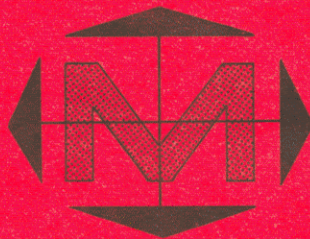


Handbook of
Operation and Service
Instructions

MITCHELL
16mm Motion Picture Camera
CAMERA



MITCHELL CAMERA CORPORATION
666 West Harvard Street
Glendale 4, California

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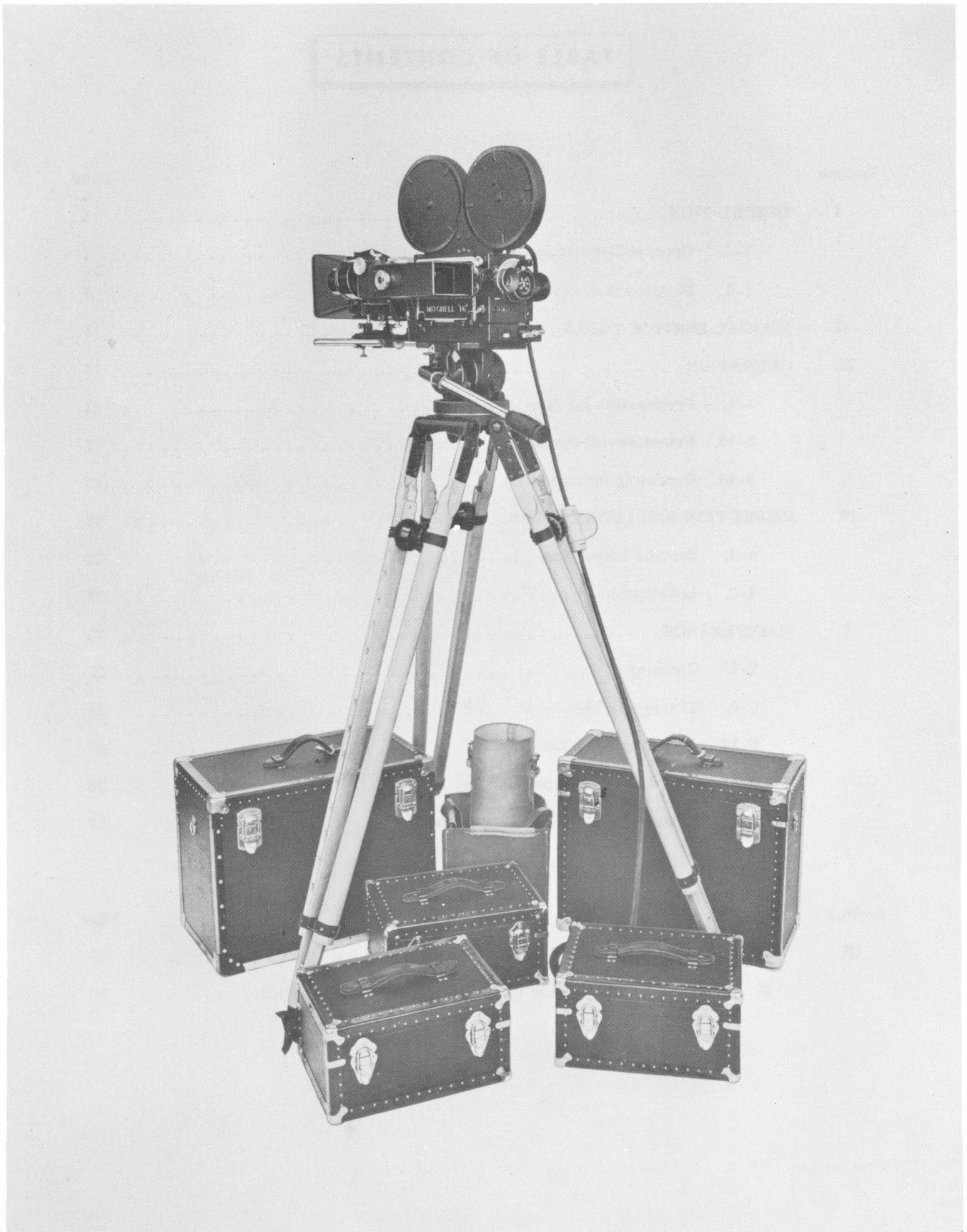


Figure 1-1. Camera and Components

SECTION I DESCRIPTION

1-1. GENERAL DESCRIPTION. (See figures 1-1, 1-2, 1-3, and 1-4.)

1-2. This instruction book has been prepared to familiarize cinematographers with operation and maintenance of the Mitchell 16mm Motion Picture Camera. This handbook contains descriptive data and illustrated instructions for operating, maintaining, and lubricating the camera and associated accessory equipment. A Trouble Shooting Chart is supplied in Section V.

1-3. The Mitchell 16mm Motion Picture Camera is unequaled for all-around use, where both high speed and normal rate operation is desired on 16mm film. The entire mechanism is manufactured to within extremely close limits to assure required accuracy and precision. It incorporates exclusive design features and famed workmanship which have made the Mitchell name synonymous with great cinematography. With proper care and operation this camera will give many years of dependable, trouble-free performance.

NOTE

For a complete catalog of repair or replacement parts for this camera, refer to 16mm Motion Picture Camera Parts List.

1-4. The camera and its accessories are designed for use in the field, laboratory, and studio. It may be operated at any speed from 8 to 128 frames per second. The lens turret, focusing tube, viewfinder, matte box, plus other features and accessories, provide flexibility

to meet almost any cinematographic requirement. The early models (prior to serial number 227) and current models (serial numbers 227 and on) are basically similar and are covered simultaneously except for the differences noted in this manual.

1-5. The camera consists of an "L"-shaped base and a camera box (figure 1-6) which slides horizontally on the base in dovetail tracks (gibs), permitting the operator to move the camera box to either focusing or photographing position. A 400-foot film magazine is mounted on top of the camera box (figure 1-2) and a viewfinder is mounted at the left side of the camera on a dovetail bracket incorporated in the upright section of the base. A rotating lens turret at the front of the camera base accommodates four lenses. (See figure 1-5.) Each of the motors provided with the camera is mounted on a door which attaches to the right side of the camera box. A matte box assembly is mounted at the front of the camera, attaching to the base. (See figure 1-10.) The camera base rests on a friction head which, in turn, is attached to a tripod.

1-6. DETAILED DESCRIPTION.

NOTE

Throughout the manual, right and left designations are from the point of view of the operator. Right and left designations of a part dismantled are used as if the part were mounted on the camera.

For information on Mitchell Cameras, Projectors and Accessories, contact

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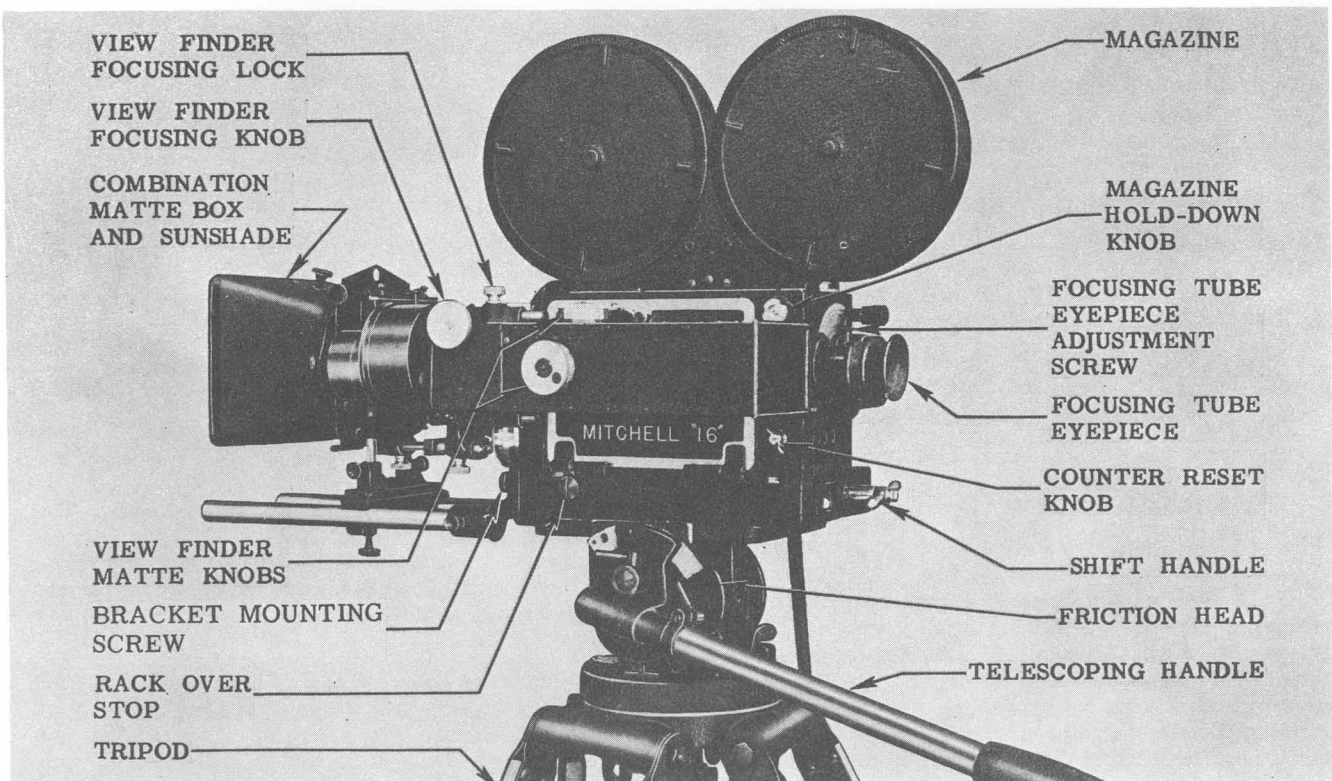


