R. Munie

Type K Photomicrographic Camera

REFERENCE MANUAL

BAUSCH & LOMB
OPTICAL CO., ROCHESTER 2, N. Y., U. S. A.

RESPONSIBILITY FOR DELIVERY

Bausch & Lomb Optical Company guarantees that every instrument is in a perfect condition when it leaves the factory. When the transportation company accepts the shipment in good order, our responsibility ceases, and the transportation company becomes the consignee's agent insofar as assurance of safe delivery is concerned.

If shipment shows evidence of rough handling on the outside of the packing case, have the agent make a notation on receipt "Received in Bad Order"; or, if there is no external evidence of rough handling, but "Concealed Damage" is revealed after unpacking, call the representative of the transportation company within 48 hours of the delivery of shipment and have him make out a "Bad Order" report. Unless this procedure is followed, you lose all right to recovery from the carrier.

GUARANTEE

Bausch & Lomb Optical Company guarantees the instruments manufactured by it to be made of the best materials by skilled craftsmen, free from defects in material and workmanship under normal use and service.

If an instrument manufactured by Bausch & Lomb Optical Company proves defective in material or workmanship, a satisfactory adjustment will be made. This guarantee does not cover damage in transit, damage caused by carelessness, misuse or neglect, or unsatisfactory performance as a result of conditions beyond the control of the manufacturer. Claims for adjustment must be made to the Company within thirty days from date of delivery.

BAUSCH & LOMB OPTICAL COMPANY
Rochester 2, N. Y., U. S. A.

The illustrations shown herein are of Bausch & Lomb machines or instruments that are in current production. However, due to our constant effort to improve and refine, this company reserves the right to supply apparatus that may differ in unimportant or minor details from those shown in the illustrations.

THE BAUSCH & LOMB TYPE K PHOTOMICROGRAPHIC CAMERA

Cat. No. 42-14-44

REFERENCE MANUAL

BAUSCH & LOMB
OPTICAL CO., ROCHESTER 2, N. Y., U. S. A.

