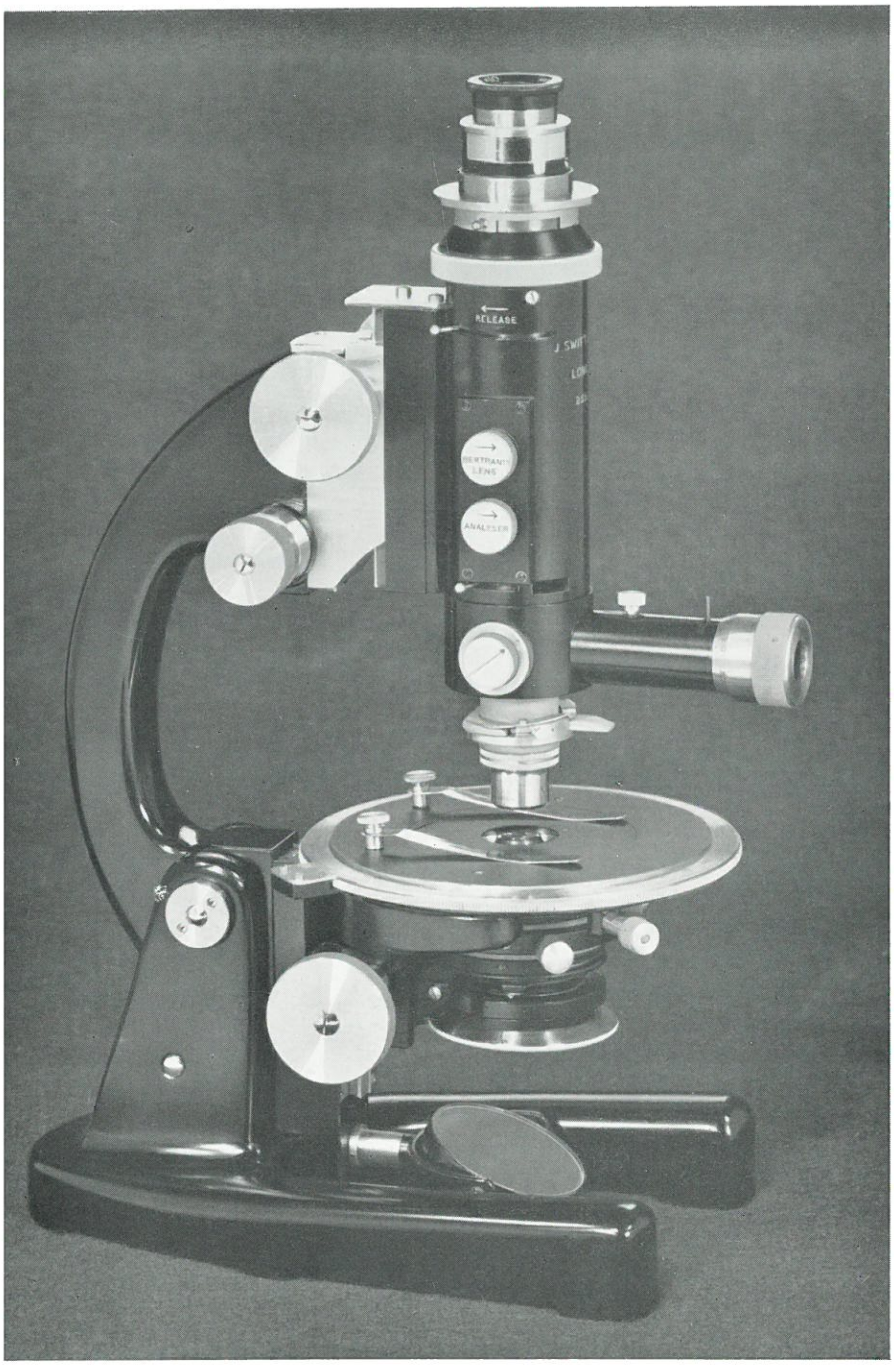
SWIFT MICROSCOPES

MODEL PMO



FOR THE

EXAMINATION

OF

OPAQUE OBJECTS

IN

POLARISED

LIGHT

'PETROMET' ORE MICROSCOPE

'PETROMET' ORE MICROSCOPE

MODEL PMO

All the essential features of both a petrological and of a metallurgical microscope are combined in this instrument in order to offer one adequately equipped for the examination of opaque objects under incident polarised light. This new technique is applicable not only to ores and minerals but to a very large number of synthetic products.

