VICKERS FIFTY-FIVE MICROSCOPE

INSTRUCTION BOOK

VICKERS LTD.
VICKERS INSTRUMENTS
YORK & CROYDON

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VICKERS
FIFTY-FIVE
MICROSCOPE

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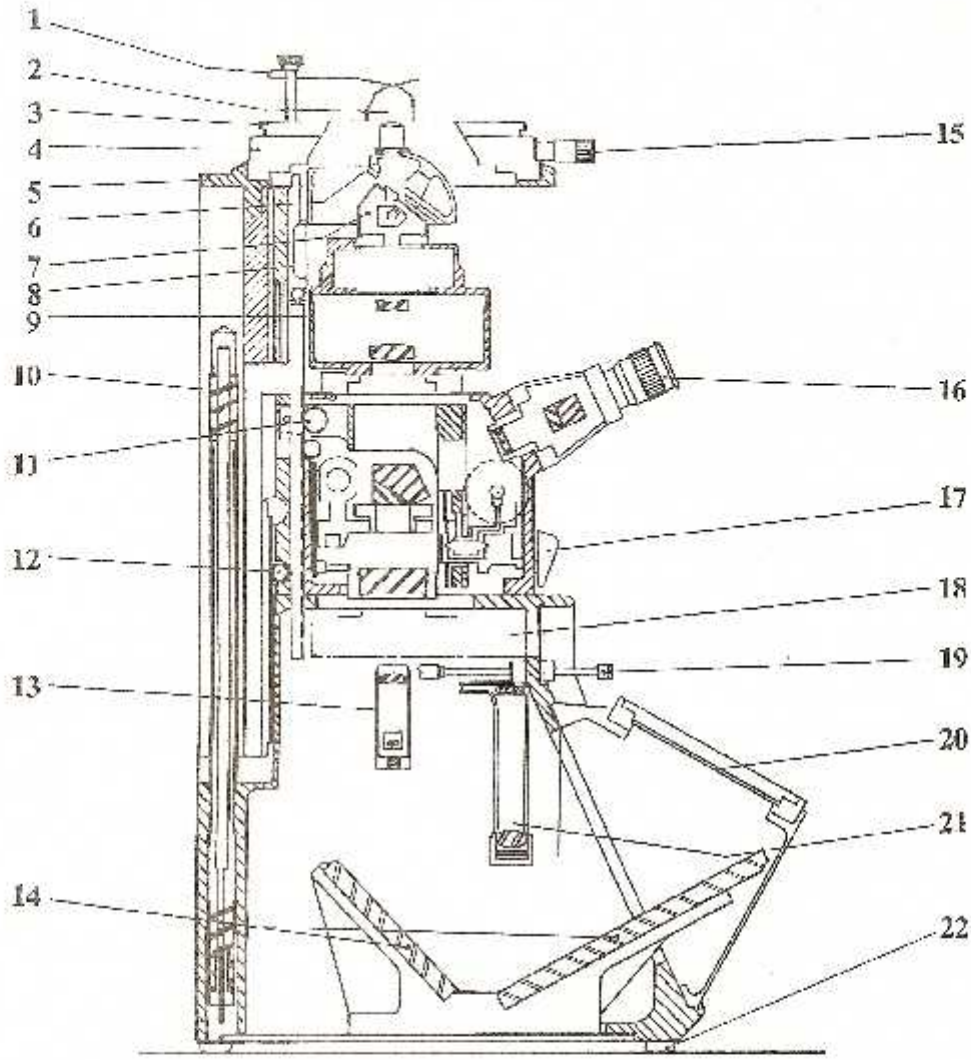

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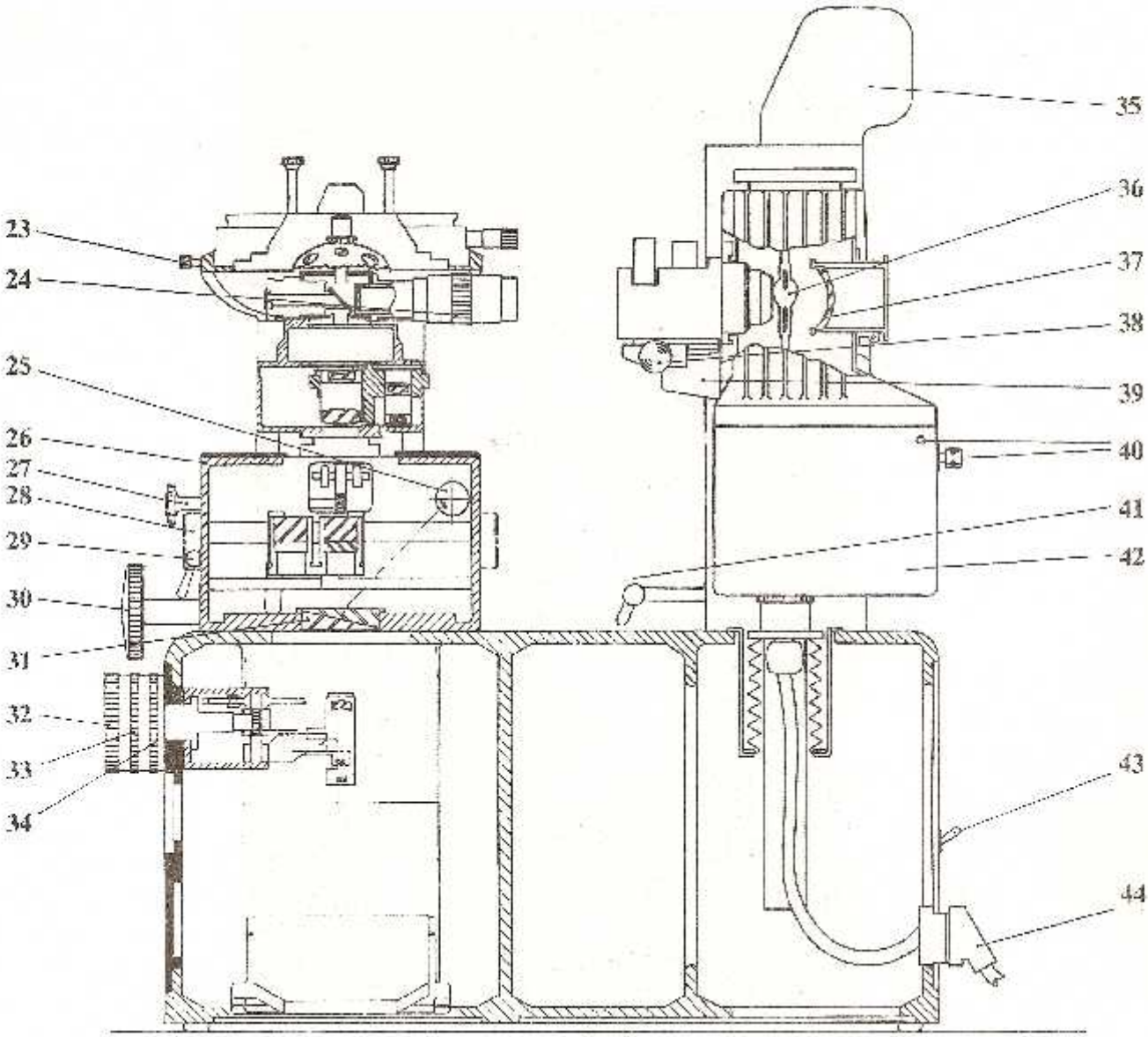

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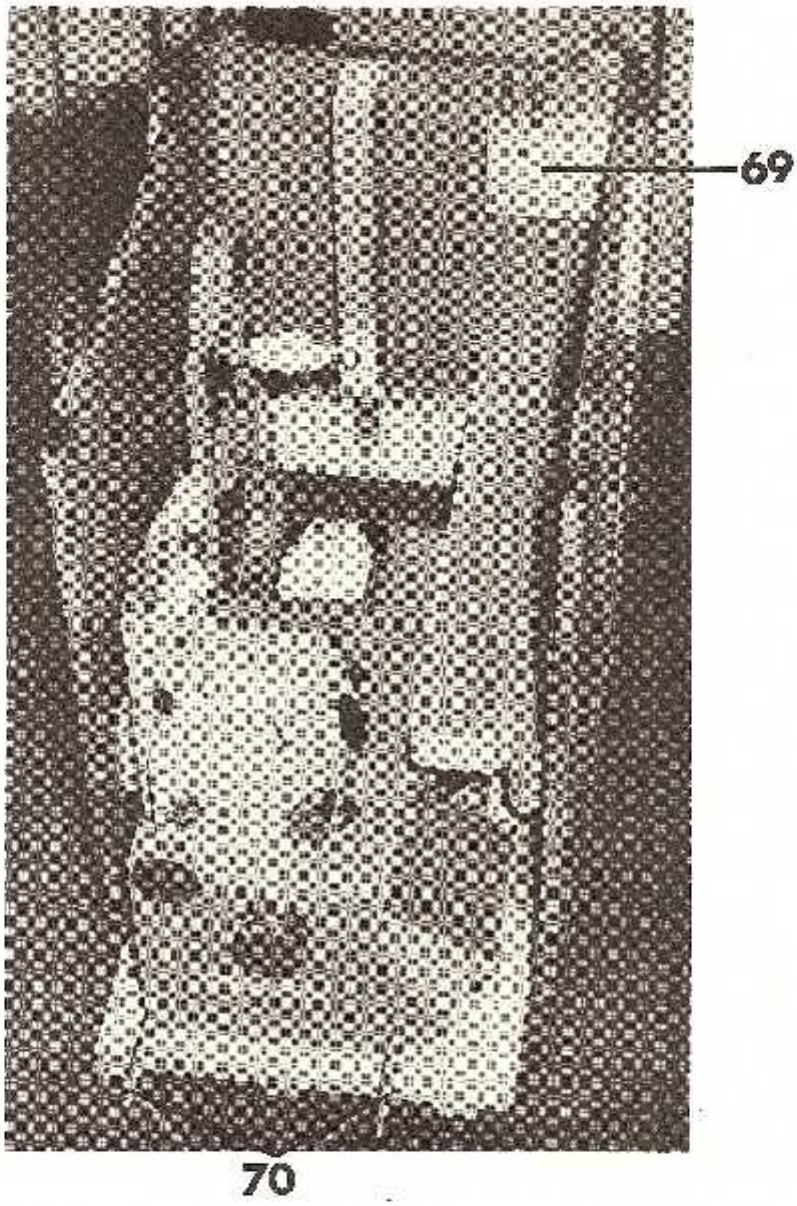


69 Lifting handles (2)
70 Lifting handles screwed into instrument casing.

UNPACKING THE M55 MICROSCOPE

Remove the lid and one end of the packing case as indicated on the exterior of the box. Remove packing blocks marked 1 to 5. Blocks 5, 4, 1 & 3 are secured by screws; those for blocks 4, 1 & 3 pass through the sides of the case, and are accessible from the outside. Packing block No. 2 is secured by four bolts which are revealed when blocks 1 & 4 are removed.

UNPACKING AND ASSEMBLY OF THE M55 MICROSCOPE

WARNING: XENON LAMP BULBS

It is essential to wear protective eye guards and gloves when handling XENON BULBS. The pressure of a XENON BULB, even when not in use, is several atmospheres, and for this reason it is delivered in a protective cover which should only be removed after mounting the bulb in its housing and after making the electrical connections. It is recommended that the protective cover be retained and replaced over the bulb whenever it is being removed from its housing.

The manufacturers' instructions for the disposal of bulbs, supplied with each bulb, must be strictly adhered to (i.e. wrapping in layers of cloth and breaking).

For safety, splinter protecting and ultra-violet absorbing goggles must be worn for any operation when the protective lamp housing is removed.

A lamp which has been accidentally touched by the hand should be cleaned with alcohol or distilled water as traces of grease, etc. (e.g. finger prints) will be burned into the lamp envelope.

The instrument is despatched in two cases, one contains the electrical equipment mounted in either a wall fitting or a cabinet, with a built-in electrical unit, on which the instrument stands. The other case contains the microscope. The electrical equipment should be unpacked first so that the cabinet is ready to receive the instrument when this is unpacked.

Remove two lifting handles from pockets in packing case (69) and screw into end of instrument main casing (70); use these to slide instrument out of case. Remaining two handles can then be screwed into the other end of the casing thus providing lifting facilities. Locate the instrument in the rings provided on the cabinet top. After removing handles, the four plug caps can be screwed into tapped holes.

Stage support bracket and stage, packed separately, can now be attached to left-hand slide column by the four screws provided.

To fit Xenon Lamp (on right-hand slide column)

Remove Xenon Lamp housing from its packing case and slide it on to the mounting bracket. Clamp the Xenon Lamp housing by moving the lever at the rear of the mounting bracket, upwards.

Move the Xenon Lamp housing to the top of slideway. The lamp condenser and filter box can then be attached to the lamp mounting bracket by placing the condenser bracket in the position cut-out to receive it at the rear of the lamp housing, and securing by two screws.

The finned cover of the lamp housing can now be removed by unscrewing four chromium plated screws, thus revealing the adjustable lamp holder and flexible lead.

The Xenon Lamp bulb must be unpacked with care and mounted printed end down, i.e. thicker electrode uppermost. The flexible lead is connected to the top end of the lamp. The protective plastic cover should not be removed until all the connections are made.

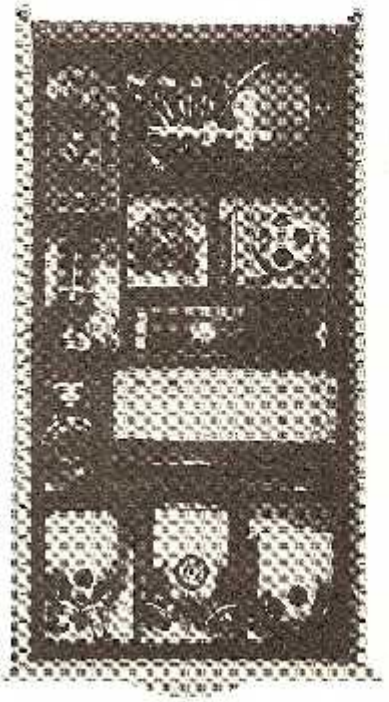
The finned cover can now be replaced after first removing the red safety cover from the illumination aperture to allow the assembly of the lamp condenser.

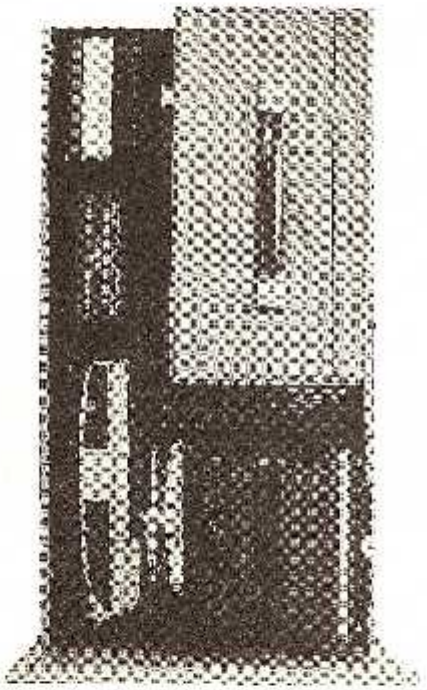
On the under side of the Xenon Lamp housing is a nine-pin plug. This plug must be coupled with the socket attached to a cable passing through the black flexible plastic insulating cover which protrudes from the aperture on the top right-hand side of the instrument, directly beneath the lamp housing.

The electrical equipment for supplying the necessary energy for the Xenon lamp is contained in either the cabinet (where supplied) or a wall mounting. The type supplied will have two cables coming from it, one has a 20 way socket attached to the end of it, and this should be pushed on to the 20 way plug on the right-hand side of the instrument, and secured with the spring clip provided. The other, a three core flex, is the mains input lead, and after checking that the voltage of the unit is as ordered, it should be connected to a suitable plug. The maximum current required is three amperes. The switch controlling the lamp is situated above the 20 way input socket on the right-hand side of the instrument. This switch must also be 'on' before the automatic exposure equipment can be operated.

LOCATION OF EQUIPMENT

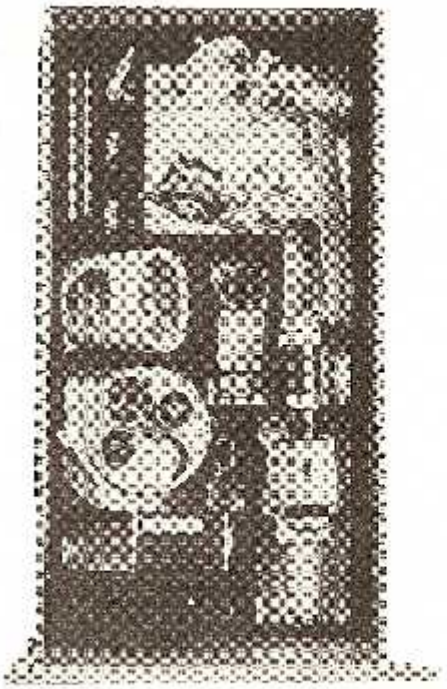
Top Right Drawer

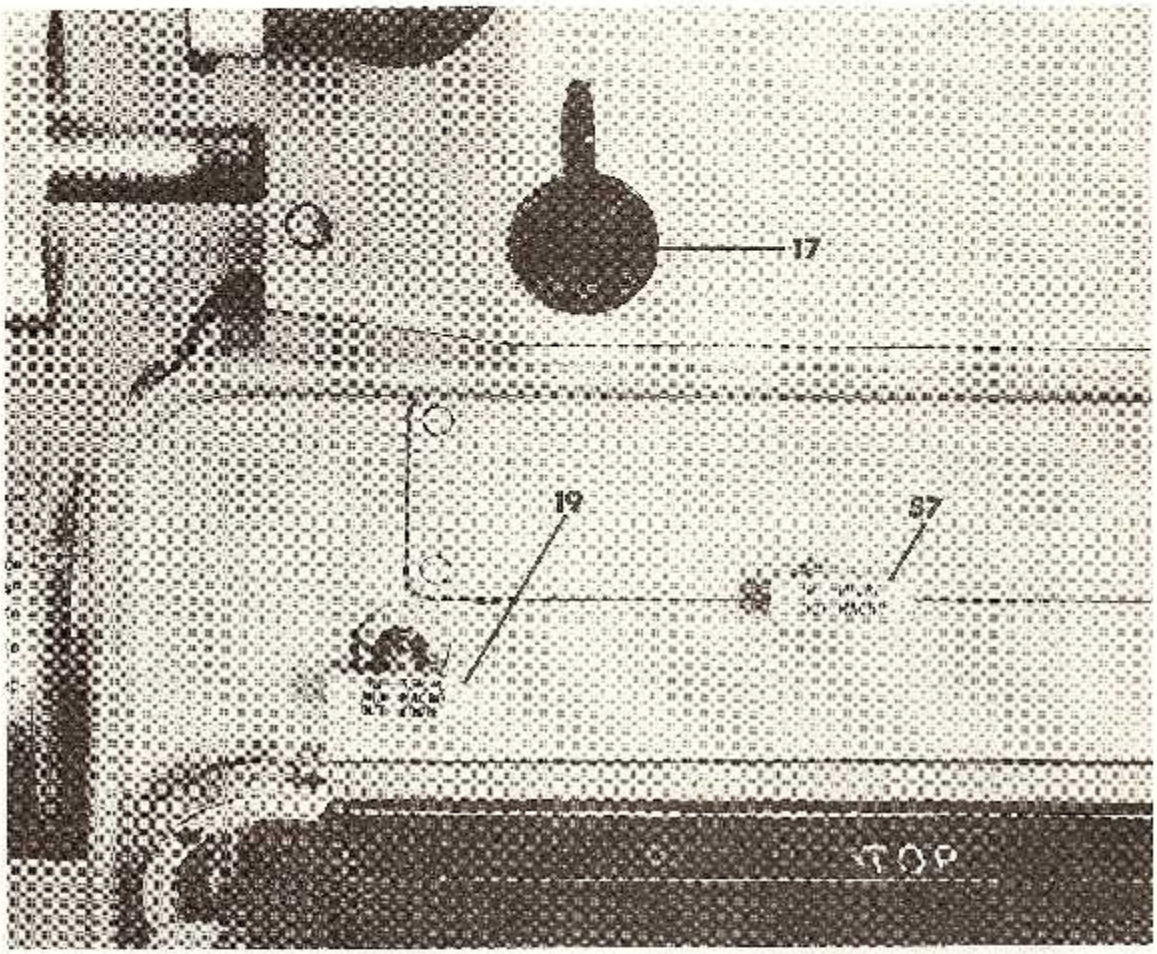




Lower Left Drawer

Lower Right Drawer





17. Selector switch
19. Selector rod
57. Micro shutter control

XENON LAMP

The ON/OFF main switch for the xenon lamp is situated on the right-hand side of the instrument.

