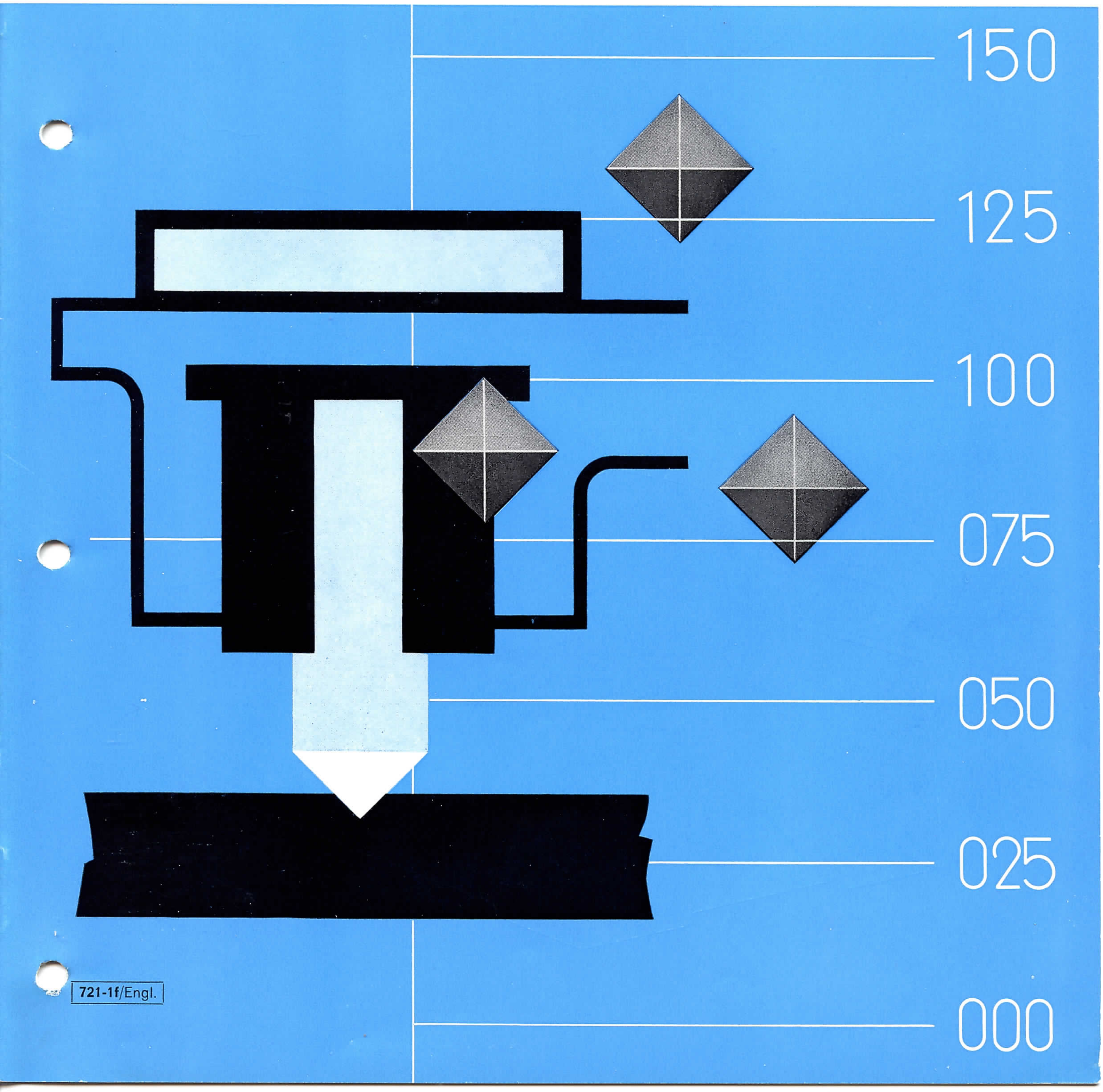
Leitz
WETZLAR

MINILOAD
Hardness Tester



721-1f/Engl.