Figure 1-2. Three-quarter Left View

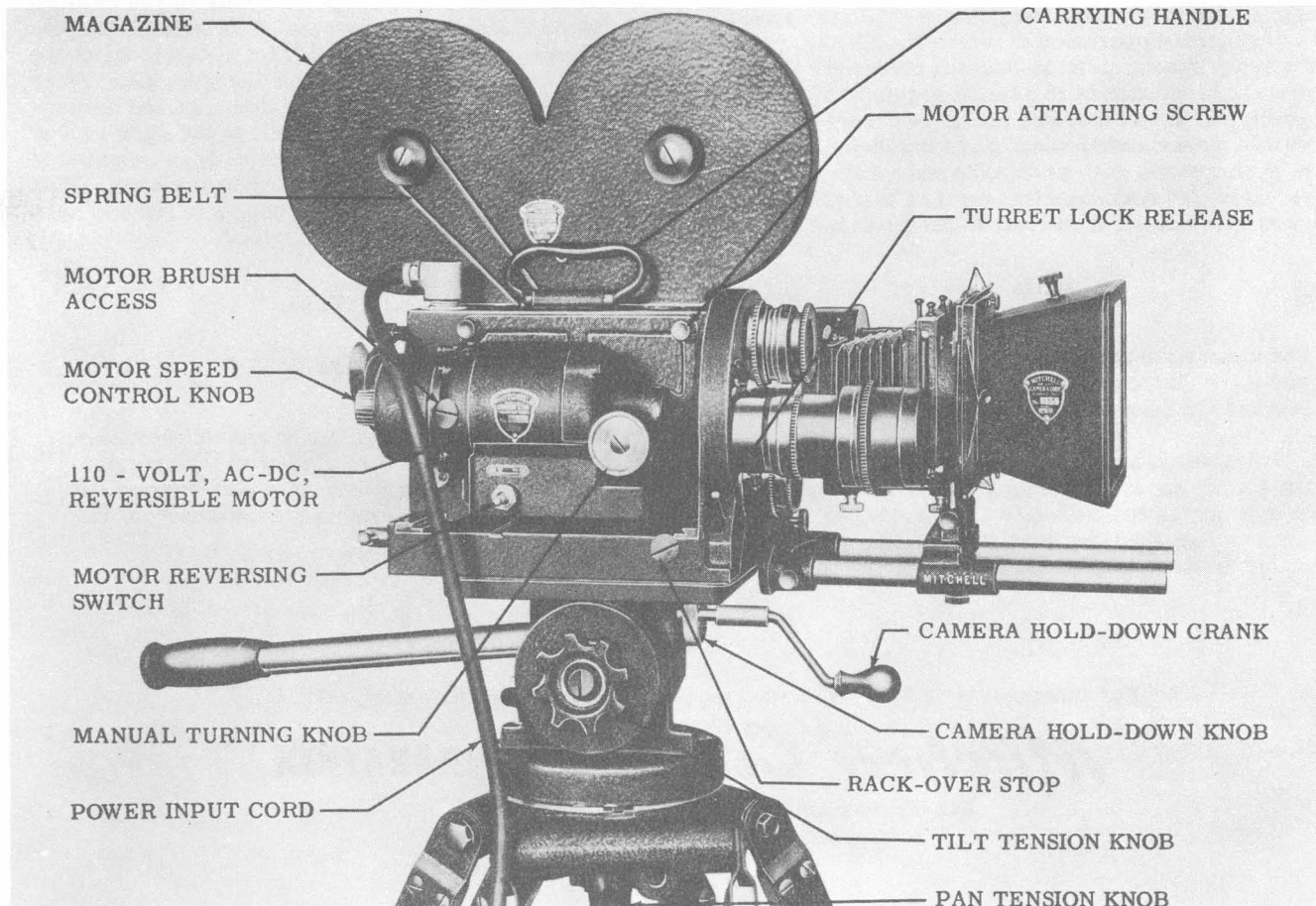


Figure 1-3. Three-quarter Right View

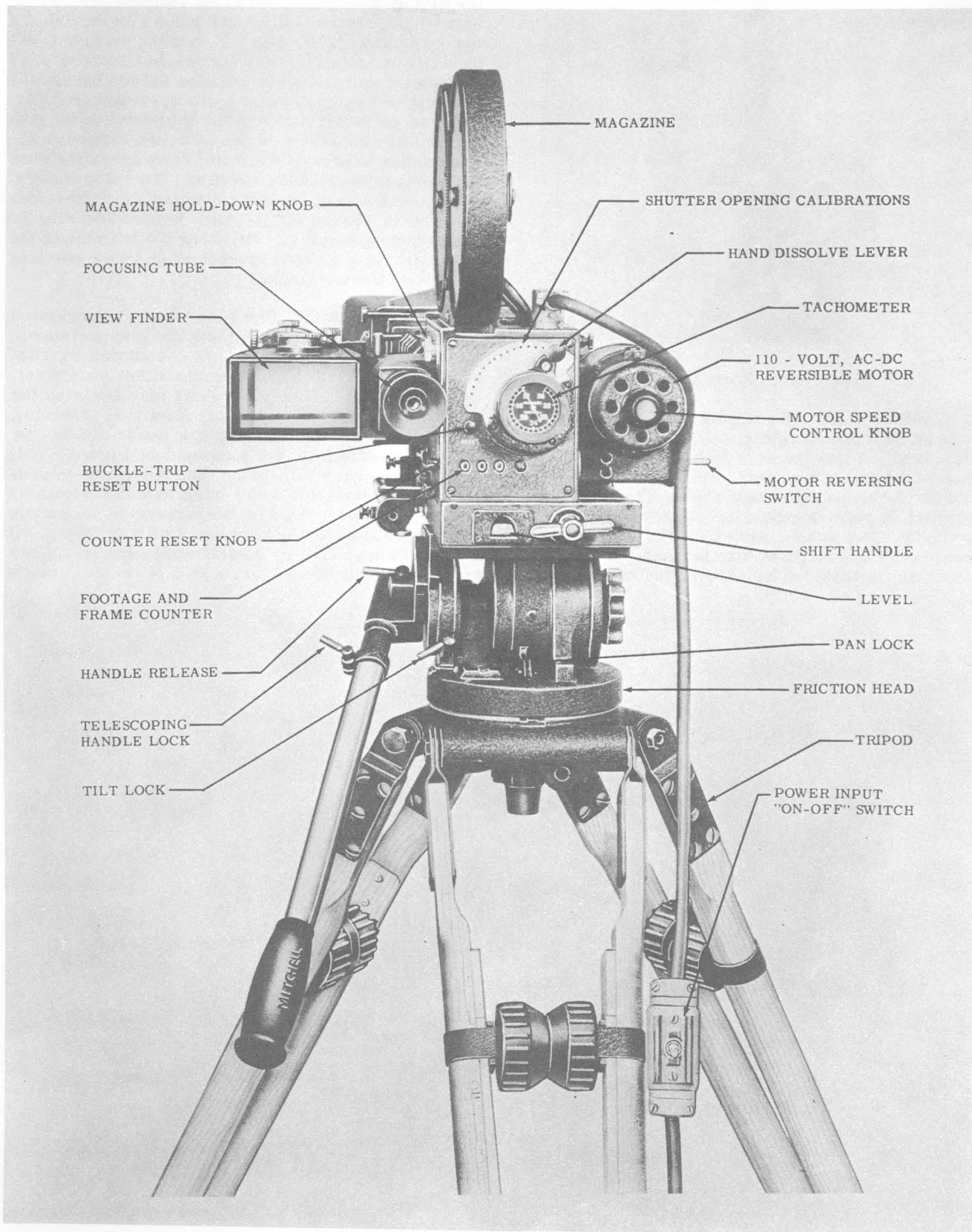


Figure 1-4. Rear View

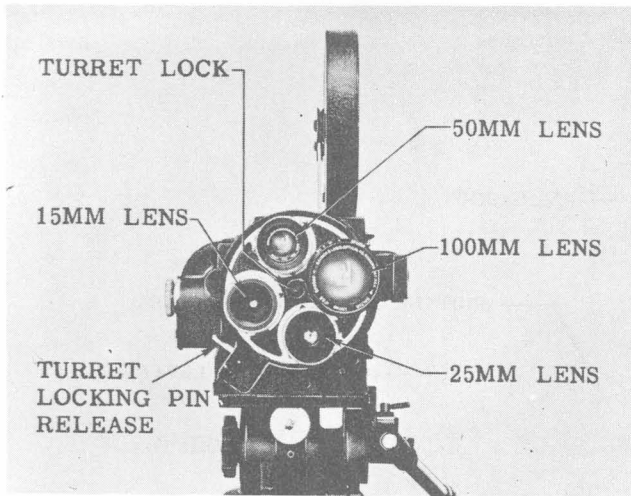


Figure 1-5. Front View

1-7. CAMERA BASE. (See figure 1-6.) The camera base is an "L"-shaped casting which is secured to the friction head. A lens turret is installed on the upright portion of the base. A release lever at the lower right side of the turret permits rapid shifting from one lens to another. A positive locking device locks the desired lens into the exact position when the turret is revolved. The horizontal section of the base incorporates the gibs and racking mechanism for shifting the camera box

from side to side. The camera box may be shifted from the photographing position to the focusing position by operating a release button and handle on the rear of the base. (See figure 3-1.) A locating plunger in the base fits into either of two recesses in a locating plate beneath the camera box to position the box accurately in photographing or focusing position. A tapered shift-lock cam on the right side of the base between the gibs contacts the actuators on two switches located in the camera box to prevent the motor from operating when the box is in the focusing position. Two stop screws, one on each side of the base, prevent the camera box from being racked off the base beyond focusing or photographing position. Adjoining the left side of the lens turret is a dovetail bracket which fits a matching bracket on the viewfinder.

1-8. CAMERA BOX. (See figure 1-6.) The camera box is divided longitudinally into two compartments. The left-hand, or operating side, contains the film moving mechanism and the intermittent movement. (See figure 1-8.) The right-hand side contains the movement drive shaft and motor electrical connector. (See figure 1-7.) The operating side has an access door hinged at the bottom. The focusing tube (figure 3-7) is an integral part of this door. The drive side is protected by a removable door, integral with the camera motor. The motor and door are fastened to the camera box with two knurled screws and a sliding latch. All gearing is protected by tubular apertures in the box casting. A plate secured to the rear of the box protects

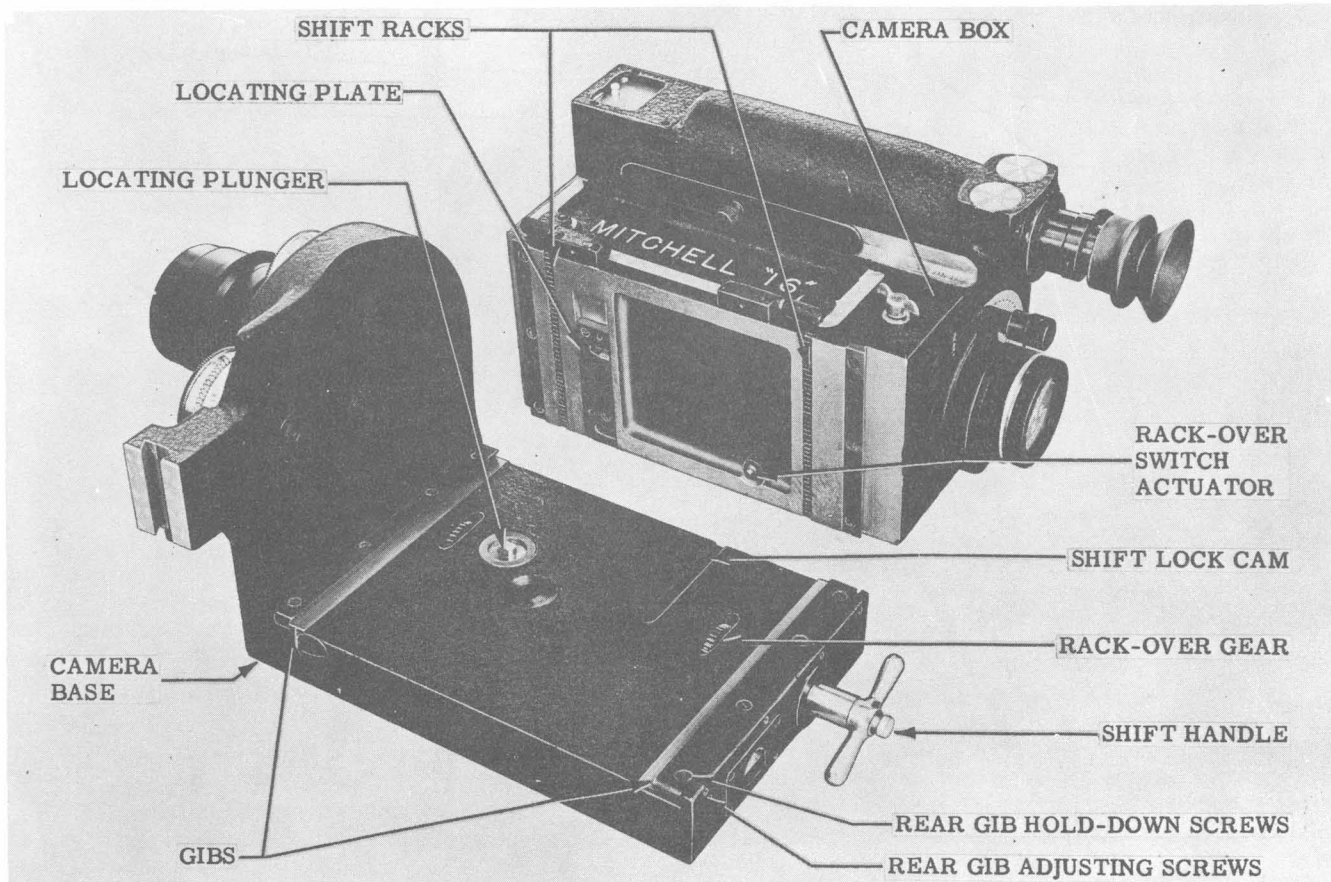


Figure 1-6. Camera Box and Base

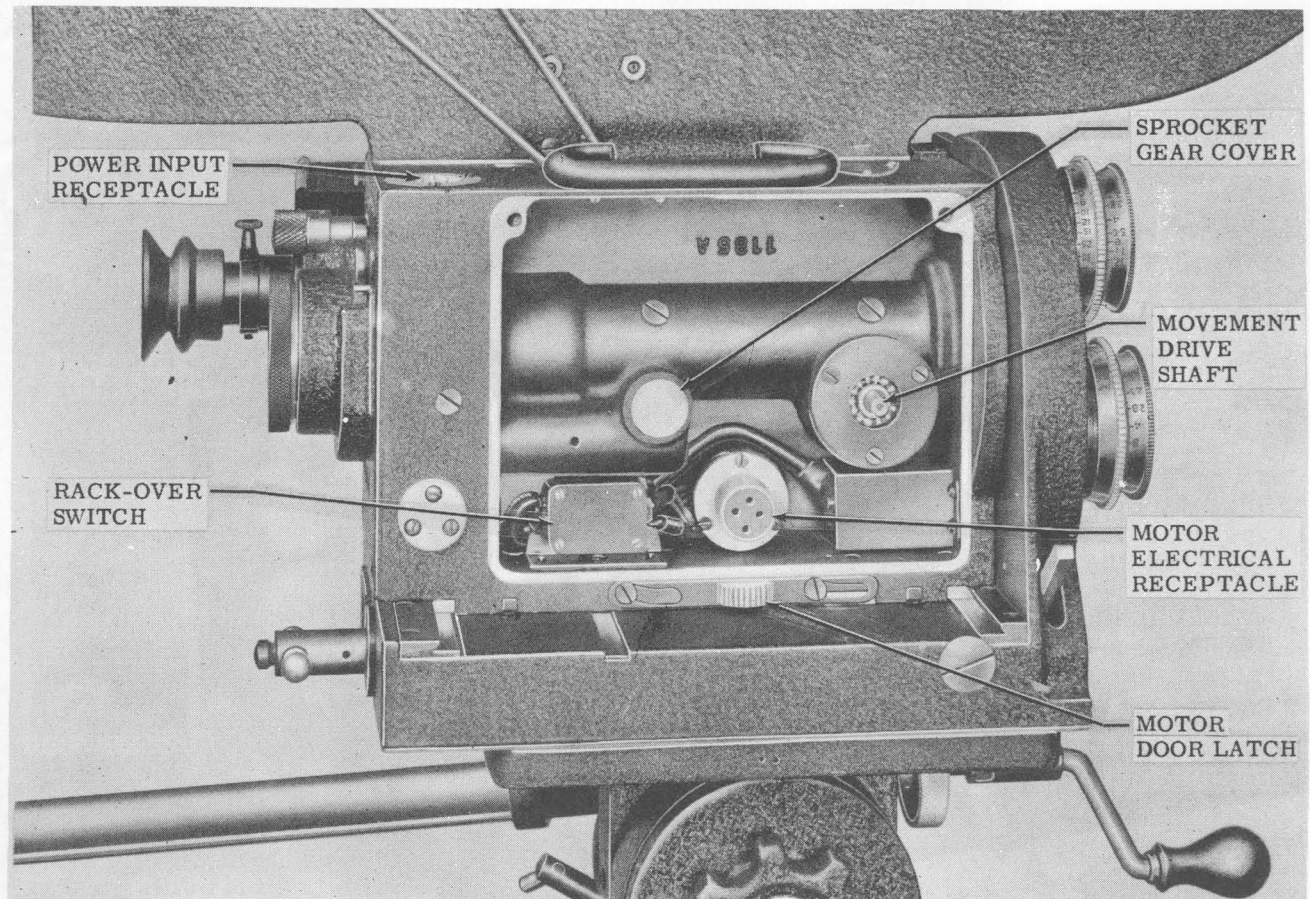


Figure 1-7. Right Side with Motor Removed

the shutter drive and counter drive mechanism. A shutter cover plate screwed to the front of the box protects the shutter. On top of the camera box is a recess in which the film magazines fit and an opening through which the film is drawn from the magazine to the film compartment of the camera. A metal dust plate is provided to cover this opening when a magazine is not in place. The magazine take-up belt passes between three rollers in an aperture at the top of the box. Two dovetail gibs on the bottom of the box slide in the base gibs, and adjoining each gib is a shift rack which engages with the gear of the rack-over mechanism. A locating plate with two holes matches the locating plunger in the camera base. A handle on the top of the box is for carrying the camera.

1-9. CAMERA DRIVE.

1-10. The camera is driven by a motor forming an integral part of the right-hand door. (For information on available motors see paragraphs 1-24 through 1-28A.) The motor drive shaft couples with the movement shaft. The movement shaft drives the pull-down lever and the assembly that actuates the registration pins by a cam arrangement. The drive gear near the center of the movement shaft meshes with the driven gear on the shutter shaft. The drive gear located to the rear of the camera on the shutter shaft, drives the driven gear on the sprocket shaft assembly. The sprocket shaft drives the sprocket. A drive gear near the right end of the sprocket shaft drives the counter drive shaft assembly.

The drive gear on the rear end of the counter drive shaft assembly drives the driven gear of the frame counter assembly. Alternate steel and composition gears are installed throughout the camera to minimize operating noise.

1-11. Film is drawn from the magazine and fed to the movement by the sprocket. The film is held against the sprocket by two sprocket film guide assemblies. The film take-up belt passes around a pulley on the sprocket assembly and a pulley on the magazine take-up drum. The sprocket assembly contains a disk-type clutch which permits slippage between the sprocket and the pulley which drives the magazine take-up belt.

1-12. MOVEMENT. (See figure 1-8.)