Observing the PROJECTION SCREEN IMAGE

In order to obtain the projected image on the focusing screen the shutter control (57) should be pulled out.

Setting of the SELECTOR SWITCH and the SELECTOR ROD

Selector Rod

The selector rod (19) has a push/pull action with three settings -

Fully 'OUT' position	-	Zoom eyepiece in position.
'MID' position	-	Eyepiece withdrawn for Macro work
Pushed fully 'IN' position	-	Special eyepiece positioned for work with 35 mm. camera unit.

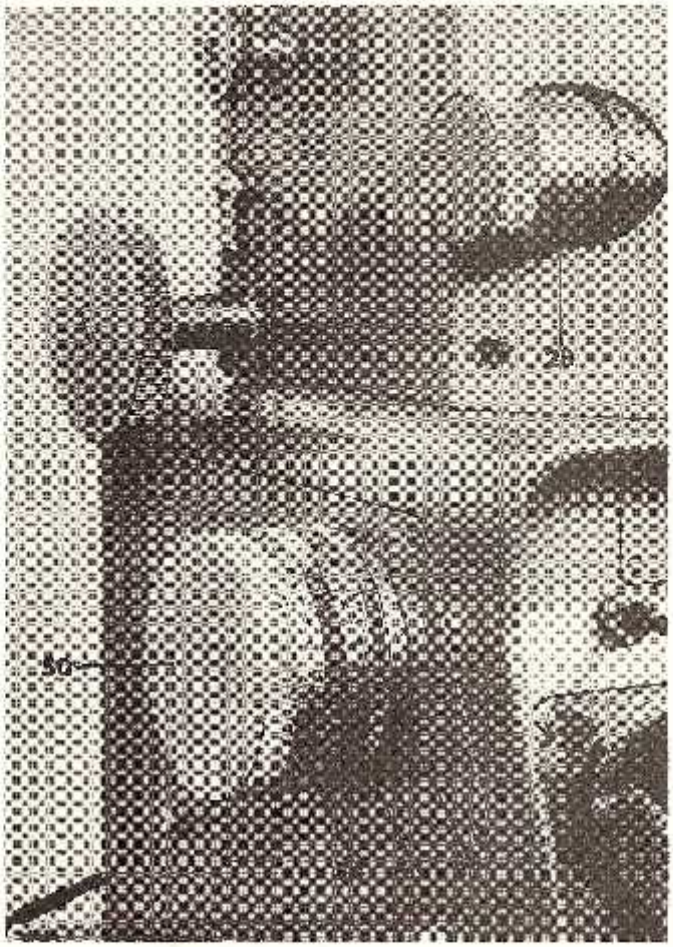
Selector Switch

The selector switch (17) also has three separate settings -

'VISUAL ONLY'	(i.e. switched fully clockwise) In this position all the light from the specimen is directed to the visual eyepiece only; very useful when working with polarized light or dealing with specimens which are highly absorbent.
'35 mm. PHOTO VISUAL'	(i.e. mid-position: switch vertical) Allows simultaneous eyepiece viewing when engaged on photomicrographic work by diverting to the eyepiece a small percentage of the rays which form the illuminated image on the focusing screen or on the film in the 35 mm. camera.
'MACRO PHOTO'	(i.e. switch fully anti-clockwise) For 'MACRO' work only, this setting swings out the image splitting prism to enable macro images to be projected on to the screen.

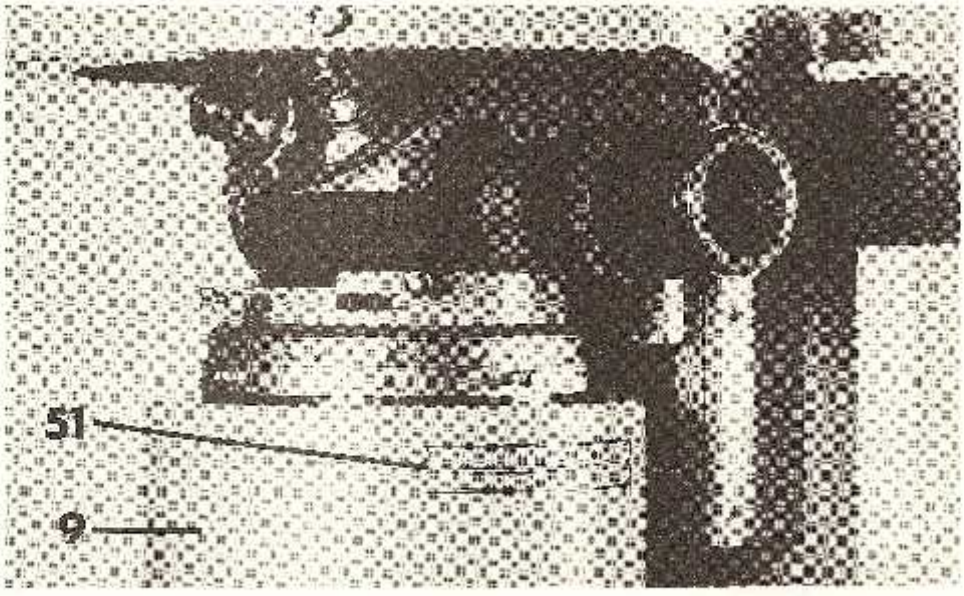
ZOOM PROJECTION EYEPIECE CONTROL

The zoom projection eyepiece (50) can be used to vary the magnification of the projected image in all micro applications except 35 mm work.



28 Fine focus control
50 Zoom control
52 Magnification changer indicator
53 Total magnification indicator
54 Objective magnification indicator

9 Magnification changer
51 Milled rings (2)
(upper) Magnification changer
(lower) Bertrand lens focusing control.



The Zoom Control (50) is used in conjunction with the objective to be used and the setting on the magnification changer.

(i) The magnification changer should first be set to 1x, 1.4x or 2x by rotating the upper of the two milled rings (51) until the desired magnification is visible.

(ii) The inner milled ring (52) on the right-hand side of the Zoom Control knob (50) is now rotated until the right-hand side arrow (pointing right) points to the value of the magnification changer setting.

(iii) The middle milled ring (53) of the Zoom Control knob (50) is rotated until the left-hand side arrow (pointing right) points to the primary magnification figure of the objective.

(iv) To use the Zoom Control, rotate the outer (left-hand side) milled ring (54) to vary the screen magnification, the central arrow (pointing left) on the Zoom Control drum now points to the magnification of the image on the projection screen.

Where extreme accuracy is required a stage micrometer should be substituted for the specimen and the exact magnification calculated from a measurement of the magnified image of the micrometer scale calibrations on the screen. This operation must be carried out without altering any of the settings on the instrument other than a slight adjustment of the fine focusing control (28) to give a sharp image of the calibrations.

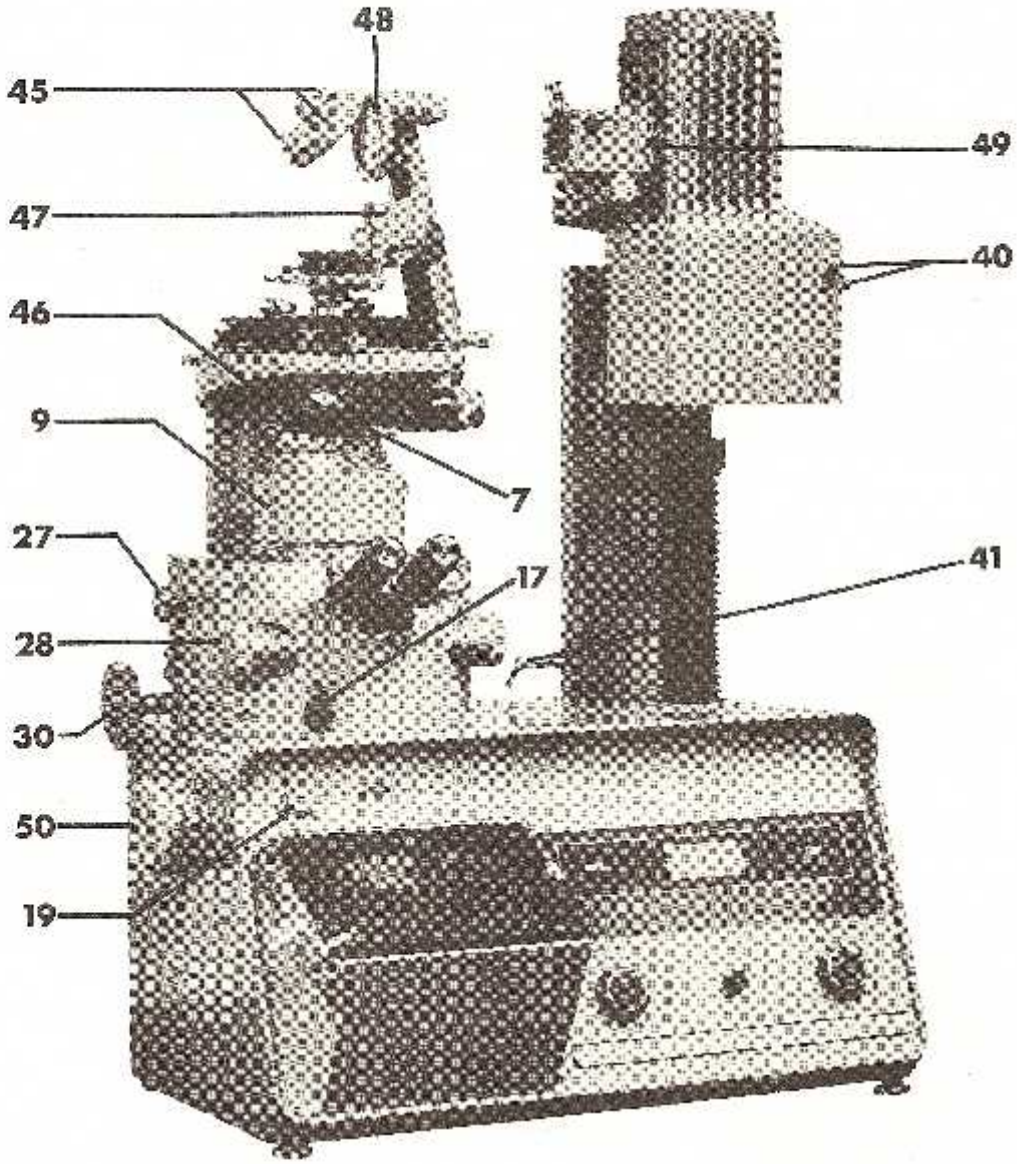
A table giving the magnification range of the projected image for the various combinations of objective and magnification changer setting is given on pages 46 and 47.

BUILT-IN BERTRAND LENS

The built-in Bertrand lens incorporated in the magnification changer (9) is moved into position by rotating the upper of the two milled rings (51) to the position marked 'B'. If the back lens of the objective is not in focus this may be adjusted by rotating the lower of the two milled rings (51) a little.

FINE MOTION FOCUSING HEAD CONTROL

Each division on the fine motion focusing control (28) approximates 1 micron movement of the objective.



7 Illumination box
9 Magnification changer
17 Selector switch
19 Selector rod
27 Subsidiary coarse motion control
28 Fine focusing control
30 Coarse focusing control
40 Lamp centring controls (2)
41 Clamp lever for lamp
45 Mirror centring screws
46 Cover glass reflector control
47 Substage bracket
48 Supplementary lens for "MACRO" only
49 Aperture slide
50 Zoom control

TRANSMITTED LIGHT

To prepare your instrument for the micro-examination of transparent objects by TRANSMITTED LIGHT the following components should first be placed in position -

i) Magnification changer (9) - slide into position and clamp.

ii) Illumination box (7) - slide into position and clamp with milled head screw (72). Withdraw cover glass reflector from optical path by pulling knurled head (46) to 'fully out' position.

iii) Transmitted light quintuple objective carrier (incorporating a built in corrector lens) fitted with transmitted light objectives. Position in dovetail slide beneath stage and clamp. This slide can be easily identified as it can be raised or lowered by rotating the coarse motion pinion control (27).

iv) Substage illumination bracket (47) carrying illumination mirror supplementary lamp condensor and a swing-out substage condenser. Swing out the supplementary lamp condenser (48).

v) Insert monocular or binocular eyepiece if required. Clamp securely in position with milled head of screw situated on underside of the eyepiece aperture.

TO USE

a) Move xenon lamp, which is counterbalanced to facilitate movement, to position marked 'TRANS ILLUM' and clamp with lever (41)

b) Switch on lamp, and check that the 'aperture slide' (49) which carries the patch stop for dark ground illumination and an annulus for phase contrast illumination, is in the mid (clear) position. This slide is situated on the lamp condenser bracket.

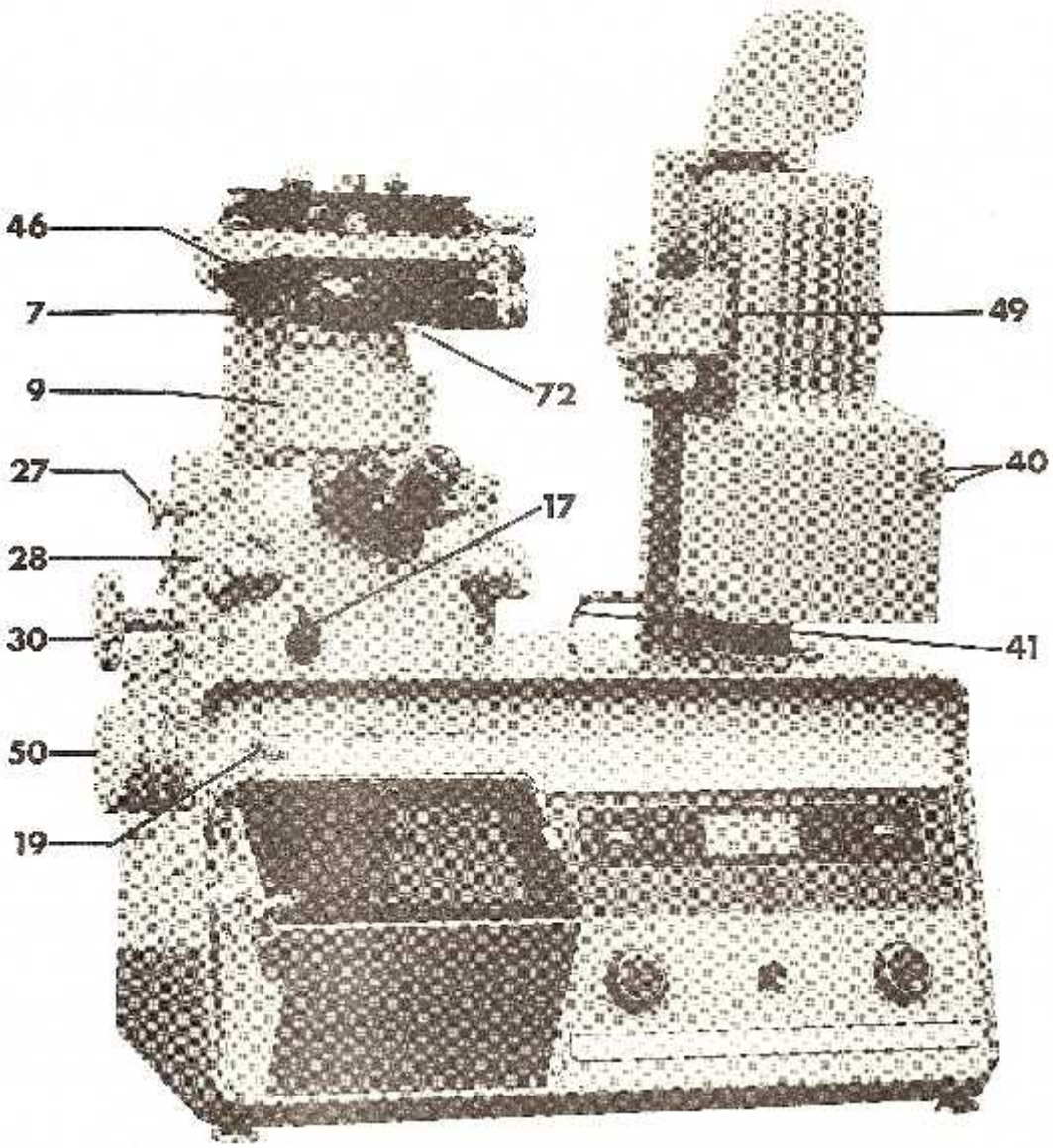
c) Rotate the subsidiary coarse motion pinion control (27) to lower objective bracket to about 1/10" above the position in which it makes contact with the illumination box: to achieve this it may be necessary to lower the stage using the coarse motion focusing control (30).

d) Place specimen in position, set magnification changer (9), zoom control (50), selector switch (17) and selector rod (19) as appropriate.

e) Pull out shutter control (57) if the image is required on the screen.

f) Focus the specimen using coarse motion focusing control (30) and fine motion focusing control (28), adjust lamp centring controls (40) and the substage condenser to give optimum results.

g) Centre the lamp iris by means of the three screws on the mirror (45).



7 Illumination box
9 Magnification changer
17 Selector switch
19 Selector rod
27 Subsidiary coarse motion control
28 Fine focusing control
30 Coarse focusing control
40 Lamp centring controls (2)
41 Clamp lever for lamp
46 Cover glass reflector control
49 Aperture slide
50 Zoom control
72 Illumination box clamp screw

NORMAL INCIDENT ILLUMINATION

For the micro-examination of opaque objects by NORMAL INCIDENT ILLUMINATION,

PLACE IN POSITION

i) Magnification changer (9) - slide into position and clamp.

ii) Illumination box (7) - slide into position and clamp with milled head screw (72). Check to see that the cover glass reflector is in position by pushing the knurled head (46) in as far as it will go.

iii) Incident light sextuple objective carrier fitted with incident light objectives - position in dovetail slide beneath stage, and clamp. This slide can be easily identified as it can be raised or lowered by rotating the coarse motion pinion control (27).

iv) Insert monocular or binocular eyepiece if required - clamp securely in position with milled head of screw situated on underside of eyepiece aperture.

