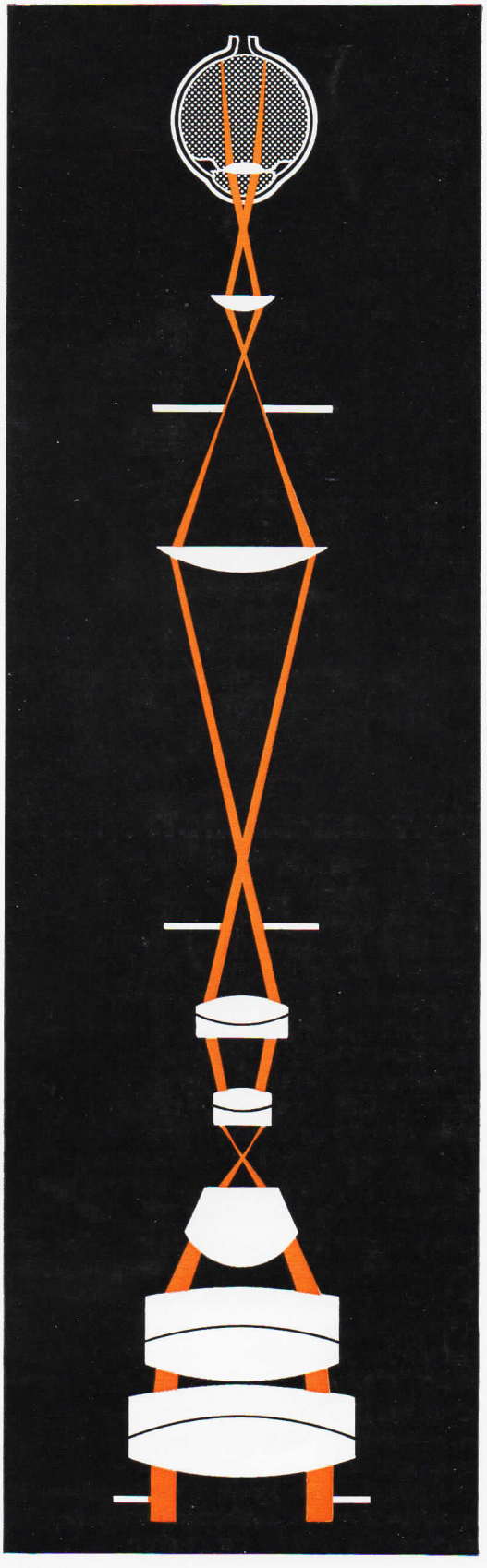
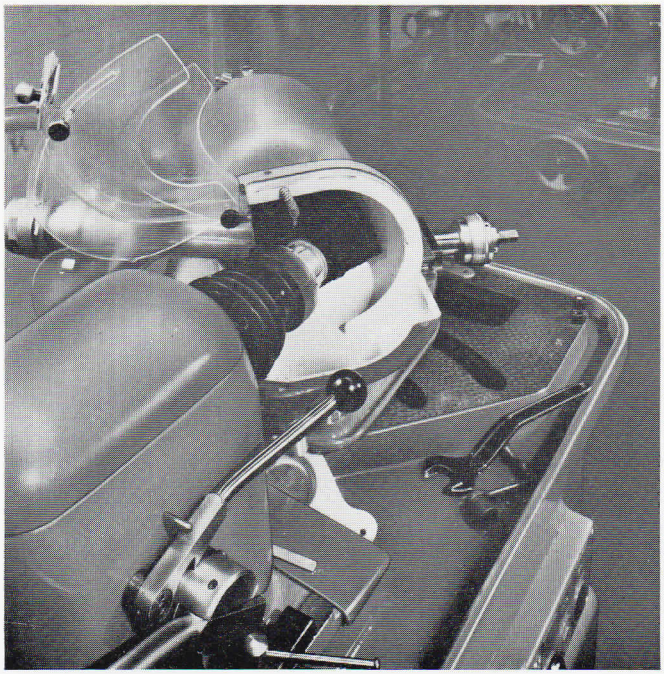
WATSON

MICROSYSTEM 70

OPTICAL COMPONENTS



OBJECTIVES EYEPIECES CONDENSERS



High precision optical grinding . . .

together with extreme care in polishing . . .

The entirely novel approach made by Microsystem 70 to the mechanical design of microscopes is matched by new ideas and methods in the optical field.

With the availability of modern high speed computers, the improvement of microscope objectives has become a continuous activity. Watson design specialists have programmed some of the most advanced lens computing techniques for electronic data processing.

Many Watson objectives have been redesigned with improved characteristics and a number of new designs are currently in hand.

