SWIFT

MICROSCOPES & OPTICAL INSTRUMENTS

J. SWIFT & SON
LONDON

SWIFT MICROSCOPES

INTRODUCTION

We have been making scientific instruments for over one hundred years and were the pioneers, in Britain, of the manufacture of polarising microscopes.

Long experience of instrument craftmanship, close association with users and active attention to improving the methods of optical and mechanical production have made the name SWIFT synonymous with fine microscopes.

In 1953 we introduced the " Century " range of microscopes ; the introduction of this new *rational* design, based on a common stand, coincided with the celebration of the firm's centenary.

" Century " instruments are now in use throughout the world, and have been designed to offer :

(*a*) Maximum freedom of choice of outfits and accessories.

(*b*) Maximum facility for adaptation and conversion.

(*c*) Greatest degree of protection against accident or misuse.

CHOICE

With the exception of a few specialised polarising instruments, all SWIFT microscopes are based upon a common stand, which can be fitted, at choice, with common components and accessories. This flexibility of design offers a free selection for any need of microscopy, and choice is not fettered by the rigid design of a limited range of models. Instruments to suit any individual requirement can be built up on the basic stand, although, for convenience of ordering we list standard outfits, such as those required for student use.

ADAPTATION

The simplest stand is a *potential research* instrument, and the common components of the rationalised design may be added to an instrument, or exchanged from one instrument to another, even after the date of the original purchase. These features are important for two reasons.

Firstly, many teaching and government laboratories have to assess their requirements within a fixed annual grant. The SWIFT design enables simple instruments to be purchased in greater quantity with the assurance that they may be subsequently developed by a small additional outlay to bring them to the standard ultimately required. Also, when changed circumstances





demand it, instruments can be converted for alternative purposes. For example, biological instruments can be converted to polarising instruments for chemical or mineralogical work.

Secondly, the demands that may be made upon an instrument are not always foreseen at the time of purchase. SWIFT instruments can be adapted to changing requirements and no instrument need become obsolete due to changing technological requirements. We ensure that the simplest versions of our " Century " models will accept the accessories and refinements which could formerly be fitted only to the more elaborate and expensive instruments.

PROTECTION

In skilled and patient hands, any microscope will last for ever, but instruments may be mis-handled or neglected.

We receive microscopes of all makes for repair, and have been able to make a careful study of the causes of their derangement ; and we are grateful for the advice we have received from users throughout the world.

By shrewd design we have tried to obviate the chance of wear or damage to our instruments, and the various protective features that we have incorporated are fully described in the catalogue.

The protective features of our instruments are of great importance when instruments are used in colleges where instruments are shared between day and evening students.

DESIGN

The design of our instruments has been based on the experience of those who use them, but in designing the present range of SWIFT microscopes, we have had to reconcile factors that are not always compatible. Function, appearance and price have made conflicting demands upon our designers.

FUNCTION

The true *function* of a microscope has been our first consideration, and will remain so. None of our traditional standards of workmanship have been sacrificed in order to reduce costs. In fact, and as will be clear from a study of our catalogue, the microscopes which are intended for student use are as well made as our research models, being based upon the same unit stand, and only the care with which *all* our instruments are manufactured permits our most simple models to be developed to research requirements.



APPEARANCE

The *appearance* of our instruments has been determined by their function, yet wherever possible, our designs have been made in harmony with modern trends. We take special care to impart a durable and pleasing finish to our instruments, because a fine appearance affords added pleasure to the user.

COST

In a competitive world, price cannot be ignored. We have only been able to make fine microscopes at realistic prices by a rationalisation of design and improved methods of production.

DEMONSTRATION

We shall always be pleased to *demonstrate* the truth of any statement in our catalogue. Instruments can be seen at any time in our London showroom, and wherever possible, our technical representatives will be glad to demonstrate instruments on customers' premises.

GUARANTEE

Our instruments are *guaranteed* for five years against faulty workmanship.

SERVICE

Our representatives will call, by arrangement, to maintain instruments in a clean and satisfactory condition, performing any necessary lubrication and adjustment, free of charge, for a period of five years from the date of purchase.

TECHNICAL WRITERS

We are proud of our instruments, and photographs and technical details will be gladly supplied, free of charge, to technical writers.

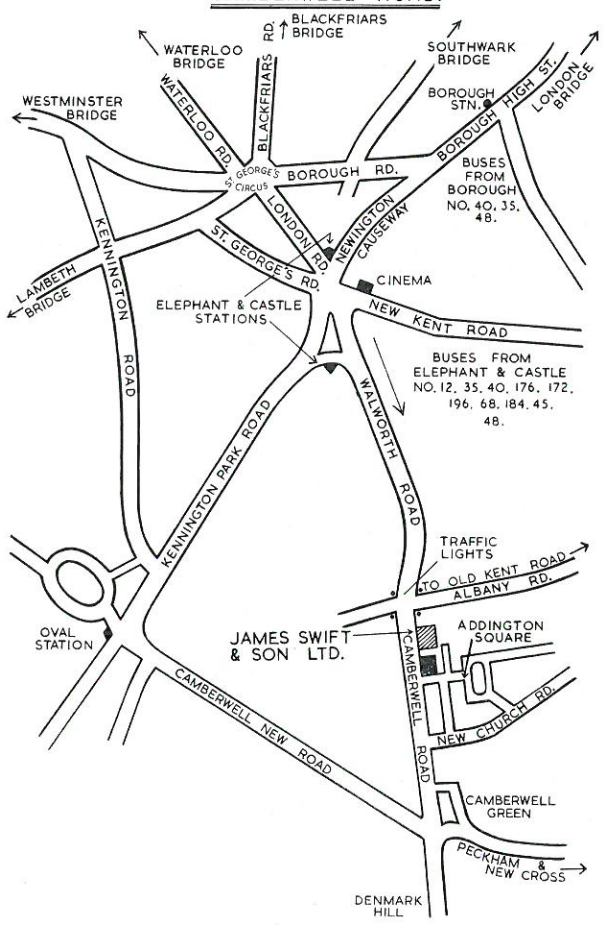
ARRANGEMENT OF CATALOGUE

In this catalogue we have presented the various aspects of our instruments in a logical form. Each section is complete in itself, yet carries cross-references which link it to complementary information in other sections. Whilst the usual standard outfits are listed, the overall scheme of the catalogue permits a microscope to be " tailor made." Our technical staff is, of course, always ready to give advice and assistance in the selection of any instrument.

Throughout the catalogue we have included general technical information, which though of necessity summarised, may, in many instances, obviate reference to text books on microscopy. We shall be pleased to supply additional copies of such information sections for student use.



SIMPLIFIED MAP
SHOWING APPROACHES TO
CAMBERWELL ROAD.



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SETTING-UP PROCEDURE

The ideal condition of illumination of a specimen under a microscope is such that the specimen appears self-luminous, and the mathematical considerations of the *resolving power* of a microscope apply to such an ideal condition.

The *visibility* of an object under a microscope depends on the contrast between the object and the background.

If a microscope is to be used to its full advantage and in the greatest comfort, the correct setting-up of the instrument is of the greatest importance.

The procedure described below applies to orthodox instruments ; the additional adjustments required of a polarising instrument are described later.

WITH SIMPLE PEARL OR OPAL LAMP

PRELIMINARY

1. Arrange the microscope for comfortable use.

2. Screw the objectives into the rotating nosepiece. One socket of SWIFT nosepieces is marked with a red dot. The objective of lowest power should be placed in this socket and the others arranged so that they come into position in the order of their power, low-medium-high, when the nosepiece is rotated in a clockwise direction as viewed from the eyepiece. Spare holes in multiple turrets should always be fitted with a dust excluding plug.

3. Position the objective of low power, for example the 16 mm. ($\times$10), and adjust the coarse body control until the objective is about $\frac{1}{2}$ inch above the stage.

4. Arrange the lamp so that its aperture is approximately 6 inches from the substage mirror of the microscope.

5. Open fully the substage iris diaphragm.

6. Remove the eyepiece and look down the tube. Adjust the mirror and lamp so that the light is coming directly up the microscope tube.

NOTE.—The plane mirror should always be employed with a condenser. The concave mirror may be used without a condenser with objectives of low power.

7. Replace the eyepiece. Position and focus the object on the stage.

NOTE.—It is customary to compute an objective to give best definition at the centre of the field, and in order to achieve this, a slight curvature of field may result, producing a reduced sharpness of image at the edges of the field. This effect is less noticeable with the objectives of high power and with the higher powers of eyepiece. SWIFT Telaugic eyepieces are designed to offset any curvature of field. (See Section D).

SUBSTAGE

8. Reduce the aperture of the iris diaphragm of the lamp and adjust the substage until the image of the lamp iris appears in focus simultaneously with the object that has already been focused. If there is no iris or other control over the aperture of the lamp, focus a pencil or other small object held before the lamp. The surface of a ' pearl ' or ' silverlight ' bulb may be focused by making a small ink mark upon its surface.

If a grey glass diffuser, placed before the lamp, is focused, the substage setting should be re-adjusted slightly, after all the following adjustments have been made, in order to lose the grain of the diffusing glass.

MIRROR

9. Adjust the mirror until the lamp iris is centrally disposed in the field of view. If no iris is fitted to the lamp, move the mirror until the field is evenly illuminated.

10. Open the iris of the lamp until its edge just disappears from view. The simple opal lamp with iris diaphragm will fill all but the objectives of lowest power when the lamp iris is fully open. If the full field cannot be illuminated, either (*a*) the cap of the lamp-house should be removed or (*b*) the lamp should be brought nearer the mirror, or (*c*) the substage condenser should be lowered.

NOTE.—With simple two-lens Abbé condenser systems, focusing the aperture of the light source may not always ensure that the full numerical aperture of the objective is being utilised. Any adjustment of the lamp iris should always be followed by the removal of the eyepiece and the observation of the back lens of the objective as described in (12) below. It may sometimes be necessary to re-adjust the position of the condenser in order to fill the objective satisfactorily.

CENTRING THE CONDENSER

11. If the substage is fitted with centring adjustments, focus the image of the closed iris diaphragm in the substage by means of the coarse adjustment of the body. The focal plane will usually be found above that of the specimen. Adjust the condenser centring screws until the image of the iris is centrally placed in the field of view.

An alternative method of centring the condenser is by closing the substage iris, removing the eyepiece, and observing the image of the substage iris at the back lens of the objective. The substage centring screws can be adjusted until the disc of light is concentric with the back aperture of the objective. This second method of condenser centring can be employed if the substage iris cannot be closed sufficiently for its edges to be brought within the field of view of an objective.

NOTE.—The mirror will need re-centring if any appreciable adjustment of the substage centring is made. Repeat (9) above.

SUBSTAGE IRIS DIAPHRAGM

12. With the eyepiece removed, open the substage iris until about three-quarters of the back aperture of the objective is filled with light. If the aperture is over-filled, glare will result and the image contrast be markedly reduced. Image relief may be increased by closing the substage iris, but if closed to excess spurious diffraction images will result. Any reduction of the aperture of the objective will, of course, result in a diminution of resolving power. (See Objectives, Section D).

HIGH POWER OBJECTIVES

13. The above procedure also applies when the objectives of higher power are used, but the initial setting-up is always best performed with an objective of low power.

OIL IMMERSION OBJECTIVES

14. When using oil immersion objectives a small drop of immersion oil should be placed upon the specimen after setting up the instrument in the manner described above and finding the desired portion of the specimen with the dry objectives of lower power.

The immersion objective should be positioned and lowered carefully by means of the coarse adjustment, viewing the objective from the side. The downward movement should be continued slightly beyond the point where the objective picks up the oil, and the probable focusing position, so that the objective must be *raised* into correct focus, by using the fine adjustment control. This procedure minimises the risk of damage to the specimen.

NOTE.—With the SWIFT range of microscopes, it is possible to set the stop screw on the body motion block so that any objective cannot be lowered far enough to injure any specimen. After this initial setting, the objective can always be lowered to the limit of travel of the coarse adjustment, without fear of damaging the specimen, and the object brought into focus by means of the fine adjustment control.

OIL CONDENSERS

15. Best results with immersion objectives are achieved when the upper lens of the condenser is oiled. A small drop of immersion oil should be placed on the upper lens and the substage raised until the under surface of the specimen makes contact with the oil, and an even film of oil free from bubbles, is spread over the lens of the condenser.

POLARISING ATTACHMENTS

16. The use of polarising attachments will be found in the pages dealing with the use of the polarising microscope.

SETTING-UP WITH AN INTENSITY LAMP

Lamps which have light sources of high intensity are fitted with condensers to enable the image of the light source to fill the aperture of objectives of low and medium power.

Such a lamp should be placed about ten inches from the mirror, and the lamp condenser adjusted until the image of the light source is focused on to the substage iris diaphragm. This can be observed by viewing the closed substage iris in the mirror. The substage is then adjusted until the image of the lamp iris appears in the same plane as the object.

The lamp iris will now permit the illuminated area of the specimen to be controlled, while the substage iris can be adjusted to fill the back lens of the objective. As stated before, if the aperture of the objective is over-filled, glare and a reduction of image contrast will result.

This type of intensity lamp should be used with objectives of the highest powers, for dark ground work where the general level of illumination is obviously reduced, and for photography. This type of lamp is also valuable when used with the polarising microscope for the conoscopic observation of small grains.

GENERAL NOTES

1. The advantage of a lamp iris diaphragm will have become apparent from the above procedural description. Theoretically, only that portion of the object which it is desired to examine should be illuminated. Light reaching the eye from the periphery of the field will not contribute to better observation of the more important centre of the specimen. This does not apply of course if it is the general overall picture which is sought.

2. It is clearly advantageous to have some means of fixing the lamp in relation to the foot of the microscope, in order that the set-up of the instrument is not easily disturbed. SWIFT lamps can be attached to the foot by means of a simple bracket.

3. After the critical setting of the substage condenser and iris, it follows that the substage iris and the focusing adjustments should not be used as a means of varying the *intensity* of the light reaching the eye. Since simple lamps are not usually controlled by a rheostat, colour filters (chosen with regard to the colour of the object), or neutral density filters should be employed to reduce the intensity of light.

A useful method of controlling the light is by the insertion of a simple polariser in the substage carrier and a polaroid disc (or *analyser*) in the eyepiece. The eyepiece can then be rotated to give any degree of light control, since complete ' extinction ' is possible when polariser and analyser are ' crossed.' Such devices cannot be employed for this purpose of course, if polarising phenomena are being observed.

4. In the setting-up procedures described, the aperture of the lamp was focused by means of the substage condenser so that it was coincident with the plane of the object. The object then appears self-luminous, which is the ideal condition. The method of illumination described with the intensity lamp, and called the Kohler method, considers the light that illuminates the specimen as emanating from the focal plane of the condenser, so that the specimen is illuminated by an infinite number of parallel beams, thus giving the greatest possible smoothness of illumination.

5. It is insufficiently stressed in manuals dealing with the use of the microscope that both eyes of the observer should remain open. Failure to do this may result in considerable eye-strain. It may take some time for the observer to ignore what he sees with his other eye, but the initial effort of adaption will be well repaid by the increased comfort and freedom from strain during long spells at the instrument.

ADDITIONAL NOTES FOR POLARISING MICROSCOPES

A polarising microscope, if used for biological investigation, should obviously be set up as critically as for observation in ordinary light. In general, however, the petrologist, mineralogist or chemist is less concerned with a critical set-up since he is not usually seeking a resolution of the highest order.

The same routine of setting up as described above, should be followed, but the following additional adjustments must be made.

PRELIMINARY ADJUSTMENTS

1. All preliminary adjustments should be made without the analyser and Bertrand lens in position. If fitted, the iris diaphragm above the Bertrand lens should be opened to its full extent.

Any substage diffuser, which is commonly supplied with a polarising microscope, should be removed for the setting-up procedure. It may be inserted later since it can sometimes produce a more satisfactory illumination for conoscopic observations. It will be clear that the introduction of any diffuser will markedly reduce the intensity of low power light sources, particularly if these are already diffused.

FOCUSING OF CROSS-LINES

2. Sharply focus the crosslines in the eyepiece by moving the eye-lens in its sliding sleeve. This setting may vary with different observers. Observers who habitually wear spectacles should retain them, or in some cases there may be insufficient movement for the crosslines to be brought into focus. The theoretically correct focus is obtained when movement of the eye produces no relative movement between specimen and eyepiece crosslines. A relative displacement is termed ' parallax.'

CENTRING OF OBJECTIVE TO STAGE ROTATION

3. Free the stage clamp and observe that one particular particle of the specimen will appear to rotate upon itself. All other parts of the specimen will rotate about this point, which is the optical and mechanical centre of the instrument. If this centre does not coincide with the cross-lines of the eyepiece, the two centring screws fitted above the nosepiece should be adjusted until the centre of rotation coincides with the intersection of the crosslines. When the objective is correctly centred, a particle of the specimen will rotate upon itself immediately under the cross-line intersection.

NOTE.—When a rotating nosepiece is used, it is obviously impossible to centre each objective individually. All objectives supplied with such a nosepiece are selected at the factory to be as par-centred and par-focalled as possible, and they should be inserted in the order described in (2) on page 1, which is the order in which they are tested at the factory. But, in general, an instrument should be centred with the highest power and any discrepancy will be less marked when returning to the lower powers.

If individual centring changers are provided with an instrument, the setting of the centring screws should be left undisturbed in their central position and the individual changers adjusted with the key provided. While adjusting, a pressure of the finger will ensure that the changer is bearing against the two adjustment screws.

Changers and objectives should be kept mounted together, to save repeated centring adjustment.

It will be apparent when centring an objective to a rotating stage, that the movement of the specimen, relative to the cross-lines, is reversed by the optical system of the microscope. A little practice will bring facility in centring.

CONDENSER CENTRING

4. The condenser of a polarising microscope is centred in the same manner as described on page 2. It may be noted that an image of the substage iris can easily be obtained if a Bertrand lens is fitted, without adjustment of the body motion or removal of the eyepiece.

Some substages used on petrological microscopes have a removable upper component mounted on a swing out arm. This should always be inserted when the condenser is checked for centring.

POLARISER

5. Always ensure that the polariser is fully pressed home into its correct operating position. Unless deliberately required otherwise the polariser should be set at zero position to give extinction with the analyser.

DAYLIGHT SIMULATION

6. Uniform lighting conditions can be ensured by placing a filter, giving 'daylight' characteristics, in the carrier below the polariser or in the condenser carrier ring.

DARK GROUND ILLUMINATION

Dark ground illuminators provide a means of illuminating transparent or semi-transparent specimens so that no direct rays pass through the objective system and the only light reaching the eye of the observer is that which is scattered by the specimen itself.

If a specimen is birefringent, a form of dark ground illumination can be obtained by the use of polarising attachments, since complete extinction is obtained when polariser and analyser are in the ' crossed ' position. Even if a specimen is not birefringent, it is possible to secure a contrast against a dark ground by immersion in suitable media. It is our contention that all microscopes should be fitted with polarising devices since they are so easily inserted and can perform so many useful functions of light control. (See page 4, note 3).

The simplest form of dark ground illumination is achieved by the insertion of opaque stops in the substage carrier to restrict the direct light from reaching the eye. Sets of ' patch stops' of various shapes and sizes can be supplied for this purpose. (See Section E).

The simple patch stops are not however satisfactory when used with objectives of the higher powers and apertures, and specially designed dark ground condensers must be employed. To reduce colour effects, such condensers are usually of a reflecting type, embodying concentric surfaces. They produce a hollow convergent cone of light, and must be focused to ensure that the apex of the cone falls on the plane of the specimen.

The procedure for setting up a SWIFT dark ground condenser is given below ; the same technique applies when such condensers are fitted to both biological and polarising instruments.

1. Set the microscope up for routine observation, as described on page 1, with a low power objective of approximately ×10 magnification. If satisfactory results are to be obtained, it is essential to have a bright source of light, as from an intensity lamp.

2. Insert the dark ground condenser, in its sleeve, in place of the usual substage condenser. If no centring devices exist on the substage, it will be necessary to mount the condenser in a centring sleeve. (MK 75. See Section E, Condensers).

NOTE.—With SWIFT polarising microscopes fitted with integral condenser systems having swing out upper components, the *lower* condenser component should be unscrewed and replaced by the dark ground condenser. This may conveniently be done by removing the centre plate of the stage. With such substage systems, the RMS sleeve is not required and the dark ground condenser screws directly into the objective thread of the condenser mount.

3. Rack up the substage until the dark ground condenser is level with the surface of the stage, *i.e.* the underside of the specimen slide.

4. Adjust the body by the coarse adjustment until the small circle engraved on the upper surface of the condenser is in focus. If the circle is not concentric with the field of view (or the crosslines of the eyepiece of a polarising microscope) adjust the substage centring screws (or the screws on the special centring sleeve) until the circle on the condenser lies in the centre of the field.

NOTE.—Should the condenser have no engraved ring upon its surface, it must be centred by observation of the cone of light falling on the specimen slide.

NOTE.—With polarising instruments, the dark ground condenser should *not* be centred by means of the *nosepiece* centring screws, or by adjusting a centring objective changer.

The polariser should be swung out from below the condenser in order to give the greatest amount of light for the dark ground illuminator.

5. Place a small drop of immersion oil on the upper surface of the condenser.

6. Lower the condenser, and place the specimen slide upon the stage, with the portion to be observed as near as possible to the centre of the stage. It is sometimes best to observe and mark such portions of a specimen when viewed before the insertion of the dark ground condenser in the substage.

7. Raise the condenser until the oil makes contact with the under surface of the specimen. Care should be taken to avoid spreading the immersion oil excessively on the stage. Adjust the condenser critically until a *spot* of light, and not a ring, is observed on the plane of the specimen. This spot represents the apex of the annular cone.

8. Remove the objective of low power and place one of high power in position. If the aperture of the objective exceeds .95 n.a. a funnel stop (MF 170) must be inserted in the objective, to ensure that no direct rays from the condenser pass through the objective. If the objective is for oil immersion, place a small drop of immersion oil in the centre of the specimen and rack down the coarse adjustment, viewing from the side until the lens enters the oil. This procedure is described on page 3. Always endeavour to set the coarse adjustment below the point of focus so that the body must be *raised* by the fine control, thus reducing the risk of damage to specimens. Focus the object critically.

9. It is possible to obtain good dark ground images with objectives of lower power than the 1/12 inch oil immersion objective. Lower powers should not however be oiled unless they are computed to be, and the funnel stop should not be used unless the aperture of the objective exceeds .95 n.a. The dark ground condenser should *always* be oiled.

USE OF THE POLARISING MICROSCOPE

A polarising microscope is essentially an ordinary compound microscope to which polarising elements and a rotating stage have been added. The appearance of many objects when placed between the polarising elements of such a microscope can provide information which it is impossible to obtain from an ordinary instrument, since every transparent crystalline body has its own unique set of optical properties, and the polarising microscope is a most valuable instrument for their determination.

Further optical accessories such as Bertrand lens, compensators, etc., are added to a polarising microscope in order to enhance the information it can give, and it is these additional features which make the instrument so apparently complex.