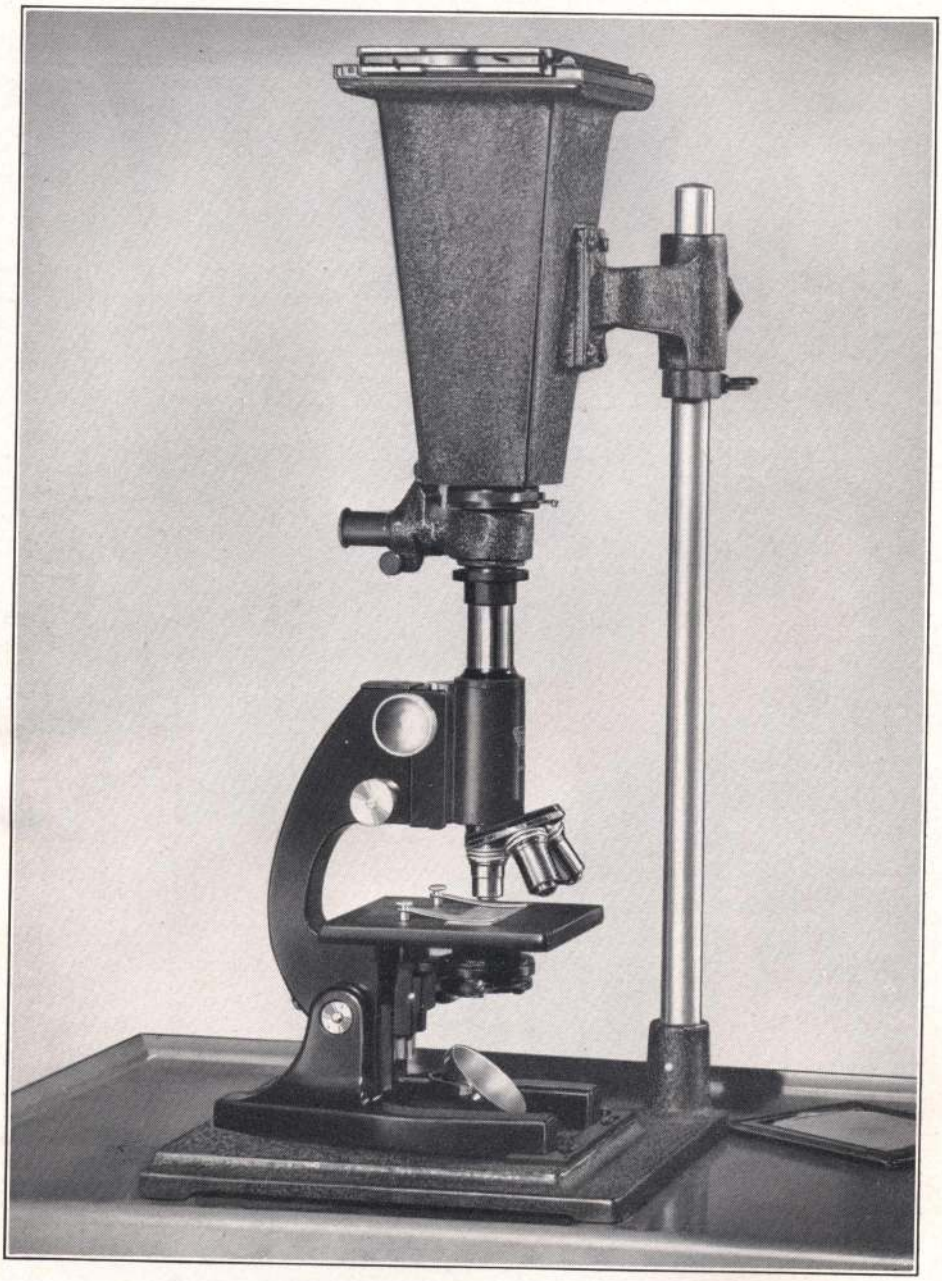

Figure 1

The Type K Photomicrographic Camera as used with the Microscope

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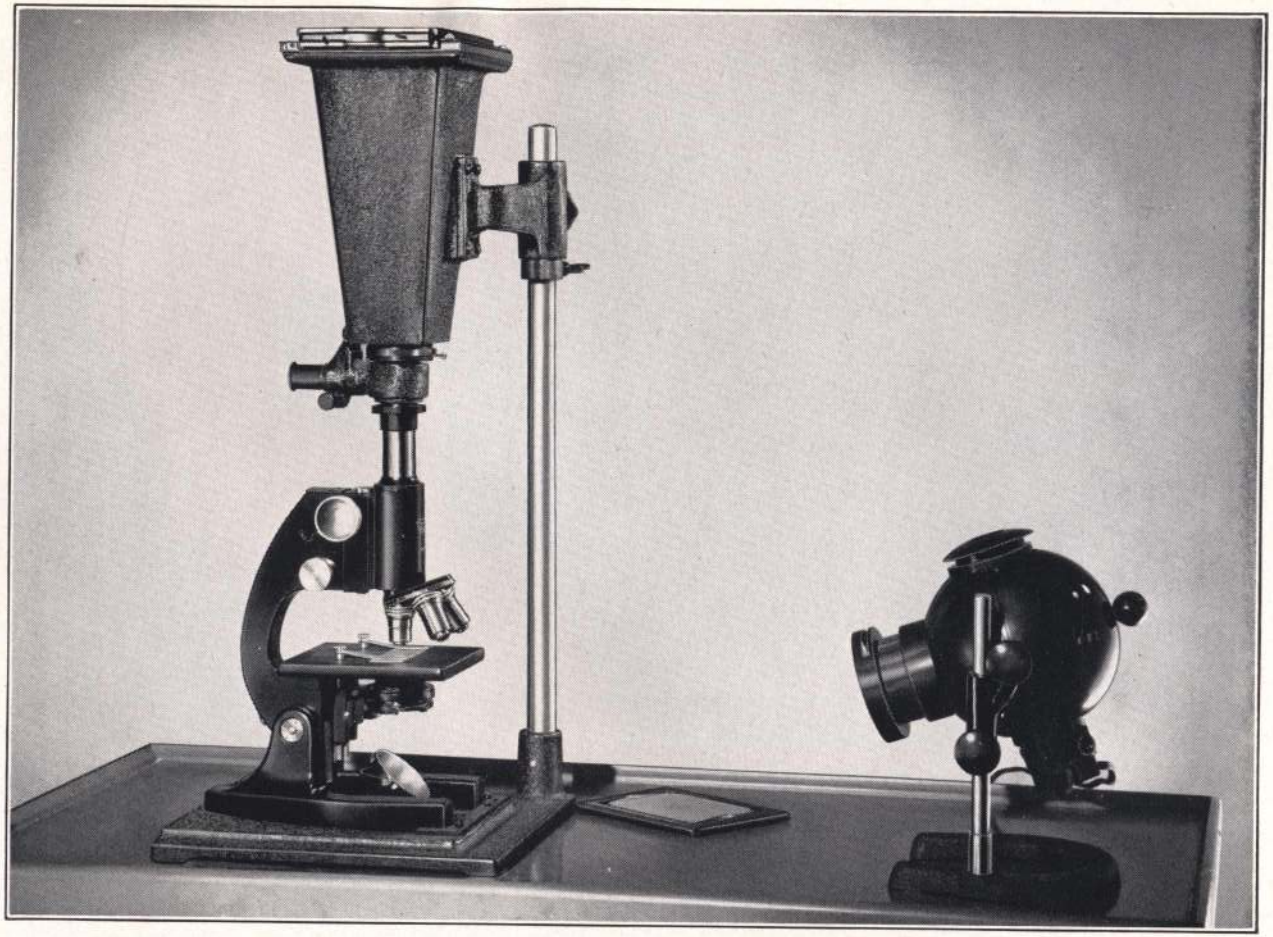

