

DYNAZOOM[®]

LABORATORY MICROSCOPES

CAT. NO. 31-01-05

REFERENCE MANUAL

FIXED POWER MODELS
AND
MICROZOOM[®]
VARIABLE POWER MODELS

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INCORPORATED
ROCHESTER 2, NEW YORK

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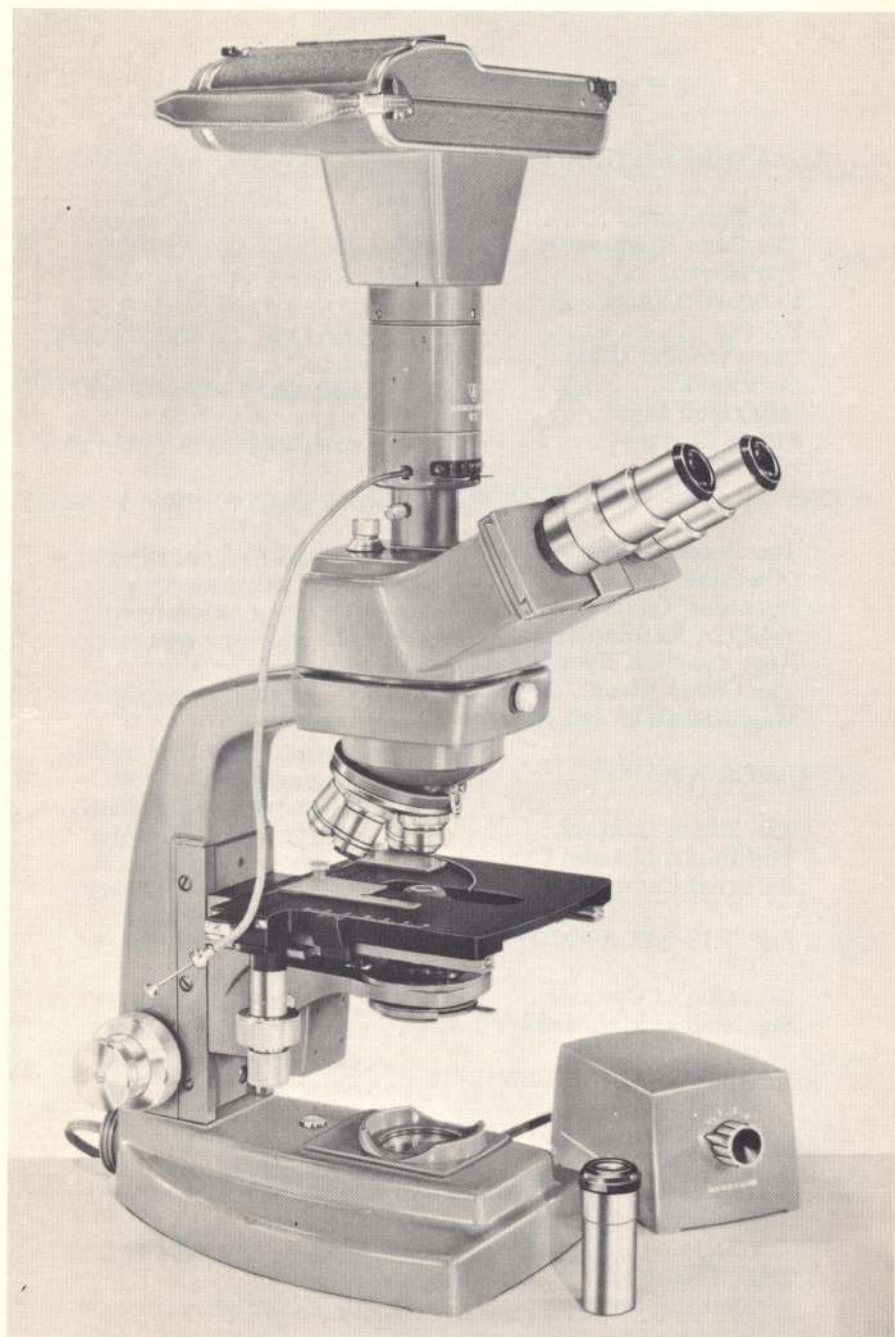


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Frontispiece

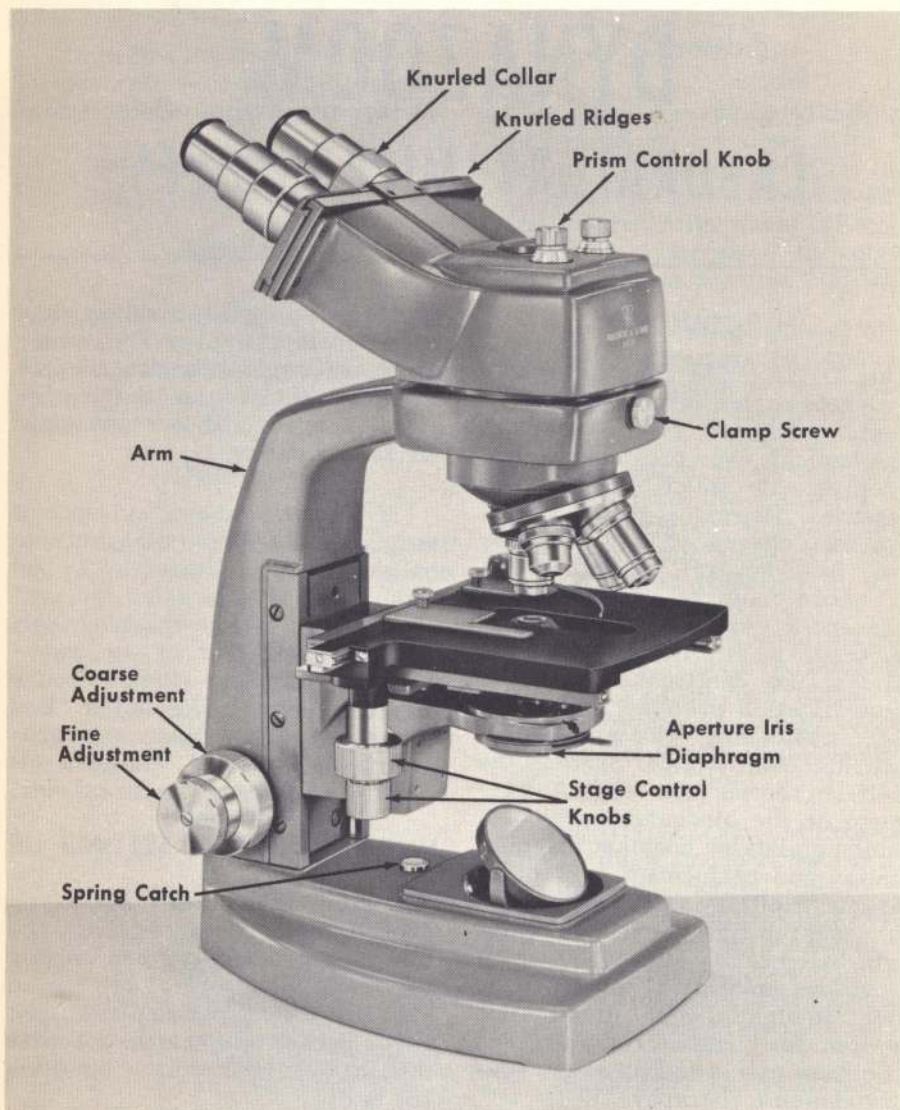


Figure 1

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DYNAZOOM

LABORATORY MICROSCOPES

INTRODUCTION

This DYNAZOOM Laboratory Microscope series introduces several design advances, both optical and mechanical, over previous microscopes, with which you may be familiar. Depending on the model you have chosen, your microscope may have several, or perhaps all of these features: Low position concentric coarse and fine adjustment with its attendant ball-bearing slides; the continuously variable magnification system, 1X through 2X, commonly known as the MICROZOOM Optical System; the self-correcting tube-length adjustment on the binocular eyepieces, which maintains constant magnification and parfocality regardless of interpupillary setting; the built-in research type mechanical stage with ball-bearing slideways and low position concentric controls; the built-in high intensity illumination system for photomicrography; and the two new attachable cameras for photomicrography.

All optics are Balcoted to reduce flare and improve contrast in the image.

RESPONSIBILITY FOR DELIVERY

Every shipment of Bausch & Lomb

products is in good condition when it leaves the factory. The transportation company, when it accepts the shipment, becomes the consignee's agent and is responsible for safe delivery.

If shipment shows evidence of rough handling, have the agent note on the receipt "Received in bad order", or if "concealed damage" is revealed after unpacking, call the representative of the transportation company within 48 hours and have him make out a "Bad order" report. Unless this procedure is followed you lose all right to recovery from the carrier.

UNPACKING AND SETTING UP

The microscope will come to you packed in a corrugated carton. The two small inner cartons contain parts and accessories. You should also find a transparent plastic dust cover packed with this manual. Use this to cover your microscope when not in use.

Grasp the microscope arm and lift out the microscope base and arm assembly. Remove the microscope body with its attached nose-piece and objectives from one of the small cartons and set it in

place in the arm (Fig. 1). The small Clamp Screw (Fig. 1) at the front of the arm is to be used to clamp the body in place for either normal (Fig. 1) or reversed (Frontispiece) usage, as you prefer.

Unpack all other loose accessories and check them against your order before discarding the carton.

GENERAL OPERATING PROCEDURE

Eyepiece

Eyepieces are wrapped separately in the carton. Select the lowest power available, for a starter, and insert into the eyepiece adapter tube (s).

Objectives

Objectives are shipped fastened in place on the revolving nosepiece. For the preliminary set-up, swing the lowest power available into operating position.

Place a specimen slide in place on the stage. Center it to the stage aperture.

Illumination

Turn on the illumination. If your microscope employs an external lamp, adjust by eye for the time being, and later follow the detailed instructions under ILLUMINATION METHODS. If it has a built-in illuminator it requires no centering. If it has an 'Optilume' (Fig. 2) it should be locked in place in the base opening by the small sliding Spring Catch (Fig. 1) near this opening.

If the illumination system you wish to use is not satisfactory at

this point please refer ahead to the sections on SUBSTAGE CONDENSERS AND ILLUMINATION METHODS for instructions on the particular combination which you have.

Focusing

Look into the eyepiece (s) and focus the stage up or down with the Coarse Adjustment (Fig. 1) until an image of the specimen is seen. The Fine Adjustment (Fig. 1) should now be used to get the sharpest focus possible.

