 0

280. **BRASS BOAT BINNACLE,** 4-in., card dial... ... ... 2 2 0

281. **MINER'S COMPASS or Dipping Needle,** 3-in., in pocket case 1 5 0

QUADRANTS.

84. **7-in. METAL QUADRANT or HALF SEXTANT,** with extended arc divided on silver to 15-secs. Coloured shades, prospect and blank telescopes, in mahogany case ... ... £5 0s. 0d.

SEXTANTS.

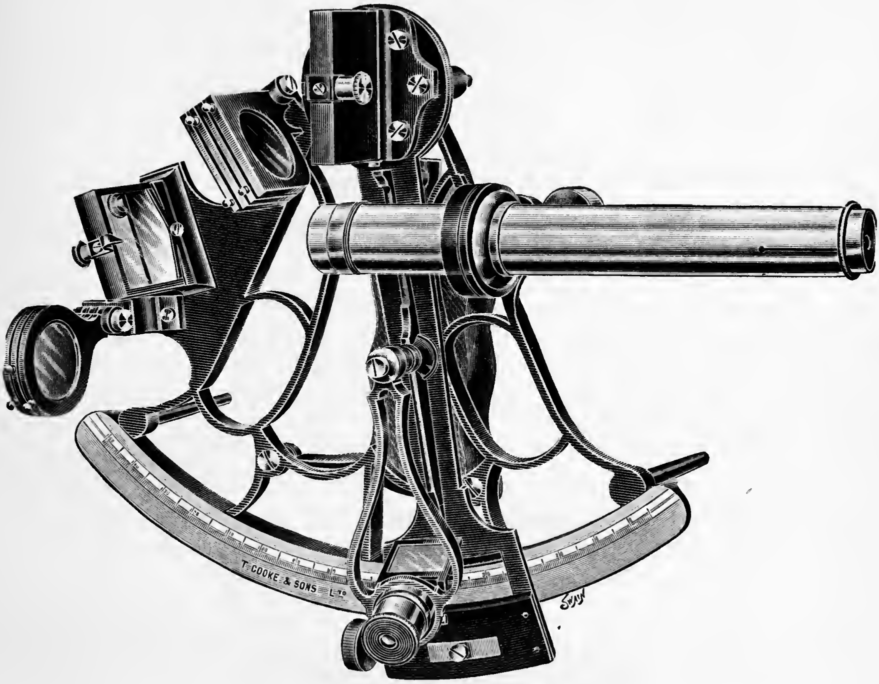


Fig. 47.

285. **6-in. THREE-CIRCLE FLAT LIMB METAL SEXTANT,** long centre with cap, rising piece, arc divided on silver to 10-secs., long telescope, prospect and blank, coloured shades, packed in mahogany case £6 15s. 0d.

286. **6½-in. ditto** three circle edge bar ... ... £7 15s. 0d.

287. **6½-in. THREE-CIRCLE EDGE BAR 'BRITANNIA' CADET PATTERN SEXTANT,** superior finish, long centre with cap, rising piece, capped adjustment, reflector to vernier, best index and horizon glasses, neutral tint shades, arc divided on silver to 10-secs., long telescope with extra power, blank, achromatic star telescope, two dark heads, and long handle with ivory plate for noting readings. Packed in polished mahogany case with flush handle, name-plate and circular fastenings. With Kew certificate, Class A. ... ... £11 15s. 0d.

288. **7¼-in. TRIANGULAR PATTERN SEXTANT,** long centre with cap, rising piece, arc divided on silver to 10-sec., capped adjustment, reflector to vernier, coloured shades, long telescope, prospect and blank. In mahogany case ... ... £9 0s. 0d.

Sextants.

289. $7\frac{1}{4}$-in. **TRIANGULAR PATTERN SEXTANT**, with bridge handle, long centre with cap, rising piece, capped adjustment, reflector to vernier, arc divided on silver to 10-secs., best index and horizon glasses, neutral tint shades, long telescopes with extra power, prospect, blank, and two dark heads. Packed in mahogany case with name-plate and flush handle ... ... £10 10s. 0d.

290. 8-in. **TRIANGULAR PATTERN SEXTANT**, bridge handle, best make, with strapped adjustment, swing horizon, cup-and-ball tangent screw, swing reflector to vernier, arc divided on silver to 10-secs., best horizon and index glasses and neutral tint shades, large size long telescopes, with extra power, prospect, blank, and two dark heads. Packed in a mahogany case with name-plate and flush handle £14 0s. 0d.

291. Extra for neutral tint shades when not included ... £0 15s. 0d.

292. Extra for best index and horizon glasses and neutral tint shades when not included ... ... £1 0s. 0d.

294. Kew Certificate, Class A, to any sextant, if not included in price quoted 0 15 0

Sextant and Quadrant Accessories.

296. **BINOCULAR TELESCOPE** for use with sextant, best quality conical bodies, oxidised or bright brass mounts with milled edge flange for clamping to the rising piece ... ... £1 0s. 0d.

				£	s.	d.
297.	Long Telescope, ordinary size	... ...	each	0	11	6
	Ditto	large	,,	0	14	6
	Ditto	with outside cell	,,	0	16	6
298.	Short or Prospect Telescopes, ordinary size	...	,,	0	4	6
	Ditto	large	,,	0	6	0
	Ditto	with outside cell ...	,,	0	8	0
299.	Blanks, ordinary size	... ...	,,	0	2	0
	Ditto large	... ...	,,	0	3	6
300.	Star Telescopes, small	... ...	,,	0	9	0
	Ditto	large	,,	0	14	0
	Ditto	with outside cell	,,	0	18	0
301.	Solid leather case to any sextant, strongly made, best quality	... ...	,,	1	1	0

BOX SEXTANTS.

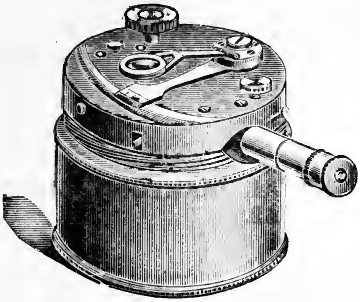


Fig. 48.

No.		£	s.	d.
305.	**BOX SEXTANT,** 3-in. diameter, divided on silver, with telescope, shades, etc., fitted in a solid leather case, with shoulder-strap	4	4	0
306.	DITTO with supplementary arc	5	5	0
307.	Light mahogany tripod stand, with ball and socket joint, fitted to either of above	1	5	0

ARTIFICIAL HORIZONS.

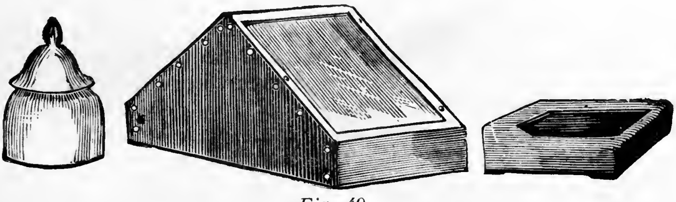


Fig. 49.

308. **ARTIFICIAL HORIZON,** plane black glass, rectangular or circular, with three levelling screws and spirit level, in mahogany case £2 5s. 0d.

309. DITTO best mercurial, with roof, trough, and turned iron bottle, filled with mercury, in a mahogany case ... ... £4 10s. 0d.

310. DITTO of cheaper make ... ... £3 10s. 0d.

311. DITTO Captain George's pattern, in cast iron, having two chambers with connecting valve, the mercury being stored in one and allowed to run into the other when required for use; plane glass surface and levelling screws ... ... £4 15s. 0d.

312. DITTO in aluminium ... ... £6 0s. 0d.

SHIP-LOGS.

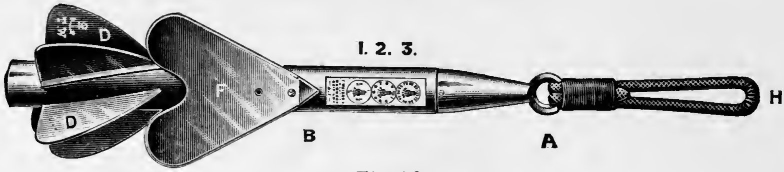


Fig. 50.

No.		£	s.	d.
314.	**WALKER'S PATENT A1. "HARPOON" SHIP-LOG** ...	2	17	0
315.	DITTO **A2.** ...	2	10	0

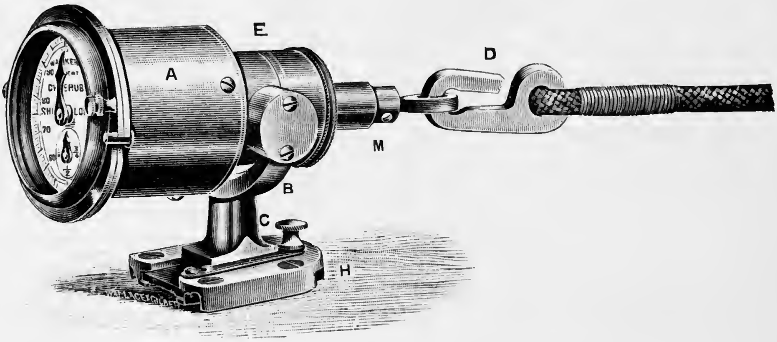


Fig. 51.

317.	**WALKER'S PATENT "CHERUB" SHIP-LOG,** with registering apparatus for fixing to taffrail, and two rotators ...	4	10	0
318.	**WALKER'S PATENT "CHERUBAL" SHIP-LOG,** with ball bearings, similar in outward appearance to the Cherub but with sliding case through which the wheels can be readily oiled	4	18	0
319.	Extra rotators, for Cherub or Cherubal Ship-logs ...	0	19	0
320.	Brass Fly-Wheel Governor, for use with Cherub, Cherubal and other ship-logs	0	11	0
321.	Ship-log Swivel	0	10	0
322.	Best Quality Log Lines, 40 fathoms, No. 8, 12/-; No. 10	0	15	0
323.	Ditto 50 ,, ,, 15/- ,,	0	19	0
324.	**WALKER'S "HARPOON" SOUNDING MACHINE,** a thoroughly reliable mechanical sounder	2	10	0

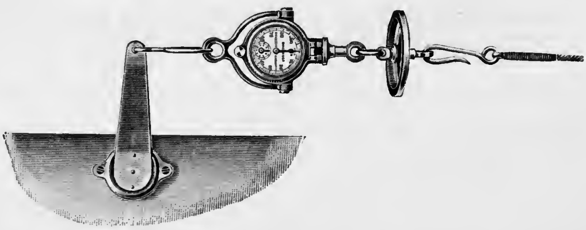


Fig. 52.

325.	**WALKER'S PATENT "EXCELSIOR" YACHT-LOG,** complete with register, rotator, 100 feet of line and sinker. Packed in a box	3	6	0
326.	Extra rotators for do.	0	10	0

LEVELLING STAVES, ETC.

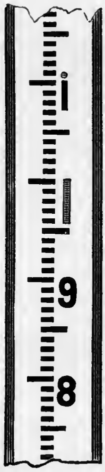


Fig. 53. Half-Centimetres.

Fig. 54. Fiftieths.

Fig. 55. Hundredths.

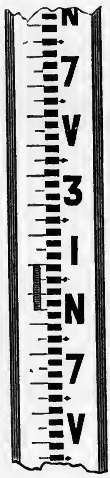


Fig. 56. Fiftieths.

SOPWITH'S TELESCOPIC LEVELLING STAFF, of best construction, strong mahogany, brass bound, with painted readings, Cooke's pattern (Fig. 55) and several others, in feet and metres.

No.		£	s.	d.
329.	In two lengths, 12 feet long, closing to 6-ft. 8-in., inner and middle	1	10	0
330.	Ditto outer and middle	1	15	0
331.	In three lengths, 14 feet long, closing to 5-ft. 3-in.... ...	2	5	0
332.	Ditto 16 feet long ,, 6-ft. 3-in.... ...	2	12	6
333.	Ditto 5 metres long ,, 2 metres	2	12	6
334.	Ditto 18 feet long ,, 7-ft. 3-in.... ...	3	3	0
335.	Ditto 9 feet long, closing to 3-ft. 6-in., for underground use	2	0	0
336.	**ROLL-UP RUBBER BAND,** stencilled any standard pattern, for use as a portable staff, 10-ft. long	0	12	6

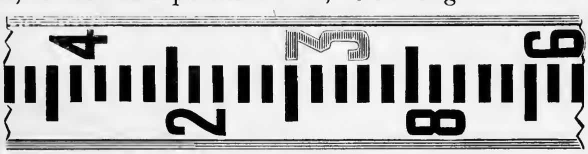


Fig. 57.

		£	s.	d.
337.	**FOLDING STAFF OR STADIA ROD,** with strong hinge, 12 feet long, closing to 6 feet	2	10	0
338.	Ditto 14 ,, ,, 7 ,, ...	2	15	0
339.	Ditto 16 ,, ,, 8 ,, ...	3	0	0

Stadia Rods can be graduated to read 1 in 50, 1 in 100, or any other ratio desired. The illustration shows a rod graduated to $\frac{1}{50}$-ths of a foot and reading 1 in 100.

Staves or Stadia Rods painted to Engineers' own designs at an extra cost.

Levelling Staves, etc.

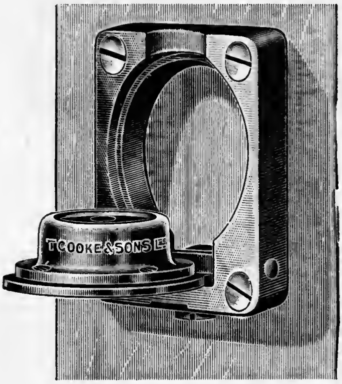


Fig. 58.

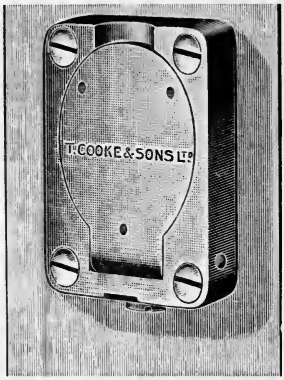


Fig. 59.

No.		£	s.	d.
340.	**PORTABLE CIRCULAR BUBBLE** for fixing to the back of staff or stadia rod, and folding up flat when not in use	0	12	6
	CANVAS CASES, Leather bound—			
341.	For one 14 feet staff	0	15	0
342.	For one 12 feet, 16 feet or 5 metre staff	0	16	6
343.	For one 18 feet staff or 12 feet folding stadia rod	0	18	0
344.	For one 14 feet folding stadia rod	1	0	0
345.	For one 16 feet do.	1	2	0
346.	**STAFF PAPERS,** for re-papering staves, of any regular pattern, 12 feet, 2/6; 14 feet, 3/-; 16 feet, 3/6; 18 feet ...	0	4	0
347.	**LEVELLING STAFF PROTECTORS,** for attaching a tripod stand to the face of the staff for convenience in carrying, at the same time protecting the latter. In two patterns for solid round, or framed pattern tripods per pair	0	3	6

SURVEYORS' RODS, ETC.

RANGING POLES, painted two or three colours, and iron shod—

No.		£	s.	d.
348.	6 feet long, divided feet ... ... per doz.	1	10	0
349.	7 „ „ „ „ ... ... „	1	15	0
350.	8 „ „ „ „ ... ... „	2	0	0
351.	10 „ „ „ „ ... ... „	2	15	0
352.	12 „ „ „ „ ... ... „	3	10	0

BAMBOO RANGING POLES, with brass ferrule at top and iron shod—

No.		£	s.	d.
353.	6 feet long	1	16	0
354.	7 „ „	2	2	0
355.	8 „ „	2	8	0
356.	10 „ „	2	15	0
	Brass jointing, 24/- per doz. extra.			
357.	**OFFSET ROD,** 10 links, shod, with point ... ... each	0	3	6
358.	**BONING RODS,** per set of three	0	15	0

Surveyors' Rods, etc.