Figure 2

The Type K Photomicrographic Camera as used with the Microscope and Illuminating Lamp

IMPORTANT

1. Carefully read the instructions contained in this book before mounting and operating.
2. Do not destroy this book. Put it in a convenient place, as you may want to refer to it again.

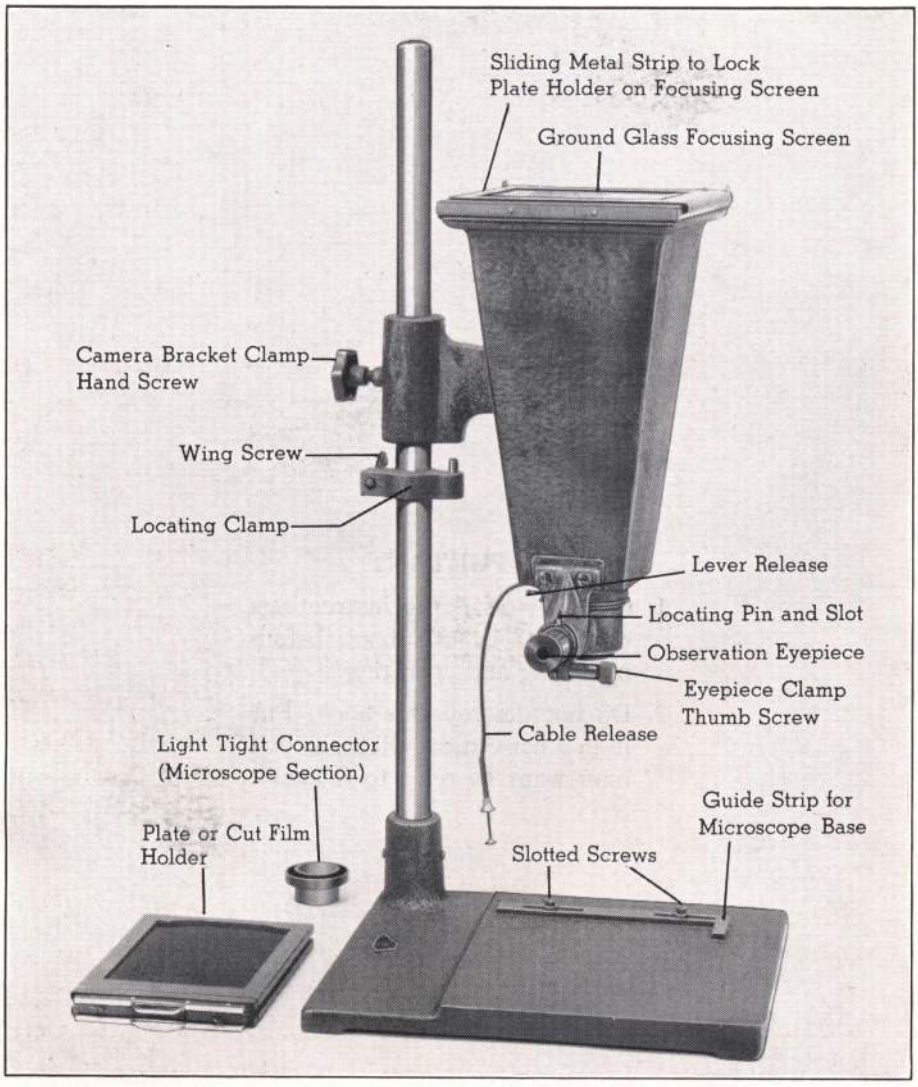

Figure 3

Reference Illustration of the Type K Photomicrographic Camera

THE BAUSCH & LOMB TYPE K PHOTOMICROGRAPHIC CAMERA

Directions for Use

Unpacking and Assembly of Camera

The Bausch & Lomb K Photomicrographic Camera with accessories is packed complete in one case. No special instructions are required for unpacking. For shipping purposes the camera is removed from the supporting rod and wrapped alone. The plate holder, ground-glass screen, light-tight connector, and cable release will be found wrapped in one package. These accessories may be easily identified by reference to Fig. 3, page 6. The Locating Clamp in the figure will be found clamped to the camera support.