SPECIFICATION

STAND

As illustrated, with solid limb with inclinable joint, coarse and fine (graduated) body adjustments, with variable safety stop, plane and concave mirrors, large protective foot, with provision for lamp attachment.

POLARISING BODY

Of 40 mm. diameter and 160 mm. tube length, with slot for insertion of compensators at 45 degrees, with dust cover ; flanged eyetube capable of accepting either of the eyepiece fittings described below.

ANALYSER

Non-rotating, with polaroid elements in sealed unit. The analyser can be swung in and out of the optical path by means of an engraved knurled knob. When out of the path, the analyser is replaced by a glass equivalent.

EYETUBE

Choice of three interchangeable eyetubes, clamped in position by means of a large knurled ring.

(a) Straight monocular eyetube to accommodate any of the Swift range of polarising eyepieces listed on page 14 of Section D of the general catalogue ; slotted for micrometers or compensators to be inserted through the ×6 Huyghenian eyepiece MS90.

(b) inclined, monocular, non-swivelling eyetube incorporating a ' Telaugic ' eyepiece of ×10 magnification. N.B.—The eyepiece is an integral part of this assembly and it cannot be interchanged with other eyepieces of the Swift range.

(c) an ocular of the Wright pattern, embodying a polaroid analyser whose rotation can be read by circular scale and vernier to an accuracy of 0.1 degree. The analyser is mounted in a carrier that can be slid in and out of the optical path, and below the analyser is a slot, with sliding cover, for the insertion of micrometers or compensators in the focal plane of the ' Telaugic ' eyepiece. The latter has a magnification of ×10 and it cannot be interchanged with other eyepieces of the Swift range.

BERTRAND LENS

Mounted above the analyser assembly and capable of being swung in and out of the optical path by means of an engraved knurled knob similar to that of the analyser, and placed immediately above it.

This is an optional of any instrument and if required must be specified on the order.

BODY SLOT

At 45 degrees to the north-south axis of the microscope, for the insertion of compensator plates and fitted with sliding dust cover.

ROTATING STAGE

Fully graduated, read by vernier to 0.1 degree with clamp to rotation and conical, self-aligning bearing. (See Section E of general catalogue.) Drilled for stage clips, attachable stages, point counter and universal stages, with centre plate removable to allow for the swing of the graduated arcs of the latter, or for the insertion of the SWIFT ' mushroom ' stage, MK12 (See Section E). Up and down focusing adjustment by rack and pinion.

RACK AND PINION FOCUSING SUBSTAGE

As shown in illustrations and described in Section E with wide dovetailed slides and choice of three mountings, accepting condensers of standard R.M.S. diameter :

(a) non-centring (*i.e.* pre-centred at works).

(b) centring, by two screws, 120 degrees apart.

(c) quick-release, centring, permitting the immediate interchange of centred condensers, phase and dark ground illumination.

These substage arrangements are fully described in Section E and are convertible, *but by the manufacturers only*.

VERTICAL ILLUMINATOR

This is built into the body tube and has an optically worked plane glass reflector coated with zinc sulphide on one side and ' Bloomed ' on the other. It is also provided with a polaroid polarising attachment, iris diaphragm and focusing condenser system.

CABINET

Of selected hardwood, and supplied with each instrument *unless otherwise requested*, when an allowance is made. The cabinet is fitted with objective and eyepiece trays, contents and magnification card in brass holder, and packings for compensators, micrometers and centring objective changers when these are supplied with an instrument. The cabinet is secured with a self-fastening catch which can be positively locked by key, and in addition to this safety feature, wooden chocks are fitted to prevent an instrument sliding from an unfastened case.

CATALOGUE NUMBERS

MODEL PMO with rack and pinion focusing substage and precentred condenser mounting .. .. **Cat. No. MPN58**

MODEL PMO with rack and pinion focusing substage and centring condenser mounting .. .. **Cat. No. MPN59**

MODEL PMO with rack and pinion focusing substage and quick-release centring condenser mounting .. .. **Cat. No. MPN60**

NOTE.—The above catalogue numbers do not embrace eyepieces, objectives, changers or condensers.

ACHROMATIC OBJECTIVES

In order that the ' Petromet ' Ore Microscope can be used for the examination of both solid and transparent objects in polarised light, objectives of a greater numerical aperture than 0.50 must be specially computed for either purpose and in the case of solid objects, where the vertical illuminator is in use, they must be mounted in short mounts so that the reflecting system is close to the back lens, in order to fill the objective and reduce glare. All SWIFT objectives up to a magnification of × 14 can be satisfactorily used for both covered and uncovered objects.