TO USE

a) Move xenon lamp, which is counterbalanced to facilitate movement, to position marked 'INCILLUM', and clamp with lever (41).

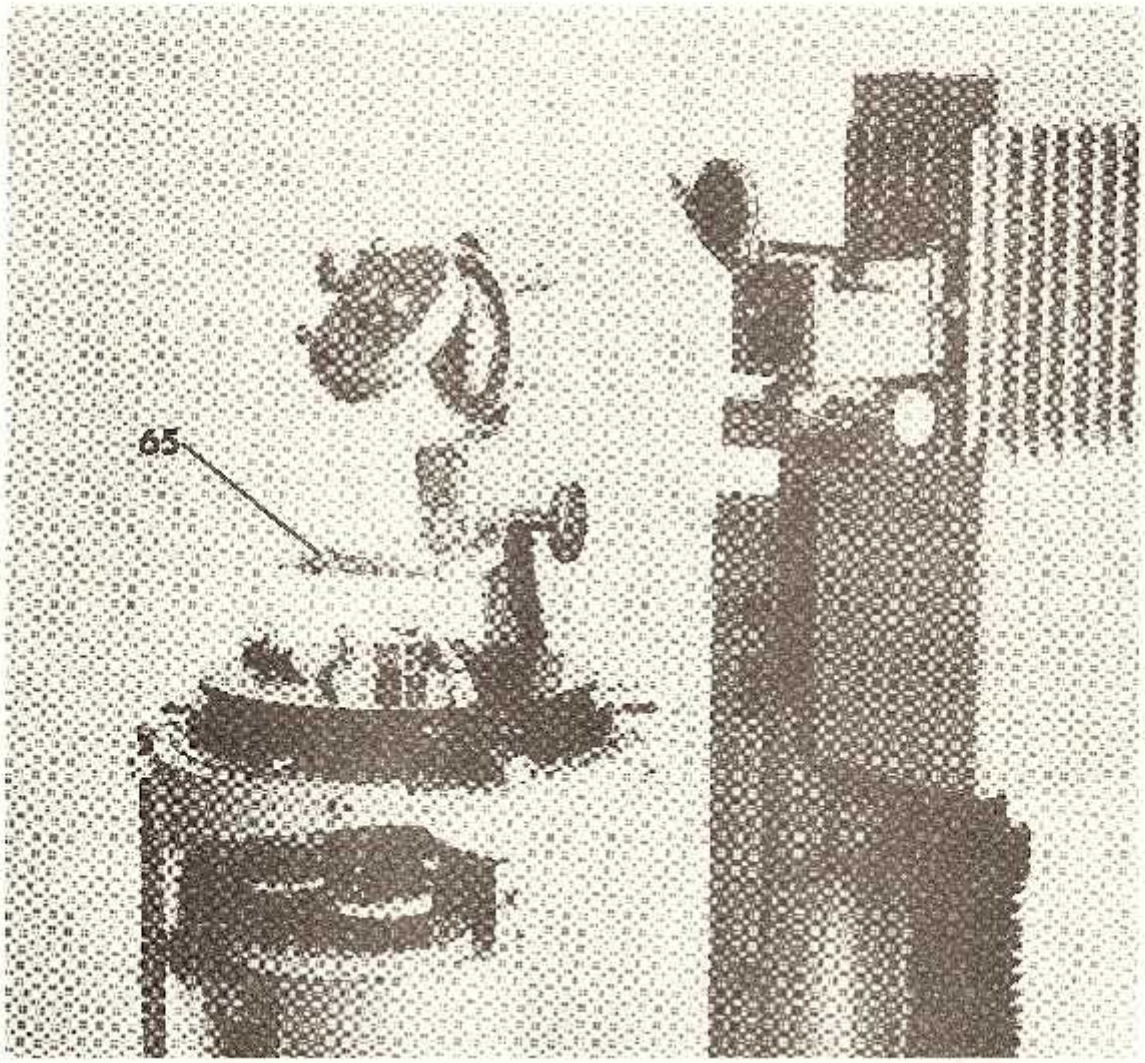
b) Switch on lamp, and check that the 'aperture slide' (49) which carries the patch stop for dark ground illumination and an annulus for phase contrast illumination, is in the mid (clear) position. This slide is situated on the lamp condenser bracket.

c) Rotate the subsidiary coarse motion pinion control (27) to lower objective bracket to about 1/10" above the position in which it makes contact with the illumination box; to achieve this it may be necessary to lower the stage using the coarse motion focusing control (30).

d) Place specimen in position, set magnification changer (9), zoom control (50), selector switch (17) and selector rod (19) as appropriate.

e) Pull out shutter control (57) if the image is required on the screen.

f) Focus the specimen using coarse motion focusing control (30) and fine motion focusing control (28), adjust lamp centring controls (40) and condenser to give optimum results.



65 Subsoiler forks

MACRO EXAMINATION OF SPECIMENS

Low power observation of an object known as 'Macro' examination can only be done on the focusing screen, and the eyepiece body, which is not needed for this technique, may be removed and replaced by a cover plate. The instrument should be set up as follows.

MACRO - TRANSMITTED ILLUMINATION

i) Remove objective nosepiece bracket, incident illuminator (7), magnification changer (9), the Akehurst slide, carrying the substage condenser, from the substage fork (65) and the polarizing substage attachment from the V-slide just above the substage fork (65).

ii) Place in position the MACRO BASE UNIT (73) incorporating the rotating changer fitted with 'MACRO' objectives. Slide into position and clamp.

iii) Move xenon lamp, which is counterbalanced to facilitate movement, to position marked 'TRANS ILLUM' and clamp with lever (41).

iv) Swing supplementary macro condenser (43) on the transmitted light mirror bracket into the light path.

v) Fit the Akehurst slide containing the auxiliary substage condenser for 'MACRO' work into the substage fork (65) and secure with fixing screw.

vi) Set the selector switch (17) and the selector rod (19) to 'MACRO'.

vii) Place object on stage.

viii) Open the macro shutter by pushing in and rotating clockwise the control (58). Pull out the micro shutter control (57).

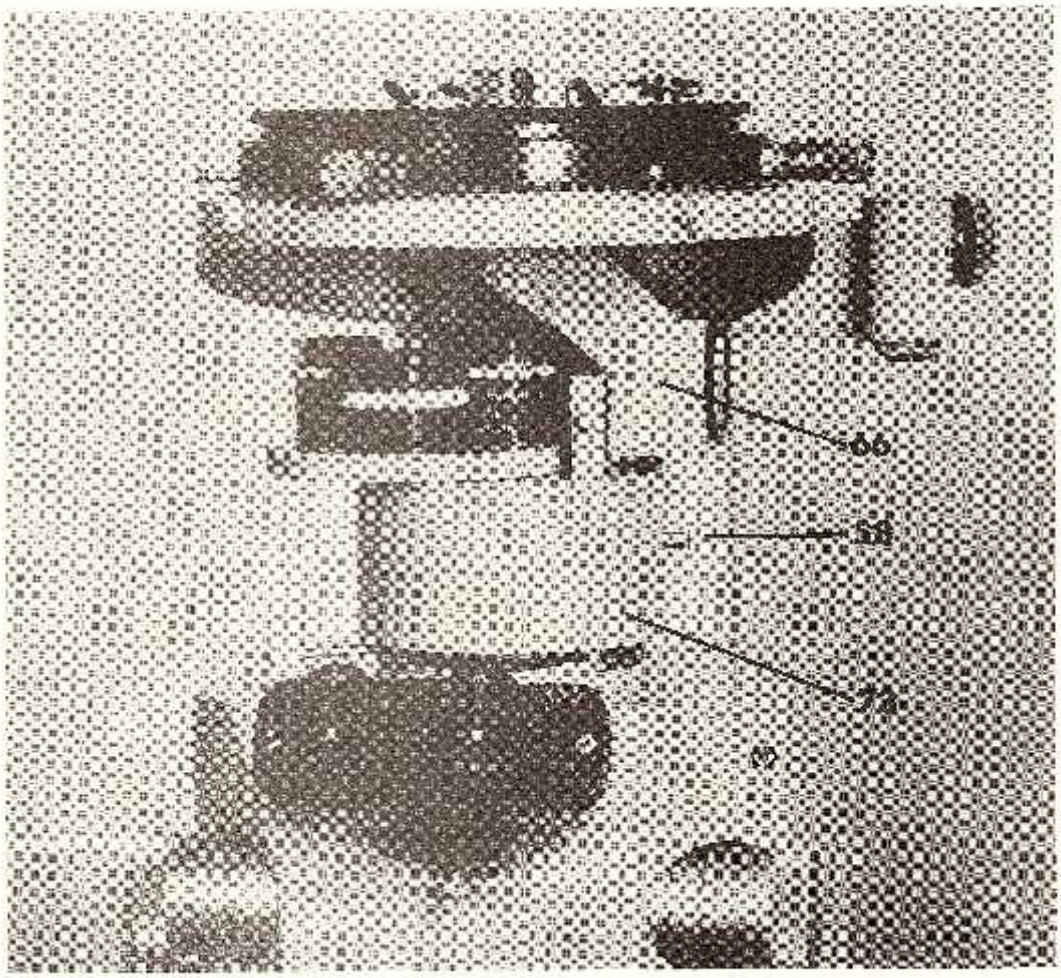
ix) Switch on lamp and check that the 'aperture slide' (49) which carries the patch stop for dark ground illumination and an annulus for phase contrast illumination is in the mid (clear) position. This slide is situated on the lamp condensor bracket.

x) Focus specimen using coarse focusing control (30) raising or lowering the lamp house if necessary, and adjusting the lamp centring controls to obtain full and even illumination.

xi) Close down the lamp iris and focus its image using the auxiliary condenser in the substage fork (65), the image of this iris should now be centred on the focusing screen by slightly raising or lowering the lamp.

xii) Open the lamp iris and if necessary refocus the lamp condenser and the auxiliary condenser (65) on substage bracket, and adjust lamp centring controls (40) to produce an evenly illuminated field.

xiii) For photographic work and any other instance where the optimum evenness of illumination is required a ground glass screen must be inserted in the filter holder of the lamp condenser housing.



58 Macro shutter control
66 10X and 15X incident illumination unit
73 Macro base unit

MACRO - NORMAL INCIDENT ILLUMINATION

Instructions for 15x and 10x objectives:

i) Remove objective nosepiece bracket, incident illuminator (7), magnification changer (9) and either swing-out or remove the transmitted light bracket.

ii) Place in position the MACRO BASE UNIT (73) incorporating the rotating changer fitted with 'MACRO' objectives. Slide into position and clamp.

iii) Move xenon lamp, which is counterbalanced to facilitate movement to bottom stop position and clamp with lever (41).

iv) Fit small incident illumination unit (66) (for 15x and 10x objectives only) on to object changer unit and clamp securely.

v) Set the selector switch (17) and the selector rod (19) to 'MACRO'.

vi) Place object on stage.

vii) Open the macro shutter by pushing in and rotating clockwise the control (58). Pull out the micro shutter control (57).

viii) Switch on lamp and check that the 'aperture slide' (48) which carries the patch stop for dark ground illumination and an annulus for phase contrast illumination is in the mid (clear) position. This slide is situated on the lamp condenser bracket.

ix) Fully open the iris on the lamp condenser.

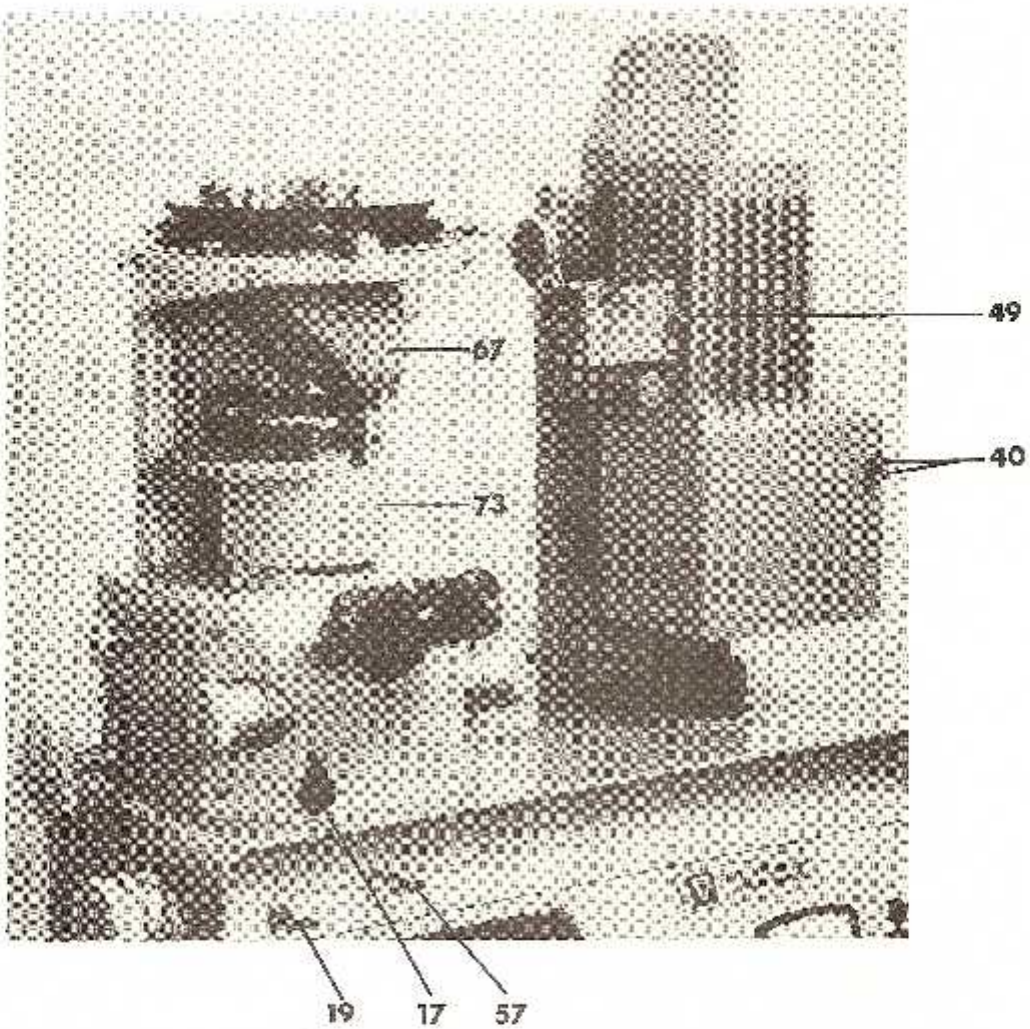
x) Tilt the glass reflector on the incident illumination unit (66) so that the light is reflected on to the specimen.

xi) Focus specimen using coarse focusing control (30).

xii) Raise or lower the lamp house, adjust lamp centring controls, and focus lamp condenser as necessary in order to obtain full and even illumination.

xiii) For photographic work and any other instance where optimum evenness of illumination is required it may be necessary to insert a ground glass screen in the filter holder of the lamp concenser housing.

MACRO - NORMAL INCIDENT ILLUMINATION



17 Selector switch
19 Selector rod
40 Lamp centring controls
49 Aperture slide
57 Micro shutter control
67 5X Incident illumination unit
73 Macro base unit

Instructions for 5x objective only.

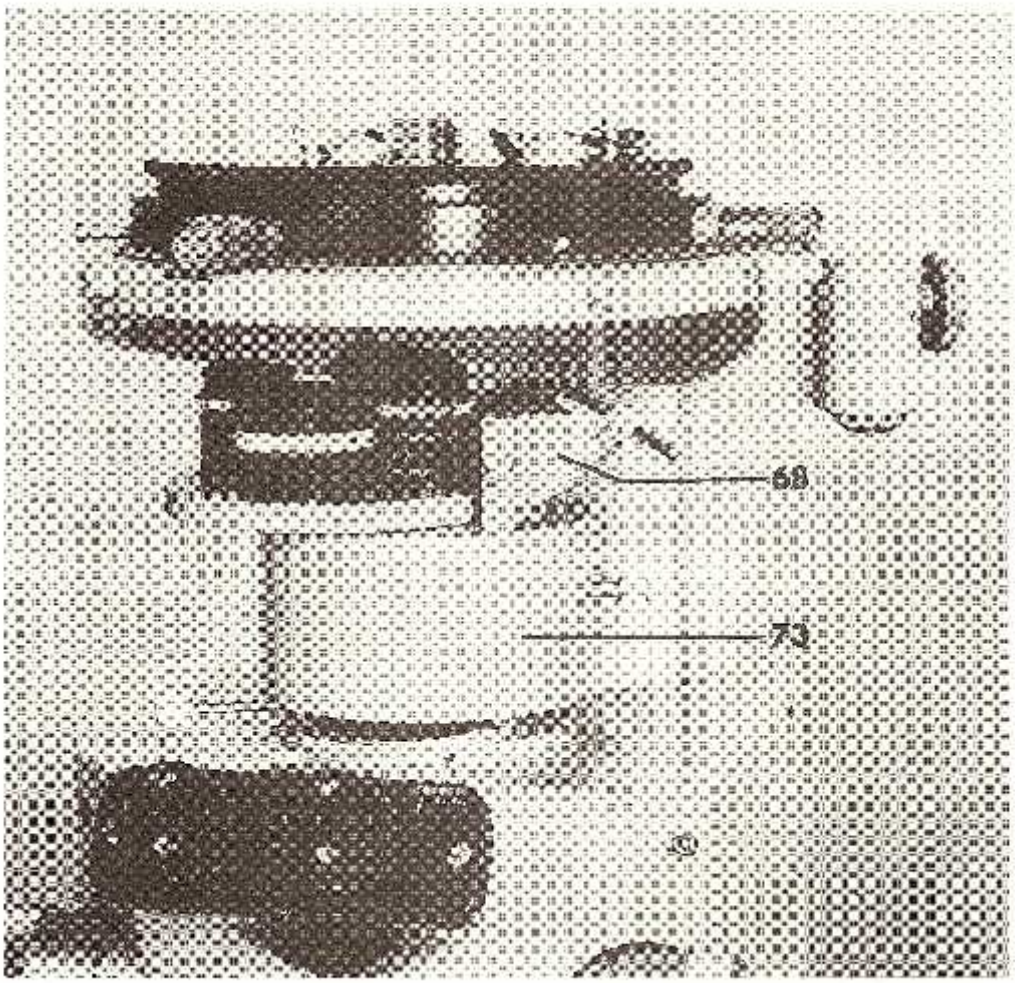
Set up as for the 15x and 10x objectives observing the additional instructions listed below.

a) Replace the small incident illuminator unit (66) with the larger one (67)

b) Fit the supplementary condenser into the front filter holder of the lamp condenser housing - position with recessed side of the flanges on the condenser facing the microscope stage.