In the past the polarising microscope has usually been associated with the studies of the mineralogist and petrologist, and for a long time the instrument was referred to as a *petrological* microscope. In recent years, however, it has been increasingly used in other fields for the analysis and identification of materials which are not easily identifiable by the usual chemical and physical methods, particularly when the samples are very small or their destruction not permissible. Today, in addition to the traditional fields of mineralogy and petrology, the polarising microscope is used in the fields of biology, chemistry, ceramics, brickmaking, pharmacy, metallurgy, textiles, civil engineering and soil mechanics.

The setting up of a polarising microscope was described on page 5, but little reference was made to the use of the polarising features and accessories. The essential features of a SWIFT polarising microscope are described below, and their uses briefly explained. For more detailed information on the use of the polarising microscope, the reader is referred to *Crystals and the Polarising Microscope*, by Hartshorne and Stuart. (Edward Arnold & Co.)

POLARISER

The polariser is mounted immediately below the substage condenser, and intercepts the ordinary light reflected from the mirror, so that all light entering the condenser is plane polarised in one direction. The polariser may, of course, be swung out of the optical path to enable specimens to be observed in ordinary light. The polariser can be rotated, is fully graduated in degrees, and is fitted with a ' click ' position at every 90 degrees. In the zero position, the polariser vibration direction is East-West and is normal to the vibration of the *analyser*, which is mounted above the objective and will be described later.

The polariser is, in general, only used alone (that is, without being used in conjunction with the analyser) for the observation and identification of minerals which are *pleochroic*, and for the determination of the refractive indices of anisotropic or doubly-refracting materials.

Pleochroism is the variation with vibration direction of the selective absorption of coloured crystals. For example, a thin section of the mineral biotite, if rotated on the stage of the microscope, with the polariser and *not* the analyser inserted, will change from pale brown to dark brown according to the position of rotation. Hornblende, tourmaline, andalusite, aegerine, etc., are examples of minerals which exhibit pleochroism.

Methods of determining the refractive index of minerals will be described later.

ANALYSER

The analyser is mounted in a block which slides into the microscope body tube, above the objective. When biological instruments are converted for use with polarised light, the analyser is usually placed in a cap or cell above the eyepiece, and the polariser in the substage filter carrier.

The analyser direction is usually fixed, and produces a plane polarisation of the light coming through the objective, at right angles to the vibration direction of the polariser as described above. If the analyser is of the rotating type, its vibration direction is at right angles to the polariser when the analyser scale setting is at zero.

When the polariser and analyser are set at right angles they are said to be in the *crossed* position. When they are crossed and there is no birefringent object on the stage, no light reaches the eye of the observer from the mirror mounted below the condenser. The crossed position is the position of complete extinction.

NOTE.—Before the advent of ' polaroid,' all polarising elements were constructed of *nicol* prisms. The term *nicol* as in *crossed nicols* is still used, and denotes polarising elements whether or not they are of nicol prisms or ' polaroid.' The term *polars*, signifying both analyser and polariser, is sometimes used with reference to modern polaroid instruments.

Objects which possess the optical characteristics of birefringence or double refraction can be observed in colour between crossed nicols, since any doubly-refracting material has two vibration directions, and retardation of the light in one direction is not equal to that in the other. Interference takes place in the analyser when the resultant *slow* and *fast* rays vibrate in the same North-South plane, giving rise to what are called *polarisation colours*. These colours will depend on the degree of birefringence, and the thickness of the section, and in the optical orientation of the specimen with respect to the axis of the microscope. The determination of the birefringence of a specimen from its thickness and polarisation colour is described below.

ROTATING STAGE

A rotating stage is essential for the observation of objects in polarised light. It is calibrated in degrees and has a vernier reading to 0.1 degrees. It can be clamped to prevent its rotation should measuring or rotating devices be attached to the stage. Such devices may include hot stages for the observation of crystals at different temperatures and for changing the temperature (and therefore the refractive indices) of immersion media ; rotating devices for the observation and measurement of optical vectors ; and universal stages for the more complete measurement of the crystallographic properties of any particle, by the orientation of rock sections and crystals in all planes.

The centre portion of the stage of all modern SWIFT polarising microscopes is removable, in order to accommodate the swing of the circle of a universal stage, and the lower part of the body tube is machined to give clearance to the swing of the graduated arcs.

The stage can be rotated to observe the pleochroic effects already described and the twinning, twinkling and zoning of minerals, to measure the extinction angles of minerals and crystalline substances, and to enable objects to be identified by means of their polarisation colours when viewed between crossed nicols.

WEDGES AND COMPENSATORS

Immediately above the objective and the centring nosepiece, a slot is cut through the body tube, at an angle of 45 degrees, for the insertion of quartz wedges, gypsum and mica plates. The use of these plates is briefly as follows :—

Quartz Wedge

When a wedge of a uniaxial crystal such as quartz is cut parallel to the optical axis and inserted at 45 degrees, between *crossed* nicols, a series of interference colour bands appear, called Newton's Colours. The amount of retardation produced by the object on the stage can be observed by its ability to compensate the order of the colour produced by the specimen in relation to the colours of the quartz wedge. When the colour of the mineral is compensated by placing the *slow* of the wedge on the *fast* of the mineral, the true position of the colour in Newton's Scale can be assessed. Given the knowledge of the retardation obtained by using such a wedge, and the thickness of the specimen under observation, the birefringence of a mineral can be obtained and the mineral identified. Details of how to observe the interference colours and determine the thickness of specimens are given in the booklet on the Polarisation Colour Scale, by Jones and Brammall (Cat. No. MA 50). The quartz wedge is used when the birefringence of the specimen is high and when the interference colours of a crystal are high and need appreciable modification.

Sensitive Tint Plate

A gypsum plate, cut to a polarisation colour of red of the first order on Newton's Scale, when inserted between the crossed nicols, will enable the *fast* and *slow* directions of a birefringent specimen to be determined. The gypsum plate is cut so that its *slow* direction (*i.e.* the direction of greatest retardation, is parallel to its long edge. The specimen is rotated until the order of colour is raised or lowered by the maximum amount. For example, if the colour is raised, then the *fast* direction of the specimen is coincident with the *fast* direction of the gypsum plate.

In addition to gypsum such plates are often made of quartz or mica. The sensitive tint plate is useful for the study of materials of moderate birefringence.

Mica Plate, Quarter Wave

The mica plate is a cleavage plate of mica of a thickness to give a retardation of $\frac{1}{4}$ wavelength between the two vibration directions. By rotating the specimen with the mica plate inserted in the slot of the body tube, with the polariser and analyser crossed, the *fast* and *slow* directions of the specimen may be determined by the rise and fall of order of the colour. For example, a maximum rise of colour will occur when the *fast* direction of the mica plate is coincident with

the *fast* direction of the specimen. The quarter wave plate is mostly used for the determination of materials of low birefringence.

NOTE.—Wedges, gypsum, and mica plates may also be inserted in the upper body slot, in the focal plane of the eyepiece. When inserted here, the interference colour bands will appear much sharper, which is very convenient for the observation of small grains and for demonstrating the use of the wedges and plates. When the eyepiece slot is used for this purpose, it is necessary to slide the analyser from the optical path and add a cap analyser above the eyepiece. The *crossed* position of such an analyser must be set by the index line marked on the cap, since wedges and compensators can only be used between *crossed* nicols.

BERTRAND LENS

The Bertrand lens slides in and out of the body tube and permits the microscope to be converted quickly for the *conoscopic* observation of specimens. (Ordinary observation is termed *orthoscopic*). When the condenser is racked up, and with an objective of high aperture, the specimen is traversed by convergent beams of light which come to a focus in the upper focal plane of the objective. The amount of convergent light available can often be increased by the use of a substage diffuser, and with substages which have removable upper components of the condenser, the latter must be placed in position in order to achieve the necessary convergence of light. The beams of light may be assumed as emanating from the substage iris diaphragm, the theoretical focal plane of the condenser. Interference figures are produced in the upper focal plane of the objective and these figures differ for crystals having one or two optic axes. A uniaxial crystal gives a characteristic ' ring and brush ' whilst a biaxial crystal gives a figure with two ' eyes,' or *melatopes*. The complete uniaxial figure is only obtained when the section under examination is perpendicular to its optical axis, and remains unchanged when the stage is rotated. The complete biaxial figure is only obtained when the section under examination is perpendicular to the acute bisectrix of the optic axes of the crystal. If the crystal is not ideally oriented, figures will be obtained which will swing unsymmetrically about the axis of the microscope, according to the inclination of the optic axes.

Interference figures vary in presenting more colour bands according to the specimen under examination. But though the coloured bands increase and close together with greater thickness, the distance between the melatopes will remain the same.

The most comprehensive figure will be obtained when the objective has the greatest numerical aperture, but the greater the magnification of the objective, the smaller the apparent size of the figure. In general, figures are best observed with an objective of from ×30 to ×40 magnification (6 mm. or 4 mm.) having the greatest aperture possible, to enable the greatest optic axial angle to be embraced.

In general, the objective should be brought close to the specimen in order to collect the greatest cone of rays, and the condenser raised as far as possible, though more latitude is available when substage condensers of large diameter and longer focal length are employed instead of the small condensers with swing-out convergent systems which were necessarily used with nicol prisms of narrow aperture.

Most modern polarising microscopes have a pre-focused Bertrand lens, but if of the focusing type, the Bertrand lens should be adjusted to obtain the sharpest figure and this adjustment should be checked every time the eyepiece or objective is changed. In some instruments there may be an iris diaphragm mounted above the Bertrand lens and this should be adjusted to obtain the sharpest figure and to separate any interference figure from those produced by adjacent grains.

When obtaining the interference figures of a specimen it is essential, of course, that the polariser and analyser are placed in the *crossed* position, and at first, the substage iris should be open fully. The condenser and mirror should be correctly centred. (See Setting-up). Increased eyepiece magnification will increase the size of an interference figure, but only at the expense of definition.

An alternative method for observing magnified interference figures is by placing a positive lens, such as a magnifier, above the eyepiece, which is left in position. The SWIFT Becke eyepiece employs a Ramsden eyepiece which is mounted in a focusing sleeve and fits on the shoulder of any SWIFT polarising microscope. (See Section D. Special eyepieces).

Interference figures may also be observed by the method of Lasaulx, by removing the eyepiece and observing the back of the objective. A pin-hole stop, fitting into the eyepiece tube, will be found a most satisfactory accessory for the isolation of figures from small grains, though it does not permit of measurement. (See below).

GENERAL MEASUREMENTS AND OBSERVATIONS

MEASUREMENT OF GRAIN SIZES, ETC.

The insertion of a micrometer scale in the focal plane of the eyepiece will enable objects on the stage to be measured. Such a scale is an arbitrary one, however, and must be calibrated against an accurately ruled stage micrometer. Any calibration only holds true for a given combination of objective, eyepiece, and eyepiece scale. The lines on the eyepiece and those of the stage micrometer are sharply focused together and the stage micrometer shifted until certain lines on both scales coincide. It will then be easy to see how many divisions on one scale relate to the divisions on the other, and their ratio will give the absolute measure of the eyepiece divisions. For example, if 60 divisions on the eyepiece scale coincide with 0.3 mm. on the stage scale then each division of the eyepiece scale equals :—

$$\frac{0.3}{60} = 0.005 \text{ mm.}$$

Detailed information of micrometer-particle-sizing graticules is given in catalogue Section J, Graticules.

MEASUREMENT OF THE ANGLE OF THE OPTIC AXES OF CRYSTALS

The insertion of a micrometer in the focal plane of the eyepiece, as above, will enable measurements to be taken of the apparent distance between the melatopes of the isogyres of interference figures and, therefore, of the angle between the optic axes. The axes of the optical ellipsoid are the alpha, beta and gamma directions and the alpha and beta directions become the bisectrices of the acute and obtuse optic axial angles.

The linear division of the eyepiece scale is quite abitrary and must be calibrated against an angular value in conjunction with an apertometer on the stage, or what is more usual, a mineral of known optic axial angle.

From Mallard's formula :— $D = K. \sin E.$

the value of K for a given combination of condenser, objective, eyepiece, and eyepiece scale is obtained. Once K has been determined, the value of E, the optic angle in air, can be found from any measured value of D, which is the distance in terms of the arbitrary eyepiece scale, between the ' eyes ' or melatopes, of the figure.

To obtain V for E, the formula is used :— $\sin E = \text{Beta} \sin V.$

from which the value of the refractive index beta is obtained.

MEASUREMENT OF THE REFRACTIVE INDEX OF A CRYSTAL

The visibility of transparent bodies viewed under the microscope depends on the difference of refractive index between them and the fluids in which they may be immersed. Minerals in thin sections are customarily mounted with Canada Balsam and therefore may be considered as being ' immersed ' in Canada Balsam, whose refractive index is 1.54.

By closing the iris diaphragm and adjusting the substage, and with the higher power objective slightly off focus, a ring or edge of light called the Becke line, can be observed to surround minerals when their refractive indices differ from that of the surrounding medium. When the objective is raised, the ring or edge of light passes from the substance with the lower to the one with the higher index. The Becke test thus forms a simple means of identification when minerals are mounted in thin sections with Balsam or when individual crystals are observed in liquids of known refractive index.

Topaz, apatite and olivine give good results for this test, and have a refractive index greater than that of Canada Balsam. Fluorspar, nosean and leucite are examples of minerals having refractive indices lower than that of Balsam.

NOTE.—Becke line effects are also useful in obtaining ' relief ' between the constituents of rock section. On former microscopes employing swing-out convergent systems, it was customary to use the high power condenser lens for this purpose, even with the objectives of low power. An alternative to this method of obtaining ' relief ' is to rack down the substage condenser system or close the iris diaphragm. It may sometimes be useful to employ the concave mirror or the patch stops described below.

DARK GROUND AND OBLIQUE ILLUMINATION

(See Setting-up Procedure)

Objects may be observed by Dark Ground illumination by the insertion of patch stops in the swing-out carrier fitted to the substage. Such stops are only useful with objectives of low power, and different combination of stops and objectives should be experimented with so that quick observations can be made of objects which are difficult to observe in ordinary lighting.

With objectives of high power it will be necessary to use a dark ground condenser, the setting-up of which is described on page 7 of this section. Certain of the patch stops may be used to illuminate the object obliquely to permit the easy differentiation of certain crystalline substances

and for the determination of refractive index by the Schroeder van der Kolk method. The latter method should be employed with care, however, since spurious results may be obtained with different settings of the substage condenser.

DRAWING APPARATUS

The Hutchinson (squared) micrometer will be found of use for simple drawing and for the estimation of the relative proportions of the minerals present in sections under the microscope.

The Camera Lucida will be found useful for more accurate drawing of specimens viewed under the microscope. It is attached to the top of the body tube, above the eyepiece. The most suitable eyepiece is one of approximately ×6 magnification. Eyepieces of high power are not suitable for use with drawing apparatus.

The microscope should be used upright, unless the drawing board can be tilted towards the observer. With the Swift-Ives camera lucida it is, of course, necessary to tilt the board so that its surface is perpendicular to a line drawn to the reflecting prism on the drawing apparatus. If the drawing board is used in the horizontal plane, the drawing will not be in correct proportion.

The side reflecting prism should be swung out of action and the object on the microscope stage observed through the centre prism immediately above the eyelens of the eyepiece. The condenser and light sources should then be adjusted so that the object is evenly illuminated. With a sheet of paper on the drawing board, the reflecting prism should be oriented until the image of the paper or a hand or pencil placed upon it is superimposed on the field of view of the microscope.

It is important to obtain the correct relative brightness of microscope image and paper. The microscope light source may be modified by the use of neutral filters, or filters may be inserted in the drawing apparatus itself, either to reduce the light from the microscope or that of the drawing paper reflected through the prism. It may also be found useful to illuminate the paper with a separate lamp.

MODAL ANALYSIS

The speedy modal analysis of rock sections may be made by means of the Swift Automatic Point Counter. The instrument consists of an electrically operated carriage which is attached to the stage of a microscope and connected to a series of push-buttons and recording counters. It is only necessary for the observer to identify the mineral lying under the intersection of the cross-lines, and depress the push-button which has been previously labelled. A count of the particular mineral is recorded and the stage is automatically stepped so that a new portion of the specimen appears on the cross-lines.

The standard model will permit of the analysis of specimens containing up to 7 constituents, and an additional bank of 7 counters is available should extension of the standard model prove necessary.

Apart from petrological analysis, the instrument can, of course, be used for any differential analysis, with any type of microscope employing transmitted or reflected illumination.

A general description of the instrument appears in Section E (Stages and attachable stages) and full details are given in leaflet P.C.1.

CARE OF THE MICROSCOPE

When not in use, the microscope should always be kept in its case or under a dust-proof cover. (Plastic Cover, Cat. No. MA 45).

Any dust which may collect on any optical surface should be lightly removed with a camel-hair brush, or soft well-washed rag, free from fluff, or preferably with special lens-cleaning tissue. SWIFT lens-cleaning tissue is specially prepared to give a high polish to lens surfaces without scratching or leaving a fluffy residue. It is offered in packets of fifty sheets, size 3 × 4 inches. (Cat. No. MA 48).

Polarising elements should never be cleaned by pressure between thumb and finger, since the cells may be rotated in their mounts and their extinction position disturbed. Modern SWIFT polarising instruments are fitted with special dust covers to the analyser and Bertrand lens, but such optical accessories should always be left in position within the body tube. The eyepiece should not be removed from the instrument and all body and eyepiece slots should be kept closed with their sliding covers. Unused holes in multiple objective turrets should be sealed with a dust excluding plug. (Cat. No. MK 55).

The component parts of an objective should never be unscrewed. Dust should be brushed from the back lens with a camel-hair brush and the front lens cleaned with tissue. Oil and Canada Balsam should be removed with tissue moistened with xylol or ether. Alcohol should not be used. Lenses or other optical components should *never* be left soaking in such solvents, nor should objectives be immersed in the media employed in refractive index determinations. Immersion oil should be removed immediately after use.

The coarse slides of the body and substage should be lubricated periodically with good quality grease after all old grease has been removed with petrol or xylol. Lubricating oil may be used but more frequent application will be necessary in view of its tendency to ' creep.' Any mechanical movement of the microscope which may develop undue stiffness should be lubricated with a small application of good instrument oil. Immersion oil (cedar oil) should never be used to lubricate any parts of a microscope. Such oils oxidise very rapidly in air, becoming very viscous and even crystalline.

The coarse motion of the body will usually become more free with use, and the motion may be damped by adjustment of two screws at the top of the motion block. These screws, on a SWIFT instrument, act upon circular clutches and arrest the fall of the body under its own weight.

The inclination of the limb of a microscope should never be altered by straining upon the eyepiece tube. The instrument should always be inclined and carried by gripping the throat of the limb.

It is important to ensure that the door of a microscope case is fastened before lifting it. Damage is frequently caused by instruments falling from unfastened cases. SWIFT microscope cases can be supplied with special fasteners which operate independently of the lock and key.

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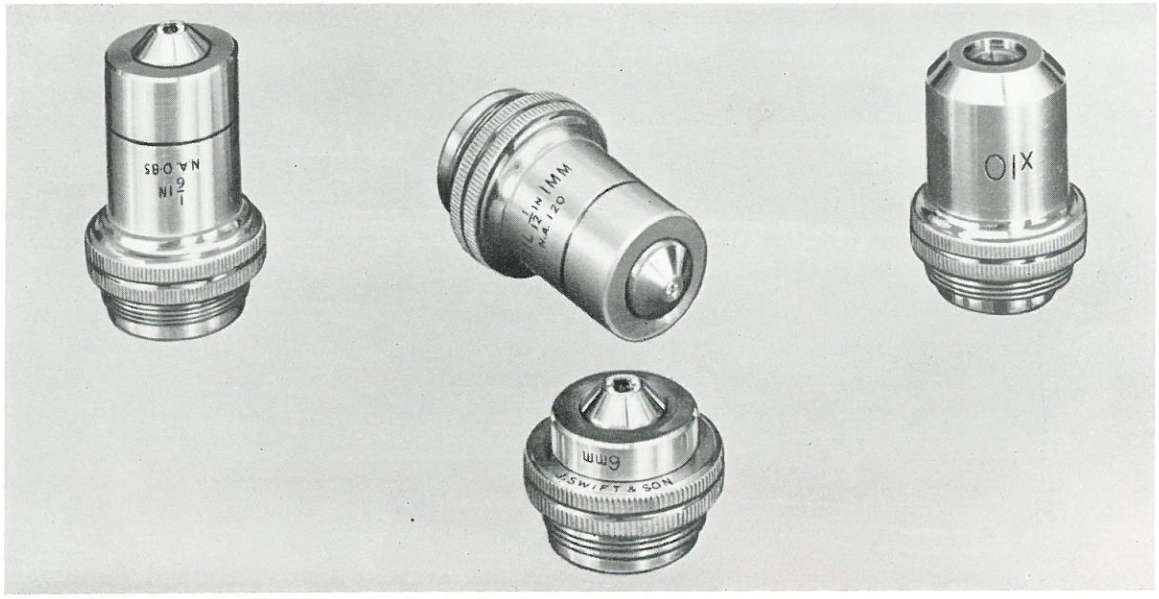
OBJECTIVES

GENERAL INFORMATION



CHOICE

The primary factors governing the choice of an objective are its magnification and numerical aperture. Other factors, such as depth of focus and working distance, are determined by these two primary factors.

MAGNIFICATION

The initial magnification of a microscope, when the object is in focus, is the ratio of the size of the image formed in the focal plane of the eyepiece, to that of the object. All SWIFT objectives are engraved with the initial magnification they give when used with the standard mechanical tube length of 160 mm., measured from the shoulder of the objective to the top of the eyepiece tube.

The eyepiece magnifies the image that is formed by the objective in the body tube, and the total magnification of the microscope is found by multiplying the initial magnification of the objective by that of the eyepiece. For example, a 4 mm. ($\frac{1}{6}$″) objective with an initial magnification of $\times 45$ and an eyepiece of $\times 10$ magnification will give a total magnification of $\times 450$.

Increasing the mechanical tube length, by raising the eyepiece or extending the draw-tube, will increase the initial magnification of the objective (though at the expense of other factors described below) and this can be found by:

$$\text{Initial Magnification} = \frac{\text{Tube length in mm.}}{\text{Focal length of objective in mm.}}$$

Inclined monocular or binocular bodies are fitted with a correcting lens to compensate for the increased mechanical tube length and restore the conditions for which the objectives are computed. This compensating lens increases the initial magnification of any objective by a factor of 1.5, since the mechanical tube length has been increased in this proportion and the formula above still holds true.

It should be noted such calculations of initial and overall magnification are only approximate, and precise measurement of the magnification of any combination of objective and eyepiece must be made by the observation of a correctly-ruled stage micrometer against a micrometer scale placed in the eyepiece.

NUMERICAL APERTURE

The numerical aperture, usually written N.A., gives the measure of the resolving power of an objective, *i.e.* its ability to resolve the separation of two adjacent points of an object. The greater the numerical aperture, the greater the resolving power.

The numerical aperture of an objective depends on the diameter of its back lens. The amount by which the back lens is filled with light can be simply observed by removing the eyepiece and directly viewing the back of the objective; if the back lens is not filled, the full N.A. of the objective is not being utilised.

