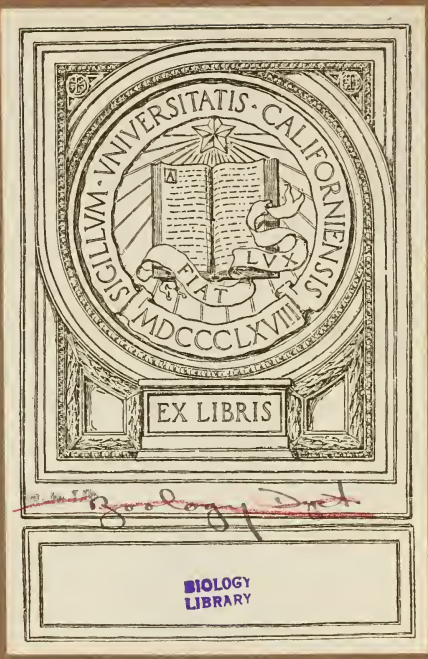
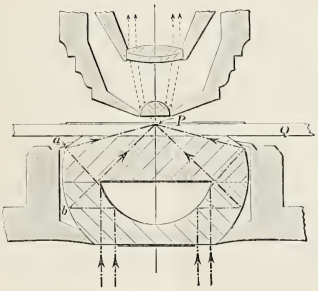
REFLECTING CONDENSER
FOR OBSERVING
LIVING BACTERIA ETC.
UNDER DARK GROUND
ILLUMINATION. E.LEITZ.



Reflecting Condenser for Observing Living Bacteria etc. under Dark Ground Illumination.



Reflecting Condenser A.

This Reflecting Condenser, which was originated by Mr. W. v. Ignatowsky, a member of the scientific staff of the firm, was fully described in the Zeitschr. f. wiss. Mikr., Vol. 25, 1908, No. 1. It serves for observation under dark-ground illumination, and more especially for bringing into view living and unstained bacteria.

This mode of illumination derives its success from the contrast produced between the intensely illuminated bacteria and their dark surroundings. Two reflecting surfaces, one internal, the other external, as shown in the figure, are so shaped as to almost completely unite the rays in a point *P*, and, by reducing the astigmatism to its lowest limits, gives rise to an intense illumina-

tion of the bacteria. Also, the apertures of the extreme rays $a\,P$ and $b\,P$ lie within the limits 1.1 and 1.45, from which it will be seen that a considerable amount of light is collected at P. When dry lenses are used all the rays which enter from below and converge towards P go to illuminate the bacteria, as shown by lines and dots, and are totally reflected at the surface of the cover-glass. The light diffused by the bacteria, as represented by dotted lines, enters the objective and thus produces an image of the bacteria, which under these circumstances behave as self-luminous bodies. Since the rays are united at P by reflection instead of by refraction, there is no chromatic dispersion, and the annular illumination of the bacteria obviates diffraction.

The light-gathering power of this reflecting condenser is such that with an arc lamp fed by a continuous current of 4 amp. the intensity of the illumination suffices for the photography of living bacteria.

The optical portion of the dark-ground illuminator is contained in a mount provided with a centreing arrangement and slips from below into the sleeve which usually carries the Abbe condenser.

Since the point P should lie within the preparation it is necessary to use slides of uniform thickness, not exceeding 1.0 mm. The requisite correction is effected by raising or lowering the dark-ground illuminator by means of the movement forming part of the illuminating apparatus. It should however be noted that the space below the object slide Q should always be filled with oil.

The best source of light for the dark-ground illumination is furnished by a small arc-lamp, but where this is not available a Nernst lamp or incandescent gas lamp may be used, although, naturally, the illumination will not be so bright.

The object may, as stated above, be viewed with dry lenses, the illuminating rays being totally reflected from the upper surface of the cover-glass, whereas only those rays which are dispersed by the bacteria are allowed to enter the objective. High powers of the dry series are better adapted for this purpose than lower powers, partly owing to their higher apertures and their consequent greater light gathering power, and partly owing to their greater magnifying power. Owing to the influence which the thickness of the cover-glass exercises upon the performance of high power dry lenses, it is essential to employ cover-glasses of the proper thickness, viz.