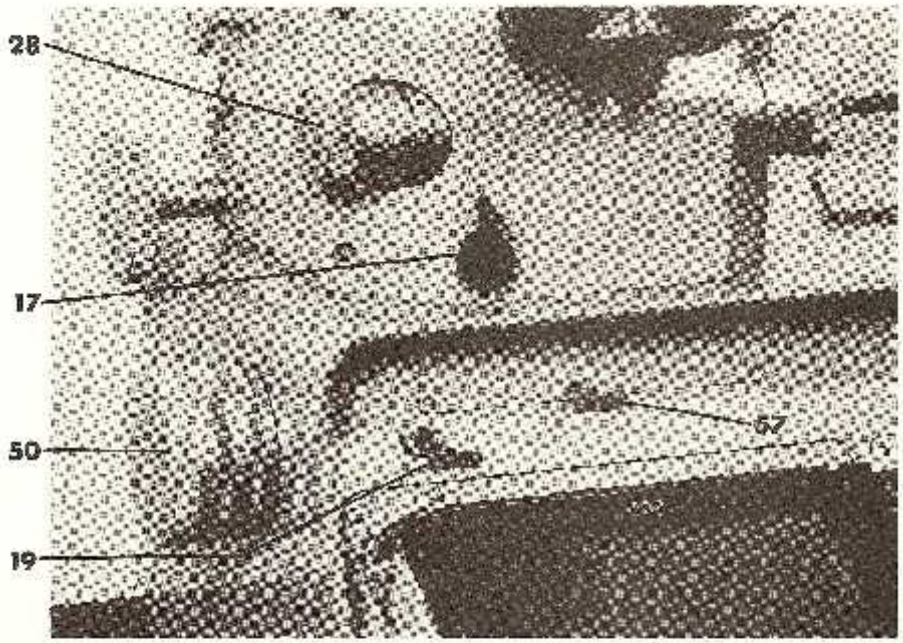
c) Raise the lamp house to suit the larger diameter condenser.

MACRO - INCIDENT – OBLIQUE ILLUMINATION

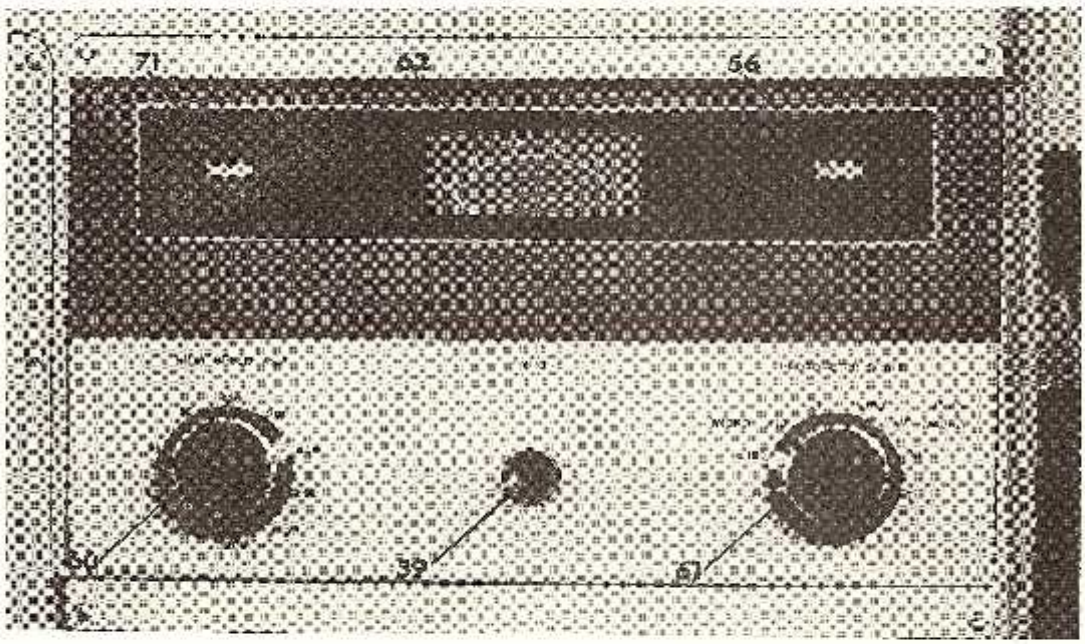


68 Oblique illumination mirror
73 Macro base unit

Proceed as for Normal Incident Macro work when using the 15x and 10x objectives, but in place of the Normal Incident reflector unit fit the oblique illumination mirror (68). The mirror should, of course, be tilted to illuminate the specimen as desired. A ground glass diffusion screen is not normally used for this technique.



17 Selector switch
19 Selector rod
28 Fine focusing control
50 Zoom control
57 Micro shutter control



56 Mains indicator
59 Expose button
60 Film speed control
61 Photometer scale control
62 Meter scale
71 Exposure duration indicator

AUTOMATIC INTEGRATING PHOTOGRAPHIC TIMER

The Automatic Integrating Photographic Timer may be used for making all photographic exposures with the M55 Microscope between 1/20th second and several minutes.

Photographic materials rated at photographic speeds of 5 A.S.A. to 3200 A.S.A. can be used and correct exposure is automatically obtained providing the duration of the required exposure is between 1/20th of a second and several minutes. Interruptions or variations in the rate of output of the source of illumination are automatically compensated for, the exposure being controlled by the measurement of the actual quantity of light falling on the photographic materials, and not on a pre-set exposure time.

If the level of illumination is insufficient to deflect the needle beyond the red portion of the scale when the switch (61) is turned to the 1x position, it will be necessary to expose the photographic material by manual control of the shutter. To open the shutter, turn the switch (61) to position "T" and press down the expose switch (58). The "Magic-eye" is illuminated when the shutter is open. To close the shutter depress the expose switch once more.

When exposing plates, sheet film or Polaroid on micro set - ups, it is not necessary to swing out the shutter in order to focus the image on the screen. The "T" position on the integrator or photometer timer can be used for this purpose.

Coloured Filters

When coloured filters are used it MAY BE NECESSARY to turn the A.S.A. Film speed control (60) to an A.S.A. setting which does not correspond to the normal A.S.A. rating, for the photographic materials being used, in order to obtain correct exposures when using the automatic exposure equipment. This is because the sensitivity of the photo detector cell to the colour temperature of the filter MAY BE different from that of the photographic material. Owing to the vast range of filters which could be used, the effect a particular filter has on the normal A.S.A. setting must be ascertained by the user from test exposures. In this way a factor for the adjustment of the normal A.S.A. setting can be calculated and applied each time the filter is used with the same type of photographic material.

Photometer Scale Switch (61)

MACRO and 35 mm. work - use calibrations on RIGHT - HAND SIDE OF SCALE ONLY (engraved 'MACRO')

ALL MICRO WORK (except 35 mm.) - use calibrations on LEFT HAND SIDE OF SCALE (engraved 'MICRO').

Automatic Micro Exposures

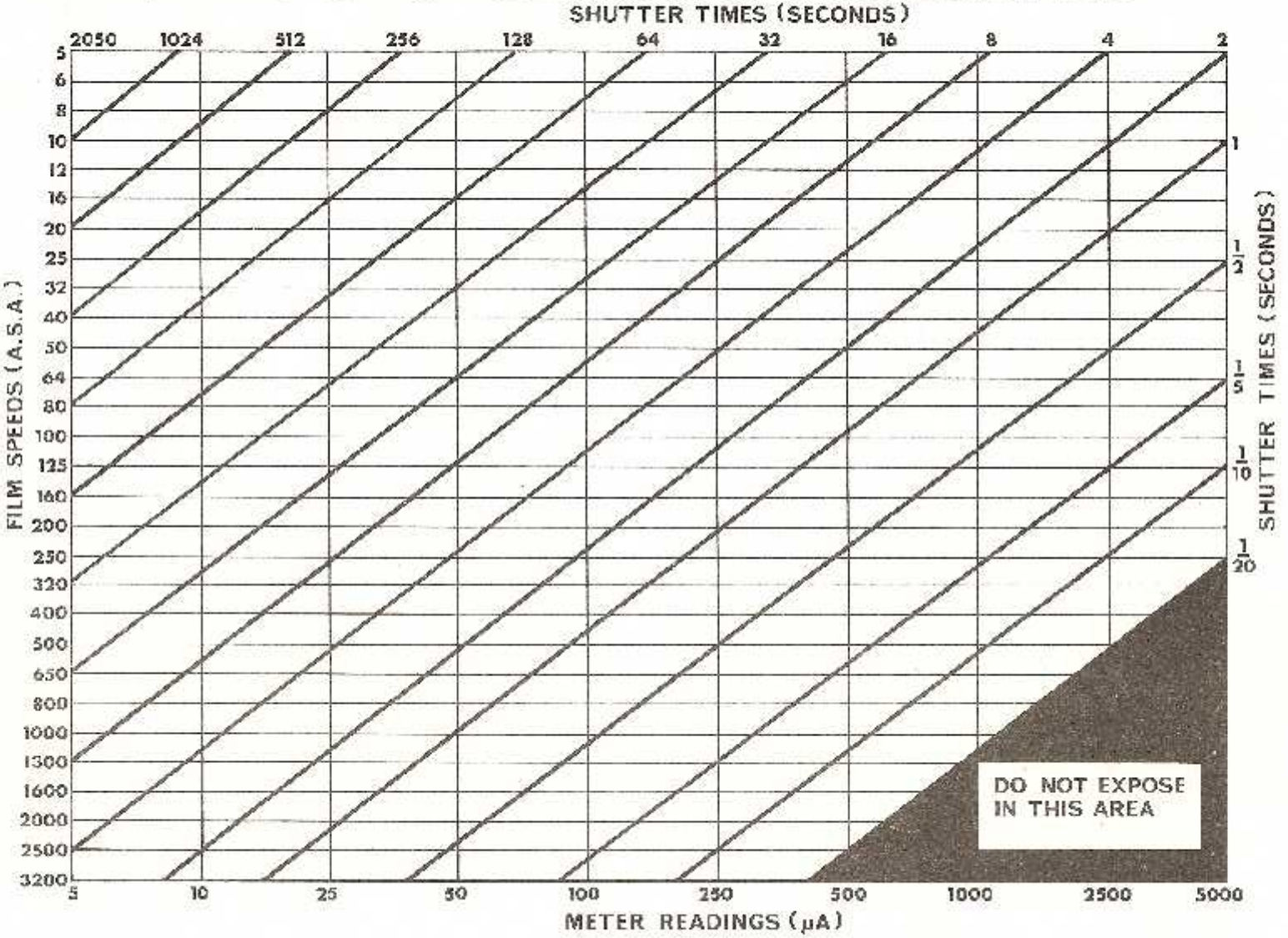
i) Switch on timer by mains switch (56) and allow to warm up for about one minute.

ii) Insert the shutter into the light path by pressing in control (57).

iii) Set 'FILM SPEED' control (60) to the A.S.A. rating of the photographic material to be used.

TABLE A

Guide to exposure times (seconds) against meter readings (μA) and film speeds (A.S.A.) for 'MICRO'



iv) Set the 'Photometer Scale' switch (61) to a position where the pointer gives a reading on the meter scale (62). The reading should be adjusted so that it is NOT IN THE RED SECTION OF THE SCALE. This switch varies the sensitivity of the photo detector circuit in order that a large range of light intensities can be handled. A check should be made to see that the correct section of the scale settings is being used (i.e. 'MACRO' and 35 mm. or 'MICRO'.)

v) All that remains to be done, after ensuring that the photographic material is in position, is to depress the 'expose' switch (59) to start the exposure.
The progress of the exposure can be observed on the exposure duration indicator (71) the illuminated portion diminishing as the exposure progresses.

Note: With some specimens, in order to obtain a suitable meter reading it may be necessary to reduce the intensity of the illumination by placing a neutral filter in the filter holder of the lamp condenser housing. Ensure that the maximum speed of the shutter is not exceeded - see table A.

Some operators may prefer a lighter or darker result than the normal A.S.A. setting produces, and if this should be the case, as the film speed control (60) is calibrated to produce an 'average' negative, it is necessary for the user to make test exposures and determine which A.S.A. setting for the photographic material he/she is using gives the desired result. In this connection it should also be remembered that the type of developer used can greatly alter the stated A.S.A. rating of a photographic material, and the manufacturer's own rating may not give the result required. A.S.A. ratings should therefore always be looked upon only as a guide which must be confirmed or adjusted from the results obtained.

AUTOMATIC MACRO EXPOSURES

i) Switch on the timer by the mains switch (56) and allow to warm up for about one minute.

ii) Ensure that the micro shutter (57) is out of the light path by pulling out control (57).

iii) Open the macro shutter by pushing in and rotating clockwise the control (58).

iv) Focus the specimen and close down the macro lens aperture (generally to f11).

v) Set the "Film Speed" control (60) to the A.S.A. rating of the photographic material to be used.

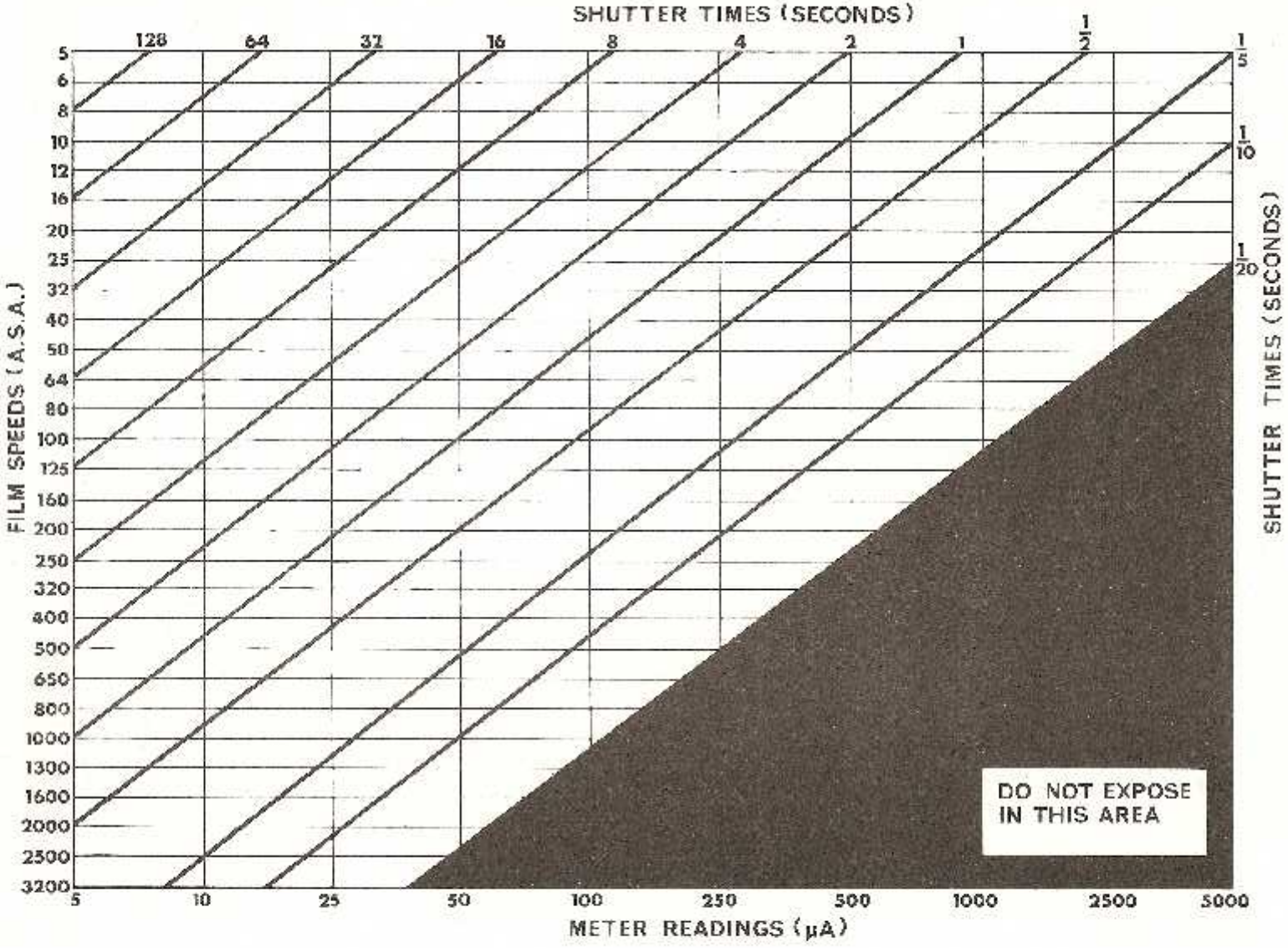
vi) Set the "Photometer Scale" switch (61) to a position where the pointer gives a reading on the meter scale (62), using the section marked "MACRO - 35 mm.".
Ensure that the maximum speed of the shutter is not exceeded -see table B.

vii) Release the control (58) to close the shutter.

viii) After placing the photographic material in position, depress the expose switch (59) to commence the exposure. The progress of the exposure can be observed on the exposure duration indicator (71), the illuminated portion diminishing as the exposure progresses.

TABLE B

Guide to exposure times (seconds) against meter readings (μA) and film speeds (A.S.A.) for 'MACRO – 35mm.'



J36 PHOTOMETER TIMER

The unit includes a micro-ammeter which measures the current that is caused to flow in a circuit when light falls on a cadmium sulphide cell and a separate circuit operates the electro-magnetic shutter at pre-set times of 1/20 32 secs.

The Timer has a built in safety device operating at 5000 microamps (full scale deflection on the X100 range) and no harm is done when the needle of the micro-ammeter shoots to the end of the scale when the light intensity is too great.

CONTROL OF LIGHT INTENSITY

In the use of the unit it is necessary to control light intensity to particular values, this can best be done by means of filters.

For use with colour film, filters for reducing the light intensity must be neutral. These should be the gelatine type neutral density filters as manufactured by Messrs. Ilford and Kodak. Most glass filters are unsuitable and tend to produce greenish colour casts.

For black and white work, also, gelatine neutral density filters provide the best method of controlling light intensity.

COLOUR REVERSAL MATERIALS

When exposing colour reversal materials it will probably be necessary to estimate the exposure time with greater accuracy than is the case with black and white materials.

To achieve this, the meter reading should always be such that it is in the middle of one of the ranges listed in the tables. The use of gelatine neutral density filters is recommended for this purpose. Small variations in exposure can also be made in this manner to suit different specimens and the following filters should be sufficient for this work.