It has already been shown that increasing the power of the eyepiece will increase the overall magnification, and this can also be done by projection or photographic enlargement. But since the resolving power of the objective remains unchanged, the overall magnification may be increased to a point where further increase offers no further advantage in resolving the structure of the object. The so-called Maximum Useful Magnification that can be obtained from an objective is approximately 1,000 times its numerical aperture. Thus a 4 mm. ($\frac{1}{6}''$) objective of initial magnification $\times 45$ and N.A. 0.85 will give a Useful Magnification of $\times 850$, which could be approximately achieved with a $\times 20$ eyepiece ($45 \times 20 = 900$). With a $\times 25$ eyepiece, however, the total magnification would be 1,125, which is greatly in excess of the Maximum Useful Magnification. In general, the mineralogist is less concerned with resolution than the biologist, but the greater the N.A., the greater the angular coverage of the objective, and this factor is of great importance for the mineralogist when measuring the optic axial angles of crystals from their interference figures.

DEPTH OF FOCUS

The depth of focus is the depth to which an object remains in focus without alteration of any focusing adjustment. Those familiar with photographic instruments will be aware that the greater the aperture of the lens, the less the depth of focus. Similarly, the greater the N.A. of an objective, the less its depth of focus. Therefore, in order to obtain the greatest depth of focus when thick specimens are examined, it may be advisable to use the lowest powered objective which will resolve the required detail.

The depth of focus of any objective can be increased by reducing the cone of light admitted, or by reducing the size of the back lens by means of a stop or diaphragm, but the reduction of N.A. will obviously reduce the resolving power of the objective, as described above.

The depth of focus of an objective is inversely proportional to the square of its N.A.

CORRECTION OF IMAGE

SWIFT achromatic objectives are corrected for two colours, namely, the Hydrogen C (Red) and the Hydrogen F (Blue) wavelengths. Monochromatic aberrations (spherical and coma) are corrected for the Mercury (Green) wavelength.

They are computed to be used with a mechanical tube length of 160 mm., as described under MAGNIFICATION, and for a cover glass thickness of 0.007 inches (0.18 mm.).

If objectives are not used with the correct tube length and thickness of cover glass, the quality of their images will be impaired, the impairment increasing with the higher powers. Objectives with an N.A. of less than 0.5 are for most practical purposes insensitive to variations of cover glass thickness and tube length. With objectives of higher power, a variation of cover glass thickness may be compensated by a special tube length corrector, or by varying the tube length by means of the draw-tube, increasing the tube length if the cover glass is too thin, or vice versa, if too thick. The degree to which the effect of cover glass variation can be compensated varies with the focal length and N.A. of the objective.

The thickness of the cover glass is of no importance with oil immersion objectives, since the immersion fluid has the same refractive index as the glass and the objectives are computed for this condition. But it follows that objectives computed for use with oil must not be used dry, or vice versa.

UNCOVERED AND OPAQUE OBJECTS

It follows from the above information that objectives of higher power, that is, with apertures greater than N.A. 0.5 must be specially computed when they are required for the examination of uncovered objects. This condition is usually encountered when opaque objects are viewed in reflected light, as in metallurgical and ore microscopy.

All SWIFT objectives up to a magnification of ×14 can be satisfactorily used for both covered and uncovered objects, and objectives of the higher powers can be supplied specially computed for the examination of uncovered objects, and *these are designated in our catalogues by the suffix* **M**. They are also supplied in short mounts in order to permit any reflecting system to be mounted close to the back lens in order to fill the objective and reduce glare.

Oil immersion objectives, of course, are not specially computed for uncovered objects, since these systems are homogeneous, as described above.

POLARISATION

It is possible for an optical system, without any detriment to its normal function, to contain a small amount of inherent birefringence or polarisation. This is sometimes called ' strain ' and may enter the system during manufacture of the lenses and their mounts. In the observation of

polarising phenomena it is clearly important that the optical system of the microscope should not introduce the effects which are being sought. Accordingly, all SWIFT objectives are classified under two categories, Normal and Polarisation Free, and objectives in the second category are specially mounted and selected, at extra cost, in order to be free of any inherent birefringence. *They should be ordered with the suffix PF, e.g. MS154PF or MS118MPF.*

BLOOMED OBJECTIVES

All the light reaching a lens is not transmitted, and some reflection of light from the surface is unavoidable. In the very complex lens systems of high-power microscopes, the internal reflections at the glass surfaces can sometimes impair the sharpness and contrast of the image. For the most critical work, therefore, SWIFT objectives can be supplied with their air/glass surfaces coated with a material of low refractive index, in order to reduce the reflectivity of the glass components.

This ' blooming ' of the objectives is most important with the objectives of the higher powers, particularly when they are used with vertical illuminators for the examination of opaque objects. (See above). In such investigations, the specimen is illuminated by light passing down through the objective and the glare and lack of image contrast can be very marked if the objectives are not bloomed.

SPECTACLES

In general, observers who habitually wear spectacles should retain them when using a microscope. If removed, the accommodation of their defective vision may necessitate an adjustment of the body tube in order to bring the object into focus. This adjustment will impair the parfocality of the objective and eyepiece systems.

For example, a myopic or short-sighted person will find it necessary to lower the objective if he removes his spectacles and this re-adjustment may be so great that the higher powers may strike the specimen when swung into position after initial focusing with the low power objective.

SETTING-UP

An objective is computed for certain given conditions of the tube length, cover glass thickness, etc., as described above, but the correct setting of the substage condenser also enters into the calculations of the computor.

It is important, therefore, that if an objective is to fulfil the intentions of its designer, the substage condenser should be correctly adjusted. This is particularly important in regard to field curvature.

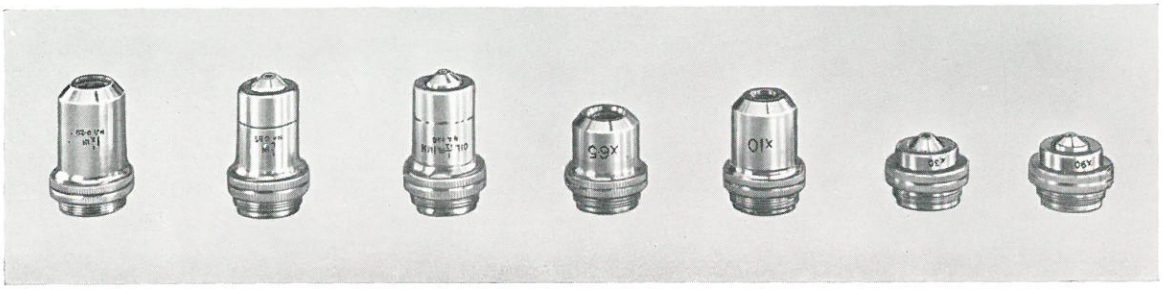
The correct setting-up of a microscope is described in **Section B**.

ACHROMATIC OBJECTIVES

Nominal Focal length		Numerical Aperture N.A.	Initial Magnification	Working Distance (Air or Oil gap) in mm.	Notes	Catalogue Number
mm.	in.					
130	5.2			Infinity at Tube Length 145 mm. 330 (13″) at Tube Length 200 mm.	Telescope objective for cathetometry, etc.	**MS130**
100	4			430 (17″) at Tube Length 145 mm. 190 (7½″) at Tube Length 200 mm.	For cathetometry, travelling and engineers' microscopes. Not parfocal with full range below	**MS100**
75	3	0·08	×1·5	90 (3½″) at Tube Length 160 mm. 60 (2½″) at Tube Length 200 mm.	Not parfocal with full range below	**MS101**
45	2	0·12	×3	45	Not parfocal with full range below	**MS102**
45	2	0·17	×3	34	Not parfocal with full range below	**MS103**
32	1½	0·12	×4	32	Parfocal with full range below	**MS104**
32	1½	0·20	×4	18	Not parfocal	**MS105**
25	1	0·16	×5	26	Parfocal. Suitable for use with universal stage	**MS106**
25	1	0·25	×6·5	13	Parfocal	**MS107**
16	2/3	0·17	×10	14	Parfocal	**MS108**
16	2/3	0·30	×10	7·5	Parfocal	**MS109**
12	1/2	0·50	×14	1·55	Parfocal	**MS110**
6	1/4	0·80	×30	0·58	Parfocal	**MS111**
6	1/4	0·80	×30	0·58	As MS111 but in short mount (not parfocal) and computed for uncovered objects and Bloomed	**MS112M**
4	1/6	0·72	×40	0·61	Parfocal	**MS113**
4	1/6	0·72	×40	0·61	As MS113 but in short mount (not parfocal) and computed for uncovered objects and Bloomed	**MS114M**
4	1/6	0·85	×45	0·41	Parfocal	**MS115**
4	1/6	0·85	×45	0·41	As MS115, but in short mount (not parfocal) and computed for uncovered objects and Bloomed	**MS116M**
3	1/8	0·90	×55	0·30	Parfocal	**MS117**
3	1/8	0·90	×55	0·30	As MS117 but in short mount (not parfocal) and computed for uncovered objects and Bloomed.	**MS118M** *See notes overleaf*

OIL IMMERSION OBJECTIVES

Nominal Focal length		Numerical Aperture N.A.	Initial Magni-fication	Working Distance (Air or Oil gap) in mm.	Notes	Catalogue Number
mm.	in.					
3	1/8	0·92	×60	0·23	Parfocal with dry systems above	**MS150**
3	1/8	0·92	×60	0·23	As MS150 but in short mount (not parfocal) and Bloomed	**MS151M**
2	1/12	1·2	×90	0·18	Parfocal	**MS152**
2	1/12	1·2	×90	0·18	As MS152 but in short mount (not parfocal) and Bloomed	**MS153M**
2	1/12	1·3	×90	0·18	Parfocal	**MS154**
2	1/12	1·3	×90	0·18	As MS154 but in short mount (not parfocal) and Bloomed	**MS155M**



NOTES

(*a*) General information regarding the selection of an objective is given on Page 1 of this section.

(*b*) All objectives in short mount, with suffix M, whilst not parfocal with those in the standard long mounts, are parfocal with respect to each other.

(*c*) The first three objectives listed above are intended for use with cathetometers, travelling microscopes, engineer's microscopes, etc., since the body racking length of an orthodox microscope would be insufficient to enable objects on the stage to be focused.

(*d*) If required for polarising instruments, any of the above objectives should be ordered with the suffix PF (Polarisation Free), *e.g.* MS154PF or MS118MPF. (See page 3).

(*e*) Objectives required for use with vertical illuminators for reflection microscopy can be supplied with ' bloomed ' surfaces, at extra cost. (See page 4).

IMMERSION OIL

Specially prepared for SWIFT oil immersion objectives. Refractive Index (ND) 1.515. In two ounce bottles.

Cat. No. MA49

LENS CLEANING TISSUE

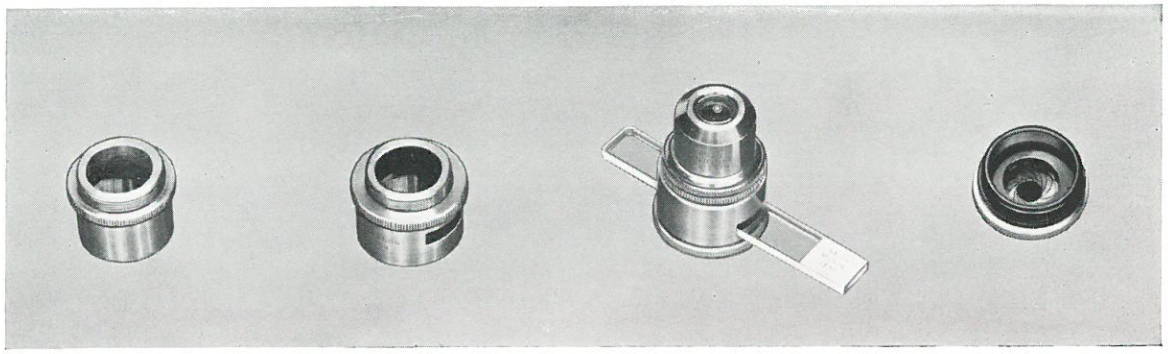
A specially prepared tissue which gives a high polish to lens surfaces without scratching or leaving a fluffy residue. In booklets of 50 sheets, size 3 ins. ×4 ins.

Cat. No. MA48

OBJECTIVE ADAPTORS AND CHANGERS

All SWIFT objectives are computed for a mechanical tube length of 160 mm. measured from the top of the eyepiece tube to the shoulder of the objective. If this tube length is not maintained the perfection of the image is impaired. (See OBJECTIVES General Information). When microscope bodies are supplied with a fixed eyepiece tube the mechanical tube length includes the depth of any nosepiece or objective-changing device. If such devices are not used, the tube length must be made good by means of an adaptor.

ADAPTORS



Plain Adaptor MK56 | *Slotted Adaptor MK57* | *Slotted Adaptor with objective and compensator* | *Davis Shutter MK59*

PLAIN ADAPTOR

When objectives are used singly the body tube should be fitted with a plain adaptor, MK56, in order to maintain the correct tube length as described above.

This adaptor will also be found useful for bringing objectives to a lower focusing position when universal stages are used with polarising microscopes, thus enabling the body to be racked higher in order to clear the rotating arms of the universal stage.

OBJECTIVE ADAPTOR .. .. Cat. No. MK56

SLOTTED ADAPTOR

The slotted adaptor, MK57, in addition to maintaining the correct tube length, carries a slot, which can be set at 45 degrees, for the insertion of quartz wedges and retardation plates when polarising devices are attached to a microscope. Conventional instruments may thus be converted to useful polarising microscopes and polarisation phenomena can be effectively observed and measured. These plates are described more fully in the section of our catalogue dealing with polarising instruments, but, briefly, they permit of the identification of optically active substances by the observation of the interference colours of Newton's Scale.

SLOTTED ADAPTOR .. .. Cat. No. MK57

CENTRING NOSEPIECE

For the serious examination of objects under polarised light, it is essential to be able to centre the objective against the rotation of the stage. All our polarising bodies are fitted with a centring nosepiece which is an integral part of the body tube, but an attachable centring nosepiece unit is available for attachment to plain body tubes, thus enabling objectives to be centred when a rotating stage is employed. The attachable centring nosepiece is also a useful accessory to a biological instrument having a substage condenser without centring facilities, enabling an objective to be centred against the substage iris diaphragm.

ATTACHABLE CENTRING NOSEPIECE .. .. .. Cat. No. MK58

DAVIS SHUTTER

This adaptor, which is mounted above the objective, enables the aperture of objectives to be varied without altering any set-up of the microscope, and is also useful in photo-micrography for increasing the depth of focus and controlling exposure.

DAVIS SHUTTER .. .. Cat. No. MK59

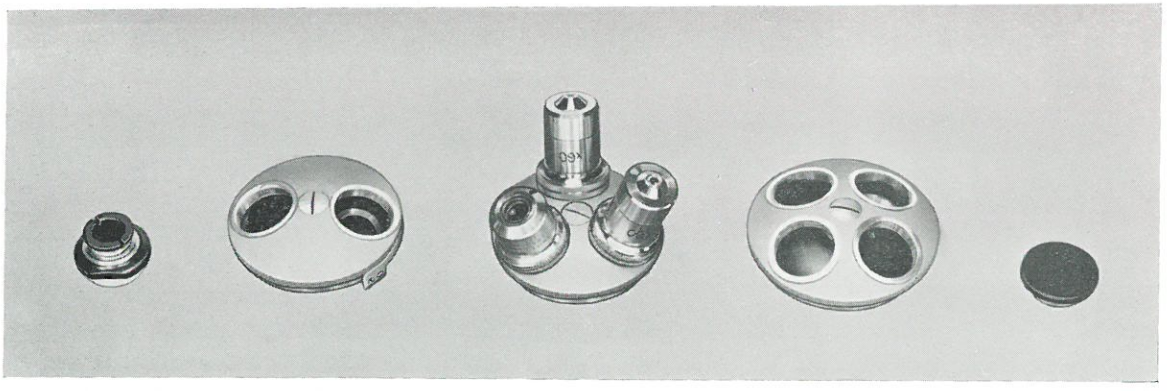
OBJECTIVE CHANGERS

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.

Objective changing devices are of two types : the objectives are either mounted in a rotating turret or nosepiece, or in separate holders which can be individually centred and quickly interchanged.

ROTATING NOSEPIECES

SWIFT rotating nosepieces are manufactured for 2, 3 or 4 objectives.



Fixing Screw | *Double MK52* | *Triple MK53* | *Quadruple MK54* | *Dust Plug MK55*

A fixing screw is supplied with all nosepieces, and carries the standard R.M.S. thread, and hese nosepieces can therefore be attached to the body tube of microscopes of any manufacture.

Unused holes in a rotating nosepiece may be effectively sealed by means of the dust plug, MK55.

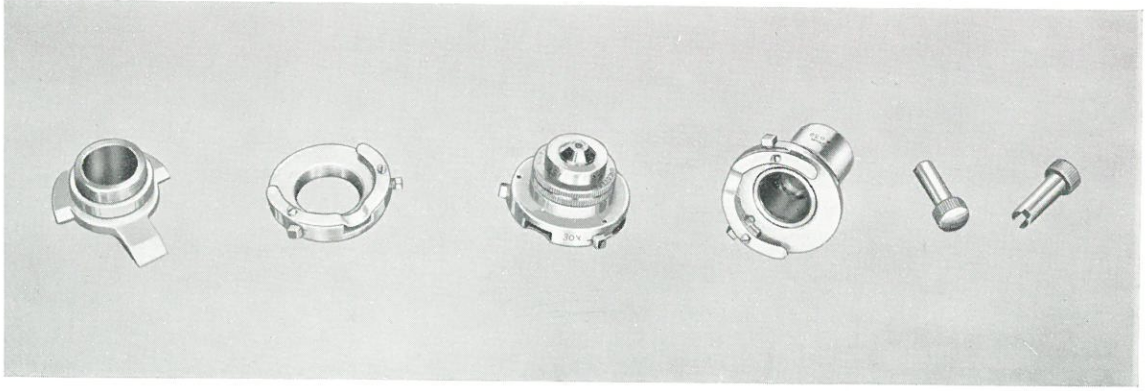
All rotating nosepieces are precision made from solid metal and give accurate centration vith par-focalled objectives. They have a peripheral bearing in addition to the central conical bearing, to achieve the greatest possible strength and stability. The outer ring runs within a lustproof flange and has pockets for the retention of lubricant. All nosepieces are fitted with a nurled grip-ring to avoid the need of handling objectives during rotation.

It is usually desirable to maintain a series of objectives in a regular order in the nosepiece nd one socket is therefore marked with a red reference dot. When objectives are ordered vith SWIFT nosepieces it is customary for us to insert the objective of the lowest power in the eference hole, and the other objectives in ascending order of power when the nosepiece is otated in a clock-wise direction, when viewed from above. In these positions, the objectives re then checked for centration and parfocalisation, and it is clearly advantageous for objectives o be always used in the position in which they are tested at the factory.

DOUBLE NOSEPIECE	Cat. No. MK52
TRIPLE NOSEPIECE	Cat. No. MK53
QUADRUPLE NOSEPIECE	Cat. No. MK54
DUST PLUG	Cat. No. MK55

CENTRING CHANGERS

When SWIFT objectives are fitted to our own rotating nosepieces they are accurately centred nd parfocalled, only a slight adjustment of the fine adjustment control being necessary when hanging from one objective to another. Over a long period of time, however, a certain amount f wear must inevitably occur, and though the design of our microscopes endeavours to prevent he possibility, objectives may be strained or thrust against objects on the stage and their centring isturbed. Obviously, no adjustment is possible in order to change the relation of the objective ockets to each other in a rotating nosepiece. Accordingly, some users prefer the individual entring changers shown below, which permit of adjustment at any time.



Tube Fitting MK 60

Objective Fitting MK 61

Centring Key

These centring changers enable objectives to be centred in their individual mounts, which are then pressed home on the tube fitting which is screwed to the body tube of the microscope in lieu of the rotating turret nosepieces described above. One changer should be ordered with each objective required so that each objective is always used with its own changer. Once an objective is centred, the adjusting screws can be locked, and only occasional re-centring will be found necessary. At no extra cost, each changer can be engraved with the power of the objective to be used with it. All changes are supplied with a centring key.

The individually centring changer has an advantage when used with microscopes having rotating stages, since the singly mounted objective remains clear of any apparatus such as a mechanical stage, point counter or universal stage, which may be mounted on the stage of the microscope, and which, when rotated, would foul any objectives projecting from the off-centre position of a revolving nosepiece.

NOTE

When centring changers are supplied with SWIFT polarising microscopes, the centring nosepiece is still retained as an integral part of the body tube, in order to maintain the standardisation of our polarising bodies and to offer a convenient quick adjustment of centring should need arise. The retention of the centring feature on our polarising bodies enables centring changers to be exchanged for rotating nosepieces at any time after purchase.

When polarising devices and a rotating stage are added to the Model S (Biological) instruments, a rotating nosepiece may be replaced by centring changers, as an alternative to using the Attachable Centring Nosepiece MK58 as described above, thus enabling objectives to be centred with the axis of rotation of the stage.

CENTRING OBJECTIVE CHANGER, TUBE FITTING .. Cat. No. MK60
CENTRING OBJECTIVE CHANGER, OBJECTIVE FITTING Cat. No. MK61
(One required per objective)

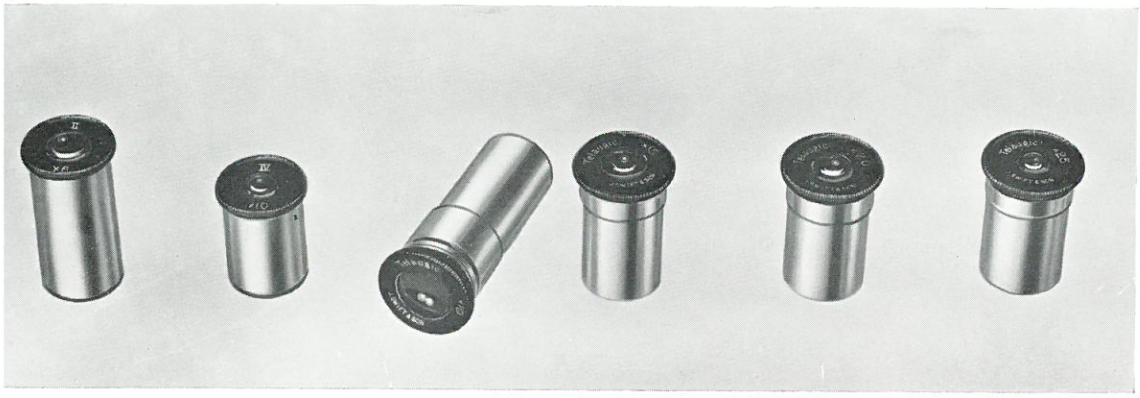
OBJECTIVE CHANGER CASES

Repeated unscrewing of objectives from their changers tends to disturb the centring adjustments previously made, and when objective changers are supplied with a microscope, the case is fitted with sockets for holding the changers assembled with their objectives.

Mahogany cases, with sliding covers, can be supplied separately to house sets of three or six changers, assembled with their objectives.

CASE FOR THREE CENTRING CHANGERS .. .. Cat. No. MK62
CASE FOR SIX CENTRING CHANGERS .. .. .. Cat. No. MK63

EYEPIECES



The eyepiece, sometimes called the *ocular*, magnifies the image of the object that is formed ›y the objective in the upper part of the microscope body.