Fig. 61.

No.		Straight. s. d.	Folding. s. d.
359.	**SURVEYORS' RODS**, ash, natural wood, painted feet and quarters, 5 feet long, per pair	5 6	—
360.	Ditto lancewood, fully divided and engraved, natural wood or stained black, 5 feet, per pair ...	8 0	10 0
361.	Ditto 6 feet, per pair	10 0	12 0
362.	**SOLID LEATHER CASE** to hold a pair of 5 feet folding rods	—	7 6
363.	Ditto to hold a pair of 6 feet folding rods ...	—	9 0
364.	**FLAGS** for Surveying Poles, white and red	7/-, 9/- & 12/- per doz.	
366.	**SURVEYORS' WALKING STICK**, with 5-ft. rod, malacca cane		1 5 0
367.	Ditto crooked bamboo cane		1 5 0
368.	Ditto silver-mounted root bamboo		0 16 0
369.	Ditto plain " "		0 13 0
370.	**TROPICAL UMBRELLA**, large size, double, with jointed stick and spike		1 12 0
371.	Ditto smaller, without stick and spike		0 12 6

373. **RECESS RODS**
small, 5/- ; large, 6/6

374. **HORSE STANDARDS**
20/-, 25/-, 30/-

375. Ditto portable, in walking stick, as illustrated ... 17/- to 30/–

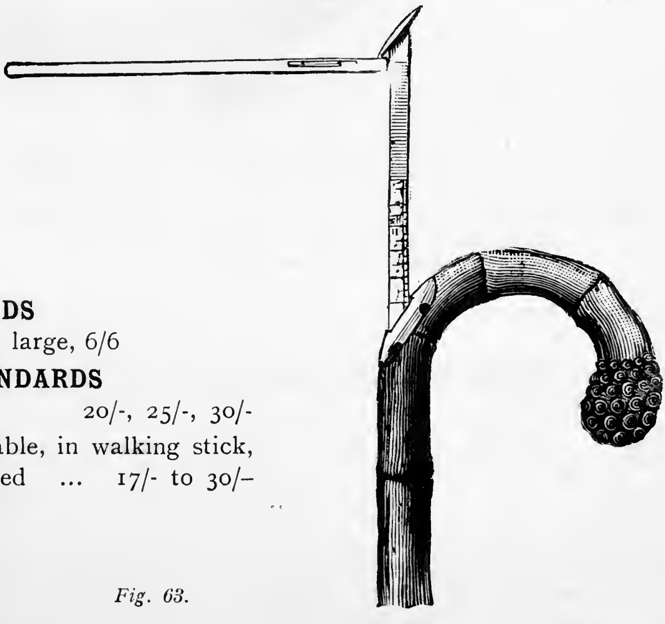


Fig. 63.

LAND SURVEYING CHAINS.

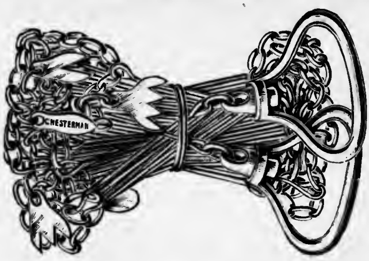


Fig. 64.

4 Pole Surveying Chain.

The four pole chains are divided into links and tallied at every ten links; the 50 and 100 feet chains are divided into feet and tallied at every ten feet; the metre chains are divided into fifths of a metre and tallied at every two metres.

No.	Description.	Length. 50 Feet.	4 Poles.	100 Feet.	
	Made of best iron wire, with three oval rings, brass swivel handles and tallies.				
381	No. 8 W. G.	5/6	7/-	8/-	Each
	Made of best cast steel wire, with three oval rings, brass swivel handles and tallies.				
382	No. 8 W. G.	10/-	15/-	18/-	,,
383	,, 10 ,, ...	8/6	13/6	16/-	,,
	,, 12 ,, ...	7/6	12/-	14/-	,,
384	,, 12 ,, all joints brazed ...	12/-	21/-	23/-	,,

No.	Description.	Length in Metres. 10	20	25	
	Made of best iron wire with three oval rings, brass swivel handles and tallies.				
385	No. 8 W. G.	5/-	7/6	9/-	Each
	Made of best cast steel wire, with three oval rings, brass swivel handles, and tallies.				
386	No. 8 W. G.	8/6	15/-	19/-	,,
387	,, 12 ,, ...	6/6	12/-	15/-	,,

Any of the foregoing may be had galvanised, or with all joints brazed, so as to form a solid chain.

Chains in all Foreign Measurements to order.

Land Surveying Chains.

		s.	d.	
388.	**LAND CHAIN STRAPS**	0	6	each.

LAND CHAIN ARROWS.

15 INCHES LONG, IN SETS OF TEN.
Made of best cast steel wire.

		s.	d.	
389.	No. 8 W. G.	1	6	per set.
390.	,, 10 ,, ...	1	3	,,
	Made of best iron wire.			
391.	No. 7 W. G.	1	0	,,
392.	,, Galvanised	1	3	,,
393.	**LEATHER QUIVER** for Arrows	1	6	each.

COMPOUND STEEL-BAND CHAINS.

These are usually employed in two or more separate lengths, made attachable by swivels and hooks. The first length of each set is divided in the usual manner into links or feet and numbered at every ten, the others not being subdivided.

Each set is provided with handles and wound upon a steel cross, which is included in the prices quoted below, but a metal reel may be had if desired, at an extra cost.

No.	Width of Band.	Length in Chains of 100 Links.				
		2	3	4	5	
397	$\frac{1}{4}$-in. Steel Band	16/-	20/-	25/-	30/-	Each
398	$\frac{1}{8}$-in. ,, ,, ...	16/-	20/-	24/-	28/-	,,
399	$\frac{1}{16}$-in. ,, ,, ...	12/-	15/-	18/6	22/-	,,

Single Four-pole lengths for repairing the above, without handles :—

400. The first four-pole length, sub-divided, $\frac{1}{4}$-in., 8/-; $\frac{1}{8}$-in., 9/-; $\frac{1}{16}$-in., 7/-
401. The other lengths, not sub-divided, $\frac{1}{4}$-in., 4/6; $\frac{1}{8}$-in., 4/-; $\frac{1}{16}$-in., 3/-

No.	Width of Band.	Length in Feet.				
		200	300	400	500	
402	$\frac{1}{4}$-in. Steel Band	20/-	27/-	34/-	42/-	Each
403	$\frac{1}{8}$-in. ,, ,, ...	18/-	24/-	30/-	36/-	,,
404	$\frac{1}{16}$-in. ,, ,, ...	15/-	18/-	22/-	28/-	,,

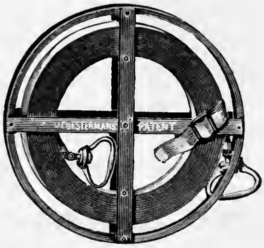
Single 100-ft. lengths for repairing the above, without handles :—

405. The first 100-ft. length, sub-divided,
$\frac{1}{4}$-in., 10/-; $\frac{1}{8}$-in., 10/6; $\frac{1}{16}$-in., 7/6
The other lengths, not sub-divided,
$\frac{1}{4}$-in., 6/3; $\frac{1}{8}$-in., 5/6; $\frac{1}{16}$-in., 3/6

406. **METAL REEL** for any of the above, 7/6
Long lengths in one piece, of any width required, can be supplied to order.

407. Repairing Outfit consisting of hand punch, 2-doz. brass sleeves, 1 gross rivets, and 1 spare punch, in box, 10/-.

STEEL-BAND MEASURING CHAINS.



4 Poles on Cross.

Fig. 65.

4 Poles in Case.

Fig. 66.

A standard measure, practically unalterable; strong as a chain, but much lighter and more compact. When not in use it is coiled on a steel cross, which is included in the prices quoted below, but it can be fitted with a metal case at an extra cost.

No.	FEET AND LINKS.	Width of Band.	50	66 / 100	100	Feet. Links.
411	Divided into links and numbered at every 10 links.	$\frac{1}{2}$-in.		13/6		Each
412		$\frac{5}{8}$,,		18/-		,,
413		$\frac{3}{4}$,,		20/-		,,
414	Divided into feet and numbered at every 10 feet.	$\frac{1}{2}$,,	9/6		16/-	,,
415		$\frac{5}{8}$,,	13/-		22/-	,,
416		$\frac{3}{4}$,,	15/-		26/-	,,
417	Etched feet one side and links the other.	$\frac{1}{2}$,,	13/-	16/-	22/-	,,
418		$\frac{5}{8}$,,	18/-	23/-	32/-	,,
419		$\frac{3}{4}$,,	20/-	25/-	37/-	,,
420	Etched feet, inches, and eighths one side and links the other.	$\frac{1}{2}$,,	17/-	21/-	30/-	,,
421		$\frac{5}{8}$,,	21/-	26/-	38/-	,,
422		$\frac{3}{4}$,,	24/-	30/-	44/-	,,

Steel Bands.

No.	Feet and Metres.	Width of Band.	50 / 15	66 / 20	25	100 / 30	Feet. / Metres
426	Etched feet one side and decimetres the other.	½-in.	14/-	17/-	21/-	24/-	Each
427		⅝ ,,	19/-	24/-	30/-	36/-	,,
428		¾ ,,	20/6	26/-	32/-	38/-	,,
429	Etched feet, inches, and eighths one side, and millimetres the other.	½ ,,	20/-	25/-	30/-	36/-	,,
430		⅝ ,,	25/-	32/-	39/-	46/-	,,
431		¾ ,,	28/-	36/-	44/-	53/-	,,
	METRES.						
432	Divided into fifths of a metre and numbered at every second metre.	½ ,,		13/6		19/-	,,
433		⅝ ,,		18/-		25/-	,,
434		¾ ,,		20/-		28/-	,,
435	Etched decimetres both sides.	½ ,,	14/-	17/-	21/-	24/-	,,
436		⅝ ,,	19/-	24/-	30/-	36/-	,,
437		¾ ,,	20/6	26/-	32/-	38/-	,,
438	Etched millimetres both sides.	½ ,,	20/-	25/-	30/-	36/-	,,
439		⅝ ,,	25/-	32/-	39/-	46/-	,,
440		¾ ,,	28/-	36/-	44/-	53/-	,,

No.	Cape Feet.	Width of Band.	60	66		100	Cape Feet.
443	Etched feet, tenths, and hundredths, on one side only.	½-in.	22/-	24/-		34/-	Each
444		⅝ ,,	27/-	30/-		43/-	,,
445		¾ ,,	31/-	34/-		50/-	,,
446	Divided into feet and tenths, and numbered at every ten feet.	¼ ,,	20/-			24/-	,,
447		⅝ ,,	26/-			38/-	,,
448		¾ ,,	28/-			42/-	,,

449. **METAL CASE** (in place of cross) for ¼-in. or ½-in. band, 4/-

450. Ditto for ⅝-in. or ¾-in. band, 6/-

Other lengths may be obtained, and any of the above may be had ⅜-in. wide, if required, at proportionate cost.

451. Metal Crosses for bands, 3/-

WIND-UP MEASURES OF BEST MAKE.

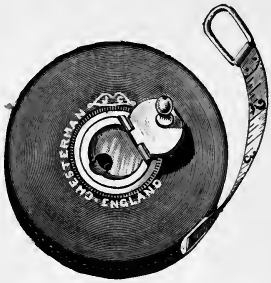


Fig. 67.

With Steel Tapes.

Steel Tapes are usually marked feet, inches and eighths on one side and links on the other, and this pattern will always be supplied unless special instructions are received that they are required otherwise. They may be had marked in a variety of ways, as below :—

No.	Description.	Width of Tape.	In leather case with flush handle.				Tape only, without case.				
			15 50	20 66	— 75	30 100	15 50	20 66	— 75	30 100	Metres Feet
455	Marked London and 12ths (feet into inches and 8ths) or London and 10ths (feet into 100ths), on one side only.	$\frac{3}{8}$-in.	15/-	19/-	21/-	26/-	10/6	14/-	16/-	21/-	each
456		$\frac{1}{2}$-in.	19/-	24/-	26/-	33/-	14/-	18/-	20/-	27/-	„
457		$\frac{5}{8}$-in.	23/-	29/6	32/6	42/-	17/6	23/-	26/-	35/-	„
458	Marked as above on one side, with links on back, or marked metres, c/ms and m/ms on one side only.	$\frac{3}{8}$-in.	17/6	22/-	25/-	31/-	13/-	17/-	20/-	26/-	„
459		$\frac{1}{2}$-in.	21/-	27/-	30/-	38/-	16/-	21/-	24/-	32/-	„
460		$\frac{5}{8}$-in.	24/6	31/6	34/6	45/-	19/-	25/-	28/-	38/-	„
461	Marked with any 2 measurements, one on each side.	$\frac{3}{8}$-in.	21/-	27/-	29/6	38/-	16/6	22/-	24/6	33/-	„
462		$\frac{1}{2}$-in.	25/-	33/-	36/-	46/-	20/-	27/-	30/-	40/-	„
463		$\frac{5}{8}$-in.	29/6	38/6	42/6	55/-	24/-	32/-	36/-	48/-	„

Any of the above can be had $\frac{1}{4}$-in. or $\frac{3}{4}$-in. wide at proportionate prices, and any other length can be supplied to order.

Steel Tapes are made in all Foreign Measurements and charged according to their equivalent in English.

Steel Tapes in German Silver Cases.

Convenient for the Pocket.

Marked one or both sides with any one or two measurements :—

			12-ft.	18-ft.	25-ft.
466.	With $\frac{5}{16}$-in. tape	... ...	7/6	10/6	13/-

WIND-UP MEASURES OF BEST MAKE.

Fig. 68.

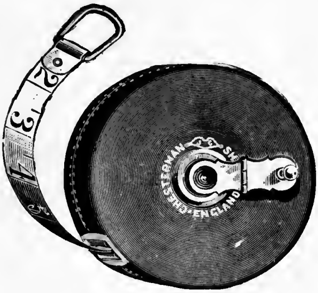


Fig. 69.

The folding handle is the cheapest, most serviceable, and the easiest to wind, but the flush handle has the advantage of lying flat to the case, and so taking up less space in the pocket.

Chesterman's "Constantia" and Rabone's "Rigida" Tapes are recommended for accuracy and durability. Metallic (wired) tapes can be supplied at the same prices.

In one width only, $\frac{5}{8}$-inch.

No.	Constantia / Rigida / Metallic } Tape $\frac{5}{8}$-in. wide.	Marked on both sides.					
		15	20		25	30	Metres
		50	66	75		100	Feet
469	In Leather Case with Folding Handle ...	6/6	7/6	8/3	9/-	10/6	each
470	In Leather Case with Flush Handle ...	7/-	8/3	9/-	9/9	11/6	,,
471	Tape only, without case...	3/9	4/6	5/-	5/6	7/3	,,

WITH LINEN TAPES.

In one width only, $\frac{1}{2}$-in.

No.	Linen Tape $\frac{1}{2}$-in. wide.	Marked on both sides.					
		10	15	20		25	Metres
		50		100			Links
		33	50	66	75		Feet
472	In Leather Case with Folding Handle ...	3/6	4/6	5/-	5/6	6/-	each
473	In Leather Case with Flush Handle ...	4/-	5/-	5/9	6/3	6/9	,,
474	Tape only, without case...	1/6	2/-	2/9	3/-	3/6	,,

ANEROID BAROMETERS.

Fig. 70.

Fig. 71.

