(*b*) Vacuum pumps employing oil (not mercury) and mechanically driven, suitable for producing a high vacuum rapidly in large apparatus. (*See* leaflet entitled " The Rapid Production of High Vacua," pp. F 7-8.)

(*c*) Large bore discharge tube for use as vacuum gauge.

Bibliography.—The following are references to work with this Vacuum Spectrograph :—

McLennan - - - *Proc. Phys. Soc.*, 31, pp. 1-29, 1918.
McLennan and Lang - *Proc. Roy. Soc.* (A.), 95, pp. 258-273, 1919.
Simeon - - - *Proc. Roy. Soc.* (A.), 102, pp. 484-496, 1922.
Fowler - - - *Proc. Roy. Soc.* (A.), 103. pp. 413-429, 1923.
Simeon - - - *Proc. Roy. Soc.* (A.), 104, pp. 368-375, 1923.
Simeon - - - *Phil. Mag.*, 46, pp. 816-819, Nov. 1923.

Other references to work in this region with similar instruments are :—

Lyman - - - *Astrophys. Journal*, 35, pp. 341-353, 1912.
Lyman - - - *Spectroscopy of the Extreme Ultra-Violet*, Longmans, Green & Co., 1914.
Saunders - - - *Astrophys. Journal*, 43, p. 234, 1916.
McLennan - - - *Proc. Roy. Soc.*, 98, p. 114, 1920.
Millikan - - - *Astrophys. Journal*, 52, pp. 47-62, 1920.
Millikan - - - *Astrophys. Journal*, 53, pp. 150-160, 1921.
McLennan and Petrie - *Trans. R.S.C.*, 15, pp. 15-29, 1921.
Wood - - - *Phil. Mag.*, 46, pp. 741-750, Nov., 1923.
Hutchinson - - *Astrophys. Journal*, 58, pp. 280-293, 1923.
Millikan and Bowen - *Phys. Rev.*, 23, pp. 1-34, 1924.

E 45/6. DR. MÜLLER'S X-RAY SPECTROGRAPH

FOR CHEMICAL, CRYSTALLOGRAPHIC AND RADIOGRAPHIC LABORATORIES, AND FOR THE GENERAL STUDY OF X-RAYS

Provision is made for the following work :

(1) Determination of space lattice structure of crystals and powders, and hence
(2) Analysis of Crystals and Powders.
(3) Determination of Wavelengths of characteristic emissions of anti-cathodes with sufficient accuracy for analysis of solids used as anticathodes.
(4) Determination of end radiation from tubes with different excitations.
etc. etc.

DESCRIPTION OF DR. MÜLLER'S X-RAY SPECTROGRAPH E 45/6

To meet the requirements of the various classes of work mentioned above, Dr. Müller has designed an extremely compact form of X-ray Spectrograph. While of sufficient accuracy for this class of work, the instrument is made of simple design and at such moderate cost that it can be put into the hands of advanced students who are capable of profiting by experience of this important class of work.

The instrument consists of a support carrying a rotating table for the crystal mount, and passing through the latter a bar of triangular section upon which slide carriers for slit and plate-holders respectively. This support is mounted on a box containing a spring motor, to the shaft of which is attached a cam. A lever, which can be clamped at any orientation to the axis of the crystal table, is kept in contact

with the cam by a spring, and is thus oscillated through a certain angle as the cam rotates. Three cams are supplied giving angles of oscillation of 5°, 10° and 15° respectively.

The crystal mount consists of a vertical plate with lead screen, to which the crystal can be attached with soft adhesive wax and which is provided with tilting

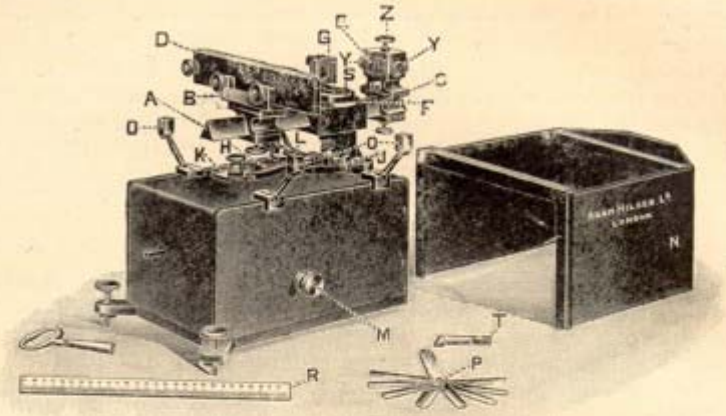

Fig. E 45/6. Arranged for Bragg Method

adjustment about a horizontal axis. The mount can be traversed in a slide across the rotating table so as to bring the face of the crystal up to the axis of rotation. The edge of the table is divided in degrees to facilitate the setting relative to the lever in order to register lines upon each side of the normal to the photographic plate.

The plate-holder, which is attached to its slide by two milled head screws, is designed to take plates 4¾ ins. × ¾ in. (12 cms. × 1·9 cm.) which can be cut from standard

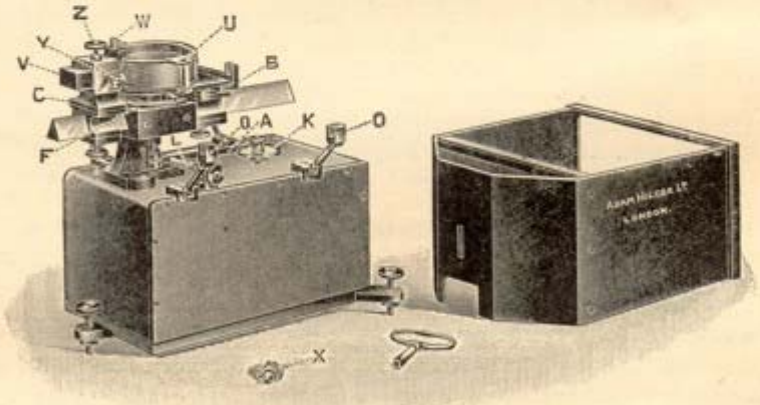

Fig. E 45/6. Arranged for Debye and Scherrer Methods

size plates (¼-plate size). It is provided with a black paper screen, so that the instrument may be used in daylight without risk of fogging the plate, and no special sheath for the plate is necessary.

