WILD
HEERBRUGG

**Wild Heerbrugg Ltd.**
**CH-9435 Heerbrugg/Switzerland**
Optical Precision Instrument Makers
Telephone (071) 72 24 33 / 72 14 33
Telegrams: Wico Heerbrugg / Telex 77191

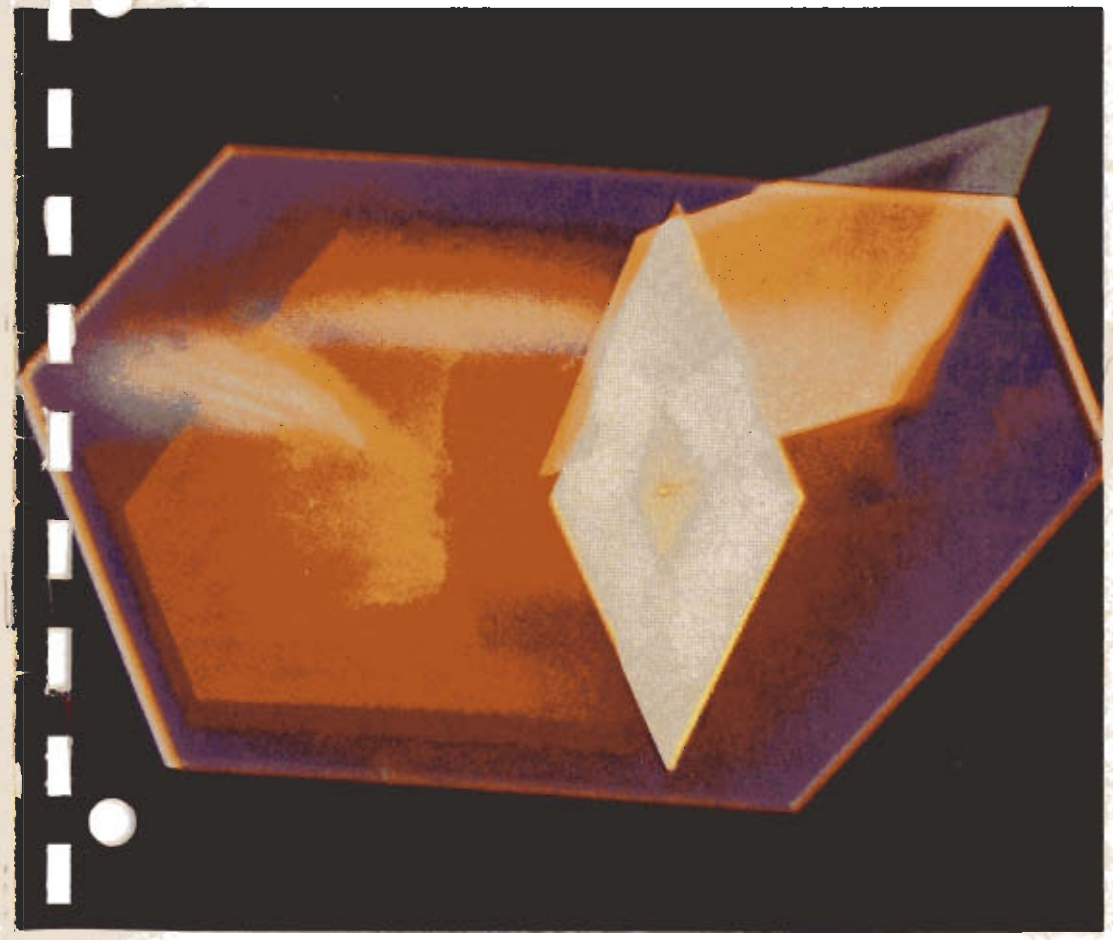


M1 127e I.72 Printed in Switzerland



# Wild M 21

# Polarising Microscope



WILD
HEERBRUGG

# Wild M21

# Polarising Microscope

The polarising microscope is of fundamental importance in geology, and its applications in mineralogy, crystallography, petrography and palaeontology have long been widely appreciated. It is less well-known however, that the polarising microscope can also be used with considerable success in many other branches of natural science. It can simplify and improve observation and reveal much new information which is unobtainable by other means.

In biology the polarising microscope was in use before staining techniques were developed. Since natural birefringence often occurs in biological material the polarising microscope can be employed not only for the recognition and identification of crystalline inclusions, but also to obtain a more detailed picture of the finer cell and tissue structures. The precise measurements which can be made with a good polarising microscope are particularly advantageous in the examination of plant cell-walls and plant protoplasm, where very fine structures are revealed which lie far beyond the resolving power of the normal light microscope and therefore cannot be studied by direct observation.

Although certain fine structural details can be observed and identified with a good biological microscope, such as the Wild M11, M12 or M20, using strain-free optics and polarising filters, only precise measurement of the type and degree of birefringence can be used as a basis for determining the cause and structure of double-refracting elements. To study the finest structural details a good polarising microscope is therefore essential. In fact the polarising microscope effectively bridges the gap between normal and electron microscopy and is a valu-



Wild M21 Polarising Microscope, Outfit I, with optics set O 71

able complementary instrument to the electron microscope.

