ADAM HILGER, LTD.

ABRIDGED CATALOGUE,

MAY, 1921.

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MAY, 1921.

Abridged Catalogue. Full illustrated particulars of any of the Instruments mentioned in this catalogue will be sent post free on request.

INDEX OF SECTIONS.

The following Section is not included in this volume, but will be sent post free on application.

ILLUSTRATED CATALOGUE.

A new edition of our Illustrated Catalogue is now ready. This Catalogue is bound in cloth-covered boards, contains about 130 pages, nearly 100 illustrations and numerous bibliographies.

Owing to the high cost of printing, we have found it impossible to distribute these free of charge. We have decided to charge for these Catalogues at the actual cost price. This is six shillings, and a copy will be sent post free to any part of the world on receipt of a remittance to that value.

Complete illustrated descriptions of any of our instruments (together with bibliographies where these are available), will be sent post free on request.

SYMBOLS.

We are now making use of the Symbols by which our instruments have for long been known in our Workshops. These Symbols will be found in brackets at the left-hand side of the page, and also under the illustrations. We recommend our customers to make use of these Symbols when making inquiries or sending orders. They will be found particularly useful when cabling.

In addition to the instruments described in this Catalogue, the following, chiefly of value in industrial applications, are described in separate booklets, which we shall be pleased to send post free upon application :—

Strain-viewer for Glassware.
Annealing Temperature Apparatus.
Projection Comparator.
Nutting Colorimeter.
Coker's Polarized Light Apparatus.
Interference Testing Outfit.
Interferometers for Testing Prisms and Lenses, including Camera Lenses.

Full illustrated description of any instrument, post free on request.

PUBLICATIONS FROM THE RESEARCH DEPARTMENT OF ADAM HILGER, Limited.

TABLES OF REFRACTIVE INDICES.

Compiled by R. KANTHACK.

Edited by J. N. GOLDSMITH, Ph.D., M.Sc., F.I.C.

Prospectus and Specimen Pages post free.

Vol. I.—Essential Oils.

Demy 8vo, 148 pages. £1 nett. Cloth Bound. Postage 8d.

ADAM HILGER, LIMITED. 1918.

Vol. II.—Oils, Fats and Waxes.

Demy 8vo, 292 pages. £1 5s. nett. Cloth Bound. Postage 8d.

ADAM HILGER, LIMITED. 1920.

Vol. III.—Sugar Tables. *In the Press.*

Report on the Quantum Theory of Spectra.

By LUDWIK SILBERSTEIN, Ph.D.

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By LUDWIK SILBERSTEIN, Ph.D.

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LONGMANS, GREEN & Co. 1918.

Elements of Vector Algebra.

By LUDWIK SILBERSTEIN, Ph.D.

Crown 8vo, 42 pages. 5s. 6d. nett. Postage 4d.

LONGMANS, GREEN & Co. 1919.

Refractive Index, Absorption, Wavelength and Rotatory Power in relation to Molecular Structure.

By LUDWIK SILBERSTEIN, Ph.D.

Second Edition. Small Royal 8vo, 17 pages. Paper Cover, 1s. 6d. nett. Postage 2d.

ADAM HILGER, LIMITED. 1920.

Optical Methods in Control and Research Laboratories.

Prepared by F. TWYMAN,

from matter supplied by the Scientific Staff of ADAM HILGER, LIMITED.

Small Royal 8vo. 35 pages. Paper Cover 1s. 6d. nett. Postage 2d.

Prospectus and Specimen Pages post free.

ADAM HILGER, LIMITED. 1920.

ADAM HILGER, Ltd., 75a, Camden Road, London, N.W.1.

SECTION C.

SPECTROMETERS AND GONIOMETERS FOR GENERAL WORK.

(C 14) EDUCATIONAL SPECTROMETER.—The focal length of the object glasses is 120 mm., and their aperture 17 mm.

The eyepiece has an equivalent focus of 10 mm.

The circle reads by vernier to one minute.

The prism is of approximately 1·62 refractive index, and the D lines are easily divided.

(C 15) Comparison Prism for the above Spectrometer.

(C 16) Replica Diffraction Grating 14,000 lines per inch, interchangeable with the prism.

(C 1) TABLE SPECTROMETER.—(Formerly known as No. 1 A).

Specification :—

Object Glasses of Collimator and Telescope, $1\frac{1}{4}$ inch ($31\frac{1}{2}$ mm.) clear aperture, $11\frac{1}{4}$ inches (285 mm.) focal length.

Prism, $1\frac{5}{16}$ inch (33 mm.) high ; $1\frac{5}{8}$ inch (41 mm.) length of refracting faces ; refractive index for D 1·65.

Divided Circle, 6 inches diameter, divided to read by vernier to 1 minute of arc.

(C 2) Protective cover to prism table .. ..

(C 3) Levelling screws .. ..

(C 4/5) Photographic scale adapted on a third tube with screw adjustment to photographic scale .. ..

(C 6) Well-made case, with lock and key .. ..

(C 7) TABLE SPECTROMETER.—The divided circle is 8 inches in diamteter. The telescope vernier reads to 30 seconds of arc. The prism stands on a separate levelling table, 6 inches in diameter, which is worked optically flat and stands on three levelling screws which fit in radial grooves in the rotating prism table. This latter reads by vernier to 30 seconds. One flint prism is supplied, refractive index for D 1·65. The objectives are of $11\frac{1}{4}$ inches (285 mm.) focal length, and $1\frac{1}{4}$ inches ($31\frac{1}{2}$ mm.) clear aperture.

(C 8/9) Photographic scale on a third tube uniform in design with telescope and collimator, with screw adjustment to photographic scale .. ..

(C 10) Well-made case, with lock and key .. ..

(C 12) TABLE SPECTROMETER.—Designed with special reference to accurate measurement of angles.—The mechanical work, centring of fittings, etc., is of the highest degree of perfection. The divided circle is 10 inches in diameter, and can be rotated to eliminate errors of the division. The circle has two divisions on platinoid, one on the top, on which the prism table reads to 30 seconds of arc by vernier, and one on the edge, on which the telescope reads by two microscopes, each with high quality micrometer eyepiece, to 1 second of arc. By a system of reflecting prisms the micrometers are read from the eye end of the telescope. One large dense flint prism is supplied. The collimator is supported on a separate pillar rising direct from the base. Three eyepieces are supplied, each with cross webs. Both collimator and telescope have rack and pinion focussing and divided draw tubes (millimetre division). The objectives are of $1\frac{5}{8}$ inches clear aperture and of $14\frac{1}{2}$ inches focal length. The base is of cast-iron, very massive and rigid, with levelling screws standing in cups.

