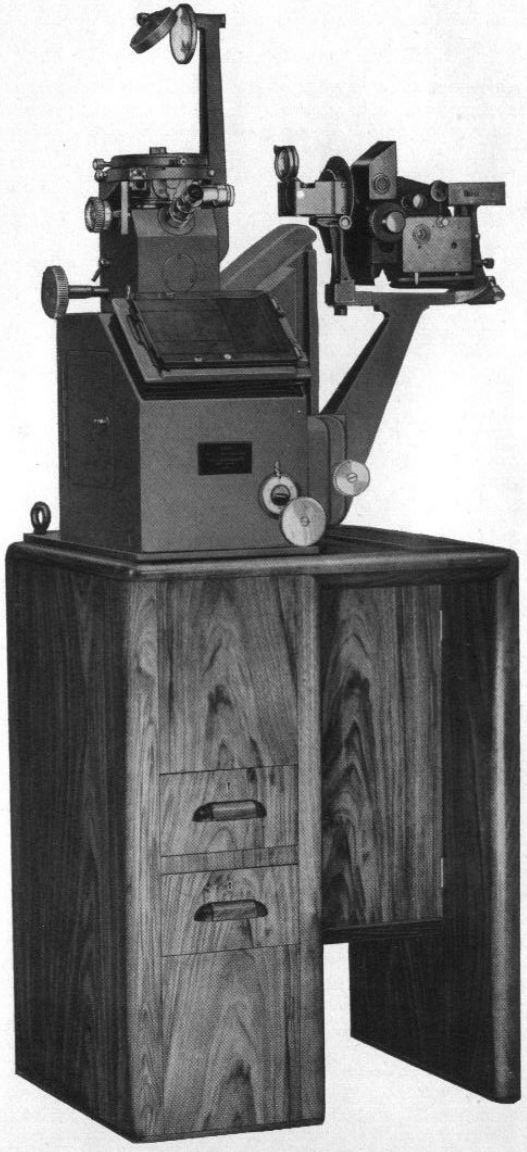


VICKERS PROJECTION MICROSCOPE
set up for the micro examination of a metallurgical specimen.

VICKERS PROJECTION MICROSCOPE

The Vickers Projection Microscope, originated in the Research Laboratories of our associated Company, Messrs. Vickers-Armstrongs, Ltd. It has now been manufactured for a number of years, and altogether nearly six hundred instruments have been put into service. During all this time the closest liaison has been kept with practical metallurgists and microscopists, and this reveals itself in the many novel features which are incorporated in the design.

The instrument provides for three main classes of microscopic examination :—

1. Opaque objects under powers ranging from 18× to 4400× with normal incident illumination from clear glass or metallic reflectors, and with dark ground illumination from 56× to 1850× (see illustration opposite). Polarizing equipment may be used throughout the above range.

2. Translucent objects under powers between 18× and 4400× with transmitted light (see page 26). Polarized light is available.

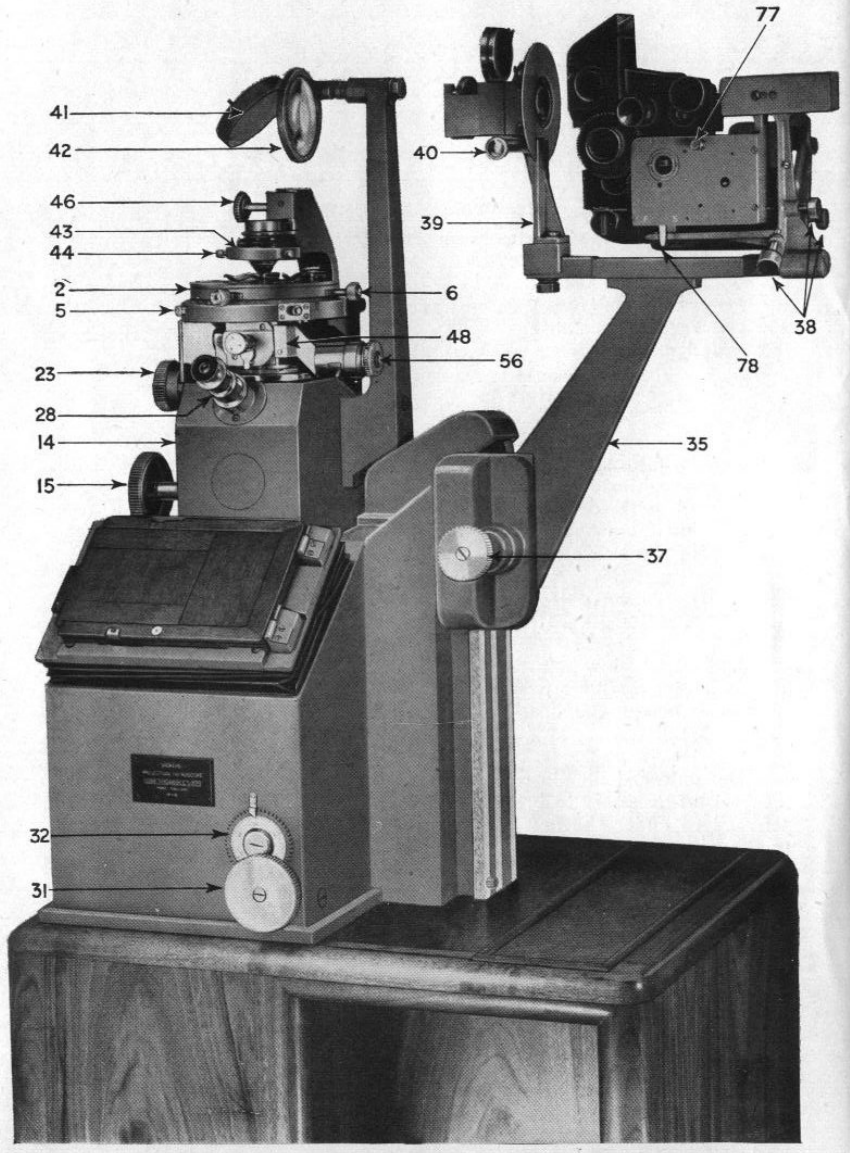
3. Macro or low power examination of opaque or translucent specimens under magnifications of 3× to 39×, the former by normal incident or oblique illumination and the latter by transmitted light (see page 37).