Fig. 3 illustrates the way in which the camera attaches to the supporting rod. The Camera Bracket Clamp Hand Screw may be turned in against the supporting rod to hold the camera at the position desired.

The Observation Eyepiece may have slipped out of position during shipment. As shown in the illustration, the Locating Pin on the side of the eyepiece tube should engage in the slot provided in the eyepiece mount. In case the eyepiece has moved out of position, loosen the eyepiece clamp by turning the Eyepiece Clamp Thumb Screw counter clockwise, and set the Locating Pin into the notch as far as it will go, then tighten the eyepiece clamp by the Eyepiece Clamp Thumb Screw.

The threaded end of the Cable Release screws into a small receptacle on the edge of the shutter. This does not appear in the illustration, but will be found just back of the Lever Release.

Aligning the Camera with the Microscope

An L-shaped Guide-Strip is provided on the base plate of the camera support. This is held in position by two Slotted Screws. With a screwdriver, loosen these screws so that the Guide-Strip may be moved within the limits of its slots. Now place the microscope stand on the plate with the ends of both toes of the microscope base touching the slotted Guide-Strip.

Three sets of holes in the base plate accept the Slotted Screws, providing three positions for the Guide-Strip. In case the base of the microscope is long, it may be necessary to move the Guide-Strip to the position nearest the edge of the base plate.

Place a specimen slide on the microscope stage and focus on it with a convenient combination of objective and eyepiece. Remove the eyepiece and slip the Light-Tight Connector over the eyepiece adapter tube of the microscope. The connector should be put on with the flange end up. Put the connector on as far as it will go, then replace the microscope eyepiece.

(The Light-Tight Connector shown in the illustration is for use only with microscopes using standard size eyepieces. For microscopes using other than standard size eyepieces, a special connector must be ordered.)

Now loosen the Camera Bracket Clamp Hand Screw and carefully lower the camera, at the same time rotating it about the support rod as required, until the opening of the camera is centered as closely as possible over the microscope eyepiece. Tighten the Camera Bracket Clamp Hand Screw to hold the camera in this position and then move the microscope sidewise to bring its Light-Tight Connector in line with the camera. It may be necessary to readjust the camera and microscope two or three times and by small amounts before perfect alignment is accomplished. The adjustments described should be repeated, however, until it is possible to lower the camera and have it couple perfectly with the Light-Tight Connector on the microscope. The narrow rim projecting out from the lower end of the camera should fit into the circular groove of the Light-Tight Connector on the microscope with equal clearance all around.

Do not allow the camera to actually rest on the connector of the microscope, but clamp the camera securely in place with about $\frac{1}{16}$ to $\frac{1}{8}$ inch space between the outer rim of the connector and the end of the camera. This small space is required to permit focusing of the microscope with the fine adjustment.

Having centered and coupled the camera with the microscope, loosen the Locating Clamp by turning out the Wing Screw and slide it up the support rod until it is directly beneath the camera bracket. Turn the clamp to the position shown in the illustration, then move it up until the pin enters the hole in the under side of the camera bracket. When the Locating Clamp is bearing against the camera bracket, tighten it securely on the supporting rod by turning in the Wing Screw. The Locating Clamp will now prevent

the camera from sliding down the support rod when the Camera Bracket Clamp Hand Screw is loosened. The camera may be lifted up off the pin in the Locating Clamp and turned aside to permit visual observation with the microscope. With the Locating Clamp properly set, the camera may be quickly brought back into position with the microscope.

The Guide Strip should now be adjusted to mark the position of the microscope. Set the strip so that the long slotted piece presses against the ends of both toes, and the short right angle piece at one end bears against the side of the microscope. Tighten the Slotted Screws to hold the strip securely in position. With the position of the microscope thus determined by the strip, the microscope may be quickly aligned with the camera at any time, if it is necessary to remove the microscope for other service.

A final check on the centering and correct coupling of the camera and microscope can be made in the following manner. With the microscope still in focus on a specimen and with light coming through the microscope from a lamp, set the exposure lever for time and open the shutter. Looking down into the camera, a small disc of light should appear accurately centered in the prism of the Observation Eyepiece. This disc of light is formed by the light rays emerging from the eyepiece and is referred to as the Ramsden disc. If the camera is raised too high above the microscope, the light rays from the microscope eyepiece will not all pass through the observation eyepiece prism. The prism will be filled with light and rays will be seen reflected from the prism faces. The camera must be coupled close enough to bring the Ramsden disc up into the prism, and adjusted so that the disc is centered with the upper face of the prism.