1-13. The high speed movement moves the film intermittently and holds it in position for the exposure of each successive frame. A double-prong pull-down claw moves the film into place behind the aperture. Two registration pins on the registration arm hold the film stationary at the moment of exposure. The registration pin throw-out knob is provided to enable the operator to withdraw the registration pins for threading film. The movement is a double cam type. Both cams are mounted on the movement drive shaft. One actuates the pull-down mechanism; the other the registration pins. The movement is designed to operate satisfactorily at speeds as high as 128 frames per second.

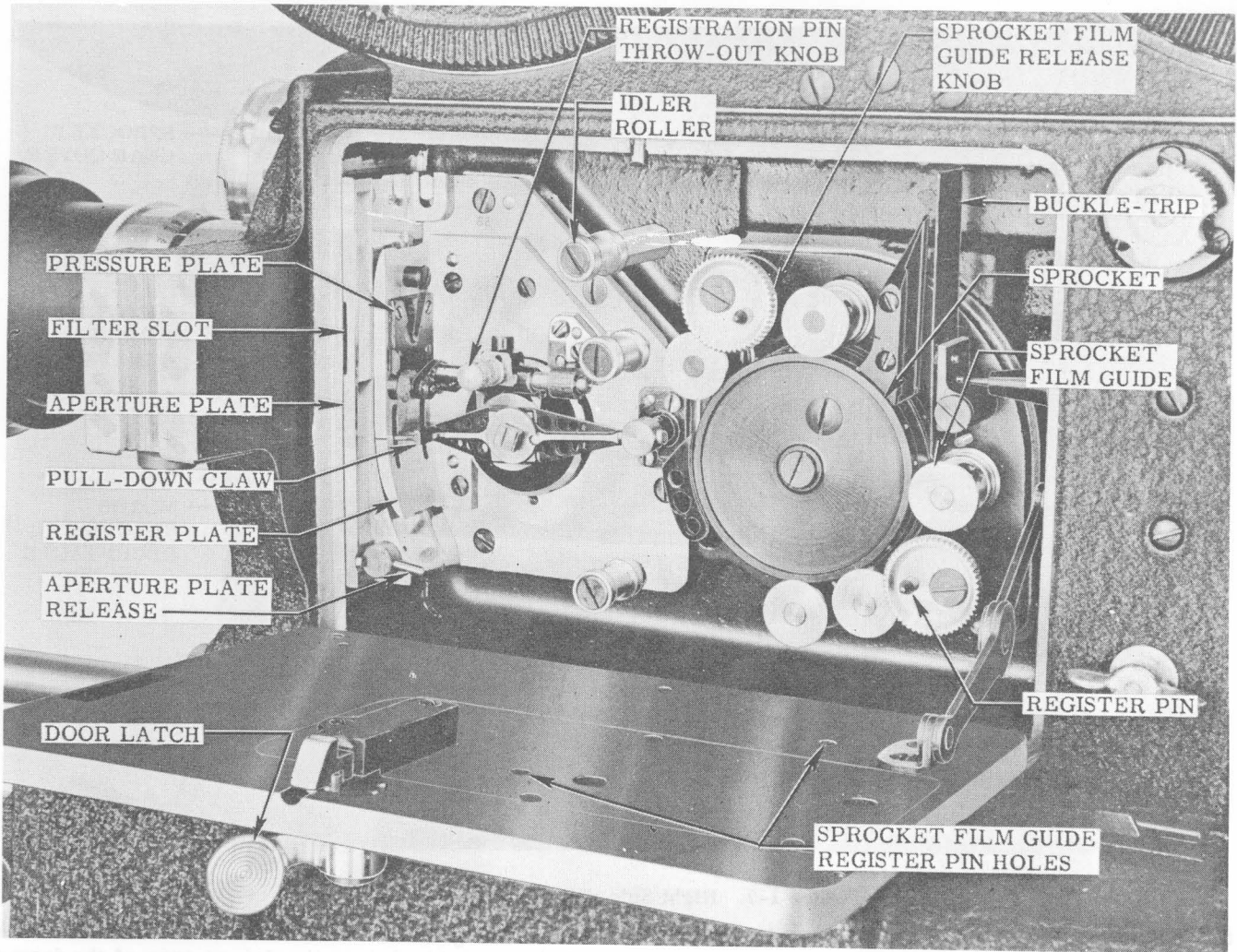


Figure 1-8. Left Side with Door Open

1-14. The aperture plate (figure 1-8) is mounted on a holding stud and sleeve, and can readily be removed for cleaning. It is made of stainless steel, hard chrome plated, and has raised surfaces at the sides of the film path which allow the film to touch the plate only outside the picture area. The register plate is directly behind the aperture plate, and the removable pressure plate fits into a recess in the register plate. The pressure plate has two rollers and two rails which limit the space between register plate and aperture plate, holding the film flat at the aperture. A filter slot is provided at the front of the aperture plate.

1-15. BUCKLE TRIP. (See figure 1-8.) A buckle trip, located behind the rear film stripper, will automatically shut off the camera motor if the film fails to return to the magazine. Two micro-switches are incorporated in the buckle trip. A reset button is located at the back of the camera above the footage counter.

1-16. SHUTTER. Cameras previous to serial number 227 have a two-blade dissolving shutter built into the camera box. Later models use a three-blade dissolving shutter. A shutter adjusting (hand dissolve) lever at the rear of the camera is used for hand dissolves or can be set at fixed shutter openings in increments of

10 degrees. The lever moves across a calibrated segment, which indicates the degree of shutter opening. The segment is graduated from zero degrees to a maximum opening of 175 degrees on cameras previous to serial number 227; on later models maximum opening has been increased to 235 degrees. (See Table I for shutter exposure time for various shutter openings.) The dissolve handle has a positive pin lock so that the shutter setting will not change while the camera is being operated. The shutter is synchronized with the movement so that when its open segment is in front of the aperture the film will be at rest, with the registration pins engaged. The film moves while the opaque segment of the shutter covers the aperture.

1-17. FOCUSING TUBE. (See figure 3-7.) The focusing tube is used for accurate focusing and framing through the camera lens. It is an integral part of the camera door casting. Its aperture is sized and positioned to correspond exactly with the camera aperture. With the camera box racked over to the right (figure 3-1), the focus tube is positioned behind the lens. Thus the scene may be framed through the lens and the lens may be focused. When ready for the take, the camera aperture is racked over to the left, placing the camera aperture in position without disturbing the focus or position of the

lens. The focusing tube has an adjustable eyepiece with a rubber visor. The image is seen on a ground glass, upright and correct as to right and left. The magnification rates can be adjusted to five or ten times by sliding a knurled knob on the bottom of the tube. With ten times magnification the entire field is not visible. The normal image is obtained with the knob in the rear position. Two viewing filters, green and pan, are built into the tube to aid in judging exposure and contrast. The green filter is used with orthochromatic film; the pan filter is used with panchromatic film. Each filter is placed in position by turning a knurled knob on the outside of the tube. A sliding door in the tube permits access to the ground glass so that the ground glass may be removed for cleaning or replacement.

1-18. TACHOMETER. (See figure 1-4.) A tachometer registering from 12 to 36 frames per second is located at the rear of the camera box. The tachometer is attached to the camera backplate and is driven by the shutter shaft. During operation of more than 36 frames per second, the camera tachometer should be ignored. The actual frames per second will be indicated on the motor tachometer.

1-19. LENSES. Either Bausch & Lomb Baltar coated lenses in Mitchell precision focusing mounts or Eastman Cine Ektar lenses in type "C" mounts are available with the Mitchell "16". A type "C" lens adapter is required to mount all Ektar lenses. The lenses are mounted in micrometer focusing mounts with iris diaphragms.

Footage and iris adjustments are clearly marked on the lens mounts. Covers are provided to cover all lens turret openings in which no lens is mounted.

1-20. COUNTERS AND LEVEL. (See figure 1-2.) A footage and frame counter is built into the rear of the camera box. The reset knob is located to the left of the counter. The camera base incorporates a spirit level.

1-21. VIEWFINDER. (See figure 1-9.) The magnifying prismatic viewfinder is attached to the left-hand side of the camera (figure 1-2) beside the focusing tube by means of a dovetail bracket. Adjustable mattes, controlled by two calibrated knobs on the top and side of the finder, may be set to mark the fields of lenses of various focal lengths. The image seen on the ground glass is upright and correct as to right and left. The finder has a picture area of about 1-7/8 x 3-5/8 inches. Without mattes the field corresponds to that of a 17.5mm lens. When the 15mm lens is used, an adapter (reducing lens) is installed on the viewfinder lens to change the actual size of the image. In this case, the adjustment knobs must be set on the red calibration for 15mm. The focusing adjustment has a locking nut on top of the finder. A second locking nut secures the viewfinder in place after making the adjustment for parallax. The viewfinder bracket is constructed so that the finder may be swung upward to a vertical position, permitting access to the camera door without disturbing the parallax adjustment. (See figure 3-6.) An eccentric incorporated in the bracket permits up-and-down adjustment of the finder. (See paragraph 5-12.)

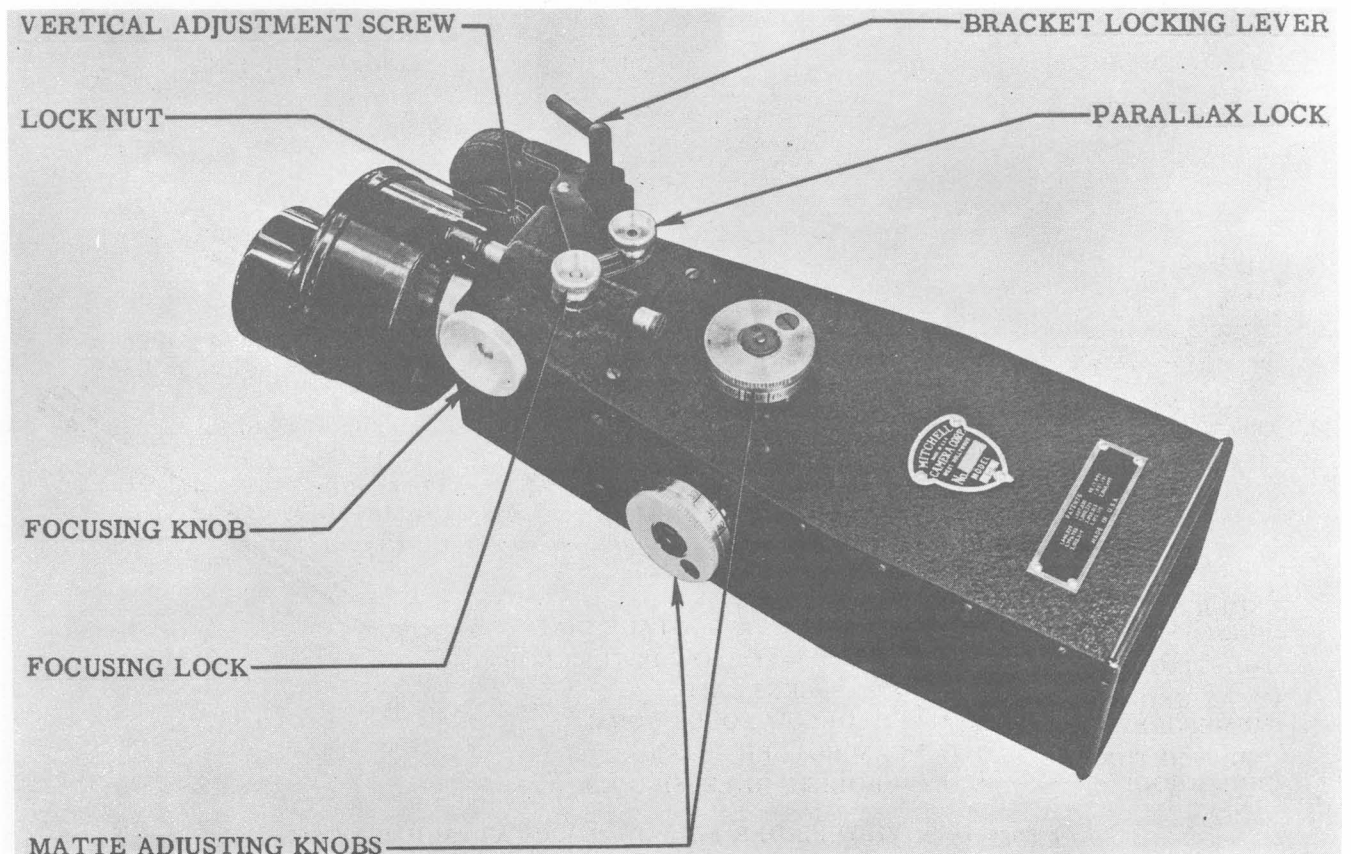


Figure 1-9. Viewfinder

Section I
Paragraph 1-21A

1-21A. VIEWFINDER FOLLOW-FOCUS ATTACHMENT. (See figure 1-9A.) The follow-focus attachment affords complete control over picture framing and lens focusing for action shots, moving toward or away from the camera, and is especially useful in the close, critical range. The attachment does not interfere with the use of any standard accessory. It is designed for use with the standard Mitchell viewfinder (see paragraph 1-21). After mounting and adjusting the attachment, operation of the single follow-focus control knob will focus the camera lens and simultaneously adjust the viewfinder for parallax. The attachment is easily mounted by fastening it with thumb screw (A) and thumb screw (B) to the camera base.

NOTE

If the camera does not have side locking screw hole in base, it will be necessary to remove thumb screw (B) and use hold in follow focus bracket as a guide to drill new hole. Use No. 23 drill and 10-24 tap for this operation. A small amount of metal may have to be filed or milled from dovetail on camera base to allow lens engaging gear to swing back far enough for other lens to be rotated into position.

If roller mechanism binds after locking screw (B) is tightened, it may be necessary to adjust the position of the side arm unit in relationship to the camera base by

adjusting screw (C). Then install finder cam roller harness by loosening clamp and slipping harness over rear end of finder.

NOTE

On older finders only, remove dovetail swivel pin and insert new dovetail bracket. The operation should be performed by an experienced camera technician.

To adjust the follow-focus attachment, rotate the follow-focus control knob so that the cam roller is at infinity or the extreme rear position, focus the selected lens at infinity and swing the focusing gear engage lever to engage the lens gear with the focusing gear. With gears properly meshed, the cam roller should be in the extreme rear position and the lens on the infinity mark or slightly beyond. After installing the lens cam that matches the focal length of the lens to be used, focus lens at some nearby object, about 10 feet away. Line-up vertical centerline in camera focus tube with the center of the object. Rotate the cam adjusting screw until the vertical centerline of the finder matches the intersection of the focus tube vertical centerline through the center of the object. Lock the cam roller with the screw. Finally, install finder return spring by attaching it to the hook on the follow-focus unit. The plastic footage dial is provided for ready indication of various lens settings required in any particular sequence of shots.

