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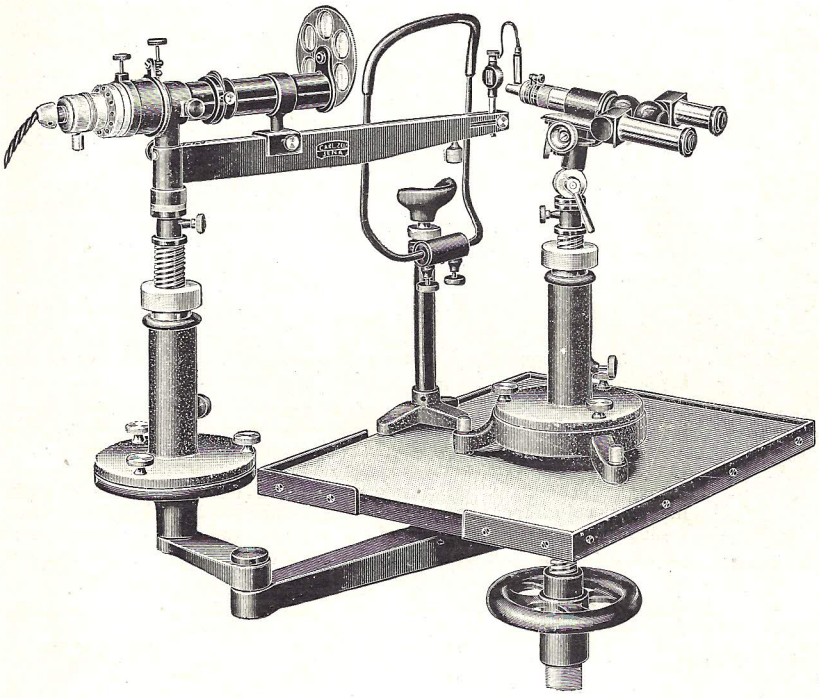
Prof. Koeppe's Eye Microscope

Like the Corneal Microscope, the Koeppe Eye Microscope is adapted for the stereo-microscopic examination and investigation of all parts and layers of the living eye, up to the retina, with natural (including redless and monochromatic) focal light, as furnished by Gullstrand's slit lamp. In addition, it lends itself to observation with *polarised focal light* and to important *ultra-microscopic* observations.



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The Eye Microscope (with polarising attachment) on stand and foot, together with the slit lamp (with screening tube, slit lamp lens and silvered mirror), all mounted on instrument table with jointed bracket arm, chin and head rests.

A single objective furnishes stereoscopic vision by a binocular microscope attachment. The latter may be arranged for observation by erect or inverted images. The latter arrangement is less costly, but the correct interpretation of

the inverted image occasions sometimes difficulties to those lacking experience. The angle comprised within the eye between the axis of the illuminating system and that of the viewing system should be capable of variation from 90° down to a very acute angular value. As this limit is easily attainable by a single objective the latter has over the paired objectives of the corneal microscope the advantage of being capable of more general application, especially in the examination of the deeper strata of the vitreous humour and that of the retina, whilst the chamber-angle is accessible to examination by a single objective. For the microscopic examination of the chamber-angle and the fundus of the eye it is necessary to employ the Koeppe **self-fixing eye-glasses.**

Paired Eyepieces	Objectives							
	a_1 2×		a_2 3×		a_3 5×		aa 6×	
	Microscopic*) and Total**) Magnifications							
(2) Bi 9×	18*	30** Chamber Angle	27*	30** Retina	45*	50** Retina	54*	
(3) Bi 12.5×	25*	40**	37.5*	40**	62.5*	65**	75*	
(4) Bi 18×	36*		54*		90*		108*	

*) Product of the magnifications due to the objective and eyepiece.

**) with due regard to the magnifying properties of the media of the eye and the magnifying power of the eyeglass.

For purposes of the consulting room it is sufficient to provide the simple slit-lamp and microscope outfit specified in the Price Slip. For scientific investigations on the eye it will be necessary to add thereto the higher powers, a polarising attachment.

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Fig. 2. Polariser.

In consequence of partial polarisation of the incident light of the slit-lamp by the fine particles of the tissue of the eye and owing to the polarising effect of the silvered mirror it is generally unnecessary to provide a separate polariser. If necessary, a polariser may be introduced into the screening tube of the slit-lamp for illuminating the eye with light modified by linear or pure polarisation. The analyser is situated in an intermediate fitting, which should be screwed into the binocular microscope attachment in the place of the one used when natural slit-lamp light is applied. In front of the analyser a selenite film in a diagonal position provides a means of accentuating differences in the intensity of the illumination. The position of the plane of polarisation is shown on a scale of degrees.