No.		£	s.	d.
478.	**WATCH SIZE ANEROID,** $1\frac{3}{4}$-in. dia., gilt or nickel case, silvered-metal dial, with revolving altitude scale to 8,000 feet, in snap morocco case	1	1	0
479.	Ditto better quality movement	1	10	0
480.	If compensated for temperature ... ... extra	0	3	0
481.	Ditto best quality, 5,000 feet to 10,000 feet, compensated	2	8	0
482.	Ditto in hunter case...	2	13	0
483.	Ditto as No. 481, with raised dial and thermometer ...	2	16	0
484.	Ditto but with small Singer pearl compass and thermometer on reverse	3	12	0
485.	Ditto but with full size bar needle, or Singer pearl compass on reverse	3	12	0
486.	Keyless action to any of the last five	0	7	0
487.	Ditto as No. 481, but in hall marked silver case ...	3	17	0
488.	Ditto in silver hunter case	4	15	0
489.	Keyless action to either of the last two	0	12	0
490.	Ditto as No. 487, but with keyless action and small Singer pearl compass and thermometer on reverse ...	7	8	0
491.	Ditto but with full size bar needle or Singer pearl compass on reverse	7	8	0
492.	Ditto as No. 481, but with keyless action, in 9-ct. gold case and outer morocco case ... ... $1\frac{1}{2}$-in. dia.	9	0	0
	$1\frac{3}{4}$-in. dia.	10	0	0
493.	Ditto in 15-ct. gold case ... ... $1\frac{1}{2}$-in. dia.	11	0	0
	$1\frac{3}{4}$-in. dia.	13	0	0

Aneroid Barometers.

Fig. 72.

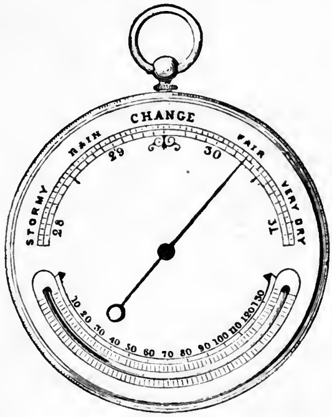


Fig. 73.

No.		£	s.	d.
496.	**POCKET SIZE ANEROID,** 2½-in. dia., gilt or nickel case, silvered metal dial, compensated, with weather range only, curved thermometer, in snap morocco case	2	12	0
497.	DITTO Watch form, Geographical Society's pattern, with revolving altitude scale, 5,000 feet to 10,000 feet	2	12	0
498.	DITTO with raised dial and thermometer	3	0	0
499.	Keyless action to either of the last two	0	8	0
500.	Full size bar needle or Singer pearl compass on reverse of any of the above	1	6	0
501.	Leather sling case in lieu of morocco	0	6	0

Fig. 74.

Military-Engineering, and Surveying Aneroid.

Aneroid Barometers.

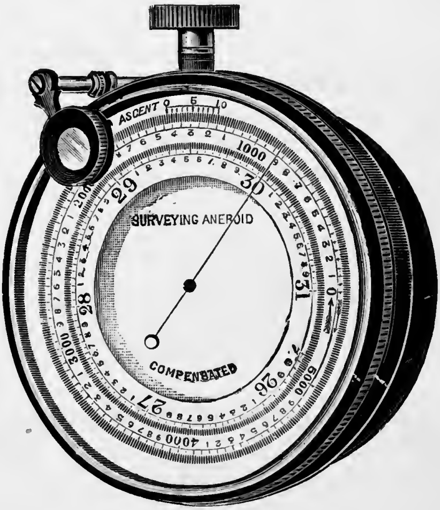
BEST QUALITY CYLINDRICAL ANEROID, in bright brass or bronzed metal case, compensated, silvered-metal dial with fixed or revolving altitude scale, 5,000 feet to 10,000 feet, in morocco case:—

505.		3-in. dia.	...	3	12	0
506.		4-in. dia.	...	3	16	0
507.		5-in. dia.	...	4	0	0
508.	Ditto with raised dial and thermometer,	3-in. dia.	...	3	18	0
509.		4-in. dia.	...	4	2	0
510.		5-in. dia.	...	4	6	0
511.	Magnifying Lens to any of the above	... ...	...	0	7	6

512. Aluminium case in lieu of brass or bronze:—
3-in., 16/- 4-in., 20/- 5-in., 24/-

513. Leather sling case, in lieu of morocco:—
3-in., 6/- 4-in., 7/6 5-in., 9/-

All the above Aneroids are priced with altitude scales 5,000 feet to 10,000 feet, except where otherwise stated. Above 10,000 feet, every 5,000 feet will be charged 7/6 extra, and below 5,000 feet every 1,000 feet will be charged 5/- extra.



No. *Fig. 75.*

515. **SPECIAL SURVEYING or MINING ANEROID,** in stout bronzed metal case, 5-in. dia., with silvered metal dial. Fixed altitude scale, graduated to 20 feet and reading by a vernier to single feet. Circle divided as desired, 5,000 feet to 10,000 feet ascent, or 4,000 feet ascent and 2,000 feet descent. Rackwork adjustment to vernier and rotating magnifier. In leather sling case ... ... £7 10s. 0d.
Altitude scale above 10,000 feet ascent, 10/- extra for every 5,000 feet.
Altitude scale below 5,000 feet ascent, 5/- extra for every 1,000 feet.

516. Aluminium case to above, in lieu of bronzed metal case, 30/- extra.

517. **WATKIN'S PATENT MOUNTAIN ANEROID,** which can be kept out of gear when not in use and is only put into action when a reading is required to be taken, thus ensuring greater accuracy. Made in two sizes, 3-in. and $4\frac{1}{2}$-in. dia., in aluminium case with sling leather outer case ... ... either size £6 6s. 0d.

518. Kew Certificate to any Aneroid 10/- and upwards, according to size.

Aneroid Barometers.

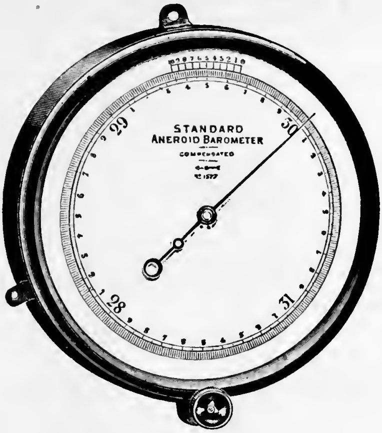


Fig. 76.

521. **STANDARD ANEROID BAROMETER,** in heavy bronzed metal case, 8-in. dia., silvered-metal dial, hand engraved, scale range 28-in. to 31-in., or otherwise as desired, reading by a vernier to $\frac{1}{1000}$-in., compensated for temperature, certificate of comparison throughout the scale with a verified Kew standard accompanies each instrument. The mechanical movement is the most perfect obtainable, and is much more sensitive than a mercurial barometer, showing instantly the most minute variation of the atmospheric pressure ... £14 0s. 0d.

This instrument is especially suitable for the Colonies and abroad owing to the difficulty of transporting standard mercurial barometers to out-of-the way places.

TRAVELLING ANEROIDS, ETC.

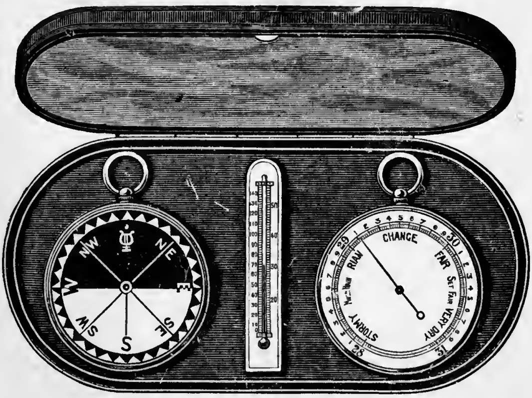


Fig. 77.

523. **LIVINGSTONE SET,** comprising best-quality watch-size aneroid with full-size compass to match, and thermometer in centre, in best morocco case ... ... £4 2s. 0d.

524. Ditto of cheaper quality and without thermometer ... £2 12s. 0d.

Travelling Aneroids etc.

525. **DOUBLE-OPENING CASE,** comprising best quality watch-size aneroid in morocco case, with small Singer pearl compass and thermometer in lid ... ... £3 18s. 0d.

526. **WATCH-FORM ANEROID,** 2½-in. dia., in nickel case with enamel dial, in morocco case, to stand or hang ... ... £1 9s. 0d.

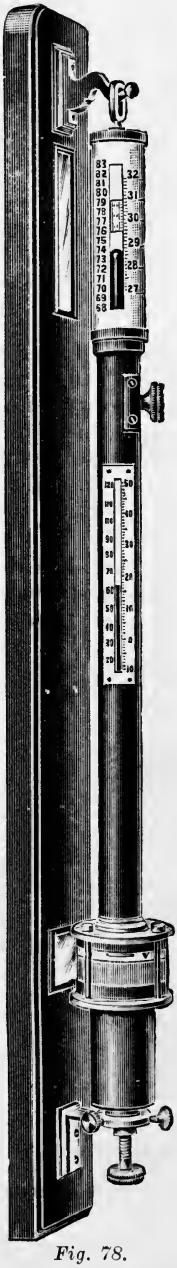


Fig. 78.

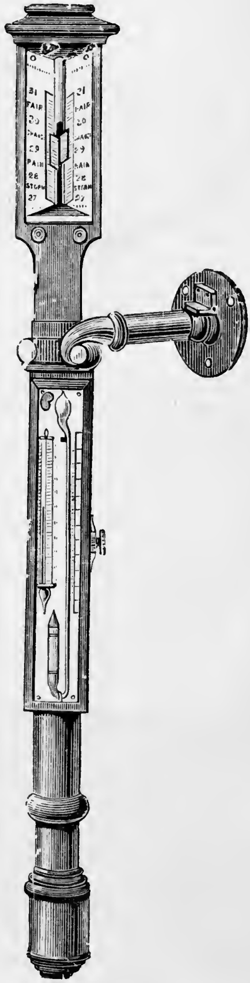


Fig. 79.

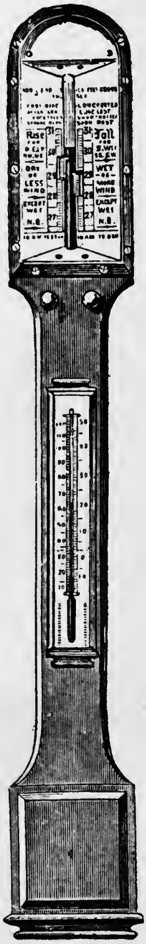


Fig. 80.

529. **STANDARD MERCURIAL BAROMETER,** on Fortin's principle, bore 0·5-in. dia., with thermometer, opal glass reflectors and adjusting screws at base. Mounted on a mahogany board, with Kew certificate. £11 0s. 0d.

530. DITTO as above, but 0·3-in. bore and without Kew certificate ... ... £7 10s. 0d.

Mercurial Barometers.

531. **GLASS CASE** for Nos. 529 and 530, extra ... ... £2 5s. od.

532. Ditto best quality, ebonised mahogany, plate glass .. £4 os. od.

533. **STANDARD MERCURIAL BAROMETER**, student's pattern, bore 0·25-in., without thermometer ... ... £3 10s. od.
Other sizes and descriptions to order.

534. **MARINE MERCURIAL BAROMETER**, Board-of-Trade pattern, bronzed metal frame, with thermometer. Fig. 79 ... £4 10s. od.

535. Ditto round or square top frame, with one or two verniers and thermometer ... ... £2 4s. od. to £2 10s. od.

536. Ditto with Sympiesometer ... ... £3 17s. od. to £5 os. od.

537. **PEDIMENT MERCURIAL BAROMETER**, in oak frame, with thermometer. Fig. 80 ... ... £3 os. od. to £6 os. od.

538. Ditto in carved oak frame ... ... £6 os. od. to £10 os. od.

HALL BAROMETERS.

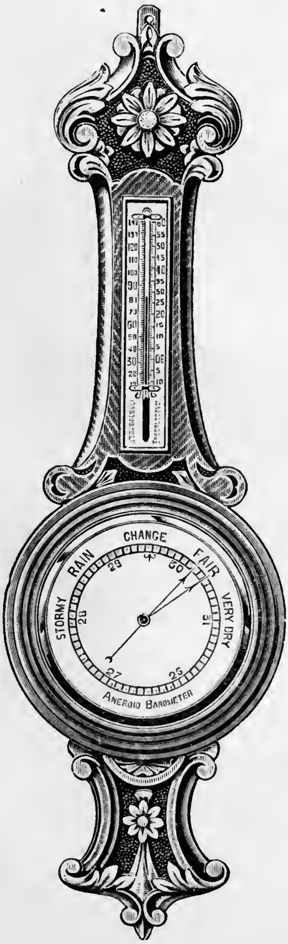


Fig. 81.

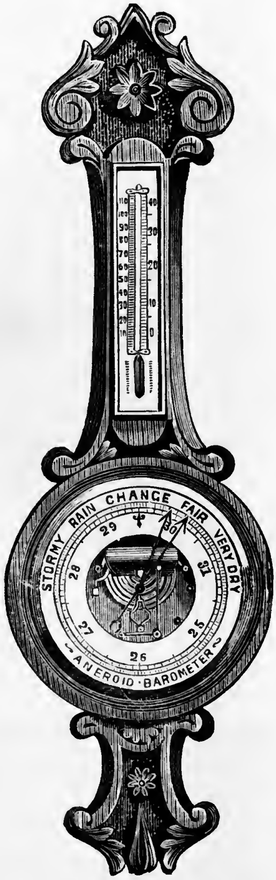


Fig. 82.

Barometers.

No.		5-in.	6-in.	8-in.
541.	**CARVED OAK FRAME PENDANT BAROMETER,** with closed porcelain dial and thermometer, in a number of patterns	24/-	28/-	33/-
542.	Ditto of better quality and finish...	33/-	37/-	43/-
543.	Ditto with open face, visible works	40/-	44/-	50/-
544.	Ditto with silvered-metal dial and thermometer scale, best engraved	42/-	50/-	60/-
545.	Ditto in massive carved oak frame	48/-	66/- and upwards.	90/-
546.	Inlaid Solid Mahogany Do.	47/-	58/- and upwards.	73/-

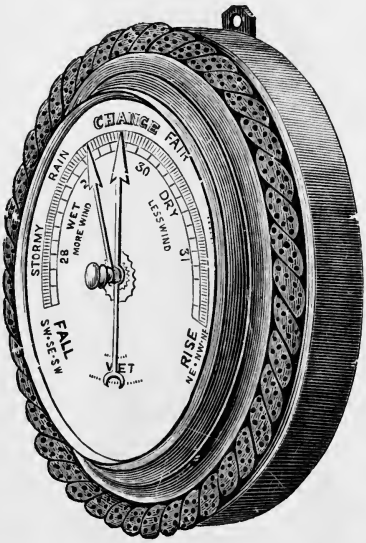


Fig. 83.

Fig. 84.

No.		5-in.	6-in.	8-in.
547.	**CARVED OAK ROUND FRAME ANEROID,** with closed porcelain dial	14/-	17/-	22/-
548.	Ditto of better quality and finish...	22/-	27/-	32/-
549.	Ditto with open face, visible works	28/-	33/-	38/-
550.	Ditto with silvered-metal dial, best engraved ...	30/-	38/-	46/-

Barometers.

Fig. 85.

553. DITTO in massive carved oak frame, with best-quality movement, compensated for temperature, and thermometer.
5-in., 42/- to 55/-; 6-in., 50/- to 62/-; 8-in., 58/- to 70/-

554. **STAND FRAME CARVED OAK ANEROID,** with porcelain dial.
23/- to 44/-

555. DITTO with silvered-metal dial, best engraved ... ... 30/- to 60/-

Hall Barometers of Cheaper Make.