All powers, when they are to be used on this instrument are ' bloomed ' in order to reduce the reflectivity of the glass components.

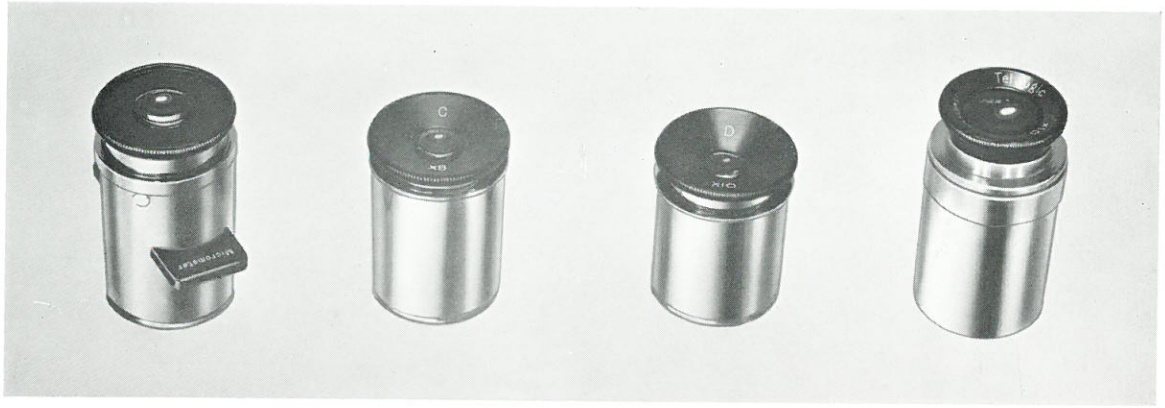
Nominal Focal Length		Numerical Aperture N.A.	Initial Magnification	Working Distance (Air or Oil gap) in mm.	Catalogue Number
mm.	in.				
32	1½	0·12	×4	32	**MS104PO**
32	1½	0·20	×4	18	**MS105PO**
25	1	0·16	×5	26	**MS106PO**
25	1	0·25	×6·5	13	**MS107PO**
16	2/3	0·17	×10	14	**MS108PO**
16	2/3	0·30	×10	7·5	**MS109PO**
12	1/2	0·50	×14	1·55	**MS110PO**
6	1/4	0·80	×30	0·58	**MS111PO**
6	1/4	0·80	×30	0·58	**MS112MPO** ★
4	1/6	0·72	×40	0·61	**MS113PO**
4	1/6	0·72	×40	0·61	**MS114MPO** ★
4	1/6	0·85	×45	0·41	**MS115PO**
4	1/6	0·85	×45	0·41	**MS116MPO** ★
3	1/8	0·90	×55	0·30	**MS117PO**
3	1/8	0·90	×55	0·30	**MS118MPO** ★

OIL IMMERSION OBJECTIVES

3	1/8	0·92	×60	0·23	**MS150PO**
3	1/8	0·92	×60	0·23	**MS151MPO** ★
2	1/12	1·2	×90	0·18	**MS152PO**
2	1/12	1·2	×90	0·18	**MS153MPO** ★
2	1/12	1·3	×90	0·18	**MS154PO**
2	1/12	1·3	×90	0·18	**MS155MPO** ★

★ Mounted in short cell and corrected for uncovered objects.

LARGE DIAMETER 30 mm.
FOR SWIFT POLARISING BODIES



MS 90
Showing micrometer

MS 91

MS 92

MS 96

Catalogue Numbers

Magnification	HUYGHENIAN	TELAUGIC
×6S	**MS90**	—
×8S	**MS91**	—
×10	**MS92**	**MS96**
×15	—	**MS97**
×20	—	**MS98**
×25	—	**MS99**