SECTION D.

WAVELENGTH SPECTROMETERS.

THE HILGER WAVELENGTH SPECTROMETER.—Constant Deviation Type.—The design of this instrument is based on the use of the well-known " constant deviation prism."

The telescope and collimator are both rigidly fixed to the cast-iron base, and the whole is screwed to a strong cast-iron tripod. The object glasses of both telescope and collimator are of 11¼ inches (285 mm.) focal length, and 1¼ inches (31½ mm.) clear aperture.

(D 1) Wavelength Spectrometer, prism of 1·65 refractive index for D, accurately calibrated to read direct in wavelengths from 385 $\mu\mu$ to 800 $\mu\mu$ .. ..

(D 2) With denser prism, 1·74 refractive index for D, and correspondingly increased accuracy of calibration, the calibration being from 390 $\mu\mu$ to 800 $\mu\mu$ .. ..

(D 4) Protective cover to prism table .. ..

(D 5) Levelling screws .. ..

(D 6) Well-made case with lock and key, for either of the above ..

(D 7) Extra high-power eyepiece, with its own zero adjusting cross-webs .. ..

(F 40) Shutter eyepiece with lateral adjustment to bright pointer ..

(F 41) Slide with light filters to the shutter eyepiece for giving the pointer any desired colour .. ..

(D 10) Camera, with 21-inch focus lens, tilting adjustment for accurately focussing the whole spectrum, and shutter for exposure. Size of plate, $4\frac{1}{4}'' \times 3\frac{1}{4}''$ .. ..

(D 11) Telescope fixed to side of the camera, and internal mirror with external milled head by means of which the spectrum can be reflected into the telescope at will. In this way the spectrum can be observed immediately before photography

(D 12) Replica of Rowland diffraction grating, interchangeable with the prism, including calibration in wavelengths for both prism and grating.

NOTE.—*D12 can only be supplied if ordered at the same time as the Spectrometer.*

For other accessories, see *Section F, " Accessories for Spectrometers and Spectrographs."*

(D 19) WAVELENGTH SPECTROMETER, Constant Deviation Type (Large Model).—This instrument reads with an average accuracy of about 1 Ångström unit, from 388·8 to 795·0 $\mu\mu$ in wavelengths direct. The principles of its construction are the same as those of the smaller model, but it is larger and more powerful in every way. The object glasses are of $1\frac{5}{8}$-inch ($41\frac{1}{2}$ mm.) clear aperture, and of $14\frac{1}{2}$ inches (368 mm.) focal length. The divided scale of wavelengths is engraved on a helical drum, the length of scale division being about 81 inches (205 cm.). A shutter eyepiece with bright pointer and lateral adjustment is supplied.

(D 21) Levelling screws to the above .. ..

(D 22) Well-made mahogany case, with lock and key.. .. ..

(D 23) Camera to go in place of the telescope, with $21\frac{1}{2}$-inch focus lens, to take plate $4\frac{1}{4}'' \times 3\frac{1}{4}''$ .. ..

(D 25) HILGER WAVELENGTH SPECTROMETER, with Diffraction Grating.—The accuracy of the instrument is about twice that of the D 1 instrument, the readings being accurate to 1 Ångström unit throughout the spectrum.
(*Resolves the 4 doublets of the E Group, and measures wavelengths to 1 Ångström Unit.*)

The diffraction grating, which is a carefully selected film replica of one of Rowland's metal diffraction gratings, is mounted on a right-angle prism from the hypotenuse of which the light is totally reflected. By this means one can pass through the spectrum by rotation of the table on which the prism stands.

This spectrometer is accurately calibrated in wavelengths throughout the whole visible spectrum from 380 $\mu\mu$ to 800 $\mu\mu$.

(D 26) Additions to convert into the prism instrument described on page 7, with wavelength graduations for both grating and prism scales, and wooden case for keeping prism and grating when not in use .. ..

NOTE.—*D 26 can only be supplied if ordered at the same time as the Spectrometer.*

The following additions can be supplied with this instrument :—

Levelling screws, case with lock and key, extra high power eyepieces, shutter eyepiece, and camera. For descriptions, see under the prism instrument, page 7.

For further accessories, see *Section F*, "*Accessories for Spectrometers and Spectrographs.*"

(D 32) DR. TUTTON'S SPECTROSCOPIC MONOCHROMATIC ILLUMINATOR.—Aperture ratio f/6.—This instrument is described and illustrated in Dr. Tutton's "Crystallography" (Macmillan & Co.,) and performs very efficiently the same functions as the Spectroscopic Monochromatic Illuminator described by Dr. Tutton to the Royal Society in 1895 (*Phil. Trans. A*, 185, 913), an illustrated account of which is also given in his "Crystalline Structure and Chemical Constitution" (Macmillan & Co., 1910). It is similar in construction to the Hilger Wavelength Spectrometer (prism form).

The wavelength drum is engraved from λ 385 $\mu\mu$ to λ 800 $\mu\mu$.

(D 33) MONOCHROMATIC ILLUMINATOR FOR THE ULTRA-VIOLET AND VISIBLE, reading from 185 $\mu\mu$ to 700 $\mu\mu$ direct in Wavelengths.—The lenses are of quartz, of 31 mm. aperture and 210 mm. focal length for $\lambda=300$ $\mu\mu$.

The beam of light from the collimator passes at minimum angle through a Cornu prism of quartz (height 32 mm., length of face 42 mm.), and is then reflected from a plane mirror into the telescope. The average accuracy of reading throughout the range is about 1 $\mu\mu$.

For quartz-condensing lenses, fluorescent eyepiece, etc., see Section F.

(D 34) Additions for converting the above Instrument into the Infra-red Spectrometer described below.

For suitable galvanometer for use with the above infra-red attachments, see p. 16.

