CATALOGUE OF A LOAN EXHIBITION OF HISTORIC SCIENTIFIC APPARATUS IN CAMBRIDGE

Arranged under the auspices of the Cambridge Philosophical Society in the East Room of the Old Schools

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PREFACE

THE exhibits enumerated in the following pages have been selected and arranged by a small Committee appointed by the Council of the Cambridge Philosophical Society. The Committee could not have accomplished their task had it not been for the ready co-operation and help afforded most willingly by all the bodies and individuals whose interest and assistance they have solicited.

Their thanks are due in the first instance to the Council of the Senate for placing at their disposal the East Room of the Old Schools, which has enabled them to display the collections under ideal conditions.

Secondly, they acknowledge with gratitude their obligations to Dr. R. T. Gunther, Curator of the Museum of the History of Science at Oxford. It is due to his researches that they have been made aware of many of the interesting objects preserved in the Colleges and Institutions of the University. He is responsible for the preparation of this Catalogue, which is mainly based on his notes, and he has undertaken a large share of the work of arrangement. His expert knowledge and enthusiastic co-operation have been invaluable at every stage of this enterprise. Nearly all the Colleges have proved to be the owners of objects of great interest. Such are the astrolabes lent by Gonville and Caius College and by King's College, the box of drawing-instruments from Jesus, the medicine-chests from Queens', St. John's, and St. Catharine's, and the mathematical and astronomical instruments from Trinity and St. John's. To Magdalene the Committee are especially indebted for the loan of the Musarithmica Mirifica from the Pepys Library. The University Library has kindly contributed some important manuscripts, and the Archaeological Museum has lent an astrolabe and an interesting series of weights and measures.

Much material has been found in the scientific laboratories, particularly in the Cavendish Laboratory and the Department of Mineralogy and Petrology. The former has

sent one of the earliest specimens of a slide-rule known, as well as apparatus used by Maxwell, Rayleigh, Thomson, and Rutherford.

From the Biological Schools has been obtained a notable series of microscopes and other apparatus used in their researches by Darwin, Balfour, and others. Finally, the Committee are exhibiting a number of books and portraits which, being self-explanatory, are not included in the Catalogue.

To the institutions mentioned above and to all who have helped them the Committee tender their hearty thanks.

A. HUTCHINSON.

Chairman of the Exhibition Committee.

WEIGHTS AND MEASURES. BALANCES

1. Imperial Standard Yard at 62° Fahrenheit. **1824.**
No. 300. Weights and Measures Office.
By *Bate, London* for UNIVERSITY OF CAMBRIDGE 1824.

2. Winchester Bushel. Bronze. **1601.**
Diameter 20 inches. Town Clerk's Office.
Inscribed:
ELIZABETH (Rose) DEI GRACIA ANGLIAE (Portcullis) FRANCIAE ET (Fleur-de-lis) HIBERNIAE REGINA E R 1601.

3. 7 pints Bronze Measure. **1601.**
Archaeological Museum.
Inscribed:

Crown
ER
ELIZABETH REGINA 1601.

Depth $9\frac{3}{4}$ inches; diam. at top $6\frac{5}{8}$ inches; diam. at bottom 5 inches.

4. Pottle Measure. $7\frac{3}{4}$ in. high × 5 in. **1641.**
Arch. Mus.

C Royal R
16 Arms 41

·:A WINE POTTLE TRYED BY IOHN RENALDS AT THE TOWER:·

Height $7\frac{3}{4}$ inches; diameter 5 inches. A pottle was nominally 2 quarts, but the capacity of this one is only 3 pints.

5. Half Gallon. **1646.**
Town Clerk's Office.
STANDARD OF THE TOWN OF CAMBRIDGE 1646.

6–8. Steel-yard Globe Weights.
Arch. Mus.
(*a*) From Clare, Suffolk. **13th Cent.**
(*b*) From Crawleys, Trumpington. **c. 1300.**
(*c*) With shields bearing '3 lions guardant passant', 'lion rampant', 'two-headed eagle'. **c. 1500.**

9. Wool Weights. **c. 1520 to 1780.**
Arch. Mus.

Eight in number including those of reigns of Henry VIII, Charles I, Anne, and George III.

10. 5 Standard Bell Weights. Temp. **Henry VIII.**
XXXXXXXXXXXII (= 112 lbs.), XXXXXVI, XXVIII, XIIII, VII.
Arch. Mus.

11–12. 4-pound and 2-pound Flat Weights.
With loop handles. Marked IIII and II, and with the Royal badge, a Tudor rose between supporters.

13. Standard 7-pound Bell Weight. Avoirdupois.
14. ,, **28** ,, ,, ,, ,,
Arch. Mus.

Mark: Crown EL
[1588.

15. Set of 6 Standard Avoirdupois Bell Weights.
Arch. Mus.

LVI li, XXVIII li, XIIII li, VII li, IIII li, II li.

Inscribed AN° DO 15 Crown EL 88 A° REG XXX.

16. Nest of Eleven Standard Troy Cup Weights. 1588.
Arch. Mus. from the Registry.

CCLVI *TR*, CXXVIII, LXIIII, XXXII, XVI, VIII, IIII, II, I, [?½] Troy ounces.
Inscribed EL AN° DO 1588 A° REG XXX.