NOTES

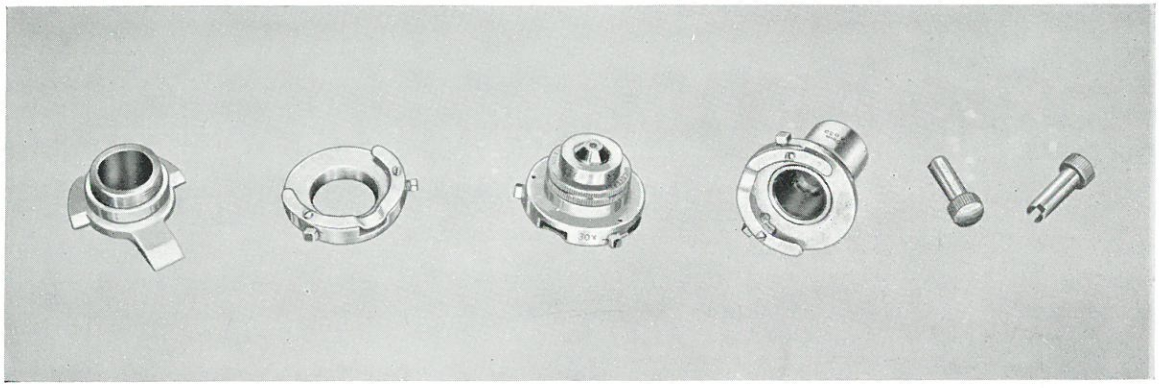
1. All the above eyepieces are parfocal with each other.

2. S : Slotted for insertion of micrometers, wedges, etc. It is not possible for eyepieces of magnification ×10 and above to be slotted and remain parfocal. In these cases, micrometers may be used which drop upon the stop of the eyepiece, below the focusing eye lens.

3. All eyepieces supplied with SWIFT polarising microscopes are fitted with a focusing eye lens and cross-lined graticule, unless otherwise ordered.

OBJECTIVE CHANGERS

For all but the most simple investigations some means of changing quickly from one power of objective to another has become indispensable with modern compound microscopes. With our ' Petromet ' Ore Microscope we offer our centring objective changers as illustrated below, which permit of adjustment at any time.



Tube Fitting MK 60 *Objective Fitting MK 61* *Centring Key*

CENTRING OBJECTIVE CHANGER, TUBE FITTING
Cat. No. MK60

CENTRING OBJECTIVE CHANGER, OBJECTIVE FITTING
Cat. No. MK61

(One required per objective)

SPECIAL MODELS PMO
WITH EXTENDING LIMB

Any version of the Model PMO Polarising Microscope can be supplied with a special extending limb having an extra dovetailed slide. This slide is as accurately fitted and lapped as the body slides of the instrument and enables the body of the microscope to be raised a further 25 mm. without any reduction of the rigidity of the limb and the focusing motions.

The extension enables large objects and apparatus to be freely accommodated on the stage, and was first offered on SWIFT models in order to permit the full rotation of a Leitz 5-axis universal stage. The feature is also of advantage when vertical illuminators are fitted to the body for the examination of large opaque specimens.

Any model with the extending limb is simply designated by the suffix S.

MODEL PMO Polarising Microscope with precentred condenser mounting, with extending limb .. .. .. **Cat. No. MPN58S**

MODEL PMO Polarising Microscope with centring condenser mounting, with extending limb .. .. .. **Cat. No. MPN59S**

ACCESSORIES FOR POLARISING MICROSCOPES

ABBÉ CONDENSER, with iris diaphragm and filter carrier .. .. .. Cat. No. MS 201

POLARISER for attachment to racking substage .. .. Cat. No. MF 110

WEDGES AND COMPENSATING PLATES

QUARTZ WEDGE, mounted in glass, and in metal carriers, six orders, for insertion in the body or eyepiece slot .. .. Cat. No. MF 101

GYPSUM PLATE, sensitive tint (Red 1st order), in metal carrier .. .. Cat. No. MF 102

GYPSUM PLATE, sensitive tint, mounted in ring to fit 23 mm. or 35 mm. substage carrier .. .. Cat. No. MF 103

MICA PLATE, $\frac{1}{4}$ wavelength, in metal carrier .. .. Cat. No. MF 104

CARRIER, to adapt standard plates and wedges to the wide 19.5 mm. eyepiece slot .. .. Cat. No. MK 73

ATTACHABLE MECHANICAL STAGE, a small mechanical stage, with scales and verniers on rack and pinion movements in two directions, can be fitted to the standard round stage and permit of full rotation of the microscope stage .. .. Cat. No. MK 6

BERTRAND LENS

This is an optional of any instrument and if required must be specified on the order.