0.17 mm, this being the thickness with respect to which the objectives have been corrected.

Independence of the cover-glass thickness may be secured by the use of objectives fitted with correction collars. The apochromatic objective of 4 mm focus and the achromatic lens No. 8, which are both supplied with a correction collar, are to be specially recommended for this purpose. It may, in fact, be said generally that apochromatic lenses are much to be preferred in dark-ground illumination, since this mode of observation is extremely sensitive to differences of colour.

The method is also available for observation with the aid of immersion lenses, which offer a two-fold advantage. In the first place, immersion lenses are within wide limits independent of variation in the thickness of the cover-glass, and in the second place, the image of the object is brighter owing to the absence of reflections at the surface of the cover-glass and of the front lens of the objective. When used in this way the immersion lens should be stopped down sufficiently so that only the diffused rays enter the eye, while the direct rays do not. Despite this limitation, the aperture can be made greater than that of a dry lens, which again is an advantage.

In the case of the $^1/_{12}$" and $^1/_{12}$"*a* lenses the necessary stopping is obtained by simply screwing a funnel into the objective.

As in the case of the dry lenses, the apochromatic lenses, e. g. the apochromatic 2 mm or the fluorite $^1/_{12}$"*a* oil-immersion lens, yield the finest and brightest images. In the case of the 2 mm apochromatic lens the reduction of the aperture has to be applied with much greater care and cannot be effected by the observer himself. The necessary modification does not, however, render the objective useless for other purposes, for the stopping devices may be removed by us.

Having screwed the objective to the microscope tube, slip the dark-ground illuminator into the condenser sleeve, place the preparation on the stage, and having placed a drop of oil on the top of the illuminator, raise the illuminator until it touches the slide.

The light should now by means of a bull's eye lens be directed upon the plane mirror. In the case of the 4 amp. arc lamp listed below the illuminating lens is attached to the lamp casing and the lamp is placed at such a distance from the microscope that the observer may conveniently reach the carbon regulator whilst

looking through the eyepiece. When a Nernst lamp or incandescent gas light is used it is necessary to employ a bull's eye lens on a stand, the distance between the source of light and the lens being about 17 cm, that from the lens to the microscope mirror about 40 cm. The pencil of light formed by the lens should after reflection at the mirror give an image of the source of light on the lower face of the dark-ground illuminator. The pencil of light does not fill the entire mirror but rather its upper portion, it being essential that the rays should be parallel to the axis of the microscope and enter through the centre of the illuminator. Before focussing the objective upon the object view the latter direct. A bright spot will be seen upon the object, which, by raising or lowering the illuminator, should be made as small as possible and, by adjusting the position of the mirror, directed into the middle of the upper surface of the illuminator, when its maximum brightness will be attained. The object should now be focussed and viewed with a very low eyepiece, say No. 0. It will generally be found that the brightest point is not situated in the centre of the field. By centreing the sleeve, the point P should be brought into the middle of the field. The low power eyepiece may now be replaced by one of higher power, the compensating eyepiece No. 18 being particularly suitable for this purpose, and, if necessary, the correction collar of the objective should be adjusted and the dark-ground illuminator raised or lowered with the aid of the condenser movement, until the bacteria are as bright and the field as dark as possible.

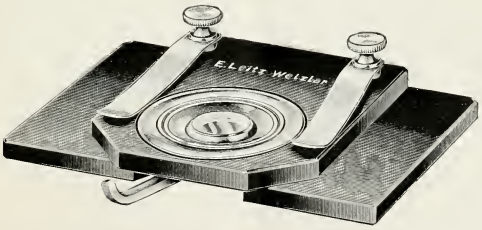
Observation with dark-ground illumination renders it imperative that the object-slide and cover-glass should be cleaned with the utmost care, otherwise the presence of particles of dust may interfere with the observation. The preparation itself should be very thin, i. e. present as little substance as possible, to prevent the particles lying outside the plane of observation from giving rise to disturbing reflections. For similar reasons it is essential to ensure the absence of air bubbles.