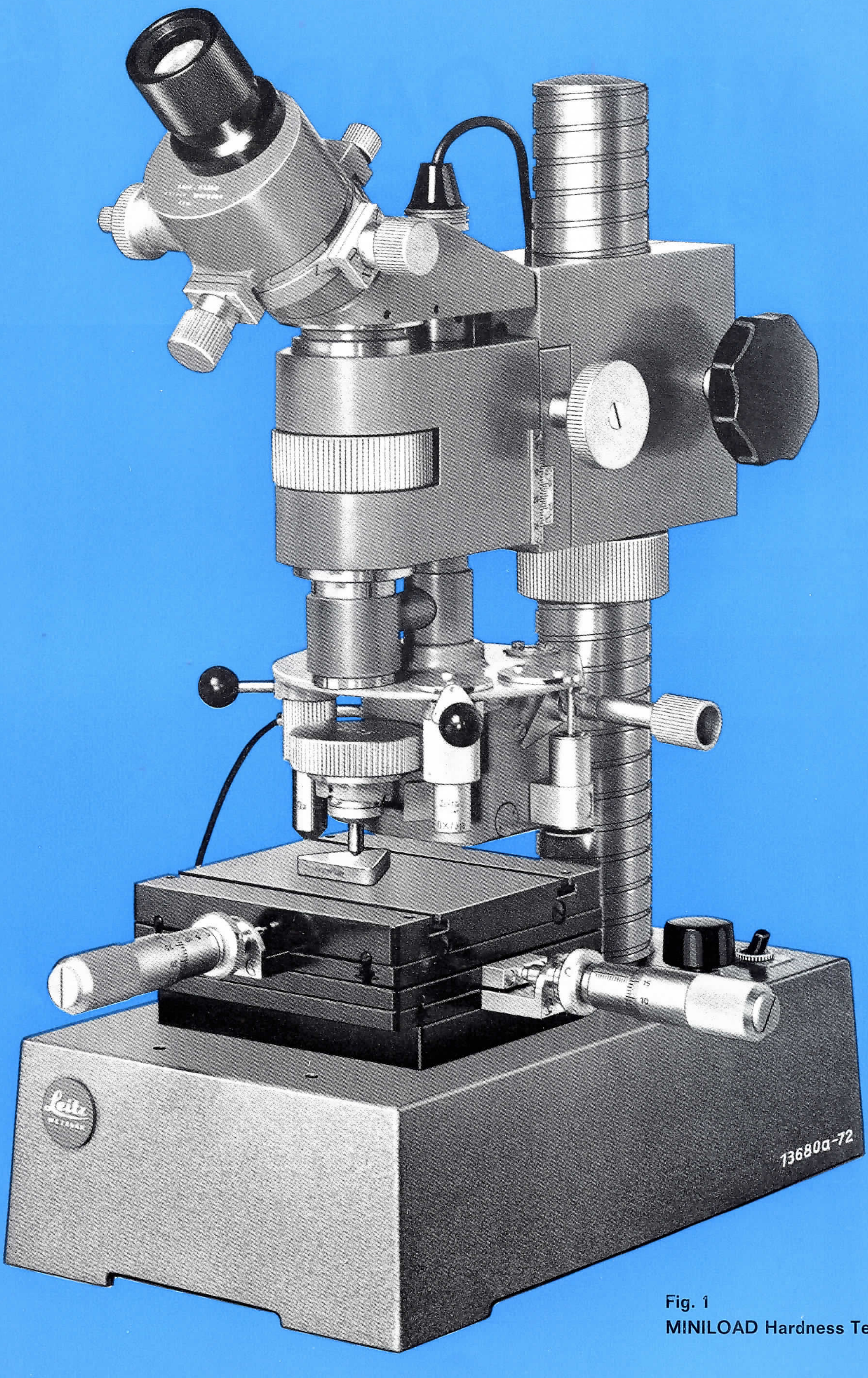


Fig. 1
MINILOAD Hardness Tester

MINILOAD
Hardness Tester

Uses

The MINILOAD hardness tester is used for non-destructive hardness tests with small measuring forces (0.005 to 2 kp). With its complete set of 3 diamonds* Vickers-, Knoop-, and scratch hardness tests can be carried out. Particularly interesting applications are hardness tests of tool edges (milling cutters, reamers, saw teeth, hobs), wires, wearing parts of motors, thin layers (e. g. surface-coated rolled steel), foils, printed circuits, photogravure rollers, gramophone records, matrices, boiler tubes, synthetic materials for dental protheses, human and animal teeth (for comparing the hardness of dental enamels), crystal inclusions of polished sections etc.

In addition, the MINILOAD hardness tester allows provisional metallographic surface examinations at 400 x total magnification, and thickness measurements of layers in polished cross sections.

Two special versions of the instrument open up further fields of applications:

1) Hardness tests on any thread flanks, (minimum pitch 0.5mm) or of other sites which are difficult to reach with special device for thread testing (Fig. 12).

2) The MINILOAD-POL permits the optical alignment of anisotropic objects and subsequent hardness tests. For this version, too, a special microscope tube with a hardness testing device is available.

Characteristic features

Diamonds interchangeable for Vickers-, Knoop-, scratch hardness tests.

Indentations of microscopic size, which do not damage functionally important surfaces, and are therefore suitable for routine tests.

Rapid and extremely simple test procedure and evaluation.

Spotting accuracy proved e. g. by hardness tests of needle points (Fig. 4c).

Measuring force directly applied to the diamond largely avoids transmission errors.

Vibration-free, controlled movement of the hardness test mechanism.

Shift compensation avoids one-sided bulging along indentations.

Observation and measurement of the indentation in the eyepiece (internal reading) at 400 x total magnification.

Photographic recording of the indentations and measuring values with the LEICA 35mm camera.

A swivelling operational unit permits hardness tests on objects of any size.

Clear and convenient arrangement of the controls.

Space-saving design — the transformer is built-in.

Extensive range of accessories for the most versatile tasks.

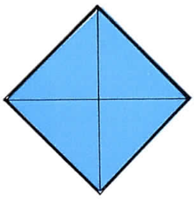
* Other types of diamond on request

Methods of hardness testing

One of its most important standards is the hardness of a raw material or of a tool, on which quality and durability depend; the hardness value further permits certain conclusions about wear and tear, workability and strength of a raw material; it can be used even for the quality control of electroplating baths.

The following hardness test methods are possible with the LEITZ MINILOAD hardness tester:

Vickers hardness



The Vickers hardness is determined by producing an indentation with a pyramid-shaped diamond, and optically measuring this indentation. The Vickers pyramid has a square base. The apical angle between opposed pyramid faces is 136°; the depth of penetration measures one seventh the length of the indentation diagonal.

The Vickers hardness is found by the formula

$$HV\ (kp/mm^2) = \frac{1854.4 \cdot P}{d^2}$$

where P* = measuring force in Pond, and
d = mean value of the indentation diagonal in μm.