0.06	neutral density	filter		83% T (1/3 stop)
0.12	"	"	"	75% T (1/2 stop)
0.18	"	"	"	66% T (2/3 stop)

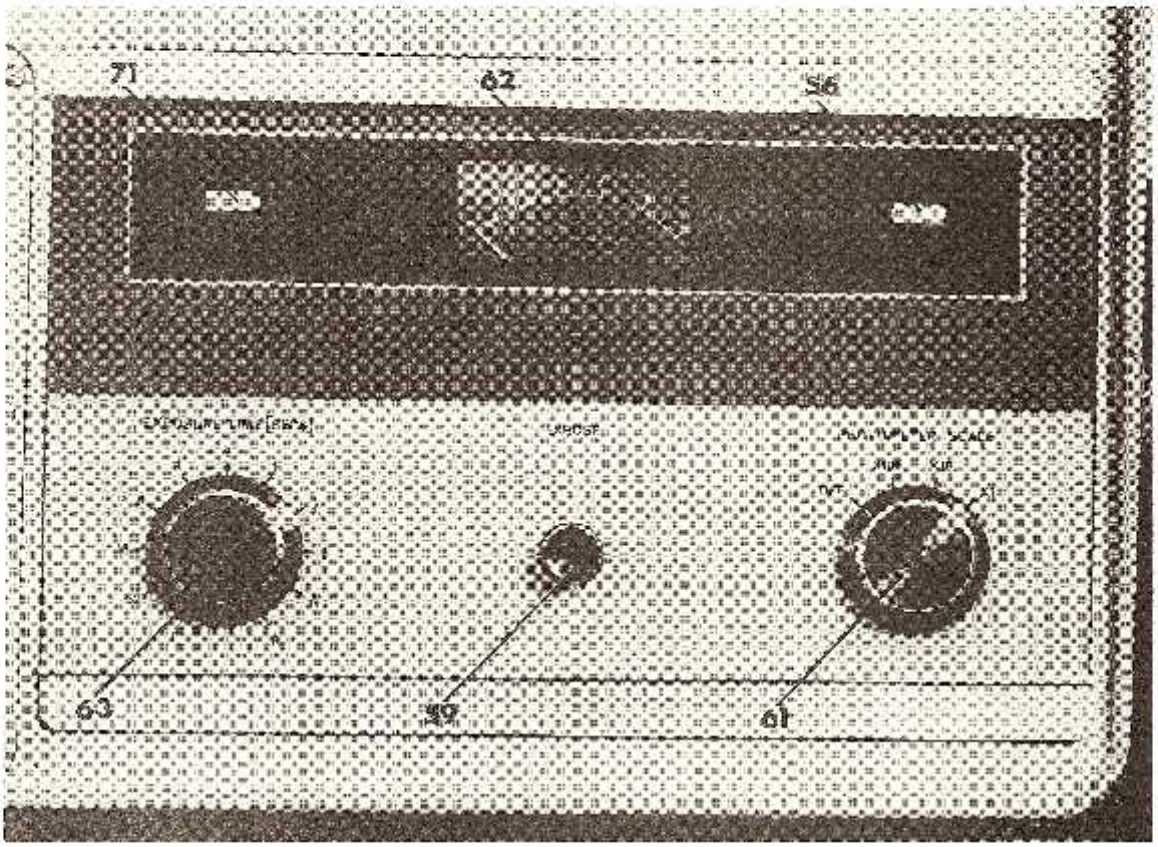
CHOICE OF FILM MATERIAL

The use of very fast film may be disadvantageous as it will only necessitate the cutting down of light intensity to a low level in order to keep exposures above the minimum of 1/20 second allowed by the timer. In any case the best films for photomicrography are usually slower than this. What is normally required is fine grain and high actuance, that is, a high capacity for rendering sharp edges of the optical image as sharp edges on the photographic image.

METHOD OF USE

The J36 unit can be used in two ways. It may be used -

(a) After calibration by the user, under the precise conditions of his use.



J38 PHOTOMETER TIMER

56 Mains Indicator
59 Expose button
61 Photometer scale control
62 Meter scale
63 Exposure time control
71 Exposure duration indicator

(b) As a factory calibrated unit, for use with the particular photographic materials for which calibration tables are supplied.

Even if method (a) be employed, these calibration tables should be found of some value in rapidly obtaining the correct calibration of the unit.

USER CALIBRATION

It is necessary that the user calibrates the unit for each type of photographic material used.
The calibration is carried out as follows:-

i) Set up the microscope as required and turn the Photometer Scale dial to X100. If the meter needle is off the scale, reduce the light intensity by means of filters (see page 29).
If in the red portion of the scale, switch to the X10 or X1 position, whichever is appropriate.

ii) Expose a series of test negatives with graded exposure times, each successive exposure being double that of the previous one e.g. 1/10, 1/5, $\frac{1}{2}$, 1, 2 seconds etc. Process the film or plates under carefully controlled conditions and select the negative which is deemed to be correctly exposed, noting the time given.

iii) Transfer the selected exposure time to the tables provided, inserting it opposite the meter reading used. Complete the table by filling in the remaining spaces as follows:-

Suppose the meter reading was 10 on the X100 range, which is equivalent to 1,000 μ.a. and assume the correct exposure time for a 35 mm. film on a micro set up was 1 second, then the table will be as the sample on page 32. Blank tables are provided at the end of the instruction book for completion by the user.

MICRO EXPOSURES

i) Switch on the timer by the switch (61) and allow to warm up for about one minute.
ii) Insert the micro shutter into the light path by pressing in control (57).
iii) If the meter needle is off the scale (62), reduce the light intensity by means of filters. If in the red portion of the scale, switch to the X10 or X1 position, whichever is appropriate.
iv) Note the meter reading and read off the exposure time in the appropriate calibration table.
v) Set the time on the switch (63).
vi) Attach the photographic material and press the expose button (59).
The lamp (71) indicates that an exposure is in progress.

MACRO EXPOSURES

i) Switch on the timer by the switch (61) and allow to warm up for about one minute.
ii) Remove the micro shutter from the light path by pulling out control (57).
iii) Open the macro shutter by pushing in and rotating clockwise the control (58).

iv) Note the meter reading and read off the exposure time in the appropriate calibration table.

v) Set the time on the switch (63) and close the macro shutter.

vi) Attach the photographic material and press the expose button (59). The lamp (71) indicates that an exposure is in progress.

SAMPLE EXPOSURE TABLE

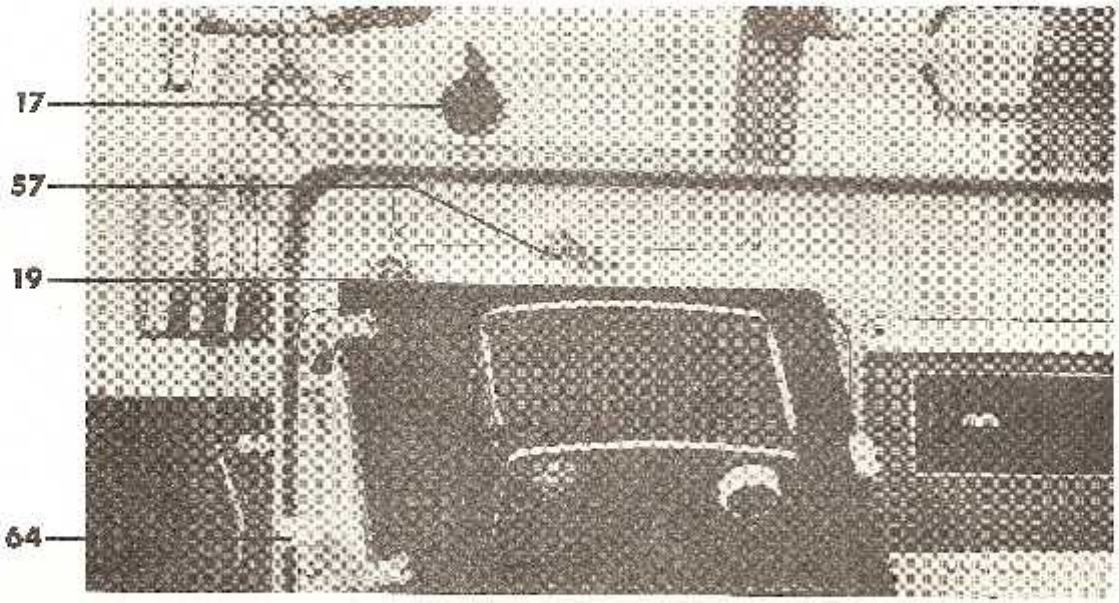
<table>
<tr><th>Meter Reading (μA)</th><th>Exposure times (seconds)</th><th colspan="3">Photographic material: Film X</th></tr>
<tr><td>5,000 - 2,500</td><td>1/5</td><td colspan="3" rowspan="5">Developer : Brand Y

Time: 6 minutes

Temperature : 70°F.</td></tr>
<tr><td>2,500 - 1,250</td><td>½</td></tr>
<tr><td>1,250 - 640</td><td>1</td></tr>
<tr><td>640 - 320</td><td>2</td></tr>
<tr><td>320 - 160</td><td>4</td></tr>
<tr><td>160 - 80</td><td>8</td><td>Micro</td><td>Macro</td><td>35 mm.
✓</td></tr>
<tr><td>80 - 40</td><td>16</td><td colspan="3" rowspan="3"></td></tr>
<tr><td>40 - 20</td><td>32</td><td colspan="3" rowspan="3">Additional remarks :

Mercury green filter used.</td></tr>
<tr><td>20 - 10</td><td>64</td></tr>
<tr><td>10 - 5</td><td>128</td></tr>
</table>

Blank tables are provided at the end of the instruction book for completion by the user.



NOTE

Whenever 35 mm. photography is undertaken on the M55, an auxiliary lens marked "35 mm. Camera/5 Inc. Macro" should be inserted into the front filter holder of the lamp condenser housing. It should be positioned with the recessed side of the flanges on the auxiliary lens mount facing the microscope stage.

17 Selector switch
19 Selector rod
57 Micro shutter control
64 Camera locking button

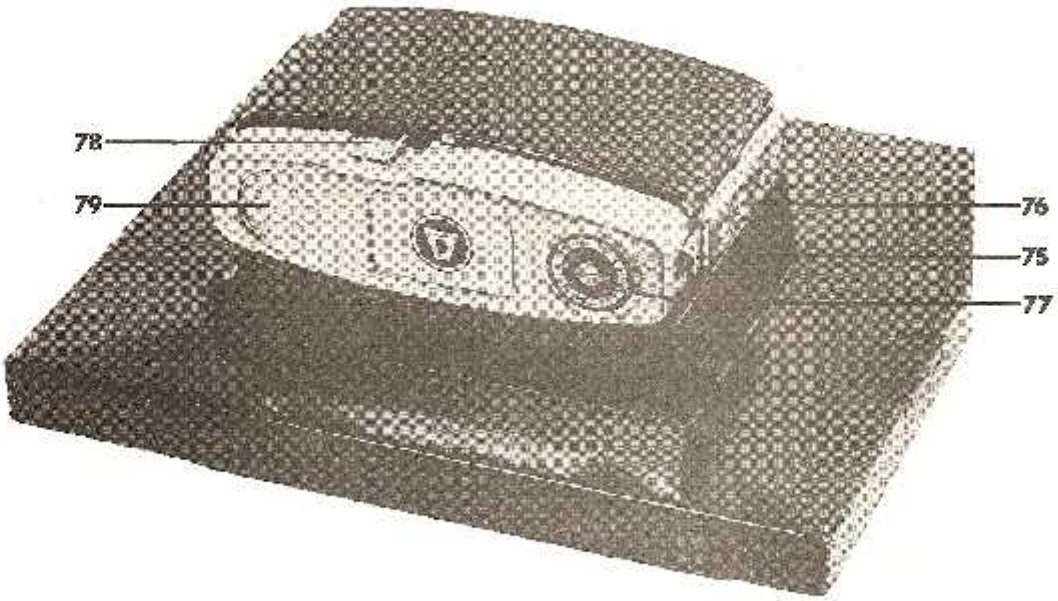
35 mm. CAMERA UNIT

To place these units into position ready for use:-

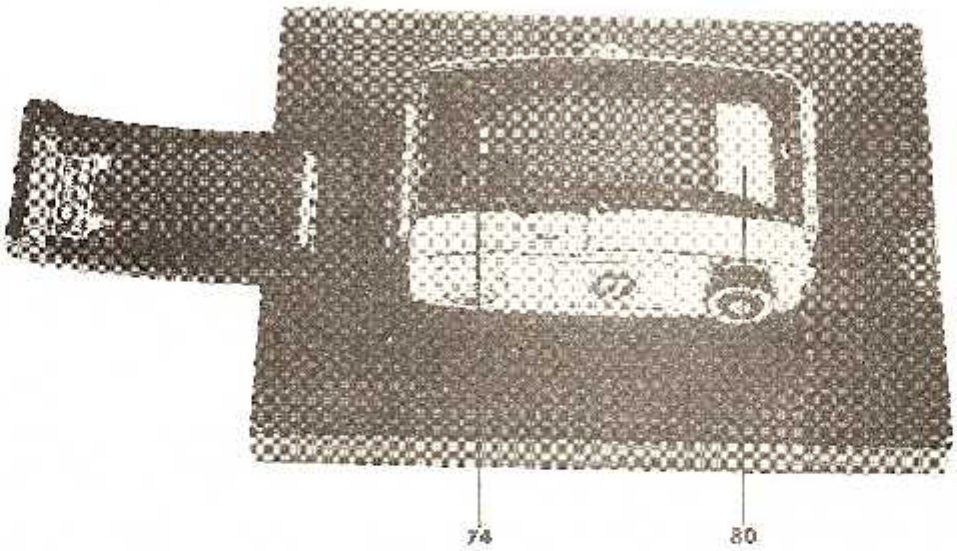
(a) Load with film (see Loading instructions on pages 35 and 37).
(b) Push in the selector rod (19) and the micro shutter control (57) and set the selector switch (17) to the centre position.
(c) Attach the camera unit to the plate holder, pressing in the button (64). When the camera is fully seated, release the button. This locks the camera in position and also uncovers the film ready for the exposure.

FOCUSING

This is carried out by using the 10X Kellner eyepiece supplied with the microscope. This eyepiece has a field which is slightly smaller than the 35 mm. format.
The collar of the eyepiece should be set to the zero graduation on the scale of the outer tube and then the crosslines sharply focused.
When used with a binocular body, it is essential that the interocular distance be set on the focusing tube in which the eyepiece is to be inserted.



75 Locking arm
76 Release button
77 Film rewind knob
78 Film wind lever
79 Film counter dial



74 Projecting pin
80 Cassette

LOADING THE SEMI-AUTOMATIC 35 mm. CAMERA

Unlock the camera by depressing the button (76) and slightly withdraw the locking arm (75). The back can now be opened.

Depress the film rewind knob (77) with the thumb and rotate anti - clockwise.

This will cause the knob to spring out approximatley 1/4" from the casing.

This is the normal position of the rewind knob when the film is to be wound back into the cassette.

Pull the rewind knob out a further 1/2 inch and place the cassette (80) with the projecting end of its spool away from the rewind knob, in the camera.

Push in the rewind knob, rotating until the fork engages in the spool.

Insert the cutaway leader of the film into the slot in the take up spool so that one of the film perforations is engaged on the projecting pin (74).
Rotate the take up spool to ensure that the film is firmly attached and that the sprocket teeth are projecting through the perforations in the film.

Rotate the rewind knob in the direction indicated by the arrow on the camera back to take up any slack on the film in its cassette.

Depress the rewind knob with the thumb and rotate clockwise to lock in position, flush with the camera casing.

To close the camera back, hold it tightly shut and push the locking arm (75) back home.

Rotate the film counter dial (79) in the direction indicated by the arrow on the dial until the black diamond is adjacent to the index mark.

There are two positions, one for 36 exposure and one for 20 exposure films.

Fully rotate the film wind lever (78) releasing it at the end of its travel and allow it to spring back.

Repeat this procedure twice to clear the fogged leader film. Check that the film is being transported by observing the anti-clockwise rotation of the re-wind knob.

The film counter will now be set at 36 or 20.

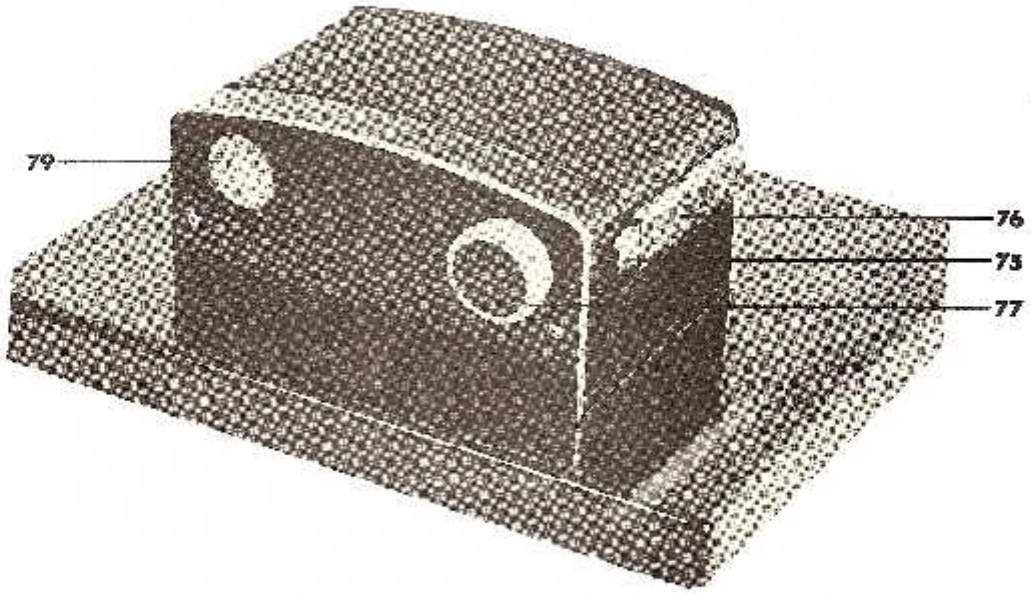
When the film has been exposed, rewind it into the cassette in the following manner:-

Press in the rewind button in the bottom of the camera.

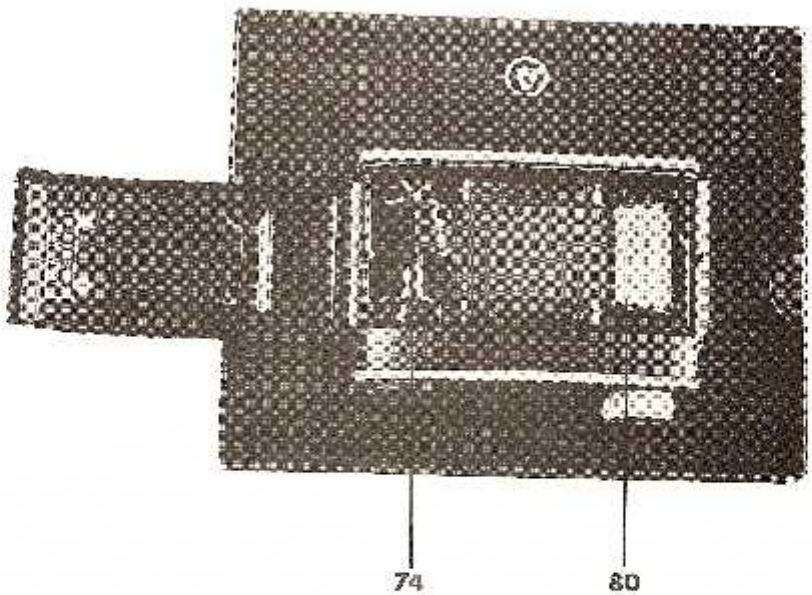
Raise the rewind knob (77) by depressing and rotating anti-clockwise.

Rewind the film by rotating the rewind knob in the direction indicated by the arrow keeping the rewind button pressed in until the rewinding is complete; this will be evident by a sudden lessening of resistance showing that the film has been detached from the take-up spool.

Open the camera back, withdraw the rewind knob and remove the cassette.



75 Locking arm
76 Release button
77 Film rewind knob
79 Film counter dial



74 Projecting pin
80 Cassette

LOADING THE AUTOWIND 35 mm. CAMERA

Unlock the camera by depressing the button (76) and slightly withdraw the locking arm (75). The back can now be opened. Pull out the rewind knob (77) and place the cassette (80) with the projecting end of the spool away from the rewind knob, in the camera.

Push in the rewind knob, rotating until the fork engages in the spool.

Insert the cutaway leader of the film into the slot in the take up spool so that one of the film perforations is engaged on the projecting pin (74). Rotate the take up spool to ensure that the film is firmly attached and that the sprocket teeth are projecting through the perforations in the film.

Rotate the rewind knob in the direction indicated by the arrow on the camera back to take up any slack on the film in the cassette.

To close the camera back, hold it tightly shut and push the locking arm (75) back home.