The projected field should now be examined on the Ground Glass Screen. In Fig. 3, the Ground Glass Screen is shown in place. One side of the camera back is arranged with a Sliding Metal Strip with turned up ends. The metal strip on the opposite side of the camera back is fixed. Insert the edge of the ground glass frame under the fixed strip and slide the movable strip outward so the screen will drop down into place. The Sliding Strip can be pushed back to engage the free side of the screen to hold it in place. Follow this same procedure for inserting plate or film holder.

Watch the Ground Glass Screen and focus the microscope with the fine adjustment. If the microscope was left in visual focus, a slight upward adjustment should bring the projected image into focus on the Ground Glass Screen.

Examine the screen to see that the projected field is centered. The field should appear symmetrical on the screen. If corners or sides of the field are cut off, then the axis of the microscope is not coincident with the camera axis, or else something in the illuminating setup is at fault.

Use and Care of The Observation Eyepiece

Although focusing with the K camera may be done directly on the Ground Glass Screen, the Observation Eyepiece, Fig. 3, affords a more rapid means of focusing and exposing negatives.

Looking into the Observation Eyepiece, adjust it in or out (taking hold of the knurled rim at the extreme outer end) until the cross lines in the field are in sharp focus. Now if the microscope is focused until the details of the object are sharply defined in the plane of the cross lines, the object will also be imaged sharply on the Ground Glass Screen.

The observation eyepiece assembly may have to be removed from the camera occasionally to clean dust particles from the prism. This is easily done by turning the Eyepiece Clamp Thumb Screw to open the eyepiece clamp, and drawing out the eyepiece tube assembly. Clean the prism with a camelhair brush, or if necessary, breathe on the prism and wipe off the moisture with lens paper or a soft clean cloth. Do not use solvents on the prism.

The Camera Shutter

The shutter of the K Camera affords instantaneous exposure of 1/25, 1/50, and 1/100 second besides "bulb" and "time" settings. On the edge of the shutter next to the Lever Release, Fig. 3, a plate engraved with these shutter speeds will be found. A small pointer projects over the edge of the plate. Moving the pointer to one of the instantaneous speeds automatically sets the shutter for that speed and it is only necessary to depress the Lever Release or Cable Release once, to give the exposure. When the pointer is set at B on the scale, the shutter opens when the release is depressed and remains open as long as the release is held down. When set at T, the shutter opens at the first depression of the release and remains open until the release is depressed the second time.

An iris diaphragm is incorporated in the shutter and is operated by a small lever on the edge of the shutter opposite the release lever. The iris should be left wide open and plays no part in the operation of the camera. If the iris happens to be closed too far, it will cut off the field projected onto the plate or Ground Glass Screen.

Practical Information for the Photomicrographer

The Specimen

A well prepared specimen slide is one of the most important factors contributing to the success of the final picture. Sections that are heavily stained are difficult to photograph as they tend to show excessive contrast and fine detail is likely to be blocked out, even though the slide may be considered satisfactory for visual observation. Sections that are cut just thick enough to include the detail desired and then carefully stained to the density that gives clean differentiation of structure will be found to produce the best photomicrographs.

When it is known that slides are to be photographed, it is well to consider the thickness of the object slide used for mounting, especially if an oil immersion objective will be required. The slides should be no thicker than the maximum working distance given for the substage condenser of the microscope. If the slide thickness is greater than the working distance, it is impossible to focus the condenser so as to meet the requirements of critical illumination. As a result the full aperture of the objective cannot be used and the field of view may be unevenly illuminated.

In case a specimen slide is much thinner than the working distance of the substage condenser, difficulty is encountered in maintaining oil contact between the slide, and condenser. This trouble may be eliminated by sticking a cover glass to the under side of the slide, using immersion oil between the slide and cover glass. Two or three cover glasses may be added to obtain the desired thickness.

Objectives and Eyepieces For Photomicrography

Of the three types of microscope objectives made by Bausch and Lomb, the apochromatic objectives are recommended for use when the most precise visual and photographic work is to be done, since their color correction is of the highest order. Where natural color pictures are to be made, these objectives are a necessity. The fluorite objectives are made in only the high power forms and possess a color correction between that of the achromatic and apochromatic types. It is not to be concluded, however, that excellent photomicrographs cannot be made using the achromatic objectives. For the most part photomicrographs are made in the usual black and white forms.