Knoop hardness

The Knoop hardness test is similar to the Vickers hardness test. The base of the Knoop pyramid is rhombic. The ratio of the two base diagonals is 7:1; the depth of penetration measures only 1/30 of the longitudinal diagonal. The angles of the opposite pairs of edges are 172° 30′ and 130° respectively.

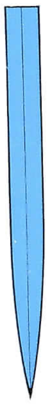
The Knoop hardness is found by the formula

$$HK\ (kp/mm^2) = \frac{14230 \cdot P}{l^2}$$

where P* = measuring force in Pond
l = length of the long diagonal in μm.

At a given measuring force the Knoop pyramid produces a diagonal about three times larger and a depth of indentation smaller by ⅓ than the corresponding values of the Vickers pyramid. Longer indentations are preferable with hard substances because of the higher reading accuracy, shallower ones with very thin films.

Scratch hardness



Indentation hardness is closely related to the tensile strength of the raw material; its resistance to wear due to grinding and scratching is also of technological interest. This property is measured by means of the scratch hardness test for which a special diamond whose shape can be adapted to the particular requirements is used; it may be conical with angles of aperture of 90°, 120°, and 150°, or pyramidal, with an interfacial angle of 120°.

Generally, e. g. with glass, this hardness is referred to a scratch width of 10 μm. For softer materials or thin films another reference scratch width can be laid down. The scratch hardness test is also used successfully for the rapid determination of the case hardening depth on a polished cross section of the workpiece.

* The measuring force depends on the thickness of the workpiece, the function of the area to be tested and its hardness. While hardness testers employing heavy measuring forces produce mean values of extensive structures, micro-hardness testers can measure also individual structural parts and thin layers, especially surface coatings of hard raw materials down to a thickness of 1 μm.

Bibliography:

H. Broschke — "Ein Härteprüfer für kleine Lasten", Microtecnic, Lausanne, Vol VI, Nr. 1/1952, p. 15.

Dr. K. Georg — "Über die Bearbeitung optischer Gläser", Werkstattstechnik und Maschinenbau, 40. Jg. (1950), Heft 9.

Dr. A. Keil u. O. Wüst — "Härtemessungen an galvanisch erzeugten Schichten", Metalloberfläche, 6. Jg. (A) 1952, Heft 7.

Dr. R. Schulze — "Maximum-Kurven als Folge von Fehlerquellen bei der Mikrohärteprüfung", Metalloberfläche, 8. Jg. (A) 1954, Heft 4.

Dr. H. W. Thoenes — "Untersuchungen über Sinterung feuerfester Schamottemörtel", Berichte der Deutschen Keramischen Ges. e. V., Band 31 (1954), Heft 4.