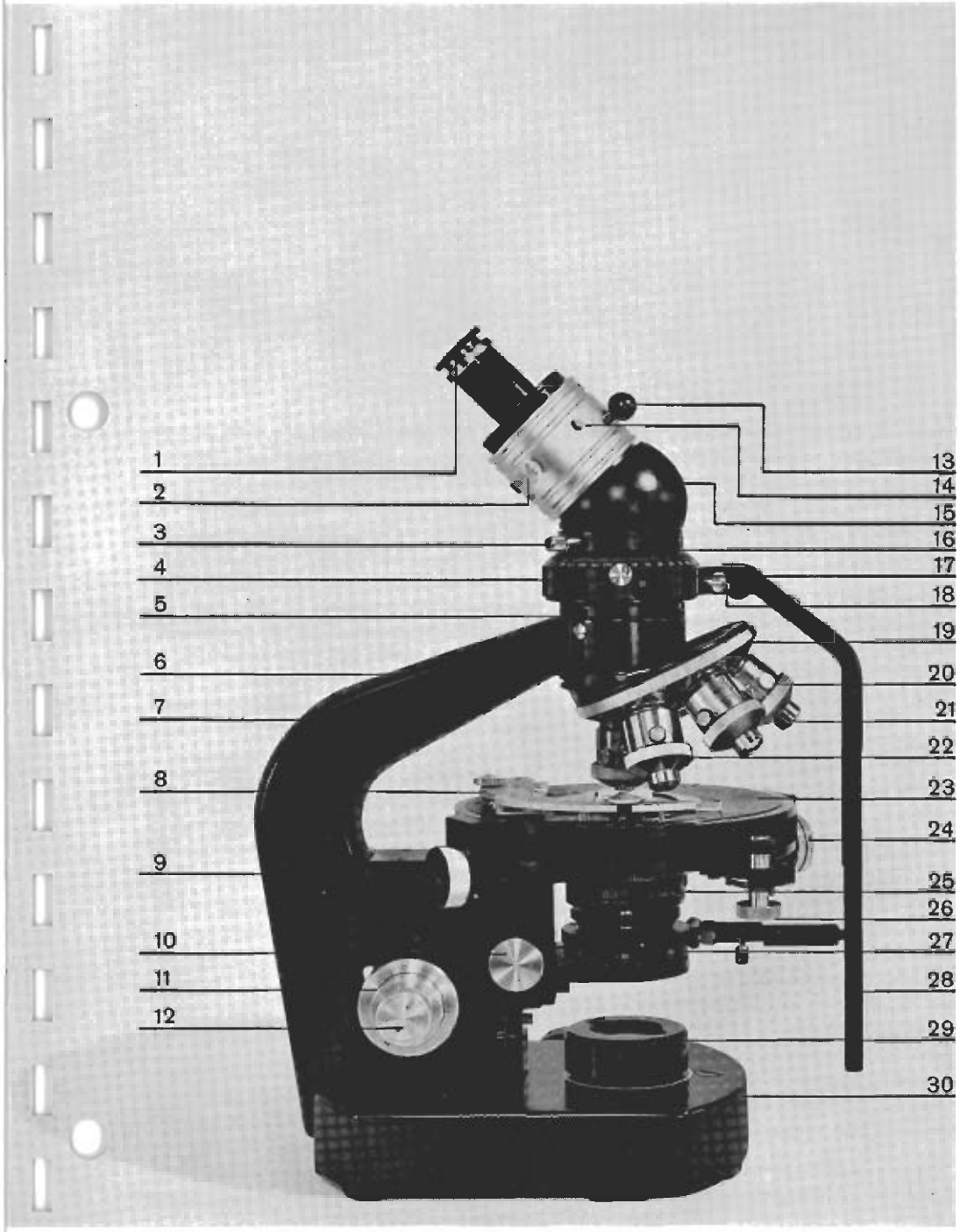
Occurrence of optical artifacts is far less common in specimens carefully prepared for polarisation microscopy than in preparations for electron microscopy.

In medicine, the polarising microscope is used with particularly good results in such fields as histology, neurology, and odontology; its applications as well as its limitations have been most carefully studied in the laboratory. Many branches of technology employ the polarising microscope. It is used above all in the textile industry, but also to study wood, paper, ceramic products, building materials, food and confectionery products. Modern criminology depends to a large extent on the polarising microscope.