17. Wollaston's Chemical Balances. **c. 1810.**
Cavendish Laboratory.

18. Balances used by Prof. W. H. Miller in making the Standard Pound.
Dept. of Mineralogy.

By Robinson.

19. Apothecaries' and Money-Changers' Scales and Weights.
Cavendish Laboratory.

MATHEMATICAL INSTRUMENTS

20. Roger North's Box of Mathematical Instruments. c. 1700.
Jesus College.

Roger North (1651–1734) resided for one year as Fellow Commoner 30 Oct. 1667; K.C. 1683; Attorney-General 1685–8; purchased Rougham 1690. His box, measuring $14\frac{1}{4} \times 10\frac{1}{4} \times 4\frac{1}{2}$ inches, is of walnut wood covered with black shagreen, strengthened at the corners with ornamented brass corner-pieces, with handles of gilt brass. Nowhere does any maker's name appear. The foot is $\frac{1}{20}$ inch shorter than the modern foot.

21. $6\frac{1}{4}$-inch Parallel Rulers, Brass. Trinity College

22. $3\frac{1}{8}$-inch radius Semicircular Protractor. c. 1700.
Trinity College.

23. $2\frac{1}{2}$-inch radius Semicircular Protractor.
'I. Rowley Fecit.' Trinity College.
With angular measures marked '4, 6, 12.' corresponding to 90°, 60°, 30°.

24. 10-inch Dialling Scale. c. 1660.
Trinity College.
'H. Sutton fecit, Ex dono Scattergood Arm.'
Obv. 'Cho. Sec. Sin. Tan. Inch.'
Rev.: 'Hours, Declin. Chord, Substile, Stile, Angle, Inclin. Merid.'

25. 12-inch Plotting Scale, Brass. c. 1700.
'I. Rowley Fecit.' Trinity College.
Obv. 'I[nches] M[easure] F. M[$\frac{1}{10}$th of foot]. Chords.'
Rev.: 'T. N. S. M. EP. EP Hours, Lon. Cho. Sin. Tan. H. T.'

26. 6-inch Brass Plotting Scale.
Trinity College.
'E. Culpeper Londini fecit' in tiniest script across end. 'Trin. Coll. Cant. Ex dono Tho. Scattergood Arm.'
Scales of 'Sin. · N.S. VS.'

27. 24-inch Navigator's Plotting Scale. 19th cent.
Silver 25 in. × 2 in. 'A. Sloper, Maker, New Kent Road, London.' Trinity College.

28. 9-inch Brass Sector. c. 1640.
'Ex dono Tho. Scattergood Arm. Trin. Coll. Cant.'
With cross bar and Lines of Metals. Engraving not unlike Allen's work.

29. 9-inch Sector. 1660.
Trinity College.
'H. Sutton fecit 1660, Ex dono, Scattergood Arm.'
Built of 3 brass plates held together by 38 rivets.
Obv. Scales marked 'S, T, T, S, and Vs.'
Rev. 'C. S. L. N[umbers]'. *Outer edge* scale of 'T'.
Cross plate engraved with Diagonal Plotting Scale on one side and Calendar on other.

30. 9-inch Wooden Sector.
Trinity College.
Obv. 'S. T. Tan Chords Latt Sin Tan.'
Rev.: 'Hours C. L. S. Num.' *Edge*: Scale of Inches.

31. 12-inch Sector. 1703.
'I. Rowley Fecit 1703, Colleg. Trinit. Cantab.'
Obv. 'Cho. Sec. Lin. Numbers'.
Rev.: 'Tan. Tan. Sin. Sin Tangents.'
Edge: Scales of Inches and of $\frac{1}{10}$ths of foot.

32. 18-inch Sector. 1703.
'I. England, Charing Cross, Londini Fecit 1703, Colleg. Trin. Cantab.'
Obv. 'Cho. Sec. Lin. poll'.

33. 6-inch French Sector, Brass. 18th cent.
'Clerget A Paris au Butterfield.' Arch. Mus.

33 a. 7-inch Gunners' Callipers. c. 1700.
By *'Butterfield A Paris'*.
Prof. A. Hutchinson.

SLIDE RULES.

34. Oughtred's Circles of Proportion. c. 1640.
Diam. 12⅜ in.

Cavendish Laboratory.

'Elias Allen fecit.'

A pair of Compass legs marked 'S, T, T, N, E, T, T, S' are pivoted to the centre of the disc engraved with circular logarithmic scales.

35. 12-inch Slide Rule.

Trinity College.

Boxwood with brass ends.
Scales marked 'E P, M, T, N, SR, S, C.R.'
'Leag. M. Lon.'

36. Selection of Slide Rules to illustrate the development of the instrument.

Prof. A. Hutchinson.

a. Circular Type derived from Oughtred's original model. E.g. Halden's Calculex, Calculimètre Charpentier, and the Calculigraphe.
b. Linear Type derived from Gunter's Scale. E.g. Tavernier-Gravet, Faber, and later models.
c. Linear Type with multiple scales. E.g. Cherry, Hannyngton, Anderson, Cooper, Naish, and Thacher.
d. Spiral Type. Lilly, Otis Calculator. Fuller.
e. Slide Rules devised for special purposes, e.g. Chemical Slide Rules, Gaugers' Slide Rules, such as Nos. 37–40.