Rotate the film counter dial (79) in the direction indicated by the arrow on the dial until the black diamond is adjacent to the index mark.

There are two positions, one for 36 exposures and one for 20 exposure films.

Press the expose button (59), on the integrating unit, three times to clear the fogged leader film. Check that the film is being transported by observing the anti-clockwise rotation of the rewind knob after pressing the expose button.

The film counter will now be set at 36 or 20. When the film has been exposed, rewind it into the cassette in the following manner:

Press in the rewind button in the bottom of the camera and, keeping it pressed in, rotate the rewind knob clockwise until a sudden lessening of resistance indicates that the film has been detached from the take up spool, ;

Open the camera back, withdraw the rewind knob and remove the cassette.

POLAROID ® LAND CAMERA BACKS

The adapter which enables these units to be used, clips into the position provided for the normal plate holder and is secured in exactly the same way. Instructions for loading and using the polaroid equipment are given by the manufacturer, and are included with each unit.

® *Polaroid is the registered trade mark of the Polaroid Corporation*

WARNING

INCIDENT OR TRANSMITTED POLARIZED LIGHT

It is important to ensure that efficient heat absorbing filters are used between the polarizer and the high intensity illuminant. If this is not done the polaroid material may be damaged.

XENON LAMP

Three heat absorbing filters (M505608) are required to provide adequate protection with continuous illumination.

TUNGSTEN FILAMENT LAMP

Two filters (M505608) are required to provide protection.

TRANSMITTED POLARIZED LIGHT

Repeat the set up for MICRO-TRANSMITTED illumination using the magnification changer designed for polarized light work together with strain free objectives and a strain free substage condenser, then proceed as follows -

i) Swing the substage polarizer into position and rotate the polaroid to 0°.

ii) Pull the slide marked 'analyser' on the magnification changer, outwards.

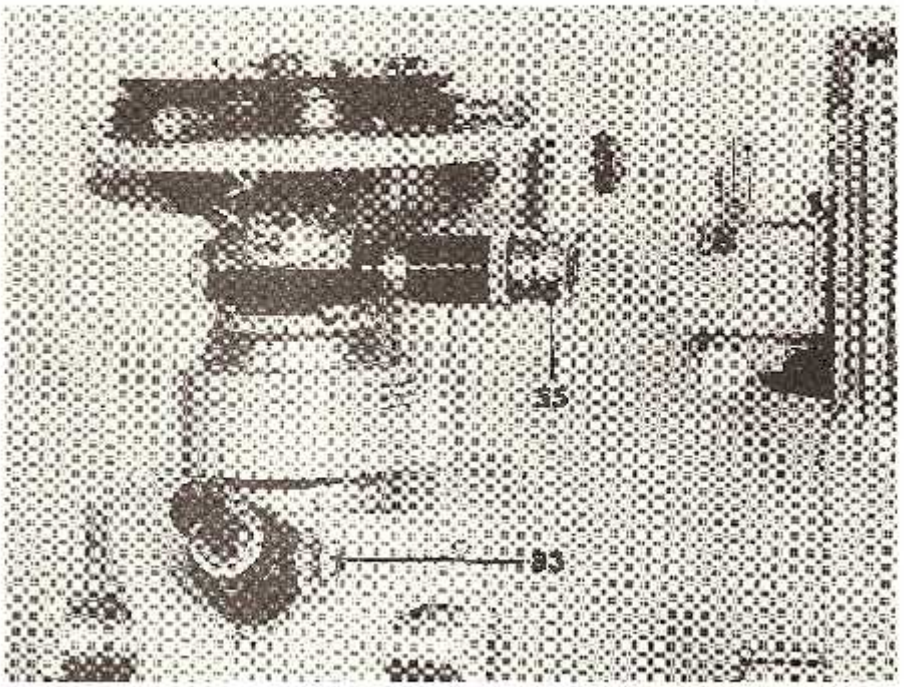
iii) Using an anisotropic object, check the extinction setting of the analyser. This is set to 90°

To observe the conoscopic figures replace the normal monocular or binocular head with the special monocular head incorporating the Bertrand lens unit, (83).

NOTE: the Bertrand lens on the magnification changer is not suitable for this work.

The sensitive tint plate is introduced into the light path in the same manner as the analyser by pulling out the slide on the magnification changer marked 'quartz'. The sensitive tint plate rotates together with the analyser when the graduated ring, through which the rods operating the 'quartz' and 'analyser' slides pass, is rotated.

$\frac{1}{4}\lambda$ and elliptic compensators can be inserted in the slot situated above the analyser by rotating the slot carrier by means of the milled wheel at the top left-hand side of the compensator unit until a clear aperture appears in the opening on the right-hand side. The handling screw should be removed after inserting the compensator. This allows the compensator to be rotated within the body of the unit, and the degree of orientation can be read on the scale at the front of the unit; a milled head screw for locking this rotation is situated on the right-hand side of the milled wheel.



83 Bertrand lens unit 55 Polarizing cap

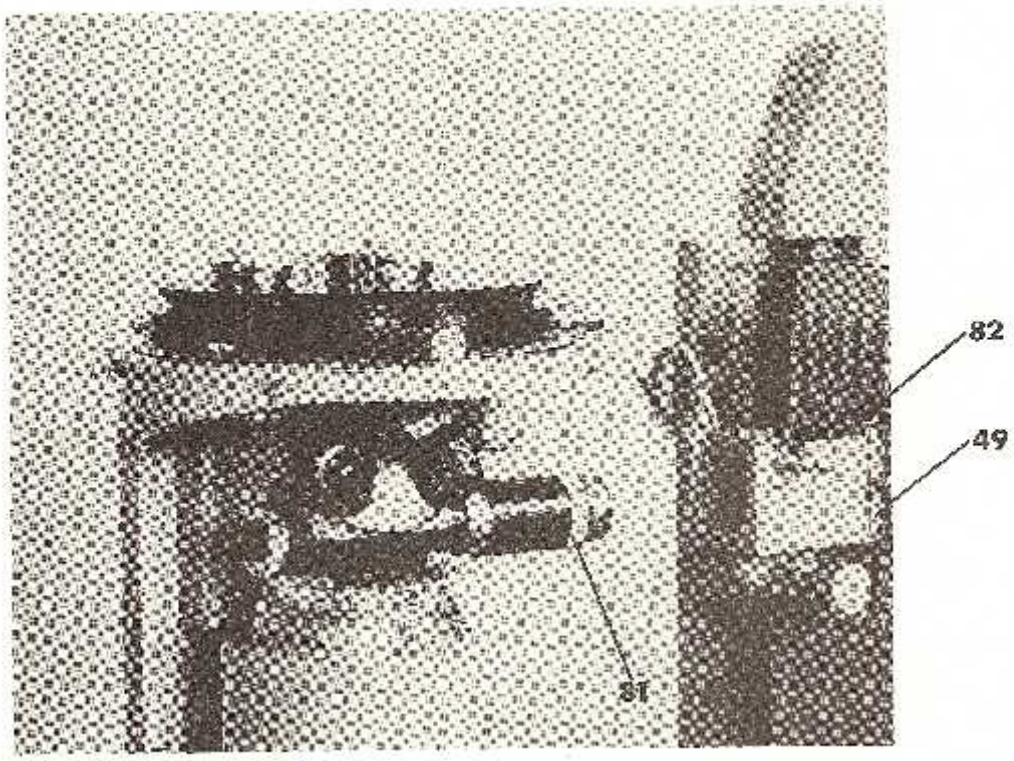
INCIDENT POLARIZED LIGHT

Using the magnification changer designed for polarized light work together with strain free objectives set up the instrument as for Micro examination by Normal Incident illumination, then proceed as follows -

i) Fit the polarizer on the end of the illumination box light tube (55).

ii) Bring the analyser into the light path by withdrawing the lever marked 'ANALYSER'.

iii) Using an anisotropic specimen, check the extinction setting of the analyser.



49 Aperture slide 81 Field iris control 82 Lamp iris control

INCIDENT DARK GROUND ILLUMINATION

Set up the instrument as for micro examination by Normal Incident illumination with the following amendments -

i) Use the triple objective carrier * fitted with DARK FIELD OBJECTIVES in their CATOPTRIC CONDENSERS.

ii) Position the dark ground illumination PATCH STOP in the optical path by pulling the aperture slide (49) towards you.

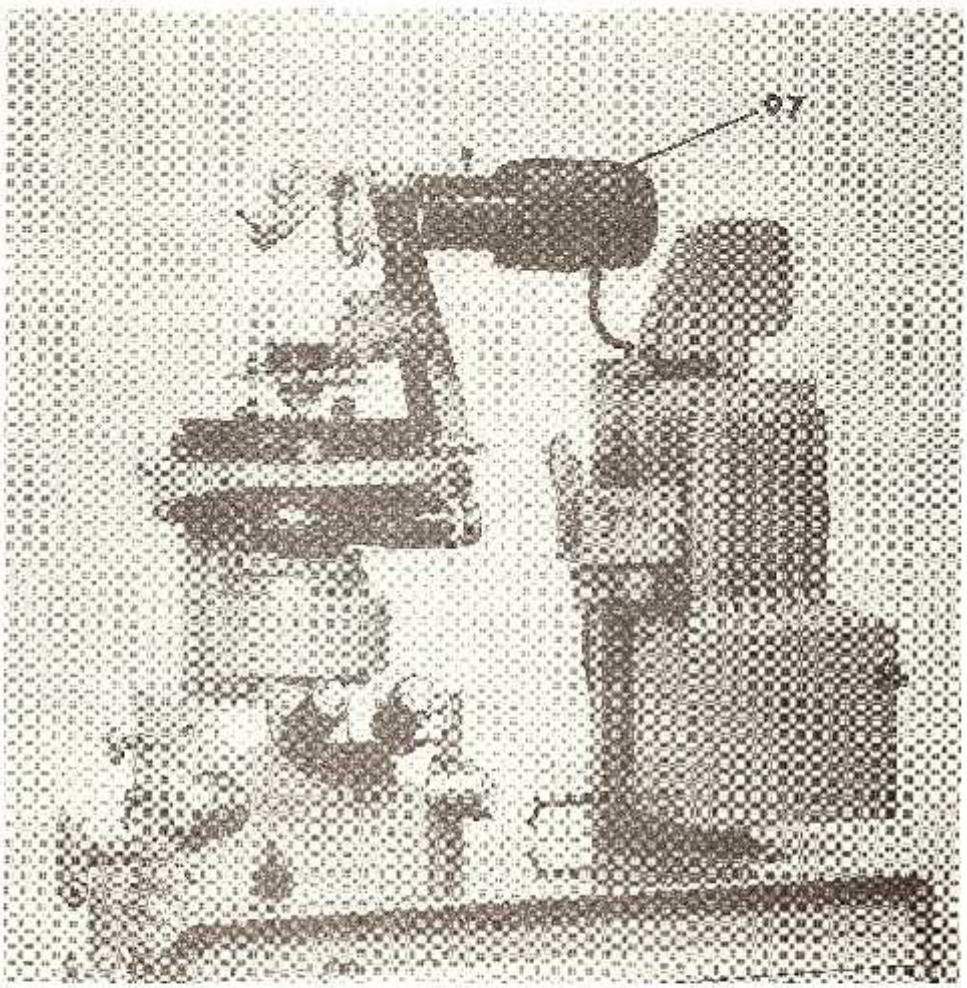
iii) 'FULLY OPEN' the LAMP IRIS (82).

iv) 'FULLY OPEN' the FIELD IRIS by rotating the milled ring (81) on the illumination box.

The dark field objectives can also be used with Normal Incident Illumination which is restored by moving aperture slide (49) back to the mid (clear) position.

* The quintuple objective carrier previously supplied, in now obsolete.

SIMULTANEOUS INCIDENT AND TRANSMITTED ILLUMINATION

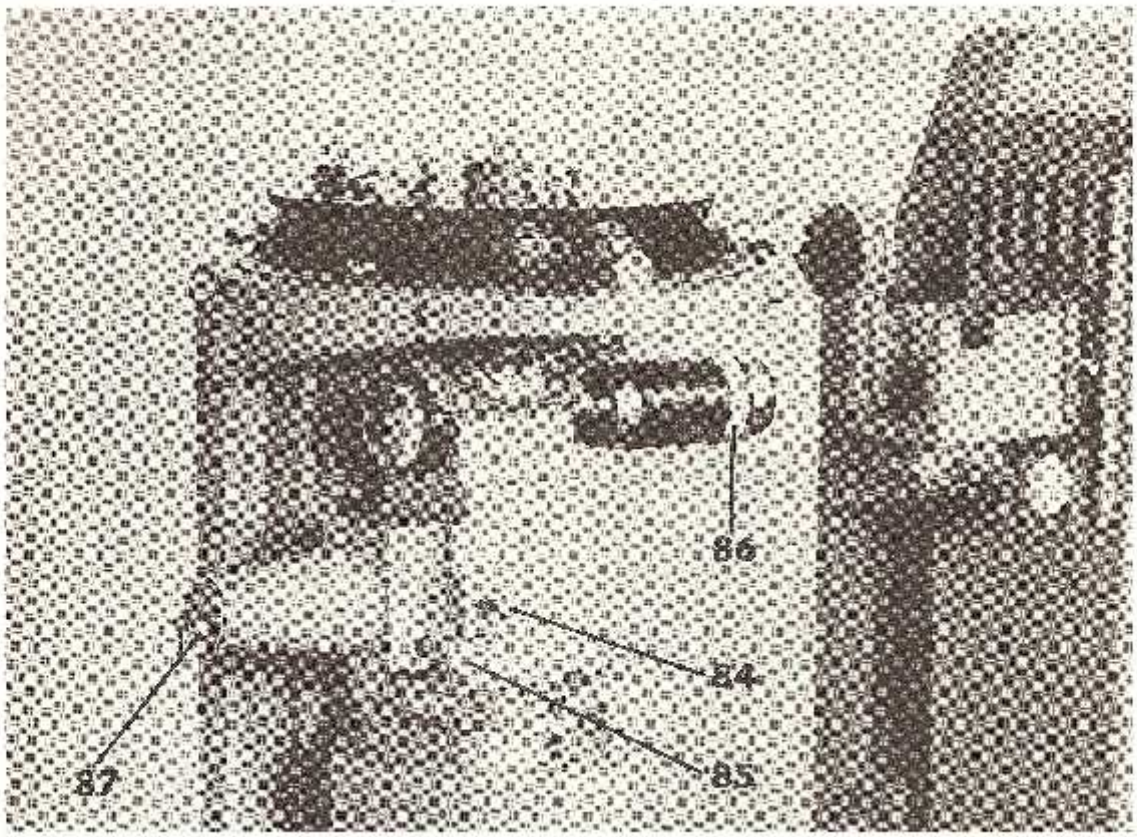


97 High power tungsten filament lamp

For micro observation of a specimen by incident illumination and transmitted illumination simultaneously, it is necessary to obtain the high power tungsten filament lamp which clamps to the top of the transmitted illumination bracket.

Using this high power tungsten filament lamp instead of the xenon lamp, set up the instrument as for TRANSMITTED ILLUMINATION. Using the xenon lamp, the instrument may now ALSO be set up for NORMAL INCIDENT ILLUMINATION in the usual manner; the transmitted light bracket is, however, left in position.

For this set-up the choice of objectives to be used (transmitted light objectives or incident light objectives) will depend on the specimen, and it will rest with the operator to select the type which will give the best results for his purpose.



84 Phase plate selector slide
85 Phase plate focusing control
86 Condenser sleeve
87 Centring screws

INCIDENT PHASE CONTRAST

Description of the unit

The incident phase contrast unit incorporates an illumination box similar to the one used for normal incident illumination and has the following controls:-

Slide (84) with 4 positions, these are, commencing from the 'IN' position.

(a) Dark ground illumination (pushed fully 'IN').
(b) Normal Incident Illumination
(c) Negative phase-contrast
(d) Positive phase-contrast (pulled to fully 'OUT' position).

Knob (85) which enables the phase ring slide to be focused into the plane of the annulus.

Sleeve (86) having a horizontal sliding movement which varies the magnification of the annulus.

Adjusting Screws (87) for centring the PHASE RING with respect to the ANNULUS.

NOTE

When using the incident phase contrast equipment, the water trough, and all but one of the heat absorbing filters, should be removed from the filter tray.

TO USE

i) With the XENON lamp raised to the position marked 'TRANS.ILL. + PHASE CONTRAST' set up the instrument as for NORMAL INCIDENT ILLUMINATION, but in place of the normal incident illumination box fit the incident phase contrast unit, setting slide (84) to the Normal Incident Illumination position (See (b) above).

ii) Place specimen in position.

iii) Focus the specimen and adjust controls in the usual manner to give even illumination - a slight alteration to the height of the lamp may be required.

iv) Push in the aperture slide (49) on the lamp condenser bracket to position the phase annulus in the light path, checking that it is reasonably centred with the lamp condenser iris diaphragm.

v) Move slide (84) on the phase contrast unit to the required position - i.e. 'Positive' or 'Negative' phase contrast setting (see (c) and (d) above).

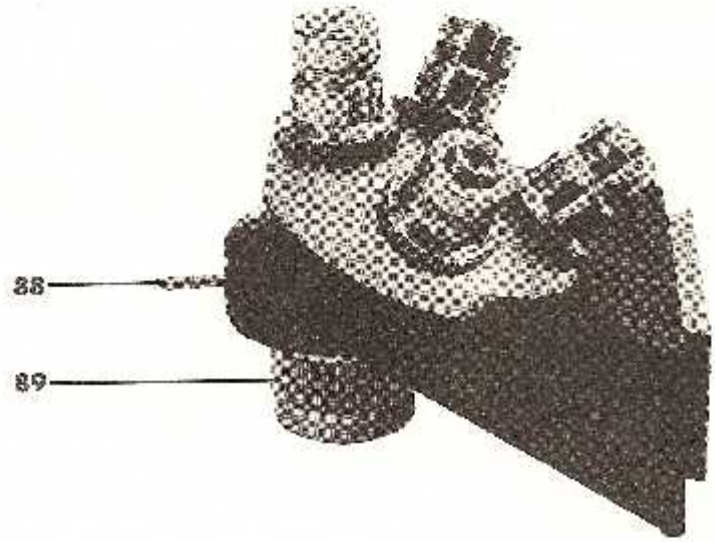
vi) With the Bertrand lens in position observe the annulus and phase ring through the eyepiece and using knob (85) focus the phase ring and annulus. The setting screws (87) should now be adjusted to position the phase ring so that it coincides with the annulus, using sleeve (86) to adjust the size of the annulus and knob (85) to re-focus if necessary - the CLEAR annulus should lay within the boundaries of the DARKER phase ring.

vii) Remove the Bertrand lens from the optical path and the specimen is now set up for observation by incident phase contrast illumination.

Comparison between Incident Phase Contrast and Normal Incident illumination of a specimen can quickly be made by moving slide (84) on the Incident Phase Contrast unit AND aperture slide (49) on the lamp condenser bracket to the Normal Incident setting and back to the Phase Contrast setting as required.

NOTE

For objectives other than the 2 mm. (140X) achromatic objective, increase the distance between the incident phase contrast unit and the objective bracket to $\frac{1}{4}$".



Nomarski Unit

88 Contrast lever
89 Prism control

GENERAL INFORMATION

The Nomarski Interference Contrast system provides an extremely sensitive technique for detecting slight surface irregularities in opaque specimens. In this respect its function is similar to that of the incident phase contrast system, but unlike the latter it will only reveal changes of slope in the surface.