HUYGHENIAN EYEPIECE

The most commonly used eyepiece is the HUYGHENIAN, and consists of two plano-convex :nses mounted at each end of the eyepiece tube, with the convex surfaces facing away from the ye. The lens nearest the eye of the observer is called the eye lens and the other the field lens.

The spacing of the two lenses and the ratio of their focal lengths are designed to correct for ıe chromatic difference of magnification by achieving a superimposition of the images formed y different wavelengths of light. With objectives of the highest power, however, some colour :inges inevitably occur in normal Huyghenian eyepieces.

The Huyghenian eyepiece has no external plane beyond the field lens. The focal plane of ıe eye lens, where the real image is formed, is situated between the two lenses, and an annular :op is placed at this position to control the aperture of the eyepiece and to form a support to hich graticules and micrometers can be secured. SWIFT eyepieces for polarising microscopes :e fitted with cross-lined graticules at this position and the eyepieces of lower power are also otted so that micrometers, quartz wedges, etc., can be inserted through the body tube and be ›cused by the eye lens.

When micrometers and graticules are supplied for use with Huyghenian eyepieces that are ɔt slotted, the eye lens mount must be removed and the graticule placed upon the annular stop the focal plane.

When using micrometers with an Huyghenian eyepiece, the field lens obviously assists in the agnification of the object and the combined magnification must be found by comparing the ale in the eyepiece with another on the stage of the microscope. Complex graticules, when ;ed with a normal Huyghenian eyepiece may appear coloured, because the single eye lens, hich views it, is uncorrected.

RAMSDEN EYEPIECE

It is not always convenient for measuring devices to be inserted in the middle of the eyepiece, and a RAMSDEN eyepiece is often employed. In such an eyepiece, two plano-convex lenses of equal focal length are mounted with their convex surfaces facing each other ; and the focal plane, on which the real image is formed, lies outside the combination of lenses, thus simplifying the mechanical designs of measuring and micrometer eyepieces.

The field of view of a Ramsden eyepiece is usually less than that of a Huyghenian of the same magnification value and the conditions for achromatism are not so completely satisfied as in the Huyghenian type of eyepiece. To overcome such chromatism, however, SWIFT manufacture ' TELAUGIC ' eyepieces, which comprise two achromatic compound lenses of improved design, and such compound Ramsden eyepieces give a wider and flatter field compared with Huyghenian eyepieces of equivalent magnification.

The flat field of the ' Telaugic ' eyepiece is especially desirable for photo-micrography, and the greater clearance that is permitted between the eye and the eye lens affords considerable comfort to wearers of spectacles. As stated, under OBJECTIVES, it is not desirable for observers to remove their spectacles when using a microscope, since the accommodation of their defective vision necessitates an abnormal focusing adjustment of the body tube which impairs the parfocality of the optical system. Because of their more complicated construction, ' Telaugic ' eyepieces are more expensive than the simpler types of eyepiece.

COMPENSATING EYEPIECES

Compensating eyepieces are computed to eliminate the colour fringe due to the chromatic differences of magnification which occur when ordinary Huyghenian or Ramsden eyepieces are used with fluorite and achromatic objectives. They can also be used with advantage with the higher powers of achromatic objectives in order to reduce the colour fringe of the oblique image.

' Telaugic ' Compensating eyepieces are available in the SWIFT range, and consist of two compound lenses.

SIZE

Eyepieces for SWIFT metallurgical body tubes are of standard 23 mm. diameter and will therefore fit any standard microscope.

SWIFT *polarising* bodies are fitted with eyepieces of 30 mm. diameter, giving a wider field and permitting their slotting for the insertion of micrometers and wedges.

MAGNIFICATION

All SWIFT eyepieces are engraved with their magnification value. The multiplication of this number by that engraved on the objective will give the approximate overall magnification of a microscope. See page 1 of this section.

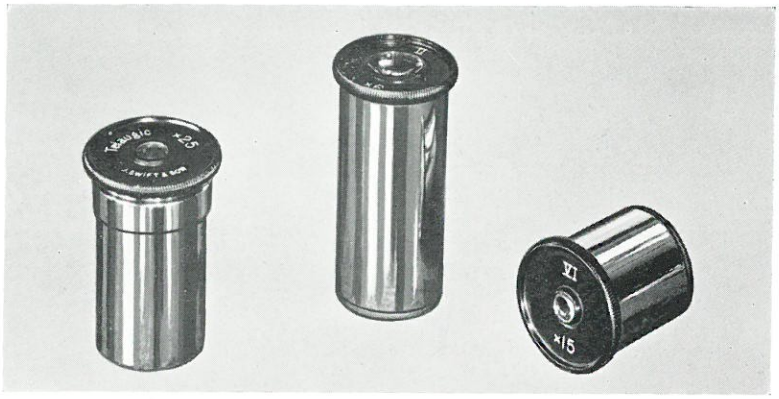
PARFOCALISATION

All SWIFT eyepieces maintain the correct length of the microscope body tube and are parfocal with each other, so that a change of eyepiece does not necessitate any appreciable alteration of the fine focusing adjustment.

MATCHED PAIRS

SWIFT eyepieces can be supplied singly or in matched pairs for binocular instruments.

STANDARD DIAMETER 23 mm.



FOR ANY STANDARD MICRO-SCOPE

Catalogue Numbers

Magnification	HUYGHENIAN	TELAUGIC	
	Normal	Normal	Compensating
×4	**MS50**	—	—
×6	**MS51**	—	—
×6F	**MS52**	—	—
×8	**MS53**	**MS70**	**MS80**
×10	**MS54**	**MS71**	**MS81**
×10F	—	**MS72**	**MS82**
×12	**MS55**	—	—
×15	**MS56**	**MS73**	**MS83**
×20	—	**MS74**	**MS84**
×25	—	**MS75**	**MS85**

NOTES

1. All the above eyepieces are parfocal with each other.
2. F : With focusing eye lens for micrometer, graticules, etc.
3. Any of the above can be supplied in matched pairs for binocular instruments.

RAMSDEN EYEPIECES (23 mm. diam.)

Simple Ramsden eyepieces of ×6 and ×10 magnification are available for measuring eye-pieces, Becke lenses, Goniometer eyepieces, etc. Although interchangeable with any of the above eyepieces, they are not completely parfocal.

RAMSDEN EYEPIECE × 6 .. .. **Cat. No. MS67**
RAMSDEN EYEPIECE ×10 .. .. **Cat. No. MS68**

LARGE DIAMETER 30 mm.
FOR SWIFT POLARISING BODIES

(SWIFT MODELS PN and PD)



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.

SPECIAL EYEPIECES



BECKE EYEPIECE

An eyepiece for use over the ordinary eyepiece of SWIFT polarising microscopes for conoscopic observation. It is an alternative to the Bertrand lens system which is mounted in the body of the microscope. It can be fitted with a graticule for the measurement of the melatopes of interference figures by the Mallard method. (See Use of the Polarising Microscope, Section B). The Becke eyepiece comprises a Ramsden eyepiece mounted in a focusing sleeve which sits on the flange which is provided on all SWIFT polarising body tubes.

BECKE EYEPIECE .. .. Cat. No. MS250

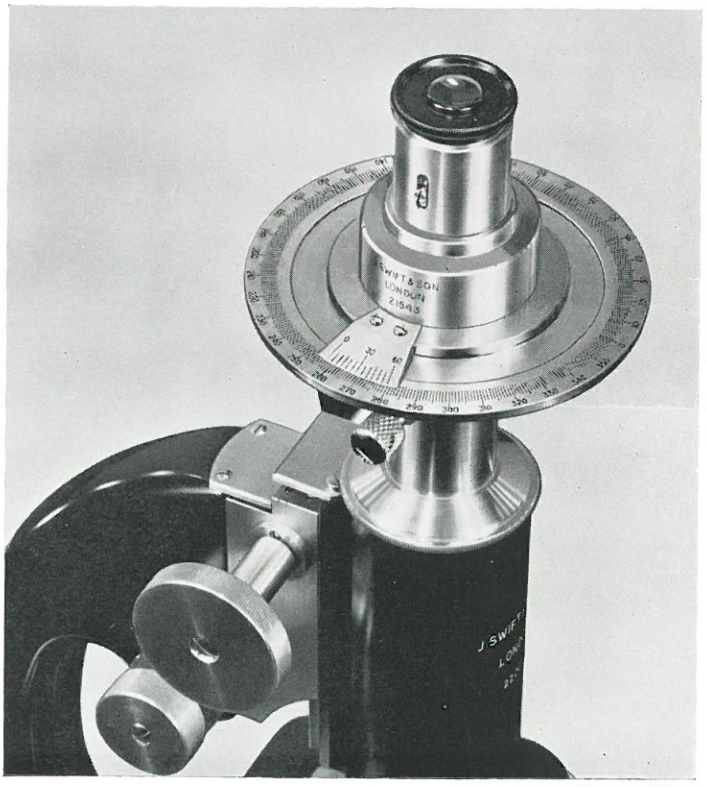
GONIOMETER EYEPIECE

An eyepiece incorporating two fine webs which can be rotated in respect of each other and the embraced angle read on a $3\frac{1}{2}$ inch calibrated circle with a vernier reading to 5 minutes of arc. The instrument is a useful accessory to microscopes having fixed stages since it enables angular measurements to be made of the facets of crystals and other substances without modification of the microscope. It also forms a useful accessory for engineers ; it can be used, for example, with the SWIFT travelling microscope L201 (See Section K).

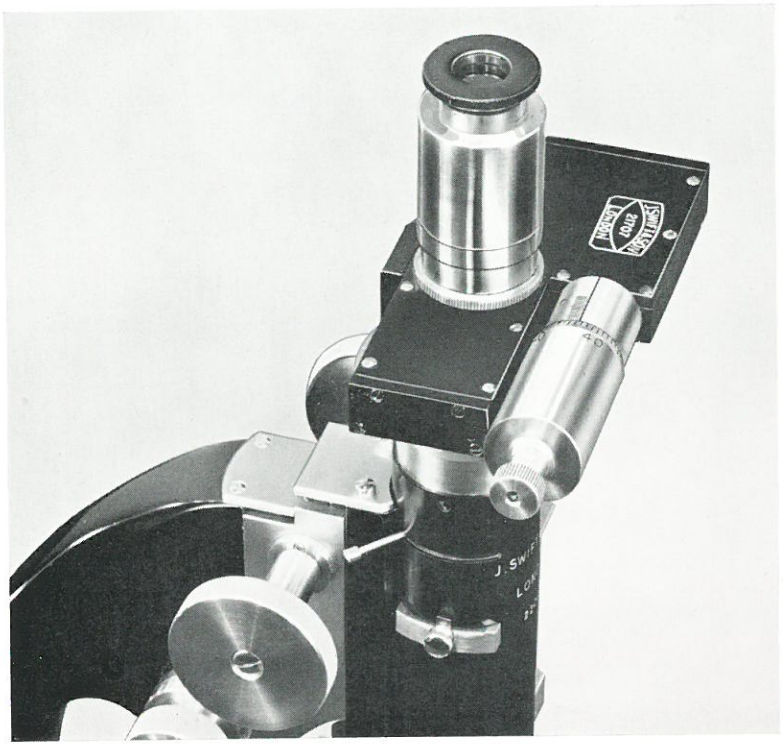
The diameter of the tube below the graduated circle is 23 mm., so that it will fit any microscope having the standard R.M.S. eyetube. The eyepiece, which is included in the instrument, is of the Ramsden type, of $\times 6$ magnification, and slides in a focusing sleeve so that the cross-webs may be sharply focused.

To special order, the goniometer eyepiece can be supplied for fitting to tubes of other sizes

GONIOMETER EYEPIECE, Cat. No. ME70



BABINET COMPENSATOR



This is an eyepiece having a double wedge of quartz with polaroid analyser, focusing eyepiece and graticule. The relative movement of the two elements is measured by means of a micrometer screw and the instrument therefore offers a very accurate means of measuring the birefringence of anisotropic materials. It is of particular interest to the glass industry.

The SWIFT Babinet compensator is usually made to fit the wide eyetubes of SWIFT polarising microscopes, but it can be supplied for attachment to any tube size, or with a bar for attachment to a stand or optical bench.

More complete information on this accessory is given in Section F. Polarising Accessories.

BABINET COMPENSATOR .. .. Cat. No. ME80

FILAR MICROMETER EYEPIECE

An eyepiece which enables very accurate measurements to be made over short distances. It can be used in conjunction with any microscope or with the SWIFT Travelling Microscope, L201, described in Section K.

The rotation of a micrometer drum moves the line graticule across the field of view. The drum is divided into 100 divisions, and each division indicates an *actual* traverse of .0002 in. (.005 mm.). Used in conjunction with an objective, the *apparent* value of the drum divisions depends on the magnification of the objective. For example, with a ×5 objective the drum would *apparently* move the graticule line a distance of .00004 in. (.001 mm.) for each division.

FILAR MICROMETER EYEPIECE for standard eyetube, 23 mm. Cat. No. ME75

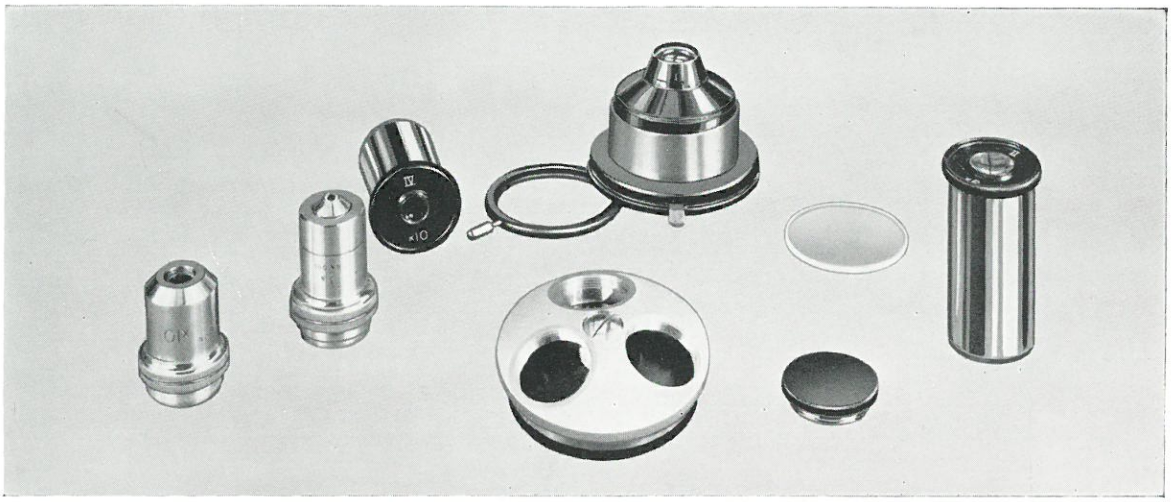
FILAR MICROMETER EYEPIECE
for SWIFT polarising eyetube, 30 mm. .. .. .. Cat. No. ME75P

SPECTROSCOPIC EYEPIECE

This eyepiece can be mounted above the eyepiece of SWIFT polarising instruments. The adjustable wedge can then be inserted through the slot of the eyepiece and body tube. Further details are given in Section F. (Polarising Accessories).

SPECTROSCOPIC EYEPIECE .. .. Cat. No. MS340

OPTICAL OUTFITS



Although any of our full range of objectives, condensers and eyepieces may be selected for use with our microscopes, the following popular outfits are itemised below and assigned embracing catalogue numbers for ease of ordering. The manner of listing the outfits will also serve as a guide to the selection and ordering of optical accessories. A full description of our Condensers will be found in Section E.

OPTICAL OUTFITS FOR POLARISING MICROSCOPES

(MODEL PN)

NOTE. All objectives supplied with polarising microscopes are polarisation free. (Suffix PF) All eyepieces are of large (30 mm.) diameter.

OPTICAL OUTFIT

Huyghenian eyepiece ×6, slotted, cross-lined, focusing.
Rotating nosepiece for 2 objectives.
Achromatic objective 25 mm. 1″ (×6.5) n.a. 0.25.
Achromatic objective 6 mm. 1/4″ (×30) n.a. 0.80.
Abbé condenser n.a. 1.20 with iris and filter carrier.

Cat. No. MS180

OPTICAL OUTFIT

As MS180 but with 2 centring objective changers and nosepiece fitting, in lieu of double rotating nosepiece.

Cat. No. MS181

OPTICAL OUTFIT

As MS180 but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS182

OPTICAL OUTFIT

As MS181 but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS183

OPTICAL OUTFIT

Huyghenian eyepiece ×6, slotted, cross-lined, focusing.
Rotating nosepiece for 2 objectives.
Achromatic objective 16 mm. 2/3″ (×10) n.a. 0.17.
Achromatic objective 4 mm. 1/6″ (×40) n.a. 0.72.
Abbé condenser n.a. 1.20 with iris and filter carrier.

Cat. No. MS184

OPTICAL OUTFIT

As MS184 but with 2 centring objective changers and nosepiece fitting, in lieu of double rotating nosepiece.

Cat. No. MS185

OPTICAL OUTFIT

As MS184 but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS186

OPTICAL OUTFIT

As MS185 but with achromatic condenser (MS205) in lieu of Abbé condenser

Cat. No. MS187

OPTICAL OUTFIT

Huyghenian eyepiece ×6, slotted, cross-lined, focusing.
Rotating nosepiece for 3 objectives.
Achromatic objective 25 mm. 1″ (×6.5) n.a. 0.25.
Achromatic objective 6 mm. 1/4″ (× 30) n.a. 0.80.
Achromatic objective 3 mm. 1/8″ (× 55) n.a. 0.90.
Abbé condenser n.a. 1.20 with iris and filter.

Cat. No. MS188

OPTICAL OUTFIT

As MS188 but with 3 centring changers and nosepiece fitting in lieu of triple rotating nosepiece.

Cat. No. MS189

OPTICAL OUTFIT

As MS188 but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS190

OPTICAL OUTFIT

As MS189 but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS191

OPTICAL OUTFIT

Huyghenian eyepiece ×6, slotted, cross-lined, focusing.
Rotating nosepiece for 3 objectives.
Achromatic objective 16 mm. 2/3″ (×10) n.a. 0.17.
Achromatic objective 4 mm. 1/6″ (×40) n.a. 0.72.
Achromatic objective 2 mm. 1/12″ (×90) n.a. 1.20.
Abbé condenser n.a. 1.20 with iris and filter.

Cat. No. MS192

OPTICAL OUTFIT

As MS192 but with 3 centring changers and nosepiece fitting in lieu of triple rotating nosepiece.

Cat. No. MS193

OPTICAL OUTFIT

As MS192, but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS194

OPTICAL OUTFIT

As MS193, but with achromatic condenser (MS205) in lieu of Abbé condenser.

Cat. No. MS195

NOTE.

Additional eyepieces or objectives can be ordered with any of the above outfits as :—

OPTICAL OUTFIT, Cat. No. MS180, plus achromatic objective 1½″ MS104 PF.

OPTICAL OUTFIT, Cat. No. MS185, plus ×10 ' Telaugic ' eyepiece MS96.

The full range of condensers will be found in Section E.

Optical outfits for use with Model M (Metallurgical) will be found in Section H.

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 and metallurgical microscopes and microscope accessories; colorimeters, strain viewer and automatic point counter. Details will be gladly sent on request.

★

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

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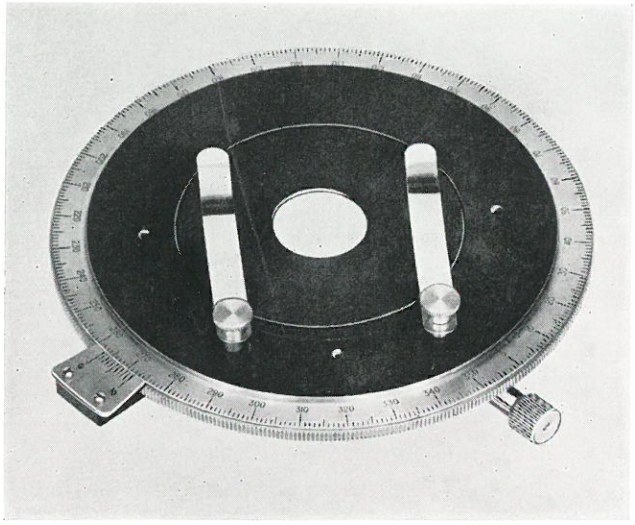
STAGES AND SUBSTAGE SYSTEMS

ANY OF THE FOLLOWING STAGES CAN BE SUPPLIED WITH SWIFT STANDS, OR CAN BE ADDED TO A STAND AFTER THE ORIGINAL PURCHASE.



Plain round stage (MK 5)

ROUND, PLAIN

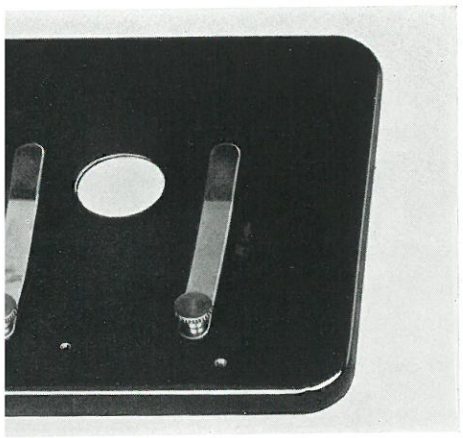
The plain rotating stage is 130 mm. in diameter and is drilled and tapped to take stage clips, mechanical stages, universal stages of most manufacturers, and the SWIFT Automatic Point Counter.

The bearing is wide, deep, and conical, and is self-compensating for wear. The bearing is practically immune from indentation by shock such as may occur with stages running on ball bearings. The stage bearing is retained by a screwed ring locked positively against a shoulder and cannot be deranged.

The stage is graduated fully, and is fitted with a vernier reading to 0.1 degrees and a clamp which affords a positive lock in any position of the stage without imparting any strain to the central bearing.

The centre (70 mm. diameter) of the plain round stage is removable for access to the condenser system and to accommodate the rotation of the circle of a universal stage. The stage is finished in black enamel, the scale and all fingered parts are chromium plated.

ROUND STAGE, PLAIN .. .. **Cat. No. MK 5**



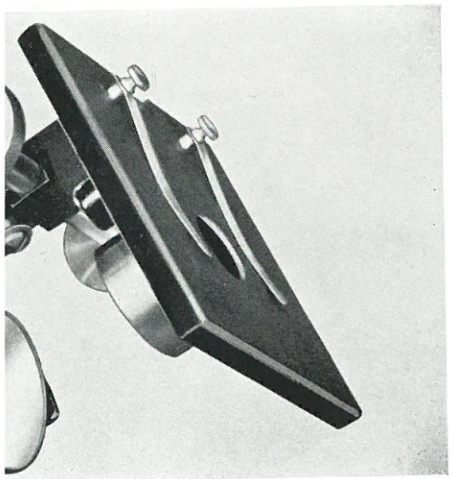
1 square stage (MK 1)

SQUARE, PLAIN

The plain square stage is 5 × 5 inches and will support a 6-inch petri dish in any position, without toppling. The stage is resistant to acids and reagents and the upper surface is flush and has no pockets to harbour oil, dirt or chemicals. It is provided with spring clips to retain the specimen. A tapped hole is provided for the attachment of the mechanical stage MK 2 (page 4).