Simple operation

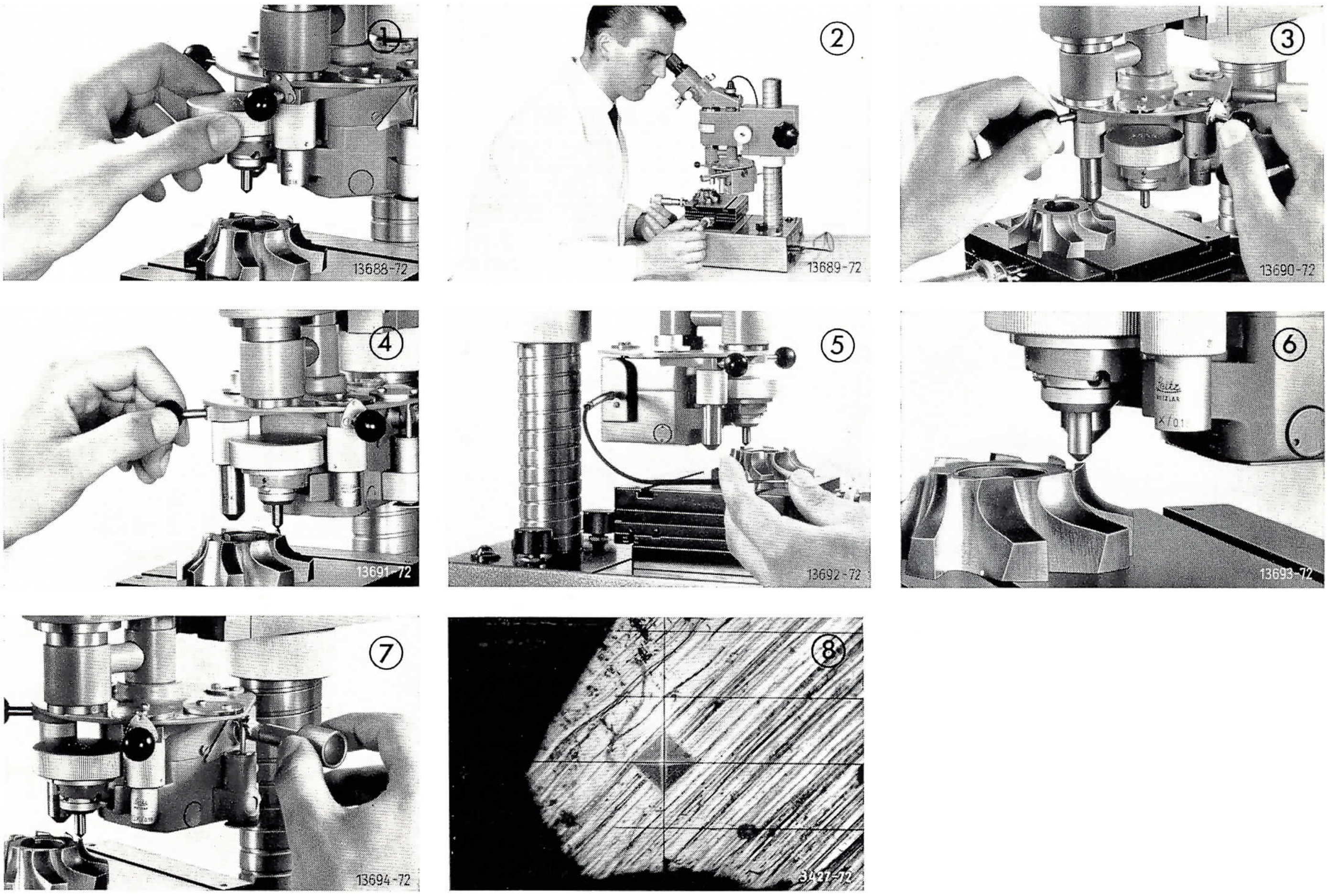


Fig. 2

1 Applying the load (weights are included for the measuring forces 10 and 15 p for special equipment and 25, 50, 100, 200, 300, 500, and 1000 p for standard equipment. In addition, a weight up to 2000 p can be supplied for the standard version of the instrument. The measuring force of the indenting unit alone is 15 p for standard equipment).

2 Finding a suitable area on the object with the stage spindles and the 10 x objective.

3 Turning in the 40 x objective for focusing on the surface.

4 Turning in the diamond.

5 Release of the diamond movement.

6 The diamond descends and makes an indentation.

7 Lifting the diamond after about 10 secs' rest. The 40 x objective is turned in, and the indentation (8) measured. If the centre lines of the eyepiece are set on the diagonals (8), their point of intersection serves as sighting point for further indentations, which can be made with a high degree of spotting accuracy.

Technical description

The miniload hardness tester consists of the stand with column, the microscope tube with micrometer eyepiece, the hardness device with objectives and the diamond holder, and the 25 x 25mm (1 x 1″) measuring stage.

The stand

The electrical equipment for the lamp is built into the foot which obviates the need for separate transformers and reduces the space required by the instrument to a minimum. A voltage selector is built into the base of the stand for adaptation to the existing mains voltage (110, 120, 130, 220, 230 or 240 v a.c.). The mains connection and two sockets for the illumination are built into the back of the base. The light is switched on with a tumbler switch and regulated by rotating knobs. A warning light in the base of the stand lights up when the current is switched on.