WATSON OBJECTIVE TYPES

Parachromatic objectives

PARACHROMATIC OBJECTIVES are a highly developed form of achromat in which the residual aberrations have been reduced as far as possible without incurring great expense. They are intended for use with Huygenian eyepieces and the low powers should not be used with other eyepieces.

Those of higher magnification (×20 and above), like all other high power objectives, give improved off-axis performance with Compensating eyepieces which reduce the slight colour fringing away from the centre of the field caused by the chromatic difference of magnification (transverse colour) inherent in all high power objectives. Compensating eyepieces also reduce field curvature and have a wider angular field than can usefully be obtained with Huygenian eyepieces.

Where it has not been possible to reduce field curvature to very small amounts without incurring extra cost, flat field versions of the Parachromatic objectives—PLANPARA—are offered.

The ×10 Fluorite objective can conveniently be used on a microscope with higher power Parachromats so that all objectives are optimised for Compensating eyepieces.

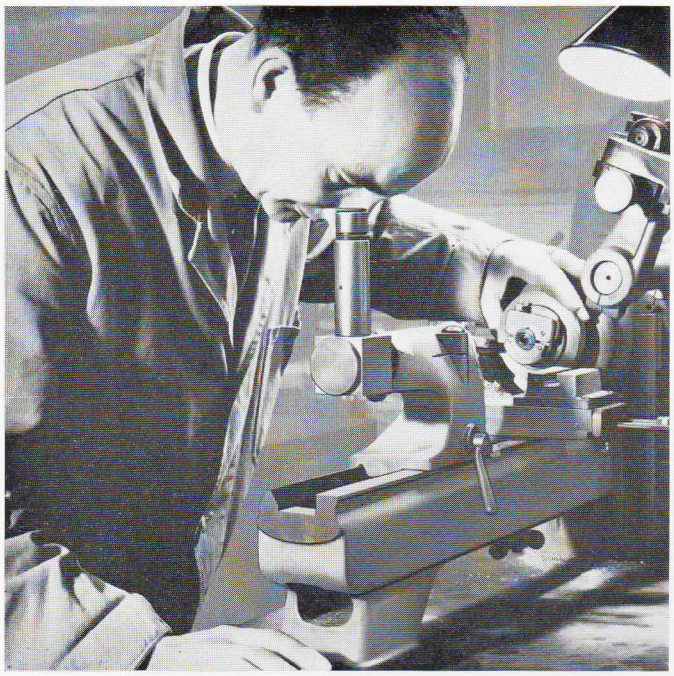
Considerations of cost may dictate the use of Parachromatic objectives, and it should be noted that with the appropriate eyepieces these objectives give remarkably good results for many applications and that the very small residual colour aberrations can be largely eliminated in black and white photomicrography by using a green filter.

Fluorite objectives

FLUORITE OBJECTIVES use special glasses to achieve substantially better colour correction than can be obtained with achromatic objectives. They should be used with Compensating eyepieces. Freedom from residual colour in the image makes these objectives particularly useful for observing unstained material and for phase contrast work.

Apochromatic objectives

APOCHROMATIC OBJECTIVES embody complex designs to achieve the best possible colour correction, combined with very high numerical aperture leading to exceptional resolving power. They should be employed where the finest possible detail must be observed and give superlative performance in the centre part of the field. Apochromats should be used with Compensating eyepieces.



and closely-controlled accuracy in mounting . . .

guarantee the exceptional quality of Watson objectives

CHOICE OF OBJECTIVES

The following notes may be helpful in choosing objectives for any particular requirement, especially where a microscope is to be specified for a single purpose.

Resolution

The smallest detail which can usually be seen with a transmitted light microscope is about

$$\frac{0.3}{\text{N.A.}} \text{ microns}$$

where N.A. is the numerical aperture. It is always necessary to use an objective with sufficient aperture to resolve the desired detail.

Depth of focus

The depth of focus of a microscope using visible light is approximately equal to

$$\frac{1}{(\text{N.A.})^2} \text{ microns}$$

so that it is important not to use excessive aperture. The importance of depth of focus will depend on the object thickness. Increased depth of focus also reduces the apparent field curvature.

Field diameter and overall magnification

The overall magnification M is the ratio of final image to object size when the former is 250mm (10in) from the eye.

$$M = M_o \times F \times M_{e/p}$$

Where M_o is the objective magnification, $M_{e/p}$ is the eyepiece magnification and F is a factor of the microscope equal to 1 for the monocular Microsystem 70 microscopes and 1.5 for the binocular instruments.

The field diameter is the diameter of the area on the object plane seen by the microscope.

$$\text{field diameter} = \frac{500 \tan \theta/2}{M} \text{ mm}$$

Where θ is the angular field of the eyepiece used.