37. Navigator's Slide Rule. Length, 2 ft. 9 in.

Cavendish Laboratory.

Signed 'Nairn & Blunt' on brass slider.

38. 12-inch Gauger's Slide Rule. c. 1816.

Cavendish Laboratory.

Ivory: by 'Bate, London.'

39. 12-inch Gauger's Slide Rules. 1816.

Cavendish Laboratory.

Boxwood: Four examples inscribed by Wollaston 'Original' and 'From Excise Office July 1816'

40. 12-inch Slide Rule for EXCHANGES, BULLION, &c. 1813.

Cavendish Laboratory.

Showing Percentages above and below par.

Published by W. Cary 182 Strand. Apr. 1, 1813.

41. Babbage's Calculating Machine. ?1830–40.

Cavendish Laboratory.

Pres. by C. Babbage 1886.

The instrument figured seems to have been a portion of the Calculating or Difference Engine devised by Babbage and executed between 1823 and 1833 with the aid of a grant of £17,000 from the Government. The greater part of the work was executed by Clement, afterwards associated with Charles Holtzappfel.

42. Napier's Bones in Ivory. c. 1700.

a. In Roger North's Box of Instruments, p. 7.

b. Holden-White Collection, Fitzwilliam Museum.

43. Napier's Bones, Cylindrical pattern. 1720.

Holden-White Collection, Fitzwilliam Museum.

In wooden box, inscribed with *a.* Table of Interest at 5 per cent., *b.* Perpetual Calendar for the years 1720–41, *c.* Tide Table for Ye Chief Ports.

44. Frost's Model of a Magic Cube of Nine. 1877.

St. John's College.

The Construction and Properties of Nasik Squares and Cubes were described by the Rev. A. H. FROST of St. John's College.

45. Crum Brown's Models of three interlocking surfaces.

Knitted in coloured wools by Professor Crum Brown of Edinburgh c. 1914.

Prof. A. Hutchinson.

ASTRONOMY

46. Holbrook's Cambridge Tables for 1430.
University Library.

Adelard's MS. De Operatione Astrolabii. c. 1140.
Fitzwilliam Museum.

Chaucer. Treatise on the Astrolabe. 1391.

Richard of Wallingford. Treatise on the Rectangulus. 1326.

Figures of the Navicula de Venetiis. 15th century.

Figures of the Chilindre. 15th century.

POCKET SUN-DIALS OF THE 16TH–18TH CENTURIES

47. 16th-cent. Sun-dial. Diam. $1\frac{3}{4}$ inches; found in 1895 on site of the Cavendish Laboratory. **16th cent.**

48. Oughtred's Double Horizontal Dial. c. 1640.
Engraved on the back of his 'Circles of Proportion' (p. 9). It includes
A Calendar Circle of days of months.
A Circle of Star positions marked: 'Cor ♌, Spi ♍, Lanx bor, Cap oph, Vultur, Os peg, Ext ala, Luc γ, Ocu γ, Seg ori, Can min, Cor ♌.'

49. Augsburg Dial.
Arch. Mus.
Signed *Nicolaus Rugendas.*

50. French Dial with Bird-gnomon.
Prof. A. Hutchinson.
By *Macquart à Paris.*

51. Ivory folding Dial, marked I 3 K.
Prof. A. Hutchinson.

NOTE. The Fitzwilliam Museum has recently received

a representative collection of foreign Portable Dials, with a few English examples, from Mr. Charles Holden-White. Examples of the signed work of the following makers are included in the collection.

English:—*H. C[ole]* 1576; *C. Whitwell; Elias Allen; Edm. Culpeper; Anthony Thompson* 1652; *A. W.* 1639.

French:—*Ch. Bloud* and *Eph. Senecal* of Dieppe; *Butterfield; Delur; Blondeau; Le Maire; Julien Le Roy; Felice Morelli; Macquart* and *H. Robert* of Paris.

German:—*David Beringer; Hans Ducher; T. D.; Johan Engelhardt; Engelbrecht; Johan Gebhart* 1556; *Conrad Karner; Udalricus Klieber* 1605; *Leonhart Miller* 1613–49; *Nicolaus Miller* 1649; *Paul Reinman; V. S.* 1576; *Hans Troschel* 1624.

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52. 4½-inch Astronomical Ring Dial. 1660.
Arch. Mus.

Hen: *Sutton fecit* 1660, for Will^m^. Rook.

53. 6⅜-inch Astronomical Ring Dial. c. 1670.
Trinity College.

Silver. In case, lid missing. Star list engraved on back.

'This Dial belonged to S^r^ Isaac Newton. It came into my possession when the observatory upon the great Gateway of Trinity College, was pulled down [1797], in which the astronomical Instruments were deposited, used by Sir Isaac Newton when residing in that College.' C. Hague. (Trinity Hall Prof. of Music, 1799.)

54. 10-inch Astronomical Ring Dial. 1703.
Trinity College.

'Made by John England, Charing Cross, London, Colleg. Trinit. Cantab. 1703'. A Quadrant on back.

55. 12-inch Universal Ring Dial on Stand. c. 1730.
Prof. A. Hutchinson.