(D 35) INFRA-RED SPECTROMETER.—Calibrated in Wavelengths from 500 $\mu\mu$ to 10,000 $\mu\mu$.—The optical elements of the Infra-red Spectrometer are as follows :—

Two symmetrical slits, each having an effective length of jaws of 20 mm. In the second of these slits is mounted a Hilger thermopile (described on p. 15).

Two concave mirrors of gold electro-deposited on glass, both of 27 cms. focal length and 38 mm. diameter.

Rocksalt prism 32 mm. high, 42 mm. length of face.

Plane mirror of gold electro-deposited on glass.

The thermopile will be supplied with a sensitive area 10 mm. long × 1 mm. wide, unless otherwise ordered. If desired the 20 mm. long × 1·5 mm. wide size can be supplied.

(*For suitable galvanometer see* p. 16).

(D 36) Additions necessary to convert the Infra-red Spectrometer into the Monochromatic Illuminator (D 33), including case for the parts not in use .. ..

SECTION E.

SPECTROGRAPHS.

(E 1) QUARTZ SPECTROGRAPHS.—Quartz Spectrograph.—(Formerly known as size D).—This spectrograph has a dispersion three times that of E 2. It takes the entire spectrum from 210 $\mu\mu$ to 800 $\mu\mu$ in three exposures, on 10×4 inch photographic plates.

It is of the " Littrow " form.

The optical train consists of one quartz lens of 76 mm. clear aperture, and 170 cms. focal length ; and a 30° prism of quartz 98 mm. length of refracting face×57 mm. high.

The whole is mounted on a substantial cast-iron base.

Overall length of spectrograph 78·7 inches (2,000 mm.).

Overall width of spectrograph 13·75 inches (350 mm.).

(E 30) QUARTZ SPECTROGRAPH.—Being the same as E.1, but with lenses and prism of smaller aperture

(E 2) QUARTZ SPECTROGRAPH.—(Formerly known as size C). Lenses of 24 inches (610 mm.) focus, the instrument giving a spectrum from 210 $\mu\mu$ to 800 $\mu\mu$ of about 200 mm. long. Prism, 41 mm. high×65 mm. long face. Size of plate, 10×4 inches. The dispersing system consists of one Cornu prism.

(E 3) QUARTZ SPECTROGRAPH.—Being the same as E 2, but with internal wavelength scale.

(E 36) QUARTZ SPECTROGRAPH.—Being the same as E 2, but with metal slides for plate-holder.

(E 4) QUARTZ SPECTROGRAPH.—Being the same as E 3, but with metal slides for plate-holder.

(E 29) QUARTZ SPECTROGRAPH.—Similar to quartz spectrograph E 2, but of smaller aperture. The prism is of the Cornu type, 27 mm. high, 40 mm. long face. The effective aperture of the lenses is 33 mm.

(E 5) Wavelength Scales on glass for E 2 or E 29 .. .. ..

(E 34) QUARTZ SPECTROGRAPH.—Being the same as E 29, but with internal wavelength scale.

(E 6) QUARTZ SPECTROGRAPH.—(Formerly known as size A).—Lenses of 8 inches (203 mm.) focus, the instrument giving a spectrum from 185 $\mu\mu$ to 800 $\mu\mu$ of about 65 mm. long. Size of plate, $4\frac{1}{4} \times 3\frac{1}{4}$ inches.

(E 7) Accurate scales of wavelengths photographed on glass.

(E 26) QUARTZ SPECTROGRAPH.—Being the same as E 6, but with internal wavelength scale.

(E 11) THE FÉRY SPECTROGRAPH.—In this instrument the collimator and camera lenses are entirely suppressed, the only optical work being the prism itself.

Protected in the United Kingdom by Letters Patent No. 10330, *A.D.* 1910, *and in the United States of America by Patent Application Ser. No.* 562310, *filed* 19*th May*, 1910.

Dimensions :—

Size of prism, 58 mm. ; length of face, 50 mm. high.

Distance from face of prism to centre of photographic plate, 1,080 mm.

Size of photographic plate, 10 inches × 2 inches (or if desired 24 cm. × 5 cm.), taking 4 spectra one below the other.

The spectrum extends from W.L. 2,100 to W.L. 8,000, the length of spectrum between these limits being 224 mm.

CONCAVE GRATING SPECTROGRAPHS.—(Eagle Mounting).—

(*See* Paper by A. Eagle, " On a New Mounting for a Concave Grating ") *Astrophys. Jour.*, 31, page 120 (March, 1910).

SIZE E 14

(*Suitable for a Grating of* 90 *c/m. radius and* 1.4" *diameter ;* 20,000 *lines per inch*).

The slit is our No. F 24 size. The size of the film is 10" × 2", of which $9\frac{1}{2}$" × 1" are exposed.

A best quality Rowland grating of dimensions mentioned above is supplied.

(E 15) Rods from camera to actuate the screw motion and rotate the grating ; also counting mechanism for accurately setting the grating.

SIZE E 16

(*Suitable for a Grating of* 120 *c/m radius and* 1·4" *diameter*).

This instrument is of the same design as size E 14, but of increased length.

A best quality Rowland grating is supplied.

SIZE E 17

(*Suitable for a Grating of* 305 c/m *radius and* 4″ *diameter*).

The camera is arranged to take plates 40×4 c/m, and all adjustments, as given under specification for size E 14, are provided, together with rods from the camera to actuate the screw motion and rotation of the grating. The slit is our No. F 31 size.

A best quality Rowland grating is supplied.

SIZE E 18

(*Suitable for a Grating of* 650 c/m *radius and* 6″ *diameter*).

This size is of exactly the same design as size E 17 described above.

A best quality Rowland grating is supplied.

(E 27) VACUUM SPECTROGRAPH.—Specially designed for the investigation of the Schumann & Lyman regions of the spectrum. The grating is mounted in a similar manner to that of our Eagle mounting. No refractive substance, *e.g.*, quartz or fluorite, is introduced, but the whole spectrum from 210 $\mu\mu$ to 50 $\mu\mu$ is obtained with one setting of the grating. A magnetically-operated shutter enables two exposures to be made on a 6×1 cm. plate.