Bertrand lens, *with* iris diaphragm .. .. Cat. No. MS 251

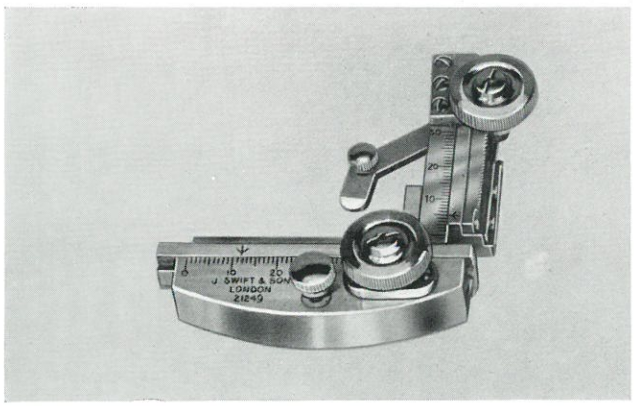
BECKE EYEPIECE, a positive focusing Ramsden eyepiece for mounting above the eyepiece of any polarising model (except Model PD) for the observation of interference figures. (See Section D.) Cat. No. MS 250

INCLINED EYETUBE, with × 10 ' Telaugic ' eyepiece. Cat. No. MS 300

PIN-HOLE EYEPIECE, a small pin-hole fitted to a standard 30 mm. eyepiece sleeve. It offers the most effective means of isolating the interference figures for small grains. Cat. No. MF 165

WRIGHT EYEPIECE, graduated, rotating. Cat. No. MS 305

CAP ANALYSER, a polaroid analyser in sealed cell. It can be rotated and is graduated, and enables wedges and compensating plates to be inserted through the eyetube slot in the focal plane of the eyepiece, thus giving sharp differentiation to the colour bands, particularly in relation to small grains. The crossed position, in relation to the polariser, is engraved on the periphery. (For straight monocular eyetube only.) Cat. No. MF 111