The construction of the Wild M21 polarising microscope follows the well-established principles of design used in the M20 research microscope. The base contains a powerful built-in illuminator (6 V / 20 W). Initial alignment and field diaphragm apertures are controlled from the side of the base. Fine centring adjustments are facilitated by a special sliding insert. This lamp greatly facilitates Köhler illumination. Because of the lateral and offset arrangement of the built-in illuminator, the very

Wild M21 Polarising Microscope with synchronised rotation bracket

1 Eyepiece with crosshair graticule
2 Clamping screw for Bertrand lens focussing sleeve
3 Tube clamping screw
4 Knurled ring for analyser rotation
5 Slot for compensators
6 Clamping lever for nosepiece
7 Limb
8 Mechanical stage
9 Stage clamping screw
10 Condenser drive knob
11 Coarse focussing knob
12 Fine focussing knob
13 Lever for engaging Bertrand lens and iris diaphragm, and for controlling the latter
14 Centring screw for Bertrand lens
15 Monocular inclined tube Fp
16 Clamping screw for analyser
17 Degree scale for analyser
18 Attachment screw for synchronising bracket
19 Sextuple nosepiece
20 Objective centring screw
21 Objective (spring loaded)
22 Knurled ring of objective mount
23 Revolving stage with 360° scale and verniers
24 Position knob for 45° stops
25 Condenser
26 Fine-motion control of stage
27 Slot for compensators
28 Synchronising bracket
29 Centring insert of lamp
30 Base plate



bright bulb, even when burning for long periods, does not heat up the base appreciably and does not interfere with the smooth operation of the various drive mechanisms. The built-in illuminator is powered via a regulating transformer.

For combination with separate microscope lamps (e.g. the 6 V / 30 W low-voltage lamp or the Wild universal lamp), the stand can easily be equipped with a mirror carrier and mirror in place of the built-in illuminator.

The condenser drive mechanism, which can be adjusted for smoothness, is conveniently operated by knobs located on both sides of the substage.

The polariser is located below the condenser and can be swung out to the side and changed in this position. It can be rotated through 360° and has click-stops every 90°. It is graduated every 15° and the 45° positions are numbered. The scale is read from the left side. The direction of vibration at zero setting is vertical (north-south). A slot is provided in the polariser frame for compensators and wedges. A recommended condenser is the aplanatic 0.65/1.30 swing-out condenser with iris diaphragm and swing-out filter holder.

The coarse and fine focussing adjustments are coaxial and low enough to be operated with the hand resting comfortably on the table. The coarse adjustment affects the limb, and its ease of run can be altered at will. The fine adjustment actuates the stage and is thus not loaded by attachments such as the photomicrographic camera. The large, easily-read drum scale of the fine adjustment is divided into intervals of 0.001 mm (1 µ). Since the fine adjustment has practically no play, however, sufficiently reliable readings can be made to 0.0005 mm ($^1/_2$ µ).

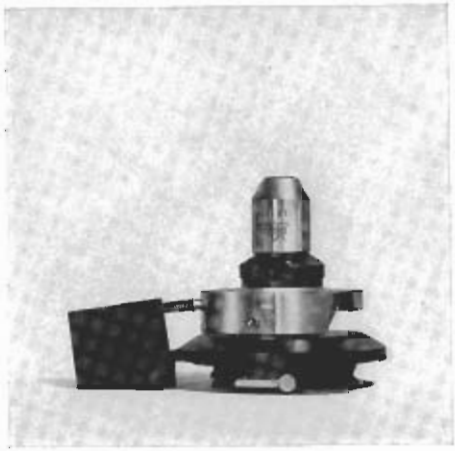
The following polarisation stages are available:

a) Ball-bearing mounted Qp Rotating Polarisation Stage with 360° scale division, numbered every 10°, with verniers reading to 0.1°. Stage clamping screw for fixing in any position. Fine adjustment of the stage can be disengaged. Click stop positions every 45° can be disengaged as desired.

b) Ball-bearing mounted Rp Rotating Polarisation Stage, simplified model. As described above but without click-stops and fine adjustment.

A special Cp attachable mechanical stage is available. Range of movement 25 × 30 mm, with stop positions every 0.2 mm (0.3 mm or 0.5 mm if required) that can be disengaged or changed. It is equipped with scale divisions and verniers to provide readings to 0.1 mm.





Quick-change mount Z with objective centring ring and strain-free achromat 10/0.25

There are three possible nosepieces:
a) Interchangeable quadruple, ball-bearing mounted, revolving nosepiece X.
b) Interchangeable sextuple, ball-bearing mounted, revolving nosepiece Y.
c) Quick-change mount Z with single objective centring ring for standard objectives.

The analyser is located above the nosepiece in an intermediate tube with a parallel light path. The analyser can be rotated 180°; it can also be slid out of position or removed completely in the 100° setting. A setscrew allows it to be locked in any position. The knurled ring for rotating the analyser is divided into two 180° scales numbered every 10°. A vernier reads to 0.1°. In the zero position the direction of vibration in the analyser is horizontal (east-west). Below the analyser there is a slot in the 45° position (with a sliding cover) for compensators (opening 12 × 4 mm). Because of the intermediate tube with its parallel beam of light, focus and magnification of the image remain unchanged when the analyser or compensators are used.

Both polariser and analyser are provided with polarisation filters of the best quality, which provide a high degree of extinction without producing interference colours. Polarisation filters have a great advantage over the Nicols used previously (and combinations thereof) in that high illumination apertures can be used without producing astigmatism. To achieve joint rotation of polariser and analyser in the crossed position, a synchronising bracket can be provided.