Accessories :—

(a) Schumann Plates of our own manufacture, specially made for use throughout the whole region. See p. 16.

(b) Vacuum pumps employing oil (not mercury) and mechanically driven.

(c) Vacuum arc lamp for metals.

(E 28) X-RAY SPECTROMETER.—This instrument is as designed for Professor Sir W. H. Bragg, on the principle of Dershem. The collimator consists of two symmetrical slits with lead jaws placed 10 cms. apart.

The motor and electro-magnetic reversing gear can be arranged to run from the lighting circuit.

The size of plate used is 12″×2¼″, *i.e.*, one-quarter of a standard 12″×10″ plate, and six exposures can be made on each plate.

SECTION F.

ACCESSORIES FOR SPECTROMETERS AND SPECTROGRAPHS.

VACUUM TUBE FOR EXPERIMENTAL WORK.—Of the end-on type. It is supplied with a tap, and sphero-cylindrical condenser.

(F 1) With glass condenser .. ..

(F 2) With quartz condenser .. ..

(F 3) COMBINED VACUUM TUBE HOLDER AND SPARK APPARATUS.—Readily interchangeable.

(F 4) ARC LAMP.—Suitable for the arc spectra of metals.

(F 5) Attachment for using the arc horizontal.

SLIT ROD FOR ATTACHMENT TO ANY COLLIMATOR.—

(F 6) ROD CARRIER for attachment to any collimator tube, with rod and clamp for same.

(F 7) ROD CARRIER with two clamps, suitable for use with mirror and condenser simultaneously.

(F 8) CONDENSING LENS of glass, with spherical surfaces in mount with stem for the above rod carrier.

(F 9) CONDENSING LENS of quartz, do. do.

(F 10) SPHERO-CYLINDRICAL CONDENSER of glass, do., do.

(F 11) SPHERO-CYLINDRICAL CONDENSER of quartz, do., do.

(F 12) CARRIER for Baly absorption tube, do. do.

(F 13) MIRROR in tilting mount, do. do.

(F 14) GLASS SPHERO-CYLINDRICAL CONDENSERS on raising and lowering stand.

(F 15) QUARTZ, do. do. do.

(F 16) GLASS CONDENSER (spherical surfaces), on raising and lowering stand.

(F 17) QUARTZ, do. do. do.

(F 18) ADJUSTABLE ABSORPTION TUBE for examination of the light absorption of liquids (see Baly's "Spectroscopy," First Edition, p. 414).

(F 114) Engraved with logarithmic scale in addition to millimetre scale.

NUTTING POLARISATION PHOTOMETER.—This is a form of polarisation photometer attachment for spectroscopes described by P. G. Nutting (see reprint No. 155, Bulletin of the Bureau of Standards), modified in one or two particulars.

(F 119) NUTTING PHOTOMETER, including small electric lamp for illumination of the scale, on separate stand with levelling screws, suitable for use with any ordinary spectroscope. The circle is divided both in " densities " and in degrees.

(F 22) Raising and lowering stand for holding tubes of absorbing liquids, with two carriers, each with stem.

(F 23) 100 mm. tubes with screwed end caps, for the above.

SPECTROSCOPIC ACCESSORIES.—Spectroscope Slits.

Note.—All Spectroscope Slits made by us have jaws of untarnishable metal.

(F 24) SLIT with fine screw adjustment.

Instead of the wedge a sliding diaphragm with three apertures can be supplied :—

(F 25) If supplied instead of wedge .. ..

(F 26) If supplied in addition to wedge .. ..

(F 27) Slit No. F 24, opening symmetrically (without wedge or diaphragm) .. ..

The above slits can also be supplied giving a length of slit of 14 mm. as follows :—

(F 28) Ordinary form (without reducing wedge) .. .. ..

(F 29) Opening symmetrically .. ..

(F 30) Glass window to protective cap in any of the above .. ..

(F 31) SLIT, with adjustment by fine steel micrometer screw, and large divided drumhead. (Maximum length of slit which can be utilised = 18 mm.)

Instead of the wedge a sliding diaphragm with three apertures can be supplied :—

(F 32) If supplied instead of the wedge .. ..

(F 33) If supplied in addition to the wedge .. ..

(F 34) Leatherette case for No. F 31 .. ..

CROSSED SLITS.

(F 35) Main slit of the same size as slit No. F 28 .. .. ..

(F 36) Main slit of the same size as slit No. F 31 .. ..

(F 39) MICROMETER EYEPIECE, pitch of screw = $\frac{1}{2}$ mm.

(F 40) SHUTTER EYEPIECE.—Including one positive eyepiece.

(F 41) Slide with light filters to the shutter eyepiece .. .. ..

(F 43/4) FLUORESCENT EYEPIECE.—As designed by Prof. Liveing for visual work in the ultra-violet, with illumination of the pointer by mirror with universal motion.

(F 45) GAUSS EYEPIECE.—This is a positive, or Ramsden, eyepiece with a plane glass inclined at 45° to the optical axis, placed between the two lenses.

(F 46) AUTOCOLLIMATING EYEPIECE.—Having slit with adjusting screw with divided drumhead and reflecting prism.

VACUUM TUBES OF FUSED SILICA, for Ultra-Violet Work, with secure mercury seals.

(F 57) Unfilled, with tube for exhaust, for experimental purposes.

(F 61) Unfilled, with tube for exhaust, end-on form.

(F 66) SPARKING TUBES.—With gold electrodes and platinum conducting wires (as used by Dr. James H. Pollok in his researches on the quantitative spectra of metals in solution; see Sci. Proc. Royal Dublin Society, vol. xi., Nos. 16, 17, 18).

PLANO-CONVEX LENSES OF QUARTZ (SECOND QUALITY), SUITABLE FOR CONDENSING LENSES.

	Diameter		*Focal Length*				*Diameter.*		*Focal Length.*	
	in.	mm.	in.	mm.			in.	mm.	in.	mm.
(F 68)	1	25·4	3	76	..	**(F 71)**	$1\frac{3}{4}$	44	$5\frac{1}{4}$	133
(F 69)	$1\frac{1}{4}$	32	$3\frac{3}{4}$	95	..	**(F 72)**	2	51	6	152
(F 70)	$1\frac{1}{2}$	38	$4\frac{1}{2}$	114	..	**(F 73)**	$2\frac{1}{4}$	57	$6\frac{3}{4}$	174

INFRA-RED ACCESSORIES.—The Hilger Wavelength Spectrometers, with the additions described below, can be calibrated interferometrically down to W.L. 2·0μ.