556. Carved and polished brown or black wood, round frame, open enamel dial, in several patterns ... ... $3\frac{3}{4}$-in., 10/- 5-in., 17/-

557. Carved and polished brown or black wood, pendant pattern frame, open enamel dial, with opal scale thermometer, in several patterns
$3\frac{3}{4}$-in., 17/- $4\frac{1}{2}$-in., 22/-

558. **BRASS CASE ANEROID,** with closed porcelain dial, in morocco case
5-in., 16/- 6-in., 24/-

559. Ditto with open porcelain or closed silvered-metal dial
5-in., 22/- 6-in., 30/-

560. Ditto with open silvered-metal dial 5-in., 28/- 6-in., 36/-

561. Curved thermometer to any of the above, 2/6 extra.

562. Any of the above with scale reading down to 22-in. and weather words arranged for an altitude of 6,400 feet :

5-in. porcelain dial	...	4/-	extra.
6-in. do.	...	5/6	,,
5-in. silvered-metal dial	...	7/-	,,
6-in. do.	...	10/-	,,

Barographs.

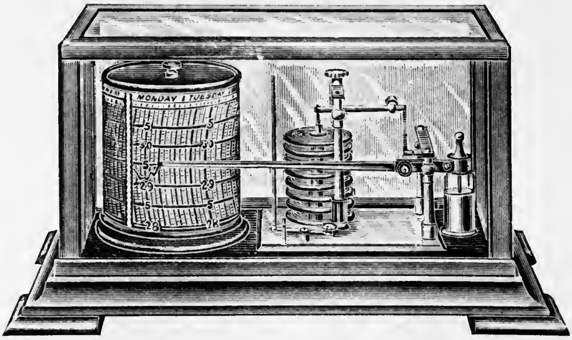


Fig. 87.

No.		£	s.	d.
564.	**SELF-RECORDING ANEROID BAROMETER,** a useful and reliable instrument of cheap make, in oak case with cover, and charts for one year	4	4	0
565.	DITTO of better quality, in ebonized case with glass shade cover	5	0	0
566.	DITTO with wood frame glass cover, in oak, mahogany or walnut. See Fig. 87	6	0	0
567.	DITTO with bevelled plate-glass, and drawer with spaces for charts	7	0	0 and upwards.
568.	DITTO but with auxiliary metal dial on which the present pressure is always shown	8	5	0 and upwards.

569. A special attachment with additional arm to record the temperature on the same drum in ink of a different colour can be fitted to any of the above at 40/- extra. Special charts are desirable, price 5/6 per set.

570. Self-Recording Aneroid for the pocket, a very handy little instrument for travellers, explorers and balloonists, with set of charts £7 10s. 0d.

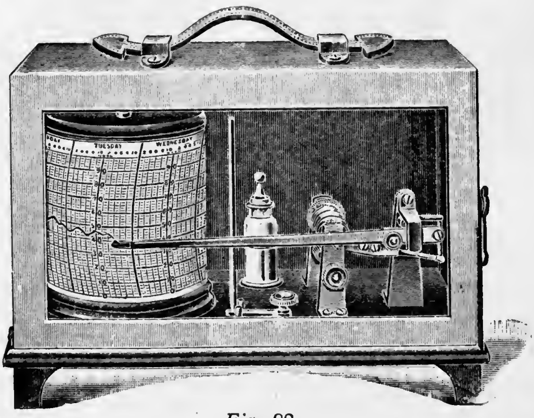


Fig. 88.

		£	s.	d.
571.	**SELF-RECORDING THERMOMETER,** in hinged mahogany case with glass front, 20° to 100° Fahrenheit ...	6	0	0

Thermographs.

No.		£	s.	d.
572.	**SELF-RECORDING THERMOMETER,** in copper case, with hinged cover and handle, as Fig. 88	6	10	0
573.	Ditto with wood frame glass cover, in oak, mahogany or walnut	6	5	0
574.	Ditto with extra tall clock drum, zero to 120° Fahrenheit or otherwise	6	15	0
575.	Ditto but with bevelled plate glass and drawer, with spaces for charts	7	15	0
576.	**SPECIAL REFRIGERATION THERMOGRAPH,** scale 0° to 70°, with extra large iron base, japanned metal cover and large drum, with 21 days' clock	12	0	0

All the above are supplied with bottle of ink and set of charts.

Extra Charts for any of the above, one year's supply, 5/6

ANEMOMETERS.

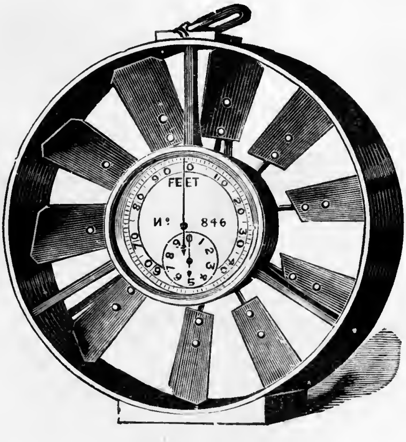


Fig. 89.

BIRAM'S ANEMOMETER, for recording the current of air in mines, sewers, furnaces, etc., with disconnector, packed in a wood case.

					£	s.	d.
581.	12-in. dia., reading to	10,000,000 ft.,	6 dials...	... ...	6	0	0
582.	6-in. ,, ,,	,,	,, ...	... ...	4	0	0
583.	6-in. ,, ,,	100,000	4 dials...	... ...	3	5	0
584.	6-in. ,, ,,	1,000	2 dials...	... ...	2	18	0
585.	4-in. ,, ,,	,,	,, ...	... ...	2	12	0

Anemometers.

Fig. 90.

586.	**BIRAM'S ANEMOMETER**, 2-in. dia., reading to 1,000 ft., special watch form, with disconnector, two dials ...	4	4	0
587.	**DAVIS'S PATENT SELF-TIMING ANEMOMETER**, dispenses with the use of a watch, in leather case	5	0	0

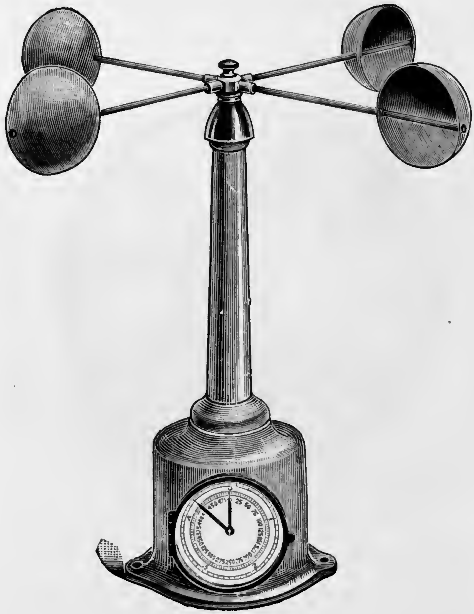


Fig. 94.

588.	**ROBINSON'S ANEMOMETER**, with 3-in. cups, reading to 500 miles, zero setting	4	16	0
589.	**ROBINSON'S RECORDING ANEMOMETER**, in japanned metal case, range of chart 25 miles, recording 8 days, enamelled dial registering 500 miles, outer circle divided to 5 miles and sub-divided to $\frac{1}{10}$-ths, zero setting ...	21	0	0

Kew pattern recording anemometers of large size to order.

Fig. 91.

590.	**PORTABLE AIR METER**, reading to 10,000,000 feet, with disconnector, 6 dials	3	3	0
591.	DITTO to 10,000 feet, 4 dials...	3	0	0
592.	DITTO to 1,000 feet, 2 dials	2	15	0

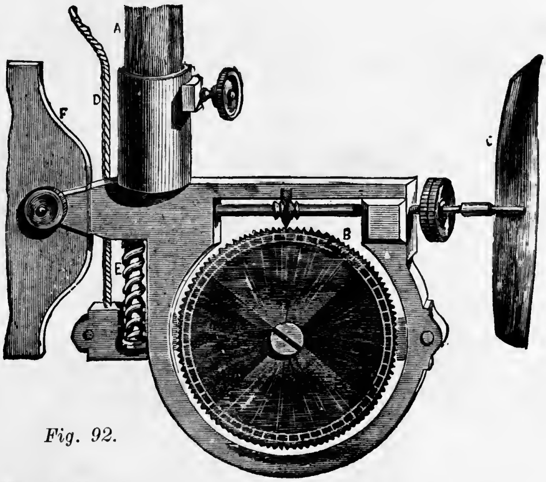


Fig. 92.

593.	**CURRENT METER**, for use in reservoirs, rivers, or streams, to show the rate of flow of the current or tide	6	0	0
594.	**TROCHEAMETER**, for registering the number of revolutions of carriage wheels, etc., in copper case with leather strap	3	15	0
595.	DITTO of cheaper make	2	5	0
596.	DITTO of best make, with three wheels, reading to 50,000 revolutions	5	10	0
597.	**MILOMETER**, or mileage recorder, suitable for motor cars and other vehicles, to 10,000 miles, in brass case ...	3	15	0
598.	**PERAMBULATOR**, with wheel 26-in. diameter, for measuring roads, paths, etc., and showing miles, 10ths and 100ths	8	10	0

Pedometers.

Fig. 93.

No		£	s.	d.
599.	**PEDOMETER,** watch size, adjustable to any length of step, in nickel case, up to 12 miles	0	11	0
600.	DITTO up to 120 miles	0	16	0
601.	**PACEOMETER,** in nickel case, to 10,000 paces	1	1	0
605.	**GAS LEAK INDICATOR,** a highly sensitive instrument for instantly detecting the presence of gas	3	15	0
606.	**POCKET GAS PRESSURE GUAGE,** in morocco case ...	2	2	0
607.	**PORTABLE RECORDING Ditto** clock driven; drum revolves once in 24 hours	7	12	0
608.	Extra charts for use with above, per 100	0	7	6

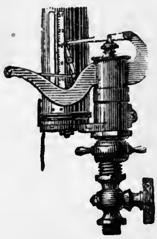


Fig. 95.

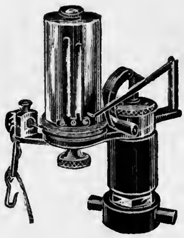


Fig. 96.

609.	**RICHARDS STEAM INDICATOR,** improved pattern, in teak case with one spring and scale; suitable for speeds up to 150 revolutions per minute	7	0	0
610.	**M'INNES Ditto** suitable for speeds up to 250 revolutions per minute. Fig. 96	6	10	0
611.	Each extra spring and scale for either of above	0	10	0
612.	Drum Springs	0	2	0

SUPERFINE METALLIC PAPER.

613. Size $7\frac{1}{2}''$ × $3\frac{3}{4}''$, for Richards Indicators,
Packet of 240 sheets, 3/6; 360 sheets, 4/6

614. Size $6\frac{1}{2}''$ × $3''$, for M'Innes Indicators, Packet of 240 sheets, 3/6

615. Best Italian Hemp Cord, large hank, 1/6

616. Wire Core Cord, 25-ft. hank, 2/3

SPRING BALANCES.

SPRING BALANCES, Messrs. Geo. Salter & Co.'s manufacture, for the use of Engineers, Surveyors, Sportsmen, Explorers, Prospectors and others, in a number of sizes and patterns :—

No.		£	s.	d.
617.	Improved spring, best quality, No. 1, with hook :—			
	80 lbs. × 1 lb.	0	9	0
	30 lbs. × $\frac{1}{2}$ lb.	0	3	6
	20 lbs. × $\frac{1}{4}$ lb.	0	5	0
618.	Patent No. 1a, strong and sensitive, with hook. These are plugged ready for stamping and are suitable for trade purposes :—			
	20 lbs. × 2 ozs.	0	7	6
	60 lbs. × $\frac{1}{4}$ lb.	0	18	0
619.	Small Brass Sportsman's, No. 15, with hook :—			
	30 lbs. × $\frac{1}{2}$ lb.	0	3	6
	50 lbs. × $\frac{1}{2}$ lb.	0	6	0
620.	German Silver ditto, No. 17, with hook :—			
	10 lbs. × $\frac{1}{4}$ lb.	0	3	0
	20 lbs. × $\frac{1}{2}$ lb.	0	3	6
621.	Railway Parcels Balance :—			
	56 lbs. × 2 ozs., with $7\frac{3}{4}$-in. enamelled dial ...	1	4	0

MAGNETOMETERS.

VIBRATION MAGNET.

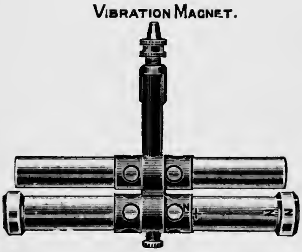


Fig. 97a.

DEFLECTED MAGNET.

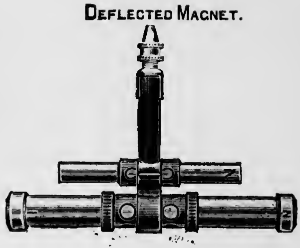


Fig. 97b.

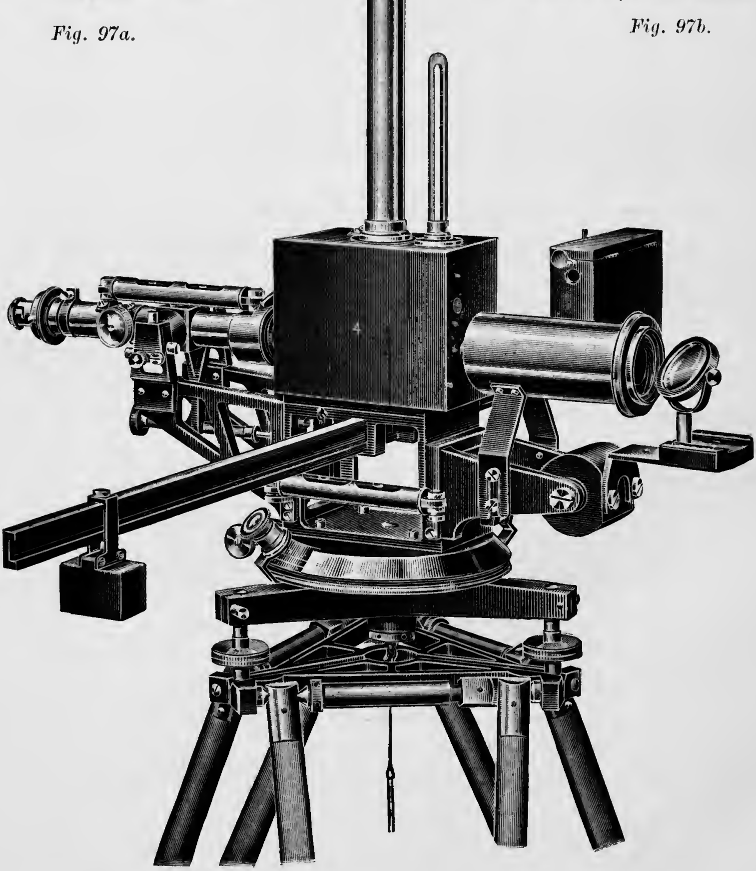


Fig. 97.

Magnetometers.

The design of the Unifilar Magnetometer, as made by us, is based on that of the ordinary Kew instruments, but modified and improved in several important details. The above instrument has been accepted by the India Office as their standard pattern.

The instrument generally consists of a graduated horizontal circle supported on three levelling foot-screws. Fixed to the cover of the circle is a light metal box carrying on one end the **Y** brackets of the telescope, and on the other a counterpoise to which is fixed a removable bracket carrying an adjustable mirror for illuminating the scales in the telescope and magnet, the mirror being also interchangeable with a lamp. The magnet box and torsion tube are fixed centrally above the instrument. The deflection bar is made channel-section of extremely hard metal, thus making it light and stiff.