The central hole is 1½ inches in diameter and thus enables specimens mounted under standard cover slips to be inserted and viewed on the reverse side. When oiled condensers are used the large hole permits full movement of a specimen without the spreading of the condenser immersion oil on the surface of the stage.

SQUARE STAGE, PLAIN .. Cat. No. MK 1



ge for metallurgical models only

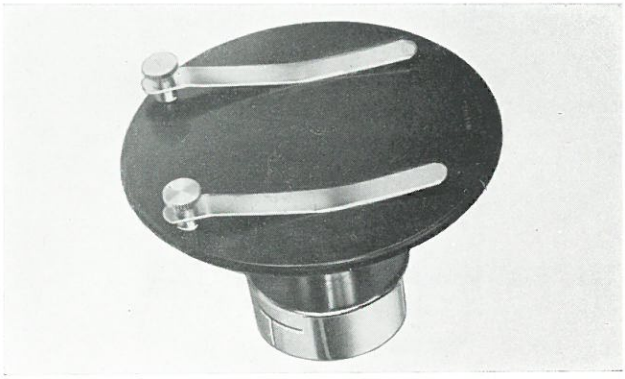
RACKING STAGE

This is supplied with our standard Model M metallurgical microscope, replacing the substage focusing system of the Models S & P. The plain square stage has a central hole, with plug, so that substage illumination may be employed. The illustration shows the simple R.M.S. condenser sleeve (MK 80) fitted to the underside of the stage, together with the double mirror. (MS 330).

MUSHROOM STAGE

This rotating stage can be instantly fitted into the sub-stage ring of our standard polarising microscope (Model P) replacing the condenser. It enables a specimen to be focused without disturbance of any vertical illuminating system employing an external illuminant. It is thus a useful adjunct to our polarising microscopes when they are fitted with reflecting illuminators for metallurgical or ore microscopy.

MUSHROOM STAGE .. .. Cat. No. MK 12



Mushroom Stage (MK 12)

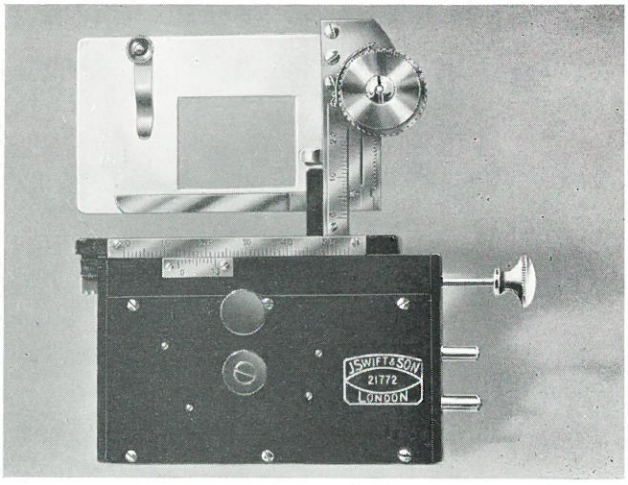
POINT COUNTER AUTOMATIC STAGE

This analytical stage can be attached to any microscope for the analysis of transparent or opaque preparations. The mechanical stage unit is coupled to an electrical recording unit. Originally designed for the modal analysis of petrological micro-sections, the instrument has since found many uses in coal petrology, ceramics, and the cement and rubber industries, as well as in biological laboratories. Full details are given in the leaflet P.C. 1 which will be sent on request.

POINT COUNTER, mechanical stage .. .. Cat. No. MK 30

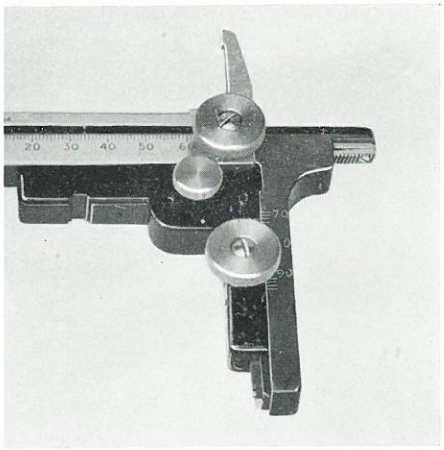
COUNTING UNIT, with 7 counters and power supply .. .. Cat. No. MK 31

ADDITIONAL BANK of 7 counters and keys .. .. Cat. No. MK 32



Automatic Point Counter (MK 30)

ACHABLE
HANICAL STAGES



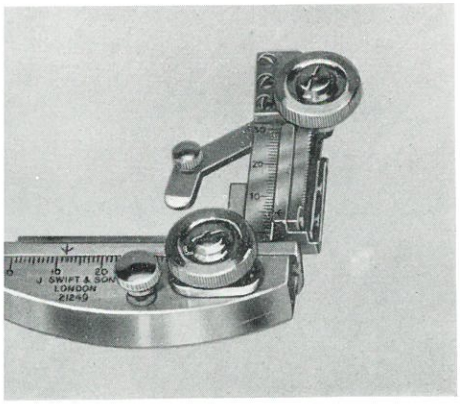
Mechanical stage (MK 2)

FOR SQUARE STAGES

An attachable mechanical stage, as shown, can be attached to the SWIFT plain square stage. Both sections of the stage are machined from solid castings, and movement is by rack and pinion in both directions. Scales, divided in millimetres, are provided on both movements. The lateral movement is 65 mm. and the transverse movement 25 mm. One clip is spring tensioned, and slides of up to 80 mm. length, of any width, can be accommodated. The stage is finished in black enamel with all controls and scales chromium plated.

NOTE.—This stage is suitable for attachment to the Model PD (' Dick ') Polarising Microscope, which has a fixed stage. It is less expensive than the MK 6 attachable stage, for round stages, described below.

ATTACHABLE MECHANICAL STAGE, for square stage .. Cat. No. MK 2



Mechanical stage (MK 6)

FOR ROUND STAGES

This mechanical stage is robustly made, yet is small in size to permit of the full movement of a rotating stage. It is fitted with scales for both movements and is machined from solid castings and finished throughout in chromium plate. It is located on the stage of the microscope by two dowel pins which engage in the stage clip holes, and is retained positively by a central fixing screw.

The slide carrier has a range of 25 mm. in each direction and will accommodate slides of 3×1 inch and 48×28 mm. Each movement is by diagonal rack and pinion, with dovetailed slides.

This stage can also be supplied for attachment to the stages of polarising microscopes manufactured by Cooke, Troughton & Simms, and Leitz. For other instruments, the dimensions of the locating and fixing holes on the microscope stage should be given when ordering.

ATTACHABLE MECHANICAL STAGE, for round stages .. Cat. No. MK 6

SUBSTAGE SYSTEMS



Plain understage sleeve (*MK* 80)

Non-centring substage (*MK* 83)

Centring condenser mount (*MK* 84)

The following substage arrangements are available with the SWIFT range of microscopes.

PLAIN UNDERSTAGE SLEEVE

This sleeve accepts condensers in mounts of standard R.M.S. diameter and will screw on to the undersurface of SWIFT plain square stages.

This simple attachment is usually only fitted on the least expensive instruments for biological work (Model SA. Section G), or beneath the racking stage of the metallurgical microscope (Model M. Section H) when examination in transmitted light is required.

The condenser is retained by a spring section of the sleeve and can be focused by a simple vertical sliding motion.

PLAIN UNDERSTAGE CONDENSER SLEEVE .. .. .. Cat. No. MK 80

NOTE.—The above sleeve cannot be fitted to rotating stages.

RACK AND PINION FOCUSING SUBSTAGE, WITH NON-CENTRING CONDENSER MOUNT

This condenser focusing system is fitted to dovetailed slides which are machined in sympathy with those of the body motion on SWIFT instruments, thus ensuring the correct alignment of condenser and objective systems. The focusing motion is by helical rack and pinion and is free from ' backlash ', and is controlled by a milled knob of 1½ inches diameter, plated in satin chrome. Upper and lower limits of travel of the condenser mount are set by positive stops so that condensers cannot be thrust through specimens or derange the mirror.

The condenser mount is pre-centred by the manufacturer and is fitted with a clamp screw so that the condenser can be retained in any desirable position which gives the iris diaphragm a convenient location. The condenser mount will accept any condensers in sleeves or fittings of standard R.M.S. diameter. It will also accept the Mushroom Stage, MK 12.

RACK AND PINION SUBSTAGE, with *non-centring* condenser mount .. .. Cat. No. MK 83

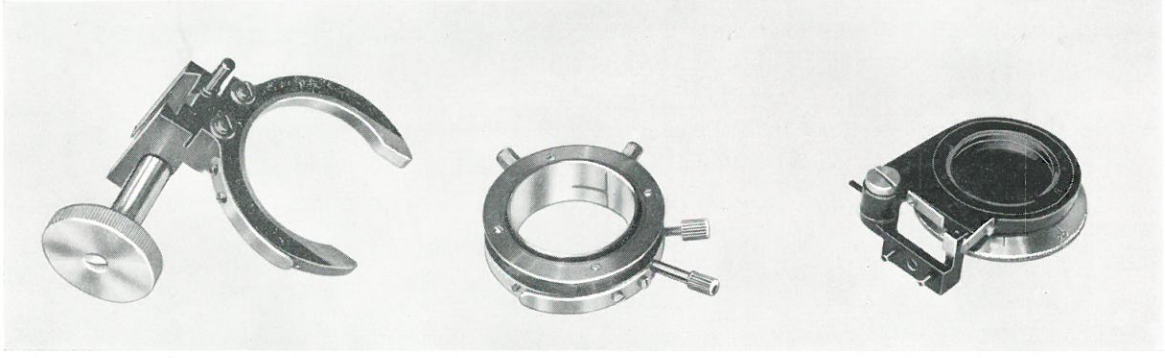
RACK AND PINION FOCUSING SUBSTAGE WITH CENTRING CONDENSER MOUNT

This condenser focusing system is identical with MK 83 above, but the condenser mount is provided with two centring screws, 120 degrees apart, which act against a third spring-loaded plunger. The mount will accept any condenser fitting of standard R.M.S. dimensions, or the Mushroom Stage, MK 12. The condenser can be clamped in any position, as described above.

RACK AND PINION SUBSTAGE, with *centring* condenser mount **Cat. No. MK 84**

RACK AND PINION FOCUSING SUBSTAGE WITH QUICK-RELEASE CENTRING CONDENSER MOUNT

This condenser focusing system is identical with MK 83 and MK 84 above, but the condenser mount is of an open horse-shoe pattern which accepts condensers which are mounted in individual centring changers. The changer has two machined slides which are inserted into the jaws of the horse-shoe bracket ; a simple rotation locates and clamps the condenser firmly in position. Each condenser changer is provided with centring screws and a clamp. Condensers can thus be pre-centred and clamped in their respective mounts and pressed home, as required, into the jaws of the special bracket.



(*MK* 85) *Without changer*

Centring condenser changer (*MK* 86)

Swing out Rotating polariser (*MF* 110)

This type of mount is most useful on research microscopes where the quick interchange of condensers, dark ground illuminators or phase-contrast accessories is required.

RACK AND PINION SUBSTAGE, with *quick-release* condenser mount, including *one* condenser changer .. .. **Cat. No. MK 85**

ADDITIONAL CENTRING CONDENSER CHANGER, for above **Cat. No. MK 86**

NOTE.—The simple understage sleeve, MK 80, described above, can be replaced on any SWIFT microscope by any of the rack and pinion systems described, but the instrument must be returned to the manufacturer for the accurate fitting of the assembly to the limb of the instrument.

Catalogue numbers have been assigned to the various substage systems for ease of reference, particularly when the conversion of an instrument is desired. The catalogue numbers of complete instruments in Section F (Polarising) and G (Biological) will be found to embrace the various substage systems.

NOTE.—Provision is made on all rack and pinion substage systems for the attachment, at any time, of a swing-out, rotating, graduated *polariser* of large diameter, moving with the condenser when the latter is focused. The polariser is, of course, fitted as standard to any polarising model. A polariser is not only useful (in conjunction with an eyepiece analyser) for the observation of birefringent specimens but offers an effective means of light control, as described in Section B (Setting-up). The polariser is large enough to permit the full aperture of the condenser to be used, as for Kohler illumination. Full details of polarising attachments are given in Section J (Accessories), but brief details are given here for convenience when selecting a substage system.

POLARISER for attachment to racking substage .. .. Cat. No. MF 110
SIMPLE POLARISER, to fit 35 mm. substage filter ring .. Cat. No. MF 113
EYEPIECE ANALYSER, to fit over standard R.M.S. eyepiece Cat. No. MF 114

RACK AND PINION FOCUSING SUBSTAGE WITH INTEGRAL CONDENSER OF VARIABLE APERTURE

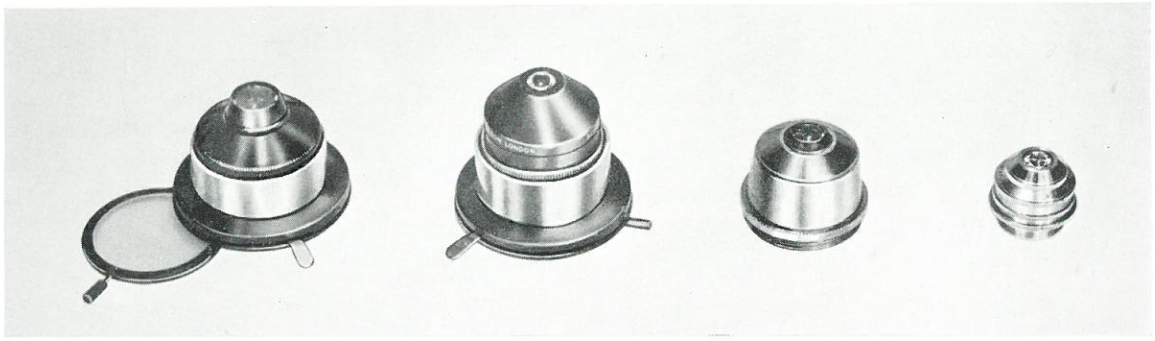
This type of substage system was once used universally with polarising microscopes which employed nicol prisms, for the difficulty of making prisms of large diameter demanded the use of a condenser system of small diameter and of variable aperture. The lower portion of the condenser is used with objectives of low numerical aperture, and an additional condenser system of high power can be inserted on a movable arm, in order to provide convergent illumination for both the orthoscopic and conoscopic observation of specimens with objectives of high power. In order to achieve a high numerical aperture, the small diameter of the condenser system necessitates a full condenser of short focal length.

The lower system is a doublet lens having an aperture of approx. 0.3 n.a. while the upper system, mounted on the swinging arm, gives a total numerical aperture of 1.0 dry, and 1.20 when oil immersed. The lower component of the condenser is mounted with a standard R.M.S. objective thread, and can thus be replaced by the Parapim Achromatic condenser of n.a. 1.40 (MS 212), by the Concentric Dark Ground Condenser (MS 215), or by any objective used as a condenser. The complete condenser unit is provided with centring screws and an iris diaphragm. Below the diaphragm is a swing-out, rotating cell for holding circular compensators, filters, diffusers, or patch stops for dark ground and oblique illumination.

Since this substage system is intended for polarising instruments, the assembly is always complete with a swing-out, rotating, graduated polariser mounted below the condenser. An additional iris diaphragm for Becke work, may be added to the lower rim of the polariser.

RACK AND PINION SUBSTAGE, with integral condenser of variable aperture .. .. Cat. No. MS 225
ADDITIONAL IRIS DIAPHRAGM TO POLARISER .. .. Cat. No. MF 155

CONDENSERS



Abbé Condenser
MS 201

Achromatic Dry
(Paragon)
MS 205

Achromatic
(Parahom)
MS 210

Achromatic Oil
(Parapim)
MS 212

GENERAL CONSIDERATIONS

The ideal condition of illumination is such that a specimen upon a microscope stage appears self-luminous, and the mathematical considerations of the resolving power of a microscope system apply to such an ideal condition. If this condition is not realised, interference effects occur between rays of light emanating from the same point source, and the interpretation of the image is made more difficult.

Although the resolving power of a microscope depends primarily on the numerical aperture and excellence of design of the objective, the condenser has a considerable effect upon the resolving ability of the objective, since it affects the degree to which the ideal self-luminous condition of the specimen can be achieved. Theoretically, if diffraction and interference effects are to be reduced to a minimum, *i.e.* the self-luminous condition be achieved, the numerical aperture of the condenser should be the same as that of the objective, though in practice, this is not always possible. Without a condenser at all, the resolution of an objective would be about two-thirds its optimum value.

The degree to which condensers are corrected for chromatic aberration will not affect the *resolution* of a microscope system, but improved correction of the condenser will improve the *contrast* between image and background, and therefore the *visibility* of an object, since glare and light scatter are reduced.

For all general work, and for most mineralogical and chemical investigation, the inexpensive Abbé condenser is quite satisfactory, and has a high aperture, though it forms an imperfect image of the source of light. For more critical research investigations, particularly in biological fields, and when fluorite and apochromatic objectives are used, and for photomicrography, an achromatic condenser should be employed.

PLAIN SLEEVE WITH IRIS DIAPHRAGM

This is a simple substage system which is only intended for inexpensive instruments with objectives of low power and utilising the condensing action of the concave mirror. More critical investigation demands the use of the condensers described below.

PLAIN R.M.S. SLEEVE, with iris diaphragm .. .. .. Cat. No. MF 151

ABBÉ CONDENSER

This is the simplest and least expensive form of substage condenser. It is a two-lens system having a maximum aperture of 1.20 when oiled, and is suitable for all routine work and for petrological and mineralogical examinations where full chromatic correction is not essential. It can be used with any of the SWIFT achromatic objectives and the dark ground illuminators. The condenser is usually mounted in a metal sleeve of R.M.S. specification, the lower part of which is fitted with an iris diaphragm and swing-out carrier of 35 mm. diameter, for filters, diffusers or patch stops. (See below). The sleeve will fit any of the substage systems described on page 5.

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

ACHROMATIC CONDENSER (PARAGON)

This is a dry achromatic condenser having three lenses, the lower two of which are compound giving a large aplanatic aperture with a high correction for spherical aberration. The maximum numerical aperture is 1.0 and the focal length is 10 mm. The diameter of the back lens combination is 18 mm. The top lens can be removed if desired and the lower portion has a numerical aperture of 0.35 with a focal length of 20 mm. The condenser is corrected for specimen slides of 1.2 mm. thickness, and is not intended for use with oil. It is mounted in the standard sleeve, with iris diaphragm and filter carrier of 35 mm.

ACHROMATIC CONDENSER (PARAGON), with iris and filter carrier .. .. Cat. No. MS 205

ACHROMATIC CONDENSER (PARAPIM)

An oil immersion condenser with a numerical aperture of 1.4 and a focal length of 5 mm. When used dry, the maximum numerical aperture is 1.0 with an aplanatic aperture of 0.95. With the top lens removed, the lower portion has a numerical aperture of 0.55 and a focal length of 13 mm. The diameter of the back combination is 0.65 inches.

The mount is provided with an R.M.S. objective thread and can be screwed directly into the lower condenser mounting of the integral petrological substage system MS 225, described on page 7. When required for use with standard R.M.S. substage systems, of any manufacture, the condenser is mounted in an adaptor of the same outside diameter as the standard condenser sleeve. The adaptor can be provided with centring screws if none exist in the substage condenser mounting.

ACHROMATIC CONDENSER (PARAPIM) .. .. .. Cat. No. MS 212

CENTRING R.M.S. ADAPTOR .. .. Cat. No. MK 75

NON-CENTRING R.M.S. ADAPTOR, with iris and filter carrier Cat. No. MK 76

NOTE.—All condensers supplied for use with polarising microscopes are specially selected to be polarisation free.

DARK GROUND CONDENSER

A concentric reflecting illuminator designed for use with objectives of medium and high power. Since its focus is achieved by reflection and not refraction, the condenser is free from chromatic aberration, and spherical aberration has been reduced to a minimum. To ensure that no direct rays from the condenser pass through the objective, the aperture of the latter should be reduced if greater than 0.95 n.a. A funnel stop can be supplied for this purpose.

The condenser is designed for use with slides of 1.0–1.2 mm. thickness, and should be oiled against the undersurface of the specimen slide, since the incident angle of the light on the surface of the slide is beyond the critical angle.

The condenser has a standard R.M.S. objective thread and will screw directly into the condenser mounting of the integral petrological substage system MS 225 described on page 7. When required for standard R.M.S. substage systems, of any manufacture, plain or centring adaptors can be used, MK 75 or MK 76, as described above.

The setting-up procedure for the dark ground condenser is described in Section B.

DARK GROUND CONDENSER, with objective screw thread .. Cat. No. MS 215

FUNNEL STOP for objectives of aperture greater than 0.95 (state make) .. .. Cat. No. MF 170

PATCH STOPS

Patch stops for dark ground and oblique illumination can be supplied in various shapes for insertion in the substage carrier ring, or the screwed ring which is fitted below the standard polariser on SWIFT polarising models.

They can be used satisfactorily with the objectives of lower power for biological purposes, and are excellent when used with a polarising instrument for the determination of the refractive indices of minerals by Becke and van der Kolk methods, or for securing diffraction relief between the mineralogical constituents of rock sections.

The stops are made in two sizes, for standard substage carrier rings and for the swing-out carrier which is fitted to the special integral condenser system, MS 225, described on page 7.

SET OF PATCH STOPS (Central disc, crescent and single and double slots), 35 mm. diameter	Cat. No. MF 175

FILTERS AND DIFFUSERS (CIRCULAR)

GREY GLASS DIFFUSER, 35 mm.	Cat. No. MF 130
Ditto 23 mm.	Cat. No. MF 130A
DAYLIGHT BLUE FILTER, 35 mm.	Cat. No. MF 131
Ditto 23 mm.	Cat. No. MF 131A
CHANCE FILTERS, SPECIAL POT GLASS, 35 mm. Ruby, red, deep orange, yellow, light and ortho green, blue-green, daylight blue, blue, purple, neutral, ultra-violet, infra-red, etc.	Cat. No. MF 132
Ditto 23 mm.	Cat. No. MF 132A

MIRROR

This item is listed in our catalogue in case of the need of replacement. It is also an item which may be ordered separately for use with Model M (Metallurgical) microscope, when substage illumination is required.