The universal illuminator unit fitted to the instrument embodies the mechanisms necessary to bring into play any of the methods of illumination referred to under the first two classes with the minimum of disturbance to the adjustment of the instrument. It also ensures the best illumination conditions when using normal incident light by bringing the reflector as close as possible to the back lens of the objective.

The Vickers Projection Microscope is quite unique in its rigidity and is practically immune from the effects of vibration.

Ease of control and convenience of operation have been studied throughout the design, the principal motions are provided with counterbalancing mechanisms, and the cabinet has been so constructed as to enable the instrument to be used from a sitting position.

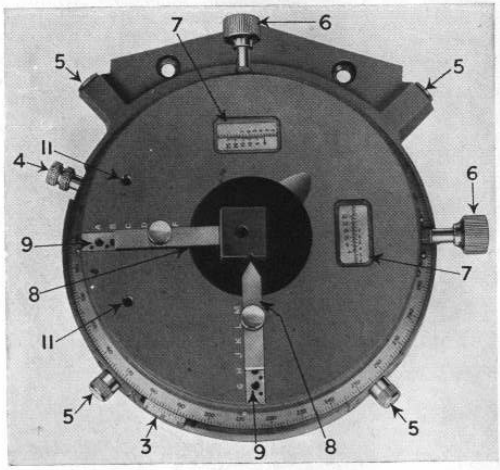
When fitted with a mercury vapour lamp, the Vickers Projection Microscope can be employed for the examination of surface finish of metals by interference methods, see page 172.



VICKERS PROJECTION MICROSCOPE
set up for micro examination by transmitted light.

LIST OF REFERENCES.

GENERAL DESCRIPTION



The Vickers Projection Microscope is of the inverted type, that is to say, the specimen is positioned above the objective. The stage (2, page 26) upon which the specimen is placed is provided with a circular movement with graduated scale and vernier reading to 5 min. (3). A knurled head (4) is provided for clamping this motion. The adjustment for centring the stage bearing with the optical axis is secured by two pairs of diametrically opposed screws (5). After adjustment this movement is locked by two screws under the stage. Two traverse movements at right angles and controlled by screw motions (6) are provided. The range of these motions is 0·7 in. in each case, and the positions of these motions are indicated by scales and verniers (7) reading to 0·001 in.

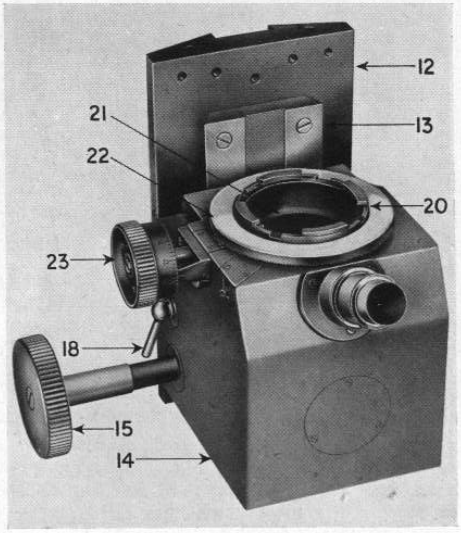
Two stage stops (8) are supplied to facilitate replacing a particular area of a specimen in the field. There are tapped holes (9) in the stage to which these stops are affixed as required. One stop is machined to a knife edge at the effective end, and, if the specimen is suitably marked to correspond with this knife edge and the scale readings noted, a particular point on a specimen may be readily replaced in the field of the microscope. To facilitate this the tapped holes in the stage are lettered. In addition a pair of the usual type of spring clips are provided, mounted from the holes (11).

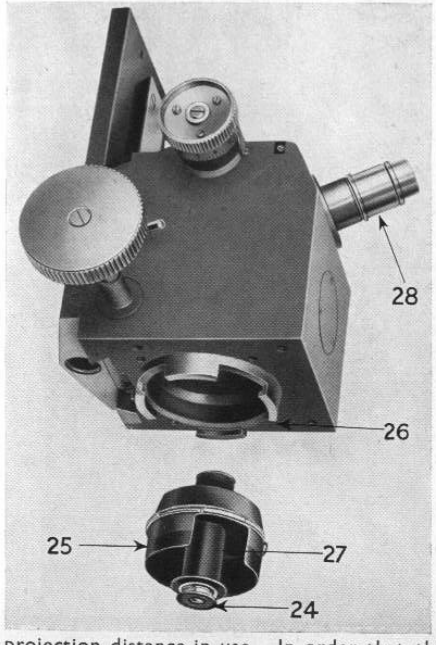
The stage is mounted on a metal support (12, page 29) connected with slides (13) engaging with the main body block (14). The coarse focusing motion is actuated by the large milled head (15) which has the effect of moving the stage support with reference to the main body block. The movement is obtained by a helical rack and pinion, and the weight of the stage is counterbalanced by spring action. A clamp (18) secures the coarse motion, and weights up to 50 lbs. can be safely carried by the stage. A scale is provided to indicate when the focal plane of the objective coincides with the lower surface of the specimen.