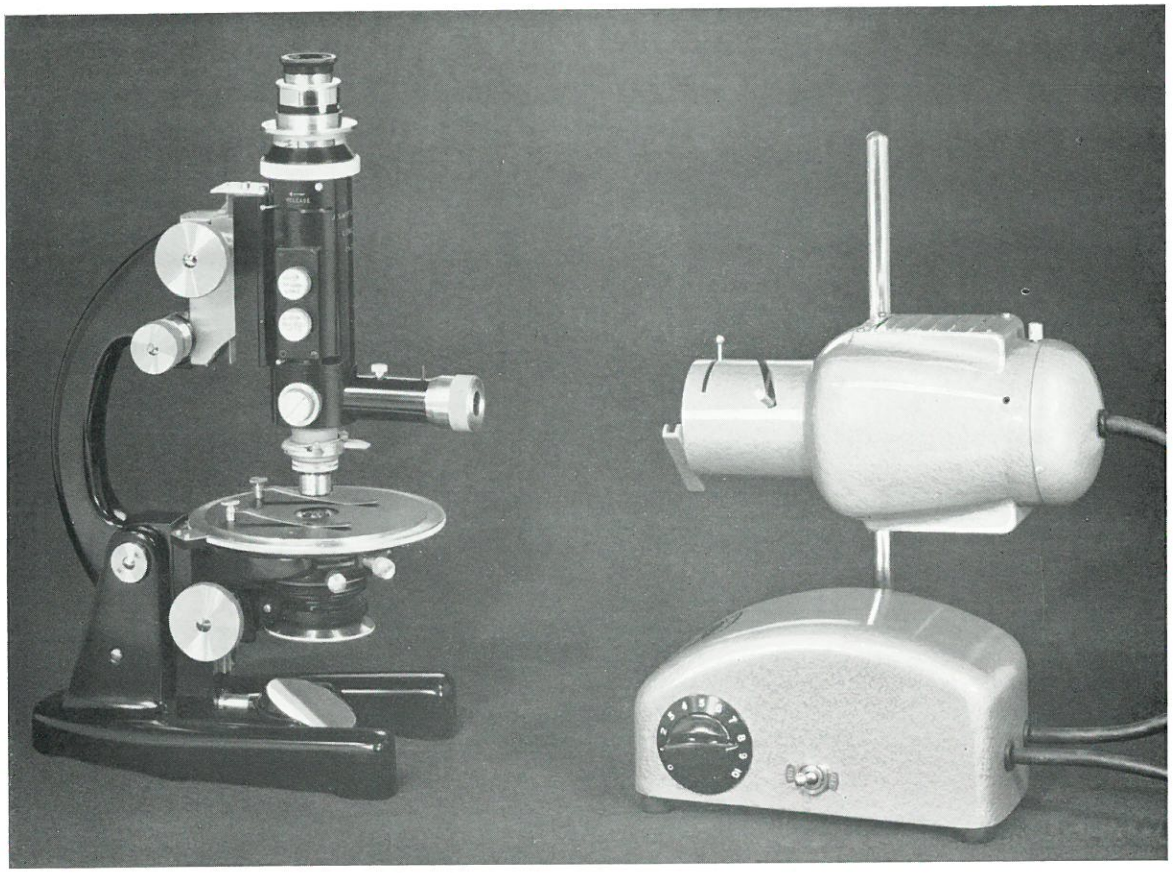


Mechanical stage (MK 6)



Wright Eyepiece (MS 305)

SWIFT MICROSCOPES



'Petromet' Ore Microscope with 'Intensity' Lamp

Owing to continued progress in design we reserve the right to modify details and specifications shown in this publication, without further notice.

JAMES SWIFT & SON LIMITED

113–115a CAMBERWELL ROAD, LONDON, S.E.5

ENGLAND

Founded in 1853

Telegrams: 'Prisms, Camber, London'
Telephone: RODney 5441

Cables: 'Prisms' London
Code: A.B.C. 5th Edition

PRINTED IN GREAT BRITAIN

J.B. LTD. 620601

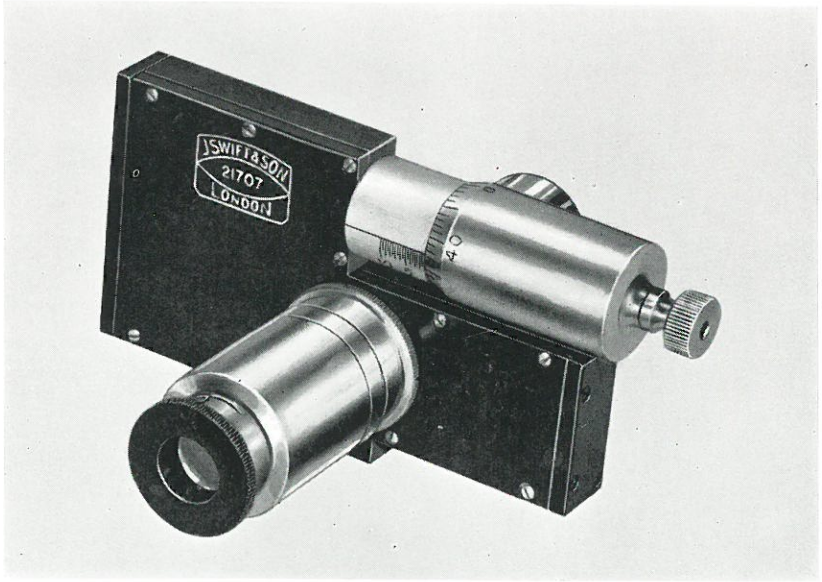
BABINET COMPENSATOR

A Babinet Compensator is a very sensitive instrument for determining the characteristics of elliptically polarised light, *i.e.* phase difference, position and ratio of the axes, and for the measurement of double refraction (birefringence) in transparent media, *i.e.* minerals and glasses.

The SWIFT instrument consists of a Ramsden eyepiece which is mounted above two acute quartz prisms, or wedges, having equal angles of approximately $2\frac{1}{2}$ degrees. The upper wedge, 11 mm. ×11 mm., remains fixed in the body of the eyepiece, and the lower, 11 mm. ×42 mm., can be moved by means of a calibrated micrometer screw of 0.5 mm. pitch. The screw is fitted with a divided drum, each division of which corresponds to 0.01 mm. The vibration directions of the two wedges are at right angles to each other, and the fixed wedge is provided with fine datum webs which form a cross whose intersection lies on the optical axis of the instrument.

The compensator can be mounted on a stand for use with an optical bench, and for the observation of large specimens, particularly glass, or it can be inserted directly into the eyetube of any microscope. The analyser is of POLAROID, mounted between optically-worked glass plates in a sleeve which fits above the Ramsden eyepiece.