PLANE AND CONCAVE MIRRORS, in Gimbal	Cat. No. MS 330
MIRROR ONLY (Standard on all models)	Cat. No. MS 331

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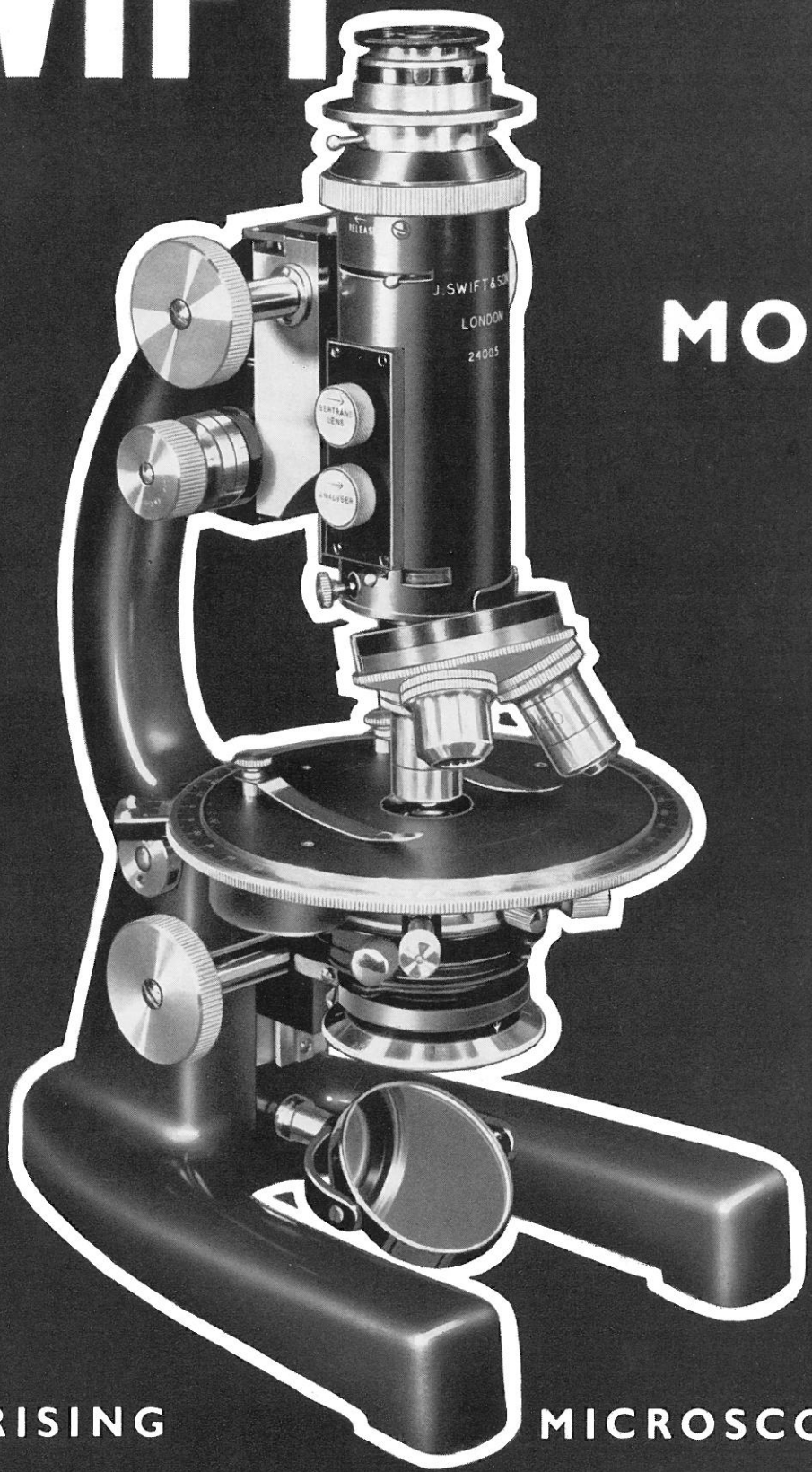


MODEL PN

POLARISING MICROSCOPES

MODEL PN

POLARISING MICROSCOPES

INTRODUCTION

When illuminated by polarised light many substances exhibit characteristics which are not observable or measurable in ordinary light. For the observation of simple polarisation phenomena, the essential features of a microscope are a polariser, mounted below the substage condenser, a rotating stage, and an analyser mounted above the objective. An instrument designed specifically for polarising work, however, is more complex because of the addition of refinements which facilitate observation and measurement of polarisation phenomena.

The polarising microscope was formerly designed purely for use in petrology since it is an invaluable weapon for the differentiation of the mineralogical constituents of rocks, and the term petrological microscope was universally used. But in recent years, the use of the instrument has been extended to many other technological fields and modern SWIFT polarising microscopes are designed to meet the needs of all investigators, including those of biological workers accustomed to work of the highest resolution. SWIFT polarising microscopes can be set up and adjusted as critically as any instrument for biological study, and have been designed to accept optical units of the standard R.M.S. specifications with which biological workers are familiar.

We believe that all microscopes should be fitted with polarising attachments, not only because the insertion of polarising elements may reveal unexpected information about a specimen, but also because the relative adjustment of polariser and analyser can often be used as an effective means of light control. (See Section B.)

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 and illustrated below.

EYETUBE

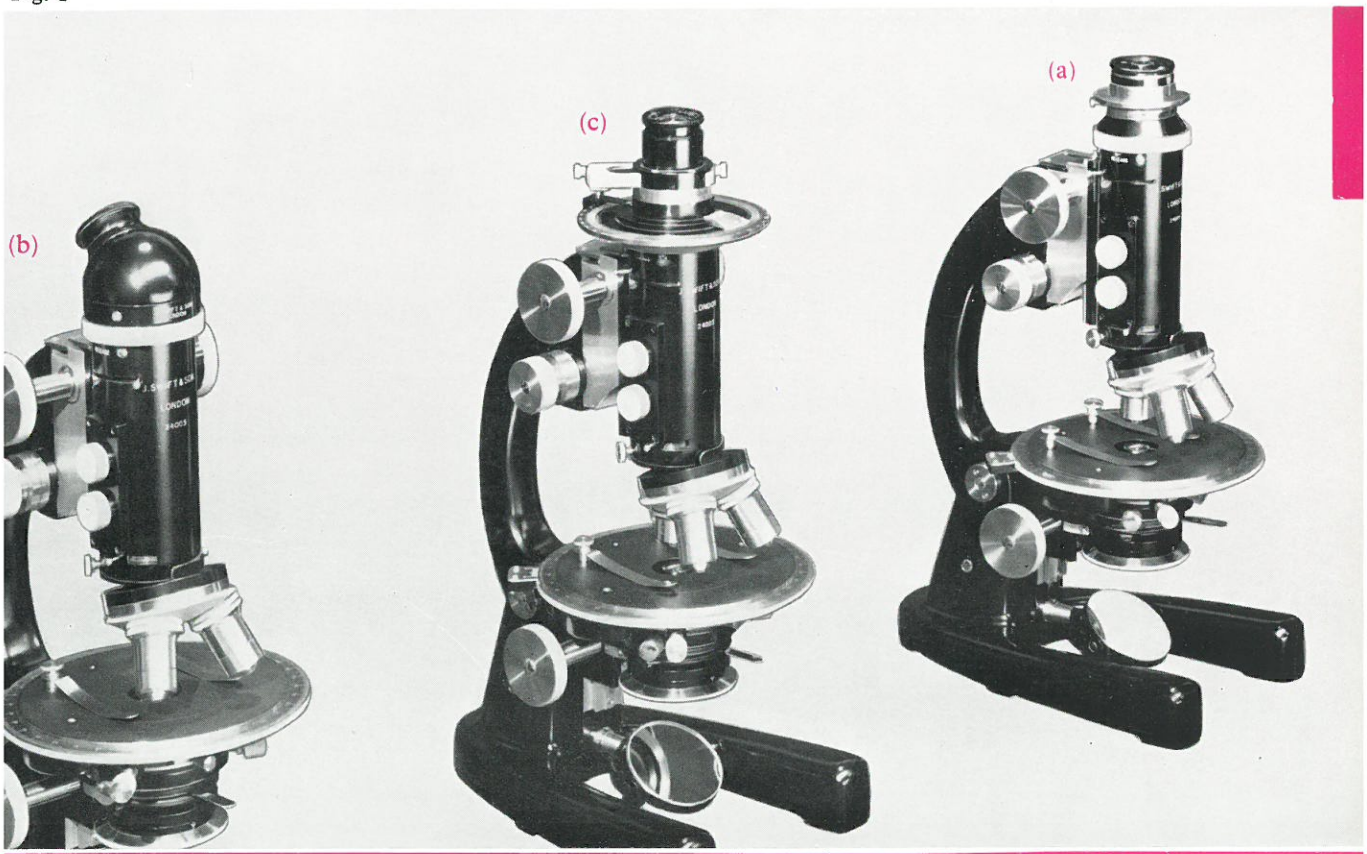
Choice of three interchangeable eyetubes, clamped in position by means of the large knurled ring shown in figure 1.

(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.

Fig. 1



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.

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.

CENTRING NOSEPIECE

Of rigid, integral construction with the body tube, and free from tremor or backlash.

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).

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*.

NOTE.—The most elementary version of the stand, as shown on Page 6, has no condenser system and the polariser is mounted on the lower part of the limb. A focusing condenser system can be added to this model at any subsequent time, but the instrument must be returned to the manufacturer for the conversion, to enable the dovetailed slides to be accurately fitted. The original polariser is utilised for the conversion, but it is mounted on the focusing system, below the condenser.

POLARISER

Of 1.2 inches diameter, rotating, divided to every 45 degrees, with ' click ' detents at every 90 degrees, and a ' click ' restraint when the polariser is concentric with the optical axis. It is fitted with filter and diffuser tray in screwed mount below the polariser cell. The thread of this cell will also accept an additional iris diaphragm with swing-out filter carrier.

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.

WEIGHT

The weight of a standard outfit, in cabinet, is approximately 24 lbs.

CATALOGUE NUMBERS

MODEL PN, Elementary Version, with fixed understage polariser, *without* condenser facilities	Cat. No. MPN 53
MODEL PN, with rack and pinion focusing substage and *non-centring* condenser mounting	Cat. No. MPN 54
MODEL PN, with rack and pinion focusing substage and *centring* condenser mounting	Cat. No. MPN 55
MODEL PN, with rack and pinion focusing substage and *quick-release centring* condenser mounting	Cat. No. MPN 56

BERTRAND LENS

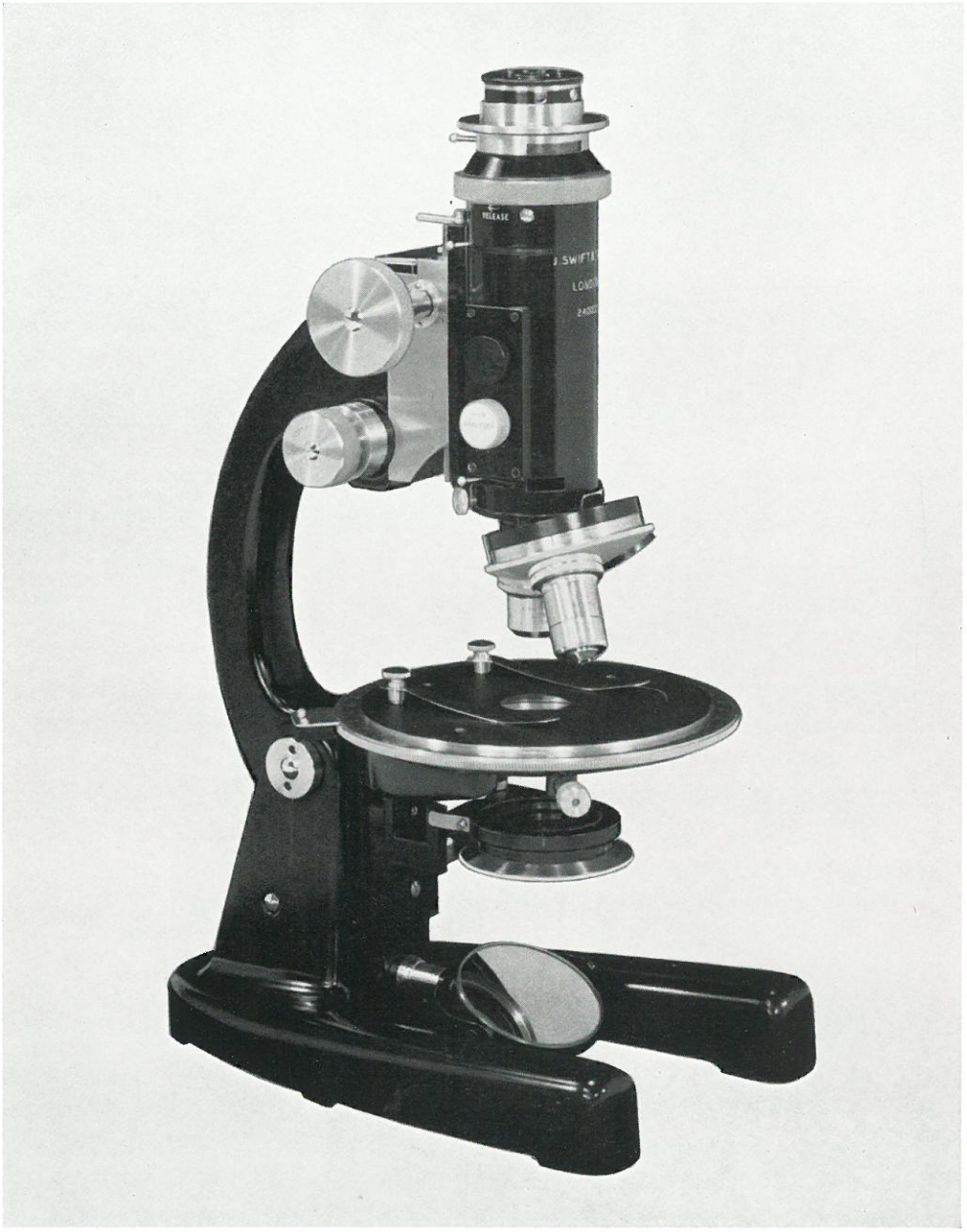
This is an optional of any instrument and if required must be specified on the order.

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

NOTE 1.—The above catalogue numbers do not embrace eyepieces, objectives, rotating nosepiece or changers (Section D) or condensers (Section E).

NOTE 2.—If more than one condenser or substage illuminator is ordered with MPN 56 an additional changer unit is desirable	Cat. No. MK 86

MODEL PN—Elementary Version



A polarising microscope with simple polarising substage without any condenser system. It represents the simplest outfit in the Model PN range.

A rack and pinion focusing substage system can be added to the stand at any time, and provision is made to permit the addition of a Bertrand Lens with iris diaphragm at a subsequent time. The polariser accepts a standard iris, MF 151.

STANDARD OUTFITS

Outfits may, of course, be selected to suit individual tastes and requirements, but the following outfits are to be recommended.

OUTFIT PA

	MODEL PN, polarising microscope, as described, *elementary* version with no condenser system, in cabinet	Cat. No. MPN 53
	Adaptor for single objectives only	Cat. No. MK 56
	Achromatic objectives (polarisation free) :	
	32 mm. (1½ inch) n.a. 0.12 (×4)	Cat. No. MS 104PF
or	25 mm. (1 inch) n.a. 0.16 (×5)	Cat. No. MS 106PF
or	16 mm. (⅔ inch) n.a. 0.17 (×10)	Cat. No. MS 108PF
	Eyepiece, Huyghenian, ×6, slotted, cross-lined focusing	Cat. No. MS 90
or	Eyepiece, Huyghenian, ×8, cross-lined, focusing	Cat. No. MS 91

OUTFIT PB

	MODEL PN, polarising microscope, as described, with rack and pinion focusing substage, in cabinet, with non-centring condenser mounting	Cat. No. MPN 54
	Eyepiece, Huyghenian, ×6, slotted, cross-lined, focusing	Cat. No. MS 90
or	Eyepiece, Huyghenian, ×8, cross-lined, focusing	Cat. No. MS 91
	Rotating nosepiece for two objectives	Cat. No. MK 52
	Achromatic objective (polarisation free) :	
	16 mm. (⅔ inch) n.a. 0.17 (×10)	Cat. No. MS 108PF
	4 mm. (⅙ inch) n.a. 0.72 (×40)	Cat. No. MS 113PF
	Abbé condenser n.a. 1.20 with iris diaphragm and filter tray	Cat. No. MS 201

OUTFIT PC

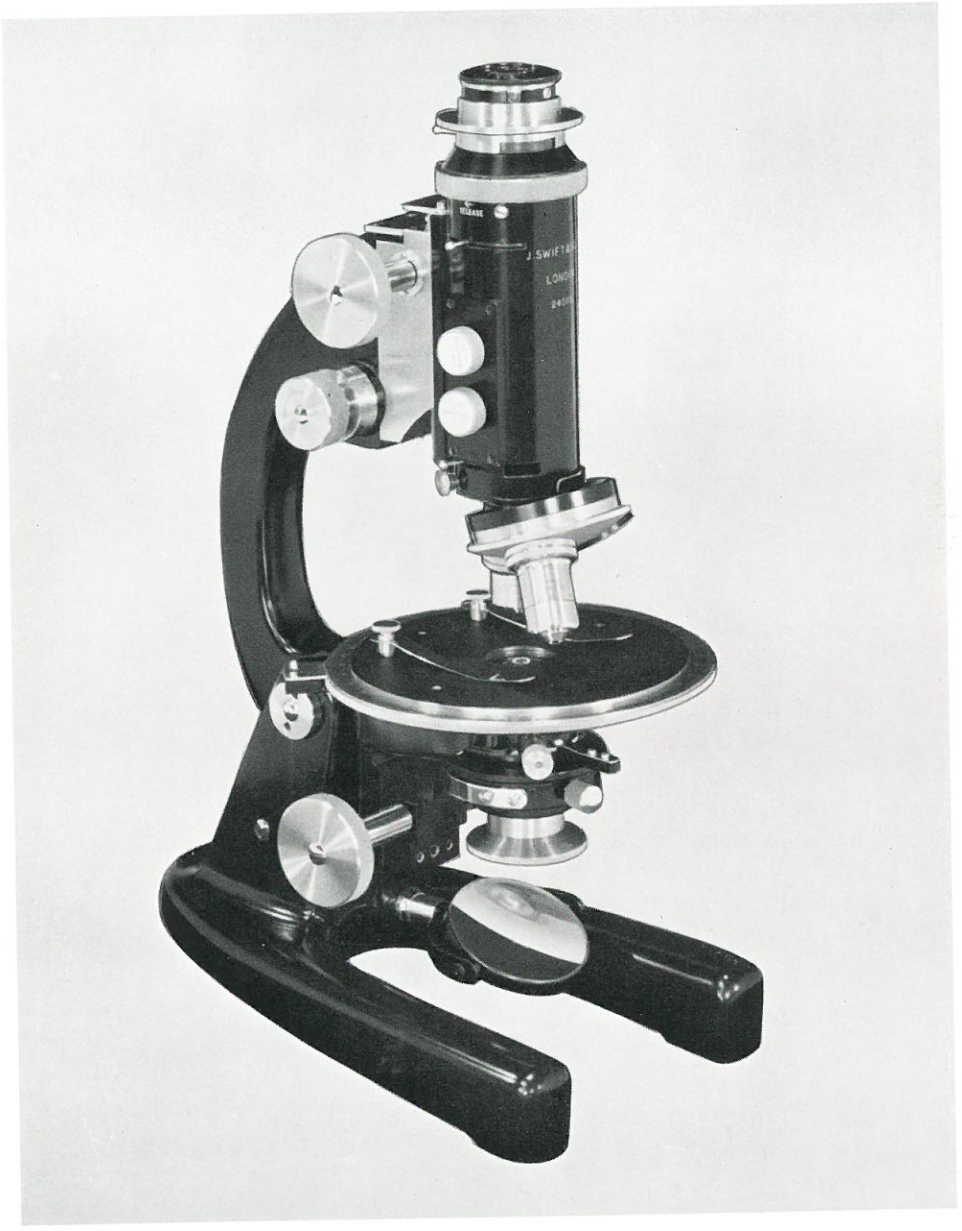
As Outfit PB but with Bertrand lens and iris diaphragm MS 251.

OUTFIT PE

	MODEL PN, polarising microscope, as described, with rack and pinion focusing substage and centring condenser mounting, in cabinet	Cat. No. MPN 55
	Bertrand lens with iris diaphragm	Cat. No. MS 251
	Eyepiece Huyghenian, ×6, slotted, cross-lined focusing	Cat. No. MS 90
	' Telaugic ' eyepiece, ×10, cross-lined, focusing	Cat. No. MS 96
	Rotating nosepiece for three objectives	Cat. No. MK 53
	Achromatic objective (polarisation free) :	
	32 mm. (1½ inch) n.a. 0.12 (×4)	Cat. No. MS 104PF
	16 mm. (⅔ inch) n.a. 0.17 (×10)	Cat. No. MS 108PF
	4 mm. (⅙ inch) n.a. 0.72 (×40)	Cat. No. MS 113PF
	Abbé condenser n.a. 1.20 with iris diaphragm and filter tray	Cat. No. MS 201
	Iris diaphragm, with filter tray, to screw below polariser	Cat. No. MF 151
	Plastic dust cover	Cat. No. MA 45

NOTE.—When ordering Outfit PA, please specify objective and eyepiece required.

MODEL PN POLARISING MICROSCOPE WITH RACK AND PINION FOCUSING SUBSTAGE AND INTEGRAL ACHROMATIC CONDENSER OF VARIABLE APERTURE



A polarising microscope to the standard specification on pages 2–5 but with substage condenser of variable aperture. The upper component is mounted on a swing-out arm and can be inserted for use with high power objectives and removed so that the lower powers may be filled. The Bertrand lens, as shown, is optional, and if required it must be stated on order.

The illustration opposite shows the Model PN instrument, to the specification given on pages 2-5, and identical with other versions of the standard model with rack and pinion focusing substage systems, but having an integral centring condenser with removable upper ' convergent ' system. The condenser is achromatic and has five lenses, the lower portion being a doublet of n.a. 0.30, for use with objectives of low power. The upper three-lens system can be swung into the optical path for use with objectives of high aperture for orthoscopic and conoscopic observation. The complete condenser system has a numerical aperture of 1.0 dry and 1.20 when oiled.

The type of substage supplied with this version of the Model PN, was customary when nicol prisms of narrow cross-section were employed to achieve polarisation, and has, in general, been superseded by substage systems using condensers of large diameter in standard R.M.S. sleeves, working in conjunction with polarisers of large diameter. Large polarisers have been made possible by the introduction of polaroid. The upper lens system was frequently inserted, even with objectives of low power, in order to obtain ' relief ' between the various constituents of a rock specimen, *i.e.*, by virtually maladjusting the condenser system, as when achieving Becke diffraction effects. Similar effects are obtainable with the later type of substage by racking down the condenser or by manipulating the iris diaphragm above the condenser. The ' split ' type of substage has been retained in our range for the benefit of those who are most accustomed to its use.

The condenser is included in the catalogue reference of the instrument, since it forms an integral part of the substage system. The lower portion can be unscrewed, however, and replaced by a dark ground condenser (MS 215) or by the oil immersion condenser, ' Paripim,' of n.a. 1.40 (MS 212), both of which have standard R.M.S. objective threads. The condenser system can also be replaced by objectives themselves, since these can sometimes serve as convenient condensing systems.

An iris diaphragm is placed below the condenser, with a swing-out rotating cell for circular compensators, filters, diffusers, and patch stops for dark ground and oblique illumination. An additional iris diaphragm may be mounted below the polariser for Becke work requiring narrow parallel light, Cat. No. MF 155.

NOTE.—The polariser used with the condenser system described above is mounted in a cell of the same design as those described on Page 5, but it is of smaller diameter than the standard polarising unit.