The body block is bored vertically to accommodate a tube corresponding with the body tube of the ordinary microscope. The upper end of this tube is fitted with a bayonet catch arrangement (20) for receiving the Universal Illuminator Unit and a parallel fitting (21) for the macro lens adaptor (page 36).

Externally, the upper end of the tube is threaded to engage with a nut (22) the underside of which rests upon the flat top of the block (14), thereby supporting the tube and the objective equipment. Rotation of the nut through bevel gearing by the milled head (23) provides the fine motion focusing adjustment. The milled head carries a graduated drum intended to be used for making small measurements.

The projection eyepiece (24) is carried by an adaptor (25) attachable to the under face of the body block by a bayonet fitting (26).

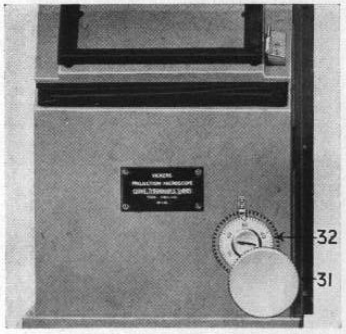




There is provision for varying the effective tube length, the eyepiece being carried by a tube (27) sliding within the adaptor. For visual work without projection a sliding tube (28) carrying a non-corrodible mirror and eyepiece is mounted through the front of the body block. This comes into action when the tube is pushed home.

The image-forming rays after passing the projection eyepiece are reflected by a non-corrodible mirror and focused upon the projection screen. A detachable hood is provided to the latter.

The projection distance is variable between 40 cm. and 90 cm. by a vertical movement of the mirror which is controlled by the milled head (31, page 30). A dial (32) indicates the projection distance in use. In order that the image may remain stationary on the screen though the projection distance may be altered, the tilt of the

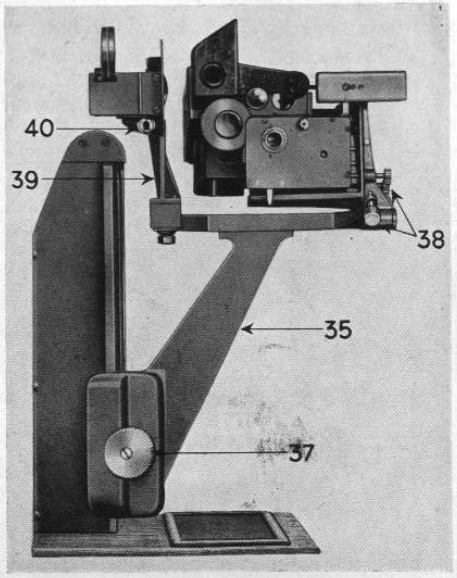


mirror is controlled by a cam. Similarly, the tilt of the screen is controlled in order to ensure that at all projection distances the image is projected normally on to the screen. The projection distance adjustment mechanism is counterbalanced in order to secure a free motion, and a clamp is provided.

The illuminating arrangements, which can be supplied for alternating or direct current, are mounted on a bracket (35) capable of vertical adjustment and counterbalanced to secure free motion. Adjustable stops are provided in order that the illuminant may be readily transferred from the position for the illumination of opaque objects to that required for transmitted light. A clamp (37) is fitted for affixing the illuminant at intermediate positions, as, for example, when the macro-equipment is employed (page 37).

The illuminants consist of a clockwork-fed arc lamp and a pointolite lamp, each having independent centring controls (38). They are mounted on a swing-over bracket enabling either form of illumination to be brought into use instantly. Alternatively, an arc lamp and a mercury vapour lamp or a pointolite lamp and a mercury vapour lamp may be fitted.

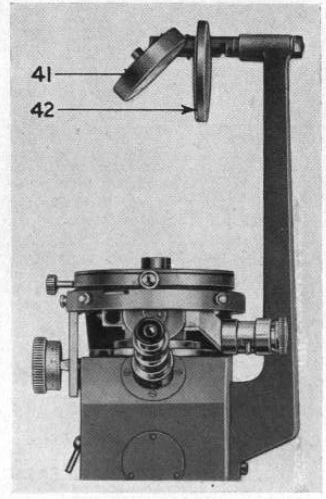
A support (39) adjustably mounted on the illumination bracket carries a lamp condenser and iris diaphragm for regulating the brilliancy of the illumination, and also heat absorbing filter, three hinged screens (neutral, green and opalescent). The whole is provided with a horizontal adjustment (40) actuated by rack and pinion.



A separate panel carrying resistances and choke for arc, pointolite, or mercury vapour lamp as the case may be, together with the necessary switches, is supplied and is connected to the instrument by a flexible cable.