Having located an area of interest on the specimen and focused on it sharply, you may now safely swing in a higher power objective on the nosepiece, since the objectives are parfocal. (Exceptions to this rule are the following low power objectives: 40mm, 32mm. With these one must refocus on going to higher powers.)

Also, if you desire still higher power, you may insert higher power eyepieces, or if your microscope has the zoom lens feature you may control the power by this means. See BODY TYPES.

The DYNAZOOM Microscope has a clutch action at the limit of the focusing motion. Should you accidentally focus too close so that the objective presses against the cover glass, this clutch will prevent serious damage to either the objective or the slide preparation.

SUBSTAGE CONDENSER

Aperture Iris Diaphragm

The Aperture Iris Diaphragm (Fig. 1) is the principal control at your disposal for modifying the image quality in the microscope. Opening

and closing this iris changes the angle of the cone of illumination entering the objective. This modifies contrast, resolving power, depth of focus, and brightness. Accordingly it is of fundamental importance that its proper use be clearly understood.

If the iris is closed all the way down contrast and depth of focus are generally at a maximum, but resolving power and brightness are low. As the iris is opened up gradually, contrast and depth of focus decrease, but resolving power and brightness increase. Since clarity of seeing is dependent on all of these factors, it is apparent that one should try to set the aperture iris for the best compromise possible.

It should immediately be pointed out that use of the iris to control brightness is ill-advised. Other means, such as voltage control or insertion of filters should be used instead, since we desire to use the iris to control the other 3 factors pointed out above.

Under no circumstances should the diaphragm be opened wider than is sufficient to fill the objective with light (tested by looking at the back lens after removing eyepiece), and generally it is advisable to start with only about two-thirds of the back lens filled. From this starting point, open and close the diaphragm until the best compromise is obtained between resolution and contrast.

In the examination of most microscopic preparations, the problem is to differentiate structure difficult to see, because its color or opacity differs so little from its surroundings, rather than to

observe detail at the limit of resolution of the objective. The skillful use of the aperture diaphragm will be found extremely helpful in examining such specimens by bringing out the optimum definition in the image. Often different diaphragm settings are required for different types of detail within the same preparation. Experience and attentive study are required to learn the most effective use of the diaphragm.

1.30 NA Abbe Condenser

The 1.30 NA Abbe Condenser is a universally popular form of substage condenser. It consists of two elements, a double convex lower element and a hemispherical upper element. With an extended or diffused light source, the Abbe Condenser gives good field and aperture coverage from the 10X, 0.25 NA objective to the 97X, 1.30 NA oil: immersion objective range. For lower powers, the upper element may be unscrewed and the lower element used alone. This arrangement covers a larger field than is possible with the complete condenser. Where a good deal of low power work is contemplated; however, the variable focus con-



Figure 2

denser is recommended in place of the Abbe. (See below).

To properly focus the Abbe Condenser, use the 10X objective, and focus to bring the lamp condenser approximately into focus on the specimen. Sometimes a small departure from this position results in a slight improvement in illumination, and is quite permissible, particularly where granularity of a diffusing filter, dirt, or other blemishes may be thrown out of focus by so doing.

Simplified Abbe Condenser

A Simplified 1.30 NA Abbe Condenser is available in simple sleeve mount in place of the rack and pinion focusing mount of the conventional Abbe above. A helical groove in the mount permits focusing by simply rotating the condenser.

Variable Focus Condenser

The Variable Focus Condenser is recommended for use on any microscope where objectives lower than 10X in power are used. It is a 1.30 NA system, like the Abbe Condenser, but with the lower element independently focusable. The lower element is normally focused all the way up except for low power work, in which instance it is focused downward until the illuminated field of view is just a shade larger than the microscope field of view.

Verti-Slide Condenser

The Verti-Slide Condenser is a simplified form of variable focus condenser, having a simple sliding focus in a tubular mount in place of the rack and pinion focusing. Its



Figure 2A

optical performance and operation follow the same pattern as the Variable Focus Condenser above.

The 1.40 NA Achromatic

The 1.40 NA Achromatic Condenser is recommended where superior color-free illumination is required, particularly in photomicrography. The higher NA is also a feature where apochromatic objectives are used. It is focused in the same manner as explained above for the Abbe Condenser. In low power work, maximum field coverage may be obtained by unscrewing the top (hemisphere) lens, or the top two lenses.

Other Condenser Types

Other Condenser Types such as the Paraboloid and Cardioid dark-field condensers are discussed later under ILLUMINATION METHODS and also in separate reference manuals.

The Centering Substage

The Centering Substage (Fig. 3) is available for those who wish this adjustment feature as for example in critical photomicrography, but normally, microscopes are supplied with the substage pre-centered at the factory. To use the centering substage, remove the eyepiece and replace by a pinhole eyecap. If no pinhole eyecap is available, try to hold your eye centered to the eyepiece tube by estimation. Look at the rear aperture of the objective, and close down the substage iris until it just cuts into the objective aperture. Center it by means of the two knurled headscrews. In most cases it will be found that if this operation is carried out for the lowest power objective, it will be quite acceptable for the other objectives.

BODY TYPES

Any of the following six body types are directly interchangeable on the arm so that an originally purchased simple body may subsequently be replaced by a more elegant one as more advanced work may require. On an interchanged body critical alignment is achieved by adjusting two screws at the rear of the arm ring. This requires a cross hair eyepiece and slide to center the body to the stage and condenser. A nosepiece wrench will be needed to transfer the nosepiece from one body to another. Or, interchangeable bodies may be ordered com-

plete with nosepieces. The two screws in the back of the arm behind the body may have to be adjusted for perfect alignment if a Zooming Microscope body is purchased as a separate item. All bodies are rotatable through a full 360°. Nosepieces rotate with body, leaving an unobstructed view of the stage and specimen for any body orientation. A clamp screw permits locking the body at any point in its 360° rotation.

The Straight Monocular

The Straight Monocular is the simplest form available. It is made available for work in ultraviolet or other special tasks where glass optics are not permissible or where a simple straight tube is required.

The Inclined Monocular

The Inclined Monocular gives a comfortable viewing angle for visual microscopy. It may be used either in the conventional or the reversed position, as desired. A knurled Clamp Screw, (Fig. 1), permits locking its orientation. It is of conventional optical tube length (145mm from objective shoulder to image plane) and contains a double-reflection prism which inclines the eyepiece axis at 45° without introducing mirror-image reversal.

The Zooming Inclined Monocular

The Zooming Inclined Monocular also designed for a comfortable viewing angle, contains a continuously variable magnification system within the body. This lens system permits changing continuously from a 1X to a 2X factor without changing eyepieces. With it you may select exactly the right magnification for any given speci-

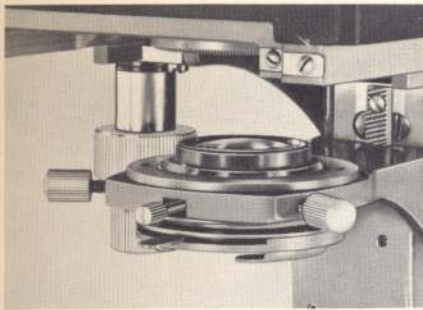


Figure 3

men. The Power Change Knob (Fig. 2A) is located at the top, and is engraved in 0.1X intervals from 1.0 to 2.0 magnification.

If, for example, you are using a 10X objective and 10X eyepiece, this zoom lens system enables you to go continuously from 100X to 200X. If the knob reads 1.5X, your total magnification with this set-up is 150X.

This lens system contains 6 lens elements in the form of 3 cemented doublets. Two of these doublets are cam driven and the third, remains fixed as you turn the power change knob. The cams cause the image to stay in constant focus.

Also within the body are two 'enhanced aluminum' first surface mirrors, arranged to incline the eyepiece axis at 60° to the vertical, without introducing mirror-image reversal. These are first surface mirrors made of accurately ground and polished glass, and coated with aluminum and a multiple-layer transparent coating to increase reflectivity and protect the aluminum. A cover glass in the eyepiece tubes seals off the body against seepage of dust and moisture, so that mirrors, cams, and lenses are protected within the sealed body.

The Photomicrographic Monocular

The Photomicrographic Monocular is designed for combined photomicrographic and visual work. It contains a beam-dividing prism which directs about 10% of the light to the 60° inclined visual eyepiece and transmits about 90% directly upward to the vertical camera tube. The body contains a 2X lens system, which lengthens the microscope sufficiently to permit keeping the observer's head well clear of the camera during use, and doubles the normal magnification achieved as a product of the eyepiece and objective.

The beam-dividing prism permits simultaneous viewing and photography, so that even live moving specimens may be photographed.

For further information on photomicrographic use of this body, refer to section on PHOTOMICROGRAPHY.

The Zooming Binocular

The Zooming Binocular Body gives one the comfortable inclined binocular viewing necessary for prolonged serious work with the microscope. The use of the Micro-Zoom Optical System has been previously described under the Zooming Monocular Body.

To set the binocular body for your interpupillary distance, grasp the straight Knurled Ridges (Fig. 1) on the eyepiece slider at the base of the eyepiece tubes, and slide the eyepieces apart to the correct distance as read on the engraved Interpupillary Scale. In the event you do not know what your interpupillary distance is,

move the eyepieces in or out until you are sure you are seeing the full field of view with both eyes. Check this by winking first one eye and then the other, without moving the head. After you have thus found your correct interpupillary setting, jot down or remember the interpupillary scale reading for future use.

Note that when you adjust the interpupillary distance, the eyepieces automatically focus in and out to compensate. This keeps tube length a constant, for optimum image quality. It furthermore holds magnification constant, so that measuring eyepieces, calibrated for one person's interpupillary distance, remain in calibration for another individual whose interpupillary distance is different. Also it maintains strict parfocality among the objectives on a multiple nosepiece.

The left eyepiece tube is individually focusable by means of the Knurled Collar (Fig. 1) so that you may get equally sharp images in both left and right sides. To set this for your eyes, it is recommended that you use the lowest power objective since the setting is most sensitive in this case. Focus the microscope with the fine adjustment, until the right image appears sharp to your right eye. Then, without further touching the fine adjustment, focus the left eyepiece until the left image appears sharpest to your left eye. The microscope is now in adjustment for your eyes.