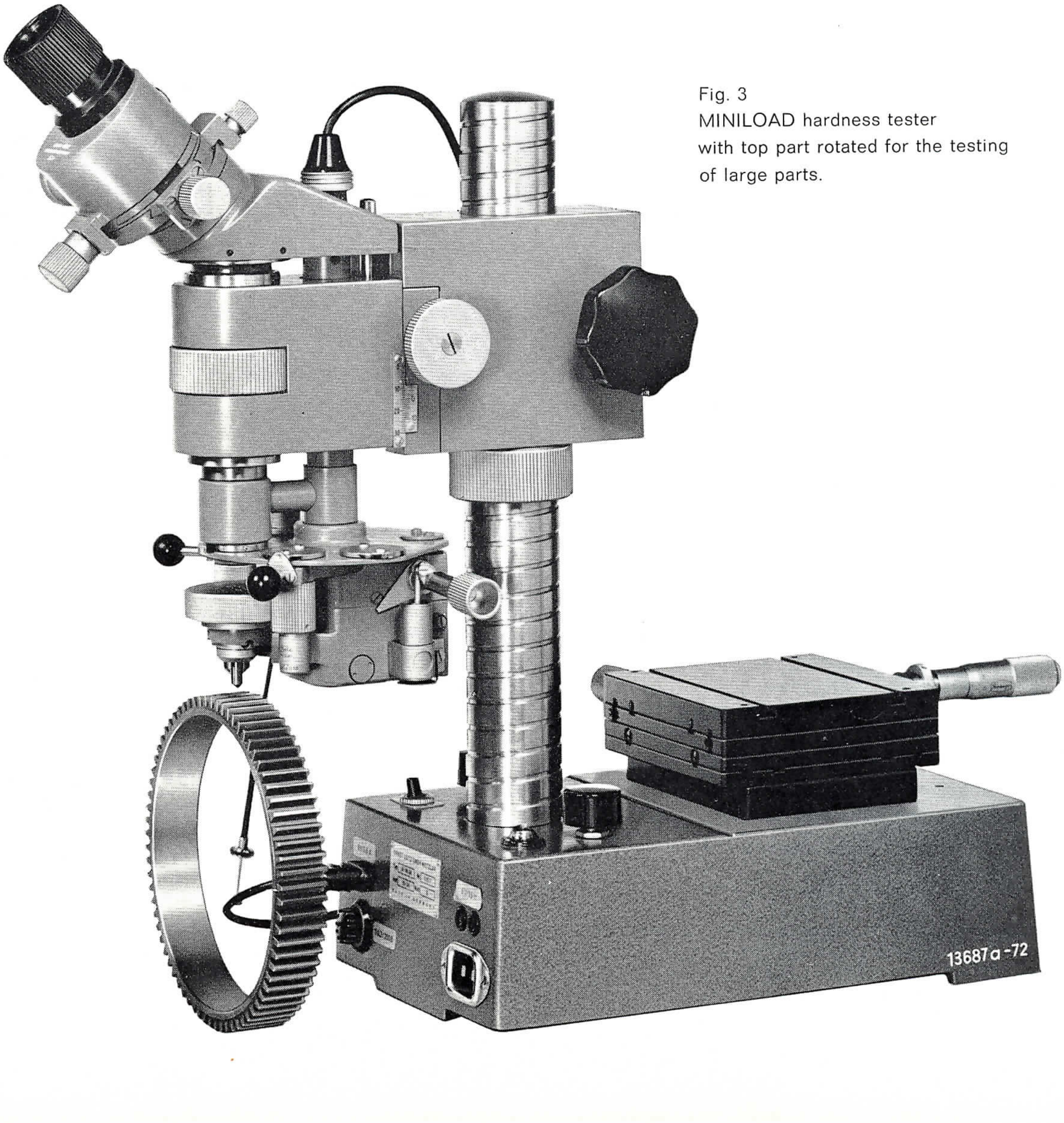


Fig. 3
MINILOAD hardness tester
with top part rotated for the testing
of large parts.

Leitz
WETZLAR

The microscope tube with the hardness testing device

can be coarse-adjusted on a holder or rotated around the column (e. g. Fig. 3) according to the size of the test piece; it can be locked with a star knob in any position.

The microscope has a rack-and-pinion movement for finer adjustment. An orientating scale with vernier permits the location and rapid reproduction of settings. A knurled ring at the midpoint of the tube actuates the fine adjustment to the surface of a testpiece. The light source, an 8 v 5 w filament lamp is directly connected on the base of the stand. Its light is directed vertically onto the testpiece by means of a little plate in the tube (brightfield illumination). All optical parts are anti-reflex coated.

When using heavy loads during the impact of the diamond on the testpiece the holder may be more or less bent, causing a lateral displacement of the diamond. The indentations suffered deformations in the shape of bulges on one side leading to inaccurate results (Fig. 4a, b).

Fig. 4a Indentations in steel. Measuring forces 15, 25, 50, 100, 200 and 300 p. Bottom rows without shift compensation (larger and deformed indentations); the two top rows with shift compensation. Scale unit 25 μm.

Fig. 4b Interference picture of the same indentations, clearly showing the one-sided bulges of the deformed lower indentations, and the positive effect of the shift compensation in the two top rows.

Fig. 4c Example of the high spotting accuracy of the instrument. Vickers indentation on the point of a gramophone stylus. Diagonal of indentation 10 μm.

Fig. 4a

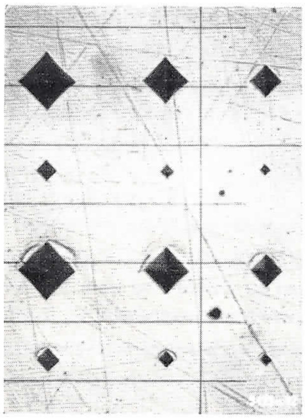


Fig. 4b

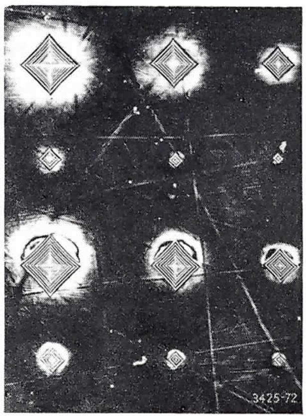


Fig. 4c

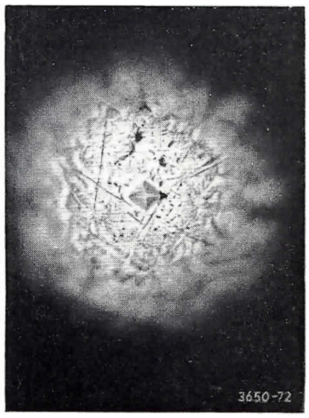
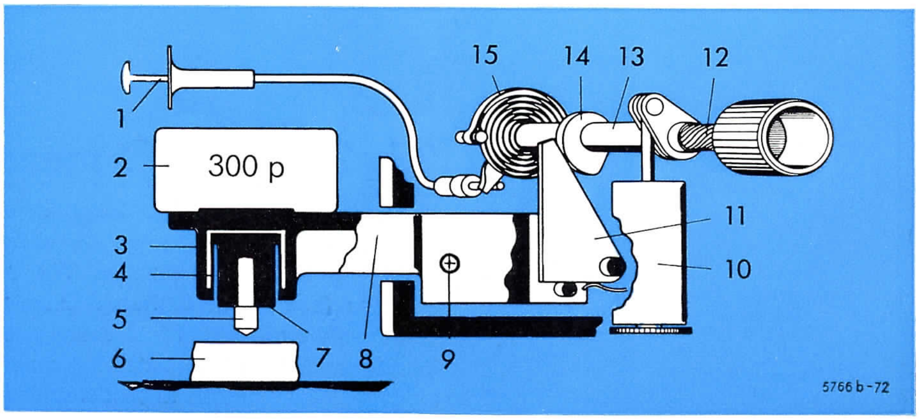


Fig. 5
Diagram of the hardness testing device

1 Cable release
2 Weight
3 Protective mount
4 Steel wires
5 Indenter
6 Object
7 Diamond holder
8 Lever
9 Lever axis
10 Oil damper
11 Cam follower
12 Flexible shaft
13 Cam shaft
14 Cam
15 Coil spring



For this reason the MINILOAD hardness tester has been fitted with a shift compensation (spring bearing of the indenter). Thus, the diamond can give way to the shift, at the same time this type of bearing is a safeguard against shock. The downward movement of the diamond is initiated with a cable release, and controlled by an oil damper (Fig. 5). A lock prevents the sideways displacement of the diamond in the lowered position.