When the instrument is used with transmitted light a mirror (41) mounted at 45° above the stage and a condenser (42) having a swing-out movement are employed.

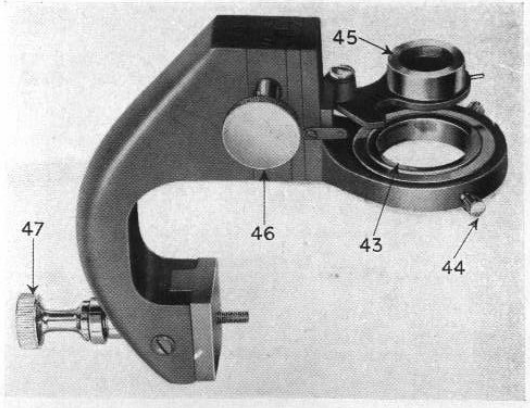
When the instrument is required to be used with transmitted light, a substage condenser bracket can be supplied as an extra. This has a standard fitting (43) to receive Abbe or oil immersion condensers, with centring arrangement (44), also a swing-out fitting (45) to support the polarizer. Both fittings are mounted on a vertical slide with rack and pinion adjustment (46). The large screw at the lower end of the bracket (47) is for fixing it to the stage support.



The instrument is also available for low power work when the illuminator unit and projection eyepiece adaptor are removed and replaced by a camera lens. The object is then supported upon a superstage and may be illuminated by normal incident, oblique or transmitted light according to requirements. The macro equipment is more fully described on page 36.

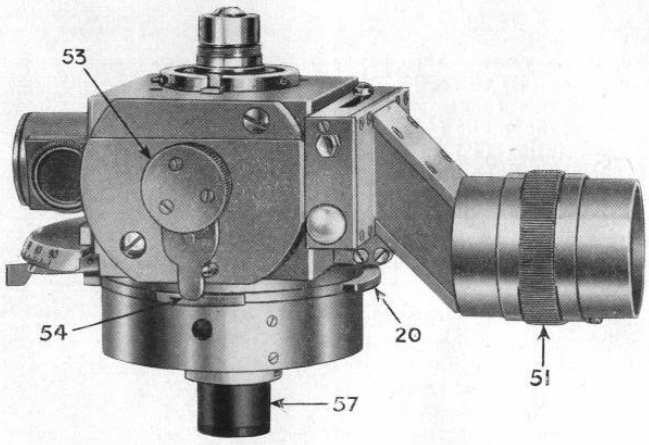
When using polarized light the metallic reflector should be used in place of the glass illuminator, as the latter will itself partially polarize the incident beam.

Two methods of examination are commonly used. The extended orthoscopic image may be examined between crossed polaroids, or alternatively a portion of the image may be isolated and the conoscopic interference figure situated within the Ramsden circle examined by means of a magnifier known as a Becke lens.

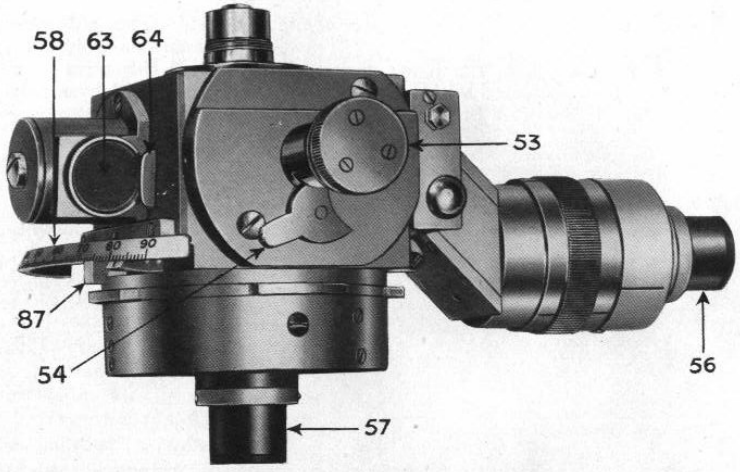


An eyepiece with iris diaphragm, polarizer, analyser, Becke lens and an objective mount, slotted for the insertion of $\frac{1}{4}$ wave plates, quartz wedge, etc., are required for this work.

The instrument is supported by a substantial cabinet which encloses the lower portion of the camera.



UNIVERSAL ILLUMINATOR UNIT
arranged for normal incident illumination with plain glass reflector.



UNIVERSAL ILLUMINATOR UNIT
arranged for normal incident illumination with metal reflector. Polarizer in position.

UNIVERSAL ILLUMINATOR UNIT

The object of this device is to provide the observer with the means of instantly changing the method of illumination of the specimen with the minimum of disturbance to the adjustment of the Microscope.

The following systems are embodied in the unit :—

(*a*) Normal incident illumination from a plain glass reflector interposed between the objective and the eyepiece at 45° to the optical axis of the Microscope, light being received by the reflector from a direction normal to this axis. This method is commonly referred to as "cover glass illumination" (see upper illustration on page 32).

(*b*) Normal incident illumination from a small triangular metal reflector, positioned and illuminated as the glass reflector under (*a*) above. This system is often called "prism illumination" (see lower illustration on page 32).

(*c*) Dark ground illumination with catoptric condenser illuminated from a silvered annulus placed between the eyepiece and the objective (see page 34). This annulus is formed on the reflector used in (*a*) above.