The lower movable iris diaphragm which forms part of the Abbe illuminating apparatus should be thrown out of action during observation with the dark ground illuminator.

In addition to the Reflecting Condenser just described a simple form of it is made consisting of a plate in which the condenser

is mounted and which may be placed upon the ordinary stage of the microscope, as shown in the subjoined figure.

In this form the Reflecting Condenser need not be specially adapted, but is ready for use with any microscope. The Condenser Plate is merely placed upon the stage and held in position by the ordinary clips. Large stands have as a rule centreing stages but in their absence it is not a very difficult matter to centre the condenser plate by hand. To facilitate this operation the upper surface of the condenser has ruled upon it two small concentric circles, which should be brought into the centre of the field of a low power lens. The axis of the condenser is thereby made to approximately coincide with the axis of the microscope. The final adjustment should, after the manner described above, be effected under a high power. The adjustment of the Reflecting Condenser along the axis, which is of the utmost importance, is accomplished with the aid of the lever shown in the illustration of the Reflecting Condenser B. The latter should be so placed upon the microscope stage that the lever is towards the observer.



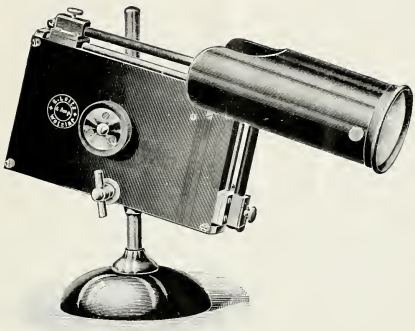
Reflecting Condenser B.

Prices.

Reflecting Condenser A with Centreing Device	16.—
Sleeve for the above	—.40

(This is necessary in the case of those stands only which are fitted with a swing-out condenser, and accordingly have no sleeve. After swinging the condenser out and opening the upper iris diaphragm to its full extent the sleeve is slipped in from below in the place of the condenser and the dark-ground illuminator introduced into the sleeve.)

Reflecting Condenser B	16.—
Electrical Arc Lamp, with hand feed for a current of 4 amps. and illuminating lens mounted on stand for connection to any existing house supply	16.—
Resistance for 110 Volts	6.—
Nernst Lamp on Stand	6.— 10.—
Incandescent Gas Lamp on Stand	6.—
Illuminating Lens on Stand, (Bull's Eye Condenser) . . to be used with Nernst Lamp or incandescent gas light	8.—
Apochromatic Objective 4 mm with correction collar . .	48.—
Achromatic Objective No. 8 with correction collar . .	20.—
Eyepiece 0	2.—
Compensating Eyepiece No. 12	10.—
Compensating Eyepiece No. 18	8.—
Funnel, screwing into the $^1/_{12}$" or $^1/_{12}$"a oil immersion lenses	—.40



Electrical arc lamp with hand feed for a current of 4 amps. and illuminating lens mounted on stand.

Ferd. Schnitzler Wwe. u. Kinder
Wetzlar

Directions for use of Dark field Apparatus.

1. Use very thin films, with few bubbles.
2. Have alllenses very clean.
3. Attach apparatus.
4. Remove all other condensers.
5. Funnel stop in oil immersion obj.
6. Center condenser with #3 obj.
7. Drop of oil on condenser and put slide on oil. No oil on slide.
8. Examine with low power. Center light by mirror.
   Focus condenser by lever.
9. Oil on 1/12 - swing in obj.
   Proceed
   Keep lens on lamp in place.
   Throw light on upper part of mirror.
   Use thin slide.
   Do not use scratched slides.
   Seal slide with vaseline
   Oil should be clear.