Indentations are evaluated at high accuracy in the micrometer eyepiece. Skilled operators can successfully measure indentations with an inaccuracy of only 0.2 μm. The scales are located in the field of view which ensures reliable and rapid reading. Two interchangeable objectives (primary magnifications 10 x and 40 x) combined with the micrometer eyepiece produce total magnifications of 100 — 400 x.

The setting scale (centre scale of eyepiece) is divided into 25 μm intervals for the 40 x measuring objective. Intermediate values are measured by displacing these divisions against an eyepiece division participating in this movement (scale unit 0.5 μm, by interpolation 0.1 μm) (Fig. 6).

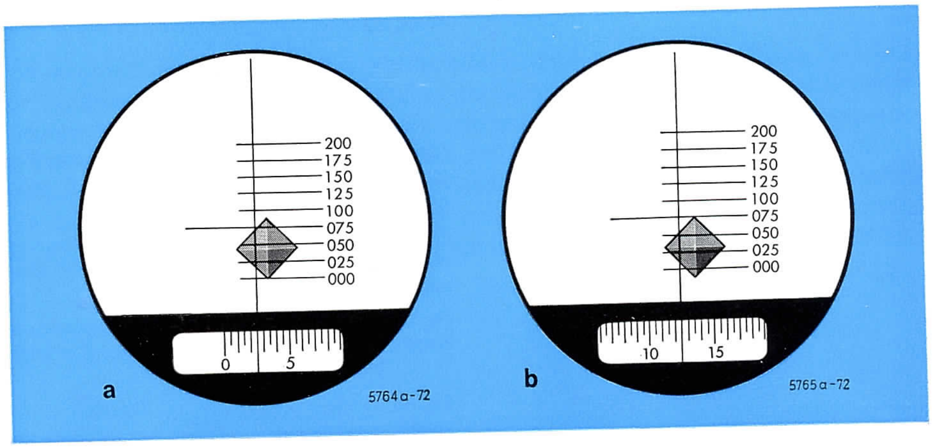


Fig. 6 Measuring a Vickers indentation

The setting scale is aligned with the diagonal of the indentation by rotating the eyepiece. One corner of the indentation can now be set on a micrometer division by means of the eyepiece micrometer screw. The value 2.5 μm (6a) is noted and the knurled screw further rotated until the opposite corner of the indentation is set on a scale division. The micrometer has moved at the same time (6b). The length of the diagonal is the difference between this and the previous reading, to which the difference in the micrometer divisions must be added:

12.5 μm (second reading) — 2.5 μm (first reading) + 75 μm (3 scale division intervals) = 85 μm.
The hardness can be determined from the length of the diagonal and the test load by means of tables included with the instrument.

Knoop hardness values are determined in the same way.

25 x 25mm (1 x 1") measuring stage

The measuring stage has longitudinal and transverse ball tracks of relatively high load bearing capacity. Its slides are held against the spindles in both directions by spring tension. The measuring ranges can be traversed with spindles (scale unit 0.01 mm). Examination of the object and the introduction into the field of view of interesting and clear details for hardness testing is particularly rapid with the measuring stage. The spindle graduations also permit the placing of indentations at predetermined intervals.

Accessories

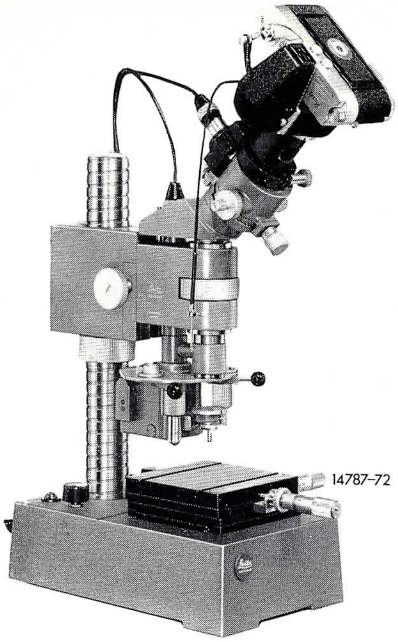


Fig. 7
Photographic attachment with LEICA on the MINILOAD hardness tester

Photographic attachment

The photographic attachment for the MINILOAD is mounted on the micrometer eyepiece and secured to the eyepiece collar (Fig. 7).

It consists of the

1) Clamping attachment with built-in intermediate optical system and ball-and-socket head for the eyepiece illumination
2) eyepiece illuminator with condenser
3) VISOFLEX mirror reflex attachment with special groundglass screen
4) slip-on 4 x magnifier.

The eyepiece image appears on the 24 x 36mm groundglass screen and is viewed through the attachable magnifier. The sharpness in the object field can be controlled, and the brightness of object field and fine measuring field balanced by means of a potentiometer.

The LEICA housing is attached directly to the bayonet mount of the VISOFLEX®. For routine investigations we recommend the LEICA MD with film marking device, with which all important data (such as raw material, measuring force, etc.) can be entered on the film during exposure.

Mounting devices

The MINILOAD hardness tester offers special advantages during the testing of finished, hardened, and ground tools: the test is almost non-destructive. The indentation is invisible to the naked eye due to the weak measuring forces. As a result of the high spotting accuracy measurements can be directly carried out on knife edges.