(*d*) Polarized light, which may be used in conjunction with (*b*) or (*c*). Polarizing equipment is not fitted unless specially ordered.

The Unit is attached to the fine motion focusing tube by a bayonet fitting device (20).

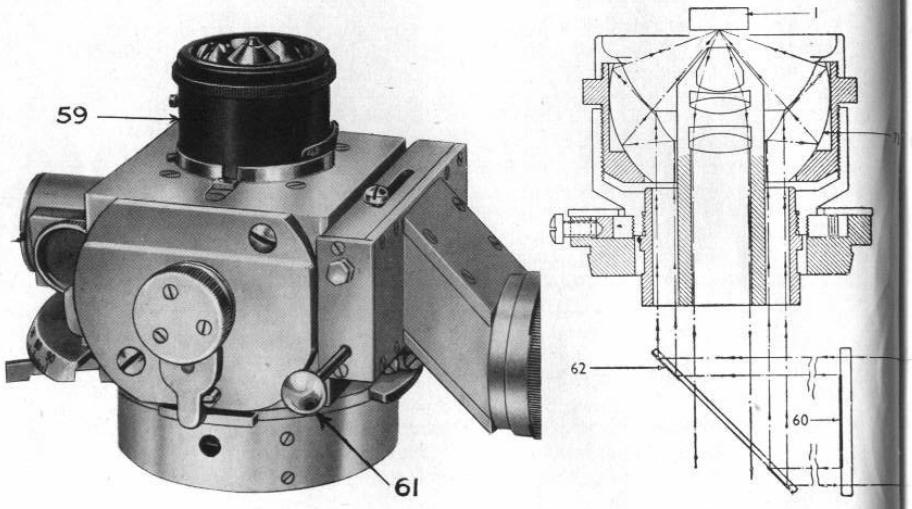
Light from the illuminant enters the tube at the right. A rhomboidal prism is located in the tube to enable the entrant beam to clear the stage support above, and at the same time to ensure that the illumination reflector is as close to the back lens of the objective as possible in order that the optimum performance shall be secured.

The knurled ring (51) controls an iris diaphragm for the purpose of limiting the area of the specimen illuminated and therefore of cutting off objectionable extraneous light. This iris also has a longitudinal adjustment in order that its aperture may be focused critically on the specimen.

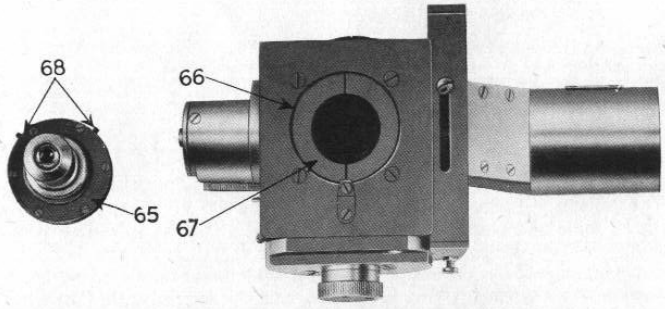
The plunger (53) carries the plain glass reflector for vertical illumination and when this is withdrawn the reflector passes out of the beam. Attached to lever (54) is the small triangular metal reflector, and when this is in the position shown in the upper illustration it is out of action. The reflector is moved into position by swinging the lever to the left. These two movements are interlocking, so that the metal reflector cannot collide with the glass reflector, that is, lever (54) cannot be moved from the position in the upper illustration until plunger (53) is withdrawn, nor can the plunger be replaced unless lever (54) is restored to its original position.

The polarizer fitting (56) is arranged to be a "push on" fit over the right-hand tube when used with incident light, and it is keyed to prevent rotation. For transmitted light the polarizer is similarly attached to the support (45, page 31). The analyser (57), which is capable of rotation, is provided with a key for location in reference to the degree scale (58) which is engraved 45°-0°-45°. The analyser can be removed from the optical train.

The arrangement for dark ground illumination is illustrated on page 34. The cylinder (59) above the unit contains a catoptric condenser (73)



UNIVERSAL ILLUMINATOR UNIT arranged for dark ground illumination.



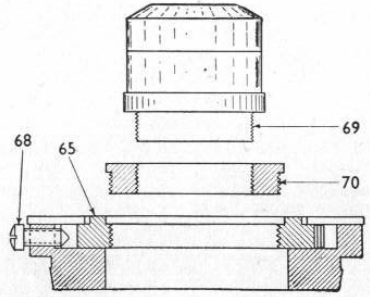
ILLUMINATOR UNIT with objective removed.

surrounding the objective. For illuminating the condenser and yet not permitting any light to reach the objective directly, a patch stop (60) is brought into play by the lever (61). This has the effect of passing only a circumferential bundle of rays which are turned upwards by a silvered annulus (62) on the glass illuminator. If the patch stop is put out of action the objective may be used with ordinary incident illumination. Thus the movement of (61) instantly changes the illumination from dark field to bright field and vice versa.

The circular ground glass screen (63, page 32) gives the means of verifying that the source of light is correctly centred. The shutter (64) puts this out of action.

The objectives are not screwed into the Microscope body as is commonly the case, but instead a circular magnetic mount (65) is attached to the base of each objective supplied with the instrument and also to the catoptric condenser for dark field illumination, and a corresponding fitting (66) to receive the mount is located in the depression on the top surface of the illumination unit, a magnet (67) being fitted at the base of this depression : thus the objectives may be readily interchanged and are automatically held in position.