For any particular objective some latitude is available in these quantities by the appropriate choice of eyepiece magnification. For low power searching objectives, when eyepieces have already been chosen to suit the principal objectives, the choice of objective magnification can be made to suit the required field diameter.

Oil immersion

Objectives with numerical aperture greater than 1.0 have to be immersion types but at medium powers there is sometimes a choice between a dry or an immersion objective. Immersion objectives can be less convenient if they have to be used in alternation with lower power (dry) objectives but they have the advantage that their performance is less dependent on cover glass and mountant thickness and they avoid the very short working distances of high aperture dry objectives.

Cover glass thickness

High power dry objectives are very sensitive to cover glass and mountant thickness. Watson objectives are corrected for a cover thickness of 0.18mm (No $1\frac{1}{2}$). The spherical aberration introduced by incorrect cover thickness appears as a milky glare reducing the contrast of fine detail. As well as using the correct cover glass, it is important to use the minimum thickness of mountant over the object and this can sometimes be achieved by preparing the object on the cover glass instead of on the slide so that most of the mountant lies under the object.

TABLE OF OBJECTIVES

	primary magnification and numerical aperture	focal length in mm	free working distance in mm	code
PARACHROMATIC SERIES	×3/0.11	50	27	1200
	×4/0.13	40	18	1203
	×5/0.12	30	16	1202
	×10/0.28	16	7	1205
	×20/0.50	8	1.5	1216
	×40/0.65	4	1.0	1208
	×60/0.85	3	0.1	1218
	×100/1.30(oil)	2	0.12	1219
PLANPARA SERIES	×4/0.10	40	7	1237
	×40/0.63	4	0.9	1209
FLUORITE SERIES	×10/0.30	16	7.7	1233
	×50/0.95(oil)	3.6	0.22	1234
	×90/1.30(oil)	2	0.12	1236
APOCHROMATIC SERIES	×20/0.65	8	0.56	1229
	×40/0.85	4	0.18	1230
	×90/1.37(oil)	2	0.12	1231

Objectives for Microsystem 70 conform to British Standards specifications. They are accurately parfocalled to an object plane 45mm below the screw thread shoulder when used at a mechanical tube length of 160mm and are accurately centred to a common standard so that they can be interchanged between any Microsystem 70 microscopes.
Rigid inspection procedures ensure that the performance of individual lenses is up to the exacting Watson standard.

recommended eyepieces ◎	cover glass category ●	remarks ■	
h	n		
h	n		
h	n		
h	n	ph	
c or h	o	ph	
c or h	o	ph s	
c or h	c	s	
c or h	o	ph s	
h	n		
c	o	ph s	working distance adequate for most counting chambers
c	o		
c	o	ph s	
c	o	ph s	
c	o		
c	c	s	
c	o	s	

◎ ● ■

h = Huygenian

c = Compensating

n = not critical

o = corrected for 0.18mm cover ± 0.05mm

c = corrected for 0.18mm cover ± 0.01mm

ph = phase contrast version available

s = spring loaded to prevent damage if lowered on to slide

Truing a lens preparatory to edging . . .

dielectric coating of lenses and mirrors . . .

HUYGENIAN EYEPIECES

Designed for use with the Parachromatic objectives. They perform excellently with medium and low power Parachromats and give a satisfactory performance with the higher powers (×20 and above) where a small amount of transverse colour and field curvature is acceptable.

magnification	single eyepiece code	paired eyepieces code	angular field	height of eyepoint
×5	1250	1251	23°	13mm
×7	1252	1253	29°	9mm
×10	1254	1255	35°	8mm
×14	1256	1257	37°	8mm

COMPENSATING EYEPIECES

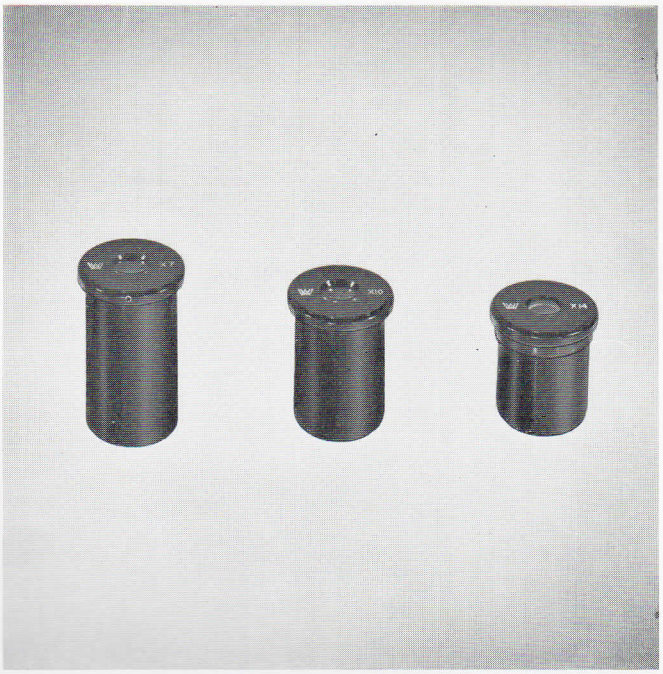
Designed to reduce the transverse colour inherent in the higher powered objectives and to provide a certain amount of field flattening. Suitable for use with Apochromatic objectives, Fluorite objectives and the higher powers of Parachromatic objectives.