In case of tools of larger dimensions, the MINILOAD hardness tester is mounted on a special base plate, with its operational unit rotated through 180°; the base plate also accommodates the mounting devices (Fig. 8). The following devices, to suit various types of objects, are available:

Fig. 8
Tilting mounting device for samples to be measured in cross section, such as sheet steel, wires, pivot- and needle points. The tilting mounting device has two interchangeable clamping jaws moved in opposite directions by a threaded spindle. The one clamping jaw is tiltable and automatically adjusts itself to the opposite jaw or the shape of the testpiece. The device can be rotated in the axis of the threaded spindle, can be tilted in both directions and clamped in any position, so that sloping faces, too, can be arranged horizontally. It is attached with four clamps to the measuring stage.

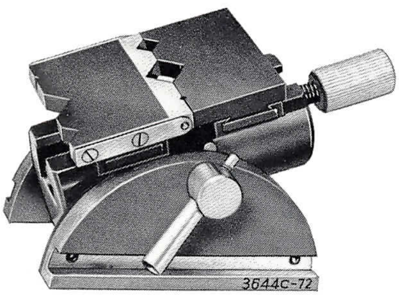


Fig. 8

Fig. 9 V-blocks for testing long shafts, cylindrical parts, lead screws, etc.

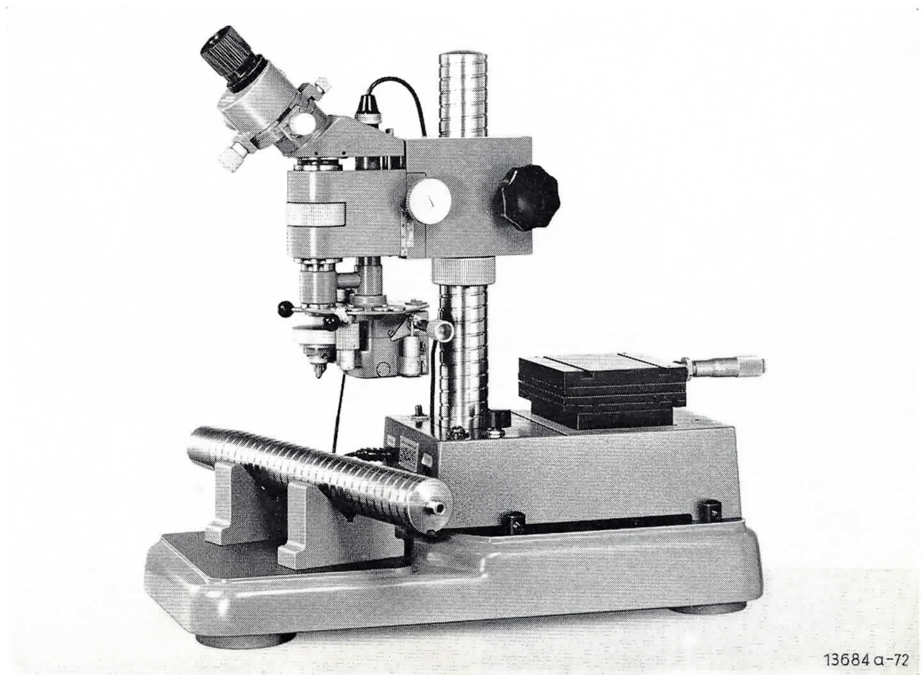


Fig. 9

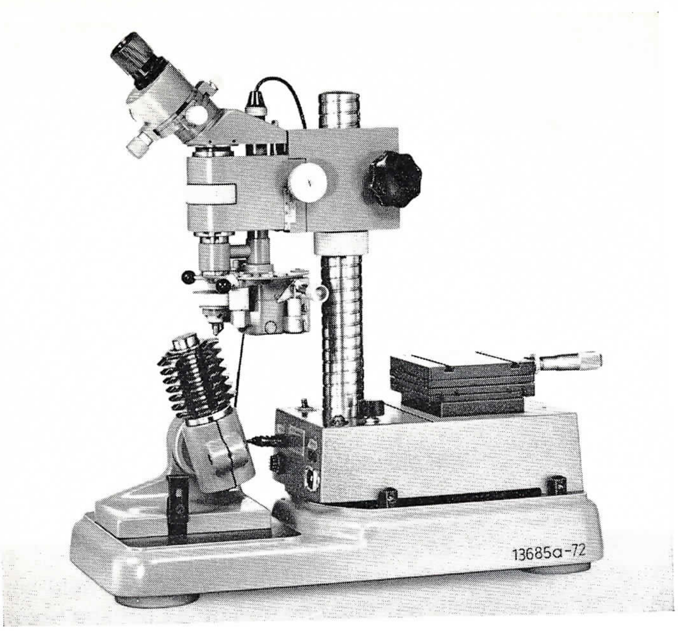


Fig. 10

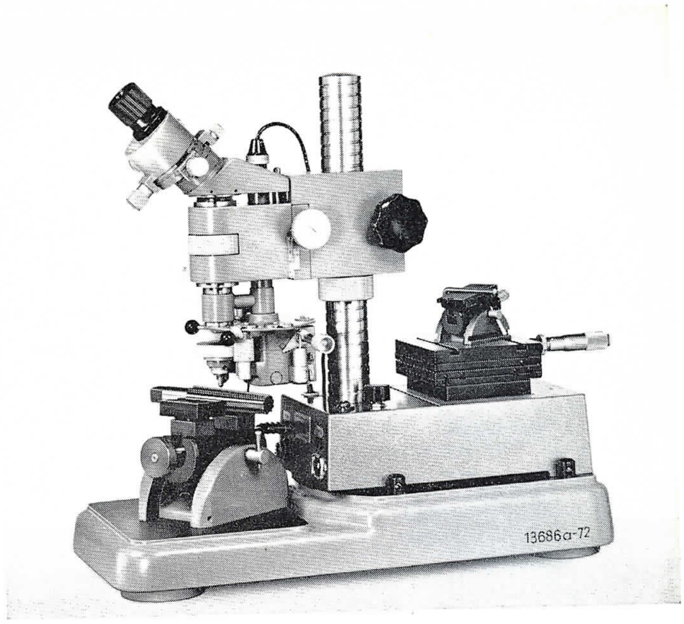
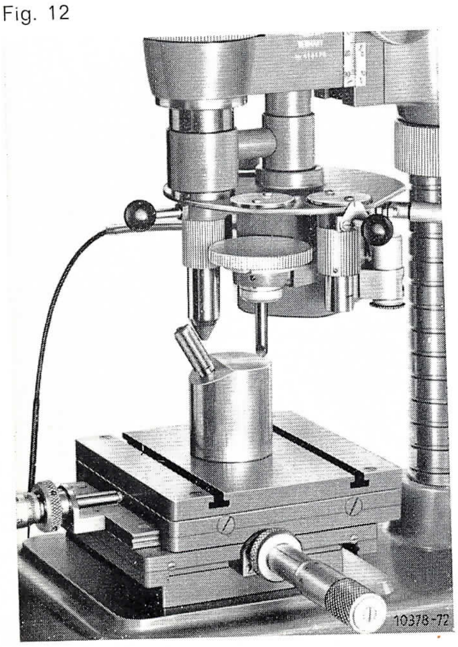


Fig. 11

Fig. 10 Tilting mount for hobs. It can be tilted through 180°; the angle of tilt can be set and read on a 5° scale. The outfit includes 5 different locating arbors for standardized bore diameters of milling cutters: MINILOAD hardness tester and holder are mounted on their base plate.

Fig. 11 Universal mounting device (with taper reamer) for cylindrical tools or parts without bores, such as drills, parallel and taper reamers etc. The clamping jaws can be moved in opposite directions by means of a spindle. They can also rotate freely in the horizontal plane, so that they adapt themselves automatically to tapering surfaces. The mounting device can be rotated in the axis of the threaded spindle, and can be tilted in both directions and clamped in any position. The tilting mounting device, too, is attached to the measuring stage.

Fig. 12



Special version for hardness tests on thread flanks

This version is fitted with a new objective with a working distance of approx. 4.2mm and a conical mount. By means of this objective and a diamond in an extended mount it has now become possible to test the hardness of threads of 0.5mm minimum pitch at any flank (Fig. 12). The primary magnification of the special objective is also 40 x, so that evaluation with this version, too, is possible at a total magnification of 400 x.