The Additions required are as follows :—

(F 77) HILGER THERMOPILE.—With symmetrical slit; symmetrical slit for the collimator, simple shutter attachment for exposing and cutting off light; helical drum divided into 100 parts per revolution to replace the wavelength drum for infra-red work.

(F 78) If the additions be ordered at the same time as the Wavelength Spectrometer, then instead of an additional helical drum for infra-red work one extended drum alone will be supplied, calibrated in wavelengths throughout both the visible and infra-red regions, as far as W.L. 2·0μ.

HILGER THERMOPILES.—(Linear Thermopiles of Great Sensitiveness).

The Design for this Thermopile is registered in the United Kingdom, and is protected by Design Patents in France, Germany, and U.S.A.

The following Thermopile, designed for use in air, can usually be delivered from stock :—

Dimensions of sensitive area—20 mm. long; 1·5 mm. wide.
Number of junctions—20.
Resistance (approximate)—10 ohms.

(F 83) Thermopile described above, mounted in simple mount
(F 84) Thermopile described above, mounted in symmetrical slit
(F 85) Raising and lowering stand to take either of the above ..
(F 86) Sensitive portion of above thermopile alone, in brass case

We can also supply thermopiles having sensitive areas as follows :—

Length.	*Width.*	*In Simple Mount.*	*In Symmetrical Slit.*	*In Brass Case.*
10 mm.	1 mm.	**(F 87)**	**(F 89)**	**(F 109)**
10 mm.	0·5 mm.	**(F 88)**	**(F 90)**	**(F 110)**

interchangeable in the mounts described above.

(F 91) BROCA GALVANOMETER (made by the Cambridge & Paul Instrument Co., Cambridge), for general work with the thermopile.

(F 92) PASCHEN GALVANOMETER (made by the Cambridge & Paul Instrument Co., Cambridge), having a resistance of about 12 ohms.

(F 93) Scale, on stand, with lamp for use with the above galvanometers.

(S 2) SPARKING APPARATUS FOR SPECTRUM WORK.—
$\frac{1}{4}$ K.W. Rotary converter 110 volts or 220 volts D.C., giving 75 volts or 150 volts respectively, 60 cycles, A.C.

(S 3) $\frac{1}{4}$ K.W. transformer specially wound for spectrum work, high voltage (approximately 15,000 volts with 150 volts on the primary) .. ..

(S 4) $\frac{1}{4}$ K.W. condenser .. ..

(S 5) Choking coil .. ..

(S 19) Lamp resistance board .. ..

SENSITIVE PLATES FOR SPECTROGRAPHIC WORK.

PANCHROMATIC "A" . Sensitive from the Ultra-violet up to 6800 Å.U.

PANCHROMATIC "B" . Rather less green sensitive than Panchromatic "A," but sensitive to about 7,800 Å.U.

WRATTEN "M" . . Of similar sensitiveness to Panchromatic "A," but of much finer grain and about one-third the speed.

ALLOCHROME . . . Evenly sensitive to about 5,600 Å.U.

DOUBLE INSTANTANEOUS . A fast "ordinary" plate of fine grain suitable for Ultra-violet work.

HILGER SCHUMANN PLATES.

Photographic Plates for the Region in the Ultra-Violet between Wavelength 220 $\mu\mu$ and 18 $\mu\mu$, for Positive Rays, and for the very soft Röntgen Rays produced by the Impact of Positive and Slow Cathode Rays (see paper by Sir J. J. Thomson, Proc. Phys. Soc., vol. xxvi., Part V., Aug., 1914, p. 388).

	Size. Inches.	Cms.		Size. Inches.	Cms.
(F 94)	$4\frac{1}{4}\times3\frac{1}{4}$	10·8×8·2	**(F 95)**	10×4	25·4×10·2

PLATES FOR THE EXTREME RED.—For the extreme red we have found the Ilford Special Red Sensitive Plates excellent. They are sensitive to 800 $\mu\mu$.

INDEX OF SPECTRA.—By W. MARSHALL WATTS, D.Sc. (Lond.), B.Sc. (Vict.), F.I.C. Revised Edition, greatly enlarged, at the following price :—

Appendices B to I inclusive are supplied bound in one volume, £2 3s.

Appendices J to Q inclusive, bound in one volume, £2 8s.

(*This work can now only be supplied in sets comprising either the two bound volumes or the two bound volumes with Appendices R to X. Price £8 3s.*

SECTION G.

SOLAR AND STELLAR SPECTROSCOPES.

STELLAR SPECTROSCOPES.—Zöllner Star Spectroscope.—See article in "Knowledge," by Prof. A. Fowler, F.R.A.S., April, 1903. . .

(G 1) With one cylinder lens cap and compound prism, adapted to any eyepiece . . . . . .

(G 2) With three different powers of cylinder lenses, in case . .

An order for a Zöllner Star Spectroscope should always be accompanied by the eyepiece to which the Spectroscope is to be adapted.

Note.—The Zöllner Star Spectroscope can also be used to test the achromatism of Object Glasses of Telescopes.

OBJECTIVE OR DISC PRISMS FOR ADAPTATION IN FRONT OF ASTRONOMICAL OBJECT GLASSES FOR STELLAR SPECTROSCOPY, OF GUARANTEED QUALITY.

Refractive index for D = 1·57 to 1·62.

	10° Refracting Angle Clear effective aperture.			40° Refracting Angle. Clear effective aperture.	
	in.	mm.		in.	mm.
(G 4)	2½	63	**(G 10)**	2½	63
(G 5)	3	76	**(G 11)**	3	76
(G 6)	4	102	**(G 12)**	4	102
(G 7)	5	127	**(G 13)**	5	127
(G 8)	6	153	**(G 14)**	6	153
(G 9)	8	203	**(G 15)**	8	203

SOLAR SPECTROSCOPES.