The specimens are usually stained in such a manner that color filters are required to bring out the desired contrasts and details. Since a filter restricts the light used to a narrow band of the spectrum, the conditions are such that the objective will perform at its best.

For most photomicrographic work the same eyepieces are used that are employed for visual observations. The Huygenian type of eyepiece is generally used with the achromatic objectives although the use of Hyperplane eyepieces with the higher power achromatic and fluorite objectives is recommended. Compensating eyepieces are especially designed for use with the apochromatic objectives but they may also be used to advantage with the achromatic oil immersion objective. The following table lists the most satisfactory objective and eyepiece combinations:

Objective	Eyepiece for Visual or Photomicrographic Work	Eyepiece for Photomicrographic Work Only
48.0 mm. Achromatic Objective	Huygenian Eyepiece	
40.0 mm. Achromatic Objective	Huygenian Eyepiece	
32.0 mm. Achromatic Objective	Huygenian Eyepiece	
16.0 mm. Achromatic Objective	Huygenian Eyepiece	Ampliplan (Low)
8.0 mm. Achromatic Objective	Hyperplane Eyepiece	Ampliplan (Med.)
4.0 mm. Achromatic Objective	Hyperplane Eyepiece	Ampliplan (High)
1.9 mm.* Achromatic Objective	Compensating Eyepiece	Ampliplan (High)
4.3 mm.* Fluorite Objective	Compensating Eyepiece	Ampliplan (Med.)
4.0 mm. Fluorite Objective	Hyperplane Eyepiece	Ampliplan (High)
1.8 mm.* Fluorite Objective	Compensating Eyepiece	Ampliplan (High)
16.0 mm. Apochromatic Objective	Compensating Eyepiece	Ampliplan (Low)
8.0 mm. Apochromatic Objective	Compensating Eyepiece	Ampliplan (Med.)
4.0 mm. Apochromatic Objective	Compensating Eyepiece	Ampliplan (High)
2.0 mm.* Apochromatic Objective	Compensating Eyepiece	Ampliplan (High)

*Oil immersion objective.

Magnification

All Bausch & Lomb objectives and eyepieces are engraved with their magnification numbers. The total magnification obtained with a given objective and eyepiece, when used for visual observation on a microscope, is given by multiplying the magnification number of the objective by that of the eyepiece. For example, a 4mm, 0.85 N.A. objective is engraved 45×. If this is used with a 10× eyepiece, the total magnification is 10 x 45 or 450×. If the same optics are used for photomicrography with a distance of ten inches between the eyepiece and the camera ground glass, the magnification at the ground glass will also be 450×. The Type K Photomicro-

graphic Camera has a fixed bellows extension of ten inches. The magnification at the focusing screen, therefore, is equal to that provided by the optics of the microscope as stated above.

It is often thought that the more magnification that can be obtained in a photomicrograph the better the picture. This, however, is not correct. On the other hand it is possible that the full value of an objective may not be realized due to the use of an eyepiece and/or a projection distance which fails to produce an adequate total magnification. Without taking space for details, it may be stated that if the total magnification is equal to or less than 400 times the numerical aperture of the objective, then the magnification is not sufficient to show the finest details revealed by the objective. The total magnification may be increased by using a higher power eyepiece and/or increasing bellows draw, until it reaches a value equal to 1000 times the N.A. of the objective. At this point the magnification becomes too great for the finest detail shown by the objective and the structure no longer appears sharp. These limits, however, are not absolute. There are a number of instances where, although the details may not be sharpest, the upper limit can be exceeded to demonstrate certain structural details to advantage.

Resolution

The purpose of a microscope or magnifier is to make visible the structure that is invisible to the naked eye. To accomplish this purpose the instrument must have both magnifying power and resolving power. Magnifying power is self-explanatory but resolving power is a factor that is too frequently disregarded or misunderstood. For a full discussion of resolving power the reader is referred to the standard texts on the microscope and photomicrography. Suffice it to say for the present that the resolving power of an objective is dependent on its numerical aperture (N. A.), which value is generally engraved on the objective.

A fault that appears in many photomicrographs is the result of illuminating too little of the aperture available in the objective used. This may come about from either of two things. First, improper use of the iris diaphragm at the substage condenser, or second, incorrect focus of the condenser itself. The substage diaphragm is designed primarily to fulfill the same function as the iris of a photographic objective and was never meant to be used as an illumination control.