The telescope is of 8-in. focal length, fitted with a high and low power eye-piece, striding level, and a longitudinal level fitted to the top side; a glass diaphragm is placed in the focus of the telescope, which, instead of having the usual cross webs, has two scales engraved on it, one a long horizontal scale of 100 divisions, and the other a short vertical scale of 40.

Two magnets are supplied, viz., the long or vibration magnet, and the short or deflected magnet. In the illustration the vibration magnet is shown with the inertia bar in its sheath. The **N.** end contains the collimator lens, whilst the **S.** end carries a piece of optical glass with a horizontal and vertical line engraved on it.

The deflected magnet which takes the place of the reflector magnet in the Kew instrument, is fixed parallel to the collimator tube which carries a similar lens and engraved piece of glass as the vibration magnet.

The magnets are suspended by means of a thin ribbon of phosphor bronze instead of the ordinary silk fibres, the ribbon being held both at the torsion tube head and magnet by improved clip chucks. With this suspension the torsion is constant.

Two spare reels of ribbon are supplied fitted in boxes.

Thermometers are fitted to both magnet boxes.

A finely divided plummet is provided, which is read by a collimating lens in front of the telescope object glass.

A rigid tripod stand is supplied, arranged for closing up into small space, and together with the deflection bar is carried in a canvas and leather-bound case.

Complete, and packed in a mahogany case with shoulder strap.

No.	**PRICES.**	£	s.	d.
625.	Kew Pattern Instrument	80	0	0
626.	India Office Pattern (Captain Fraser's) fitted with vertical circle for taking azimuths. As made for the Indian, United States, and Canadian Governments	90	0	0
627.	Examination and verification at Kew Observatory if required, extra	6	6	0

(If without vertical circle a reduction of £5 will be made.)

THERMOMETERS—various.

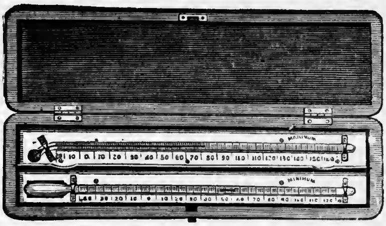


Fig. 98.

LIVINGSTONE'S MAXIMUM & MINIMUM THERMOMETERS.

	Length. 8-in. s. d.	10-in. s. d.	12-in. s. d.	14-in. s. d.
630. Divided on the stem, on ivory or metal scales, in mahogany or morocco case, per pair	30 0	35 0	—	—

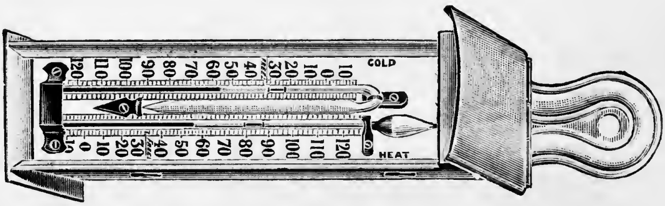


Fig. 99.

SIX'S SELF-REGISTERING MAXIMUM and MINIMUM THERMOMETERS.

	8-in. s. d.	10-in. s. d.	12-in. s. d.	14-in. s. d.
631. Opal glass scale, enamelled tube, in open-back white-japanned tin case, best make, with magnet ...	13 0	15 0	17 0	19 0
632. Zinc scale, in white-japanned tin case, with magnet...	8 0	10 0	12 0	14 0

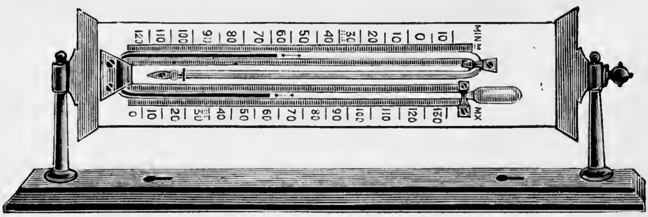


Fig. 100.

	8-in. s. d.	10-in. s. d.	12-in. s. d.	14-in. s. d.
633. Opal glass scale, best grade, mounted on oak back with revolving bronzed brackets for windows	25 0	33 0	40 0	45 0

Thermometers— various.

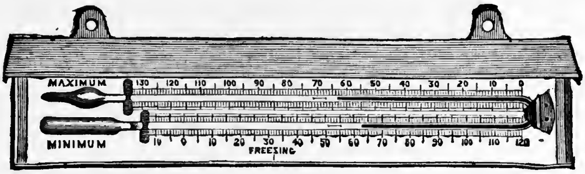


Fig. 101.

DIMENUON SELF-REGISTERING MAXIMUM and MINIMUM THERMOMETERS.

		Length. 8-in. s. d.	10-in. s. d.	12-in. s. d.	14-in. s. d.
634.	Opal glass scale in white-japanned tin case, best make, with magnet	12 0	15 0	18 0	21 0
635.	Zinc scale in white-japanned tin case, with magnet...	8 0	11 0	14 0	17 0

636. **MAGNETS**, for Six's and Dimenuon thermometers, grooved— 2½-in., 8d.; 3-in., 10d.

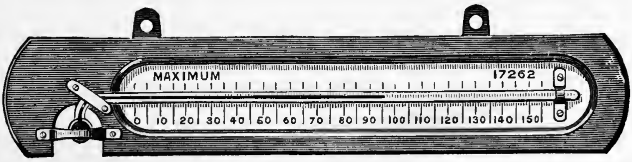


Fig. 102.

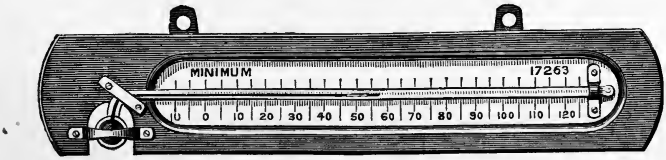


Fig. 103.

STANDARD SELF-REGISTERING MAXIMUM or MINIMUM THERMOMETERS.

		8-in.	10-in.	12-in.	14-in.
640.	Opal glass scale, engine-divided tube, in oak frame, each ...	—	16 0	20 0	—

641. Kew certificates, 3/- extra.

Goods forwarded at Purchaser's Risk.

THERMOMETERS—various.

No.		8-in.	10-in.	12-in.
644.	Brewers, copper	3/-	4/-	5/-
645.	Brass, sugar boiling	—	—	7/6
646.	Zinc minimum, suitable for cold storage ...	3/-	4/-	—
647.	Boxwood Ditto	1/6	—	—
648.	Incubator	2/6	—	—

651. Household, in boxwood, porcelain or metal, 1/- and upwards.

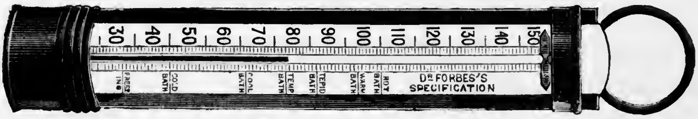


Fig. 104.

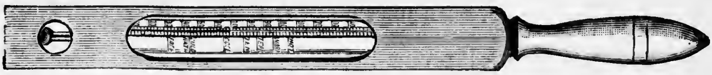


Fig. 105.

652. Bath ; porcelain, 3/6 ; japanned tin case, 2/- to 4/- ; whitewood, 1/-

653. School or public building, bold porcelain, 4/6 and upwards.

Chemical Thermometers, with engine divided tubes, best quality, in turned mahogany boxes :—

654.	8-in. to 220° F, or corresponding C	4	6
655.	10-in. ,, 220° F ,, ...	5	6
656.	12-in. ,, 300° F ,, ...	6	6
657.	12-in. ,, 400° F ,, ...	7	6
658.	14-in. ,, 500° F ,, ...	8	6
659.	14-in. ,, 600° F ,, ...	9	6
660.	16-in. ,, 700° F ,, ...	10	6

Ditto of cheaper quality, engraved stems, turned cases :—

663.	12-in. to 220° F or corresponding C	3	0
664.	12-in. ,, 300° F ,, ...	3	6
665.	14-in. ,, 400° F ,, ...	4	0
666.	16-in. ,, 700° F ,, ...	4	6
667.	Armoured Cases for chemical thermometers, any length, each	9	0

668. Ivory tusk Thermometers :—6-in., 22/- ; 7-in., 28/- ; 8-in.. 42/-

669. Silver-mounted Thermometers, to hang or stand :—
4-in., 22/- ; 6-in., 26/- to 35/- ; 8-in., 40/-.

670. Hicks' patent alarm Thermometer, including bell, battery, indicating board, etc. ... ... £2 10s. 0d.

CLINICAL THERMOMETERS.

Fig. 107.

Fig. 108.

No.		2-min. s. d.	1-min. s. d.	½-min. s. d.
674.	4-in., plain tube, in nickel case	2 6	3 0	3 6
675.	4-in., lens front ,, ,, ...	3 0	4 0	5 0

The above are provided with our own certificates, which we guarantee are within one-tenth degree of a corresponding certificate issued by Kew Observatory.

The same thermometers without certificates, 6d. each less.

No.		2-min. s. d.	1-min. s. d.	½-min. s. d.
676.	Hicks' patent lens front, with his own certificate	4 6	5 6	6 6
677.	Hicks' "Facilis," *easy to shake down*, with lens front. Fig. 107	5 0	6 0	7 0
678.	Ditto with plain front	2 6	3 6	4 6

679. Veterinary thermometers, with normal temperature for various animals, marked on stem ... ... 4/- to 6/-.

A few clinicals of different patterns, with Kew certificates, are kept in stock.

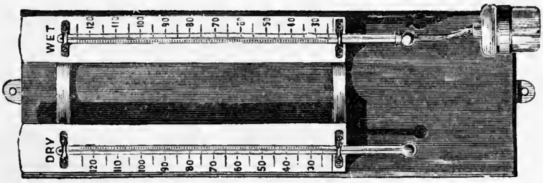


Fig. 109.

No.		£ s. d.
682.	**MASON'S WET AND DRY BULB HYGROMETER**, opal scales, engine-divided tubes, on oak board, small, 25/-; medium, 30/-; large	1 15 0

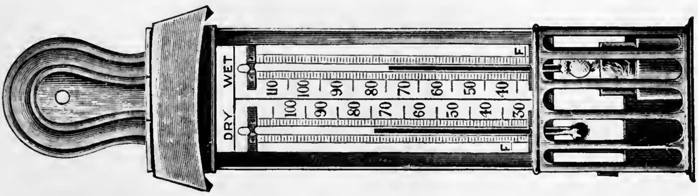


Fig. 110.

No.		£ s. d.
683.	**ADMIRALTY PATTERN HYGROMETER**, zinc, well protected	0 15 0
684.	Kew Certificates for Hygrometers	0 6 0
685.	**HYPSOMETER**, complete, portable, of best construction, with one thermometer, divided to $\frac{1}{15}$ degree	2 15 0
686.	**Extra Thermometers** for use with above, in metal cases	0 15 0

Meteorological Instruments, etc.

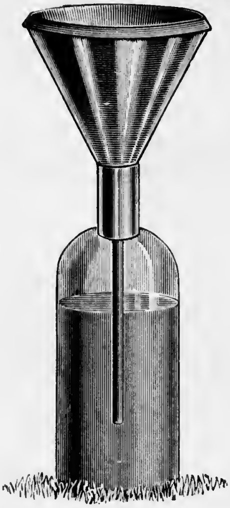


Fig. 111.

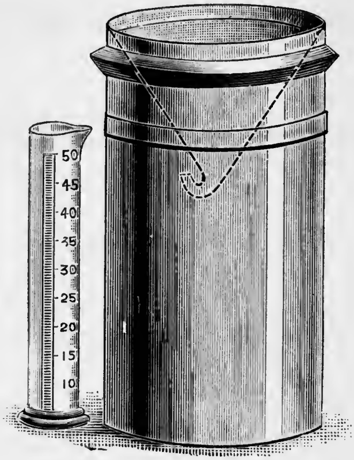


Fig. 112.

		Copper with brass ring. £ s. d.	Japanned tin with brass ring. £ s. d.
689.	**GLAISHER'S** Rain Guage, with graduated glass measure complete, 8-in. diameter ...	1 10 0	0 18 0
690.	Ditto in galvanized iron, 22/-		
691.	**SYMONS'** ditto 5-in. diameter	0 18 0	0 10 0
692.	**HOWARD'S** ditto with flint-glass bottle and graduated measure, 5-in- diameter ...	0 12 0	0 9 0
693.	**HOWARD'S** Pedestal Rain Guage, with graduated tube, showing amount of rainfull without using a measure, 12-in. diameter	3 0 0	1 15 0
694.	**GLAISHER'S** Tropical Rain Guage, extra large size, with tap and graduated measure	3 0 0	—
695.	Measuring Glasses for rain guages, 5-in., 2/- ; 8-in., 3/-		

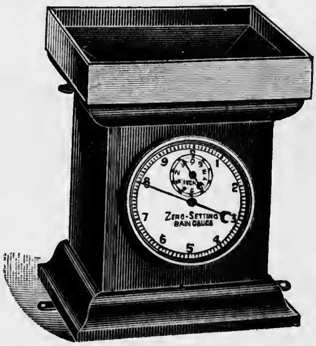


Fig. 113.

		£ s. d.
698.	**REGISTERING RAIN GUAGE,** zero setting, showing $\frac{1}{100}$-in. to 12-in. fall, in square japanned tin case, 10-in. × 8-in.	3 18 0
699.	Ditto in copper case...	4 12 0

Meteorological Instruments, etc.

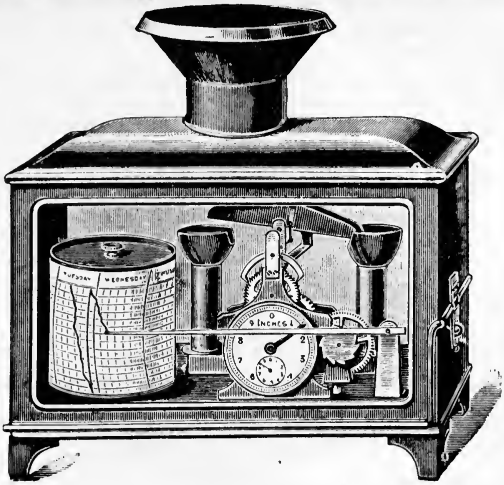


Fig. 114.

701. **RECORDING RAIN GUAGE,** runs for a week, showing rainfall in inches and $\frac{1}{100}$-ths at the exact time at which it occurred. With 8-in. funnel and including charts for one year 12 10 0
702. Extra charts, per year's supply 0 6 0
703. Rainfall Charts, per dozen 0 5 0

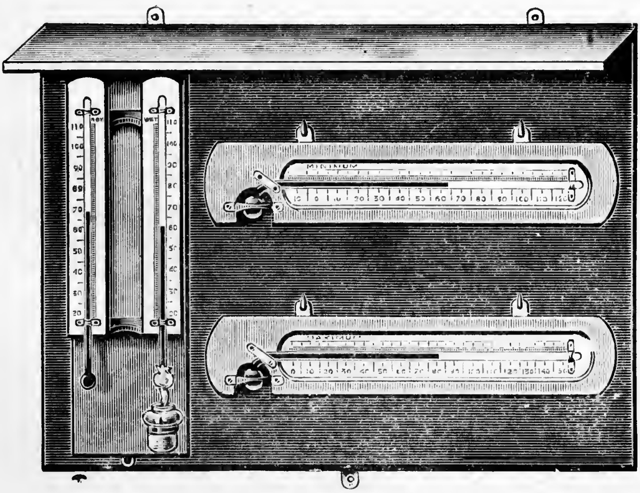


Fig. 115.