(G 19) SMALL PROMINENCE SPECTROSCOPE.—Being a **Direct Vision Spectroscope** with diffraction grating, No. J 15 (see list of Direct Vision Spectroscopes, Section J), with small auxiliary telescope for special observation of C line, adapted to customer's own telescope for use as a small solar spectroscope. (See paper on "Solar Spectroscopy with Simple Instruments," by W. Alfred Parr, Jour. B.A.A., vol. xix., 30th July, 1909, p. 395.)

EVERSHED SOLAR SPECTROSCOPES.—Designed by J. Evershed F.R.A.S., for Solar work, and especially for the observation of Solar Protuberances.

The dispersion between the A and H Fraunhofer lines is 60° for the 2 prism and 90° for the 3 prism instruments.

(G 24) EVERSHED PROTUBERANCE SPECTROSCOPE, 2 PRISM PATTERN.—A small extra charge is made for adapting the above to the telescope.

(G 25) Curved slit, permitting a larger section of the solar circumference to be observed at once.

(G 26) The above instrument can be supplied with rack and pinion motion for passing through the spectrum instead of micrometer screw.

(G 28) Case for above instrument .. ..

(G 29) EVERSHED PROTUBERANCE SPECTROSCOPE, 3 PRISM PATTERN.—Comprises three compound prisms similar to those in the two prism form; two mirrors, simultaneously rotated by rack and pinion motion, vernier for reading off the position in the spectrum.

(G 30) Curved slit .. ..

(G 31) Case for above instrument .. ..

(G 41) LITTROW SPECTROGRAPH.—With 10 ft. focus achromatic object glass and best quality 4 in. Rowland Diffraction grating.

(G 40) LITTROW SPECTROGRAPH.—With a dispersing system consisting of one 60° and one 30° prism.

(G 37) LITTROW SPECTROGRAPH.—With grating and prism mounted so as to be interchangeable one with another.

(G 38) ULTRA-VIOLET STELLAR SPECTROGRAPH, Angular Aperture of Optical System F/5.

For use up to W.L. 3000.

Specification :—

Slit, our No. F 24. (See Spectroscope slits p. 14.)

2 prisms, 40 mm. high by 70 mm. long face, giving 40 mm. effective aperture for D.

Lenses 40 mm. clear diameter, 200 mm. focal length for W.L. 5461.

The dark slide takes plates $4\frac{1}{2}'' \times 3\frac{1}{4}''$, and a number of exposures can be taken on a $\frac{1}{4}$ plate.

Length of spectrum from W.L. 3,000 to W.L. 8,000=50 mm.

Total weight (including cover and following telescope) 9 lbs. (4·1 kilos).

Similar Spectrographs working at F/5 of larger size or with a quartz train can also be quoted for on application.

SECTION H.

SPECTROPHOTOMETERS, Etc.

APPARATUS FOR SPECTROPHOTOMETRY IN THE ULTRA-VIOLET.—The apparatus recommended by us for this purpose consists of our Quartz Spectrograph, size E 6 (formerly known as size A), or size E 2 (formerly known as size C), with an auxiliary apparatus (H 16) enabling quantitative photometric measurements to be made.

(H 16) SECTOR PHOTOMETER, with motor arranged for 12, 110, or 220 volts, including the quartz bi-prism for the slit of the Spectrograph .. ..

(H 17) Tubes with quartz ends for solutions, length of liquid, 10, 20, or 40 mm. .. ..

(F 119) NUTTING POLARISATION PHOTOMETER for Spectrophotometry in the Visible. See p. 14.

(D 35) INFRA-RED SPECTROMETER for Spectrophotometry in the Infra-red. See p. 9.

(H 1) HÜFNER SPECTROPHOTOMETER.—Constant Deviation Type, with Wavelength Reading.

(H 2) Division in densities in addition to the division in degrees ..

(H 3–4) Reading microscope, attached to the telescope, for reading the circle without quitting the eyepiece, with 4-volt electric lamp for illumination, and mirror for reading the drum from the eyepiece .. ..

(H 5) Schulz's Cell, for absorption measurements, on raising and lowering stand, with rack and pinion .. ..

(H 6) Reflectors of plaster of Paris, for comparison of two light sources ; to go on same stand as Schulz's Cell .. ..

(H 7) EXPOSURE BOX.—With Hurter & Driffield sector for plate testing work, as designed by Dr. C. E. Kenneth Mees, and described in the "Photographic Journal," July, 1904.

(H 8) If for use in the tropics .. ..

(H 9) PLATE-HOLDER.—For testing plates exposed on this exposure box on the Hüfner spectrophotometer (as described in the same article), arranged for the same stand as the Schulz's Cell mount.

(H 10) ACCURATE WEDGE PHOTOMETER.—Designed according to the instructions of F. F. Renwick, Esq., for measuring the densities of photographic plates, complete with lamp.

(*When ordering state voltage of electric supply.*)

(H 11) ROTATING SECTOR.—For photometric work.

(H 12) WEDGE SPECTROGRAPH FOR TECHNICAL USE, WITH NEUTRAL TINT WEDGE AND WAVELENGTH SCALE.—Designed by Dr. C. E. KENNETH MEES for rapidly obtaining a permanent record of the absorption curves of dyes, colour filters, or the curves of sensitiveness of photographic plates. With neutral tint wedge and wavelength scale, including 12 v. ½ Watt Lamp.

(H 13) Wedge Cell for dye absorptions, with carrier fitted to Spectrograph.

(H 14) DR. EDRIDGE-GREEN'S COLOUR PERCEPTION SPECTROMETER.—

(*See* Paper by Dr. F. W. EDRIDGE-GREEN, *Trans. of Ophth. Soc.*, 1907, and " Colour Blindness and Colour Perception," *Int. Scient. Series.*)

This instrument is a spectrometer so arranged as to make it possible to expose to view in the eyepiece the portion of a spectrum between any two desired wavelengths.

Focal length of collimator and telescope object glasses = $7\frac{1}{8}$" (180 mm.).

Clear aperture of collimator and telescope object glasses = $\frac{7}{8}$" (22 mm.).

Slit, 7 mm. effective length of jaw, with wedge for reducing the length of the slit, protective cap, comparison prism, and screw adjustment for the slit width with divided head.