MODEL PN POLARISING MICROSCOPE, with integral condenser system, in cabinet .. .. Cat. No. MPN 57

Optional : BERTRAND LENS, with iris diaphragm .. .. Cat. No. MS 251

NOTE 1.—An allowance is made if no cabinet is required.

A plastic dust cover can be supplied .. .. Cat. No. MA 45

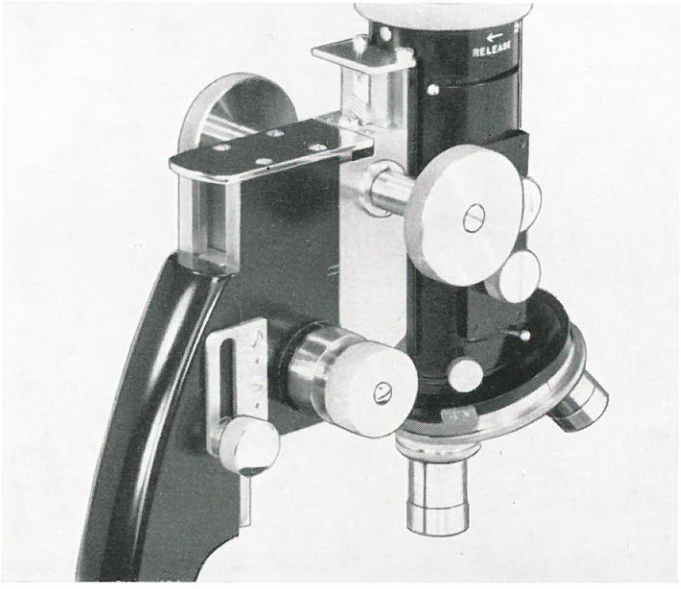
NOTE 2.—The instrument as described includes the achromatic condenser, but does not include eyepieces, objectives and rotating nosepieces or changers. These are listed in Section D.

SPECIAL MODELS PN
WITH EXTENDING LIMB

Any version of the Model PN 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, as shown below. The feature is also of advantage when vertical illuminators are fitted to the body for the examination of large opaque specimens.

NOTE.—The Leitz 5-axis universal stage can be attached to the standard models but full rotation is not possible because the large graduated drum, rotating on the horizontal axis, will not pass below the upper part of the limb. Thus, in standard models, the rotation with such a universal stage is approximately 300 degrees. Full rotation of 3- and 4-axis stages can be achieved, however, on all standard models with the fixed limb.



Any model with the extending limb is simply designated by the suffix S (*for Special*) *e.g.* :

MODEL PN, Polarising Microscope, with rack and pinion centring substage, with extending limb .. .. .. **Cat. No. MPN 55S**

MODEL PN, Polarising Microscope, with condenser of variable aperture, with extending limb .. .. .. **Cat. No. MPN 57S**

MODEL PD ('DICK')

Model PD, whilst built to the same general specification of the standard model, differs in that it has a rigid, fixed, square stage, and the polariser and analyser are coupled together and rotate simultaneously about the stage. This type of instrument is, of course, more expensive than an instrument with a rotating stage, but the design offers many advantages.

A wide range of objects, mineralogical or biological, that might be difficult to mount upon a rotating stage, can be very simply accommodated upon the fixed stage. Also, apparatus can be mounted on the stage whose use would be precluded if rotation were necessary. For example, when the optical properties of minerals are being determined at different temperatures, as in measurements of refractive index, the fixed stage obviates the need of rotating an elaborate heating arrangement, with trailing wires or pipes. The Model PD can also be used in a horizontal position, to examine specimens immersed in liquids in deep cells that could not be rotated on conventional instruments.

Since the intersection of the crosslines of the eyepiece move on the axis of rotation of the instrument and are accurately centred by the manufacturer, there is no need of centring devices in the body tube, as on conventional instruments, and delicate centring adjustments are obviated. Throughout the full rotation, the smallest objects will remain stationary, relative to the intersection of the crosslines.

SPECIFICATION

LIMB

The limb is solid and has an adjustable inclination joint. The dovetailed slides of body and substage focusing systems are machined in sympathy with each other. The foot is of the standard pattern. The limb swings rigidly in the foot support and there is an accurate location of its vertical and horizontal positions. The standard coarse and fine adjustments are fitted to the body motion, and all dovetailed slides are individually lapped. The limb is fitted with plane and concave mirrors, in gimbals.

ANALYSER

The analyser is of POLAROID and is mounted in an hermetically-sealed cell as described on page 4, and is held in an adjustable mount immediately above the eyepiece. The cell is of large diameter and of small depth, and does not restrict the field of view of the eyepiece, thus overcoming the disadvantages which were unavoidable when deep and narrow nicol prisms were employed in eyepiece analysers.

The analyser can be rotated independently in its mount, which is divided at intervals of 5 degrees, and a spring detent locates the zero position when the analyser is crossed with the zero position of the polariser. The analyser is hinged, and can be swung easily from the optical axis.

EYEPIECE TUBE

The eyepiece tube is of large diameter and takes any of the eyepieces of 30 mm. diameter which are offered with our standard polarising instruments. One slotted eyepiece *must*, however, be ordered with any outfit, since a slot is essential if wedges are to be inserted between the polars at 45 degrees to the crossed position. The Huyghenian eyepieces of ×6 and ×8

magnification can be slotted for use with Model PD. The slot in the body is provided with a sliding dust cover and special metal carriers are provided to accommodate wedges and other compensating plates. The slot will also accept SWIFT standard micrometers mounted in vulcanite holders.

POLARISER

The polariser is also of POLAROID and is fitted on the racking system of the substage. It can be rotated independently in its mount, which is divided at every 45 degrees, and can be swung out of the optical axis when desired.

Both analyser and polariser are moved synchronously by means of helical gears at either end of an axle which extends or contracts with any movement of the substage or body focusing controls. The coupling is achieved by a splined shaft which is free from shake or ' whip.' The coupled optical systems of body and substage can be rotated by either of two milled heads, one of which is placed near the eyepiece and the other below the stage, opposite the substage focusing control. The lower knob can be operated with the hand placed comfortably upon the table.

The rotating system is devoid of any tendency to give backlash, and polariser and analyser retain their true relative positions throughout the full circle of rotation. The rotating mechanism can be damped or clamped by means of a knob at the upper end of the coupling. The rotation of the optical system relative to the stage is measured on a divided circle of 3 inches diameter, which is attached to the upper gear wheel, well below the level of the eyepiece. The circle can be read by a vernier to 5 minutes or 0.1 degrees, in the same way that the movement of the conventional rotating stage is measured.

SUBSTAGE SYSTEM

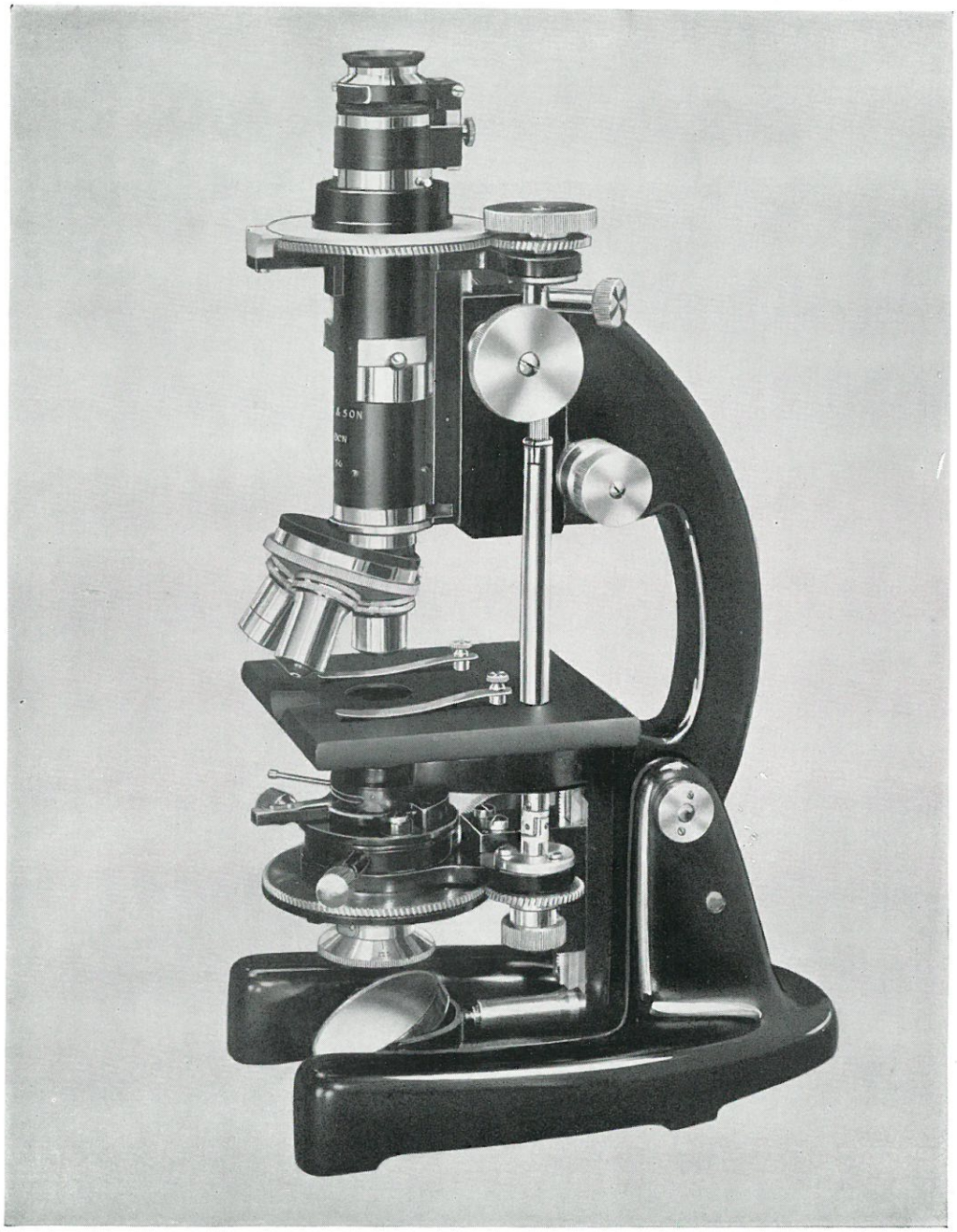
The substage is focused by a helical rack and pinion of standard design, and the condenser mounting is provided with centring screws. The substage is the same as substage MS 225, with achromatic condenser of variable aperture, as offered with our standard Model MPN 57, and described in page 9 and in Section E, but has certain small mechanical differences necessitated by its coupling to the helical gear.

The achromatic condenser is of course, included with the stand. The lower doublet has a numerical aperture of 0.30 and the top component, mounted on an arm, can be swung in and out of the optical axis, and has a three-lens system which gives a total aperture of 1.0 dry and 1.20 when oil immersed. The lower system is used for objectives of low power, which can be completely filled, and the upper component is swung in for orthoscopic and conoscopic observation with the high powers.

The lower portion of the condenser is mounted with a standard R.M.S. objective thread, and can thus be replaced by the Parapim condenser of n.a. 1.40 (MS 212), the concentric dark ground illuminator (MS 215, Section E) or by any objective used as a condenser.

An iris diaphragm is placed below the condenser with a swing-out, rotating cell for circular compensators, filters, diffusers and patch stops for dark ground and oblique illumination. An additional iris diaphragm may be mounted below the polariser for Becke work requiring narrow parallel light.

MODEL PD (' DICK ') WITH FIXED STAGE AND ROTATING POLARS



BERTRAND LENS

All instruments are fitted with a Bertrand lens, sliding within the upper part of the body tube. An iris diaphragm is mounted above it, for the localisation of interference figures from small grains.

CABINET

A hardwood cabinet is supplied with all instruments, unless otherwise requested. An allowance is made if it is not required. The cabinet is fitted with lock and key, and has holders for objectives and eyepieces, wedges, compensating plates and micrometers. If the instrument is supplied with centring objective changers, racks are provided for holding these complete with their objectives. The cabinet has a brass carrier for contents and magnification card, and is fitted with wooden chocks to prevent the instrument sliding from an unlocked case. If required, self-fastening catches can be fitted to the cabinet, at extra cost, so that the door may be fastened without use of the key. The cabinet is of standard size and measures $15\frac{1}{2} \times 10\frac{1}{2} \times 8\frac{1}{2}$ inches.

WEIGHT

The weight of the instrument, in cabinet, is approximately 21 lbs. (9.5 kg.)

POLARISING MICROSCOPE MODEL PD, in cabinet, as described **Cat. No. MP 70**

NOTES

Eyepieces, objectives and rotating nosepieces or changers are *not* included in the above catalogue number. See Section D. (N.B.—One eyepiece, at least, must be slotted to take compensators, etc. See above).

Polarising Accessories are listed on page 15 of this section.

A few items from Section E, over which confusion may arise with similar equipment for the instruments with round stages and standard substages, are listed below, for convenience.

Attachable mechanical stage (*i.e.* for *square* stage)	**Cat. No. MK 2**
Oil immersion condenser n.a. 1.40 (Parapim)	**Cat. No. MS 212**
Dark ground condenser	**Cat. No. MS 215**
Set of patch stops (Central disc, crescent, slotted) 23 mm. ..	**Cat. No. MF 174**
Iris diaphragm to lower rim of polariser	**Cat. No. MF 155**
Gypsum plate, red, 1st order, in circular mount for 23 mm. substage carrier	**Cat. No. MF 103**

Our technical staff will be pleased to give advice on the selection of any equipment.

ACCESSORIES FOR POLARISING MICROSCOPES

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 (supplied automatically with Model PD) .. .. Cat. No. MK 73

BABINET COMPENSATOR, a sensitive, calibrated, compound wedge for the measurement of low birefringences. Fuller details on request. Cat. No. ME 80

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

SPECTROSCOPIC EYEPIECE, a spectroscope, complete with adjustable slit for insertion in the eyetube slot of any polarising model except Model PD for the observation of the absorption characteristics of minerals. (Section D). Cat. No. MS 340

CAP ANALYSER, a polaroid analyser in sealed cell, for mounting above any version of Model PN. 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. Cat. No. MF 111

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. (See Section E). Cat. No. MK 6

AUTOMATIC POINT COUNTER, an electrically operated recorder, with automatic stepping of the specimen, for the speedy analysis of the modes of microscope thin-sections. Full details are given on a separate leaflet.

POLARISATION COLOUR SCALE, a small pocket booklet by Jones and Brammall giving Newton's Scale, calibrated in milli-microns for crossed and uncrossed nicols, with table of birefringences of many minerals, and with general data and formulae for the estimation of thickness and birefringence of minerals. Revised and enlarged, 1957, by Alan Stuart. Cat. No. MA 50

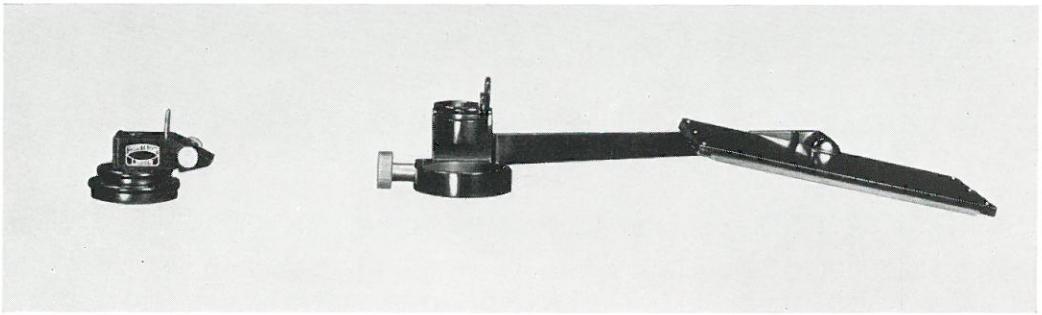
DIAMOND OBJECT MARKER, an instrument having a standard R.M.S. objective thread which can be screwed into any rotating nosepiece or changer. It has a rotating diamond point the eccentricity of which can be adjusted so that inclusions or grains in a mineralogical section, of any diameter, can be permanently engraved for reference. The diamond point is spring-loaded and engraves at a constant pressure which cannot harm the specimen. Cat. No. MK 66

WRIGHT REFRACTOMETER, a simple accessory for the determination of the refractive index of liquid. It consists of two plates of dense glass, between whose ground angular faces the liquid is placed. The plates are positioned on the stage of the microscope and the angle of refraction measured by means of an eyepiece micrometer. The range of the instrument is varied by alteration of the angle of the prism faces and the density of the glass. Cat. No. ME 85

DRAWING APPARATUS

ABBÉ DRAWING APPARATUS, with mirror 110 mm. ×70 mm. and neutral glasses for modifying illumination. Give dimensions of microscope tube when ordering.
Cat. No. MC1

SWIFT-IVES CAMERA LUCIDA, identical to principle with the foregoing, but the large mirror is replaced by a small prism. To fit over eyepiece, of which particulars should be given. Cat. No. MC3



ATTACHABLE CONE CAMERA

The camera consists of an aluminium cone 7 inches long, to which is attached a metal frame for carrying the focusing screen and single dark slide accommodating $3\frac{1}{4} \times 4\frac{1}{4}$ inch plates. The smaller end of the cone clamps over the milled rim of the eyepiece.

ATTACHABLE CONE CAMERA, complete with two single metal plate holders and focusing screen. Cat. No. MC52



JAMES SWIFT & SON LIMITED

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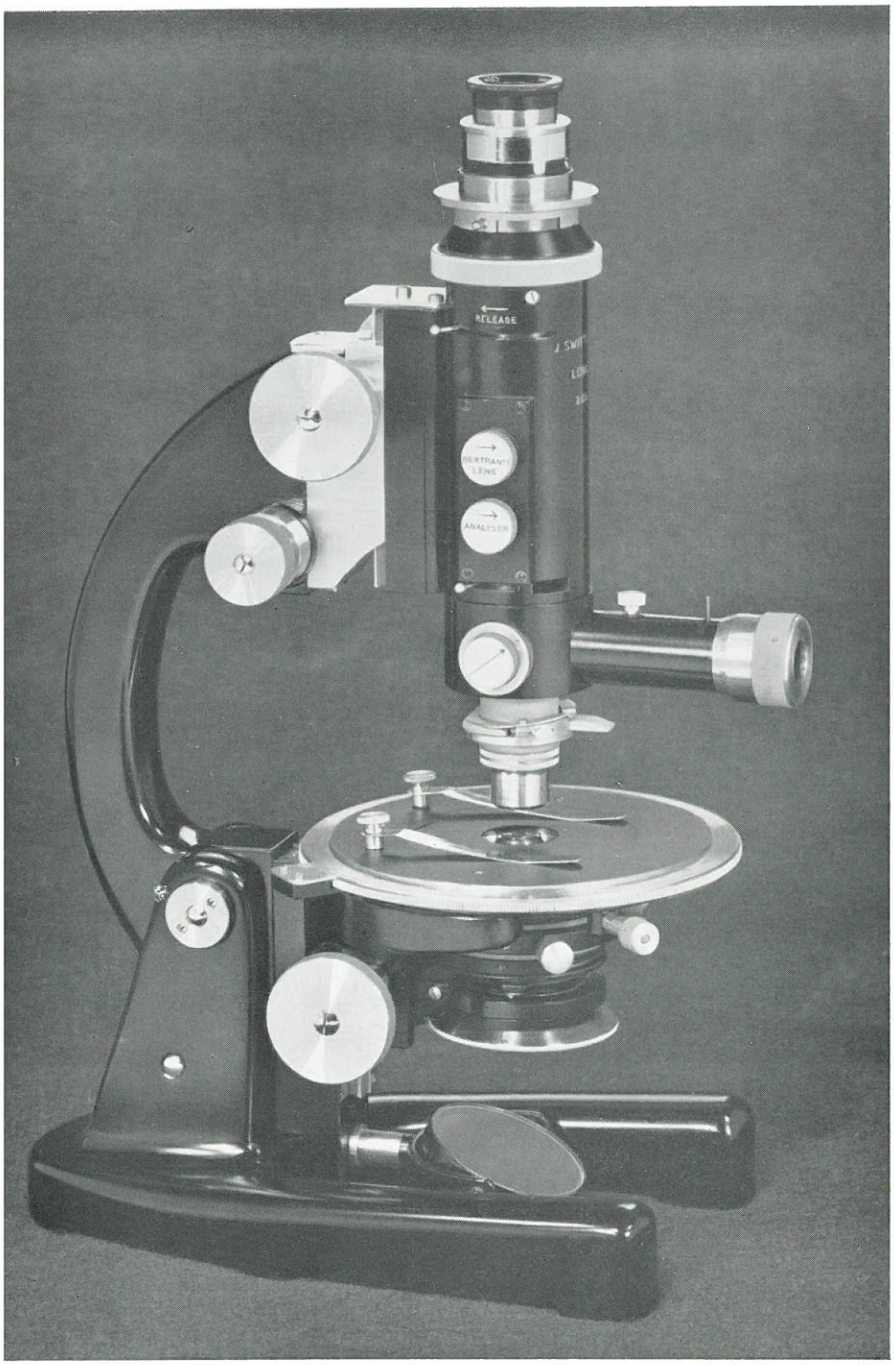
SWIFT MICROSCOPES

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.

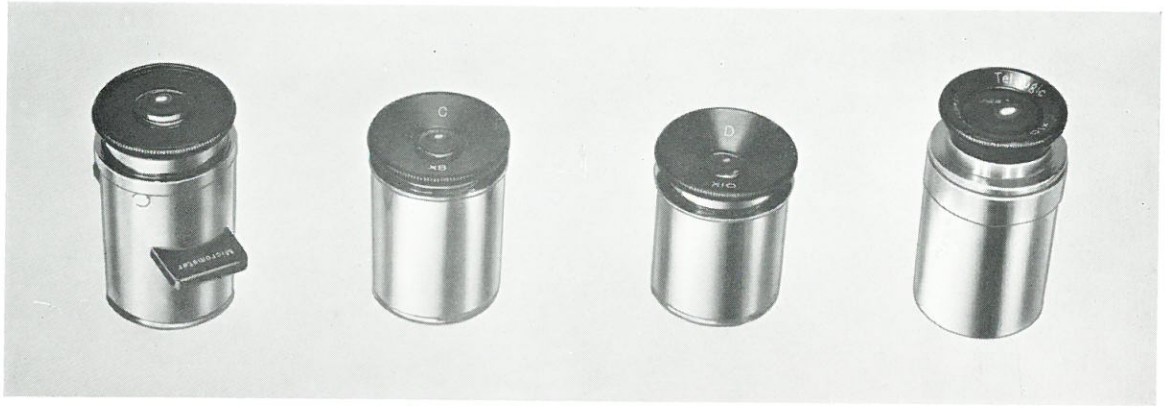
Nominal Focal Length		Numerical Aperture N.A.	Initial Magnification	Working Distance (Air or Oil gap) in mm.	Catalogue Number
mm.	in.				
32	1½	0·12	×4	32	**MS104PO**
32	1½	0·20	×4	18	**MS105PO**
25	1	0·16	×5	26	**MS106PO**
25	1	0·25	×6·5	13	**MS107PO**
16	2/3	0·17	×10	14	**MS108PO**
16	2/3	0·30	×10	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

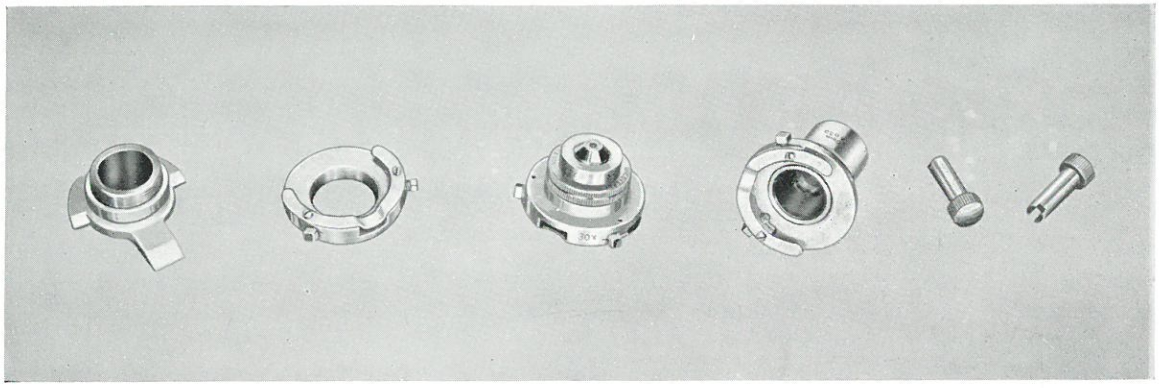
1. All the above eyepieces are parfocal with each other.