'Made by Heath and Wing London.'

T. Heath was a math. instrument maker at the Hercules next the Fountain Tavern in the Strand.

56. Astronomical Ring Dial. 1737.
St. John's College.

Inscr. 'J. Colemore 1737 Soph. at St. John's Cambridge'.

Pres. 1927. A John Colemore adm. St. J. 1733, B.A. 1737–8; curate of Edlesmere, Bucks.

ASTROLABES

57. Dr. Caius Astrolabe (B). 14th cent.
Caius College.

Diameter $3\frac{1}{2}$ inches. Believed to have belonged to Dr. Caius. Figured in *Astrolabes of the World*, pl. 132.

58. Caius College Astrolabe (A). 15th cent.
Caius College.

59. King's College Astrolabe. c. 1570–80.
King's College.

Unsigned.

Diameter 11 inches, perhaps by a Netherland craftsman.

60. Persian Astrolabe of Muhammad Mahdi al-Khadim. 1659.
Arch. Mus.

61. Kufic Arabic Astrolabe. A.H. 933. A.D. 1526.
Professor Newall.

QUADRANTS

62. 9-inch Quadrant. 18th cent.
Archaeological Museum.

Engraved on a square plate; a compass dial on back.

63. 5-inch Quadrant. c. 1660.
Trinity College.

'Trin. Coll. Cant. Ex dono Tho. Scattergood.' On back a scale of the equation of time.

64. $5\frac{3}{4}$-inch Gunter's Quadrant. 17th cent.
Jesus College.

65. 7-inch ditto.

Prof. A. Hutchinson.

66. 4½-inch Surveyor's Quadrant.

Trinity College.

With two sets of slit-sights and a 2-inch compass. The rim is graduated in degrees from 0° to 90° in opposite directions, each degree being subdivided into ⅓rds.

NOCTURNAL

67. 3-inch Nocturnal. **Early 18th cent.**

In the cabinet of Materia Medica in St. Catharine's College.

Inscribed: Jas. Symonds.

CELESTIAL GLOBES AND PLANETARY MODELS

68. The 'English' Globe. **1679.**

Trinity and Pembroke Colleges.

'By the Rt. Hon. the Earl of Castlemaine, made and sold by J. Moxon.'

69. Grand Orrery. **c. 1750.**

Formerly in St. John's College, now Sedgwick Museum.

Inscription in a clock dial of the 24 hours:—'Made by Geo. Adams at Tycho Brahe's Head in Fleet St. London.'

70. 9-inch Globe of Mars. **Before 1873.**

Trinity College.

Presented in 1873 by Capt. Hans Busk.

CALENDARS

71. Clog Almanack. **17th cent.**

St. John's College.

Length 10 inches.

72. Runic Primstaff in shape of a Sword.

Dated 1667, 1684, 1688, 1692.

St. John's College.

Length 30 inches.

73. Perpetual Calendar. 1653.
Lewis Evans Collection, Oxford.

'The figure of the Silver Plate sent me by Mr. Edward Mathews, B.D. of Sidney Colledge, my ever honoured friend and tutor, together with this book 1653.'

THE ST. JOHN'S OBSERVATORY EQUIPMENT

74. $2\frac{3}{4}$-inch Refracting Telescope.
St. John's College.

42-inches focus.
Probably by Dollond.

75. Dr. James Wood's Telescope.
St. John's College.

76. $3\frac{3}{4}$-inch Equatorial and Tripod Stand.
St. John's College.

By Dollond. Tube 46 inches long.

77. 42-inch Transit Instrument and Level. 1763.
St. John's College.

By Sisson 1763. Aperture $1\frac{3}{8}$ inches. Eyepiece fig. pl. VI, fig. 4. Magn. $\times 28$.

78. Ludlam's Apparatus for carrying the Lamp to illuminate the Cross-wires of his Transit made of tin.

79. Part of Support for Transit Lamp. 1767.
St. John's College.

Designed by Ludlam, 1767.

80. 18-inch Quadrant. 1767?
St. John's College.

By Bird, and altered by him: with two 1 ft. 10 in. telescopes. $\times 18$.

81. 18-inch Hadley's Quadrant. c. 1760.
St. John's College.

By Nairne, London.

82. Ludlam's Wooden Stand for ditto. 1767.

83. 1 ft. 7 in. Repeating Circle.
St. John's College.

By Troughton.

84. Catton's 10-inch Reflecting Circle and Stand in 2 boxes marked 'T.C.' (= Tho. Catton) (*D.N.B.*).
St. John's College.

By Troughton, London, 218.

85. Cary's Altazimuth.
St. John's College.

1 ft. 7 in. Circle, 1 ft. 10 in. telescope, 1½ in. OG. On stand 2 ft. high. By Cary, London.

REFLECTING TELESCOPES

86. Small Gregorian Telescope. c. 1760.
St. John's Observatory.

2½ inches aperture.

87. Gregorian Telescope. c. 1760.
St. John's Observatory.

2 ft. focal length. ×50 diam.

88. Gregorian Telescope. **Before 1862.**
Cavendish Laboratory.

Aperture 2 inches: length 7½ inches.

By *John Cuthbert, London*, given in 1862 by Sir James South to T. R. Robinson, father-in-law of Sir G. Stokes.