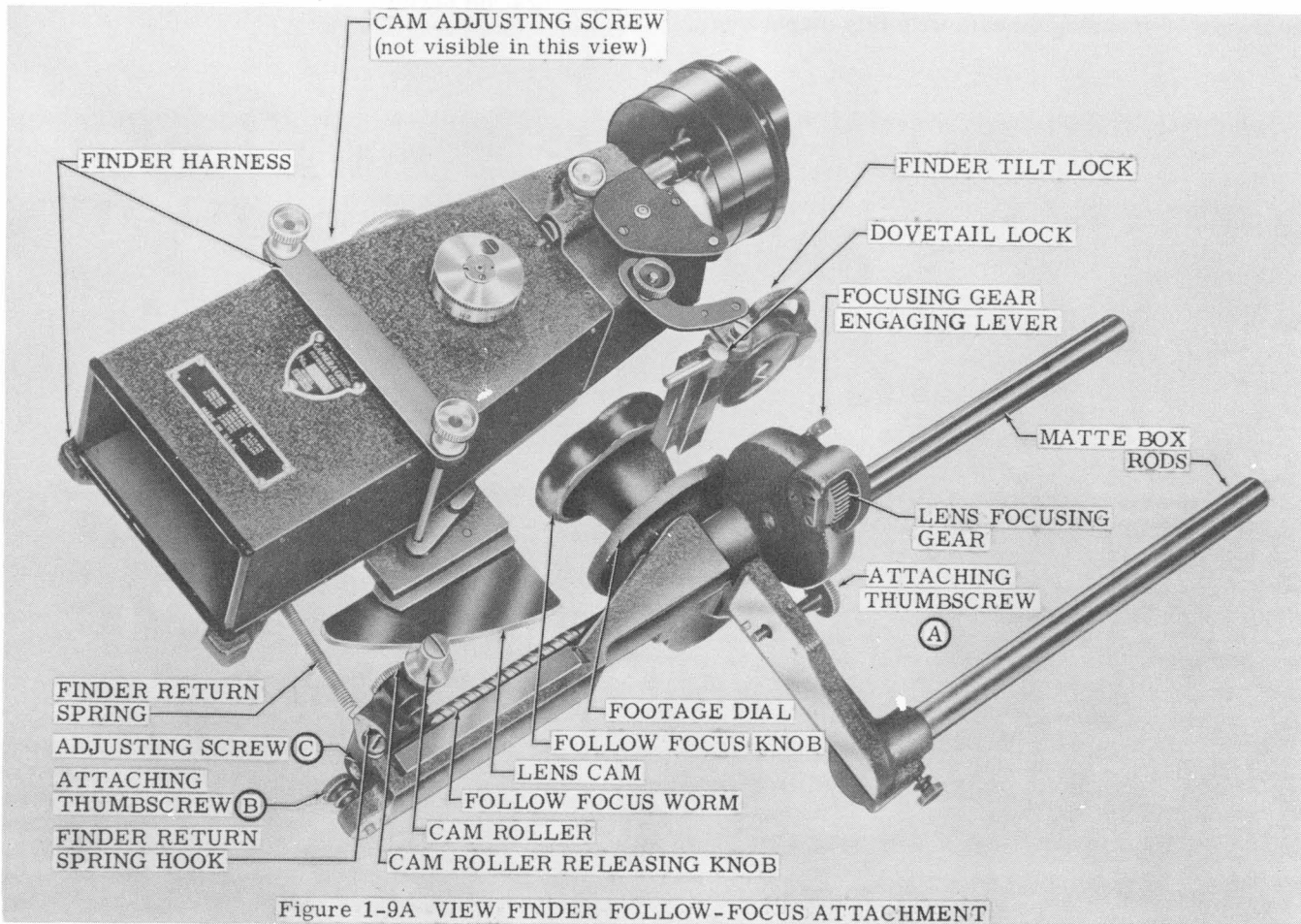


Figure 1-9A VIEW FINDER FOLLOW-FOCUS ATTACHMENT

Figure 1-9A. Viewfinder Follow-focus Attachment

CAUTION

A cam to match the focal length of each lens used is provided. Each time the lens is changed make sure the correct lens cam is in place.

1-22. **MAGAZINE.** Four 400-foot film magazines are supplied with the camera. The magazine is corduroy-velvet lined. Two covers on the left side of the magazine unscrew to permit loading or removal of the film. They are removed by turning in the counterclockwise direction. Both compartments of the magazine are lightproof, and the hubs are made to fit standard film cores. The hubs are removable to facilitate daylight loading. A spring-loaded ball at the center of each cover insures a snug fit and prevents rattling. The magazine throat or light trap consists of three velvet-covered rollers held in contact at even pressure by spring tension on the outer rollers. This keeps the magazine light-tight at all times and prevents the film from being scratched as it is drawn from the magazine. The magazine is mounted in a recess on top of the camera box and is held in place at the front by a stop and at the rear by a magazine hold-down screw actuated by the magazine hold-down knob (figure 1-2). The magazine take-up hub is driven by a belt which passes between three rollers at the top of the camera box and fits around a pulley on the sprocket assembly (figure 1-3.)

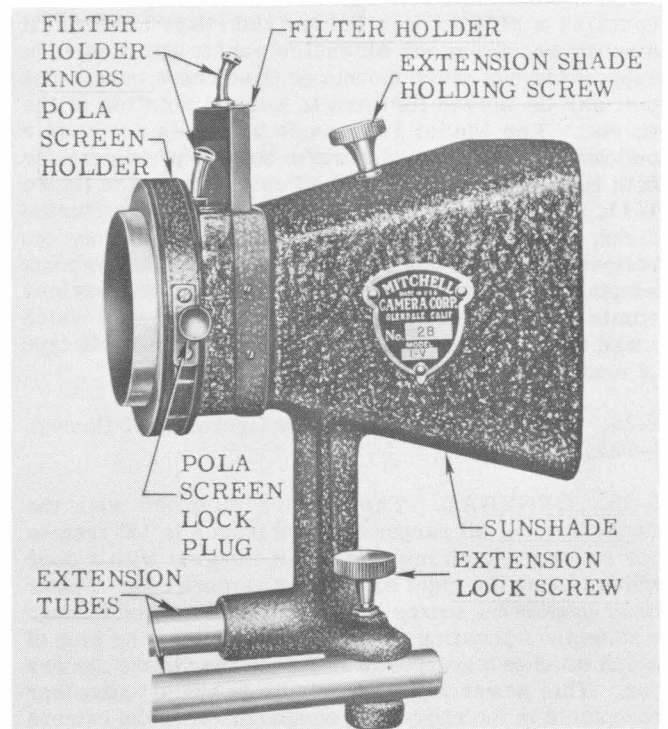
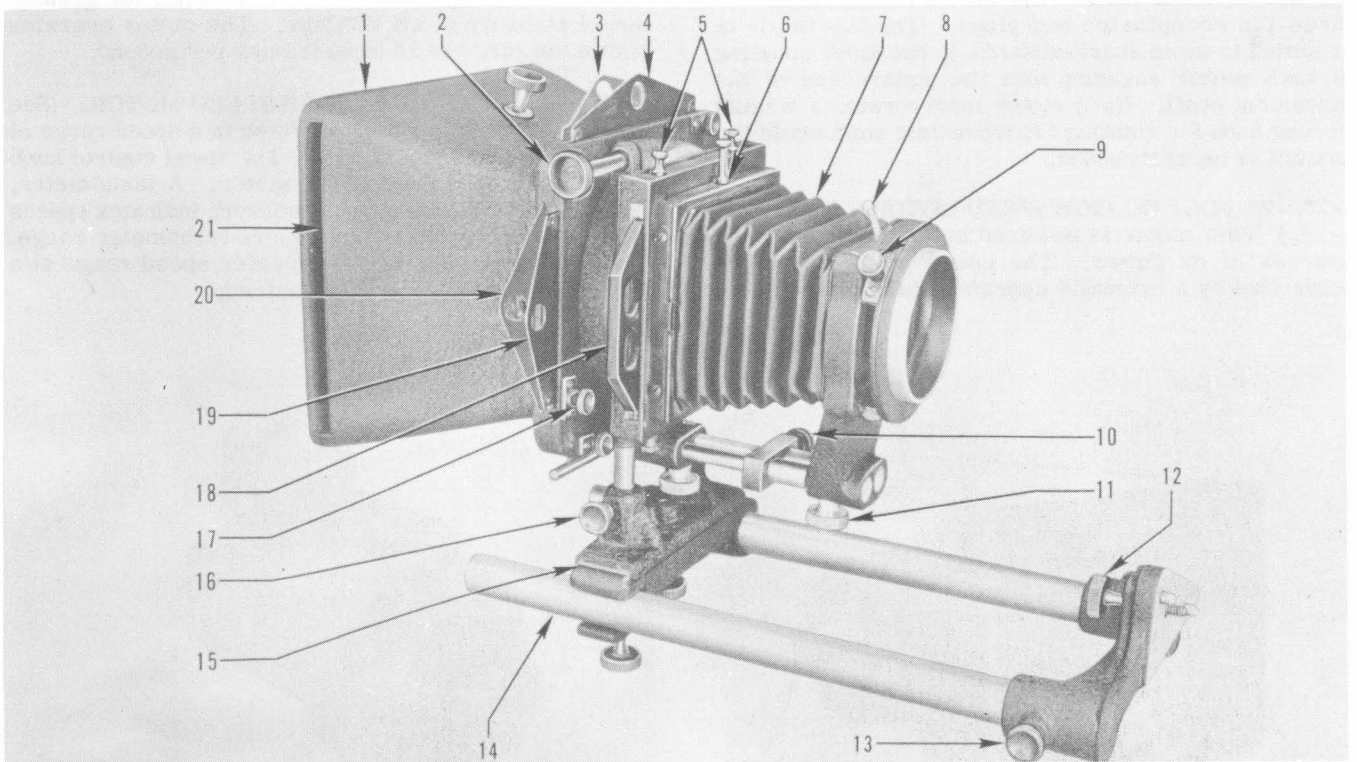


Figure 1-10. Matte Box (Model 1-V)



- | | | | |
|---------------------|---------------------------|---------------------|---------------------|
| 1. Sunshade | 6. Three-inch Filter Knob | 11. Clamp Nut | 16. Rod Clamp Screw |
| 2. Clamp Ring Screw | 7. Bellows | 12. Mounting Screw | 17. Clamp Screw |
| 3. Hard Matte | 8. Two-inch Filter Knob | 13. Retaining Screw | 18. Gauze Frame |
| 4. Gauze Matte | 9. Lock Screw | 14. Tube | 19. Gauze Matte |
| 5. Frame Knobs | 10. Adjustment Screw | 15. Bracket | 20. Hard Matte |
| | | | 21. Slot |

Figure 1-11. Matte Box with Bellows (Model 1-V-50)

Section I
Paragraphs 1-23 to 1-27

1-23. MATTE BOX AND SUNSHADE. (See figure 1-10.) The combination matte box and sunshade (Model 1-V) contains a pola screen holder and filter holder. It mounts on two steel extension tubes attached to a support bracket which mounts on the camera base. The unit can be moved forward to permit rotation of the turret. The Model 1-V matte box does not have a bellows. The bellows type matte box has provisions for both horizontal and vertical adjustments. (See figure 1-11.) It contains holders for filters and diffusion disks, gauze slides and a pola screen. In addition, the bellows type matte box may be disassembled and various adaptations made. There are holding screws, various combinations of hard mattes and adjustments which make the matte box adaptable for any conceivable type of matting.

1-24. CAMERA MOTORS. (See figures 1-12 through 1-13A.)

1-25. GENERAL. The motors supplied with the cameras cover all ranges of speed from 8 to 128 frames per second. Each motor is built integral with a door which fits on the right side of the camera box. Power from an external source is supplied to the motor through a cable incorporating an "ON-OFF" switch, the plug of which matches a receptacle at the top rear of the camera box. This power input receptacle is wired to another receptacle in the right-hand compartment of the camera box. When the motor door is installed on the side of the camera, a four-pin receptacle, integral with the door, connects to the camera receptacle. (Cameras previous to serial number 227 and on are equipped with three-pin receptacles and plugs. The fourth pin is grounded to avoid shock-hazards.) The drive coupling of each motor engages with the square end of the movement shaft. Each motor incorporates a manual turning knob for rotating the movement shaft while the camera is being threaded.

1-26. 24-VOLT DC HIGH SPEED MOTOR. (See figure 1-13.) This motor is powered by batteries or other sources of dc power. The speed of the motor is controlled by a manually operated rheostat and has a

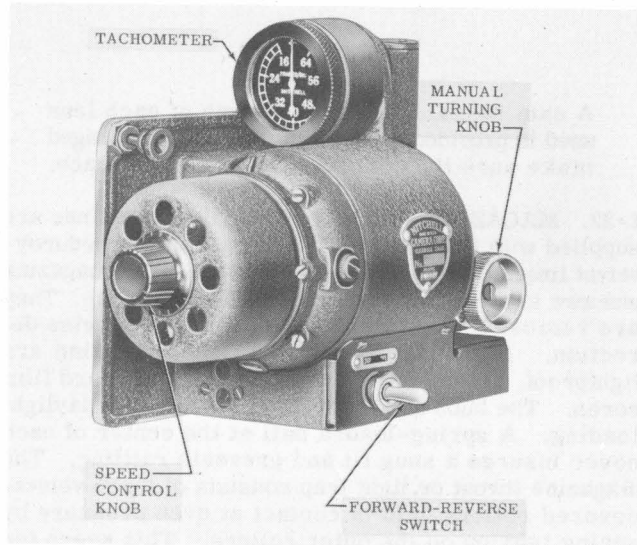


Figure 1-12A. 24-Volt Dc High Speed Motor

speed range of from 16 to 64 frames per second. A tachometer on the motor is provided to register speeds higher than the upper limits of the camera tachometer.

1-26A. 24-VOLT DC HIGH SPEED MOTOR (late model). (See figure 1-12A.) While basically similar to earlier models, this later version of the 24-volt dc high speed motor provides governor control of motor for greater speed stability at all settings. The motor operates within the range of 16 to 64 frames per second.

1-27. 110-VOLT AC-DC HIGH SPEED MOTOR. (See figure 1-13.) This motor operates in a speed range of 48 to 128 frames per second. The speed control knob is located at the rear of the motor. A tachometer, independent of the camera tachometer, indicates speeds which are in excess of the camera tachometer range. This motor is used when a greater speed range at a higher voltage potential is desired.