The Zooming Triocular

The Zooming Photo Binocular Body, (Fig. 1) embodies all of the features of the binocular described above, and has in addition a movable prism giving 100% illu-

mination to either the vertical tube for photomicrography or the inclined eyepieces for visual observation. It may optionally be used with external cameras, or attachable cameras, as described under PHOTOMICROGRAPHY below. To switch over from visual to camera, simply give the Prism Control Knob (Fig. 1) a partial turn until it comes to a positive stop. This transmits all the illumination from the visual inclined eyepieces to the monocular photographic tubes.

(Frontispiece) shows the view finder eyepiece recommended for framing and focusing the picture in photomicrography. The constant tube length of the binocular eyepiece system assures parfocality between visual and photographic images when using either of the two attachable cameras described below.

STAGE TYPES

The Plain Stage

The Plain Stage (Fig. 4) is supplied with spring clips to hold the specimen slide in place. They also are useful in giving a touch of drag so that the slide may be manipulated under better control. Keep the stage free of dust and grit, so that your slides may be easily moved without scratching them.

The Glide Stage

The Glide Stage (Fig. 5) also uses spring clips to hold the specimen slide in place, but in this case the slide is manipulated by pushing the whole stage surface. The flat surface bearing, with grease layer, gives a controlled drag to the motion, so that sur-

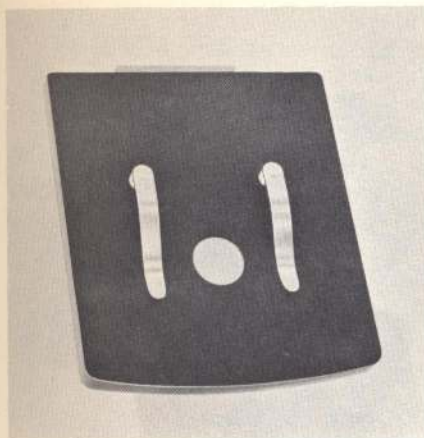


Figure 4

prising accuracy of control is attainable. The bearing surface of the Glide Stage should periodically be re-lubricated with Catalog No. 31-50-97 Grease.

The Mechanical Stage

The Mechanical Stage (Fig. 6-7) permits one to accurately hold and control the motion of the specimen slide. A spring-loaded curved metal finger is used to grip the slide and hold it firmly against the slide retainer. Thereafter the slide motion is controlled by the concentric Stage Control Knobs (Fig. 1) on the large vertical shaft. The north-south motion, controlled by the larger diameter knob, moves the entire stage surface. The east-west motion, controlled by the lower knob, moves just the specimen slide and retainer. Both motions are rack and pinion drives, working ball-bearing slides. The motion is adequate to cover a 2" x 3" specimen slide. An unobstructed stage surface for hand scanning slides with a low power objective, is available by loosening the knurled screws that hold the slide fingers. Both slide fingers are then removable.

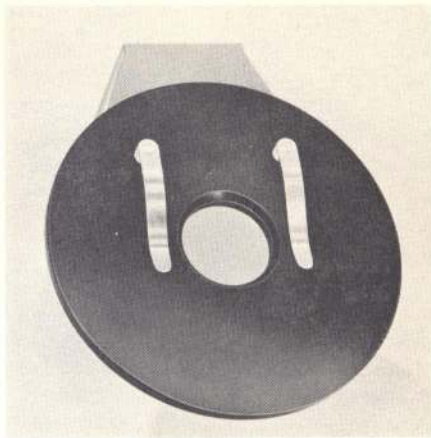


Figure 5

The stage is available in either ungraduated (Fig. 6) or graduated (Fig. 7) form. The graduations are in millimeters, with vernier scales permitting reading to an accuracy of 0.1mm. This makes possible the recording of the location of any particular area of the specimen for examination at a later time. Also length or separation measurements may be made with this device. The low position stage controls, combined with the low position concentric focusing controls, keeps the major controls conveniently grouped at a comfortable location for prolonged use.

ILLUMINATION METHODS

The Optilume

The Optilume is an inexpensive form of illuminator which may be used attached to the microscope base, as shown in Fig. 2, or placed on the work table and used in conjunction with the substage mirror. Normally it is used fastened to the base, since this gives one the advantages of a permanently aligned built-in system of illumination. Optilumes are available in models for monocular or binocular



Figure 6

observation.

To attach the Optilume to the base, first of all thread the cord through the rectangular opening, remove the Snap Plug at the rear of the base, thread the cord through the rear hole in the base, and re-insert the Snap Plug with the cord inserted in the notch. Now insert the Optilume in the rectangular opening in the base, by tilting the lens end downward and holding the Spring Catch (Fig. 1) out, insert the unit and release the Spring Catch. Pull as much cord as you need through the rear notch, and plug into a 115 volt wall outlet, Snap on the Rotary Switch (Fig. 2) and your Optilume is ready for action.

To replace a lamp in the Optilume Illuminator, remove the Optilume from the microscope base, by releasing the Spring Catch, (Fig. 1), and tipping the rear end up and out. A slot near the base permits inserting a coin to separate the base from the upper part of the Optilume. Pull the base of the Optilume off, unscrew the lamp and replace by a new one. Use

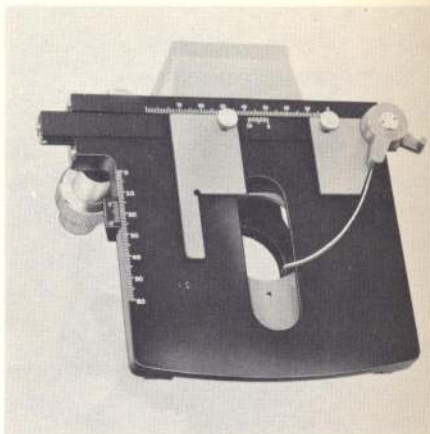


Figure 7

Catalog No. 31-31-15 (115 volts, 15 watts, mfrs. No. 15 811/102-115). Re-assemble the Optilume and re-insert in the base.

The Base Illuminator

The Base Illuminator provides high intensity Koehler illumination for photomicrography, achieved by a high speed triple lens lamp condensing system, which acts as an evenly illuminated field stop for the optical system, and images the compact coil filament into the substage iris, which acts as the aperture stop of the Koehler system.

The Base Illuminator, if purchased with your microscope, will be factory assembled in the base. The lamp and cord assembly will be packed separately. Insert the lamp and cord assembly into the hole in the rear of the base and push it all the way in until it comes to a stop.

If the Base Illuminator is purchased separately, it must be fastened to the underside of the base by the two screws provided.

Remove the lamp and cord assembly by pulling outward on the ribbed outer end. Tip the microscope up on its side, so that you can get at the underside of the base. Insert the rectangular raised section of the illuminator into the rectangular opening in the base, sliding back the Spring Catch (Fig. 1) to do this. Fasten the illuminator in place with the two screws provided. Set the microscope upright, and re-insert the lamp.

Plug the lamp cord into the transformer, and plug the transformer cord into a 115 volt AC outlet. Switch on the transformer.

For maximum bulb life, use the lowest voltage which gives you comfortable viewing, reserving the higher voltages for photomicrography. The voltage taps at the numbered dial readings, are given in the following table, along with approximate data on light output and lamp life:

| Dial Reading | Voltage | Relative Light Output | Lamp Life in Hours |
|--------------|---------|-----------------------|--------------------|
| 1 | 1 | 12 | 60,000 |
| 2 | 2.2 | 14 | 20,000 |
| 3 | 4.5 | 16.5 | 2,500 |
| 4 | 9 | 20 | 200 |
| 5 | 21 | 25 | 20 |

G.E. #1634
 (Lamp Life values are rough guides only, not guaranteed values. The lamp is rated at 20 volts, 200 hours, by the manufacturer).

To replace a lamp in the Base Illuminator, withdraw the cord and socket assembly from the rear of the base by pulling on the flanged end. Give the lamp a partial counter clockwise turn to release it from

the retaining pins. Insert a new Catalog No. 31-31-37 lamp. There is only one orientation which fits the 3 pins. Give the lamp a partial clockwise turn to lock it in place. Re-insert the unit in the microscope base.

The Mirror

The Mirror and Mount is supplied for those who prefer to use an external lamp, or for those dependent on daylight illumination. To attach the mirror and mount to the microscope base, engage the small lip on the rectangular mount into the front of the rectangular hole in the base, slide the Spring Catch (Fig. 1) backward, and snap the Mirror Mount in place.

The choice of which mirror to use — plane or concave — depends on the type of illuminator and the objective being employed. For general use of the microscope the plane mirror is recommended. However, for low power work, or work without a substage condenser, the concave mirror will be found to cover a large field.

For U. V. work and certain other critical observations, an interchangeable first surface plano mirror is available as an accessory.

External Lamps

Koehler illumination with an external illuminator requires the use of the plane mirror. In this system, the light source is to be imaged in the substage condenser iris, and the lamp condenser is then to be imaged in the field of view by properly focusing the substage condenser. For optimum field coverage, set up the illuminator at the distance recommended by the manufacturer. If no illuminator manual is available, a distance of

about 8 inches from lamp condenser lens to mirror is suggested as a starter. Focus the substage condenser until the lamp condenser (or field diaphragm adjacent to this condenser) is in focus on the specimen. Some adjustment of the light source or lamp condenser may then be necessary to achieve best uniformity of field illumination. Refer to separate Reference Manual on the illuminator being used.

Filters

Colored filters are useful in controlling the contrast in an image, where various contrasting colors are present in the specimen. If, for example, a specimen has faint red and blue areas, a filter peaked in the red will make the blue areas dark and the red areas light. Conversely a blue filter will reverse this contrast pattern. A set of 2" square "interference filters" is available, (Catalog No. 42-27-55-01), for this use in microscopy. These give relatively narrow pass bands and are more resistant to light and heat than the traditional gelatin filters.

To reduce light intensity, neutral density filters are available. These come in various densities and sizes. The 3" diameter set, Catalog No. 31-34-66-01, contains 3 neutral filters and a daylight blue filter. The 2" square set, Catalog No. 31-34-38-01 contains 4 neutral filters and a daylight blue filter. The built-in Base Illuminator (Frontispiece) has an opening for 2" round filters, either neutral or daylight blue. The set of 2" round filters, Catalog No. 31-34-11-04 comprising 3 neutral filters and a daylight blue filter is supplied as standard equipment for this illuminator.

A ground glass filter is a simple

expedient for reducing light level in a microscope. It should be located far enough from a field plane that no graininess is apparent in the field of view.