Each magnetic mount is provided with a means (68) of centring the objective in relation to the mount and therefore to the illumination unit and the whole projection system. Consequently, once this adjustment has been correctly secured on each objective, it can be removed together with its mount and replaced in the correct position with certainty.



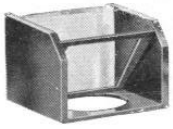
In view of the importance, when using the higher powers, of placing the back lens of the objective as close as possible to the incident light reflector, the usual objective stem carrying the thread standardised by the R.M.S. is omitted on objectives of 8 mm. or less. In these objectives, when supplied for the Vickers Projection Microscope, the smaller thread on the objective cell proper (69) engages with a tapped hole in an adaptor (70) which is screwed into the magnetic centring mount (65). This adaptor is itself screwed into the centring mount by an R.M.S. thread, consequently if it be removed any objective having a standard thread may be attached to a centring mount. These centring mounts are offered separately (M576) in order that observers may readily use objectives not specially made for this instrument.

The Microscope is designed for use with objectives corrected for a tube length of 250 mm. and most of the objectives offered with this instrument are so corrected. It is, however, possible to use objectives corrected for 160 mm. and for this purpose a corrector lens can be supplied. It is held in a metal mount which is inserted into a fitting approached from the underside of the illumination unit by means of a special tool.

MACRO EQUIPMENT

M555 M556

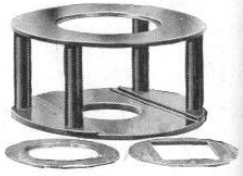
Adaptor M557 M558



M552

M553

M554



M551

The accessories for this work are illustrated above. Lenses M555 and M556 are used in conjunction with Illuminator M552, and Lenses M557 and M558 with Illuminator M553.

For macro work the projection eyepiece and the universal illuminator unit are removed. The two low power lenses are each provided with an adaptor to connect them with the body tube of the Microscope, whilst one adaptor serves both high power lenses. It should be noted that the M555 Lens is inserted down the microscope tube whereas in the case of all other objectives the whole of the body of the Lens is visible.

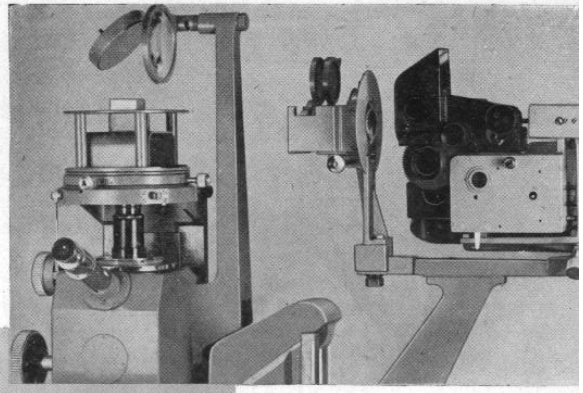
The Superstage M551 is used for supporting the specimen and the illuminators.

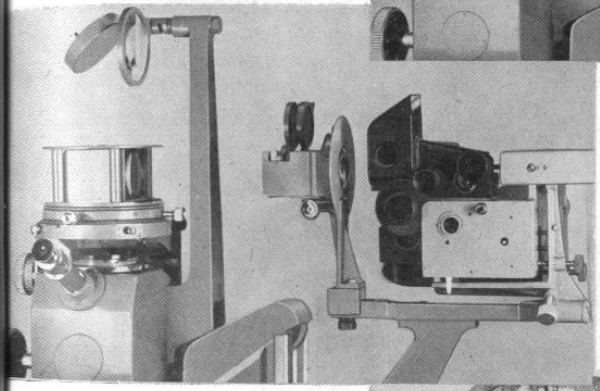
When it is desired to enhance the relief in a specimen the oblique illuminator M554 should be used. With a perfectly plain surface on the specimen all the incident light would be reflected to one side and lost, but when the surface is imperfect the aperture of the objective is filled with scattered light and the detail is thrown into relief.

For the examination of transparent objects the illuminator is removed, the specimen placed on the superstage, and light received from the mirror above.

FOUR SETTINGS FOR MACRO (LOW POWER) PROJECTION

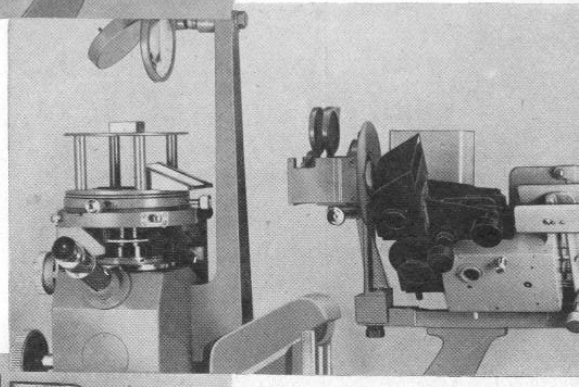
Equipment for **2 in. and 1·375 in. Lenses** (M557 and M558), giving screen magnification ranging from 12× to 39×.