The important thing to be remembered in regard to the substage diaphragm is its limiting effect upon the aperture of the substage condenser with which it is used. The

numerical aperture of any lens is practically the ratio of half its diameter to the focal length. It follows then that closing the iris diaphragm in effect reduces the diameter of the lens. Consequently, the numerical aperture of the condenser is likewise reduced. Reducing the working aperture of the substage condenser effects a reduction also in the aperture (and hence the resolving power) of the objective in use.

It can be demonstrated that an image formed by a lens of a mathematical point cannot be another point but, due to the finite wavelength of light, becomes instead a diffused disc of some size, referred to as the circle of confusion. The numerical aperture of the lens system is an important factor in determining the size of the circle of confusion so that as the aperture is reduced the disc of light becomes larger. Considering the structure within a specimen as made up of a multitude of points each of which is represented in the image by a disc of light, appreciable reduction in aperture produces an overlapping with the result that the image becomes fuzzy. The circle of confusion is actually a diffraction phenomenon, further reduction in aperture produces diffraction bands about all the parts of the structure in the specimen so that it may be difficult to determine with certainty the actual structure of the specimen.

It may be found in many cases that the best image quality is obtained when the aperture of the objective is reduced slightly by partly closing the substage diaphragm. The diaphragm may frequently be closed to reduce the aperture of the objective by as much as one-third without disturbing the image quality too much. The diaphragm should never be closed to the point where diffraction bands are visible in the image.

The working aperture of the objective, as mentioned above, may be affected by the adjustment of the substage condenser. The substage condenser serves to illuminate the specimen with light and, at the same time, converge the light at an angle as great as that taken in by the objective so that the resolving power of the objective may be utilized. If the objective in use is of low power, the numerical aperture will also be relatively low and the field of view large in proportion. If a high aperture condenser is used, say the entire substage condenser, its focal length is necessarily very short. As a result, the image of the lamp condenser when focused on the specimen plane is small, too small to fill the field of the lower power objectives, while the numerical aperture available is greater than that taken in by the objective. Under such circumstances, the condenser is often racked up or down until the field is fully illum-

inated without regard to what happens to aperture. This is a practice to be avoided if possible. The result is usually a loss in resolution due to a restriction in numerical aperture just the same as if the substage diaphragm has been closed too far.

Most substage condensers are of the divisible type and may be separated into two or three parts. The lower element is usually designed to illuminate the field and aperture of the lower power objectives. With the second element added, the aperture and focal length are correct for the intermediate objectives. The entire unit is used for the high aperture dry and the oil immersion objectives.

Use of Filters

Filters are used in practically all photomicrographic work for the purpose of enhancing the contrast between certain colors in the specimen or to bring out detail within a section of a certain color. As mentioned previously the use of a narrow band of the spectrum as transmitted by a filter or combination of filters affords the best working conditions for an optical system, since it practically eliminates the residual chromatic aberrations that are present in all lenses. The "M" series of Wratten filters, (see list of accessories page 18), is designed especially for use in photomicrography. The reader is referred to the booklet "Photomicrography," published by Eastman Kodak Company, for full details in regard to their characteristics and use.

Determination of the Photographic Exposure

A number of factors are involved in determining the exposure times in photomicrography. These include the type of light source used, the type of film, aperture of the objective, magnification, density of the specimen, and the filter in use. With a given set of conditions the best method of determining the exposure time is to make an exposure test strip. This is done by withdrawing the dark slide of the plate holder and giving the entire film of plate an exposure that is estimated to be well on the under-exposure side, then inserting the dark slide to cover about the first inch of the plate and repeating the same exposure. After the second exposure again move the slide in another inch and then make an exposure twice as long as the second. Repeat the process, doubling the exposure each time, until the plate has been exposed across its entire length. On development the negative will be graded in density according to the exposure times given. From these steps the correct exposure time can be chosen. Once an exposure time has been determined for a given set of conditions, all

factors should be recorded for future reference.

If, after an exposure has been determined for one set of conditions, the magnification is changed by changing bellows draw, eyepieces or both, the exposure will vary directly as the square of the magnification. Or, $\frac{T_1}{T_2} = \left(\frac{M_1}{M_2}\right)^2$. Where T_1 is the original exposure time, T_2 is the required exposure time, and M_1 and M_2 are the corresponding magnifications.

In case the exposure time is known for a given set-up and the working aperture of the objective is changed by adjusting the substage diaphragm, the exposure will vary inversely as the square of the apertures. Or $\frac{T_1}{T_2} = \left(\frac{N.A._2}{N.A._1}\right)^2$; where T_1 and T_2 are the same as above and $N.A._1$ and $N.A._2$ represent the first and second working apertures respectively.