magnification	single eyepiece code	paired eyepieces code	angular field	height of eyepoint
×7	1268	1269	32°	11mm
×10	1270	1271	36°	8mm
×14	1272	1273	37°	13.5mm
×20	1274	—	36°	8mm

POINTER EYEPIECES *code 1260*

Optically similar to the ×10 Huygenian eyepiece but incorporating an adjustable pointer which can be used to indicate any point on the object of special interest.

checking the angle of a prism . . .



guarantee the quality of all Watson optical components

MICROMETER EYEPIECES

Watson micrometer eyepieces are fitted with focusing eye lenses to enable the graticule to be sharply focused.

	code
×5 Huymic eyepiece	1262
×10 Ramsden micrometer eyepiece	1264

Normally supplied without graticule or micrometer scale, these eyepieces will accept any graticule on a 19mm diameter disc. The scales most commonly supplied are listed below but others are available to order.

Horizontal scale of 10mm divided into 100 parts, each division=0.1mm	*332D*
Horizontal scale as Code No. 332D, but with cross lines	*336D*
Horizontal scale of 5mm divided into 100 parts, each division=0.05mm	*337D*
Horizontal scale of 2mm divided into 100 parts, each division=0.02mm	*338D*
Square, each side 1cm divided into 1mm squares	*340D*
Eyepiece graticule with two lines crossing at right angles in the centre	*343D*
Eyepiece micrometer, combined vertical and horizontal scale, 10mm divided into 100 parts	*767D*
Vertical scale 10mm divided into 100 parts	*791D*

OTHER MEASURING EYEPIECES

A separate leaflet describes the wide range of measuring accessories available, including Filar micrometer eyepieces, Image-shearing eyepiece and stage micrometers for calibration.

Condensers are supplied in mounts to fit the Microsystem 70 range of microscopes. They include an iris diaphragm and a carrier for filters of 32mm diameter. Substage centring is provided on all Microsystem 70 microscopes; swing-out condensers are unnecessary.

ABBE CONDENSER *code 155/2*

A two-lens condenser which is recommended for use with the mains and low voltage illuminating bases. It provides illumination with sufficient aperture for all objectives and will fill the field down to an overall magnification of ×20. For lower magnifications it can be used with the top lens removed.

UNIVERSAL No. 3 CONDENSER *code 155/1*

A new five-component Achromatic condenser which has been specially designed for use with Microsystem 70. It is specially recommended for use with the Köhler illuminating base and will also give improved performance with the simple bases when these are used with the auxiliary field iris unit. The condenser is highly corrected both spherically and chromatically and a special feature is the accessible entrance pupil which makes it suitable for illuminating techniques which require stops or filters to be imaged on to the back lens of the objective. The Phase Contrast accessories for Microsystem 70 incorporate this condenser and it should be specified when it is proposed to add Phase Contrast facilities to the microscope at a later date. The condenser has an Aplanatic aperture of 0.9 providing the usual $\frac{2}{3}$ cone illumination with a ×100/1.30 objective and will fill the fields of all objectives on the binocular microscopes. The condenser is intended to be used dry with slides in the thickness range 1.0 to 1.2mm.

ZONAL DARK GROUND CONDENSER *code 155/4*

A catoptric condenser designed on the concentric principle. It is suitable for use with slides 1.0 to 1.2mm thick with which it must be in oil contact. It can be used with ×100 or ×90 objectives whose aperture must be reduced to 1.0 by means of a funnel stop. It can also be used with a ×40 or ×50 objective without funnel stop. The condenser gives an intense black background and is easier to centre than other types of immersion dark ground condenser.

FUNNEL STOPS

Funnel stop for ×100/1.30 Parachromatic objective *code 789*
Funnel stop for ×90/1.30 Fluorite objective *code 785*

PHASE CONTRAST ACCESSORIES

Equipment for phase contrast illumination with Microsystem 70 is described in the separate leaflet 'Phase Contrast equipment for Microsystem 70'.

Prices of all the optical components described in this catalogue are contained in the Microsystem 70 List of Parts and Prices.

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