The adapter above the fixed intermediate tube can receive the following tubes with a dovetail-ring mount:
a) Monocular inclined tube Fp with a Bertrand lens (that can be focussed and centred) and an iris diaphragm. Both of these can be moved out of the light path as required.
b) Straight monocular tube Ep with the same characteristics as under (a) but specially designed for photomicrography using the Wild MKa Cameras with focussing telescope. Both tubes have orientating slots on the upper edge (90° and plus and minus 45°) for the crosshair eyepieces.
c) Binocular tube Gp. Used in conjunction with an auxiliary microscope, this tube can be employed for both orthoscopic and conoscopic observations.

1

2


3

1 Monocular inclined tube Fp with focussing and centrable Bertrand lens and iris diaphragm

2 Monocular straight tube Ep with focussing and centrable Bertrand lens and iris diaphragm

3 Binocular inclined tube Gp



Polarisation objectives. The following six strain-free and bloomed polarisation objectives are available:

- Pol-Achromat 4/0.10
- Pol-Achromat 10/0.25
- Pol-Achromat 20/0.45
- Pol-Achromat 40/0.65
- Pol-Achromat 50/0.85
- Pol-Achromat 100/1.25 oil immersion

These objectives are supplied in centring mounts with easily accessible centring screws which are protected against inadvertent displacement.

The Pol 20, 40, 50 and 100 objectives are spring-mounted to protect specimen and front lens.

Eyepieces:

- Pol-Huygens 6×
- Pol-Huygens 10×
- Pol-Compensating 6×
- Pol-Compensating 10×
- Pol-Compensating 15×
- Pol-Compensating 20×
- Pol-Wide field 10×

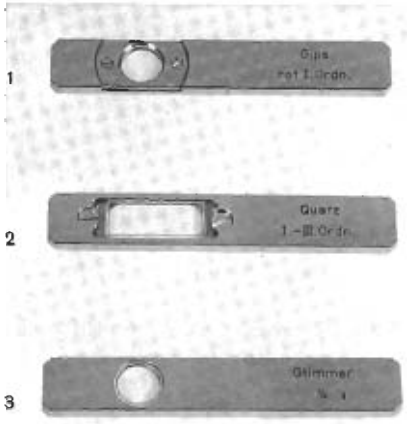
All Pol eyepieces are supplied with crosshairs, orientating pin, and adjustable eye-lens.

**Compensators.** The following compensators are available for the determination of the character and amount of birefringence:

| |
|---|
| Red I compensator (sensitive tint plate) |
| λ/4 compensator (mica) |
| Quartz wedge, I–III order |
| Tilting compensator, after Ehringhaus, 4 orders |

The direction of vibration of the fast ray is parallel to the length of the metal frame except in the Ehringhaus compensator, where it is parallel to the width.

The compensator slot will also accommodate the Berek and Brace-Koehler rotating compensators. Other makes of compensators may be used if their stop pins are removed.