707. **METEOROLOGICAL SET,** consisting of standard maximum and minimum thermometers and hygrometer, mounted on oak board, with Kew certificates ... ... £4 15s. od.
708. Ditto smaller size, without Kew certificates... ... £3 5s. od.
709. Ditto consisting of 5-in. aneroid barometer, Mason's hygrometer, Six's thermometer, 8-in. boxwood thermometer, 5-in. japanned Howard's rain guage with glass measure, and record calendar for 12 months. Packed in a stained deal case ... ... £2 os. od.
710. Meteorological pads, for one year ... ... each 1s. od.

Meteorological Instruments, etc.

Fig. 116.

No.		£	s.	d.
713.	**UNIVERSAL SUNSHINE RECORDER**, with cards for one year	13	0	0
714.	Ditto with metal-dial bar needle compass in base ...	13	10	0
715.	**Additional Cards** for above, sufficient for one year, viz.: 150 summer solstice, 150 winter solstice, and 100 equinoctial	2	0	0

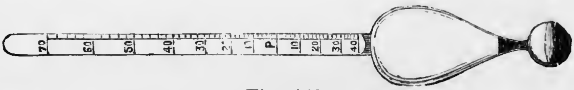


Fig. 118.

No.		£	s.	d.
716.	**HYDROMETER**, glass, for testing spirits, paper scale ...	0	2	6
717.	Ditto ivory scale	0	3	0

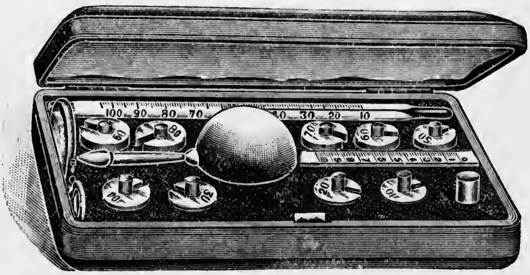


Fig. 119.

SIKES' HYDROMETER, brass, complete in case, with measure and book of instructions :—

No.		£	s.	d.
718.	Pocket size, as illustrated	3	0	0
719.	Excise pattern	2	16	0
720.	**COMPARATIVE SCALES** for ditto, each	0	4	0
721.	**SALINOMETER**, glass	0	6	6
722.	**ACCUMULATOR HYDROMETER**	0	2	6
723.	**PETROL** ,, ...	0	2	6
724.	**LACTOMETER**	0	2	6

STANDARD RAIL TEMPLATES.

Messrs. T. Cooke & Sons, Ltd. have been appointed by the Engineering Standards Committee the sole makers of Templates for standard section tramway rails, bull-headed and flat-bottomed railway rails. The following are the prices of commercial sets, made of nickel, each of which has been verified by comparison with the standard reference templates made by themselves and deposited at the National Physical Laboratory at Bushy. The prices include a N.P.L. certificate to the effect that they have been so tested, and that their accuracy is within $\frac{1}{100}$ of an inch.

TRAMWAY RAIL TEMPLATES.

The set of Templates for each weight of straight and corresponding curved rail (Report No. 2*) comprises **fourteen** pieces, and the prices are as follows :—

No.	No. of "B.S." Section.	Weight of Rail.		Price per Set.		
		Straight.	Curved.			
		lbs. per yard.	lbs. per yard.	£	s.	d.
729	1 and 1c	90	96	9	9	0
730	2 and 2c	95	101	9	9	0
731	3 and 3c	100	106	9	9	0
732	4 and 4c	105	111	9	9	0
733	5 and 5c	110	116	9	9	0

If made in Steel, 20/- per set extra.

*Specification and sections of British Standard Tramway Rails and Fish Plates, 21/- nett.

BULL-HEADED RAILWAY RAIL TEMPLATES.

The set of Templates for each weight of rail (Report No. 9†) comprises **three** pieces, and the prices are as follows :—

	Weight of Rail in lbs. per yard.		Price per Set.		
			£	s.	d.
736.	100	... ...	5	0	0
737.	95	... ...	5	0	0
738.	90	... ...	5	0	0
739.	85	... ...	5	0	0
740.	80	... ...	5	0	0
741.	75	... ...	4	10	0
742.	70	... ...	4	10	0
743.	65	... ...	4	10	0
744.	60	... ...	4	10	0

If made in Steel, 12/- per set extra.

†British standard specification and sections of Bull-headed Railway Rails, 10/6 nett.

FLAT-BOTTOMED RAILWAY RAIL TEMPLATES.

The set of Templates for each weight of Rail (Report No. 11*) comprises **three** pieces, and the prices are as follows:—

	Weight of Rail in lbs. per yard.		Price per Set. £	s.	d.
747.	100	... ...	5	5	0
748.	95	... ...	5	5	0
749.	90	... ...	5	5	0
750.	85	... ...	5	5	0
751.	80	... ...	5	0	0
752.	75	... ...	5	0	0
753.	70	... ...	5	0	0
754.	65	... ...	5	0	0
755.	60	... ...	5	0	0
	If made in Steel, 12/- per set extra.				
756.	55	... ...	4	10	0
757.	50	... ...	4	10	0
758.	45	... ...	4	10	0
759.	40	... ...	4	10	0
760.	35	... ...	4	2	6
761.	30	... ...	4	2	6
762.	25	... ...	4	2	6
763.	20	... ...	4	2	6
	If made in Steel, 10/- per set extra.				

*British standard specification and sections of Flat-bottomed Railway Rails, 10/6 nett.

FIELD OR MARINE BINOCULARS of best quality.

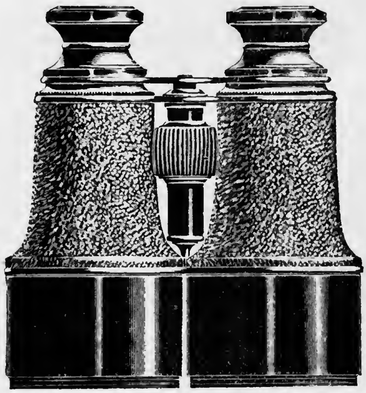


Fig. 120.

SIX LENS, low or medium shape, covered morocco leather, with japanned tubes and shades, in black or brown leather sling case.

No.			*In Brass.* £	*s.*	*d.*	*In Aluminium.* £	*s.*	*d.*
771.	19 lines, power about 3	... ...	1	18	0	3	5	0
772.	21 ,, ,, ,, 3½	... ...	2	2	0	3	12	0
773.	24 ,, ,, ,, 4	... ...	2	6	0	3	18	0
774.	26 ,, ,, ,, 4½	... ...	2	10	0	4	5	0

Field or Marine Binoculars.

TWELVE LENS, medium or tall shape, covered Russian leather, with japanned tubes and shades, in black or brown leather sling case.

775.	19 lines, power about $4\frac{1}{2}$	2 10 0	4 0 0
776.	21 " " " 5	2 15 0	4 8 0
777.	24 " " " $5\frac{1}{2}$	3 2 0	4 17 0
778.	26 " " " 6	3 8 0	5 6 0

The medium shape is recommended for general purposes.

Any of the above glasses, in aluminium, can be had with bright tubes at an extra cost of 2/6.

Any 19, 21, or 24 lines glass can be had with covered instead of japanned shades, at the same price.

780. Brown or black leather cases with sling strap for above, 7/6.

OPERA GLASSES.

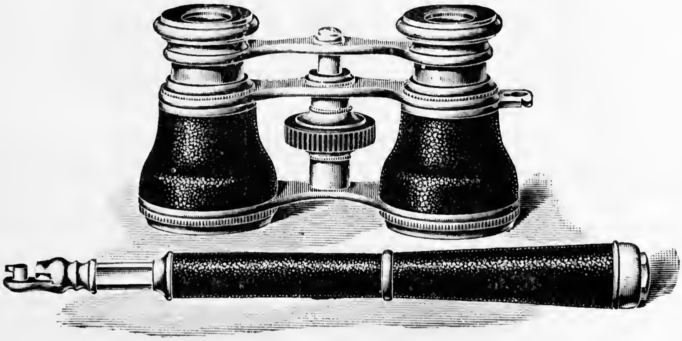


Fig. 121.

		£ s. d.	£ s. d.
784.	**OPERA GLASS**, half-pear shape, japanned mounts, covered morocco leather, in soft case	0 15 0	0 17 6
785.	Ditto conical shape, with rolled gold mounts, straight bars	0 18 0	1 2 0
786.	Ditto half-pear shape, gilt mounts, covered Russia 1 1 0	1 4 0	1 7 0
787.	Ditto aluminium and pearl, Duchess, pearl heads and draws, superior lenses	2 10 0	2 15 0
788.	Ditto tortoiseshell and gilt, enamel bands ...	—	1 13 0
789.	Ditto aluminium and tortoiseshell, half pear shape, polished mounts	—	1 2 0
790.	Ditto gilt mounts, bent bars, and heads japanned aluminium	1 5 0	1 13 0
791.	Ditto ivory and enamel, gilt mounts, ivory heads, with handle	—	1 13 0
792.	Ditto aluminium and tortoiseshell, Duchess, enamel bands, with fixed handle	2 12 0	2 15 0

Opera Glasses.

793. **OPERA-FORM THREE-CHANGE GLASS,** theatre, field, and marine, half-pear shape, japanned mounts, covered morocco 1 10 0 1 12 6 1 15 0

A number of other sizes and patterns are kept in stock, with and without handles.

AITCHISON'S PATENT ALUMINIUM COLLAPSIBLE FIELD GLASSES:—

797.	No. 1, 6 lens	£2 10s. 0d.
798.	No. 2, 12 „	£4 4s. 0d.

DRAW BINOCULAR, aluminium, in solid leather sling case:—

799.	Small	£1 8s. 0d.
800.	Large	£2 8s. 0d.

PRISMATIC BINOCULAR GLASSES.

Prismatic glasses are now largely used in place of the old form of Binoculars, on which they are a distinct improvement. They possess the advantages of higher power and proportionately larger field of view, and are adjustable for interocular distance as well as for any difference of focus between the eyes.

Monoculars can also be had, which being of less than half the size and weight, are very portable, and suitable for use on horseback. They can be had in either black or brown leather sling cases.

GOERZ TRIEDER BINOCULARS.

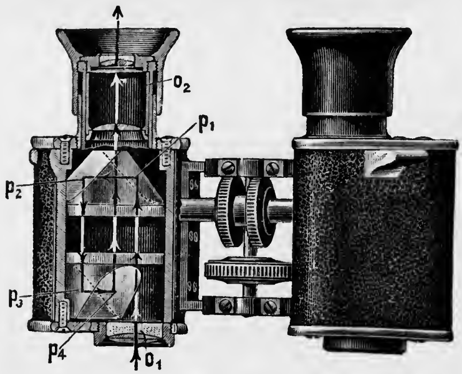


Fig 122.

No.	*Power.*	*Field.*	*Monocular.*	*Binocular.*
805.	× 3	13·3°	2 5 0	5 15 0
806.	× 6	6·7°	2 15 0	6 10 0
807.	× 9	4·4°	3 0 0	7 5 0
808.	× 12	3·3°	4 0 0	9 10 0

809. Eye-cups (spare) for above, 3/- each.

ZEISS PRISM BINOCULARS.

These have the advantage of increased stereoscopic effect, which is obtained by the object-glasses being placed further apart than the eye-pieces. Those marked "night" are particularly serviceable for observation in the dusk or in foggy weather. The combined day and night glass is fitted with revolving eye-pieces, and is very suitable for use at sea.

The Monoculars, of course, have no stereoscopic effect.

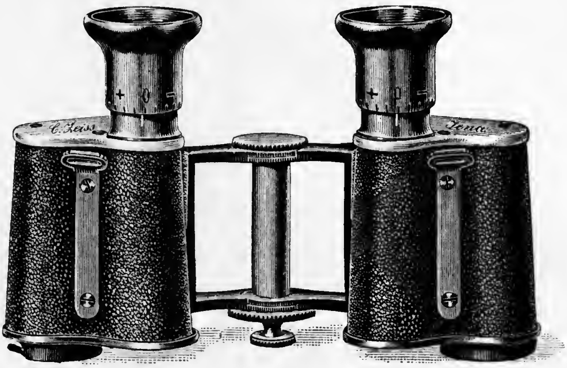


Fig. 123.

No.	*Power.*	*Field.*	*Monocular.*	*Binocular.*
811.	× 4	9·3°	2 10 0	5 10 0
812.	× 6	6·2°	2 15 0	6 0 0
813.	× 8	4·6°	3 0 0	6 10 0
814.	× 5 (night)	6·9°	4 0 0	8 15 0
815.	× 7½ ,,	5·3°	4 0 0	8 15 0
816.	× 10	3·4°	4 5 0	9 5 0
817.	× 12	2·7°	4 5 0	9 5 0
818.	× 5 & 10 (combined day & night)	6·9° / 3·4°	5 10 0	12 0 0

819. Eye-cups (spare) for above, 2/6 and 3/- each.

Also Prismatic Binoculars and Monoculars by Busch, Ross, Voigtländer, and other makers.

822. **ZEISS REVOLVER TELESCOPE,** small, with eye-pieces magnifying 12, 18 and 24 times, on tripod stand ... 22 0 0

823. DITTO large, with eye-pieces magnifying 12, 25 and 40 times, on tripod stand 29 0 0

824. **ZEISS HINGED STEREO-TELESCOPE,** with single eye-pieces, magnifying 15 times, on tripod stand 25 0 0

825. DITTO with revolving eye-pieces, magnifying 10 and 18 times, on tripod stand 31 0 0

TERRESTRIAL and NAVAL TELESCOPES.

Fig. 124.

No.

828. **COASTGUARD TELESCOPE**, object-glass 3-in. aperture, with one draw, brass bronzed, leather covered body, pancratic eye-piece and dew shade, leather sling and caps, mounted on tall tripod stand, and packed in a varnished deal case, complete ... ... £17 10s. 0d.

829. **TELESCOPE**, object-glass 2½-in. aperture, with terrestrial eye-piece and tripod, in pine case ... ... £10 0s. 0d.

A separate catalogue of astronomical instruments may be had on application.

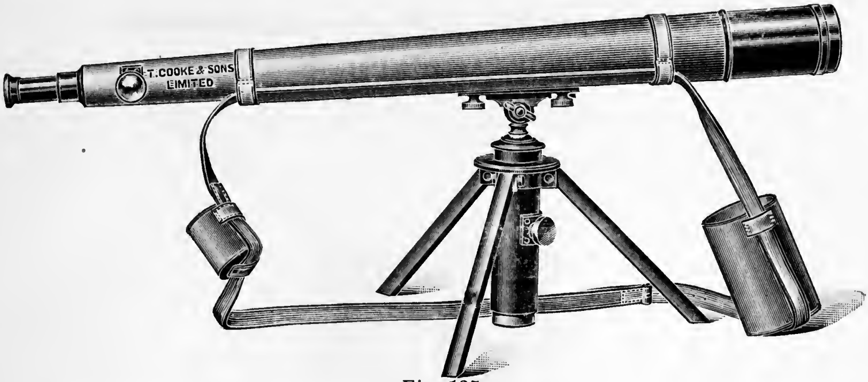


Fig. 125.

830. **TELESCOPE,** with object-glass of 3-in. aperture, power 45, taper brass leather-covered body with leather sling and caps, rack focussing motion and draw to eyepiece, on brass folding table tripod £10 0s. 0d.

Fig. 126.

831. **DRAW TELESCOPE,** with three, four, or five draws, brass-bronzed, leather-covered body, pancratic eye-piece, dew shade, leather sling and caps.

APERTURE OF OBJECT-GLASS.

$1\frac{1}{2}$-in.			$1\frac{3}{4}$-in.			2-in.			$2\frac{1}{4}$-in.			$2\frac{1}{2}$-in.			$2\frac{3}{4}$-in.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
4	4	0	5	0	0	5	18	0	7	0	0	8	10	0	10	10	0

832. DITTO as above, but of fixed power and without leather sling and caps. $1\frac{1}{4}$-in., £2 10s. 0d.; $1\frac{3}{8}$-in., £3 0s. 0d.