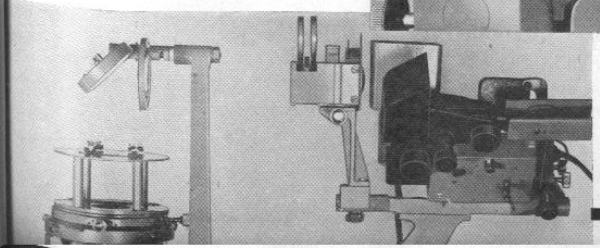




Equipment for **5·5 inch and 3·5 inch Lenses** (M555 and M556), giving magnification from 3× to 14·5×

The set-up for **oblique illumination.**





Macro examination of **transparent objects.**

SUMMARY

VICKERS PROJECTION MICROSCOPE with centring, traversing and rotating stage, universal illuminator unit (but without polarizing equipment), visual eyepiece tube, projection eyepiece adaptor and bracket carrying condensing lens and mirror.* Camera with non-corrodible metal projection mirror and mechanism for controlling effective camera length, focusing screen and ½ plate double dark slide with ¼ plate adaptor and hood. Illuminant bracket carrying two sources of illumination with independent centring controls and rapid change-over device, lamp condenser on focusing mount, heat absorbing filter, colour filter, neutral filter and diffusing screen. Resistances for lamps mounted on separate panel and connected to the instrument by flexible cable. Cabinet for supporting the Microscope, fitted with cupboard and drawers for containing all accessories.

Objectives, Eyepieces and Substage Condensers are not included above.

* N.B.—This is an essential part of the apparatus even if no transparency work is to be done, as it is required for adjusting the instrument.

CODE	Arc Lamp	Pointolite Lamp	Mercury Vapour Lamp
M500	A.C.	A.C.	—
M501	D.C.	D.C.	—
M502	A.C.	—	A.C.
M503	D.C.	—	D.C.
M504	—	A.C.	A.C.
M505	—	D.C.	D.C.

Dimensions

Overall height: 5 ft. 3 in.
Floor space: 2 ft. 4 in. × 2 ft. 4 in.
Nett weight, approx.: 2 cwt.

Cooke Objectives, corrected for use on uncovered objects and 250 mm. tube length. These objectives are coated (see page 5) and are supplied fitted to magnetic centring mounts.

	Focal Length		Type	Numerical Aperture	Working Distance
	in.	mm.			mm.
M511†	1⅓	33	Achromatic ...	0·10	38
M512†	1	25	,, ...	0·15	17
M513†§	⅔	16	,, ...	0·28	4
M514†	½	12	,, ...	0·42	1·2
M533†	⅓	8	,, ...	0·45	2·2
M534	⅙	4	,, ...	0·85	0·46
M516†	1/12‡	2	,, ...	1·30	0·25
M517†	⅔	16	Apochromatic ...	0·30	4
M518	⅙	4	,, ...	0·95	0·12
M519	⅛	3	,, ...	0·95	0·1
M520†	1/12‡	2	Fluorite ...	1·30	0·25
M521†	1/12‡	2	Apochromatic ...	1·32	0·25

† May be used on covered specimens.

‡ Oil Immersion.

§ If the dark field equipment is obtained this objective is unnecessary as the objective M522 will serve the same purpose with the patch stop removed.

M1497 Small bottle of oil (supplied with each immersion lens).

M1498 8 oz. bottle of immersion oil.

Eyepieces

Huyghenian		*Compensating*		*Kellner*
M1501 4×	**M1511** 8×	**M1519** 4×	**M1536** 10×	**M1541** 10×
M1506 6×	**M1516** 10×	**M1526** 6×	**M1538** 12·5×	
		M1531 8×	**M1533** 15×	

Eyepieces (pairs)

Huyghenian		*Compensating*		*Kellner*
M1502 4×	**M1512** 8×	**M1520** 4×	**M1537** 10×	**M1542** 10×
M1507 6×	**M1517** 10×	**M1527** 6×	**M1539** 12·5×	
		M1532 8×	**M1534** 15×	

N.B.—For eyepiece and stage micrometers, see page 109.

M540 **Binocular Attachment** without eyepieces.

M544 **Catoptric Condenser** with magnetic mount.

Cooke Dark Ground Achromatic Objectives for use with M544, corrected for use on uncovered objects and 250 mm. tube length, and coated (see page 5)*

	Focal Length		Numerical Aperture	Working Distance
	in.	mm.		in.
M522	$\frac{2}{3}$	16	0·25	0·20
M523	$\frac{1}{3}$	8	0·45	0·09
M524	$\frac{1}{6}$	4	0·65	0·035

*N.B.—These objectives are entirely suitable for use with bright field illumination, and the change-over from dark to bright field is instantly secured by removal of patch stop, see page 35, para. 1.

M547 **Polarizing Equipment** for transmitted or incident light, consisting of Polaroid screen as polarizer in non-revolving fitting and Polaroid screen as analyser, and provision on Universal Illuminator for axial movement of analyser with scale engraved 45°-0°-45°.

M551 **Superstage** for macro work, with rectangular stop. (The circular stops provided with the centring stage can be used with this superstage.)

M552 **Vertical Illuminator** with condensing lens for use with 5·5 in. and 3·5 in. Macro Lenses.

M553 **Vertical Illuminator** with condensing lens for use with 2·0 in. and 1·375 in. lenses.

M554 **Oblique Illuminator** for use with all lenses.