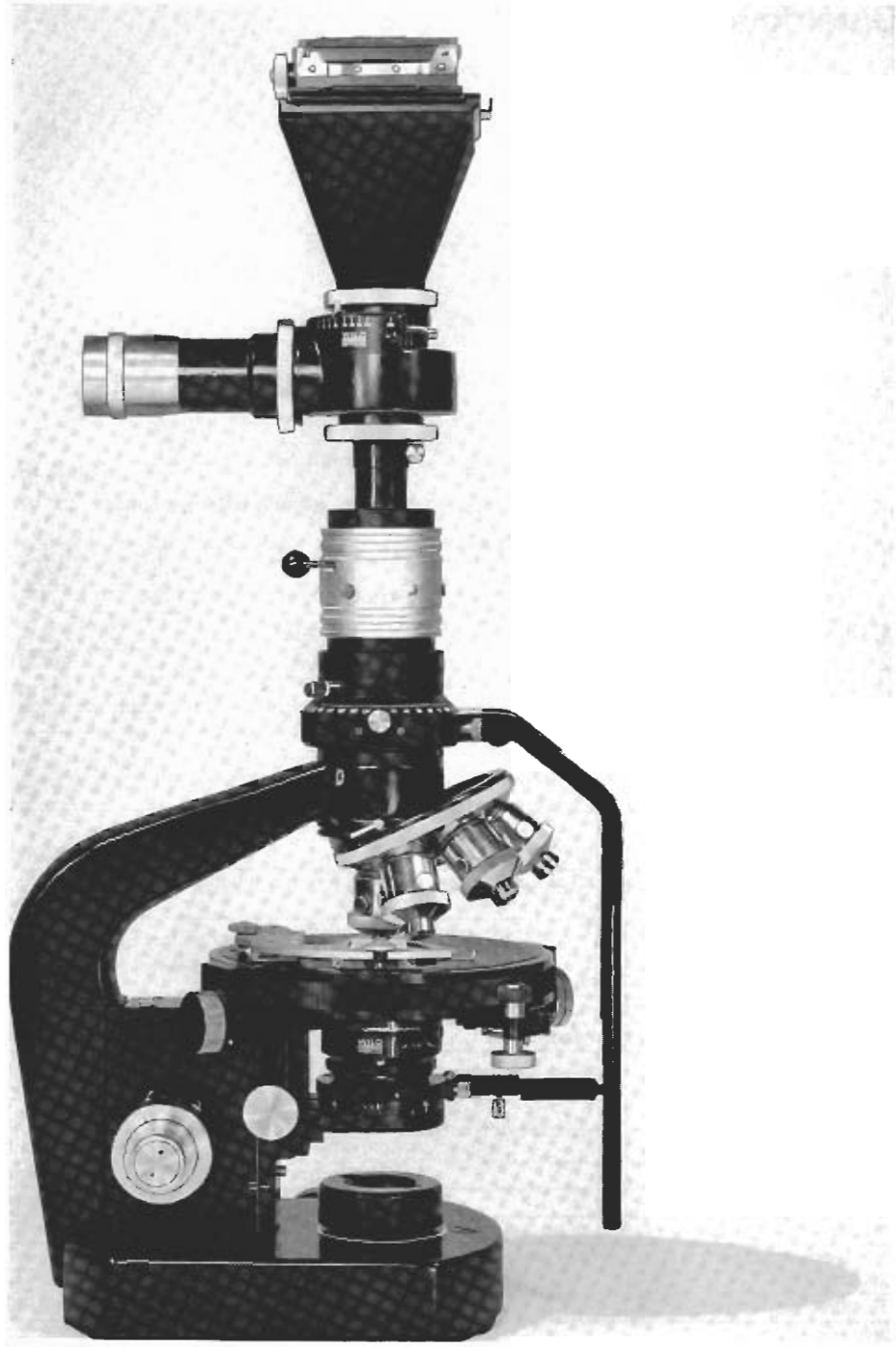



**Auxiliary test preparations.** A stage micrometer with photo-printed scale and a slide of short artificial fibres are used to centre the objectives and to check the position of polariser and analyser respectively.

**Packing.** While the M21 stand can be kept in the laboratory under a transparent dust cover, a solid mahogany case with lock is available for storage and transportation. Various holders inside this case provide safe storage for the most important accessories. Two drawers are provided for storing separate objectives and eyepieces. For shipment over long distances, the microscope is screwed firmly to the bottom of the case.

1 Red I compensator
2 Quartz wedge I–III order
3 Compensator λ/4

Page 11: Wild M21 Polarising Microscope with camera attachment and focussing telescope



# Catalogue references

| | Stock No. |
|---|---|
| M21 stand with polariser, analyser and standard accessories, without other equipment | 264 961 |

## Tubes

| | |
|---|---|
| Inclined monocular tube Fp with Bertrand lens and iris diaphragm | 256 525 |
| Straight monocular tube Ep with Bertrand lens and iris diaphragm | 256 537 |
| Inclined binocular tube Gp | 256 520 |
| Phototube Hp (observation 25%) | 256 542 |

## Stages

| | |
|---|---|
| Rotating stage Rp, 360° scale, with two stage clips | 259 025 |
| Rotating stage Qp, 360° scale, with 45° click stops and with fine movement, with two stage clips | 259 024 |
| Attachable point counting stage Cp with two interchangeable 0.2 mm step control knobs | 250 300 |
| Step control knob, interval 0.3 mm, for attachable point counting stage Cp | 259 006 |
| Step control knob, interval 0.5 mm, for attachable point counting stage Cp | 259 007 |
| Stage clip for rotating stages Qp and Rp | 240 773 |

## Objective changers

| | |
|---|---|
| Quadruple nosepiece X | 184 946 |
| Sextuple nosepiece Y | 212 414 |
| Plug for empty standard nosepiece sockets | 125 936 |
| Quick-change mount Z with centring mount for one objective, including two centring keys | 259 042 |
| Objective centring ring | 212 732 |
| Centring key | 109 450 |