Wearers of spectacles should discard these when working with the microscope. In cases of dissimilar refraction in the two eyes and of astigmatism, if any, exact particulars of the required correction for distance should be given at the time of ordering In these cases the correcting glass should be mounted in the half-stops of the eyepieces

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L. Koeppe: Die Mikroskopie des lebenden Auges. Bd. I: Die Mikroskopie des lebenden vorderen Augenabschnittes im natürlichen Lichte. J. Springer, Berlin 1920. 310 pp, 62 illustrations.

— — Die ultra- und polarisationsmikroskopische Erforschung des lebenden Auges und ihre Ergebnisse. E. Bircher, Berne and Leipzig, 1921; 269 pp., 74 illustrations.

— — Die Bedeutung der Gitterstruktur für die Theorie der subjektiven Farbenerscheinungen in den lebenden Augenmedien. E. Bircher, Berne and Leipzig, 1921. 21 figures.

Directions

To obtain stereoscopic vision apply the two half-stops to the eyepiece in such a position that the covered halves are on the inner sides and that, after the adaptation of the binocular attachment to the interpupillary distance, their edges may be in vertical planes and not in oblique positions.

Spectacle wearers should abandon their spectacles when using the microscope. **Uncomplicated myopia or hypermetropia** may be corrected by extending or shortening the viewing distance Any **astigmatism** in the observer's eyes should be corrected by cylinder glasses mounted in the half-stops. When using the instrument, make sure, after setting the binocular tube to the distance between the pupils, that the stops marked R (for right) and L (for left) on the eyepiece may have their edges in vertical planes. The axes of cylinder glasses correcting for distance will then occupy their proper positions. **Differences in the visual distances** of the two eyes should be corrected by a glass having a refraction equal to the existing difference. The half-stop containing this glass is marked R or L, as the case may be.

Stereo-microscopic Observation with natural Slit-lamp Light.

For this mode of observation use the lens adapter shown in Fig. 3. The requisite adjustments and general procedure are fully described in the Directions to the Slit Lamp (Med 135).

Observation with the Polarising Microscope.

Apart from stereoscopic examination with the slit-lamp microscope, the instrument is available for use as a polarising microscope for the optical study of biophysical properties of the living tissues of the eye. This affords a means of comparing the appearances which are disclosed by polarised slit-lamp light with the images of the tissues as seen by natural slit-lamp light. This is a most important advantage, as without this comparison it is not possible to form a complete and exact estimate of the nature of the component tissues.

The **analyser** within the objective adapter (Fig. 3) can be turned through an angle of 90° and is provided with a scale by the aid of which the position of its plane of polarisation can be read off. When the analyser is at 90° its plane of polarisation is vertical. The selenite film is pivoted to a projecting arm and may be swung into a slit in front of the analyser. It can be displaced to either side up to 45° with respect to the horizontal plane. In its 45° position to the latter and with the analyser with its plane of polarisation in a vertical position, the plane polarised field of view presents a reddish tint. The film cannot be lifted out of the slit except when it is in its normal position (45° position from the lower left to the upper right), as shown in Fig. 4.

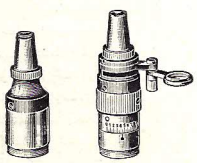

Fig 3 7747

Left: Adapter with objective attached (for observation by natural slit-lamp light).

Right: Adapter with objective attached and analyser for microscopic observation with polarised light; showing the selenite film swung out of action.

Attach the **polariser** (Fig 2) by means of the bayonet catch to the screen-tube of the slit-lamp in the place of the front stop with the index line at the top. The plane of polarisation will be vertical when the index is set to 90° on the scale (see also Directions to the Slit-lamp, Med 135, p. 2).

The examination with polarised slit-lamp light can be made in three different ways, and all three may be applied alternately by way of comparative examination. These three modes are: (1) By diffraction of polarised light, (2) by elliptical polarisation, (3) by purely plane polarisation.

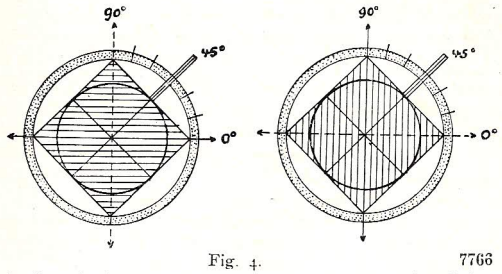

Fig. 4. 7766

The Analyser in its two principal positions, the selenite film being in its normal position.