Its use is limited by the size and separation of the surface irregularities, and generally, etched specimens with fine detail are not suitable for examination by the Nomarski method.

An advantage of the Nomarski Interference technique over the conventional phase contrast method is that it allows continuous variation in contrast over any particular part of the object. The images rendered are easier to interpret than those produced by phase contrast methods.

The Nomarski system is a qualitative one and is therefore unlike most other interference systems which allow measurements of path difference to be made.

INSTRUCTIONS FOR USE

Set up the microscope for incident polarized light work, but with the Nomarski unit in place of the standard nosepiece carrier.

The following objectives should be used:-

M. 022354	15x (16mm.)	M. 022954	50x (4mm.)
M. 022454	30x (8mm.)	M. 022654	140x (2mm.)

The use of low and medium power objectives will be generally more effective than the high power, owing to the superior colour saturation.

The adjustment of the unit is obtained using the procedure detailed below.

1. Set the polars to extinction. This operation must be carried out accurately. Polarizer 0^{o}, Analyser 90^{o}.

2. Focus an image of the specimen, using the 50X objective.

For initial trials use a well polished, unetched specimen such as a stainless steel mirror or a metal stage micrometer.

A series of coloured fringes will be seen crossing the field of view. The width of the fringes will depend on the separation of the Nomarski prism in relation to the back focal plane of the objective.

3. Adjust the contrast lever (88) until the zero order (black) fringe lies across the centre of the field.

4. Rotate the chromed milled ring (89) until the fringe broadens out to cover the whole field.

The prism setting is correct, if, when moving the contrast lever (88) through the zero order position, "brushes", typical of crossed polars, are observed to move in and out of the field of view.

If the prism setting is incorrect a dark fringe will move across the field of view. If this is observed the prism height requires a further slight adjustment by means of the milled ring (89).

If the above adjustments have been carried out correctly and the specimen used is both perfectly level and flat, the colour over the whole field will be uniform.

Movement of the contrast lever will produce changes in the field of view corresponding to the Newton scale of colours.

The technique, is so sensitive, that even with well polished specimens, some surface irregularities will generally be observed.

The differences in gradient of these irregularities can be deduced by the local differences in colour: i.e. steep gradients will show a range of colours compressed over a small area, whilst more gentle gradients will only produce a change of tint in a single colour.

Changing the objective will require a different setting of the prism height in order to maintain the prism to back focal plane relationship. This is carried out by means of the milled ring (89).

The approximate settings for the different objectives are as follows:-

1. 15 x (16mm.) objective:prism in lowest position. Milled ring (89) turned to extreme clockwise position.

2. 50x (4mm.) objective: prism in mid position.

3. 30x (8mm.) objective: prism near top position.

4. 140x (2mm.) objective: prism near top position slightly above 8mm objective.

Care must be taken if the Nomarski prism requires cleaning since it can be displaced if excessive pressure is used.

MAGNIFICATION TABLE FOR INCIDENT LIGHT OBJECTIVES

O.C. mm.	N.A.	PRIMARY MAGNIFICATION			MAGNIFICATION ON SCREEN			35 mm. CAMERA		
		1.0x	1.4x	2.0x	1.0x	1.4x	2.0x	1.0x	1.4x	2.0x
					ACHROMATIC OBJECTIVES					
68	0.05	3.5	5.0	7.0	24 - 35	33 - 50	46 - 70	7	10	14
33	0.10	6.0	8.5	12.0	40 - 60	55 - 85	80 - 120	12	17	24
25	0.13	10.0	14.0	20.0	65 - 100	95 - 140	130 - 200	20	28	40
16	0.25	15.0	21.0	30.0	100 - 150	140 - 210	200 - 300	30	42	60
8	0.50	30.0	42.0	60.0	200 - 300	280 - 420	400 - 600	60	85	120
4	0.80	50.0	70.0	100.0	330 - 500	465 - 700	660 - 1000	100	140	200
3	0.85	85.0	120.0	170.0	560 - 850	790 - 1190	1130 - 1700	170	240	340
1.8	1.30	140.0	195.0	280.0	930 - 1400	1300 - 1960	1860 - 2800	280	390	560
					DARK GROUND OBJECTIVES					
16	0.25	15.0	21.0	30.0	100 - 150	140 - 210	200 - 300	30	42	60
8	0.50	30.0	42.0	60.0	200 - 300	280 - 420	400 - 600	60	85	120
4	0.65	50.0	70.0	100.0	330 - 500	465 - 700	660 - 1000	100	140	200
					APOCHROMATIC OBJECTIVES					
16	0.30	17.0	24.0	34.0	115 - 170	160 - 240	225 - 340	35	48	68
4	0.95	50.0	70.0	100.0	330 - 500	465 - 700	665 - 1000	100	140	200
3	0.95	85.0	120.0	170.0	565 - 850	790 - 1190	1130 - 1700	170	240	340
2.2	1.32	115.0	160.0	230.0	765 - 1150	1070 - 1610	1530 - 2300	230	320	460
					FLUORITE OBJECTIVES					
1.8	1.30	140.0	195.0	280.0	930 - 1400	1300 - 1960	1860 - 2800	280	390	560

MAGNIFICATION TABLE FOR TRANSMITTED LIGHT OBJECTIVES

O.C. mm.	N.A.	PRIMARY MAGNIFICATION			MAGNIFICATION ON SCREEN			35 mm. CAMERA		
		1.0x	1.4x	2.0x	1.0x	1.4x	2.0x	1.0x	1.4x	2.0x
					ACHROMATIC OBJECTIVES					
33	0.10	6.0	8.5	12.0	40 - 60	55 - 85	80 - 120	12	17	24
25	0.15	10.0	14.0	20.0	65 - 100	95 - 140	130 - 200	20	28	40
16	0.25	20.0	28.0	40.0	130 - 200	185 - 280	260 - 400	40	56	80
8	0.50	40.0	55.0	80.0	260 - 400	376 - 560	530 - 800	80	112	160
4	0.66	80.0	110.0	160.0	530 - 800	740 - 1120	1060 - 1600	160	225	320
4	0.85	80.0	110.0	160.0	530 - 800	740 - 1120	1060 - 1600	160	225	320
1.8	1.30	190.0	265.0	380.0	1260 - 1890	1770 - 2650	2530 - 3790	380	530	760
					APOCHROMATIC OBJECTIVES					
16	0.30	20.0	28.0	40.0	130 - 200	185 - 280	260 - 400	40	56	80
4	0.95	80.0	110.0	160.0	530 - 800	740 - 1120	1060 - 1600	160	225	320
2.2	1.32	160.0	225.0	320.0	1060 - 1600	1490 - 2230	2130 - 3190	320	450	640
					FLUORITE OBJECTIVES					
3.75 oil	0.95	90.0	125.0	180.0	600 - 900	830 - 1250	1200 - 1800	180	250	360
1.8	1.30	190.0	265.0	380.0	1260 - 1890	1770 - 2650	2530 - 3790	380	530	760

INSTRUCTIONS FOR THE HANDLING AND ALIGNMENT OF THE D/C XENON LAMP

All operations listed hereunder must be effected during the initial installation of the Microscope.

Subsequent replacement of used Xenon bulbs will require adjustments B.i) - B.xv) to be carried out, the remaining items should, however, be checked although actual re-adjustment may be unnecessary.

A. Handling the Bulb

i) ON NO ACCOUNT SHOULD ANY ADJUSTMENT BE MADE TO THE UNCOVERED BULB UNLESS PROTECTIVE GOGGLES AND LEATHER GLOVES ARE WORN. THE PLASTIC PROTECTIVE COVER SHOULD NOT BE REMOVED FROM THE BULB UNTIL IT HAS BEEN INSERTED IN THE LAMP BASE COLLET.

ii) ON NO ACCOUNT SHOULD THE INSTRUMENT BE LEFT UNATTENDED WITH AN UNCOVERED BULB IN POSITION UNLESS THE LAMP HOUSING COVER IS FITTED.

iii) THE BULB MUST BE INSERTED WITH THE PRINTED END (i.e. SMALL ELECTRODE END) IN THE COLLET, and care must be taken to hold the bulb only at the end nearest the collet when tightening the clamp ring. Failure to observe this precaution could result in breakage of the bulb.

iv) ON NO ACCOUNT MUST THE BULB BE LIT WITH THE LAMP HOUSING COVER REMOVED.

v) Should the quartz envelope become contaminated by contact with the fingers, it must be cleaned when COOL, first with alcohol and then with distilled water.

vi) The lamp housing cover must not be removed until at least 10 minutes have elapsed after switching off.

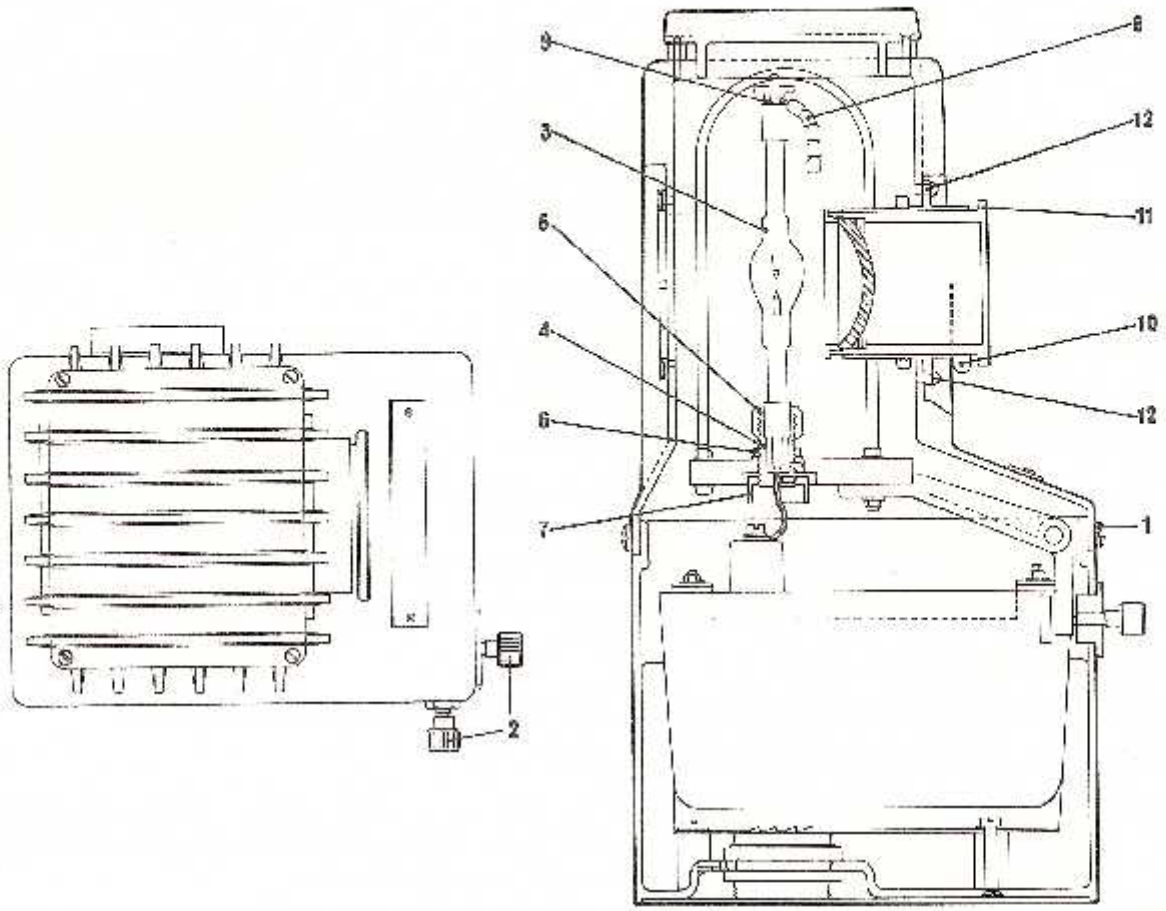
vii) To destroy burned-out bulbs, first wrap the bulb, without its protective plastic cover, in a large thick cloth, e.g. heavy canvas, place the wrapped bulb on a hard underlay, and smash the bulb with a hammer. For this operation goggles and gloves must be worn.

B. Aligning the Bulb

i) Remove the four, plated, cheese headed screws marked (1) and remove the top half of the lamp housing.

ii) Set the lamp centring controls (2) to the middle of their adjustment run.

iii) Insert the lamp (3) in the collet (4) and tighten the milled clamp ring (5), taking care to ensure that the lamp is vertical.



XENON LAMP ILLUMINATION UNIT

OZONE CONCENTRATION IN THE XENON LAMP

A small amount of ozone is generated by the Xenon Lamp while in operation and it is, therefore, strongly recommended that the lamp be used in well ventilated surroundings.

iv) If necessary, adjust the height of the collet to bring the electrodes central to the lamp condenser axis. To do this, slacken clamp ring (6) and rotate adjusting ring (7) clockwise to lower collet and anticlockwise to raise collet. Finally tighten clamp ring (6).

v) Re-check that the lamp is still vertical

vi) Connect the insulated cable (8) to the top of the lamp (9).

vii) Replace the top half of the lamp housing and insert screws (1).

viii) Switch on the lamp.

ix) Adjust the microscope for normal incident work using a 50X objective and a stainless steel mirror specimen. Adjust the height of the lamp housing if necessary, to centre the lamp iris in the objective back aperture.

x) Place the dust excluding end cap on the end of the illumination base.

xi) Close the lamp iris.

xii) Focus the lamp condenser to image the electrodes on the end cap.

xiii) Release the mirror clamp screw (10).

xiv) Pull the mirror mount (11) out as far as it will come. Only one electrode will be seen to have a bright spot of light on its point (called the hot electrode) the other electrode is bare (called the cold electrode).

xv) By means of the lamp centring controls (2) place the two electrodes symmetrically about the centre point of the end cap.
If more than half a turn of the screws is required then the lamp is not truly vertical and it must therefore be corrected.

NOTE: To move the electrode images horizontally across the end cap, the lamp must be tilted in the opposite direction. If the electrode images require to go down on the end cap, then the lamp must be tilted back away from the lamp condenser or alternatively the collet may be raised.

xvi) Switch off lamp and make correction as necessary.

xvii) Repeat vii), viii), xi) and xiv).

xviii) Remove the end cap from the illumination box.

xix) Open the lamp iris fully.

xx) Swing in the Bertrand Lens on the magnification changer.

xxi) Focus the lamp electrodes by using the Bertrand Lens focusing movement and the lamp condenser movement.

xxii) If necessary place the two electrodes symmetrically in the illuminated aperture of the Bertrand Lens by means of the lamp centring controls (2); the amount of movement required will be small.

xxiii) Replace the end cap on the illumination box.

xxiv) Close the lamp iris.

xxv) Focus the lamp condenser to image the electrodes on the end cap.

xxvi) Refocus the mirror by pushing the mirror mount (11) in, until an inverted image of the hot electrode is focused on the end cap.

xxvii) Rotate the mirror to bring this inverted image into coincidence with the 'Cold electrode'. If the two cannot be made to coincide, then set the mirror so that the inverted image is as close to the 'cold electrode' as possible.

xxviii) Re-tighten the mirror clamp screw (10).

xxix) Release the four mirror mount housing clamp screws (12).

xxx) Move the mirror in the opposite direction to that which the inverted 'hot electrode' image on the end cap requires to be moved, to make it coincide with the cold electrode.

xxxi) Re-tighten the clamp screws (12).

xxxii) Remove the end cap from the illumination box.

xxxiii) Repeat xix), xx) and xxi).
The electrodes should now be symmetrically placed with a bright spot of light on the point of each electrode also symmetrically placed. If not, repeat xiii) xiv), xxvi), xxvii), xxviii), xxix), xxx), xxxi) using the Bertrand Lens instead of the end cap. The Lamp is now aligned to the optical axis of the microscope.

xxxiv) Focus the lamp iris using the Bertrand Lens.

xxxv) Focus the lamp condenser to give an evenly illuminated objective back aperture.

xxxvi) Close the lamp iris down to 4/5 the radius of the objective back aperture.

The microscope is now ready for use.

Assembly and Use

i) Fit the triple nosepiece and securely clamp.

ii) Insert the larger nozzle on the air line into the transmitter.

iii) Insert the smaller nozzle on the air line into the indenter objective.

NOTE: Ensure that this nozzle is always turned in a clockwise direction. otherwise the sealing round the air inlet hole may be damaged.

iv) Fit the monocular tube and filar micrometer eyepiece with centring mount.

v) Place the stainless steel specimen on the microscope stage.

vi) Attach the specimen holder to the microscope stage with screw (90).

vii) Fit the flexible specimen retainer (95) and tighten screw (91). an alternative specimen holder is provided for normal use and is described at the end of this section).

viii) Centre the flexible specimen retainer over the specimen and tighten screw (92).

ix) Slide the body down until the spring is almost fully compressed and lock with screw (93).

x) Rotate the indenter objective into position, fully open the lamp iris, and focus the specimen.

NOTE: If the field iris is partially closed it will assist in the focusing of a featureless specimen.

xi) Select the required load on the transmitter.

xii) Depress the transmitter lever (this will cause an immediate defocusing of the image) and leave for 20 seconds.

xiii) Raise the transmitter lever. The diamond will return to its original position and a focused image of the indentation will be observed approximately centred in the field of view.

xiv) Allow 20 seconds to elapse between subsequent indentations.

xv) Centre the fixed cross lines of the filar micrometer eyepiece on the indentation by adjustment of the centring mount screws. Subsequent indentations will then be placed on the intersection of the crosswires.

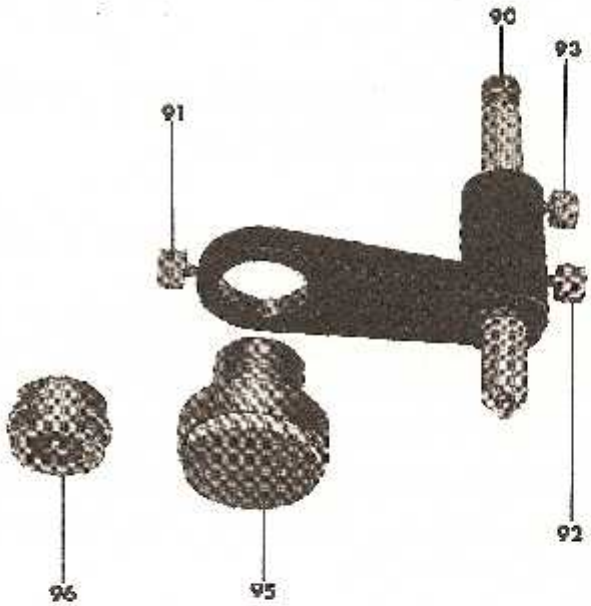
xvi) Set the microscope magnification changer to 1.4X.

xvii) Rotate the reading objective (M022952 50X) into position and adjust the variable length eyepiece tube to give a magnification of 75X, measured at the filar micrometer eyepiece focal plane.

NOTE: When the hardness testing equipment is supplied with the microscope, this adjustment has been calculated and is shown on the transmitter.

SPECIMEN HOLDER

90 Stage attachment screw
91 Clamp screw for specimen retainer or mount
92 Centring clamp screw
93 Height clamp screw
95 Specimen retainer
96 Specimen mount



xviii) Measure the indentations acress both diagonals. The Vickers Hardness Numerals for the average of the readings will be found in the appropriate tables.