Fig. 12 MINILOAD hardness tester, special version for measuring hardness on thread flanks.

Technical data

Stand

Length	180mm	7.2″
Depth	286mm	11.44″
Height	approx. 450mm	19″
Mains connection adjustable to	110, 120, 130, 220, 230, 240 v a. c.	
Filament lamp	8 v 5 w	
Maximum testpiece height (with the testing device swung in)	150mm	6″
Weight with microscope and hardness testing device	approx. 20 kg	44 lbs.

Set of test loads

On special request:	(5), 10, 15, 25, 50, 100, 200, 300, 500, 1000, 2000 p
for standard equipment:	25, 50, 100, 200, 300, 500, 1000, 2000 p

Optical Data

Total magnification	100 x	400 x
Object field diameter	1.8mm	0.45mm
Working distance	12.7mm	0.2mm
Scale unit in the micrometer eyepiece		0.5 μm
By interpolation		0.1 μm

Measuring stage and mounting devices

Mounting area	120 x 120mm	4.8 x 4.8″
Traversing area	25 x 25mm	1 x 1″
Scale unit of the measuring spindles	0.01mm	
Largest diameter to be mounted in tilting mounting device	approx. 34mm	1.46″
Universal mounting device	approx. 50mm	2″
Diameter of the locating arbors for the tilting mounting device	13 ,16, 22, 27, 32mm (0.52, 0.64, 0.88, 1.08, 1.28″)	

Our production programme also includes

Microscopes for linear and angle measurements
Optical linear measuring instruments with mechanical tracing
Linear measuring instruments for statistical quality control

Angle measuring instruments
Alignment and Auto-Collimation Telescopes
Measuring and Contour projectors

Surface measuring instruments
Optical installations and attachments for machine tools
Instruments for testing thermal behaviour

Microscopes of the most advanced design for all investigations in transmitted, incident, and polarized light
Equipment for fluorescence microscopy
Special devices for microscopy, e. g. micromanipulator, interference microscope, binocular prism magnifiers, stereo microscopes

Fully automatic microscope camera ORTHOMAT®

LEICA® 35mm camera with accessories for scientific and technical photography
LEICAFLEX® 35mm single-lens reflex camera

Miniature projectors
Large lecture hall projectors

TRINOVID® binoculars

® = registered trademark

Design subject to alteration without notice.

The illustrations in this catalogue are not binding in all details.
We supply blocks of illustrations appearing in our catalogues free of charge for scientific publications.

ERNST LEITZ GMBH WETZLAR GERMANY

Subsidiary: Ernst Leitz (Canada) Ltd., Midland, Ontario

List 721-1f/Engl. ①

Printed in Germany

VIII/66/FY/SD