MS. note: 'Sir James South lent this to me Jan. 1862, and gave it to me in the summer of 1862. It is by Cuthbert, a famous maker of Dumpy telescopes, and defines very sharply. T. R. Robinson.'

89. Newtonian Reflector. 1671.

Photograph of original belonging to the Royal Society.

90. 6-foot Newtonian Reflecting Telescope.

Trinity College.

Octagonal oak tube of 6½ inches diameter, on stand 4 ft. high. 'G: HEARNE LONDON FECIT'.

SURVEYING INSTRUMENTS

91. Three French Folding Squares and Plumb-level. 18th cent.

(*a*) By *Butterfield*. 'Demi pied du Rhin.'
(*b*) By *Langlois*. 'Demi pied du Roy.'
(*c*) By *Clerget*. ,, ,,
Ruled with a *'ligne d'aplomb'*.

92. 12-inch Spirit Level. 1703.

Trinity College.

'I. Rowley Fecit'. 'Colleg. Trinit. Cantab. 1703.'

The square telescope tube appears to have been mounted on a semicircle (now lost). The shape of the eyepiece is like those turned in wood by Marshall: it is fitted with a cross thread, and like the object glass is provided with a cap. The spirit-level with red fluid is 6 inches long.

93. 18-inch Octant. c. 1750.

Prof. A. Hutchinson.

By 'John Rutledge'.

94. 7-inch Sextant. c. 1770.

St. John's College.

By 'Edw[d] Nairn London.'

95. 11½-inch Sextant. Period c. 1790.

Cavendish Laboratory.

By 'Troughton, London.'

96. Theodolite. c. 1800.

Cavendish Laboratory.

By *'Thomas Jones Charing Cross London'*.

97. Theodolite. c. 1800.
Cavendish Laboratory.
By '*Thomas Jones & Sons 62 Charing Cross London*'.

MECHANICS AND PHYSICS

98. Clerk Maxwell's Dynamical Tops. 1855–6.
Cavendish Laboratory.
For illustrating the properties of Moments of Inertia. When balanced on its centre of gravity the top moves as a body under no forces. The earlier model is made of wood.

99. Ditto.
Cavendish Laboratory.
Made of brass by Ramage of Aberdeen and exhibited by Maxwell at a Cambridge tea-party in 1857. The axis of rotation was indicated by a colour-disc fixed upon and spinning with the top. *Royal Soc. Edinb.* xxi.

100. Maxwell's Model to illustrate motion of Saturn's Rings. 1857.
Cavendish Laboratory.

101. Robinson's Cup Anemometer.
Cavendish Laboratory.

102. Large Air-pump. c. 1790-1800.
Queens' College.
By 'R[ichard] Saunders, Salisbury Court, London'.

103. Historical Series of Pumps from the Cavendish Laboratory.
1. Hawksbee type. 2. Ladd. 3. Tate. 4. Tait: single barrel. 5. Fleuss. 6. Gaede Mercurial. 7. Hyvac. 8. Toepler. 9. Modern Gaede Diffusion pump.

104. Hydrometers.

Cavendish Laboratory.

Set of five in box, by *Will. Twaddell, Spirit Proof Maker, No. 84 Saltmarket, Glasgow.*

105. Hydrometer. No. 10198.

Cavendish Laboratory.

By *Dring & Fage.*

106. Sikes's Hydrometer. No. 3006.

Cavendish Laboratory.

By *Bate, Poultry, London.* Maker for the Revenue of the United Kingdom.

107. Argent[omete]r.

Cavendish Laboratory.

SOUND

108. Pepys's Musarithmica Mirifica. **After 1669.**

Magdalene College.

A Musical Composing Machine, based on the apparatus described in the *Musurgia Universalis*, Rome, 1650, by Athanasius Kircher.

109. Edison Phonograph.

Cavendish Laboratory.

HEAT

THERMOMETERS

110. Thermometer of the Accademia del Cimento. **1660.**

Cavendish Laboratory.

111. Thermometer by Nairne. **c. 1767.**

St. John's College.

2-foot tube.

112. Thermometer by Newman, London. **c. 1780.**

St. John's College.

113. Thermometer by Bréguet. **c. 1820.**
Cavendish Laboratory.

114. Standardized Thermometers c. 1841, used by Prof. Miller when making the Standard Pound in the basement of Cockerell's Building.
Dept. of Mineralogy.

115. Maxwell's Apparatus for Experiments on the Viscosity of Gases. **1865–6.**
Cavendish Laboratory.

In the vessel to be filled with the gases were a number of superposed circular discs, half of which are fixed, while the others which are attached to a steel torsion wire are free to turn.

Constructed at King's College, London. The experiments led Maxwell to the conclusion that 'the coefficient of internal friction is independent of the density of any particular kind of gas' and 'that the velocity is directly proportional to the temperature measured from the absolute zero of the air thermometer'.

J. Clerk Maxwell, Bakerian Lecture, *Phil. Trans.* 1866.

116. Maxwell's Models of Thermodynamic Surfaces.
Cavendish Laboratory.

117. Crookes's Radiometer. **1896.**
Cavendish Laboratory.

LIGHT

118. Thomas Young's Optometer. **1801.**
Royal Institution.

119. Wollaston's Spectacles for Stereoscopic vision. **c. 1803.**
Cavendish Laboratory.

119 a. Camera Lucida. **? 1786, 1807.**
Cavendish Laboratory.