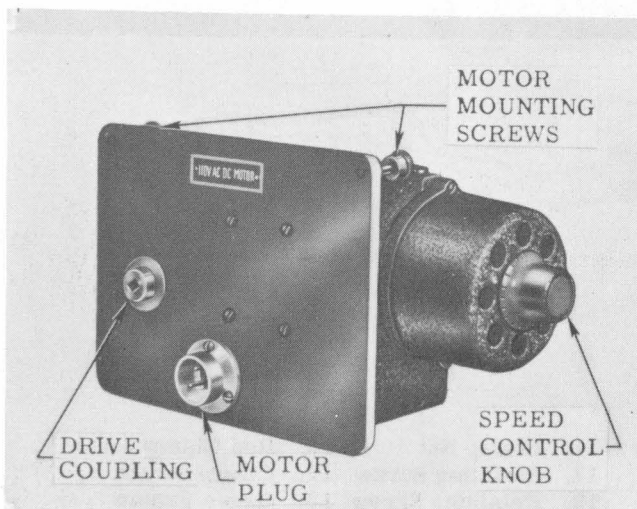


Figure 1-12. 110-Volt Ac-Dc Reversible Motor

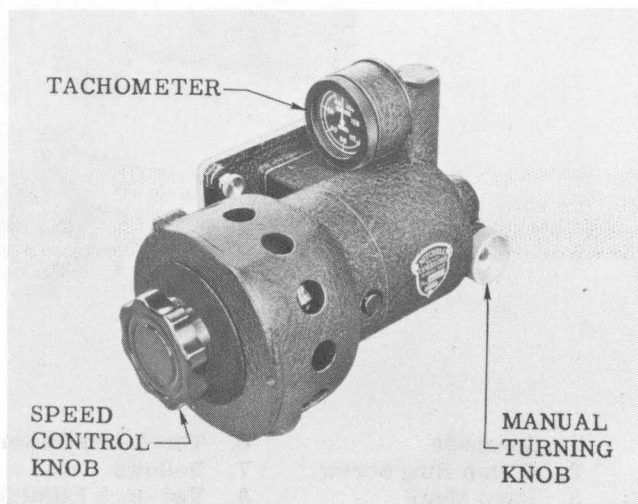


Figure 1-13. High Speed Motor



Figure 1-13A. Electrical Hook-up for 115 Volt Ac Synchronous Motor

Section I
 Paragraphs 1-28 to 1-31

1-28. 110-VOLT AC-DC REVERSIBLE MOTOR. (See figure 1-12.) This motor operates on either ac or dc current obtained from a power supply with an average potential of 115 volts. Clockwise rotation of a governor knob at the rear of the motor increases the speed regulation point. On early motors a three-position series resistance switch is inserted in the line circuit to compensate for a dc line voltage variation which may be anywhere from 100 to 135 volts. The switch allows for more accurate adjustment of camera speed in the 8 to 36 frames per second range. With the switch turned to the left, resistance is removed for speed regulation at low line voltage. Maximum resistance is obtained at switch middle position to provide proper speed regulation at high line voltage. Models subsequent to serial number 227 do not require this switch since the governor automatically adjusts for varying line voltage. On early models the forward-reverse switch for process photography is on top of the motor. On later cameras it is located on the side of the motor.

1-29. 115-VOLT AC SYNCHRONOUS MOTOR. (See figure 1-13A.) The motor operates the camera at a rate of 24 frames per second in synchronization with another motor which may drive a device such as a sound recording machine. The motor is supplied with a capacitor box that includes an ON-OFF toggle switch. Power is supplied to the capacitor box through a relay box, power cable and grounding clip. The power output side of the relay box has two receptacles. The camera motor power cable is plugged into one of the receptacles while the other is available to supply power to another synchronous motor. No speed adjustment may be made at the motor, speed being determined by the current cycle. The motor is available with either a single phase, 60-cycle, or 50-cycle stator. For wiring schematic, see figure 1-13B.

CAUTION

Make certain that grounding clip is secured to clean, bare metal. The relay box is provided to reduce shock hazard by grounding one side of the power supply. In the event motor will not operate, reverse polarity of power input plug at power source.

1-30. MOTOR CABLES. One cable for the 110-volt motors and one for the 24-volt motor are provided. The cables have "ON-OFF" toggle switches and plugs (figure 3-2) which fit the receptacle at the top of the camera box. The 110-volt motor cable has a conventional two-prong straight electrical plug at the power source end. The 24-volt motor cable has a two-prong twist-lock plug for connection to a battery receptacle.

1-31. FRICTION HEAD. (See figure 3-9.) The camera is attached to the friction head by a single 3/8-16 screw. The screw is rotated by turning a knob directly beneath the friction head top plate, and is accessible through the supports of the top plate. It turns in a horizontal plane, and can be tightened with one hand. Further tightening may be accomplished by means of the handcrank. The panoram mechanism of the friction head is so designed that the camera may be rotated 360 degrees in either direction. The tilt mechanism is so designed that the camera may be tilted in the vertical plane approximately 45 degrees above and 45 degrees below the horizontal plane. The tilt mechanism is designed to prevent possible damage to the camera by violent tilting when the tilt lock is accidentally loosened. Both the panoram and tilt movements may be made at the same time, as they are controlled by a single handle. Two locks, one for panoram and one for tilt, secure the friction head in any given position. Each lock acts independently of the other.

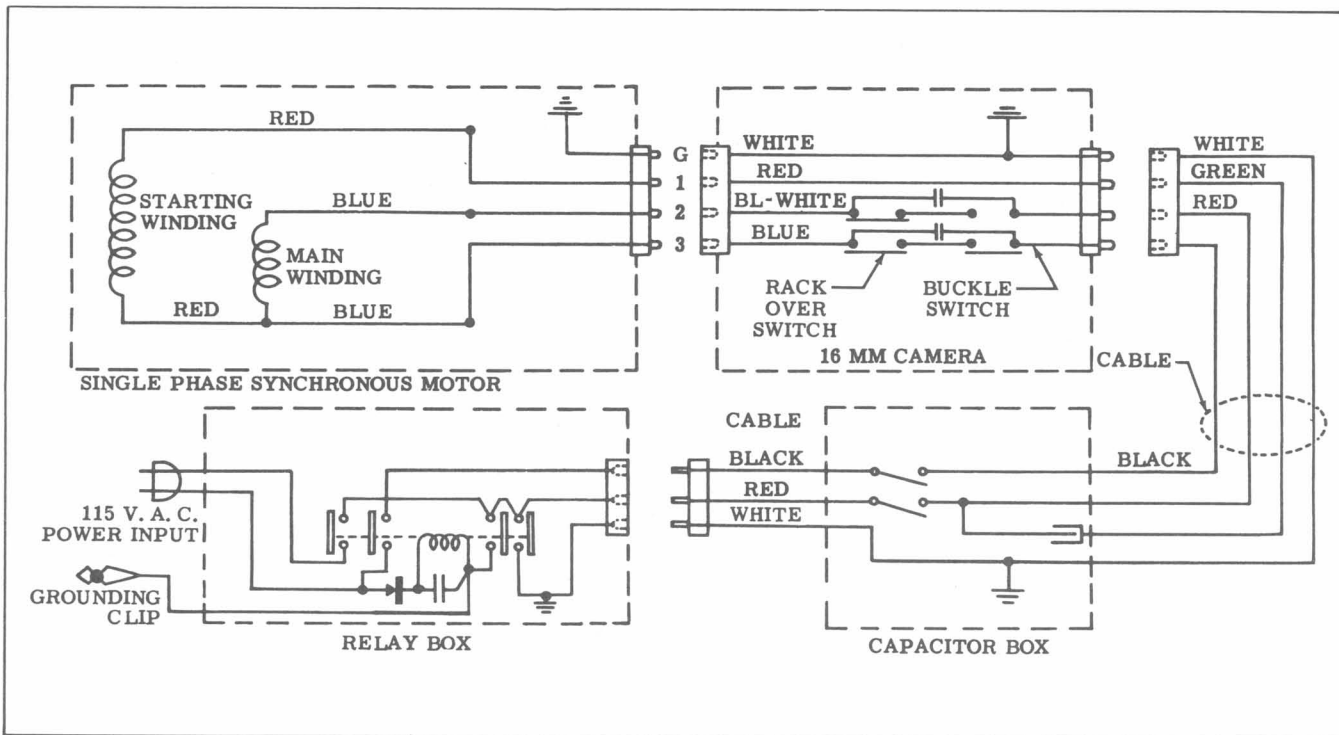


Figure 1-13B. 115 Volt Ac Synchronous Motor Electrical Schematic

1-32. TRIPOD. (See figure 1-14.) The tripod has a height of 78 inches when extended and 50 inches when lowered. Legs are of seasoned maple impregnated with oil and are attached to a metal casting at the top. The base shoes are cast brass, with points of steel screwed in and locked with a nut. Inside each shoe, set at a

45-degree angle, is a second point for low settings. By turning large knurled knobs in the tripod legs, the legs may be tightened at any desired height. Underneath the tripod top are three tiedown eyes which are used to anchor the unit.

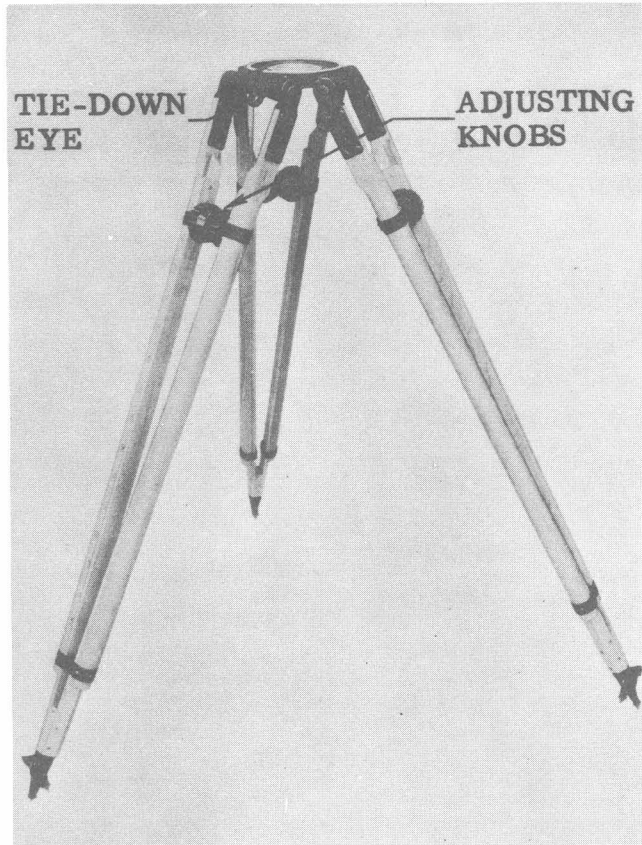


Figure 1-14. Tripod

1-33. LOW MOUNT (HI-HAT). (See figure 1-15.) The "Hi-Hat" or low mount is suitable for mounting the camera on airplanes, small boats, and other places where a tripod can not be used. The "Hi-Hat" is 4-1/2 inches high.

1-34. CARRYING CASES. (See figure 1-16.) A camera carrying case and an accessory case are furnished with all camera models. The motor carrying cases and the tripod boot and saddle are furnished with some models in addition to the camera case and accessory case.

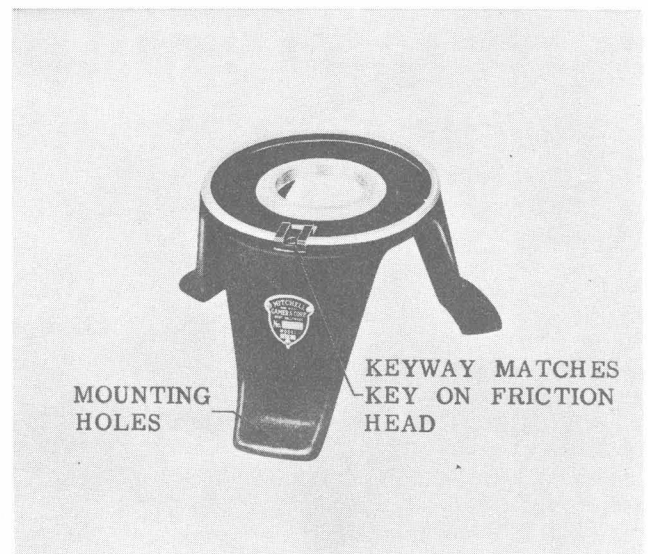


Figure 1-15. Hi-Hat

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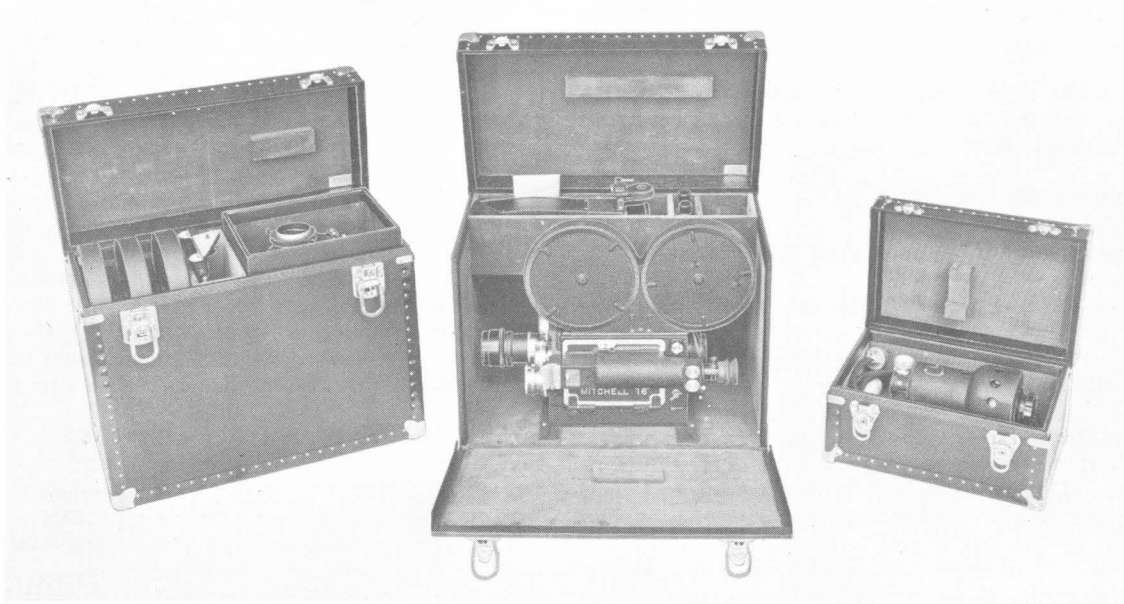


Figure 1-16. Camera and Accessory Cases

SECTION II SPECIAL SERVICE TOOLS

2-1. SPECIAL SERVICE TOOLS.

2-2. No special service tools are required. The

service instructions covered in this manual will be limited to operations requiring screwdriver, pliers, and wrench.

SECTION III OPERATION

3-1. PREPARATION FOR USE.

3-2. UNPACKING. Note carefully the way each component fits into its compartment when first removing the camera and accessories from the carrying cases. Be careful to replace the components in the same way. Figure 1-16 shows the equipment packed in the proper manner.