If the original set of conditions is altered by changing objectives, the total magnification and the working aperture may be affected at one time. Other factors remaining the same, the new exposure time may be easily determined by first taking into account the effect due to change in magnification and then determining the effect due to changing the aperture.

The exposure factors for the various color filters depend upon the type of negative material, and the light source employed. Full information in regard to filter factors for a particular film or plate may be obtained from the manufacturer.

Negative Materials and Processing

Information in regard to films or plates suitable for photomicrography and the processing of the same may be obtained from the manufacturers of photographic materials. Although a wide variety of negative materials and developers are available, with a little experimental work in processing it will be found that one or perhaps two types of film or plate and the developer recommended by the manufacturer can be used to produce the full range of effects desired.

Miscellaneous Accessories

for Photomicrography

Miscellaneous Accessories

for Photomicrography

STAGE MICROMETERS

Description	Catalog Number
Stage Micrometer, glass, ruled to 0.001 inches	31-16-89
Stage Micrometer, glass, ruled to 0.01mm	31-16-90
Centering Slide	31-16-95

FOCUSING GLASSES

Doublet Focusing Glass 3.5×	81-34-86
Achromatic, Adjustable Focusing Glass 7×	81-34-97

MICROSCOPE LAMP

Spherical Lamp with Spherical Condenser	31-33-75-01
Ground and Blue Glass Filters, 100 watt, 115 volt Mazda Bulb	

WRATTEN FILTERS

Orange-Red	From 5900 to Red End	42-47-60
Green	From 4800 to 6200	42-47-61
Blue-Violet	From 3700 to 5100	42-47-82
Purple	From 3200 to 4700 and from 6500 to Red End	42-47-83
Orange	From 5500 to Red End	42-47-84
Pure Red	From 6100 to Red End	42-47-85
Strong Yellow	From 5100 to Red End	42-47-86
Blue	From 4300 to 5400	42-47-87
Pale Green	For Orthochromatic reproduction with tungsten light	42-47-88
Complete set of "M" filters as listed above, in case		42-47-89
Neutral Filters		31-34-18

PLATE HOLDER

For 3¼" x 4¼" Plates	42-15-21

CUT FILM HOLDER

For 3¼" x 4¼" Film	42-15-39

FILM PACK ADAPTER

Film Pack Adapter	42-15-38

SOFT CORED CARBONS

Carbons—cored 8mm diameter, 6" long for D.C.	41-42-72
Carbons—cored 5.6mm diameter, 6" long for D.C.	41-42-73
Carbons—cored 6.4mm diameter, 6" long for A.C.	41-42-64

BULBS

6-volt, 108-watt Ribbon Filament Bulb, prefocus base	42-42-36
Tungsten Arc Bulb	42-42-60

RESISTANCES AND TRANSFORMERS

Description	Catalog Number
Resistance fixed form, 4.5 amperes, for use with arc lamp, 115 volt D.C. or A.C. With cord	42-46-52-25
Resistance fixed form, 4.5 amperes, for use with arc lamp 220 volt D.C. or A.C. With cord	42-46-53-25
Resistance fixed form, 8 amperes, for use with arc lamp 115 volt D.C. or A.C. With cord	42-46-57-25
Transformer for 6 volt, 108 watt bulb on 115 volt, 60 cycle A.C.	42-46-97
Transformer, same as above but for 220 volts	42-46-98
Transformer, for 115 volt, 25 cycles	42-46-91
Transformer for use with Tungsten Arc Bulb on 115 volt, 60 cycle A.C.	42-46-92

SUBSTAGE CONDENSERS

SUBSTAGE CONDENSERS

Type	N.A. in Oil Immersion Contact	E.F. in mm.	Slide Thickness	Top Element Removed N.A.	With Two Upper Elements Removed N.A.	Catalog Number
Abbe Condenser*	1.25	9.9	1.8	0.30		31-58-74-28
Abbe Condenser*	1.40	7.9	1.0	0.70	0.40	31-58-72-28
Achromatic Condenser**	1.40	8.9	1.6	0.59	0.20	31-58-37

*For use on any Microscope with ring support attached directly to the stage or carried on the rack and pinion substages, such as B&L Types H and G. Outside diameter of condenser 38.6mm, equipped with iris diaphragm.

**For use with Research Type Substage having centering adjustment. This condenser attaches to a quick change slide. The iris diaphragm is not included since this is part of the complete substage.

When used without immersion oil (dry), any condenser of N.A. greater than 1.00 will furnish illumination not over 1.00 N.A.

E2-531, 500, IV-46

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