Wollaston's Original Model in wooden frame. A label '1786' may indicate the date of the invention though it was not put on the market until 1812.

120. Optical Lantern. **After 1808.**
By Watkins & Hill, Charing Cross.
St. John's College.

121. Stokes's Discs for the Phenakistoscope.
Cavendish Laboratory.

122. Maxwell's Zoetrope. **c. 1850.**
Cavendish Laboratory.

123. Maxwell's Stereoscope.
Cavendish Laboratory.
By Elliot Bros., 449 Strand, London.

124. Maxwell's Colour Top. **1855.**
Cavendish Laboratory.
Three sectors coloured vermilion, emerald green, and ultramarine can be exposed in varying proportions so as to imitate any desired colour. Within them are similarly variable black and white sectors. With this instrument Maxwell obtained his Colour equations. Cf. paper read to Royal Scottish Society of Arts, 1855.

125. Maxwell's Colour Box. **1856–60.**
Cavendish Laboratory.
Phil. Trans., March 1860.

126. Slides used in experiments on Colour. **c. 1864.**
Used by Maxwell at his Royal Institution Lecture.

127. Heliostat. **c. 1880.**
Dept. of Mineralogy.
Used by Sir G. Stokes.
'J. T. Silbermann Invent Duboscq Soleil. No. 56.'
16 inches high × 6 inches on 3 levelling screws. The orientation circle is inscribed 'Midi, Minuit, Est, Ouest.'

128. Uranium Glass (Stokes Collection).
Cavendish Laboratory.

ELECTRICITY AND MAGNETISM

129. Load-stone in silver mounting. Early 18th cent.
Professor Nuttall.

130. Chinese Geomantic Compasses.
Archaeological Museum.
Diameters 11 inches and 6 inches.

131. Nairne's Frictional Machine. c. 1773.
Cavendish Laboratory.
Used by Cavendish.

132. Holtz Machine.
Cavendish Laboratory.

133. Early Volta Pile.
Cavendish Laboratory.

134. Wollaston's Midget Thimble-Battery.
Oxford Museum of History of Science.

135. Glass Punctured by Electric Spark by Ruhmkorff. 1801.
Belonged to Sir G. Stokes.
Cavendish Laboratory.

136. Maxwell's Apparatus to attempt to show the kinetic energy of an Electric Current.
Cavendish Laboratory.
A ring round which an electric current was flowing was rotated rapidly on a vertical axis around a central electromagnet carried on a horizontal axis within the ring.
Electricity and Magnetism, ii, pp. 211–21.

137. Maxwell's Apparatus to prove the Inverse Square Law.

138. Water-dropping Accumulator. Kelvin Model.

139. Maxwell's Apparatus for comparison of Electrostatic and Electromagnetic Forces.

140. Rayleigh's Spinning Coil for the Absolute Determination of the Ohm. 1862–3.

141. Rutherford's Magnetic Detector for Electric Waves. 1896.
Cavendish Laboratory.

142. Selection of Manuscripts.
Cavendish Laboratory.

143. Selection of Electrical Measuring Instruments.
Contributed from the Cavendish Laboratory.

ELECTROMETERS AND ELECTROSCOPES.

(*a*) Gravity controlled:

1. Early gold leaf electroscope used in Maxwell's time.
2. An original Wilson gold leaf electroscope. 1900.
3. Curie type gold leaf electroscope.
4. Wilson's tilted gold leaf electroscope. 1903.
5. The original Wilson universal gold leaf electroscope.
6. Kaye's tilted gold leaf electroscope. 1911.
7. Carmichael's tilted quartz-fibre electroscope. 1933.
8. Thomson's electrostatic voltmeter.
9. Capillary electrometer.

(*b*) Torsion controlled:

1. Thomson Quadrant electrometer. Elliott 1880.
2. Thomson Quadrant electrometer. Elliott 1884.
3. Thomson's attracted-disc absolute electrometer.
4. Thomson's portable attracted-disc electrometer.
5. Dolezalek Quadrant electrometer.
6. Compton's Quadrant electrometer (Compton's original instrument).
7. Lindemann electrometer. Lent by Cambridge Instrument Co.

GALVANOMETERS.

1. Astatic Galvanometer used in Maxwell's time.
2. Thomson's Reflecting, possibly used in Maxwell's time.
3. Thomson's Reflecting, made by Prof. Stewart about 1884.

4. Thomson's reflecting galvanometers. Astatic and non-astatic forms.
5. d'Arsonval. Moving Coil galvanometer. 1890.
6. Modern instrument. Lent by Cambridge Instrument Co.

ATOMIC PHYSICS

144. Sir J. J. Thomson's Experimental Apparatus.

(1) Early X-ray bulbs.

(2) Apparatus used to determine the ratio of charge to mass for the electron.

(3) Parabola apparatus. [The first mass-spectrograph.]

Cavendish Laboratory.

145. Lord Rutherford's Experimental Apparatus.

(1) Apparatus used to determine ratio of charge to mass for the α-particle.

(2) Apparatus used to determine the charge on the α-particle.