For observations with **polarised diffracted light** natural slit-lamp light should be used (without silvered mirror). The natural light transmitted through the slit, on meeting minute particles or ultramicrons in the eye tissues, undergoes plane polarisation at right angles to the direction of incidence. The rotation of the analyser will then give rise to extinctions and colour effects in the field of polarisation. By way of comparison it is advisable in the examination of these minute objects to apply short-wave blue or redless light as well as unfiltered white or yellow filtered slit-lamp light

Observations with **elliptically polarised** light should be made with the aid of the silvered mirror, the latter being set at the principal angle of incidence (about 75°) with respect to the axis of the slit-lamp-lens, so as to obtain the maximum degree of polarisation. The elliptically polarised light reflected back from the eye is made to undergo plane polarisation by the insertion in front of the analyser of a selenite

film producing a phase difference of 1/4 wave-length. This will give rise to variations in the intensity when the analyser is rotated.

To illuminate the eye with **purely plane polarised** light the polariser should be fitted to the screen tube of the slit-lamp (Fig. 2). Again the selenite film may be used for producing interference colours.

Ultra-microscopic Examination.

Minute structures in the tissues of the eye of a pointlike order of magnitude in all three dimensions or at least in two linear dimensions of a magnitude less than half a wave-length of the illuminating light may be brought into view by ultra-microscopic means in the form of monochromatic or polychromatic diffraction discs or bands with undefined contours. The modes of illumination which may be employed are: Dark-ground illumination, direct illumination or by incident light, and negative bright-ground illumination or by transmitted light (For details the reader should consult the Directions to the Slit-lamp, Med 135, pp. 4 and 5).

Under this mode of observation the diffraction discs of the pointlike ultra-microns, whatever their position relatively to the axis of illumination and observation, always remain visible, whereas the diffraction bands of the linear ultra-microns can only be seen when the light is incident approximately at right angles to their long axis. Whenever the direction of the illuminating pencil changes they disappear, reappearing again when their long axis happens to be at right angles to the direction of the illuminating pencil. The linear ultra-microns comprise extremely fine crystals, minute splinters, edged rods, fissures, spiculae, fibrils, etc., such as occur in calcareous degeneration of the corneal seams, in calcareous deposits in clouding of the ligaments, etc. The diffraction discs and bands appear with or without coloured fringes, according as the slit-lamp light used is chromatic (white) or approximately monochromatic.

To obtain monochromatic light it is best to use the two yellow filters in the coloured glass disc attached to the screen-tube of the slit-lamp. The blue filter as well as the red-absorbing filter are to be avoided as they absorb too much light. Moreover, the long-wave light transmitted through the yellow filters furnishes broader and more distinct diffraction discs and bands than the short-wave light of the blue and redless filters.

For the study of **colour appearances in ultra-microns** it is necessary to employ mixed, i. e. white, light. Colour appearances due to the absorption of certain wave-lengths provide a means of estimating the size of the ultra-microns. For example, a certain particle may be of ultra-microscopic magnitude with respect to the red region of the spectrum but not so in relation to the green region, in which case it diffracts red rays only. In the conjunctiva, the cornea, the lens, the vitreous humour and the fundus of the eye the ultra-microns sometimes flash up with a red or green colour, and linear ultra-microscopic particles will be seen to exhibit red or green fringes. The iridescence due to grating-like boundary surfaces within the media of the eye (lens or cornea) belong to this category of phenomena; it can only be seen in the focus of reflected light.

In conjunction with the analyser the ultra-microscopic method of observation by transmitted light brings into view biochromatic appearances (basal and axial colours), due to double refraction, in minute crystals (cholesterin splinters and particles of lime). The application of this method frequently affords a diagnostic means of differentiating in certain positions of the analyser ultra-microscopic crystals the contours of which can be recognised by their fine diffraction discs or bands from other chromatic effects which, though similar in appearance, are due to the diffraction caused by ultra-microscopic elements, as well as from similar elements exhibiting better defined contours and therefore not of ultra-microscopic size.

Adjustments for Illumination and Observation.

For the purposes of ultra-microscopic observation the Koeppe slit-lamp lens should be employed with a small stop of $^6/_9$ mm., so as to restrict the illumination to rays near the axis. The slit may be contracted to the utmost admissible limit (about 0.5 mm.) (Fig. 4 in Med 135). The axis of the microscope and that of the pencil of light entering the eye should be set as nearly as possible at right angles to one another, and by way of comparison all intermediate positions down to the extreme acute-angular position should be applied. The silvered mirror and the slit of the lamp should in all cases be set at right angles to one another, and the polariser and analyser should be in their principal positions (90 and 0°). The silvered mirror should be set at such an angle that the pencil of light may meet it approximately at the principal angle of incidence (about 75°). When, on the other hand, little polarised light is needed the angle of polarisation should be avoided.

Further particulars respecting the different modes of illumination and adjustment will be found in the Directions to the Slit-lamp, Med 135, pp. 4—9.