3-3. SETTING UP TRIPOD AND MOUNTING FRICTION HEAD. Set up tripod with legs spaced so points are about four feet apart. Unscrew the knurled adjustment knobs between the tripod legs and adjust height to suit.

If it is necessary to anchor tripod, use tie-down eyes under tripod head. Remove hold-down nut from friction head and place friction head in position on tripod. Be careful not to burr threads of friction head against top casting of tripod when mounting. Turn friction head until key on under side falls into keyway on tripod casting and mount friction head hold-down nut and tighten.

3-4. MOUNTING THE CAMERA.

a. Lock the pan and tilt locks so the friction head will not move while the camera is being attached.

Section III

Paragraphs 3-5 to 3-12

b. Place camera over the friction head so the spring-loaded hold-down screw on the friction head enters the threaded hole in the camera base.

c. Turn the hold-down screw knob in a clockwise direction, holding the camera squarely on the friction head until drawn down snugly.

3-5. MOUNTING MAGAZINE.

a. Load magazine as instructed in paragraph 3-17.

b. Pull a six-inch loop of film out of the magazine.

c. With camera box door open, drop film loop down through the top opening.

d. Slide loaded magazine into position so spring-loaded hold-down screw engages with tapped hole in magazine. Tighten magazine by turning notched knob at upper left side of camera box.

e. Thread film as explained in paragraph 3-20. Before attaching magazine drive belt, remove slack from takeup core (turning pulley on core clockwise); then slip belt uncrossed over rear pulley on magazine to operate camera forward. Refer to paragraph 3-32 for reversing direction of film in camera.

3-6. MOUNTING MOTOR. (See figures 1-3, 1-7, 1-12, and 1-13.) Both the high and low speed motors are mounted on separate camera doors and are easily interchanged for desired speed range. When the motor assembly is mounted on the camera, the motor drive shaft engages with the movement shaft and the motor electrical receptacle engages with a receptacle at the right side of the camera box. To install motor, proceed as follows:

a. Adjust manual turning knob on motor until motor drive socket lines up with movement shaft.

b. Push motor assembly into position and pull back sliding latch at bottom of camera box.

c. Tighten the two knurled motor mounting screws at upper corners of the motor door.

d. Attach power input cable for appropriate motor to receptacle at top rear of camera box. The cable with the twist-plug is used only with the 24-volt dc motor; the other cable is used with the 110-volt ac-dc motor.

3-7. MOUNTING VIEWFINDER. To mount viewfinder on camera, slide dovetail bracket on viewfinder into bracket on side of camera base and turn locking lever (figure 1-9) at top of bracket.

3-8. MOUNTING MATTE BOX. (See figure 1-10.)

a. Line up matte box bracket with camera base by fitting the bracket dowels into the holes provided in the base of the camera and turn the bracket mounting screw (figure 1-2) on bracket.

b. If support tubes are not in bracket insert them into the holes provided and tighten respective set screws.

c. Slide matte box onto tubes and adjust position of

bellows (depending on type matte box used) so that sunshade will clear the field of lens in use. With the 15mm lens, the bellows must be completely contracted or the matte box unit removed.

3-9. INSTALLING MAGAZINE DRIVE BELT. The drive belt is installed by threading one end, between the rear and middle rollers at the top of the camera box, around the sprocket pulley and up between the middle and front rollers. Slip the belt uncrossed over the rear pulley for forward operation, or cross the belt and slip it over the forward pulley for reverse movement. When using the spring-type drive belt, screw the two ends of the spring together by rotating the ends in opposite directions to unwind the coils, then insert one inside the other and tighten the connection. (See paragraph 3-32.)

3-10. PRINCIPLES OF OPERATION.

3-11. GENERAL. The Motion Picture Camera is a device for intermittently driving a continuous length of 16mm film so that the exposures, which are made when the film is stationary, form a succession of images on the film. The process involves three basic operations: the feeding of the film from the feed drum to the exposure aperture; the exposure of the film through a lens while it is motionless before the aperture; and the rewinding of exposed film on a take-up core. To accomplish these operations, the camera is equipped with a film magazine which houses the film feed and take-up cores; an electric motor which drives the intermittent movement as well as the shutter, take-up mechanism, sprocket, counters and tachometer, and lenses.

3-12. OPTICAL COMPONENTS. The optical components are the camera objective lenses, a viewfinder, and a focusing tube. The camera objective lenses are mounted on the lens turret which is rotated to place the lens of proper focal length in front of the camera aperture. The viewfinder is mounted on left hand side of the camera and consists of a prism, to which the objective lens is attached, a ground glass focusing screen and a magnifying glass. The focusing tube consists of an objective lens, ground glass screen, magnifying lens, eyepiece, and filters. The focusing tube is mounted integrally with the movement access door and is placed in position by racking the camera to the right. In focusing position, the scene is viewed through the camera aperture so that the exact scene is viewed as it will be photographed. When the camera is in the photographing position, it is racked to the left. (See figure 3-1.) The adjustable mattes in the viewfinder are used to frame the scene to be photographed so that hairline mattes define the same area as does the camera aperture. In adjusting the viewfinder it is necessary to move the rear end of the viewfinder toward or away from the camera in a horizontal plane to compensate for the difference in point of view of the scene as viewed through the focusing tube and as viewed through the viewfinder. This is known as parallax adjustment. The result of correctly adjusting for parallax is that the crosshairs on both viewfinder and focusing tube impinge on the same point in the scene to be photographed. This point must be centered exactly between the horizontal and vertical mattes of the viewfinder. The adjustable lens of the focusing tube has two positions: normal when the lens knob is to the rear,

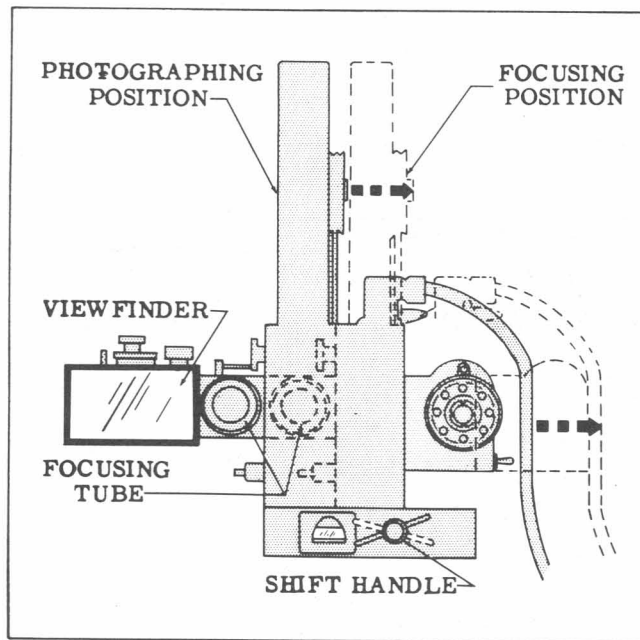


Figure 3-1. Rack-over Diagram

and magnified when the lens knob is forward. The magnified position is used for critical focusing. Before photographing, the magnification knob must be returned to the normal position and a check made with the viewfinder to determine whether the scene is properly framed. The ground glass screen in the focusing tube is a critical factor in focusing in that the screen must be correctly inserted. The ground glass is correctly inserted when the smooth surface of the glass faces to the rear and the beveled edges of glass are on the right hand side of the focusing tube. Should the ground glass be installed so that the smooth surface faces forward, the focus of the camera will be off by the thickness of the glass.

3-13. LIGHT CONTROL. The amount of light striking the film is controlled by the lens diaphragm of the objective lens and the adjustable shutter. The shutter opening can be varied from zero degrees to 235 degrees by operating a hand dissolve lever at the back of the camera. The hand dissolve lever controls fading in and fading out of scenes and exposure interval setting.

3-14. FILM DRIVE SYSTEM. Motive power for driving film through the camera is derived from one of the 110-volt ac-dc motors, or a 24-volt dc motor. The motor drives the cam shafts and gears actuating the pull-down lever and registration pins; and the shutter, sprocket, counter, and film. The movement of film is continuous as it leaves the feed drum. A continuously rotating sprocket feeds film to the registration pins and pull-down claw transforming the continuous motion of the film into an intermittent motion, thus allowing the film to remain motionless during its period of exposure. For stability while the film is being exposed, registration pins move forward and engage sprocket holes in the film. The movement of the registration pins is so synchronized with the pull-down claw that the film is always engaged, either by the pull-down claw or the registration pins. The timing is so arranged that the shutter blocks the aperture whenever film is being

moved by the claw; conversely, the shutter is open whenever registration pins are engaged. After exposure the intermittent movement of the film is changed to continuous movement by the sprocket, turning at a constant rate. The film is wound evenly on the take-up core by continuous motion irrespective of direction or movement of the film. The take-up core is driven by a belt which passes around a pulley on the sprocket. Belt drive slippage compensates for the gradually increasing diameter of the take-up roll and keeps a constant tension on the film as it is wound. If the belt is too tight to permit adequate slippage at the magazine, a clutch in the sprocket will allow slippage between the sprocket shaft and the belt drive pulley.

3-15. ELECTRICAL SYSTEM. (See figures 3-2 and 3-3.) Power to run the camera is supplied through an insulated cable extending from the electrical power source to a power input receptacle on top of the camera. A toggle switch is installed in this cable near the camera and affords an accessible means for turning the camera motor on and off. The internal wiring of the camera includes two buckle-trip microswitches which break the circuit and stop the motor whenever the film buckles. Two rack-over switches actuated by a plunger disconnect the power source from the motor whenever the camera is not in the photographing position.

3-16. OPERATING INSTRUCTIONS.

3-17. LOADING MAGAZINE. The magazine is loaded in either a dark room or changing bag. It is advisable to practice loading a magazine in the light, using an exposed roll of film to become familiar with the process. Load magazine as follows:

NOTE

Clean inside of magazine with a brush or with light air pressure before loading film.

- a. Unscrew magazine covers and turn velvet light trap rollers to make sure they are free.
- b. Unpack a roll of unexposed film from its wrapping and unwind about two feet of film.
- c. Lay roll to the left of magazine adjacent to front drum. Mount film on front drum spindle so that film feeds off spool from the rear as shown in figure 3-4. This is essential as the emulsion is on inner surface and this side must face lens.
- d. Push film end down between idler roller and center portion, then through light trap rollers of forward compartment.
- e. Place film roll core in position on hub of rear compartment. The cores supplied with film are plastic with a slot which accommodates pin on magazine hub.
- f. Replace cover on forward compartment drum.
- g. Push end of film up through rear light trap rollers, over idler roller and insert end in plastic film core installed on take-up hub.
- h. Replace cover on rear magazine compartment drum.

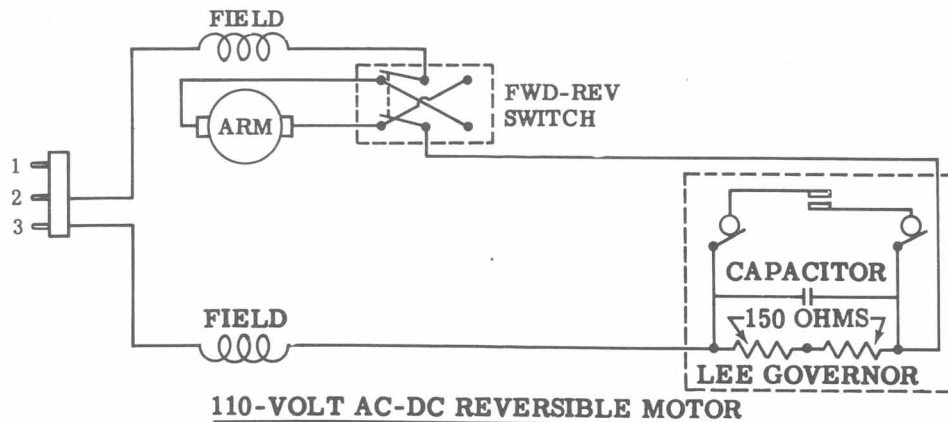
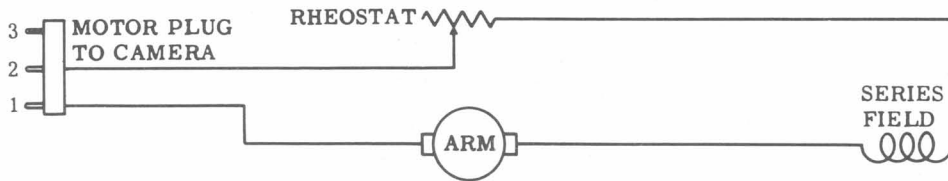
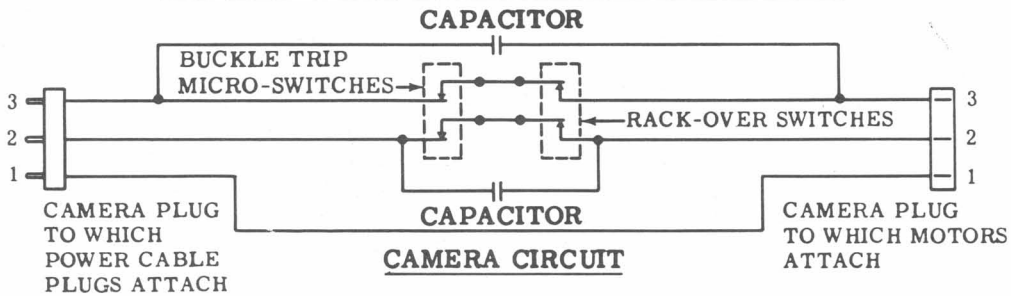
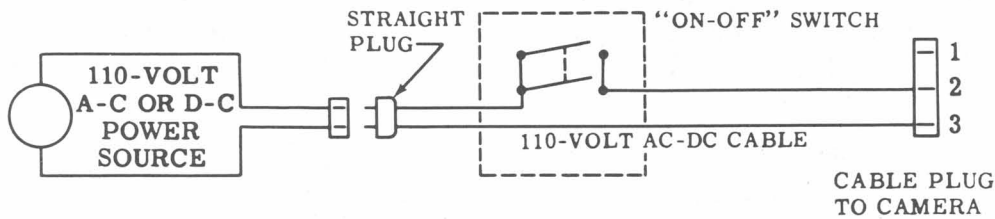
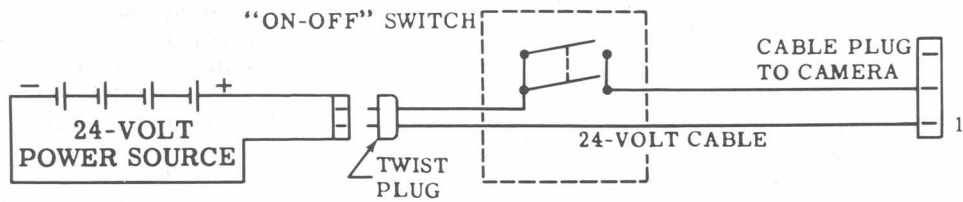