Macro Lenses, Anastigmatic

	Focal Length		Aperture	Magnification
	in.	mm.		
M555	5·5	140	F/4·5	3× to 7×
M556	3·5	89	F/3·1	6·5× to 14·5×
M557	2	51	F/3·1	12× to 27×
M558	1·375	35	F/3·1	18× to 39×

M571 **Focusing and Centring Condenser Substage.**

M574 **Condenser Mount** with iris diaphragm and filter.

M1382 **Abbe Condenser** (2-lens).

M1383 **Aplanatic Condenser** (3-lens).

M1386 **Achromatic Condenser** N.A. 1·00.

M1391 **Achromatic Oil Immersion Condenser** N.A. 1·30.

M1396 **Dark Ground Condenser** for transmitted light.

M1397 **Funnel Stop** for objectives of N.A. above 1·00 when used with M1396.

Cooke Objectives for use with specimens with cover glass 0·007 in. (0·18 mm.) thick, with magnetic centring mounts.

	Focal Length		Type	Numerical Aperture	Corrected for Tube Length
	in.	mm.			mm.
M511†	$1\frac{1}{3}$	33	Achromatic ...	0·10	250
M512†	1	25	,, ...	0·15	250
M513†	$\frac{2}{3}$	16	,, ...	0·28	250
M514†	$\frac{1}{2}$	12	,, ...	0·42	250
M533†	$\frac{1}{3}$	8	,, ...	0·45	250
M526	$\frac{1}{6}$	4	,, ...	0·65	160§
M535	$\frac{1}{6}$	4	,, ...	0·85	160§
M516†	$\frac{1}{12}$*	2	,, ...	1·30	250
M517†	$\frac{2}{3}$	16	Apochromatic ...	0·30	250
M527‡	$\frac{1}{6}$	4	,, ...	0·95	160§
M520†	$\frac{1}{12}$*	2	Fluorite ...	1·30	250
M521†	$\frac{1}{12}$*	2	Apochromatic ...	1·32	250

* Oil immersion.
† Objectives may be used with or without cover glass and are as shown in table on page 39.
‡ Objective fitted with correction collar whereby deviation from prescribed cover glass thickness can be compensated.
§ Requires Corrector Lens M575.

M575 **Corrector Lens** in mount, to facilitate use of objectives corrected for 160 mm. tube length. For attachment to Universal Illuminator Unit, with tool for inserting same.

M576 **Magnetic Objective Mount**—screwed with R.M.S. thread.

N.B.—Every objective supplied with a Vickers Projection Microscope is complete with magnetic mount. Item M576 is offered separately to enable users to adapt other objectives. It is strongly recommended that mounts supplied with Cooke Objectives are not detached, as they have been carefully adjusted before leaving the factory.

M577 **Magnetic Objective Mount** for dark ground objectives (M522-M524) when used with transmitted light without catoptric condenser.

Cooke Achromatic Objectives for Crystallographic work. Objective mounts slotted to allow insertion of compensating wedge.

	Focal Length		Numerical Aperture	Corrected for Tube Length	
	in.	mm.		mm.	
M528	$\frac{1}{4}$	6	0·65	250	For uncovered specimens.
M529	$\frac{1}{6}$	4	0·65	250	Do.
M530	$\frac{1}{12}$*	2	1·30	250	For uncovered specimens or cover glass.
M531	$\frac{1}{4}$	6	0·65	160†	For use with cover glass.
M532	$\frac{1}{6}$	4	0·65	160‡	

* Oil immersion.
† Requires Corrector Lens M575.

M581 **Projection Eyepiece with iris diaphragm.**

M582 **Becke Lens** and Mount.

M1386 **Achromatic Condenser** N.A. 1·00 (this is not necessary if user has Condenser No. M1391).

M584 **Magnetic Objective Mount** as M576 but slotted to allow insertion of Compensating Wedge.

M585 **Quartz Wedge,** 6 orders.

M586 **Gypsum Plate** of the 1st order in ebonite slide.

M587 **Mica,** $\frac{1}{4}$ wave plate in ebonite slide.

M588 **Focusing Screen,** ruled with cross lines.

M650 **Focusing Screen,** with horizontal and vertical lines intersecting at centre of plate, each graduated 100 mm.

M651 **Focusing Screen,** with grid 10 cm. × 10 cm., ruled in mm., with break at intersection of 1 cm. lines.

M652 **Focusing Screen,** with grid 10 cm. × 10 cm., ruled in cm.

N.B.—Other ruled focusing screens for measurement of particles, determination of grain size, etc. (Porton Globe and Circle, McQuaid and Ehn hexagon grain size screens) are available. Particulars on request.

M589 **Screen Focusing Magnifier.**

Spares

M591 Pointolite Lamp 150 c.p. for A.C.

M592 ,, ,, 100 c.p. ,, D.C.

M593 One dozen pairs Carbons for A.C.

M594 ,, ,, ,, ,, ,, D.C.

M595 Extra $\frac{1}{2}$ plate Double Dark Slide.

M596 Two $\frac{1}{4}$ plate Adaptors for M595.

M598 Mercury Vapour Bulb for A.C. or D.C.

M599 Neon Pilot Lamp.

M608 Heat Absorbing Filter.

When ordering it is necessary to give particulars of electricity supply. It should be noted that the mercury vapour lamp on M502—M505 will not work on voltages of less than 190.

MICROSCOPE STANDS

Series

M1000

M2000

M3000

M4000