The Panfocal Illuminator

The Panfocal Illuminator is a complete built-in illuminator which fastens into the substage adapter ring. It is a 1.40 NA variable focus achromatic design, with built-in field and aperture controls, selective filters, polarized light, and low power darkfield. The unit is inserted into the substage adapter ring, and located in place with a knurled ring fastened from above. A separate Reference Manual covers the details of operation of this illuminator.

Darkfield

Darkfield Illumination is achieved with either the 31-58-50 Paraboloid Condenser, or the 31-58-60 Cardioid Condenser. Separate Reference Manuals cover details of operation of these condensers, when using external light sources. The Base Illuminator, (Frontispiece) provides ample intensity for darkfield use with either the Paraboloid or Cardioid Condenser, and has the advantage of being a built-in, permanently aligned unit.

Polarized Light

Polarized Light for examination of crystals, fibers, minerals, etc., is available by the use of the 31-57-15 Disc Polarizer which slips into the accessory slot ring beneath the substage iris, and the 31-57-36 Body Tube Analyzer, which is inserted into the nose-piece. To insert this analyzer, unscrew one of the objectives, and slide the analyzer into the nose-

piece from below until it comes to a stop. Then re-insert the objective. The Polarizer may then be oriented as desired.

Phase Contrast

Phase Contrast illumination is available through the use of the 31-58-78-01 Turret Type Phase Contrast Accessories or the 31-58-78-01 Long Working Distance Phase Contrast Accessories. The phase contrast condensers for these units mount in the regular condenser adapter ring. Separate Reference Manuals are supplied in each case to cover the detailed operation of these phase contrast accessories.

OPTICS OF THE MICROSCOPE

The Zooming System

The MICROZOOM Optical System is an innovation of this DYNA-ZOOM Laboratory series of microscopes. It has been previously described under The Zooming Inclined Monocular section. While the 10X Huygenian Eyepiece is supplied as standard equipment a new 5X Huygens type of eyepiece, Catalog No. 31-05-03, has been designed to be used with this system. This 10X eyepiece, combined with the 1X-2X MicroZoom feature, will serve the purpose of several individual eyepieces. The 31-15-14 10X Hi-Point Eyepiece can be used by those wearing eyeglasses. The conventional 5X Huygens eyepiece (Catalog No. 31-05-02) is recommended for fixed power bodies. The new 31-05-03 5X Hi-Point eyepiece is designed for use with the MicroZoom Optical System.

For most work, the zoom system will be found to supersede the custom of changing eyepieces to

change the magnification. Furthermore, it may be used to extend the magnification range of eyepieces beyond what is otherwise available. In general, however, it should be used as a means to get just the right magnification for optimum visibility in the image.

Objective Types

Objective Types. There are three basic types of objectives available for your microscope: Achromats, fluorites, and apochromats. The achromats are the most widely used, and least complex. The apochromats are the most complex and give the finest imagery. The fluorites are a compromise form between these extremes, and are sometimes called 'Semi-apochromats'.

The objective is by far the most important lens in your microscope. It sets the limit on resolution and the useful limit on magnification. Treat your objectives with the care due a fine lens system. Be very careful not to fingerprint the front lens when you are changing objectives on a multiple nosepiece. Avoid focusing against the microscope specimen cover glass, as you may grind the front lens against bits of dust or grit. The DYNAZOOM Laboratory Microscope has a safety clutch on the coarse and fine adjustments to prevent excessive force between objective and cover glass, but the experienced microscopist will rarely depend on this, because of the possible damage from dust and grit.

Eyepiece Types

Eyepiece Types. Several eyepiece types are available for use with the different types of objectives. The main reason for using

different eyepiece tubes is that objectives vary somewhat in their correction for off-axis color, and the eyepieces compensate this color in varying degrees. Wide-field eyepieces are available for those desiring larger fields of

view.

Table of Recommended Optical Combinations. The following table is a guide to the recommended combinations to use for very best off-axis color corrections:

Table of Recommended Combinations

| <u>Objective</u> | | <u>Eyepiece Tube</u> | |
|------------------------|------------|----------------------|----------|
| 2.6X, 40mm, 0.08 NA. | Achromat | Huygens* | |
| 3.5X, 30mm, 0.09 NA. | | | |
| 4X, 32mm, 0.10 NA. | | | |
| 6X, 22.7mm, 0.17 NA. | | | |
| 10X, 16mm, 0.25 NA. | | | |
| 21X, 8mm, 0.50 NA. | | | |
| 43X, 4mm, 0.65 NA. | | | |
| 97X, 1.8mm, 1.25 NA. | | | |
| 40X, 4.3mm, 1.00 NA. | | | Fluorite |
| 98X, 1.8mm, 1.30 NA. | | | |
| 10X, 16mm, 0.30 NA. | Apochromat | Hyperplane | |
| 20X, 8.3mm, 0.65 NA. | | | |
| 47.5X, 4.0mm, 0.95 NA. | | | |
| 61X, 3.0mm, 1.40 NA. | | | |
| 90X, 2.0mm, 1.30 NA. | | | |
| 90X, 2.0mm, 1.40 NA. | | | |
| | | Compensating | |

* The 5X Hi-Point Eyepieces are also Huygens type eyepieces but are used only with MicroZoom Optical Systems.

High Eyepoint Eyepieces

For those who wear glasses, special high eyepoint eyepieces are available besides the 31-05-03 5X Hi-Point for Variable Power. These are given the tradename 'Hi-Point'. The 10X Hi-Point, Catalog No. 31-15-14, is a cemented triple form which gives color correction substantially like a Huygens, and is accordingly recommended wherever the Huygens type is recommended in the table above. There are two versions of 5X Hi-Point eyepieces available, both being of a Huygens construction. One of these, Catalog No.

31-05-03, performs best with the zoom system bodies, and is engraved '5X for Variable Power'. The other, Catalog No. 31-05-02 performs best with fixed power bodies, and is engraved '5X'.

For further information on objectives and eyepieces, the reader is referred to the 'Theory of the Microscope' booklet which accompanies this microscope.

The Cover Glass

The Cover Glass, which is normally placed over the specimen, might appear to be a rather insignificant

nificant item and little consideration given to it in the preparation of the specimen slide. This, however, is far from true, as the cover glass, especially when dealing with high power dry objectives, becomes an integral part of the optical system. All laboratory microscope objectives have been designed to be used with 0.18mm thick plane, parallel cover glass, made of crown glass having a refractive index $n_d = 1.523$. A variation of only a very few hundredths of a millimeter in thickness from the nominal 0.18mm is sufficient to cause a marked deterioration of image contrast when using say, the 43X, 0.65 NA objective. Objectives of 0.85 or 0.95 NA are even more sensitive to variations in cover glass thickness; indeed, because of this extreme sensitivity, the 0.95 NA apochromatic objective is adjustable to compensate for cover glass variations.

Low power objectives having NA's of 0.25 or less are quite insensitive to cover glass thickness. Oil immersion objectives are also insensitive, because the oil and glass are almost homogeneous in refractive index.



Figure 8

Magnifications and Real Fields

Magnification and Real Fields. The following tables give total magnifications and real fields for various combinations. If your microscope has a zoom system, multiply the magnification in the following table by the zoom system factor. The field size may be computed by dividing the field size shown in the table, by the zoom magnification.

PHOTOMICROGRAPHY

Photomicrography with a microscope equipped with the built-in Base Illuminator (Fig. 8) and either of the two attachable cameras is a comparatively simple procedure. External cameras, such as the 5x7 Model L Camera, the $3\frac{1}{4} \times 4\frac{1}{4}$ type K Camera, and the $2\frac{1}{4} \times 3\frac{1}{4}$ and 35mm Model N Camera, are fully covered in separate Reference Manuals, and will not be covered in detail here.

Figs. 9 and 10 show the two attachable cameras, the Polaroid and the 35mm, in place on the microscope. To attach either of these cameras to the PhotoBinocular Body, or monocular photomicrographic body, unscrew the straight vertical tube and screw in the Camera Adapter Sleeve in its place. Set the camera into this sleeve, orient in any direction you prefer, and lock in place with the lock screws provided.

The 35mm Camera

The 35mm Camera is loaded and operated just as you would a conventional camera. It has its own built-in 3X field flattening lens system, and requires no eyepiece. Total magnification at the film plane is a product of the objective

magnification multiplied by the built-in 3X field flattening lens system. The camera may be removed, for convenience in loading, by loosening the two Clamp Screws (Fig. 10) sufficiently to permit lifting off the back. Press down on the Spring Catch (Fig. 5) and slide the Back Release in the direction away from the winding spool.

Lift off the camera back, noting that it has a wide flange on the Film Rewind end (Fig. 10) which acts as a hinge in pivoting the back upward and off.

Remove a loaded film spool

from its container. Pull out the Film Rewind (Fig. 10) and drop the loaded spool into the opening next to the Film Rewind, with the long end of the reel away from the Film Rewind. Release the Film Rewind, permitting it to engage in the film spool.

Pull 2 or 3 inches of film across the back, inserting the end in the slot of the winding spool, and engaging the pin on the winding spool into one of the film perforations. Turn the Film Wind (Fig. 10) one turn to be sure the film is bound on the spool, and make certain the sprocket wheel teeth are