The prism is of flint glass, 1·65 refractive index for D.

Eyepiece, Ramsden form.

(H 15) Well-made case, with lock and key .. ..

SECTION J.

POCKET AND OTHER DIRECT VISION SPECTROSCOPES.

(J 19) DIRECT VISION SPECTROSCOPE.—For Rapid Spectroscopic Observation of Spark, Arc, or other light sources which, when viewed from any distance exceeding a yard or two, are approximately point sources.

(J 3) RAMSAY SPECTROSCOPE.

(J 4) RAMSAY SPECTROSCOPE.—Large prism.

(J 5) Brass case for J 3 or J 4 .. ..

(J 6) DIRECT VISION POCKET SPECTROSCOPE WITH FIXED SLIT.—$3\frac{1}{2}$ inches long, in brass case.

(J 7) DIRECT VISION POCKET SPECTROSCOPE.—$3\frac{1}{2}$ inches long, with adjustable slit, in brass case.

(J 8) DIRECT VISION POCKET SPECTROSCOPE.—$5\frac{1}{2}$ inches long, with adjustable slit, in brass case.

(J 9) DIRECT VISION POCKET SPECTROSCOPE.—With Photographic Scale, and with rotating mirror for illumination of the same, in leatherette case.

(J 10) DIRECT VISION SPECTROSCOPE.—$8\frac{1}{2}$ inches long, with adjustable platinoid slit and divided drumhead. A fine micrometer screw motion is provided for passing through the spectrum and a pointer enabling wavelength determinations to be made with considerable accuracy.

(J 11) Comparison prism to J 10 .. ..

(J 12) Leatherette case for J 10 .. ..

(J 13) Bright pointer for J 10 .. ..

(J 14) Table stand for J 10, on cast-iron tripod .. .. ..

(J 15) DIRECT VISION POCKET SPECTROSCOPE.—$5\frac{1}{2}$ inches long, in brass case, mounted with **Film Replica of Rowland's Diffraction Gratings,** 14,438 lines per inch, **Visible spectrum over 20°.**

DIRECT VISION POCKET SPECTROSCOPE WITH INTERFERENCE ETALON.—Glass Interference Etalon for use with Direct Vision Pocket Spectroscope, showing the Fabry & Perot Ring System.

(J 16) J 8 Direct Vision Pocket Spectroscope, $5\frac{1}{2}$" long, with high dispersion compound prism .. ..

(J 17) Etalon, including the adaptation to our Direct Vision Pocket Spectroscope J 8 .. ..

(J 18) Similar Etalons adapted to any other Pocket Spectroscope ..

SECTION K.

DIFFRACTION GRATINGS.

(K 0) ROWLAND DIFFRACTION GRATINGS.

(K 1) INFRA-RED DIFFRACTION GRATINGS.—Plane gratings ruled on brass, 946 lines per cm.

(K 3) FILM REPLICAS OF ROWLAND'S DIFFRACTION GRATINGS.—(14,438 lines per inch). Mounted on best plane parallel worked glass.

(K 4) Mounting with three levelling screws for above grating.

(K 5) Mounted in $5\frac{1}{2}$ inch long direct vision pocket spectroscope.

(K 6) Mounted on field glasses (adapted to customers' own instruments).

(K 8) Photographed Gratings, 3,610 lines per inch.

REPLICAS OF INTEREST IN CONNECTION WITH THE RULING OF DIFFRACTION GRATINGS.—A set of replicas of three gratings ruled in the following way :—

(K 9) Uniform ruling. Spacing $\frac{1}{1800}$ inch.

(K 10) Alternate ruling. Spacing $\frac{1}{3600}$ inch.

(K 11) Ratio of spacing $\frac{1}{7200} : \frac{3}{7200}$.

SECTION L.

MICROMETERS, Etc.

PHOTOMEASURING MICROMETER, 1921 Model.

(L 1) With 6-inch (152 mm.) travel .. ..

(L 2) With 3-inch (76 mm.) travel .. ..

(L 3) NEW MODEL CROSS-SLIDE PHOTOMEASURING MICROMETER.—Six inches (152 mm.) of motion is provided in two directions at right angles to each other.

" STANDARD " SPHEROMETER (Ring Form).

(L 6) In case, 1 inch radius .. ..

(L 8) In case, 2 inch radius .. ..

(L 7) HELIOSTAT.—For use with Table Spectrometers.

SECTION M.

POLARIMETERS AND REFRACTOMETERS.

(M 2) POLARIMETER.—Taking tubes for liquids 200 mm. long.

The divided circle is 7 in. diameter, and the division is on platinoid, which does not readily tarnish. There are double verniers, reading to 0·01.

(M 3) International Sugar Scale in addition to the ordinary division

(M 4) Well-made case, with lock and key .. ..

(M 5) POLARIMETER.—As above, but taking tubes 400 mm. long, the construction being otherwise identical, with tube for liquids.

(M 110) Well-made case, with lock and key .. ..

(M 6) Addition of Direct Vision Spectroscope attachments to either of the above, with one high dispersion direct vision prism.

(M 7) Extra prisms mounted .. ..

(S 6) Sodium burner, with bottle of fused borax .. .. ..

POLARIMETER TUBES.—Lengths correct to ± 0·025 mms. at 20°C.

The end plates of all tubes are of well annealed optical glass.

GLASS TUBES.—

Straight Form.		Enlarged End Form.	
(M 111)	25 mm.	**(M 120)**	50 mm.
(M 112)	50 mm.	**(M 121)**	100 mm.
(M 113)	100 mm.	**(M 122)**	200 mm.
(M 114)	200 mm.	**(M 123)**	220 mm.
(M 115)	220 mm.	**(M 124)**	400 mm.
(M 116)	400 mm.	**(M 125)**	600 mm.
(M 117)	600 mm.		

ORDINARY WATER JACKETED (INVERSION) TUBES.—With Glass Inner Tube, the Outer Tube being Brightly Nickelled to Reduce Radiation.

(M 128)	50 mm.	**(M 131)**	220 mm.
(M 129)	100 mm.	**(M 132)**	400 mm.
(M 130)	200 mm.	**(M 133)**	600 mm.