Figure 3-2. Wiring Diagram

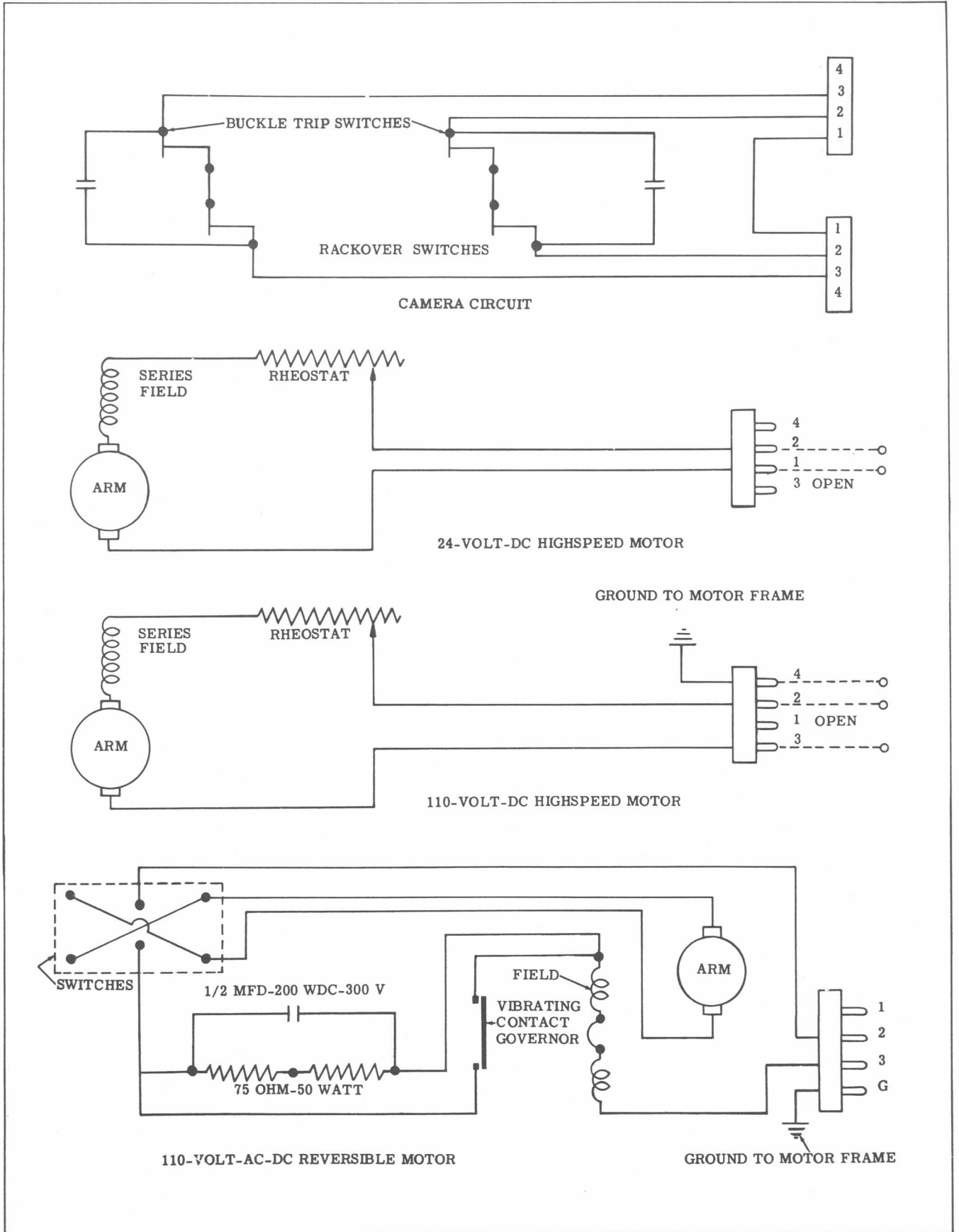


Figure 3-3. Wiring Diagram (Serial Number 227 and on)

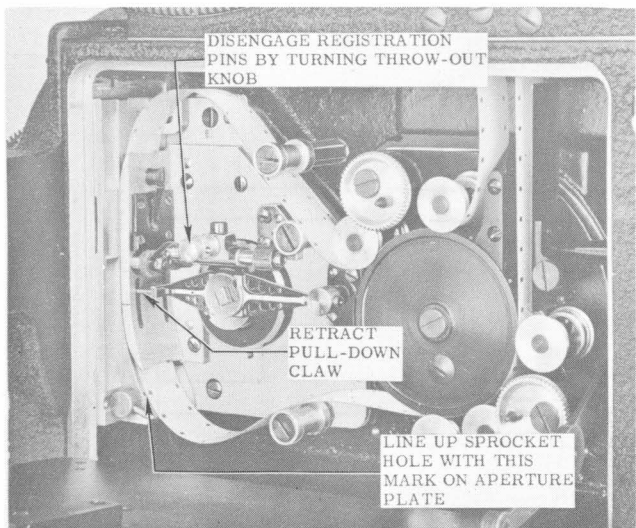


Figure 3-4. Insert Film in Movement

3-18. UNLOADING MAGAZINE.

- a. Remove magazine covers in dark room and remove exposed film roll from take-up drum.
- b. Rewrap film and place in light-proof can. Tape can to prevent light from leaking in.

3-19. CHANGING MAGAZINES. To change from one film stock to another, unthread film from sprocket and movement and wind surplus loop into rear magazine drum. Remove the magazine and install the new one as instructed in paragraph 3-5.

3-20. THREADING CAMERA. (See figures 3-4 and 3-5.) Threading film in camera is done without cutting film. This makes it possible to change quickly from one stock to another. To thread camera, proceed as follows:

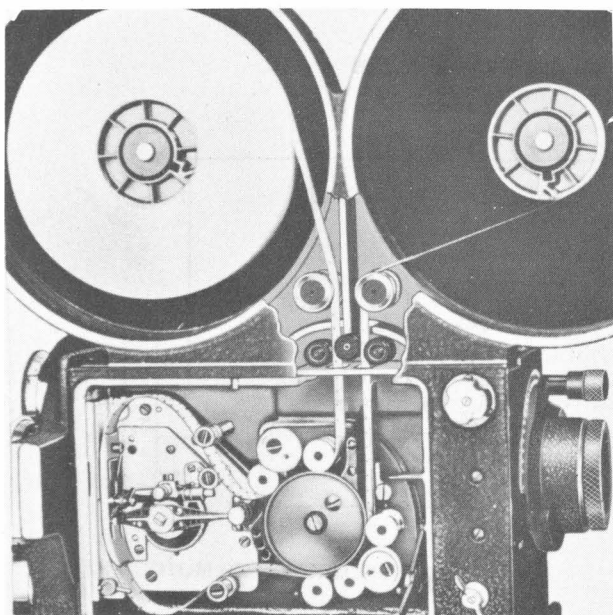


Figure 3-5. Film Threaded in Camera

NOTE

When preparing to use a cold camera, run camera for several minutes before threading film. This will allow motor and mechanism to warm up to operating temperature, insuring a constant speed when first scene is taken.

- a. Raise or remove viewfinder to permit opening of camera door. (See figure 3-6.)
- b. Rack camera over to photographing position and open door.
- c. Remove and clean aperture plate and pressure plate. (See paragraphs 5-4 and 5-5.)
- d. Reinstall plates.

NOTE

Both pressure and aperture plates must be cleaned each time camera is threaded.

- e. Release sprocket film guides by turning upper and lower eccentrics counterclockwise.
- f. Rotate manual turning knob on motor so pull-down claw is in retracted position and will not interfere with film threading.
- g. Turn throw-out knob counterclockwise to disengage registration pins.
- h. Extend film loop from magazine by pulling film from feed drum so sufficient loop will be obtained to thread film as shown in figure 3-4. Be careful not to pull film from take-up drum. When extending loop, place film in film groove between aperture plate and register plate, and over idler rollers.
- i. Line up sprocket hole on left side of film with indexing mark on aperture plate. Engage registration pins by turning throw-out knob clockwise.
- j. Make certain lower loop between movement and sprocket is adjusted correctly. Lower loop should clear bottom of camera box by 1/8 to 1/4 inch at lowest point of travel. If loop is too short, turn manual knob on motor with film disengaged from sprocket until proper size loop is obtained. Then engage lower loop of film with sprocket and film guide.
- k. Adjust upper loop. If loop is too short, draw necessary film from feed drum. Place film in position on top of sprocket and lock in place with the upper sprocket film guide assembly by turning eccentric clockwise.

CAUTION

Film loops must be adjusted accurately. Film must be fed out or taken up over sprocket. Do not move film in the race as this will scratch the film. Film breakage is usually caused by improper threading, particularly in forming of loops. If a film breaks, camera must be thoroughly cleaned and rethreaded.

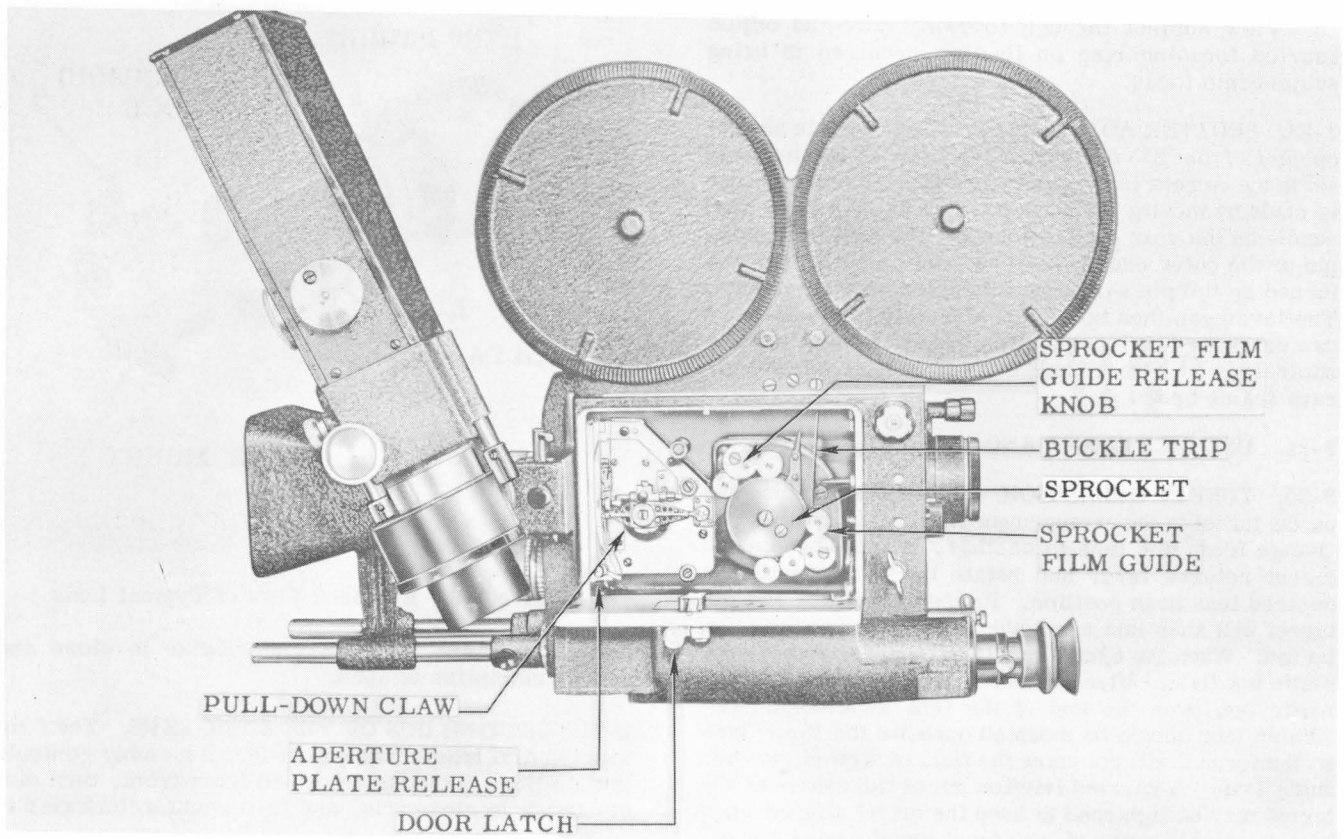


Figure 3-6. Viewfinder Raised for Access to Movement

m. Rotate motor manual turning knob and observe movement of film at aperture and action of pull-down claw and registration pins. Operate motor slowly for a few frames, observing action of movement and sprocket. Make certain film does not tighten on idler rollers or touch box at any point.

n. Close camera box door. If upper or lower sprocket guides are not in place, door will not close.

3-21. SETTING COUNTER. The footage counter at rear of camera should be reset to zero whenever a new magazine is installed on camera. The reset knob is located at rear of camera on left side (figure 1-4). The footage counter can be used to record footage of film used for an individual scene. The fourth window to right of the footage counter registers individual frames and is marked in increments of 2 to a maximum of 40. (There are 40 frames per foot of film.) The frame counter does not reset to zero with footage counter and may be used for double exposure work. The footage counter indicates exact length of film exposed so second exposure will coincide exactly with first.

3-22. USE OF FOCUSING TUBE. (See figure 3-7.) The focusing tube has two adjustments: magnification control and eyepiece adjustment. Instructions for focusing camera lenses are as follows:

a. Move magnification adjusting knob fully to the front or fully to the rear. Magnification is obtained in forward position; normal viewing is obtained in rear position. Magnification is used for critical focusing.

b. Release eyepiece lock screw, and focus cross-hairs on ground glass by turning eyepiece in a clockwise or counterclockwise direction.

NOTE

The smooth surface of ground glass must be facing to rear of tube. Focus will be in error by thickness of glass should smooth surface of ground glass be facing forward.

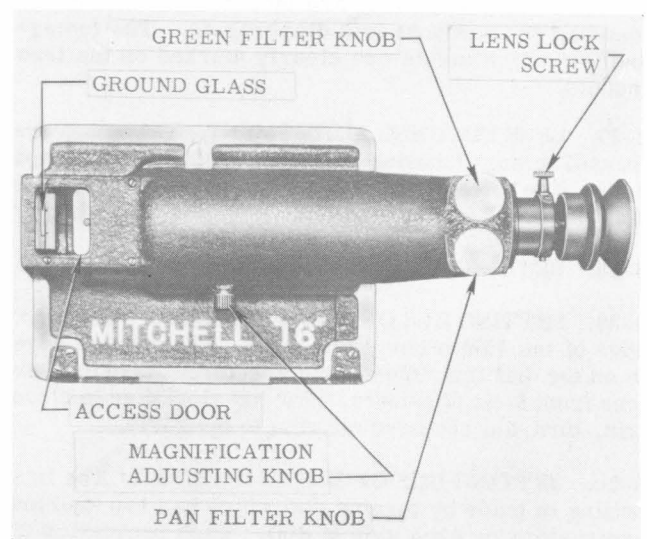


Figure 3-7. Focusing Tube

c. View subject through focusing tube and adjust knurled focusing ring on lens as required to bring subject into focus.