MAGNIFICATIONS AND REAL FIELDS

ACHROMATIC AND FLUORITE OBJECTIVES—HUYGENIAN EYEPIECES

Microscope Tube Length 160mm Image Distance 250mm Real Fields in mm

| OBJECTIVES | | EYEPIECES | | | | | | |
|-------------------------------------|-------------------------|---------------|---------------|---------------|---------------|-------------------------------------|----------------|----------------|
| Equivalent Focus Numerical Aperture | Objective Magnification | 5× | 6.4× | 7.5× | 10× | Micrometer Value* with 10× Eyepiece | 12.5× | 15× |
| 48mm 0.08 N.A. Achro. | 2× | 10× 10.2 | 12.8× 9.6 | 15× 9.2 | 20× 7.8 | 0.076mm | 25× 6.9 | 30× 5.65 |
| 40mm 0.08 N.A. Achro. | 2.6× | 13× 8.0 | 16.6× 7.25 | 19.5× 7.1 | 26× 5.9 | 0.058mm | 32.5× 5.25 | 39× 4.25 |
| 30mm 0.09 N.A. Achro. | 3.5× | 17.5× 5.9 | 22× 5.4 | 26× 5.2 | 35× 4.3 | 0.044mm | 44× 3.9 | 52× 3.4 |
| 32mm 0.10 N.A. Achro. | 4× | 20× 5.25 | 25.6× 4.80 | 30× 4.63 | 40× 3.87 | 0.038mm | 50× 3.43 | 60× 2.82 |
| 22.7mm 0.17 N.A. Achro. | 6× | 30× 3.48 | 38.4× 3.20 | 45× 3.08 | 60× 2.56 | 0.024mm | 75× 2.26 | 90× 1.87 |
| 16mm 0.25 N.A. Achro. | 10× | 50× 2.05 | 64× 1.90 | 75× 1.80 | 100× 1.50 | 0.0149mm | 125× 1.33 | 150× 1.10 |
| 8mm 0.50 N.A. Achro. | 21× | 105× 1.01 | 134× 0.93 | 157× 0.89 | 210× 0.74 | 0.0072mm | 262× 0.65 | 315× 0.55 |
| 4.3mm 1.30 N.A. Fluorite | 40× | 200× 0.51 | 256× 0.47 | 300× 0.45 | 400× 0.37 | 0.0037mm | 500× 0.33 | 600× 0.27 |
| 4mm 0.65 N.A. Achro. | 43× | 215× 0.48 | 275× 0.44 | 322× 0.42 | 430× 0.35 | 0.0034mm | 537× 0.31 | 645× 0.26 |
| 4mm 0.85 N.A. Achro. | 45× | 225× 0.47 | 288× 0.43 | 337× 0.41 | 450× 0.35 | 0.0034mm | 562× 0.31 | 675× 0.26 |
| 3mm 0.85 N.A. Achro. | 60× | 300× 0.35 | 384× 0.32 | 450× 0.30 | 600× 0.25 | 0.0025mm | 750× 0.225 | 900× 0.185 |
| 1.8mm 1.30 N.A. Achro. | 97× | 485× 0.205 | 620× 0.19 | 727× 0.18 | 970× 0.15 | 0.0015mm | 1212× 0.135 | 1455× 0.11 |
| 1.8mm 1.30 N.A. Fluorite | 98× | 490× 0.21 | 627× 0.195 | 735× 0.185 | 980× 0.155 | 0.0015mm | 1225× 0.14 | 1470× 0.115 |

* Value in plane of specimen corresponding to 0.1mm in plane of eyepiece diaphragm.

engaged in the film performances. If the Film Wind should lock, press the Rewind Catch (Fig. 5) sideward until it clicks, which will free the Film Wind for turning one full frame.

Replace the camera back, engaging the wide flange in the wide slot and pivoting the back closed. Holding the back closed, slide the Back Release toward the Film Wind until the Spring Catch snaps into position.

Close the Dark Slide (Fig. 10). Press the Rewind Catch sideward until it clicks. Turn the Film Wind

until it clicks. This brings the first unexposed picture area into place.

Set the Film Counter (Fig. 10) to read either 20 or 36, depending on the number of exposures on the film roll used.

Re-instate the camera on the microscope, locking in place with the two Clamp Screws (Fig. 10).

Insert the Viewfinder Eyepiece into the visual tube of the Photographic Monocular or the right tube of the Photo Binocular Model. (The left side is focusable, hence is not strictly parfocal with the

MAGNIFICATIONS AND REAL FIELDS

ACHROMATIC AND FLUORITE OBJECTIVES—HYPERPLANE EYEPIECES

Microscope Tube Length 160mm Image Distance 250mm Real Fields in mm

| OBJECTIVES | | EYEPIECES | | | | | | |
|-------------------------------------|-------------------------|---------------|---------------|---------------|-------------------------------------|----------------|---------------|----------------|
| Equivalent Focus Numerical Aperture | Objective Magnification | 5× | 7.5× | 10× | Micrometer Value* with 10× Eyepiece | 12.5× | 15× | 20× |
| 16mm 0.25 N.A. Achro. | 10× | 50× 2.05 | 75× 1.90 | 100× 1.60 | 0.0127mm | 125× 1.33 | 150× 1.20 | 200× 0.85 |
| 8mm 0.50 N.A. Achro. | 21× | 105× 1.00 | 157× 0.93 | 210× 0.79 | 0.0063mm | 262× 0.65 | 315× 0.60 | 420× 0.43 |
| 4.3mm 1.00 N.A. Fluorite | 40× | 200× 0.50 | 300× 0.47 | 400× 0.40 | 0.0032mm | 500× 0.33 | 600× 0.29 | 800× 0.21 |
| 4mm 0.55 N.A. Achro. | 43× | 215× 0.47 | 322× 0.44 | 430× 0.38 | 0.0030mm | 537× 0.31 | 645× 0.28 | 860× 0.20 |
| 4mm 0.85 N.A. Achro. | 45× | 225× 0.47 | 337× 0.44 | 450× 0.38 | 0.0030mm | 562× 0.31 | 675× 0.28 | 900× 0.20 |
| 3mm 0.85 N.A. Achro. | 60× | 300× 0.35 | 450× 0.32 | 600× 0.27 | 0.0022mm | 750× 0.23 | 900× 0.20 | 1200× 0.145 |
| 1.8mm 1.30 N.A. Achro. | 97× | 485× 0.205 | 727× 0.19 | 970× 0.16 | 0.0013mm | 1212× 0.13 | 1485× 0.12 | 1940× 0.09 |
| 1.8mm 1.30 N.A. Fluorite | 98× | 490× 0.21 | 735× 0.195 | 980× 0.165 | 0.0013mm | 1225× 0.135 | 1470× 0.12 | 1960× 0.09 |

APOCHROMATIC OBJECTIVES—COMPENSATING EYEPIECES

| OBJECTIVES | | EYEPIECES | | | | | | |
|-------------------------------------|-------------------------|---------------|---------------|--------------|-------------------------------------|----------------|----------------|----------------|
| Equivalent Focus Numerical Aperture | Objective Magnification | 5× | 7.5× | 10× | Micrometer Value* with 10× Eyepiece | 12.5× | 15× | 20× |
| 16mm 0.30 N.A. | 10× | 50× 2.13 | 75× 1.80 | 100× 1.50 | 0.0132mm | 125× 1.33 | 150× 1.15 | 250× 0.85 |
| 8.3mm 0.65 N.A. | 20× | 100× 1.08 | 150× 0.91 | 200× 0.76 | 0.0067mm | 250× 0.68 | 300× 0.59 | 500× 0.33 |
| 4mm 0.95 N.A. | 47.5× | 237× 0.44 | 356× 0.37 | 475× 0.31 | 0.00275mm | 594× 0.275 | 712× 0.235 | 1187× 0.135 |
| 3mm 1.40 N.A. | 61× | 305× 0.355 | 457× 0.295 | 610× 0.25 | 0.0022mm | 762× 0.22 | 918× 0.19 | 1528× 0.108 |
| 2mm 1.30 N.A. | 90× | 450× 0.23 | 675× 0.195 | 900× 0.16 | 0.00142mm | 1125× 0.145 | 1350× 0.125 | 2250× 0.070 |
| 2mm 1.40 N.A. | 90× | 450× 0.23 | 675× 0.195 | 900× 0.16 | 0.00142mm | 1125× 0.145 | 1350× 0.125 | 2250× 0.070 |

*Value in plane of specimen corresponding to 0.1mm in plane of eyepiece diaphragm.



Figure 9

camera). Focus the eyelens in the Viewfinder Eyepiece until the crossline is sharply in focus. Select the area you wish to photograph and locate it within the larger of the two frames, the one labeled "35mm." Now focus the specimen to bring it into sharp focus on the crossline. Both specimen and crossline must be sharply in focus simultaneously to assure sharp focus in the camera.

Check that the shutter is closed and pull out the Dark Slide (Fig. 10).

Set the exposure control for the time of exposure required and press the Shutter Cable Release to take the picture. The following table gives a rough exposure guide for use with the Base Illuminator, set at voltage tap 4, (20 volts):

| Objective | Illuminated NA | Exposure Time for Film Speed ASA 20 Using 1.3 Density Filter |
|--------------|----------------|--|
| 3.5X, 0.09NA | 0.09 NA | 1/100 sec. |
| 10X 0.25NA | 0.20 NA | 1/100 sec. |
| 43X 0.65NA | 0.50 NA | 1/60 sec. |
| 97X 1.25NA | 0.90 NA | 1/50 sec. |



Figure 10

(These rough values were established on the Photo Binocular Microscope, with zoom system set at 1X. Exposure time will be increased by the square of the zoom magnification. For the Photomicrographic monocular, with body tube factor of 2X, exposures will be roughly 6 times the above values).

Press the Rewind Catch side-wards until it clicks, and wind the Film Wind until it comes to a positive stop. You are now ready for another exposure.

After completing the roll of film, the film is to be rewound before removal for processing. To do this, hold the Rewind Catch (Fig. 10) against its spring action and rewind by the Film Rewind

(Fig. 10). You will note that the Film Wind also turns. Rewind until the Film Wind stops turning, then give a couple of extra turns to bring all the film into the spool,

Remove the camera back and pull out on the Film Rewind, releasing the spool of film. Store it in its container until ready to process.

The Polaroid Land Camera

The Polaroid Land Camera,* shown in Fig. 9, enables you to take pictures and have them complete and ready for viewing as finished prints in about one minute of time. Total magnification at the film plane is a product of the objective magnification multiplied by the built-in 10X field-flattening lens system of the camera.

The Polaroid Corporation Manual F10408L accompanies each Polaroid Photomicrographic unit shipped by Bausch & Lomb. Refer to pages 1, 2, 3, 5 and 6, for instructions on loading and processing.

For an exposure guide, the following approximate values are suggested. These were established on the Photo Binocular Model with zoom system set at 1X, using the

built-in Base Illuminator (Fig. 8) operating at the nominal 20 volts (dial setting No. 4), and with a 1.3 density filter in the illuminator.

These rough exposure figures were established using Polaroid Land Film Type 32, which has an ASA Exposure Index (equivalent) 400 daylight. With the Type 37 3000 Speed Land Film, exposures will be approximately 1/8 the above values. Such high speed film may be found useful in special applications, such as high power darkfield work, or photomicrography of moving objects.

External Cameras

External Cameras, such as the Model L Camera, Catalog No. 42-14-42-01, and the Model K Camera, Catalog No. 42-14-44-11 have separate Reference Manuals, and will not be covered in detail here.