(M 92) BATES TUBE.—200 mm. (*See Circular Bur : Standards No.* 44, *2nd Edition*, 1918, *P.* 44).

(M 94) BATES TUBE.—400 mm.

(M 98) PELLET TUBES.—200 mm. (For continuous observation.)

ALL-METAL WATER-JACKETED (INVERSION) TUBES.—

(M 84) 50 mm.

(M 85) 100 mm.

(M 86) 200 mm.

(M 88) 400 mm.

(M 138) Spare End-plates of well annealed optical glass, 15 mm. diameter.

(M 139) Spare End-plates of well annealed optical glass for enlarged end, 23 mm. diameter.

(M 140) Rubber Washers for above tubes, small.

(M 141) Rubber Washers for above tubes, enlarged end.

SPECTRO-POLARIMETER.—This instrument consists of a wavelength spectrometer, reading in wavelengths direct, a polariser, and an analyser—all mounted on an accurate cast-iron bed.

(*For measurements on the rotatory power for radiations of any desired wavelength*).

(M 8) Taking tubes up to 200 mm. long .. ..

(M 9) Taking tubes up to 400 mm. long .. ..

(M 10) Taking tubes up to 1,000 mm. long .. ..

(M 11) Direct vision spectroscope attachments, the complete set with three prisms .. ..

SACCHARIMETER.

(M 41) 200 mm. Saccharimeter with one enlarged end Tube ..

(M 42) 400 mm. Saccharimeter with one enlarged end Tube ..

(M 149) Quartz Control Plates for checking the 100° point, together with Bureau of Standards Certificate for same .. ..

Quartz Control Plates for checking intermediate points on the scale, together with the Bureau of Standards Certificate (state approximate sugar value required) .. ..

(M 157) Pointolite Lamp on stand, complete .. ..

(M 162) High voltage half watt Lamp on stand .. .. ..

(M 163) 6 volt half watt Lamp on stand .. ..

SACCHARIMETER TUBES.

Length	Straight Form Catalogue Symbol	Enlarged End Catalogue Symbol	Glass Inversion Tubes Catalogue Symbol
25 mm.	M 111		
50 mm.	M 112	M 120	M 128
100 mm.	M 113	M 121	M 129
200 mm.	M 114	M 122	M 130
220 mm.	M 115	M 123	M 131
400 mm.	M 116	M 124	M 132
600 mm.	M 117	M 125	M 133

(M 92) All-metal Bates pattern, 200 mm. .. ..

(M 94) All-metal Bates pattern, 400 mm. .. ..

(M 98) All-metal Pellet Tube for Continuous Circulation, 200 mm.

(M 84) All-metal Inversion Tubes, 50 mm. .. ..

(M 85) All-metal Inversion Tubes, 100 mm. .. ..

(M 86) All-metal Inversion Tubes, 200 mm. .. ..

(M 88) All-metal Inversion Tubes, 400 mm. .. ..

(M 140) Spare rubber rings for above tubes .. ..

(M 138) Spare End-plates of well-annealed Optical Glass, small ..

(M 139) Spare End-plates of well-annealed Optical Glass, large ..

DIPPING REFRACTROMETER.

(M 45) Dipping Refractometer in wooden case .. .. ..

(M 53) Auxiliary prism .. ..

(M 144) Water bath with electric lamp (voltage should be stated with order) .. ..

(M 147) Glass beakers for above .. ..

(M 171) Thermometer, divided in $\frac{1}{5}$°C., and graduated from 15°C. to 35°C., with red line at 17·5°C. .. ..

(M 179) Thermometer, divided in $\frac{1}{10}$°C., and graduated from 15°C. to 25°C., with protecting metal case and N.P.L. certificate

ABBE REFRACTOMETER.—With Water-jacketed Prisms.

The range of refractive indices measurable by the instrument is from 1·3^{000} to 1·7^{000}, and the accuracy of reading is 0·0001.

(M 46) Abbe Refractometer, complete with thermometer, and in case with lock and key .. ..

(M 135) Additional scale for percentage of "dry substance" for sugar work, for temperature of 20°C. .. .. ..

(M 136) Ditto, for temperature of 28°C. .. ..

PULFRICH REFRACTOMETER.—This instrument is designed for the measurement of the refractive indices of both solids and liquids with an accuracy of about 0·0001 ; and also the dispersion (*i.e.*, the difference of refractive index for two spectral lines) to about 0·00002.

A very efficient water jacket forms an integral part of the instrument.

The instrument is essentially the same in principle as that described in the references, but is of improved design. It is very substantially made, and will bear constant usage without risk of damage to any important part.

(M 48) Pulfrich Refractometer.—With prism of refractive index for D of 1·74 for substances of refractive indices between 1·47 and 1·73, with mount and carrier and improved water jacketing attachments. Complete in case with lock and key.

(M 56) Hydrogen End-on Vacuum Tube .. ..

(M 57) Prism of refractive index for D of 1·62, for liquids of refractive indices between 1·33 and 1·61, with mount and carrier and with glass cell for liquids.

(M 58) Thermometer .. ..

(M 24) JAMIN REFRACTOMETER.—Giving a separation between the centres of the beams of 18 mm., and taking tubes 250 mm. long. Two tubes for gases are provided.

(M 25) If the tubes are to be sufficiently accurate for work on liquids

(M 26) JAMIN REFRACTOMETER with worm-wheel motion for rotating the compensator plates and accurately divided circle for same, reading by venier to 0·02°. Screw motion for altering the sensitiveness by rotation of one compensation plate relative to the other. Separation of beams of 30 mm., and taking tubes 500 mm. long.

(M 27) If the tubes are to be sufficiently accurate for work on liquids, price extra for the pair of tubes 250 mm. long .. ..

(We do not supply tubes for liquids 500 mm. long.)

(M 75) RAYLEIGH INTERFERENCE REFRACTOMETER.—This instrument is designed for work on the refractometry of gases, of which the refractive indices differ so little from unity that a very high degree of sensitivity is required in any refractometer to be used with them. Some idea will be obtained as to the sensitivity of the instrument when it is stated that it is possible by means of it to detect the presence of of 0·01% of hydrogen in air, a quantity which causes a change of refractive index of only 0·000,000,015.