The instrument is mounted on three levelling screws, the heads of which, as well as those of other adjusting screws, are made of vulcanite to minimise risk of

shock in case the instrument is charged by induction from the tube and transformer, etc. A lead screen is also mounted upon the instrument to prevent fogging of the plate by stray X-radiation.

As described, the instrument is available for work with a single crystal by the Bragg method. By a simple interchange of parts which can be effected in about one minute it becomes suitable for the investigation of powders by the Debye method. The slit jaws, crystal mount and plate-holder are removed and the carriers moved up to support a circular camera, 6 cms. in diameter, which carries a photographic film. The camera is so disposed that a powder-holder can be inserted in the centre of the rotating table and advantage taken of the oscillating movement for this work also. In place of the slit is mounted a brass block pierced with an aperture 1 mm. in diameter. The end of this block fits into an aperture of the camera and points directly to the powder-holder in the centre.

The instrument is also available for taking photographs by Hull's powder method, a small spring attached to the slit being supplied. Thus the three standard methods now in use are available in the one instrument.

E 45/6.—Müller X-ray Spectrograph as described, including parts for single crystal and powder methods of analysis. With mahogany case with lock and key, fitted to take instrument and box, into which are fitted the parts not in use when the instrument is being used in either way ...

For full description see separate Leaflet, sent post free on request.

COMPLETE EQUIPMENT FOR THE PRODUCTION OF X-RAYS

SUITABLE FOR USE WITH DR. MÜLLER'S X-RAY SPECTROGRAPH

F 245.—Shearer Tube.—This tube has a water cooled metal anticathode, the rays emerging from a window of thin aluminium foil ($\frac{1}{10}$ mm.) placed immediately in front of the anticathode. The anticathode is detachable, and four interchangeable anticathodes are customarily supplied; iron, copper and molybdenum for the production of the K radiations of these elements, and brass for the attachment of powders when it is desired to analyse by X-ray methods the elements contained in such powders.

The tube possesses very considerable self-rectifying properties, the result being that it can be operated successfully on a closed core high tension transformer running on alternating current without the aid of any subsidiary rectifying devices.

During operations the tube is kept continuously exhausted by a simple type of mercury vapour pump. The pressure in the tube can be controlled so that the rays are of the wavelength required for the investigation. It is well suited for use with the Hilger Müller X-Ray Spectrograph.

F 258.—Transformer.—The transformer is of the closed core shell type and is oil immersed.

The secondary winding is layer wound, each layer being insulated by specially prepared varnish impregnated paper having a very high dielectric strength.

Terminals are arranged so that the milliammeter may be connected in the tube circuit at the "earth" end of the secondary winding. Thus this meter may be installed upon the switchtable and may be handled whilst the apparatus is working without danger.

The rated output of the transformer is 15 milliamperes at 60,000 volts (R.M.S. value) continuously, whilst currents up to 30 milliamperes at the same voltage may be obtained for short periods.

The transformer is contained in a galvanised iron tank fitted with a hard fibre top.

F 259.—Control Board.—The switchgear together with auto-transformer, resistance and their controls are mounted upon a metal switchtable fitted with a black polished slate top.

The auto-transformer is arranged with five tappings so that the correct voltage is applied to the primary winding of the main high tension transformer to give secondary voltages of 20, 30, 40, 50 and 60 kilovolts (R.M.S. value) as required.

A variable resistance can be put in circuit, as not only does the tube run more steadily, but in the event of a short circuit on the secondary side of the transformer the resistance limits the amount of current flowing into the primary winding of the transformer.

The main switch is solidly built and fitted with two pairs of contacts, one pair of the contacts closing first and thereby introducing a resistance into the primary circuit. This limits the initial rush of current into the transformer. When the switch is fully closed the limiting resistance is cut out by means of the second pair of contacts and the transformer is then working normally.

By means of the combination of auto-transformer and resistance controls any value of voltage across the tube may be obtained for any value of milliamperage.

F 260.—Rotary Converter.—In cases where alternating current is not available for use with the transformer it is necessary to convert the direct current into alternating at suitable voltage. This converter is of suitable capacity to work with the transformer described above.

The electrical parts (F 258, F 259, F 260) *are made by Watson & Sons (Electro-Medical) Ltd.*

(State voltage of supply in ordering.)

PUMPS

The system which we recommend for exhausting the Shearer Tube consists of an oil-immersed backing pump (Trimount No. 1) which is motor driven, supporting a mercury diffusion pump set.

The items comprised are :—

F 160.—Oil-immersed backing pump.

F 265.—5-gall. drum of oil for above.

F 266.—$\frac{1}{2}$-h.p. motor to drive pump.

F 247.—Mercury diffusion pump on stand with vacuum bottle.

The following will also be required :—

F 248.—Milliammeter reading to 18 m.a. for measuring current in tube.

F 250.—1 doz. Ilford X-Ray Plates $6\frac{1}{2}'' \times 4\frac{3}{4}''$.

F 251.—1 doz. Kodak Duplitized Film $10'' \times 8''$.

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

Entrance :—24 Rochester Place (adjoining)

Telegraphic Address—" Sphericity, Phone, London."
Telephone—North 1677/8.
Cable Code—Western Union.
Cable Address—" Sphericity, London."