(3) Apparatus used to show the identity of the α-particle and the helium nucleus.

(4) Apparatus used for the disintegration of nitrogen by α-rays.

Cavendish Laboratory.

MINERALOGY

GONIOMETERS

146. Total Reflectometer. 1802.

Dept. of Mineralogy.

Designed by W. H. Wollaston, *Phil. Trans.* 1802.

Belonged to Sir G. G. Stokes. Base-slide 3 ft. long. It was designed to give the refractive power without calculation.

147. Two-circle Goniometer. 1874.

Dept. of Mineralogy.

Constructed by Prof. W. H. Miller in 1874, 15 years before the publication of similar instruments by v. Fedorov Goldschmidt & Czapski. A vertical circle of $4\frac{1}{4}$ inches diameter by 'Cary London' has been fitted to a horizontal circle (diam. $7\frac{7}{8}$ in.) by 'Troughton & Simms'.

148. Hand Goniometer of 1½ inch radius. **c. 1835.**
Dept. of Mineralogy.

In red leather case inscribed 'W. H. Miller'. Fitted with two sets of removable radial arms. The invention of Carangeot.

CHEMISTRY

149. Series of Mortars.
Sir William Pope and Mr. E. S. Peck.

150. Iron Press for Compressing Platinum. **1829.**
Cavendish Laboratory.

Made for and used by W. H. Wollaston. *Phil. Trans.* 1829.

Length 4 ft. 3 in. Powdered platinum was confined in cylinders of about 6 inches in length, and compressed by the action of a long lever.

151. The Palladium Leaflet. **1802.**
Dept. of Mineralogy.

W. H. Wollaston's discovery of Palladium or 'New Silver' was advertised by a leaflet setting forth its properties and price.

152. Early Photographs taken by Sir John Herschel fixed by him in 1839.
Dr. R. T. Gunther.

MEDICAL AND BIOLOGICAL EXHIBITS

153. The Vigani Cabinet of Materia Medica. **1703–4.**
Queens' College.

About 600 specimens contained in 26 drawers enclosed by two doors, over three large drawers in a cabinet of oak.

154. The Addenbrooke Cabinet of Materia Medica.
1690–1700.
St. Catharine's College.

155. The Heberden Cabinet of Materia Medica. **c. 1748.**
St. John's College.

156. Specimens from the Woodwardian Collection of Fossils.
Sedgwick Museum.

157. Adam Sedgwick's Hammer and Collecting Bag.
Sedgwick Museum.

158. Medicine Mortar and Pestle. Marked 'M. E. H'.
Sedgwick Museum.
8 inches high. From Arco Wood Farm, Horton in Ribblesdale.

159. Medicine Mortar. Marked 'W'. **1688.**
Sedgwick Museum.

160. Drug Pots. **17th cent.**
Sir William Pope and Mr. E. S. Peck.

161. Pill Slabs. **18th cent.**
Dr. R. Gunther, and *see* Fitzwilliam Museum.
The glazed tiles upon which apothecaries of the 18th century used to roll their pills. Painted with the armorial bearings, and motto OPIFERQUE PER ORBEM DICOR of the Apothecaries Company. Two also bear the shield of the City of London.

HISTORIC INSTRUMENTS FROM THE ZOOLOGICAL LABORATORY

Among the instruments associated with the earlier workers in the Zoological Laboratory are the following:—

162. Sliding Microtome for celluloid method. c. 1880.
By 'R. FULCHER, CAMBRIDGE'.
On brass base.

163. Hand-cutting freezer-microtome on two pillars. By 'C. Zeiss, Jena'. **c. 1880.**

164. Caldwell-Threlfall Automatic Microtome. **1883–4.**

Length 3 feet. The original instrument, constructed by W. H. Caldwell with Sir Richard Threlfall in the workshop of the Cavendish Laboratory. Caldwell had discovered the method of imbedding in paraffin in 1881.

165. The Cambridge Rocking Microtome. **1885.**

The first mention of this instrument appears in a catalogue of the Cambridge Scientific Instrument Company dated May 1885.

166. Large Sliding Microtome.

By 'J. D. de Groot Utrecht'.

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167. Weldon's Screw Micrometer. **c. 1888.**

Zoological Laboratory.

Designed by W. F. R. Weldon, circa 1888. Wheel graduated 0 to 50. Screw 6½ inches long. By 'J. H. Steward, 406 Strand, London.'

168. Schantzer Microtome. **1887.**

Prof. Nuttall.

MICROSCOPES

169. Martin's Compound Microscope. **c. 1770.**

Dr. H. H. Thomas.

Metal form of the original of the 'drum' type, later extensively copied by continental makers and said to be the basis of the so-called continental model. Introduced soon after 1759, it embodies Martin's great improvement to the optical system through the introduction of a large lens between the objective and the ocular. With accessories and set of wooden slides.

FROM THE BOTANY SCHOOL COLLECTION.

It is probable that several of the older microscopes listed below were used by, or in the time of, Professor HENSLOW and were given by his son. The early microscope No. 174 by James Smith is not only very interesting for its own sake, but has the added association value of having belonged to Charles Darwin, whose red pocket-handkerchief is still covering the instrument.

170. 'Aquatic' Microscope. c. 1764.