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

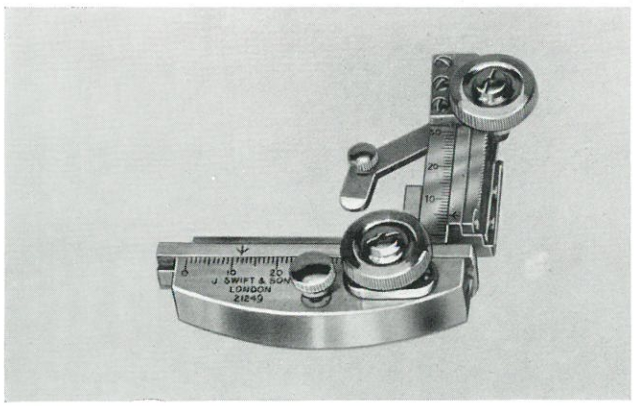
BECKE EYEPIECE, a positive focusing Ramsden eyepiece for mounting above the eyepiece of any polarising model (except Model PD) for the observation of interference figures. (See Section D.) Cat. No. MS 250

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

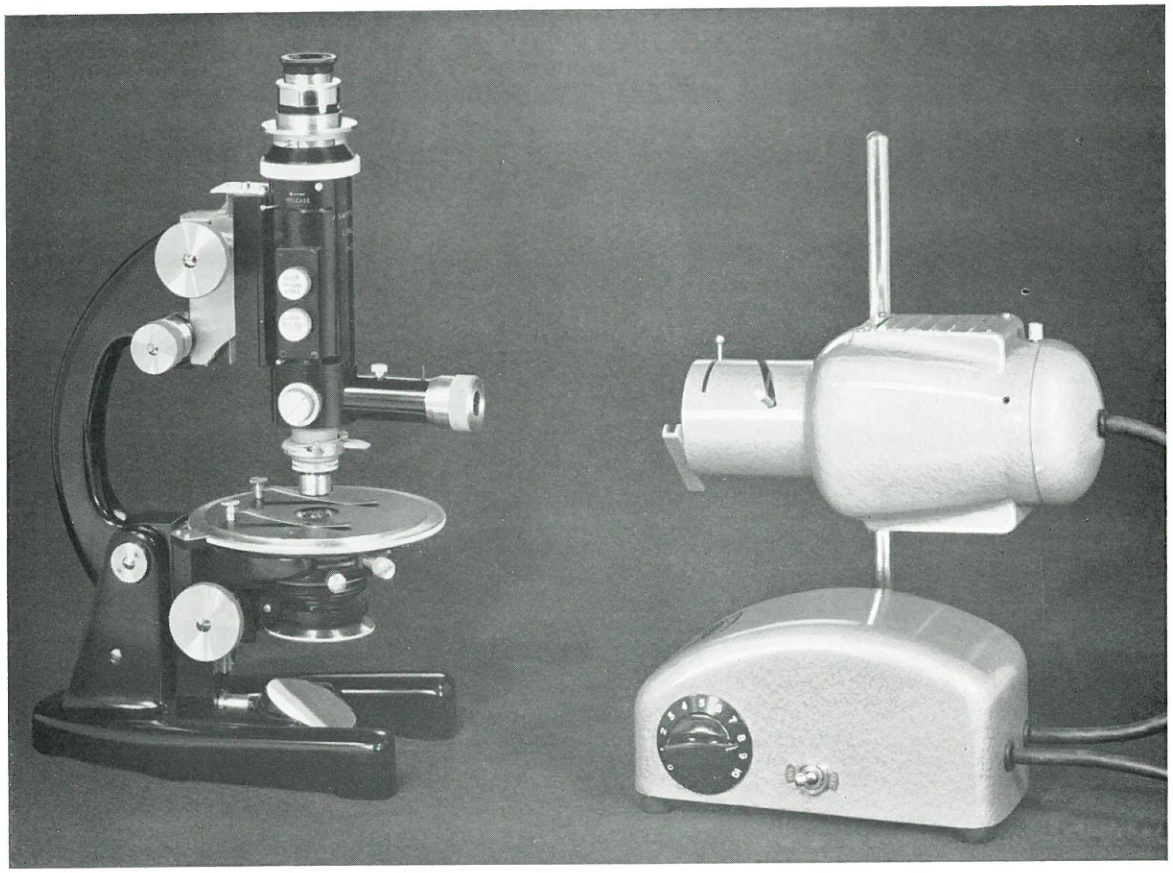


Mechanical stage (MK 6)



Wright Eyepiece (MS 305)

SWIFT MICROSCOPES



'Petromet' Ore Microscope with 'Intensity' Lamp

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JAMES SWIFT & SON LIMITED

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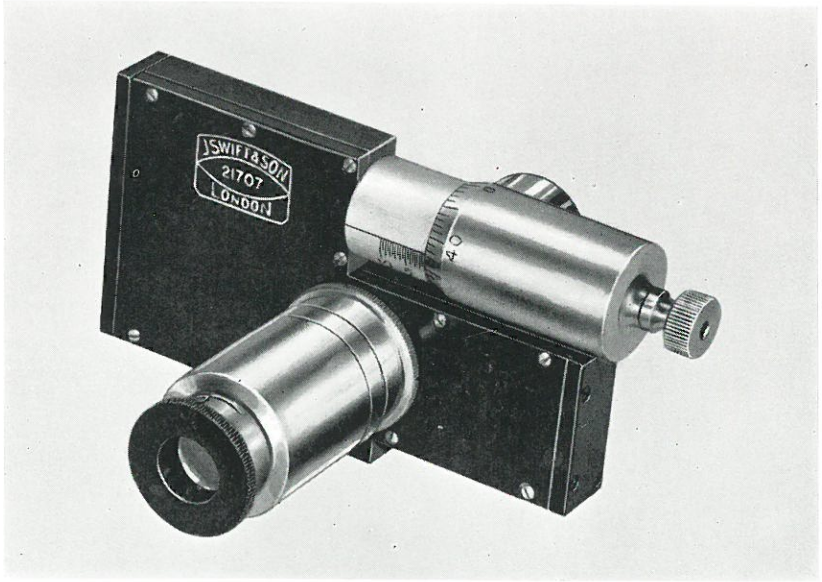
BABINET COMPENSATOR

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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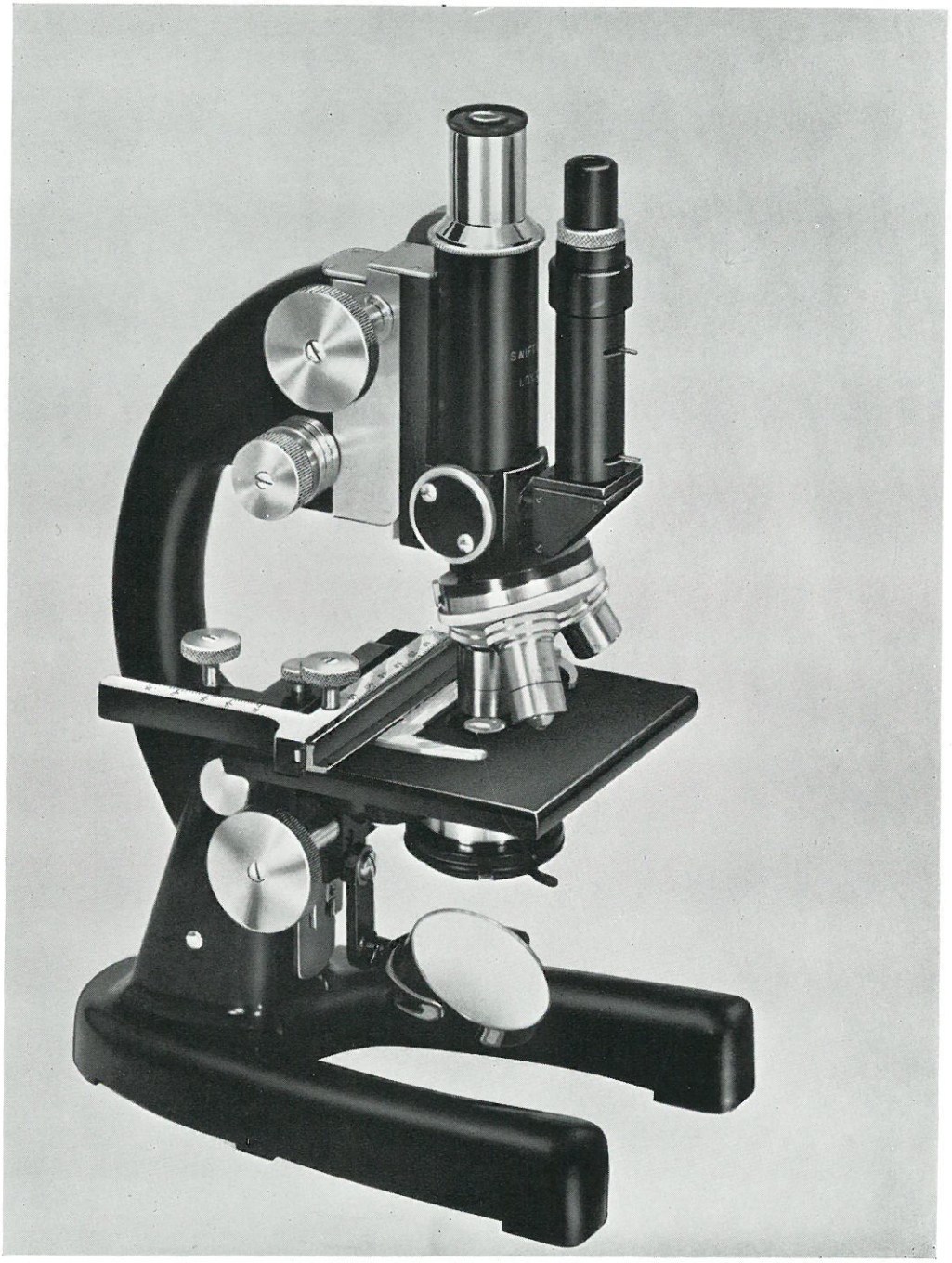
SWIFT MICROSCOPES

METALLURGICAL MODELS

(MODEL M)



METALLURGICAL MODEL M

THE MODEL M Metallurgical microscope is built upon the basic stand, as described in Section C, with solid limb with adjustable inclination joint, and coarse and fine (graduated) adjustments to the body tube. The limb and foot are fitted with stops so that the instrument can be used in correct vertical and horizontal alignment.

The stage bracket of the Models P (Polarising) and S (Biological) are replaced on the Model M by a stage which can be moved up and down by means of a helically-cut rack and pinion mechanism. This feature enables large specimens to be accommodated on the stage, and should an illuminator which requires an external illuminant be fitted to the body tube, the specimen can be focused without disturbing the critical setting of the reflecting illuminator system in relation to the external light source. The maximum clearance between the stage and a rotating nosepiece or similar device is 4 inches, so that objectives of very low power and long working distance can be used.

THE VERTICAL ILLUMINATOR is mounted parallel to, and as an integral part of, the body tube, thus minimising the risk of damage from being struck or thrust against the cabinet of the instrument. The illuminator consists of a low voltage bulb with M.E.S. fitting, with diffuser and pre-focused condenser. Two iris diaphragms give control over field and objective apertures, so that the illuminated area of the specimen can be controlled and the aperture of any objective correctly filled for maximum image contrast and reduction of glare. Unlike systems which are added to the lower part of conventional body tubes the position of the vertical illuminator cannot be deranged, the only adjustments being those of the two iris diaphragms. The lamp may be fed from accumulators or from a mains transformer.

The lamp gives 8 watts at 6 volts and the transformer, MA 20, has a controlled output up to 8 volts, permitting the lamp to be over-run for short periods.

THE REFLECTOR rotates in a mount immediately above the objective, and an index indicates the two correct settings, one for reflecting work and the other for the position normal to the optical axis when the substage illumination of transparent specimens is employed. The reflector is specially coated to give maximum reflectivity without glare.

The design of the body and illuminator system permits the attachment of a rotating nosepiece or any other objective changing device. If no changing devices are requested, the instrument is supplied with an adaptor which maintains the correct overall tube length of 160 mm.

The instrument can be fitted at any time with the G.K.N. Micro-hardness Tester, details of which will gladly be sent on request.

OBJECTIVES. Full information regarding the choice and range of SWIFT objectives is given in Section D. It is important to note that the objectives of high power are available in short mounts which enable their back lens components to be brought close to the reflecting system in order to achieve an even illumination, and that all objectives for reflecting work, of magnifications greater than ×14, are computed for use with uncovered objects. For the most meticulous work, it is recommended that the objectives of high power should be bloomed with an anti-reflection coating, to minimise glare and increase the image contrast.

THE EYETUBE is of standard R.M.S. diameter, 23 mm. and is fitted with a spring retention clip for the protection of the eyepiece. It will accept any of the SWIFT range of eyepieces in this size. For crispness of image and flatness of field, the SWIFT 'Telaugic' eyepieces are especially recommended. (See Section D). Cross-lined, protractor, and linear measuring graticules are available for insertion in the eyepiece. (See Section J).

A GRADUATED DRAWTUBE can be supplied with the instrument in lieu of the standard fixed tube.

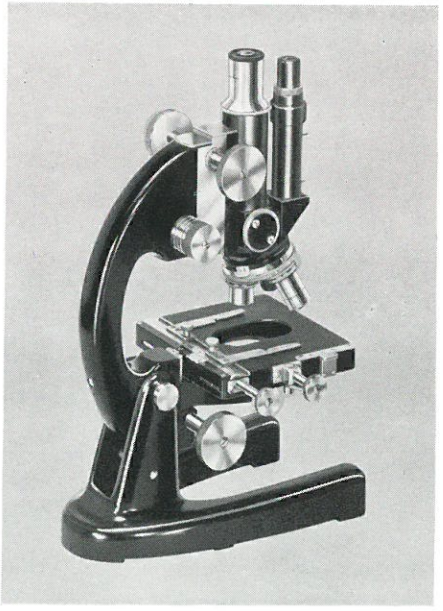
AN INCLINED, SWIVELLING EYEPIECE can be screwed into the upper part of the eyetube, replacing either the fixed or the graduated eyetubes. The eyepiece is inclined at 30 degrees and greatly adds to the comfort of viewing, particularly when the nature of the specimen demands that the stage of the microscope be horizontal. A correcting lens maintains the overall tube length at 160 mm. and gives a magnification factor of $\times 1.5$.

A GONIOMETER EYEPIECE can be inserted in place of the standard eyepiece for angular measurements to an accuracy of 5 mins. or 0.1 degrees of arc. The instrument is described fully in Section D.

THE STAGE has a central aperture so that transparent objects may be examined in transmitted light. For this purpose a plane and concave mirror can be attached to the lower part of the limb, and a simple sleeve (MK 80, Section E) can be attached to the underside of the stage, to accommodate condensers of standard R.M.S. diameter.

AN ATTACHABLE MECHANICAL STAGE, MK 2, can be fitted to the plain square stage.

A SQUARE COMPOUND STAGE can be supplied with the instrument in place of the plain square stage as shown in the illustration. This stage is equipped with scales and verniers on both co-ordinate movements. The full movement is 65 mm. in the lateral direction and 36 mm. in the transverse direction. When the stage is racked below the level of the throat of the limb the movement in the transverse direction is reduced to 17 mm. The compound stage is described in section E.



THE SWIFT AUTOMATIC POINT COUNTER can be attached to either the plain or the compound stage. Full details are given in Leaflet PC 1.

A CABINET of selected hardwood is supplied with each instrument unless otherwise requested, an allowance being made if it is not required. The cabinet is fitted with lock and key and has racks for holding eyepieces and objectives. It measures $15\frac{1}{2} \times 10\frac{1}{2} \times 8\frac{1}{2}$ inches.

THE WEIGHT of the instrument in cabinet, is approximately 20 lbs.

CATALOGUE NUMBERS

MODEL M, METALLURGICAL MICROSCOPE, in cabinet, as described and illustrated, with vertical illuminator and *plain* racking stage **Cat. No. MM 2**

MODEL M, METALLURGICAL MICROSCOPE, in cabinet, as described, with vertical illuminator and racking, *compound* stage .. **Cat. No. MM 3**

The above catalogue numbers do not embrace eyepieces, objectives, or objective changing devices. See Section D. Eyepieces chosen must be of standard 23 mm. diam.

TRANSFORMER, for Model M, for 200–230 volt A.C. supply .. .. **Cat. No. MA 20**

TRANSFORMER, for Model M, for 110 volt A.C. supply .. .. **Cat. No. MA 21**

The following accessories, full details of which are given in the appropriate section of the catalogue, are listed below for convenience.

DUSTPROOF ROTATING NOSEPIECE for two objectives .. .. **Cat. No. MK 52**

DUSTPROOF ROTATING NOSEPIECE for three objectives .. .. **Cat. No. MK 53**

DUSTPROOF ROTATING NOSEPIECE for four objectives .. .. **Cat. No. MK 54**

ATTACHABLE MECHANICAL STAGE, with scales and verniers .. **Cat. No. MK 2**

GRADUATED DRAWTUBE .. .. **Cat. No. MK 20**

INCLINED, SWIVELLING EYETUBE (without eyepiece) .. .. **Cat. No. MS 301**

PLAIN R.M.S. SLEEVE to screw on underside of plain or compound stage **Cat. No. MK 80**

ABBÉ CONDENSER, n.a. 1.20 with iris and filter tray, to fit above .. **Cat. No. MS 201**

PLAIN AND CONCAVE MIRROR, with gimbal, for mounting on lower part of limb .. .. **Cat. No. MS 330**

GONIOMETER EYEPIECE .. .. **Cat. No. ME 70**

METALLURGICAL SPECIMEN MOUNTER .. .. .. **Cat. No. MA 38**

ATTACHABLE CONE CAMERA .. .. **Cat. No. MC 51**

Lamps, Filters, Micrometers, Drawing Apparatus, etc., will be found in Section J, General Accessories.

SPECIMEN OUTFIT

MODEL M METALLURGICAL MICROSCOPE in cabinet .. .. **Cat. No. MM 2**

Transformer for A.C. mains 200–250 volt, 6–8 volts with control .. **Cat. No. MA 20**

Dustproof rotating nosepiece for 2 objectives .. .. .. **Cat. No. MK 53**

Achromatic Objective 16 mm. ($\frac{2}{3}$ in.) n.a. 0.17 (× 10) .. .. **Cat. No. MS 108**

„ „ 4 mm. ($\frac{1}{6}$ in.) n.a. 0.72 (× 40) .. .. **Cat. No. MS 114M**

Huyghenian Eyepiece × 6 .. .. **Cat. No. MS 51**

„ „ × 10 .. .. **Cat. No. MS 54**

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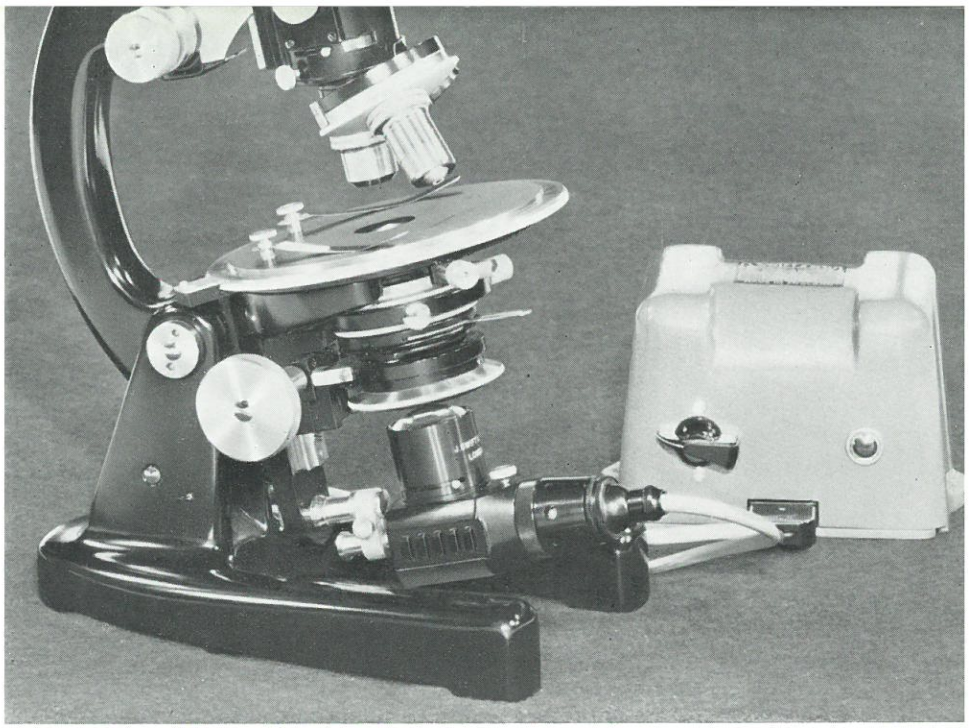
SWIFT



The SWIFT substage illuminator directly replaces the light-reflecting mirror of the microscope, to provide built-in electric illumination of the substage. The illuminator is mains operated ; the transformer has a rheostat for varying the intensity of illumination according to the magnification being used, and the type of object under examination. The illuminator is readily fitted to any SWIFT microscope, and may be used with substage condensers and with dark ground condensers. Every endeavour will be made, where practicable, to supply an illuminator to fit any alternative make of instrument.

SUBSTAGE ILLUMINATOR

15 watt, 6 volt lamp.

Adjustable iris diaphragm which restricts illumination to the field of view—thus avoiding glare from the surrounding area.

for ordering:

ML63 Substage Illuminator

ML64 Transformer with rheostat

ML65 Spare lamp 15w, 6v



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TWINLOCK