| | Stock No. |
|---|---|

## Illuminators

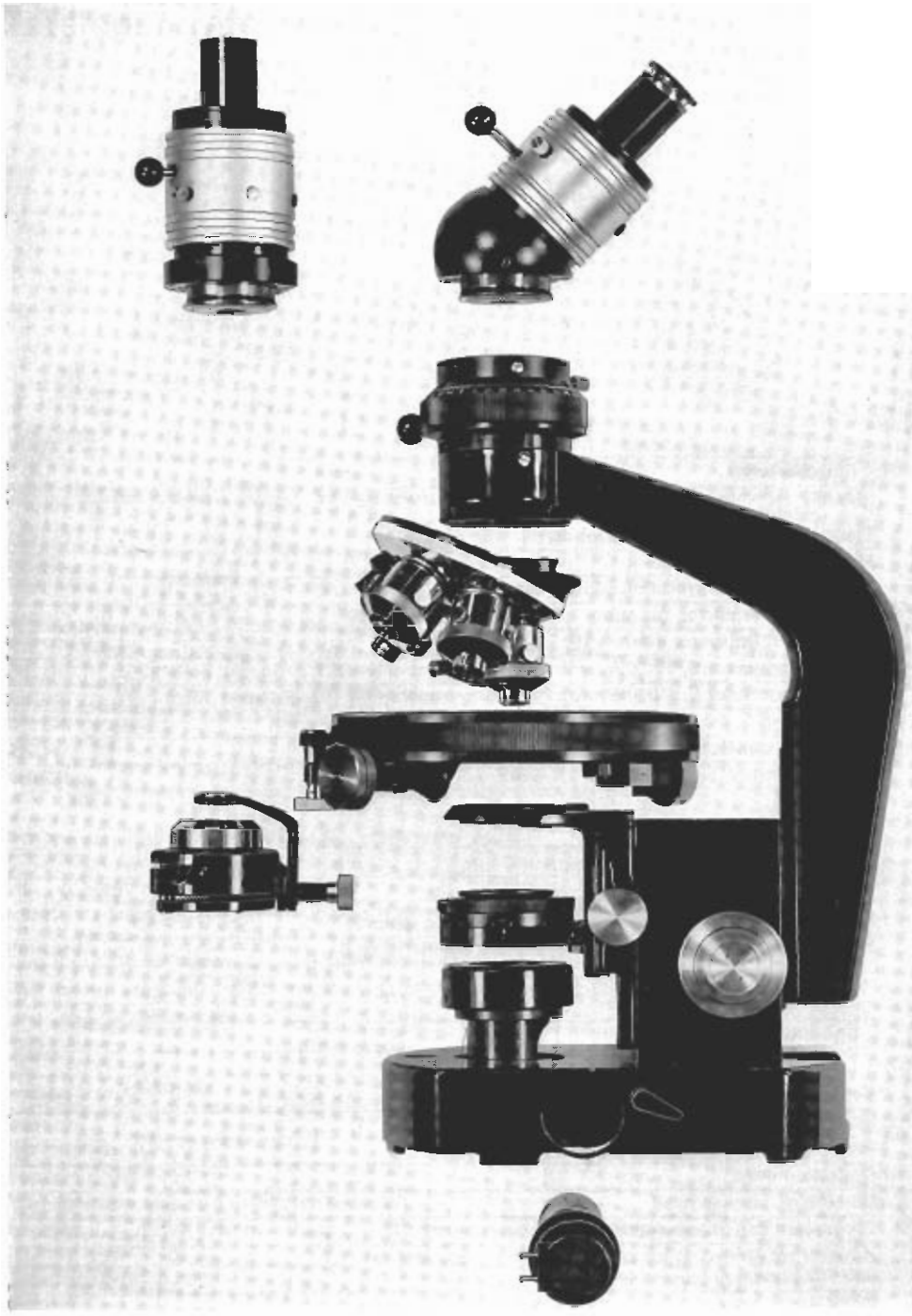
| | |
|---|---|
| Plano-concave mirror and mirror carrier with gimbal, L | 242 920 |
| Mirror carrier with gimbal | 250 744 |
| Mirror carrier with precision centring screws | 212 420 |
| Plano-concave mirror, for mirror carriers 250 744 or 212 420 | 212 416 |
| Cold mirror, for mirror carriers 250 744 or 212 420 | 127 670 |
| Built-in illuminator S, 6V/20W, with step transformer 110–220V and spare bulb | 243 386 |
| Built-in illuminator S, 6V/20W, with regulating transformer 110–250V and spare bulb | 250 719 |
| Built-in lamp S, 6V/20W, with centring insert | 248 535 |
| Regulating transformer 0–8V/50VA, 110–250V | 194 817 |
| Step transformer 2/4/6/8V/30VA, 110–220V | 127 933 |

## Spare bulbs

| | |
|---|---|
| Bulb 6V/20W, clear, in centring socket, for built-in lamp S | 177 160 |
| Bulb 6V/20W, frosted, in centring socket for built-in lamp S | 193 167 |

## Special equipment

| | |
|---|---|
| Drawing tube, in case | 256 577 |
| Intermediate attachment 2.5×, for drawing tube 256 577 | 214 066 |
| Projection prism for tube ⌀ 25 mm | 255 582 |
| Projection head | 197 951 |
| Discussion tube, in case | 256 547 |
| Discussion and image-superimposing tube, in case | 256 579 |
| Adapter set (3 pieces) for conversion of discussion tube into image-superimposing tube | 105 941 |
| Comparison tube | 184 555 |