By 'DOLLOND LONDON'.

A type much used in the 18th century for the study of pond-life, &c. This set includes an instrument of the earlier screw-barrel form, also ivory slides and mica cover-slips.

171. Miniature Model Microscope. c. 1830.

Signed: 'CARY LONDON'.

A very early example of a mechanical stage. Objectives of the Coddington type.

172. Large Microscope. c. 1840.

Inscribed '*A. Ross London* 1783'.

173. Dissecting Microscope. 1839.

By '*A. Ross London*'.

174. Charles Darwin's Large Microscope. c. 1847.

Signed: 'Jas. Smith LONDON [No.] 143'.

Height 16 inches. Tube on trunnions mounted on two turned pillars.

Limb of Lister form, carrying tube with rack coarse adjustment lever. Fine adjustment to O.G. tube.

Covered with red pocket-handkerchief 30 inches square marked C.D.[arwin]. With Darwin's MSS. notes on the use of the instrument.

Type described in *Micr. Journal* 1842.

175. Large Microscope. 1851.

Marked on tube: 'Smith & Beck 6 Coleman St. London 587'. Bought by Prof. J. S. Henslow.

176. Pillischer Microscope. 1870.

The first model with the fine adjustment to be carried on the pillar, and with other features of interest which were subsequently copied by German makers.

177. Sorby's Microspectroscope for Ross Microscope. c. 1878.

By '*John Browning* LONDON'.

Marked 'From Prof. G. Henslow'.

178. F. H. Wenham's Large Radial Microscope. c. 1882–6.

Signed and numbered: 'ROSS 5300 LONDON'.

For oblique illumination in altitude and azimuth.

Mechanical stage is a modification of Tulley's, by which rectilinear motions are actuated by milled heads placed within the circumference of the stage. Cf. Mayall, *Cantor Lecture* 1886.

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179. Erasmus Darwin's Large Microscope. 18th cent. Derby Museum.

Type of Jones's Improved Microscope.

180. Francis Darwin's Small Microscope.

Given in his memory to his godson, Francis T. N. Elborn.

181. Illustrations of the work of Stephen Hales. Dr. Clark Kennedy and Corpus Christi College.

Stukeley's drawing of Hales's Planetarium and Map of Cambridgeshire when they went 'asimpling' in 1704.

181 a. Illustrations of the work of early Cambridge Botanists with special reference to their use of the microscope and to their physiological experiments.

FROM THE ZOOLOGICAL LABORATORY.

182. Small Microscope with vertical motion only.

By *Hartnack succ. de G. Oberhaeuser Place Dauphine* 21, *Paris*. Box 'No. 5113'. A derivative of the drum type. Lens for illuminating opaque objects on jointed arm fixed to tube.

Numbers **183** to **189** are engraved with the inscription *Francis Maitland Balfour, Morphological Laboratory*, 1882.

183. Student's Microscope, non-inclinable. 1875.

'1476 Carl Zeiss, Jena, 2409.'

Focusing screw below pillar. Used by F. M. B. as a freshman.

184. Inclinable Microscope. 1873.

By 'Carl Zeiss, Jena'.

Nose-piece for four powers.

185. Folding Microscope on three legs.

By Baker, London. Taken to Naples by F. M. B.

186. Folding Microscope.

Made specially for F. M. B. by 'C. Verick, Rue de la Parcheminerie, Paris'.

187. Student's Microscope. 1877.

By 'Carl Zeiss Jena, No. 2998'.

With revolving stage and microscope tube. Treble nose-piece.

188. Microscope. No. 7100. 1878–9.

By 'Carl Zeiss, Jena'.

This instrument was used for most of F. M. B.'s researches, and like the last has a revolving stage and microscope tube.

189. Large Zeiss Microscope. No. 8295. 1881.

A gift to Balfour from his relations.

190. Large Microscope to clamp to table.

With tube fitted on brass pillar with screw-fitting. Property of Alfred Newton after 1866.

191. Stephenson's Binocular Dissecting Microscope.
By 'J. Swift & Son, London'.

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192. Large Microscope.
School of Biochemistry.
By 'Powell & Lealand, 140 Euston Road'.

193. Nelson's Microscope Lamp.
Dr. R. Gunther.

194. Micromanipulator. c. 1914.
Devised by M. B. R. Swann.

195. Micromanipulator. c. 1922.
School of Biochemistry.
Devised by H. Hartridge.
The micromanipulator, though it can be traced back to a rough apparatus made by Schmidt during the American civil war, did not become a really practical tool until about 1924 in the hands of Robert Chambers, who has since brought it to a great degree of perfection. It is widely used for all kinds of microsurgical operations on cells, for micro-injections and for the isolation of single bacteria.

196. Blackman's Apparatus for determining Carbon Dioxide in the Air.
Botany School.

197. Morley Fletcher's Apparatus for measuring the Carbon Dioxide production of Muscles in vitro.
1897.

198. Wooden Drum Chronograph.
Botany School.
Made by Horace Darwin for Francis Darwin. The prototype of the familiar brass instrument for making physiological records. The original drawings are in the possession of Mr. R. S. Whipple.

199. Capillary Electrometer.
Physiological Laboratory.
Made by Keith-Lucas in 1910 for research on nervous impulse.

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