In coupling an External Camera to the vertical camera eyepiece tube of either the Triocular or Photomicrographic Monocular, the microscope must be centered to the camera, and a light-tight coupling must be made. The light-tight coupling, supplied with the camera, facilitates lining up the microscope and camera to a common center.

| Objective | Illuminated NA | Exposure Time For Type 32 Land Film |
|--------------|----------------|-------------------------------------|
| 3.5X, 0.09NA | 0.09 NA | 1/25 sec. |
| 10X 0.25NA | 0.20 NA | 1/25 sec. |
| 43X 0.65NA | 0.50 NA | 1/10 sec. |
| 97X 1.25NA | 0.90 NA | 1/10 sec. |

* Polaroid is a registered trade mark of the Polaroid Corp.

CARE OF THE MICROSCOPE

Cleaning of Optics

The experienced microscopist keeps the optics of his microscope clean and free from fingerprints and dust. A transparent dust cover is provided with the microscope and should be used whenever the microscope is not being used. Avoid fingerprinting the exposed lens surfaces of eyepieces and objectives. Keep eyepieces in the microscope at all times to keep dust from seeping in.

Despite all such normal precautions, optics do become dirty. Dust generally does little damage to image contrast, unless it becomes excessive. A fingerprint or smear, on the other hand, will degrade an image badly, giving a milky washed-out appearance. To remove dust, try to blow it off with a syringe, or dust it off with a camel hair brush. Avoid hard wiping, as dust is often hard and abrasive.

To remove fingerprints, wipe lightly with a clean soft cloth or absorbent cotton, moistened with soap and water, alcohol, or xylol. A small amount of absorbent cotton wound on the end of a tapered stick, makes a handy cleaning tool for recessed optical surfaces. Avoid excessive use of solvents as this may cause run-ins in cemented optics, or the flowing solvent may pick up grease from the mounts, making cleaning a tedious job.

Mechanical Maintenance

Keep the transparent dust cover on the microscope whenever the 'scope is not being used. If the microscope is not to be used for some time, keep it in storage case.

Should the microscope become

dirty, it may be cleaned with a soft cloth moistened in xylol. Avoid excessive solvent running into bearings.

Lubrication of the microscope is rarely required, due to the use of ball-bearings and nylon bushing bearings in all critical points. The coarse and fine adjustment mechanism is completely enclosed and uses self-lubricated ball-bearings for both thrust bearings and slide bearings. The zooming system cams are enclosed and self-lubricated. The same is true of the movable prism in the tri-ocular.

Mechanical stages use ball-bearing slides, which require no lubrication. The racks and pinions should be kept clean, but should not be lubricated. Use a small stiff brush, such as a toothbrush to clean the racks.

The above applies also to the rack and pinion of the substage focusing mechanism. The slide bearings of the substage are oil-impregnated. Should they become sticky, a few drops of light machine oil wiped on the bearing is recommended.

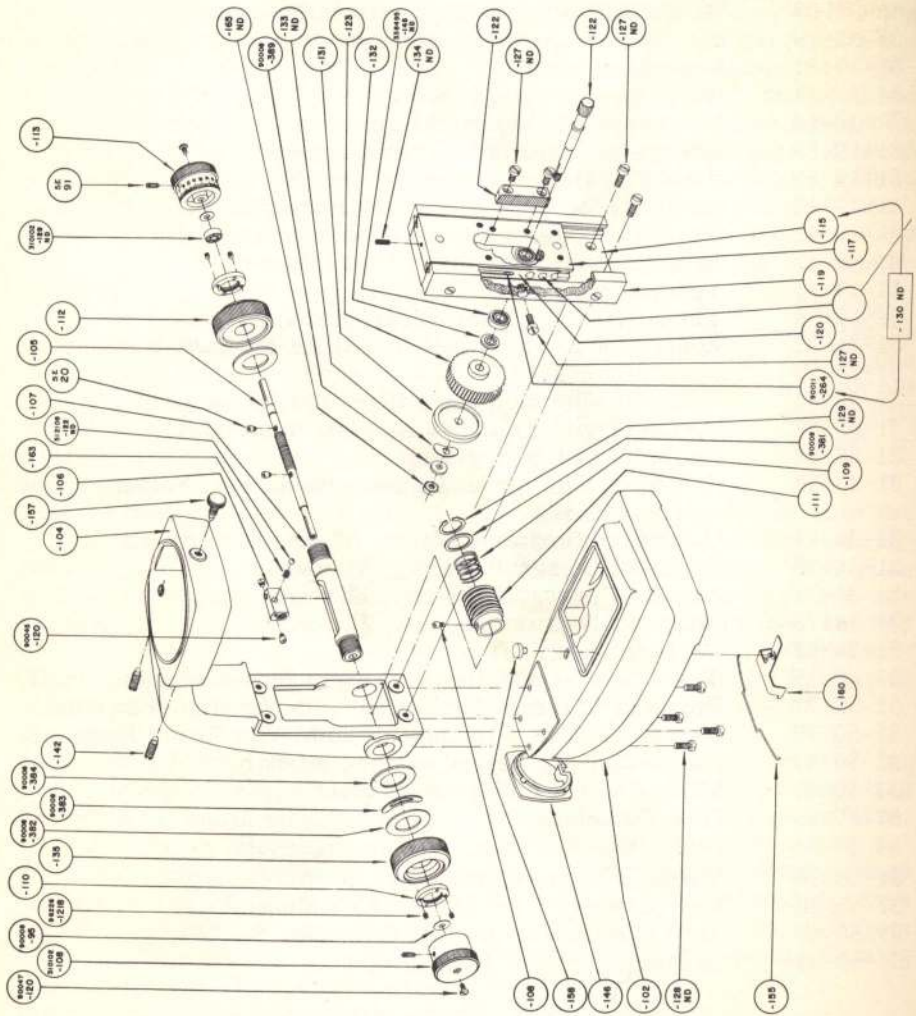
The Glide Stages depend for their action on a controlled drag in the greased bearing surfaces. This grease layer should be replaced if the stage motion becomes too stiff. The recommended grease is available in a 4 oz. jar from Bausch & Lomb. Specify Catalog No. 31-50-97.

Professional cleaning and check-up on lubrication every few years is recommended for your microscope. Bausch & Lomb dealers usually maintain complete repair and service facilities. In addition, the Factory at Rochester, N.Y. has a fully staffed repair department.

ACCESSORIES AND REPLACEMENTS

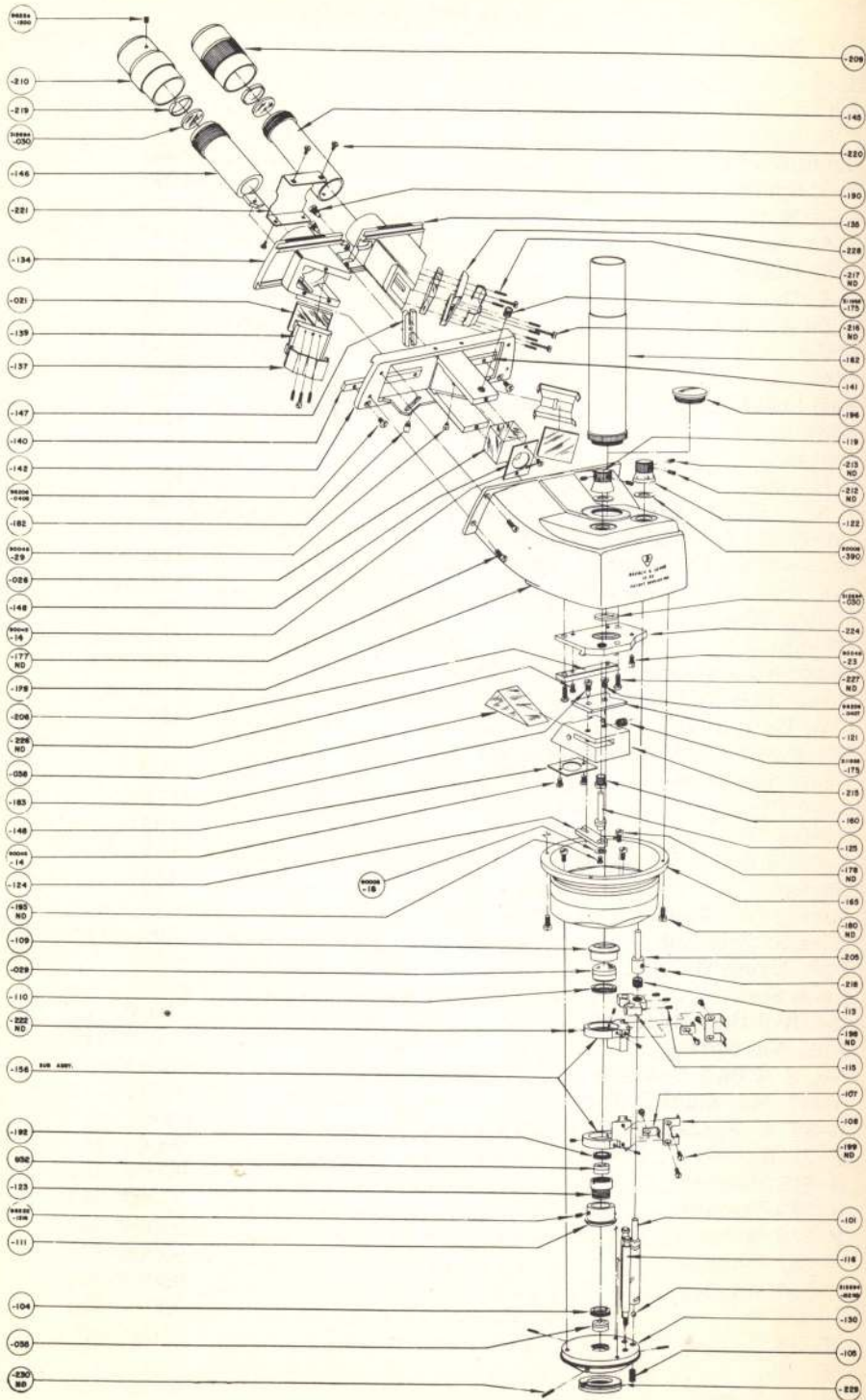
| | |
|----------|---|
| 31-05-02 | Hi-Point Eyepiece, 5X for Variable Power. |
| 31-05-03 | Hi-Point Eyepiece, 5X for Fixed Power. |
| 31-05-18 | Eyepiece, Viewfinder. |
| 31-19-01 | Nosepiece, single |
| 31-19-17 | Nosepiece, double, revolving. |
| 31-18-18 | Nosepiece, triple, revolving. |
| 31-19-19 | Nosepiece, quadruple, revolving. |
| 31-19-39 | Binocular Body, Microzoom 1X-2X. |
| 31-19-40 | Inclined Monocular Body, Microzoom 1X-2X. |
| 31-19-41 | Inclined Photomicrographic Monocular Body. |
| 31-19-42 | Inclined Monocular Body, Fixed Power. |
| 31-19-43 | Vertical Monocular Tube. |
| 31-19-59 | Triocular Body, Microzoom 1X-2X. |
| 31-31-37 | Replacement Bulb, 20V for 31-33-59 Base Illuminator. |
| 31-33-59 | Base Illuminator. |
| 31-33-86 | Optilume with blue glass filter (for Monocular). |
| 31-33-87 | Optilume with daylight filter (for Monocular). |
| 31-33-88 | Optilume with blue glass. |
| 31-33-89 | Optilume with ground glass, condenser, reflector (for Binocular). |
| 31-34-11 | Cardboard Box for 6 filters, 2" square or round. |
| 31-34-73 | Neutral Filter, 0.7 density, 2" round. |
| 31-34-74 | Neutral Filter, 1.0 density, 2" round. |
| 31-34-75 | Neutral Filter, 1.3 density, 2" round. |
| 31-34-88 | Daylight Filter, 2" round. |
| 31-40-15 | Two-Tone leatherette carrying case with lock and handle. |
| 31-50-77 | Polaroid Camera Attachment with Viewfinder Eyepiece. |
| 31-50-79 | 35mm Camera Attachment with Viewfinder Eyepiece. |
| 31-50-89 | Plano-Concave second surface mirror. |
| 31-50-90 | Mirror Mount for 31-50-89 Mirror. |
| 31-57-15 | Disc Polarizer. |
| 31-57-36 | Body Tube Analyzer. |
| 31-58-16 | Variable Focus Condenser 1,30 NA. |
| 31-58-30 | Iris Diaphragm for 31-58-16 Condenser |
| 31-58-49 | Abbe Condenser 1,30 NA, divisible. |
| 31-50-97 | Grease, 4 oz., for Glide Stage. |