Exploded view of the Wild M21



# Optics

| | | | Stock No. |
|---|---|---|---|
| **Objectives** | | | |
| Pol.-Achromat | 4×/0.10 | in centring mount | 175 106 |
| Pol.-Achromat | 10×/0.25 | in centring mount | 175 108 |
| Pol.-Achromat | 20×/0.45 | in centring mount | 175 110 |
| Pol.-Achromat | 40×/0.65 | in centring mount | 175 112 |
| Pol.-Achromat | 50×/0.85 | in centring mount | 175 116 |
| Pol.-Achromat HI | 100×/1.25 | in centring mount | 175 114 |
| Pol.-Achromat | 2×/0.06 | without centring mount | 243 305 |
| Pol.-Achromat | 4×/0.10 | without centring mount | 243 306 |
| Pol.-Achromat | 7×/0.20 | without centring mount | 255 575 |
| Pol.-Achromat | 10×/0.25 | without centring mount | 243 307 |
| Pol.-Achromat | 20×/0.45 | without centring mount | 243 308 |
| Pol.-Achromat | 40×/0.65 | without centring mount | 243 309 |
| Pol.-Achromat | 50×/0.85 | without centring mount | 243 310 |
| Pol.-Achromat | 60×/0.70 | without centring mount | 243 311 |
| Pol.-Achromat HI | 85×/1.25 | without centring mount | 243 312 |
| Pol.-Achromat HI | 100×/1.25 | without centring mount | 243 313 |

| | |
|---|---|
| **Eyepieces** | |
| Pol. crosshair eyepiece, Huygens, 6×/18 | 175 103 |
| Pol. crosshair eyepiece, Huygens, 10×/14 | 175 105 |
| Pol. crosshair eyepiece, compensating, 6×/18 | 175 107 |
| Pol. crosshair eyepiece, compensating, 10×/14 | 175 109 |
| Pol. crosshair eyepiece, compensating, 15×/11 | 175 111 |
| Pol. crosshair eyepiece, compensating, 20×/8.5 | 175 113 |
| Pol. crosshair eyepiece, wide field, 10×/18 | 175 115 |

| | |
|---|---|
| **Condenser** | |
| Pol. swing-out condenser N.A. 0.65/1.30 with iris diaphragm | 243 322 |

# Components and Accessories

| | Stock No. |
|---|---|
| **Polarisation accessories** | |
| Polariser in mount | 221 809 |
| Analyser in sliding mount | 221 815 |
| Red I compensator | 221 805 |
| Mica quarter-wave plate | 221 819 |
| Quartz wedge, orders I–III | 221 820 |
| Tilting compensator, after Ehringhaus, 4 orders | 198 150 |
| Synchronising bracket for polariser and analyser | 219 195 |
| Polarisation test slide for polarisation directions | 270 601 |
| Auxiliary microscope (for observation of interference figures in the binocular tube) | 175 127 |
| **Miscellaneous** | |
| Cabinet for M21 | 202 313 |
| Daylight filter, clear, ⌀ 33 mm | 126 126 |
| Daylight filter, frosted, ⌀ 33 mm | 126 127 |
| NG4 neutral filter ⌀ 33 mm, D = 1.0 | 126 131 |
| KG1 heat-absorbing filter ⌀ 33 mm | 126 119 |
| Eyecup, single | 239 362 |
| Eyecup for spectacle wearers, single | 217 314 |
| Dust cover for M21 | 126 273 |
| Plastic bottle with 15 $cm^3$ of immersion oil | 250 794 |
| Rubber ring for coarse adjustment knob | 217 543 |
| Standard accessories for M21, comprising: Dust cover, clear daylight filter, neutral filter, heat-absorbing filter, chamois leather and dusting brush | |



# Bibliography


**a) Principles**

1. Roubault M.
«Détermination des minéraux des roches au microscope polarisant»
Ed. Lamarre-Poinat, Paris, 1963

2. Bruhns W.
Ramdohr P.
«Petrographie»
**Sammlung Göschen, Band 173**

3. Bruhns W.
Ramdohr P.
«Kristallographie»
Sammlung Göschen, Band 210

4. Buchwald E.
«Einführung in die Kristalloptik»
**Sammlung Göschen, Band 619**

5. Burri C.
«Das Polarisations-Mikroskop»
**Verlag Birkhäuser, Basel, 1950**

6. Capdecomme L.
«Le microscope polarisant, instrument de mesure»
Microscopie Fr. 1 (1949), p. 141–150

7. Duparc L.
Pearce F.
«Traité de techniques minéralogiques et pétrographiques. I. Les méthodes optiques»
Leipzig, 1907

8. **Duplaix S.**
«Détermination microscopique des minéraux des sables»
**Paris et Liége, 1948**

9. Kästner
«Einführung in den Gebrauch des Polarisations-Mikroskopes»
Buchverlag GmbH, Leipzig, 1953

10. Kordes Ernst
«Optische Daten»
Verlag Chemie GmbH, **Weinheim/Bergstr., 1960**

11. Pohl R.W.
«Optik und Atomphysik»
Springer-Verlag, Berlin, Göttingen, Heidelberg, 1954

12. Policard A.
Bessis M.
Locquin M.
«Traité de microscopie, instruments et techniques»
Masson & Cie, Paris, 1957

13. **Rinne-Berek**
«Anleitung zu optischen Untersuchungen mit dem Polarisations-Mikroskop»
**2. Auflage, Stuttgart, 1953**

**b) Applications**

14. Comard L.
«Théorie et pratique de la méthode de Fédérow, procédé classique et méthode analytique générale»
Ann. Min. (13), Mem. 5 (1934), p. 153 ff.