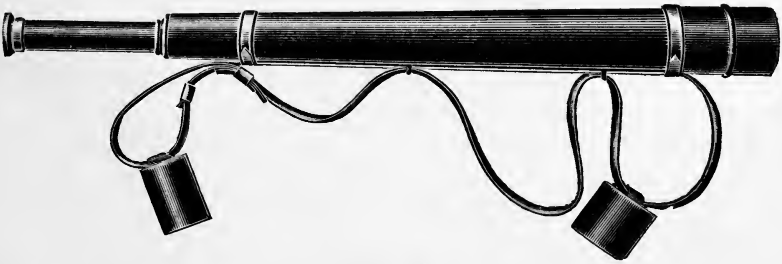


Fig. 127.

833. **NAVAL TELESCOPE** with one draw, brass-bronzed, leather-covered body, pancratic eye-piece, dew shade, leather sling and caps. Sizes and prices as Draw Telescopes No. 831.

834. **"OFFICER-OF-THE-WATCH" TELESCOPE,** with one draw, object-glass of $1\frac{1}{4}$-in. aperture, power 15; $23\frac{3}{4}$-in. long when open, 18-in. when closed. With leather-covered body and cap £2 10s. 0d.

COOKE LENSES FOR PHOTOGRAPHY.

H. D. Taylor's Patents.

In their freedom from astigmatism and curvature of field, these lenses are a distinct advance on everything preceding them. With their large apertures they are specially suited for all rapid and accurate work requiring uniformly fine definition.

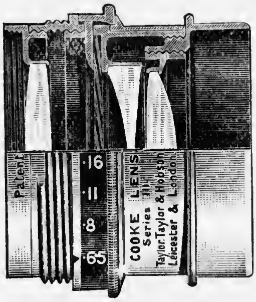


Fig. 128.

Sectional view of a **COOKE LENS**, showing its three simple glasses and the screw adjustments by which final perfection is obtained.

These lenses are constructed of particularly pure, transparent, and durable glasses, and their images are remarkably free from all traces of flare and ghost, or other results of surface reflections.

SERIES III. Full Aperture f/6·5.

No. Lens and Flange.	All dimensions in inches. Approx. equivalent focus.	With large aperture to cover plates.	When stopped down to cover plates.	Diameter of Flange Screw.	Diameter of Hood.	PRICES. Lens with Iris Diaphragm.	Patent Flange, extra.
838	4.25	$3\frac{1}{4} \times 3\frac{1}{4}$	5 × 4	1·25	1·15	£3 12s.	2/-
839	5	$4\frac{1}{4} \times 3\frac{1}{4}$	7 × 5	1·5	1·25	£4 0s.	2/-
840	5·5	$4\frac{1}{4} \times 3\frac{1}{4}$	8 × 5	1·5	1·4	£4 5s.	2/-
841	6	5 × 4	$8\frac{1}{2} \times 6\frac{1}{2}$	1·5	1·4	£4 10s.	2/-
842	7·5	$6\frac{1}{2} \times 4\frac{3}{4}$	10 × 8	1·5	1·65	£5 10s.	2/-
843	8·25	7 × 5	11 × 9	1·75	2·1	£6 1s.	2/-
844	11	$8\frac{1}{2} \times 6\frac{1}{2}$	14 × 11	2·25	2·5	£10 10s.	2/3
845	13	10 × 8	17 × 14	2·5	2·8	£15 0s.	2/6

NOTE.—Messrs. T. Cooke & Sons being unable to cope with the large demand for these lenses in addition to their ordinary business, have appointed Messrs. Taylor, Taylor & Hobson, of Leicester, their Sole Licencees for the British Isles, and they are now manufacturing the Cooke lens for them with the greatest success.

COOKE LENSES

SERIES V. Full Aperture f/8.

No. Lens and Flange.	All dimensions in inches.					PRICES.	
	Approx. equivalent focus.	With large aperture to cover plates.	When stopped down to cover plates.	Diameter of Flange Screw.	Diameter of Hood.	Lens with Iris Diaphragm.	Patent Flange, extra.
849	4·25	3¼ × 3¼	5 × 4	1·25	1·15	£2 18s.	2/-
850	5	4¼ × 3¼	6½ × 4¾	1·25	1·15	£3 3s.	2/-
851	5·5	4¼ × 3¼	7 × 5	1·25	1·15	£3 8s.	2/-
852	6	5 × 4	8 × 5	1·25	1·15	£3 12s.	2/-
853	7·5	6½ × 4¾	8½ × 6½	1·5	1·4	£4 10s.	2/-
854	9	8 × 5	12 × 10	1·5	1·65	£5 10s.	2/-
855	11	8½ × 6½	15 × 12	1·75	2·1	£7 15s.	2/-
856	13	10 × 8	17 × 15	2	2·5	£10 0s.	2/-
857	16	12 × 10	18 × 16	2·5	2·8	£15 0s.	2/6
858	18	15 × 12	24 × 20	3	3·3	£18 10s.	3/-
859	24	18 × 16	27 × 24	4	4·25	£30 0s.	4/-

Larger Sizes to order.

FLANGES for attachment to cameras are charged extra because the Royal Photographic Society's Standard Screws are now so common, and our methods of making interchangeable screws so accurate, that it is not necessary to buy a flange with every lens.

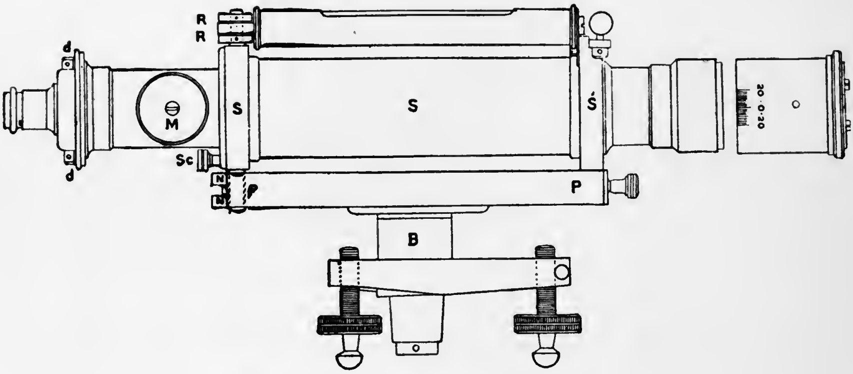
STANDARD ADAPTERS are made to carry lenses in flanges larger than their own.

PAIRING LENSES FOR STEREOSCOPIC WORK. We can usually select from stock and without extra charge pairs of Cooke Lenses having the same *equivalent focus;* but if it is required that they shall be identical also in *back focus*, that is, the focus as measured from the flange screw shoulders, we make an extra charge of 7/6 for thus matching them.

Cooke Lenses received in 1895 the only medal given annually for inventions of sufficient merit by the Royal Photographic Society.

Also Focussing and Extension Cooke Lenses, Cooke Portrait Lenses, Cooke Lenses with shutters, and Cooke Lenses for process work. Descriptive booklet free on request.

FIG. 3.



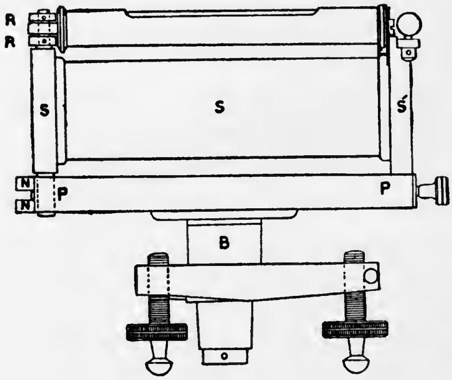


FIG. 2.

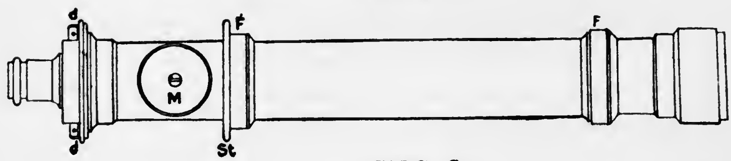


FIG. 1.

ON THE ADJUSTMENT OF

COOKE'S REVERSIBLE LEVEL.

THIS Instrument has been specially designed with two objects in view; first to afford an easy, efficient, and at all times available means of adjusting the line of collimation of the telescope to perfect perpendicularity to the vertical axis of the instrument; and secondly, to obtain a form of construction in which elegance and great compactness are attained, and strength and rigidity are secured to the instrument where most required, rendering it far less liable to be deranged by careless handling, which is almost inevitable under some circumstances, than the older well-known forms of reversible levels, notably the **Y** Level, all the advantages of which are retained in this instrument, whilst its objectionable features are avoided.

A general view of the Level is given on page 19, and its construction is shown opposite, where Fig. 1 is the telescope (shown in longitudinal section), which bears two perfectly equal cylindrical flanges **F** and **F′** turned on it concentrically with the tube, being essentially similar to the telescope of a **Y** Level. The cross-lines, consisting of one horizontal line and two subsidiary vertical lines, are ruled upon parallel glass carried by a perforated block in the eye end, which is adjustable vertically to correct collimation by the two antagonistic screws **d** and **d.** The object-glass is made to approach to, or recede from the cross-lines for focussing, by turning the milled head **M.**

The two flanges **F** and **F′**, instead of resting upon two **Y**'s, fit perfectly within two corresponding collars **S** and **S′**, which latter form the ends of the rigid socket **S-S-S′.** The two flanges **F** and **F′** and their corresponding collars **S** and **S′** being exactly equal, the telescope tube can be introduced indifferently from either end of the socket **S-S-S′** and pushed home until the stop-flange **St** comes in contact with the socket end. The telescope can be further secured in its socket by the screw **Sc.**

One end **S** of the socket is furnished with a threaded bolt which passes through a hole in the base-plate **P-P** and is adjustable vertically, and locked by the two lock-nuts **N** and **N.**

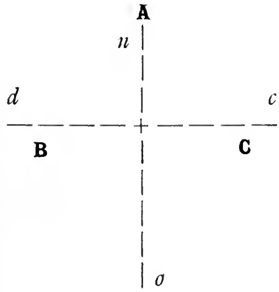
The adjustment of the socket **S-S-S′** so that its axis of figure may be exactly at right angles to the vertical axis **B,** is effected thus :—

First, some minute and well-defined test object, which need not necessarily be on the same level or height as the instrument, is selected. A small needle-hole in a piece of paper, fixed not less than 20 feet away, forms a convenient mark; but if the instrument requires adjustment in the open field, where perhaps the above-mentioned mark cannot be made use of, it will be most likely an easy matter to select some immovable and sufficiently well-defined test-mark from the features of the surrounding landscape. The instrument is mounted firmly upon its stand in such a manner that when the telescope is directed towards the test-mark, it may then lie directly over one of the foot-screws. The eye-piece is carefully pushed in or out in its tube until the cross-lines are seen as distinctly as possible, and the telescope is then focussed upon the test-mark, and with the aid of the foot-screw the image of the latter caused to fall nicely upon that part of the horizontal line lying midway between the two vertical lines. All error of parallax must now be corrected. If, when the eye is moved gently up and down the eye-piece, the image of the test-mark does not move in the slightest degree with respect to the horizontal cross-line, then the telescope is correctly focussed; but if the image seems to follow the movements of the eye, that is to tend to move above the cross-line when the eye is raised, and to move below it when the eye is lowered, then the image is not focussed exactly upon the cross-line, but lies on the side of the cross-lines towards the object-glass. The object-glass must now be caused to approach the cross-lines by means of the milled head. If the image of the test-mark should apparently move in a direction contrary to that of the eye, that is to tend to move below the cross-line when the eye is raised, and *vice versa*, then the image lies nearer to the eye than the cross-lines, and the error is corrected by moving, with the aid of the milled head, the object-glass farther away from the cross-lines. After all parallax has been removed and the test-mark carefully bisected by the cross-line, the screw **Sc** is taken out and the telescope is withdrawn carefully from its socket, and when right out, the socket is turned round with the other hand, end for end, and then the telescope is carefully pushed home again. The telescope is now reversed in its socket, or more correctly the socket is reversed upon the telescope. Care should be taken that no dust is allowed to settle upon the flanges of the telescope during its insertion, and that the hole in the stop-flange **S** through which the screw **Sc** passes, is kept vertically below the centre of the tube when the telescope is pushed home, so that the single line in the eye end may be as horizontal as possible, If on re-directing the telescope towards the test-object, the image of the latter is no longer bisected by the cross-line, but falls either above or below it, then the foot-screw below the telescope is turned until the image of the test-mark is brought as exactly as possible half-way back towards bisection by the cross-line. The lock-nuts **N** and **N** are then loosened sufficiently to allow them to be turned by a moderate pressure on the end of the lever used for their adjustment, and the end **S** of the socket is raised or lowered until the test-mark is again nicely bisected by the cross-lines, after which the operations of reversal of the telescope in its socket, and the correction of the error half by the foot-screw and half by the lock-nuts **N** and **N** are repeated until the bisection of the image is as nice and exact as possible, and remains quite undisturbed by the reversal of the telescope within its socket.

If it be thought necessary to adjust or examine the collimation of the telescope, the test-mark is carefully bisected by the cross-line, and then the screw **Sc** is withdrawn and the telescope is carefully twisted or rotated half-way round in its socket, so that the screw-hole through which **Sc** passes is brought to the top, and the cross-line is again horizontal. If the image is not now bisected, but falls above or below the cross-line, the error or deviation is half corrected by means of the foot-screw lying under the telescope and then the image is caused to be bisected by the cross-line by adjusting the latter by means of the antagonistic screws **d** and **d.** The telescope is twisted half-way round again and any remaining error corrected as before; if necessary, the operation is repeated until accuracy is attained.

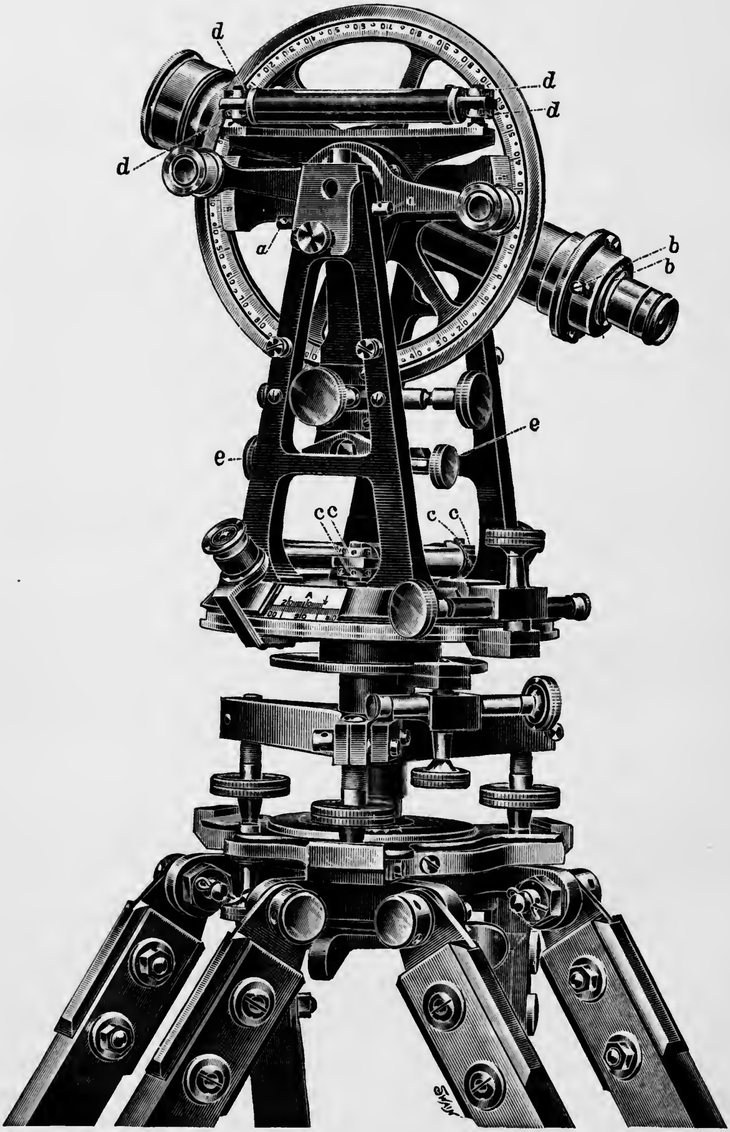
This adjustment, if required, should precede the adjustment of the socket.