(For other Accessories and Attachments, write to Factory for literature).



31-01-05 Base and Arm

| Part Name | Part Number |
|--|---------------|
| Base | -102 |
| Arm | -104 |
| F.A. Nut Housing | -107 |
| Drive Screw | -108 |
| F.A. Spring | -109 |
| Lock Nut | -110 |
| F.A. Worm | -111 |
| C.A. Button "A" | -112 |
| F.A. Drum A | -113 |
| Slide Adapter | -115 |
| Slide | -117 |
| Gib | -119 |
| Ball Spacer | -120 |
| Rack | -121 |
| Pinion | -122 |
| F.A. Gear | -123 |
| F.A. Screw & Nut Assy. | -124 |
| No. 8-32Tx,375 Mach. Screw | -127 ND |
| No. 8-32Tx,437 Mach. Screw | -128 ND |
| No. 5103-62 Tru-Arc Retainer | -129 ND |
| Clutch Wheel | -131 |
| Washer | -132 |
| Shakeproof Washer No. 3502-16-07 | -133 ND |
| No. 8-32Tx,375 Set Screw | -134 ND |
| C.A. Button "B" | -135 |
| No. 8-32Tx,375 Steel Mach. Screw | -137 ND |
| Centering Screw | -142 |
| Base Plug | -146 |
| Spring "B" | -155 |
| Lock Screw & Tip Assy. | -157 |
| Button C | -158 |
| Spring "A" Assy. | -160 |
| Elastic Stop Nut | -165 ND |
| F.A. Drum B | -167 |
| Knob Screw | -169 |
| No. R-3 Ball Bearing | 310102-129 ND |
| F.A. Nut Spring | 310102-136 |
| No. R-4 Ball Bearing | 338495-145 ND |
| .0937 Dia. Steel Ball | 512108-122 ND |
| F-39 A Washer | 90008-95 |
| F-21 Washer | 90008-269 |
| F-312 Washer | 90008-381 |
| F-252 Washer | 90008-382 |
| F-313 Washer | 90008-383 |
| F-252 Washer | 90008-384 |
| F-157 Washer | 90008-389 |
| I -253 Pin | 90011-264 |
| SB-15 | 90045-20 |
| SB-20 | 90045-25 |
| SD-62 Screw | 90047-120 |
| 2-64 U 4S Screw | 96226-1218 |

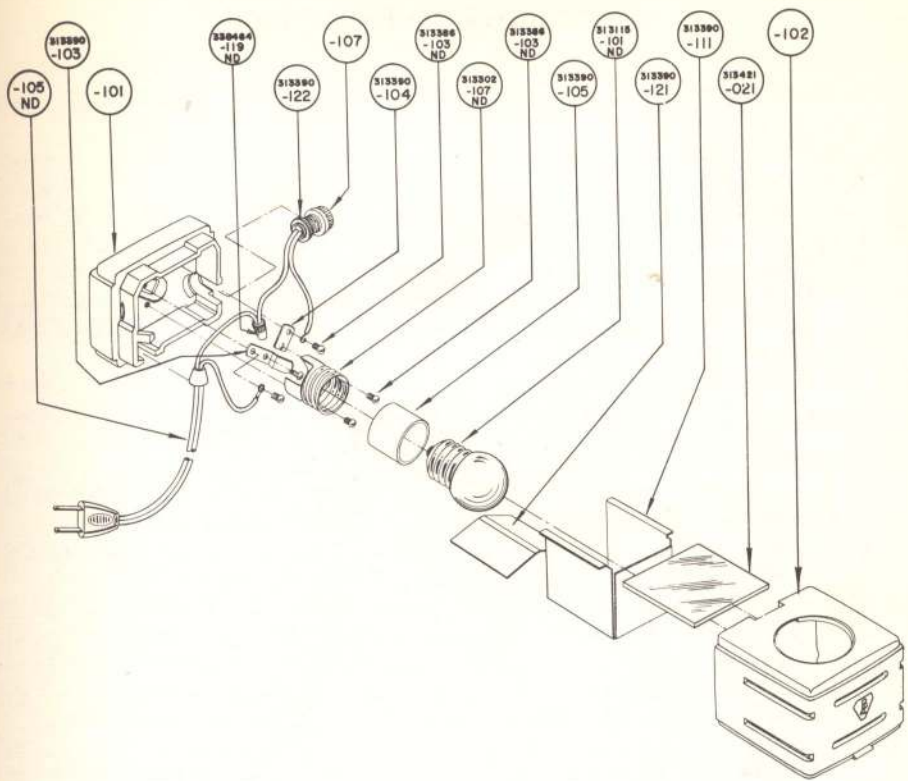


31-19-59 Triocular Body

| Part Name | Part Number |
|--------------------------------------|-------------|
| Mirror "A" | -021 |
| Mirror "B" | -022 |
| Prism "BC" Assy. | -026 |
| Lens "AB" Assy. | -029 |
| Lens "CD" Assy. | -032 |
| Lens "EF" Assy. | -035 |
| Prism "A" | -038 |
| Lead Screw | -101 |
| E.F. Retainer | -104 |
| Adjusting Screw | -105 |
| Spring "A" | -107 |
| Spring "B" | -108 |
| "AB" Lens Mount | -109 |
| "AB" Retainer | -110 |
| "CD" Lens Mount | -111 |
| Bushing | -113 |
| Tie Block | -115 |
| Post | -116 |
| Prism Shift Knob | -119 |
| Prism Slide | -121 |
| Magnification Knob | -122 |
| "CD" Lens Cell | -123 |
| Prism Link | -124 |
| Link Shaft | -125 |
| Housing | -128 |
| Nosepiece Support | -130 |
| E.P. Slide (Right) | -134 |
| E.P. Slide (Left) | -135 |
| Mirror Clip "A" | -136 |
| Mirror Clip "B" | -137 |
| Mirror Mount Right | -139 |
| Right Gib | -140 |
| Left Gib | -141 |
| Top Plate Assy. | -142 |
| E.P. Tube (Left) | -145 |
| E.P. Tube (Right) | -146 |
| Link | -147 |
| Prism Plate | -148 |
| Lens Slide Assy. | -156 |
| Shaft Bearing | -160 |
| Triocular Tube | -162 |
| Lower Housing | -165 |
| No. 4-40Tx,187 Mach. Screw | -177 ND |
| No. 4-40Tx,312 Mach. Screw | -178 ND |
| No. 6-32Tx,281 Mach. Screw | -180 ND |

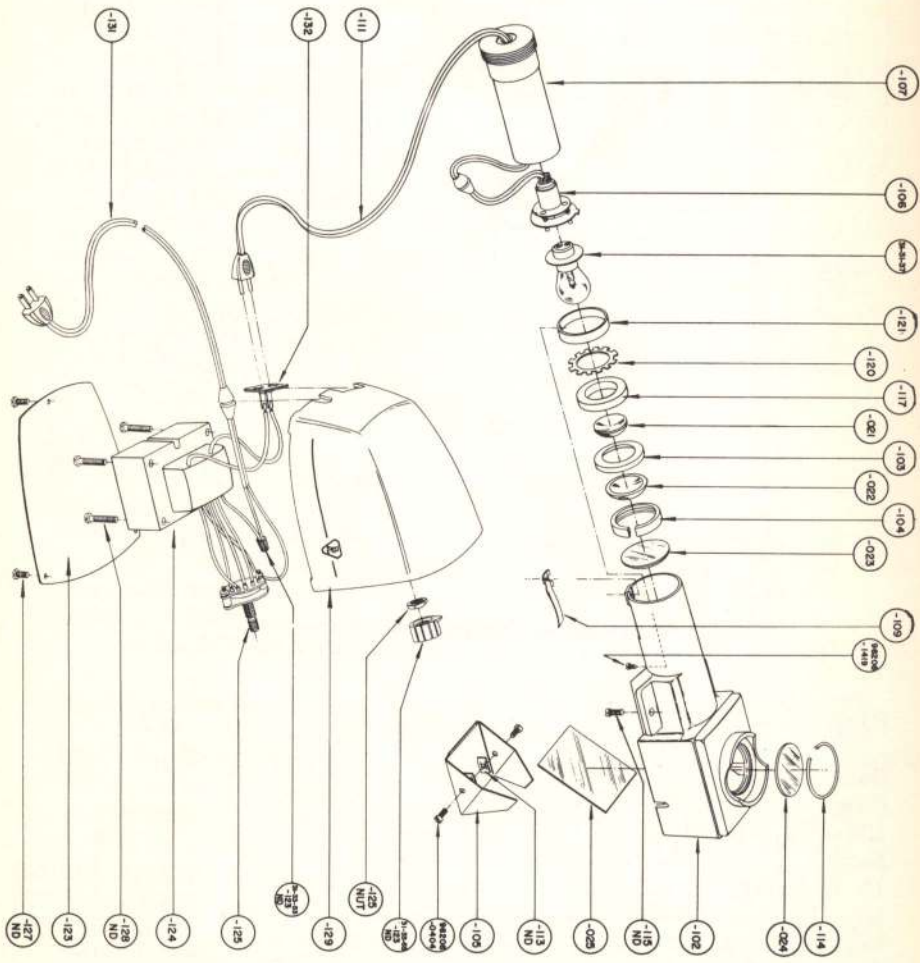
31-19-59 Triocular Body (Con't)