Specimen Holder for normal use.

i) Place the specimen face down upon a piece of lens tissue on the microscope stage.

ii) Load the specimen mount (96) with a plastic medium such as plasticine and insert into the specimen holder.

iii) Release screw (92) and centre the mount over the specimen.

iv) Release screw (93) and slide the bracket down until the mounting media is in contact with the specimen.

v) Clamp screw (93).

vi) Exert a downward pressure on to the bracket and the mounting media will adhere to the specimen.

vii) Release the pressure to allow the spring loaded bracket carrying the specimen to lift and clear the stage surface.

viii) Position the specimen as required in relation to the objective and clamp screw (92).

SYNOPSIS OF SETTING UP FOR VICKERS HARDNESS TESTER

i) Use indenter objective and 50X reading objective.

ii) Set magnification changer to 1.4X

iii) Select load required.

iv) Read filar division across both diagonals and take the average of both readings.

v) The following tables give Vickers Hardness Numerals per load used, e.g. An impression measuring 185 micrometer divisions obtained with a load of 100 grammes, V.H.N. - 305

vi) For complete instructions on assembly and use, see pages 52 and 53

vii) Formulae for obtaining Vickers Hardness Numerals on page 62.

viii) For modification to conventional formulae for Vickers Hardness Numerals see page 62.

SPECIAL NOTE: When not in use the transmitter should always be left with the load indicator set at 5 gm. position otherwise damage may be caused to the unit during transportation.

VICKERS HARDNESS NUMERALS FOR 5 GRAMME LOAD

FILAR MICRO-METER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10									1509	1444
20	1503	1182	1077	983	903	834	771	715	663	620
30	578	543	509	479	452	428	407	388	369	343
40	328	313	298	282	268	257	246	236	226	217
50	209	200	193	186	179	172	166	160	155	150
60	145	140	136	131	127	123	120	116	113	109
70	106	103	101	97.8	94.9	92.7	90.2	88.0	85.7	83.6
80	81.4	79.5	77.5	75.8	74.0	72.	70.5	68.9	67.3	65.5
90	64.1	63.0	61.6	60.3	59.0	57.8	56.6	55.4	54.2	53.2
100	53.1	51.1	50.1	49.1	48.2	47.3	46.4	45.5	44.7	43.9
110	43.0									
120	36.2									
130	30.8									
140	26.6									
150	23.1									
160	20.3									
170	18.0									
180	16.1									
190	14.6									
200	13.0									
210										
220										
230										
240										
250										
260										
270										
280										
290										
300										
310										
320										
330										
340										
350										
360										
370										
380										
390										

VICKERS HARDNESS NUMERALS FOR 10 GRAMME LOAD

FILAR MICRO-METER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10										
20	2507	2363	2150	1971	1811	1669	1543	1431	1331	1240
30	1152	1085	1018	957	903	851	805	762	722	686
40	652	620	591	564	539	515	493	472	453	434
50	417	401	386	371	358	345	333	321	310	300
60	290	280	271	263	255	247	239	232	225	219
70	213	207	201	196	191	185	180	176	171	167
80	163	159	155	151	148	144	141	138	135	132
90	129	126	123	121	118	116	113	111	108	106
100	104	102	100	98.2	96.4	94.6	92.8	91.1	89.5	87.8
110	86.1	84.6	83.1	81.7	80.2	78.8	77.5	76.2	74.9	73.7
120	72.4	71.3	70.0	68.9	67.9	66.7	65.7	64.7	63.6	62.7
130	61.7	60.7	59.9	58.9	58.1	57.2	56.4	55.5	54.8	54.0
140	53.2	52.4	51.7	51.0	50.3	49.6	48.9	48.3	47.6	46.9
150	46.3	45.7	45.2	44.6	43.9	43.4	42.9	42.3	41.7	41.2
160	40.7									
170	36.0									
180	32.2									
190	28.9									
200	26.1									
210	23.6									
220	21.5									
230	19.7									
240	18.1									
250	16.7									
260	15.4									
270	14.3									
280	13.3									
290	12.4									
300	11.6									
310	10.8									
320	10.3									
330	9.6									
340	9.1									
350	8.6									
360	8.1									
370	7.6									
380	7.2									
390	6.9									

VICKERS HARDNESS NUMERALS FOR 20 GRAMME LOAD

MEAN MICRO-METER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
30	2318	2170	2038	1914	1806	1703	1609	1525	1445	1372
40	1304	1241	1182	1128	1077	1030	986	944	905	869
50	834	802	772	743	715	689	665	642	620	599
60	520	501	343	326	309	494	479	465	451	438
70	426	414	402	391	381	371	361	352	343	334
80	326	318	310	303	296	289	282	276	269	263
90	258	252	246	241	236	231	226	222	217	213
100	208	206	201	197	193	189	186	182	179	176
110	173	169	166	163	160	158	155	152	150	147
120	145	143	140	30	136	133	131	129	127	125
130	123	121	120	118	116	114	113	111	110	108
140	106	105	103	102	101	99.3	98.0	96.8	95.5	93.8
150	92.6	91.4	90.4	89.2	87.8	86.6	85.8	84.8	83.4	82.6
160	81.4	80.5	79.4	78.6	77.6	76.6	75.8	74.8	73.8	73.0
170	72.0	71.4	70.4	69.6	68.8	68.0	67.4	66.6	65.8	65.0
180	64.4	63.6	63.0	62.2	61.8	61.0	60.2	59.6	59.0	58.4
190	57.8	57.2	56.6	56.0	55.4	54.8	54.4	53.8	53.2	52.8
200	52.2									
210	47.4									
220	43.0									
230	39.4									
240	36.2									
250	33.4									
260	30.8									
270	28.8									
280	26.8									
290	24.8									
300	23.2									
310	21.8									
320	20.4									
330	19.2									
340	18.2									
350	17.2									
360	16.3									
370	15.3									
380	14.7									
390	13.8									

VICKERS HARDNESS NUMERALS FOR 50 GRAMME LOAD

FILAR MICRO-METER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
30										
40										
50	2065	2005	1880	1857	1788	1725	1662	1605	1550	1498
60	1450	1402	1357	1314	1275	1238	1196	1161	1127	1095
70	1064	1034	1006	978	952	927	902	880	857	834
80	814	795	776	755	738	721	703	688	673	658
90	644	630	618	603	590	578	565	551	542	532
100	521	511	501	491	482	473	464	456	447	439
110	430	423	415	408	401	394	387	381	374	368
120	362	356	350	344	339	334	328	322	318	313
130	308	303	299	294	290	286	282	277	274	270
140	266	262	258	255	251	248	245	241	238	234
150	231	228	226	223	219	217	214	211	208	206
160	203	201	198	196	194	191	189	187	184	182
170	180	178	176	174	172	170	168	166	164	162
180	161	159	157	155	154	152	150	149	147	146
190	144	143	141	139	138	137	136	134	133	132
200	130	128	128	126	125	124	123	121	120	119
210	118	117	116	115	114	113	112	111	110	108
220	107	107	106	105	104	103	102	101	100	99.5
230	98.5	97.5	96.5	96.0	95.5	94.5	93.5	92.5	92.0	91.5
240	90.5	89.5	89.0	88.5	87.5	87.0	86.0	85.5	85.0	84.0
250	83.5	83.0	82.0	81.5	81.0	80.0	79.5	79.0	78.0	78.0
260	77.0	76.5	76.0	75.0	74.5	74.5	74.0	73.0	72.5	72.0
270	71.5	71.0	70.5	70.0	69.5	69.0	68.5	68.0	67.5	67.0
280	66.5	66.0	65.5	65.0	64.5	64.0	63.5	63.5	63.0	62.5
290	62.0	61.5	61.0	60.5	60.0	60.0	59.5	59.0	59.0	58.5
300	58.0	57.5	57.0	56.5	56.0	56.0	56.0	55.5	55.0	54.5
310	54.0									
320	51.0									
330	48.0									
340	45.5									
350	42.5									
360	40.5									
370	38.0									
380	36.0									
390	34.5									

VICKERS HARDNESS NUMERALS FOR 100 GRAMME LOAD

OCULAR MICROMETER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
30										
40										
50										
60										
70	3128	2865	2612	2397	2208	2054	1905	1760	1716	1671
80	1529	1390	1351	1312	1276	1243	1211	1178	1148	1117
90	1088	1060	1029	1006	1080	1150	1131	1106	1085	1064
100	1043	1023	1002	984	964	946	928	911	895	878
110	862	846	831	817	803	788	774	762	749	737
120	724	713	700	688	676	667	657	647	636	627
130	617	607	598	589	581	572	564	556	548	540
140	532	525	517	510	503	496	490	483	476	469
150	468	457	452	446	439	434	429	425	419	413
160	407	403	397	393	388	383	379	374	369	365
170	359	357	352	348	345	340	337	334	330	326
180	322	319	315	311	308	305	301	298	295	292
190	289	286	283	279	277	274	272	269	266	264
200	261	258	256	253	250	248	246	243	241	238
210	236	234	232	230	228	226	224	221	220	217
220	216	214	212	210	208	206	204	202	200	199
230	197	195	193	192	191	189	187	185	184	183
240	181	179	178	177	176	174	173	171	170	168
250	167	165	164	163	162	160	159	158	157	156
260	155	153	152	150	149	148	147	146	145	144
270	143	142	141	140	139	138	137	136	135	34
280	133	132	131	130	129	128	127	127	126	125
290	124	123	122	121	120	120	119	118	118	117
300	116	115	114	113	112	12	12	111	110	109
310	108	108	107	106	106	105	105	104	103	103
320	102	101	101	00	99	98	98	98	97	97
330	96	96	95	94	93	93	92	91	91	91
340	91	90	89	88	88	88	87	87	86	86
350	85	84	84	84	83	83	83	82	82	81
360	81	80	80	79	79	79	78	78	77	76
370	76	76	76	75	75	74	74	73	73	73
380	72	72	71	71	71	70	70	69	69	69
390	69	68	68	68	67	67	67	66	66	66

VICKERS HARDNESS NUMERALS FOR 200 GRAMME LOAD

FILAR MICRO-METER DIVISIONS	0	1	2	3	4	5	6	7	8	9
0										
10										
20										
30										
40										
50										
60										
70										
80										
90										
100	2084	2046	2006	1966	1926	1892	1856	1822	1790	1756
110	1722	1692	1662	1634	1604	1576	1550	1524	1498	1474
120	1448	1426	1400	1378	1356	1334	1314	1294	1272	1254
130	1234	1214	1198	1178	1160	1144	1126	1110	1094	1080
140	1064	1050	1034	1020	1006	992	980	968	952	938
150	926	914	904	892	878	866	858	848	834	824
160	814	806	794	786	776	766	758	748	738	730
170	720	714	704	698	690	680	674	666	658	650
180	644	636	630	622	616	610	602	596	590	584
190	578	572	566	558	554	548	544	538	532	528
200	522	516	512	506	500	496	492	486	482	476
210	472	468	464	460	456	452	448	442	440	434
220	430	426	424	420	414	412	408	404	400	398
230	394	390	386	384	382	376	374	370	368	368
240	362	358	356	354	350	348	344	342	340	336
250	334	330	328	326	324	320	318	316	312	312
260	308	306	304	300	298	298	296	292	290	286
270	286	284	282	280	278	276	274	272	270	268
280	266	264	262	260	258	256	254	254	252	250
290	248	246	244	242	240	240	238	236	236	234
300	232	230	228	226	224	224	224	222	220	218
310	216	216	214	212	210	210	210	208	206	206
320	204	204	202	200	198	196	196	196	194	194
330	192	190	190	188	188	186	184	182	182	182
340	180	180	178	178	178	178	174	174	172	172
350	170	168	168	166	166	166	166	164	164	162
360	162	160	160	158	158	158	156	154	154	152
370	152	152	152	150	150	148	148	148	146	146
380	144	144	142	142	142	140	140	138	138	138
390	138	138	136	136	134	134	134	132	132	132

DIAGONAL LENGTH IN MICRONS EQUIVALENT TO FILAR MICROMETER DIVISIONS AT 75x MAGNIFICATIONS AT EYEPIECE FOCAL PLANE

FILAR MICRO-METER DIVISIONS 1 Div=0,01mm	0	1	2	3	4	5	6	7	8	9
0	-	0,133	0,267	0,400	0,533	0,667	0,800	0,933	1,067	1,200
10	1,33	1,46	1,60	1,73	1,86	2,00	2,13	2,26	2,40	2,53
20	2,67	2,80	2,94	3,07	3,20	3,34	3,47	3,60	3,74	3,87
30	4,00	4,13	4,27	4,40	4,53	4,67	4,80	4,93	5,07	5,20
40	5,33	5,46	5,60	5,73	5,86	6,00	6,13	6,26	6,40	6,53
50	6,67	6,80	6,94	7,07	7,20	7,34	7,47	7,60	7,74	7,87
60	8,00	8,13	8,27	8,40	8,53	8,67	8,80	8,93	9,07	9,20
70	9,33	9,46	9,60	9,73	9,86	10,00	10,13	10,26	10,40	10,53
80	10,67	10,80	10,94	11,07	11,20	11,34	11,47	11,60	11,74	11,87
90	12,00	12,13	12,27	12,40	12,53	12,67	12,80	12,93	13,07	13,20
100	13,33	13,46	13,60	13,73	13,86	14,00	14,13	14,26	14,40	14,53
110	14,67	14,80	14,94	15,07	15,20	15,34	15,47	15,60	15,74	15,87
120	16,00	16,13	16,27	16,40	16,53	16,67	16,80	16,93	17,07	17,20
130	17,33	17,46	17,60	17,73	17,86	18,00	18,13	18,26	18,40	18,53
140	18,67	18,80	18,94	19,07	19,20	19,34	19,47	19,60	19,74	19,87
150	20,00	20,13	20,27	20,40	20,53	20,67	20,80	20,93	21,07	21,20
160	21,34	21,46	21,60	21,73	21,86	22,00	22,13	22,26	22,40	22,53
170	22,67	22,80	22,94	23,07	23,20	23,34	23,47	23,60	23,74	23,87
180	24,00	24,13	24,27	24,40	24,53	24,67	24,80	24,93	25,07	25,20
190	25,33	25,46	25,60	25,73	25,86	26,00	26,13	26,26	26,40	26,53
200	26,67	26,80	26,94	27,07	27,20	27,34	27,47	27,60	27,74	27,87
210	28,00	28,13	28,27	28,40	28,53	28,67	28,80	28,93	29,07	29,20
220	29,34	29,46	29,60	29,73	29,86	30,00	30,13	30,26	30,40	30,53
230	30,67	30,80	30,94	31,07	31,20	31,34	31,47	31,60	31,74	31,87
240	32,00	32,13	32,27	32,40	32,53	32,67	32,80	32,93	33,07	33,20
250	33,33	33,46	33,60	33,73	33,86	34,00	34,13	34,26	34,40	34,53
260	34,67	34,80	34,94	35,07	35,20	35,34	35,47	35,60	35,74	35,87
270	36,00	36,13	36,27	36,40	36,53	36,67	36,80	36,93	37,07	37,20
280	37,33	37,46	37,60	37,73	37,86	38,00	38,13	38,26	38,40	38,53
290	38,67	38,80	38,94	39,07	39,20	39,34	39,47	39,60	39,74	39,87
300	40,00	40,13	40,27	40,40	40,53	40,67	40,80	40,93	41,07	41,20
310	41,33	41,46	41,60	41,73	41,86	42,00	42,13	42,26	42,40	42,53
320	42,67	42,80	42,94	43,07	43,20	43,34	43,47	43,60	43,74	43,87
330	44,00	44,13	44,27	44,40	44,53	44,67	44,80	44,93	45,07	45,20
340	45,33	45,46	45,60	45,73	45,86	46,00	46,13	46,26	46,40	46,53
350	46,67	46,80	46,94	47,07	47,20	47,34	47,47	47,60	47,74	47,87
360	48,00	48,13	48,27	48,40	48,53	48,67	48,80	48,93	49,07	49,20
370	49,33	49,46	49,60	49,73	49,86	50,00	50,13	50,26	50,40	50,53
380	50,67	50,80	50,94	51,07	51,20	51,34	51,47	51,60	51,74	51,87
390	52,00	52,13	52,27	52,40	52,53	52,67	52,80	52,93	53,07	53,20

VICKERS HARDNESS NUMERALS

The preceeding tables have been computed for a load of 5 to 200 grammes and a magnification, measured at the filar micrometer eyepiece focal plane, of 75X using the M022952 50X objective, and the magnification changer set to 1,4X.

V.H.N. FORMULAE

The Vickers Hardness Numerals in the tables have been derived from the conventional formulae, ignoring the 'Z' factor referred to below, where:

$$Hp = \frac{2P\sin\frac{\theta}{2}}{d^2} \quad Kg/mm^2$$

where P is the applied load in kilogrammes,
d is the average diagonal length in millimetres
or more conveniently expressed as

$$VHN = \frac{1854 \times P}{d^2} \quad Kg/mm^2$$

where P is the load applied in grammes
and d is the average length of the diagonal in microns.

V.H.N. MODIFIED FORMULAE

While every effort has been made to ensure a mathematical point at the apex of the pyramidal indenter, a minute ridge, which will in no case exceed 1 micron, may be apparent. The hardness figure obtained under such condition demands slight modification.

The formulae for the derivation of the hardness numeral requires slight correction by the addition of the Z term in the denominator, thus -

$$VHN = \frac{1854 \times P}{(d^2 - z^2)} \quad Kg/mm^2$$

where Z is the length of the ridge in microns.

The value of Z is stated on the data label and may be safely ignored when d exceeds 10 microns.

EXPOSURE TABLE

Meter Reading (uA)	Exposure times (seconds)	Photographic material:		
5,000 - 2,500		Developer :		
2,500 - 1,250				
1,250 - 640		Time :		
640 - 320				
320 - 160		Temperature :		
160 - 80		Micro	Macro	35mm.
80 - 40				
40 - 20		Additional remarks:		
20 - 10				
10 - 5				

EXPOSURE TABLE

Meter Reading (uA)	Exposure times (seconds)	Photographic material:		
5,000 - 2,500		Developer :		
2,500 - 1,250				
1,250 - 640		Time :		
640 - 320				
320 - 160		Temperature :		
160 - 80		Micro	Macro	35mm.
80 - 40				
40 - 20		Additional remarks:		
20 - 10				
10 - 5				

EXPOSURE TABLE

<table>
<tr><th>Meter Reading (uA)</th><th>Exposure times (seconds)</th><th colspan="3">Photographic material:</th></tr>
<tr><td>5,000 - 2,500</td><td></td><td colspan="3" rowspan="5">Developer :

Time :

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<tr><td>2,500 - 1,250</td><td></td></tr>
<tr><td>1,250 - 640</td><td></td></tr>
<tr><td>640 - 320</td><td></td></tr>
<tr><td>320 - 160</td><td></td></tr>
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<tr><td>80 - 40</td><td></td><td colspan="3" rowspan="4">Additional remarks:</td></tr>
<tr><td>40 - 20</td><td></td></tr>
<tr><td>20 - 10</td><td></td></tr>
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</table>

EXPOSURE TABLE

Meter Reading (uA)	Exposure times (seconds)	Photographic material:		
5,000 - 2,500		Developer :		
2,500 - 1,250				
1,250 - 640		Time :		
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320 - 160		Temperature :		
160 - 80		Micro	Macro	35mm.
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10 - 5				