In order to adjust the bubble-tube, the instrument is first set as nearly level as the operator is able to judge, by means of the three foot-screws. The telescope is then turned in a direction



as nearly as possible parallel to the line joining two of the foot-screws. If **A, B** and **C** represent the three foot-screws, then the telescope is directed along the line *d—e* which is parallel to the line joining **B** and **C,** and by means of the two foot-screws **B** and **C** the bubble is brought to the centre of its run, so that both ends of the bubble read the same. The telescope is then turned round end for end, one-half revolution, and if the bubble now departs from the centre of its run it is brought half-way back again by one of the foot-screws **B** or **C** and the other half of the error is corrected by means of the lock nuts **R** and **R.** For example, if, on the telescope being reversed on its axis, the bubble comes to rest eight divisions away from its previous central position, then by one of the foot-screws **B** or **C** the bubble is caused to move back four divisions and the remaining four divisions are corrected by means of the lock-nuts **R** and **R.** Both ends of the bubble should now give the same reading. The telescope is now turned at right angles to its former position so that it lies directly over the foot-screw **A** along the line *n—o*, and the foot-screw **A** is turned until the bubble gives similar readings at both ends. The telescope is then reversed, and any deviation (which will be very slight) of the bubble is half-corrected by the foot-screw **A** and half by the lock-nuts **R** and **R.** The bubble tube should now be approximately correct in its adjustment, and any further exactitude may be obtained by a continuation of the above method, the telescope being directed along either of the lines *d—e* or *n—o*, and care being taken to allow the bubble time to settle to its rest after each reversal of the instrument.

After adjustment the telescope ought to lie in its socket with its stop-flange **St** against the end **S** of the socket, so that it may be secured by the screw **Sc.**



Cooke's Pattern Transit Theodolite.

with centering arrangement to stand.

ON THE ADJUSTMENT OF

COOKE'S TRANSIT THEODOLITE.

A GENERAL view of Cooke's pattern of transit theodolite is shown in the drawing on the opposite page, which represents a 5-inch instrument, that is to say, one in which the diameter of the circles is 5 inches.

All instruments are carefully examined and adjusted before leaving the works, but in case of rough handling or possible accidental injury while in use, it is very desirable that from time to time the various adjustments should be tried and proved, without which it is impossible for the Engineer to have any certainty as to the accuracy of his work.

For this reason he should make himself thoroughly acquainted with the details of his instrument, so that at any time he may be able to perform the necessary corrections for himself. With a view to simplifying this operation, the method of carrying out the various permanent adjustments of this pattern of transit theodolite is here given, and it is recommended that they be performed in the order named.

I.—Adjustment of the levels on the horizontal plate perpendicular to the vertical axis of the instrument.

Having set up the instrument firmly on good solid ground, release the lower clamping screw and turn the head until the longer of the two levels lies in a direction parallel to an imaginary line joining the centres of two of the foot-screws. The shorter tube then lies towards the third. Now level the instrument by means of the foot-screws, so that both bubbles lie in the middle of their runs. Then turn the head of the instrument one half round in azimuth, that is to say, through an angle of 180 degrees. If the bubbles remain true they are in perfect adjustment, but if not, then by means of the capstan-headed lock-nuts (*c—c*) by which the larger one is attached to the horizontal plate, correct it for half the error only, and for the other half by means of the foot-screws.

Now complete the revolution of the head, bringing it to its first position, and again notice this bubble. If it is not quite exact, the same operation must be repeated, that is to say, half the error must be again eliminated by means of the capstan-headed nuts, and the other half by means of the foot-screws. By repeated trials this level can thus be eventually exactly corrected, after which the smaller bubble may be compared with and adjusted by it, and when the head of the instrument can be twisted through an entire revolution without disturbing either of the bubbles from their positions in the middle of their runs, the levels are in perfect adjustment.

The same adjustment can be made by reference to the level which is mounted on the vernier arms of the vertical circie, sometimes called the azimuth level. This bubble is of more delicate construction than those on the horizontal plate, so that by its use greater accuracy may be attained. It must first be carefully corrected, so that the head of the instrument may be turned in azimuth through an entire revolution without disturbing the position of the bubble, after which the levels situated on the horizontal plate can be compared with and adjusted by it. The operation is, however, of somewhat longer duration. and as the method given above will be found sufficiently accurate for all practical purposes, no further description of it is given here.

II.—Adjustment of the central line of vision of the telescope perpendicular to the transit axis.

This is horizontal collimation, and is effected by means of the pair of antagonistic screws (*b—b*) situated near the eye end of the telescope.

Having carefully levelled the instrument, direct the telescope to some small object, such as a pin-hole in a piece of white paper, fixed at as great a distance as can be distinctly seen, and by means of the lower tangent screw bring the centre of the webs to fall exactly upon it, all clamps being firm. Now having turned back the covers of the bearings and loosened one of the clipping screws (*e—e*) at the lower extremity of the vernier arm, gently lift the upper part of the instrument and reverse the transit axis in its bearings. Release the clamp to the vertical circle and then transit the telescope, after which again direct it to the previous object. If it falls exactly on the cross-hairs the adjustment is perfect, but if not, correct half the error only by means of the antagonistic screws (*b—b*) and then repeat the operation. This time it will be found to be almost, if not quite, correct, but if necessary again divide the error by means of the screws, and so on until the adjustment is perfect.

No adjustment is provided or required for vertical collimation with this instrument.

III.—Adjustment of the transit axis so as to be truly horizontal.

This adjustment is effected by means of the antagonistic screws (*a—a*) situated just below one of the **Y** bearings, and can be carried out with the aid of a striding level. It is an adjustment that is not likely to require much attention, for having once been carefully corrected by the maker of the instrument nothing but very rough usage can possibly displace it again..

Having levelled the instrument carefully by means of the bubbles on the horizontal plate and noticed that this adjustment is perfect, turn back the caps which cover the ends of the transit axis in its bearings. Now erect the striding level on the top of the axis just over the bearings, and observe it carefully. (Reverse it, in order to examine its own adjustment, and if any error be discovered, this must be corrected before proceeding further). If the bubble does not remain in the middle of its run, it must be made to do so by slightly opening or closing the slit in the bottom of the adjustable **Y**, by means of the antagonistic screws (*a—a*), which has the effect of lowering or raising that end of the transit axis. When the adjustment is completed for one position, the bubble in the striding level ought to remain steady while the head is twisted in azimuth through an entire revolution.

This same adjustment may be accomplished without the aid of a striding level in the following manner :—Set up the instrument at about forty or fifty feet distance from a high wall or other object of considerable elevation, level it carefully, and direct the telescope to some small point situated as high up as possible, and bring the cross lines to bear exactly upon it. All parallax must now be carefully eliminated by means of the focussing screw and by gently moving the eye-piece in or out of its socket until the cross lines and the object are brought exactly into the same focus. Then tilt the telescope and make a small mark on the wall near to the foot, at the point of intersection of the cross lines. Now turn the telescope 180 degrees in azimuth, transit it, and again direct it to the upper mark, after which tilt it as before and see if the point of intersection of the cross lines exactly corresponds with the lower mark. If it does so the transit axis is truly horizontal, but if not, half the error must be corrected by means of the antagonistic screws (*a—a*) as previously described, and the operation repeated in order to ensure accuracy.

IV.—Adjustment of the level attached to the vernier arms of the vertical circle, so that when the central line of vision of the telescope is horizontal, and the zero lines of the vertical verniers coincide with the zero diameter of the vertical circle. the bubble may be in the middle of its run.

This adjustment is effected by means of the capstan-headed lock-nuts (*d—d*) that attach the level bubble to the vernier arms.

Having levelled the instrument carefully by means of the bubbles on the horizontal plate, bring the bubble in the azimuth level to the middle of its run by means of the antagonistic screws (*e—e*) at the end of the clipping arm. Now set the zero diameter of the vertical circle to coincide exactly with the zero lines on the vertical verniers, and clamp it there. Observe an ordinary levelling staff held at as great a distance as it can be distinctly seen, and take the reading by the horizontal web. Now release the clamp and transit the telescope, and again adjust the zero diameter of the vertical circle to the zero lines on the verniers. Revolve the head in azimuth one half turn, bringing the telescope to its former position. and once more take the reading of the staff. If it is not the same as previously observed, correct half the error by the antagonistic screws at the end of the clipping arm and then repeat the operation until all error is by this means eliminated. When the adjustment is complete correct the azimuth level by means of the capstan-headed lock-nuts, so that the bubble remains in the middle of its run.

NOTES ON THE CONSTRUCTION AND USE OF

COOKE'S TACHEOMETERS.

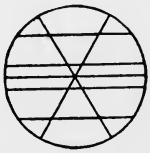
A TACHEOMETER is a transit theodolite of which the telescope is provided with an extra lens for the purpose of converting it into a telemeter.

English Engineers have been slow to take advantage of this instrument, which for distance-measuring purposes is much more expeditious and accurate than any system of chaining, especially over difficult ground.

The use of the anallatic lens dispenses with the tedious addition to every reading of what is called "the constant" of the instrument, which is always necessary in the case of theodolites merely provided with stadia lines.

The diagram shows the arrangement of lenses usually employed.

In order to overcome the loss of light occasioned by the introduction of the extra lens, the telescope of a tacheometer is made correspondingly larger than that of a theodolite, while at the same time eye-pieces of higher power are employed, which facilitate the reading of the stadia rod with accuracy. The eye-pieces are made to slide vertically across the eye-end by means of a rack-and-pinion movement, which enables a better view to be obtained of the outer pair of lines; A very small movement suffices for this.



The lines on the diaphragm are usually ruled to read 1 in 50 between the outer pair, and 1 in 100 or 1 in 200 between the inner pair, and the anallatic lens serves to make these values constant for any distance. Readings taken on a staff on which the unit of measurement is divided into fifty equal parts will therefore be correct when the outer pair of lines is used, but the difference of the readings must be multiplied by two or four before reduction when taken with the inner pair. The ratio of 1 in 50 allows the foot staff to be divided throughout into $\frac{1}{50}$ths of a foot, a sufficiently open division to enable it to be read without error at a considerable distance. The metre staff is usually divided to two centimetres and halves, from which results to within one-half of a metre are easily obtained.

Similarly readings taken on a staff on which the unit of measurement is divided into one hundred equal parts will be correct when the inner pair of lines, if set at 1 in 100, is used, but the difference of the readings must be divided by two before reduction when taken with the outer pair. Unfortunately divisions so small as $\frac{1}{100}$th of a foot are only readable at short distances, so that frequently wider graduations such as $\frac{1}{50}$th of a foot are used, although the staff is numbered to read in $\frac{1}{100}$ths.

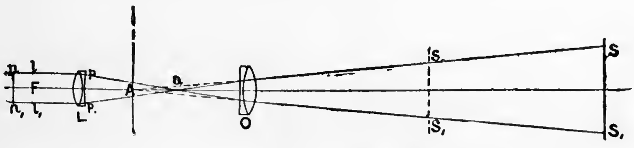
The centre line in the diaphragm being exactly at the half distance across either pair, it naturally follows that readings of 1 in 100, 1 in 200, or 1 in 400, as the case may be, are immediately obtainable.

The circles are divided to 360 degrees as in theodolites, or to 400 grades. The latter is called the centesimal method, and was originated solely to facilitate the reduction of the readings, each right angle being composed of 100 grades of 100 centesimal minutes each, as against 90 degrees of 60 minutes each by the sexagesimal method. Tables and diagrams are now obtainable for both methods, so that nothing is gained by departing from the more familiar division of 360 degrees.

The vertical circles of Cooke's Tacheometers are engraved with the zero at the top, therefore the 90 degrees and 270 degrees (or 100 grades and 300 grades) naturally correspond with the indices on the opposite verniers when the telescope is horizontal. When reading the circle it follows that angles less than 90 degress (or 100 grades) represent rising sights, while those greater denote falling ones. If the opposite vernier is used the determining angle is 270 degrees (or 300 grades), so that whichever vernier is employed no confusion is possible.

It is necessary that the position of the anallatic lens with reference to that of the object glass of the telescope shall be fixed and unvarying in order to obtain the best results. For this reason no attempt is made to provide for the adjustment of the measuring angle by moving it backwards and forwards in the tube as is done in the instruments of some makers. (This condition also requires that the adjustment to focus shall be at the eye-end of the telescope instead of at the object-end as in the case of a theodolite). The lines on the glass diaphragm which constitute the measuring angles are accurately ruled in the first instance to within $\frac{1}{10000}$ of an inch, so that no after adjustment of any kind is necessary. In the event of any diaphragm being broken or damaged, an exactly similar one can be obtained from the makers on quoting the number of the instrument.

The adjustments of the tacheometer are similar to those of the transit theodolite already described, with the exception that an extra bubble is fitted to the telescope body which can be adjusted at the same time and in the same way as that attached to the vernier arms.



The principle of the action of the anallatic lens in automatically referring all readings to the centre of the instrument may be explained as follows :—

Let **O** be the object-glass, **L** the anallatic lens, and **A** the vertical axis of the instrument, while **S S′** is a staff or stadia rod held at such a distance that $\frac{\text{S-S}'}{\text{S-A}} = \frac{1}{100}$, and let **S A**; **S′ A** be two rays, which, if produced, would meet at **A.** But the effect of the object-glass **O** upon these rays is to refract them so that they converge more rapidly, and after crossing each other at *a* they fall upon the anallatic lens **L** (which has a principal focal length = **L** *a*) at *p'* and *p* respectively, and emerge therefrom as the parallel rays *l' n'*, *l n*.

Now, if the staff be brought nearer to the instrument, say to **s-s'**, then $\frac{\mathbf{s\text{-}s'}}{\mathbf{sA}} = \frac{1}{100}$ as before, and the rays **s-A, s' A** follow the same course as previously. Hence, if the stadia lines are placed so as to cut the parallel lines *n-l*, *n' l'*, it naturally follows that all readings are automatically referred to the centre of the instrument as required.

The measurement of heights and distances by means of the tacheometer is effected as follows :—A stadia rod being held vertically upon the point whose height or distance is required, the telescope is directed towards it at such an angle as will cause the outer pair of lines in the diaphragm to lie across it. Two readings of the rod, one by each line of the pair, are then taken and booked, and the difference between these two readings is called the generating number **(G)**. But if the staff is at such a distance that its full length is insufficient to fill the space between the outer pair of lines, the inner pair should then be used, and the difference between the readings must be multiplied by two or four as the case may be to obtain the true generating number.

The inclination of the telescope must then be read on the vertical circle and the angle booked. From the information now obtained the horizontal distance of the staff from the centre of the instrument and the difference of height between the centre of the telescope, and a point on the staff midway between the two readings, may be calculated. Much time and labour will be saved by the employment of a slide rule, a book of tables, or a reduction diagram.

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INDEX.—continued.