| Part Name | Part Number |
|--|---------------|
| Actuating Screw | -182 |
| Screw "A" | -183 |
| Screw "C" | -190 |
| "CD" Retainer | -192 |
| No. 2-56Tx,125 Mach. Screw | -193 ND |
| Plug | -196 |
| No. 2-56Tx,187 lg. Set Screw | -197 ND |
| No. 2-56Tx,125 Set Screw | -198 ND |
| No. 4-40Tx,125 Mach. Screw | -199 ND |
| Lead Screw Shaft | -205 |
| Prism Support "A" | -206 |
| E.P. Tube Adapter (Left) | -209 |
| E.P. Tube Adapter (Right) | -210 |
| No. 2-56Tx,156 Set Screw | -212 ND |
| No. 2-56Tx,156 Set Screw | -213 ND |
| Prism Mount | -215 |
| No. 2-56Tx15/32 Cap Screw | -216 ND |
| No. 2-56Tx 3/8 Set Screw | -217 ND |
| No. 2-56Tx,125 Set Screw | -218 ND |
| Spring Ring | -219 |
| Cover Screw | -220 |
| Top Dust Cover | -221 |
| No. 4-40Tx,187 Set Screw | -222 ND |
| Prism Support "B" | -224 |
| No. 4-40Tx,187 Set Screw | -226 ND |
| No. 4-40Tx,250 Set Screw | -227 ND |
| Mirror Mount (Left) | -228 |
| Centering Mount | -229 |
| No. 4-48Tx,312 Set Screw | -230 ND |
| Retaining Ring Small | 311955-175 |
| Dust Cover | 312694-030 |
| .1562 Dia. Steel Ball | 312694-152 ND |
| F-15 | 90008-18 |
| F-316 | 90008-390 |
| SB-9 | 90045-14 |
| SC-8 | 90046-23 |
| SC-10 | 90046-29 |
| 4-40F 5 S | 96206-0405 |
| 4-40F 7 S | 96206-0407 |
| 2-64S 3 S | 96222-1218 |
| 2-64T 2 S | 96224-1200 |



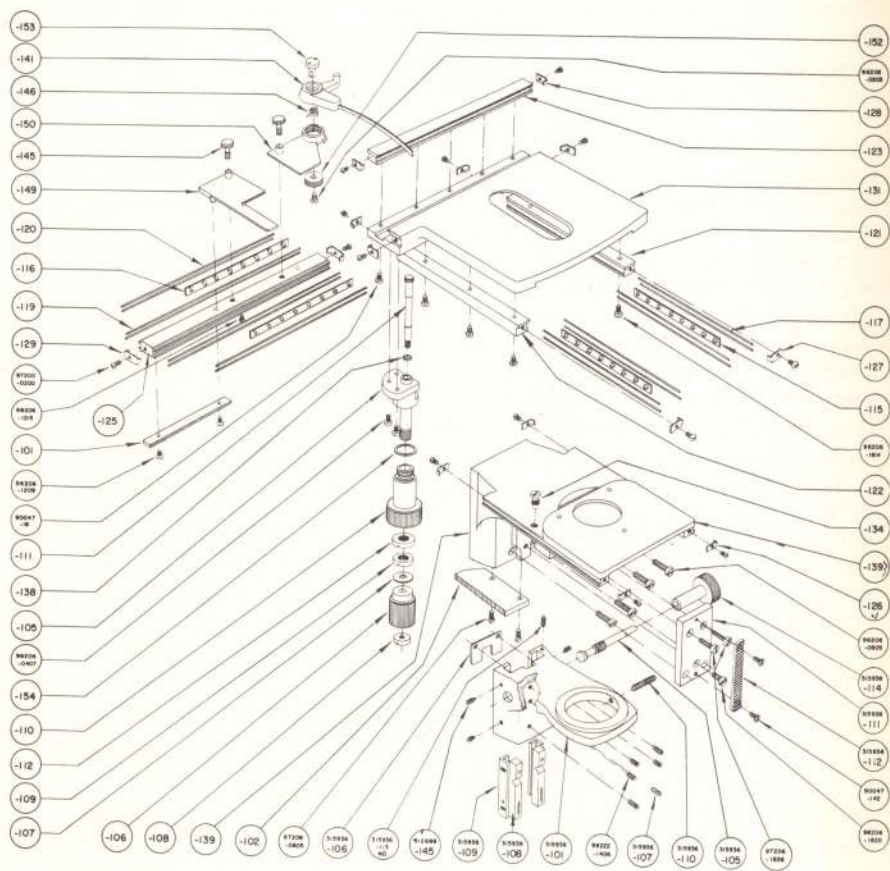
31-33-86 Optilume Illuminator

| Part Name | Part Number |
|---------------------------------|---------------|
| Base | -101 |
| Cover | -102 |
| LW-8E Cord Set | -105 ND |
| Switch | -107 |
| 15 W Lamp | 313115-101 ND |
| LY -115 Lampholder | 313302-107 ND |
| No. 4-.187 lg. Screw | 313386-103 ND |
| Terminal "A" | 313390-103 |
| Terminal "B" | 313390-104 |
| Insulator | 313390-105 |
| Filter Support | 313390-111 |
| Filter Support Spring | 313390-121 |
| Switch Nut | 313390-122 |
| Filter Mod I | 313421-021 |
| LC-26 Connector | 338464-119 ND |



31-33-59 Base Illuminator

| Part Name | Part Number |
|---|---------------|
| Lens A | -021 |
| Lens B | -022 |
| Lens C | -023 |
| Cover Plate | -024 |
| Mirror | -025 |
| Housing | -102 |
| A-B Spacer | -103 |
| | -104 |
| Mirror Support | -105 |
| Lampholder | -106 |
| Lampholder Tube | -107 |
| Spring | -109 |
| Cord Set | -111 |
| No. C 7795-440 Speed Nut | -113 ND |
| Spring Ring | -114 |
| No. 8-32Tx, 375 Mach. Screw | -115 ND |
| Lens Cell Washer | -117 |
| Lens Retainer | -120 |
| Stop Ring | -121 |
| Cover | -123 |
| Transformer | -124 |
| Switch | -125 |
| Nut (Supplied with -125 Switch) | -125 |
| No. 6-32Tx, 250 Mach. Screw | -127 ND |
| No. 6-32Tx, 1,250 Mach. Screw | -128 ND |
| Transformer Housing | -129 |
| Cord Set | -131 |
| LC-14 Interlock Connector | -132 |
| Nut (Supplied with -125 Switch) | -125 |
| Lamp <i>G.E. #1634</i> | 31-31-37 |
| Wire Connector | 313353-123 ND |
| Selector Knob | 313353-146 |
| 4-40 F 12 S | 96206-0404 |
| 4-48 F 6 S | 96206-1419 |



31-58-38 Mechanical Stage

| Part Name | Part Number |
|------------------------------------|---------------|
| Transverse Rack | -101 |
| B.F. Rack | -102 |
| Sleeve & Block Assy. | -105 |
| Inner Pinion Knob | -106 |
| Lower Washer | -107 |
| Lower Lock Nut | -108 |
| Pinion Lock Nut | -109 |
| B.F. Pinion Knob | -110 |
| Transverse Pinion | -111 |
| Upper Lock Nut | -112 |
| B.F. Bearing Assy. | -115 |
| Cross Slide Bearing Assy. | -116 |
| Retaining Gib Rod | -117 |
| Cross Slide Rod | -119 |
| Cross Gib Rod | -120 |
| Retaining Gib (Right) | -121 |
| Retaining Gib (Left) | -122 |
| Cross Slide | -125 |
| Stage Retainer | -126 |
| B.F. Retainer | -127 |
| Gib Retainer | -128 |
| Slide Retainer | -129 |
| B.F. Stop Screw | -134 |
| Upper Pinion Washer | -138 |
| Stage Support Blank | -139 |
| Finger Assy. | -141 |
| Slide Holder Screw | -145 |
| Finger Spring | -146 |
| Left Slide Holder | -149 |
| Right Slide Holder | -150 |
| Cross Slide Assy. | -151 |
| Finger Bushing | -152 |
| Finger Pivot | -153 |
| B.F. Washer | -154 |
| Gib Screw A | 312688-145 |
| Substage Support | 315936-101 |
| Pinion | 315936-105 |
| Pinion Cover | 315936-106 |
| Support Screw | 315936-107 |
| Pinion Support | 315936-108 |
| Gib | 315936-109 |
| Substage Screw Assy. | 315936-110 |
| Slide | 315936-111 |
| Rack | 315936-112 |
| No. 6-32Tx.500 Set Screw | 315936-113 ND |
| Substage Pinion Button | 315936-114 |
| SD-7 | 90047-18 |
| SD-80 | 90047-142 |

31-58-38 Mechanical Stage (Con't)

| Part Name | Part Number |
|-----------------------|-------------|
| No. 2-56 C 5 S | 96202-0203 |
| No. 4-40 F 7 S | 96206-0407 |
| No. 8-32 F 308 | 96206-0805 |
| No. 2-64 F 6 S | 96206-1209 |
| No. 2-64 F 3 S | 96206-1215 |
| No. 6-40 F 13 S | 96206-1614 |
| No. 2-56 B 6 T | 97200-0200 |
| No. 8-36 F 12 T | 97206-1826 |
| No. 6-32 G 12 T | 97208-0605 |
| No. 4-48 S 8 U | 98222-1406 |

THESE DIRECTIONS or instructions do not presume to cover all details, variations, or changes in this equipment; nor to provide for all possible contingencies to be met in connection with installation or use. We would be glad to help on any problems not covered in this manual.

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