15. Courtel R.
Pons L.
«Le microscope polarisant et à contraste de phase dans l'industrie des graisses»
Rev. I.F.P. 7 (1952)

16. Frey-Wyssling A.
«Submikroskopische Morphologie des Protoplasmas und seiner Derivate»
Protoplasma-Monographien 15

17. **Frey-Wyssling A.**
«Submicroscopic Morphology of protoplasm and its derivates»
Elsevier Publishing Comp., New York, Amsterdam, London, Bruxelles, 1948

18. Helmoke J.G.
«Grenzen der licht- und polarisations-mikroskopischen Methoden in der Erforschung des Zahnschmelzes»
Mikroskopie Bd. 13 (1959), p. 313–320

19. Herzog Alois
«Handbuch der mikroskopischen Technik für Fasertechnologen»
Akademie-Verlag, Berlin, 1951

20. Orcel J.
«Les méthodes optiques»
Gr. Fr. Argiles
C.R. Réunions Et. 3 (1951), p. 18–34

21. Pfeiffer H.H.
«Das Polarisations-Mikroskop als Meßinstrument in Biologie und Medizin»
Vieweg und Sohn,
Braunschweig, 1949

22. Pfeiffer H.H.
«Über Meßunsicherheit und Meßempfindlichkeit von Kompensatormessungen an biologischen Objekten»
Optik 5 (1949), p. 217–223

23. Pfeiffer H.H.
«Beitrag zur Morphologie der periodischen Segmentierung quergestreifter Muskeln»
Mikroskopie Bd. 7 (1952), p. 266–272

24. Ruch Fritz
«Birefringence and Dichroism of cells and tissues»
Physical Techniques in Biological Research, Vol. III
Academic Press Inc., New York, 1956

25. Scharf J.H.
«Polarisationsoptische Untersuchungen an markhaltigen Ganglienzellen in der Wirbeltierreihe und beim Menschen»
Mikroskopie Bd. 7 (1952), p. 174–190

26. Schmidt
«Bestimmung der Lage der optischen Achse in Biokristallen»
Abderhaldens Handbuch der biologischen Arbeitsmethoden, Abt. V, Teil 2, 8, 1357–1400
Urban und Schwarzenberg, Wien, 1929

27. Schmidt
«Die Doppelbrechung von Karyoplasma, Zytoplasma und Metaplasma»
Protoplasma-Monographien Bd. 11, Bornträger, Berlin, 1937

28. Schmidt W.J.
Keil A.
«Die gesunden und die erkrankten Zahngewebe des Menschen und der Wirbeltiere im Polarisations-Mikroskop»
Carl-Hauser-Verlag, München, 1958



**Our manufacturing programme includes:**

Wild M4 and M4A stereomicroscopes with interchangeable magnification changer or built-in magnification changer drum. Range: 1.5× to 160×.

Wild M5 stereomicroscope for advanced work. Range: 2× to 200×.

Wild M7 zoom stereomicroscope with 5:1 zoom magnification changer. Range: 3× to 124×.

Wild M11 field, course and laboratory microscope.

Wild M12 advanced laboratory microscope. Modern design, simple and convenient operation. For all techniques.

Wild M20 research microscope. Combines maximum operational convenience with highest precision. The universal instrument for advanced work and special research techniques.

Wild M21 polarising microscope for orthoscopic and conoscopic observations.

Wild M40 inverted biological microscope for tissue culture, plankton and chemical investigations.

Wild M50 inverted metallurgical microscope for investigations in incident light (bright field, dark field and polarisation).

Wild M501 sampling microscope, with stopmotor-driven stage, for systematic scanning and for representative gridding in stereological work. With the aid of mathematical procedures, the instrument is used for quantitative determination of the three-dimensional structure of a body from inspection of sections, and is particularly useful in biology, metallurgy and geology.

Wild image converter unit for investigations in the UV and IR regions of the spectrum. Equally suitable for macro, stereo and micro applications.

Wild interference attachments for the M12 and M20 microscopes. For interferometric measurements and observations in incident light.

Modern microscope lamps: low voltage, quartz-iodine, high pressure xenon and mercury vapour sources. Electronic flash outfit.

Transmitted-light illumination bases for Wild microscopes, with one or two lamps for various light sources. Built-in filter sets for fluorescence. Optimum light intensity for microprojection.

Wild objectives of highest quality. For all techniques, including phase contrast, polarisation, incident light and interference.

Wild eyepieces, matched to objective performance. Special eyepieces for measuring, polarisation, photography, wide field, etc.

Wild condensers for all techniques, including bright and dark field, polarisation, fluorescence and phase contrast.

Electronic micro-length measuring attachments (Wild/Censor for Wild stereomicroscopes and Wild/Tesa for Wild microscopes). Direct readoff for precise and rapid work.

Wild Variomag zoom adapter for M12 and M20 microscopes permits stepless variation of magnification.

Photomicrographic outfits from 35 mm to 4×5 in. formats. Attachable cameras for all stands, including stereomicroscopes.

Wild Photoautomat – the simplest instrument for fully automatic, electronically-controlled exposure and film transport.

Special equipment for cinemicrography, including time-lapse and TV microscopy.