The instrument is inserted in the eyetube of the microscope, in place of the usual eyepiece, and is set by means of a locating pin, or clamp, till the axes of the quartz wedges are at 45 degrees to the East–West vibration direction of the polariser of the microscope. The micrometer drum is then set to the zero position and the analyser placed above the eyepiece in the crossed position



to the polariser. If the illuminant is white light, a black line appears in the centre of the field and coloured bars of light on either side. If monochromatic light is used, such as from a sodium lamp, black bars or fringes will appear on either side of the centre position. The fringes appear where compensation occurs of the two rays passing from the lower wedge, and they are separated by spaces which have the colour of the monochromatic light; in the case of sodium, this would be yellow. The angles of the wedges are such as to give fringes about 0.7 mm. apart, and the field of the Ramsden eyepiece embraces about 6–7 fringes.

The distance between two black compensation bars is the wavelength of the illuminant, and the micrometer drum and scale are calibrated by observing the movement necessary to move the wedge from fringe to fringe. The constant of any instrument, using sodium light, is then found by :

$$K = \frac{589 \text{ millimicrons}}{\text{Drum divisions}}$$

The calibration of all instruments is substantially linear, because of the accuracy with which the quartz wedges are worked but, if required, a calibration over the full range of the wedge movement can be supplied with any instrument.



When a mineral specimen is placed upon the stage of the microscope and turned 45 degrees from the position of extinction, the dark bar in the centre of the compensator will be displaced to the right or left, depending on its vibration direction. The amount by which the micrometer drum must be turned in order to return the black bar to the intersection of the cross-webs represents the retardation (in millimicrons, from the calibration) of the light that has passed through the mineral specimen. The retardation of a birefringent mineral is given by :

$$R = M\ (n_2 - n_1)$$

where M is the thickness of the specimen, and n_2 and n_1 the refractive indices in the two vibration directions at right angles to each other.

The birefringence of a specimen can thus be determined if its thickness is known, and the latter can be determined

by micrometer measurement, or if this is not practicable, by focusing on upper and lower surfaces of the specimen using the calibrated fine adjustment control of the microscope.

NOTE.—The measurement with a microscope must not be taken *through* the specimen because of the error introduced by its refraction and which clearly cannot be corrected for unless the refractive index is known. A mark on the upper surface of the slide must first be focused and the specimen then slid over the mark (or as near the mark as possible) and the upper surface of the specimen then focused. If the specimen is already mounted under a cover slip, a mark on the slide should be focused to one side of the specimen and then a mark on the upper surface of the cover slip. The thickness of the cover slip, which should be known, can then be subtracted from the total measurement made. If the thickness of slide and cover glass are accurately known, they can be subtracted from the total thickness as measured with a micrometer.

An alternative method of ascertaining the thickness of a specimen is by the observation of the interference colour of a known constituent in a section under examination. For example, the thickness of a familiar mineral such as quartz, having a birefringence of 0.009, could be evaluated by reference to Newton's Colour Scale. If of frequent occurrence, a grain of a familiar mineral can be selected which is ideally oriented to give the maximum birefringence.

$$\text{Thickness in microns} = \frac{\text{Interference Colour Value}}{\text{Birefringence} \times 1{,}000}$$

The Polarisation Colour Scale, calibrated in millimicrons for crossed and parallel nicols, is set out in a small pocket booklet by Jones and Brammall, together with useful formulae and table of birefringences of many minerals.

The Babinet Compensator is supplied in a black leatheroid-covered case, and is finished in black semi-matt stove enamel, with all controls and fingered parts plated in satin chrome. The case measures $5\frac{1}{2} \times 5\frac{1}{2} \times 3$ inches. The weight of the instrument is 32 ounces.

BABINET COMPENSATOR

As described, with analyser, for use with microscope . . . . . Cat. No. ME 80
(Please state diameter of microscope tube).

NOTE.—Every instrument is drilled and tapped to take a rod of $\frac{1}{2}$ inch diameter.

BABINET COMPENSATOR

As above, but with rod of $\frac{1}{2}$ inch diameter, for optical bench mounting, and fitted with divided circle 115 mm. diameter, reading to 0.1 degrees . . . . . Cat. No. ME 81

TRIPOD BASE

For above . . . . . Cat. No. MA 10

POLARISATION COLOUR SCALE

With formulae and tables . . . . . Cat. No. MA 50

SWIFT MICROSCOPES

James Swift and Son, Ltd., have been manufacturing instruments of precision for over one hundred years. Our instruments include a full range of polarising, metallurgical and biological microscopes and microscope accessories; colorimeters, strain viewer and automatic point counter. Details will be gladly sent on request.

★

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