3-23. SHUTTER ADJUSTMENT. Variations in shutter openings from 235 degrees to fully closed can be made while the camera is in operation. This exposure change is made by moving the hand dissolve (shutter adjusting) handle on the rear of the camera. The knurled locking pin at the outer end of the lever can be pulled out and turned so the pin will clear the holes on the segment. The lever can then be moved smoothly for fades. As camera speed is increased, shutter opening time is naturally reduced. Table I gives shutter speeds for each frame speed.

3-24. USE OF TURRET AND LENSES.

3-25. TURRET OPERATION. The lenses are mounted on the turret in the arrangement shown in figure 1-5. To change from one lens to another, press down on the turret release lever and rotate the turret until the desired lens is in position. Release the lever and the turret will snap into exact photographing position when turned. When the 63mm lens is to be used, remove the matte box first. After the lens is in position, mount the matte box over the end of the lens assembly. The 100mm lens should be mounted opposite the 15mm lens so the former will not enter the field of view of the wide angle lens. A knurled friction nut at the center of the turret may be tightened to keep the turret aligned when heavy special lenses of long focal length are installed. For normal use with lenses provided, the lock should be backed off 1/4 turn after tightening.

NOTE

All lenses removed from turret should be replaced by a lens hole cover.

3-26. LENSES. (See figure 3-8.) Some cameras are supplied with three CINE EKTAR lenses, others are supplied with four BALTAR lenses. The type "C" mount and lens adapter are required to mount all EKTAR lenses on the camera turret. The fourth position on the turret is covered by a lens hole cover when no fourth lens is used. All lenses are mounted in micrometer focusing mounts with iris diaphragms. The footage and iris adjustments are clearly marked on the lens mounts.

3-27. LENS FOCUSING ADJUSTMENT. The lenses are focused through focusing tube as described in paragraph 3-22. The footage dial on lens can be used, providing distance to subject is known.

3-28. SETTING IRIS OF THE CINE EKTAR LENS.

3-29. SETTING IRIS OF THE 15MM LENS. The front edge of the 15mm lens is knurled. The knurled edge is on the dial that adjusts iris aperture. Looking into lens from front of camera, turn dial clockwise to close iris, turn dial counterclockwise to open iris.

3-30. SETTING IRIS OF THE 25MM LENS. The iris setting is made by turning dial which has two knurled protrusions on each side of dial. Each protrusion is made of five individual knurls. Looking into lens from

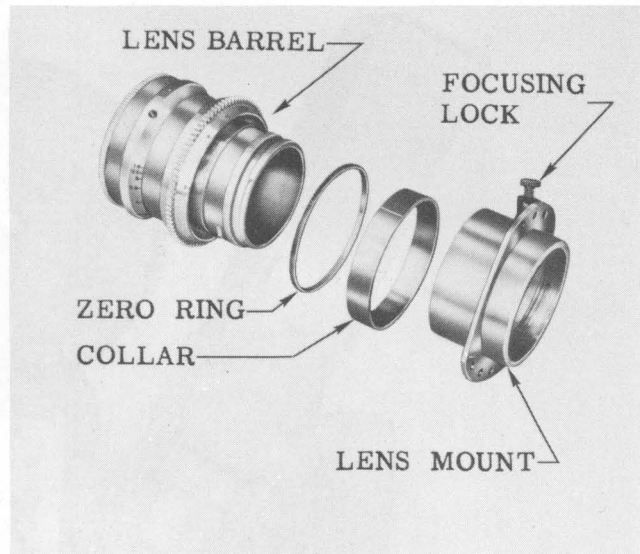


Figure 3-8. Exploded View of Typical Lens

front of camera, turn dial clockwise to close and counterclockwise to open.

3-31. SETTING IRIS OF THE 63MM LENS. The first knurled dial from front end of lens assembly controls iris setting. Looking into lens from front, turn dial clockwise to close iris, and turn counterclockwise to open iris.

3-32. SETTING IRIS OF THE BALTAR LENS. The front edge of the lens is knurled. The knurled edge is on the dial that adjusts the iris aperture. Looking into the lens from the front of the camera, turn the dial clockwise to close the iris and turn counterclockwise to open the iris. The preceding instructions cover the setting of the lens iris for all four of the f/2.3 BALTAR lenses (15mm, 25mm, 50mm, 100mm).

3-33. OPTICS. It is not within the scope of this handbook to cover such factors as film speed, light intensity, shutter speed and shutter opening, all of which affect the setting of the iris. Table II gives information on iris setting for high speed operation.

3-34. OPERATION OF CAMERA MOTORS.

3-35. OPERATION OF 110-VOLT AC-DC REVERSIBLE MOTOR. The 110-volt motor operates on either ac or dc. The speed of the motor is variable so that film may be driven through the camera in the range of 8 to 36 frames per second. The motor is reversible to move film through the camera in either direction. There are two operating controls on the camera motor: a toggle reversing switch, and a speed control knob. The toggle reversing switch is located on the lower right hand side of the motor assembly. When the toggle reversing switch is in a forward position film is driven through the camera in such a manner (forward) that film feeds from the front section of the film magazine through the camera mechanism into the rear section of the film magazine. When the switch is in the rear position film is driven through the camera in the reverse direction. The speed control is a manually operated governor and is adjusted by turning the speed control knob located on

the rear end of the motor. The speed control knob is turned in a clockwise direction to increase camera speed and in a counterclockwise direction to decrease camera speed. To run camera forward, push the toggle reversing switch forward and slip the pulley belt around

the rear pulley without crossing. To reverse direction of film in the camera, turn the motor off with the toggle switch on the power cable, push the reversing switch to rear, cross the pulley belt and position on the forward pulley.

TABLE I

SHUTTER EXPOSURE TIME
(In Fractions of a Second)

Obtained with Various Camera Speeds and Shutter Openings

Shutter Openings Degrees	Camera Speeds (Frames per Second)								
	8	12	16	24	32	48	64	96	128
20	1/144	1/216	1/288	1/432	1/576	1/864	1/1152	1/1728	1/2304
35	1/82	1/123	1/165	1/247	1/329	1/494	1/658	1/987	1/1316
50	1/58	1/86	1/115	1/173	1/230	1/346	1/461	1/691	1/922
65	1/44	1/66	1/89	1/133	1/177	1/266	1/354	1/532	1/709
80	1/36	1/54	1/72	1/108	1/144	1/216	1/288	1/432	1/576
95	1/30	1/45	1/61	1/90	1/122	1/180	1/242	1/360	1/485
110	1/26	1/39	1/52	1/78	1/105	1/157	1/209	1/314	1/419
125	1/23	1/35	1/46	1/68	1/92	1/136	1/184	1/272	1/369
140	1/21	1/31	1/41	1/62	1/82	1/123	1/164	1/247	1/329
155	1/19	1/28	1/37	1/56	1/74	1/110	1/148	1/220	1/296
170	1/17	1/25	1/34	1/51	1/68	1/102	1/136	1/204	1/271
185	1/16	1/23	1/31	1/46	1/62	1/91	1/124	1/182	1/248
200	1/14	1/22	1/29	1/43	1/57	1/86	1/115	1/173	1/230
215	1/13	1/20	1/27	1/40	1/54	1/80	1/107	1/161	1/214
235	1/12	1/18	1/25	1/37	1/49	1/74	1/98	1/147	1/196

TABLE II
 LENS STOP CONVERSION CHART FOR HIGH-SPEED OPERATION

F. Value for 24 Frames per Second	36 Frames per Second	48 Frames per Second	72 Frames per Second	96 Frames per Second	120 Frames per Second
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LENS STOPS COMPENSATED FOR SPEEDS ABOVE

F2.	F1.4				
2.3	2.	1.4			
2.8	2.3	2.	1.4		
3.2	2.8	2.3	2.	1.4	
4.	3.2	2.8	2.3	2.	1.9
4.5	4.	3.2	2.8	2.3	2.1
5.6	4.5	4.	3.2	2.8	2.5
6.3	5.6	4.5	4.	3.2	3.
8.	6.3	5.6	4.5	4.	3.6
9.1	8.	6.3	5.6	4.5	4.3
11.3	9.1	8.	6.3	5.6	5.
12.5	11.3	9.1	8.	6.3	5.9
16.	12.5	11.3	9.1	8.	7.1
18.	16.	12.5	11.3	9.1	8.5
22.	18.	16.	12.5	11.3	10.
25.	22.	18.	16.	12.5	11.9
32.	25.	22.	18.	16.	14.
36.	32.	25.	22.	18.	17.

3-36. OPERATION OF 110-VOLT AC-DC HIGH SPEED MOTOR. This motor is not reversible and has only one control, the rheostat control knob which governs motor speed. The motor has a minimum speed of 48 frames per second and a maximum speed of 128 frames per second.

3-37. OPERATION OF THE 24-VOLT DC HIGH SPEED MOTOR. The 24-volt motor operates on direct current only. It has a speed range such that film may be driven through the camera in the range of 16 to 64 frames per second. A tachometer is mounted as an integral part of the motor to indicate motor speed. The camera tachometer can not be used in the speed range of this motor

3-38. PANNING AND TILTING. (See figure 3-9.) Panning and tilting are performed through use of the friction head pan and tilt tension knobs, pan and tilt locks and handle. Each lock is independent of the other so that panning and tilting may be accomplished separately or together. The panning and tilting operation is as follows:

a. Adjust tension knobs of friction head to give desired tension so panning and tilting can be done smoothly. (Do not tighten tension knobs more than necessary as this will squeeze grease from the friction clutch plates.)

b. Tighten pan and tilt locks to secure the camera in a particular position.

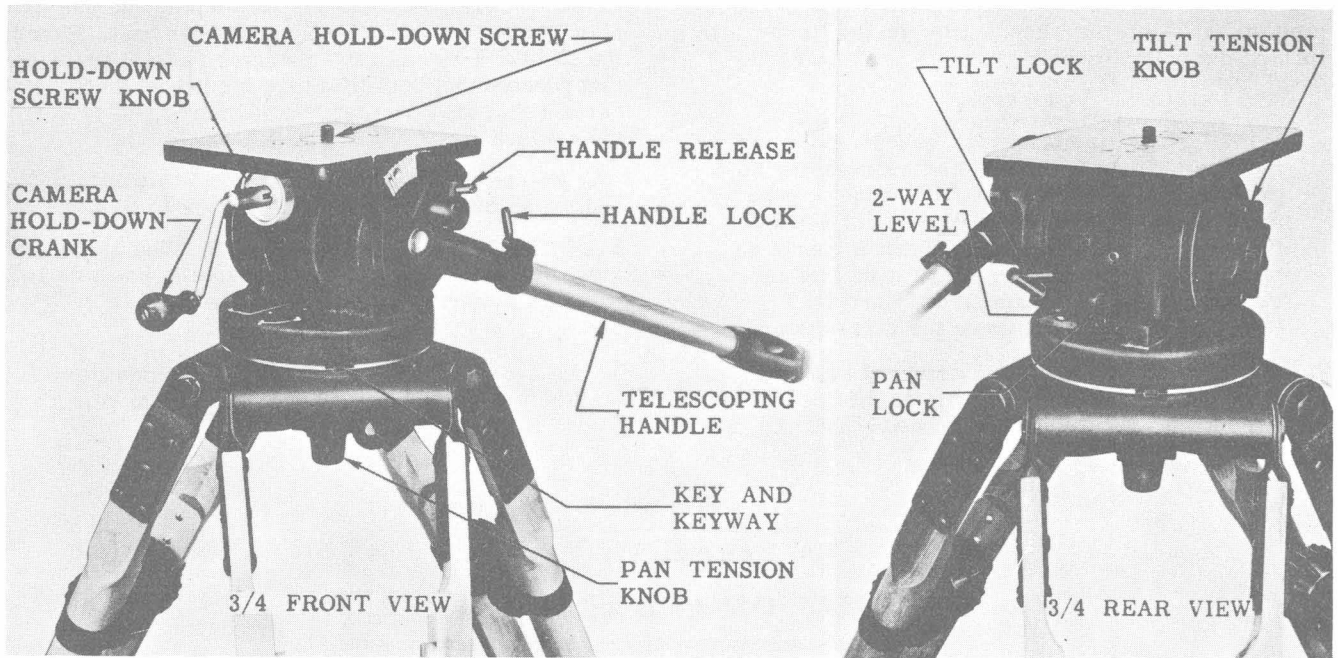


Figure 3-9. Tripod and Friction Head

- c. To pan only, release pan lock and secure tilt lock.
- d. To tilt only, release tilt lock and secure pan lock.
- e. To both pan and tilt, release both locks.

CAUTION

When either one of the locks or both are released, stability of the camera is the responsibility of the operator. Keep one hand on the control handle when releasing tilt lock to prevent camera from tipping over.

3-39. USE OF VIEWFINDER. (See figure 1-9.)

- a. Adjust mattes on viewfinder to correspond with lens being used. Scribed numbers on matte-adjusting knobs at top and side of finder correspond to focal length of lenses supplied with camera.
- b. Loosen locking nuts that hold the focus and parallax adjustment.
- c. Line up crosshairs in focusing tube with subject to be photographed.
- d. Focus viewfinder on the same check point that was viewed through focusing tube. Move viewfinder in a horizontal plane if necessary so that crosshairs of focusing tube and viewfinder coincide exactly on the selected check point of subject.
- e. Tighten locking nuts that hold focus and parallax adjustments.

- f. The viewfinder can be swung on its pivot point for access to the movement without disturbing the above adjustments.

3-40. USE OF MATTE BOX. The various components of the matte boxes are shown in figures 1-10 and 1-11. Ten filters and one pola screen are supplied with the non-bellows type matte box (Model 1-V). Many possible combinations of filters, mattes and gauzes can be made in the bellows type unit. The selection of filters for the Model 1-V and combinations for the bellows type matte box are not within the scope of this manual but rather belong to text books on optics and photography.

NOTE

When used with the 15mm lens the matte box bellows must be fully collapsed and as close to the lens as possible to clear the wide angle field of the lens. The 100mm lens must be removed from the turret to allow sufficient clearance for the bellows when the matte box is used with other lenses.

3-41. FILM BUCKLES. Film buckling is immediately apparent as the buckle trip switch will stop the camera. Buckling must be corrected immediately. No attempt should be made to turn the camera by hand or serious damage may result, necessitating complete overhaul. The occurrence of buckling will be indicated by the noise of the film crumpling inside the camera before the motor is stopped by the buckle trip switch. As soon as the motor stops, proceed as follows:

- a. Throw operating switch on power cable to "OFF".

b. Remove the belt from the take-up pulley on magazine and take up the excess film in the camera by turning the pulley by hand.

CAUTION

Do not allow the magazine belt to move the mechanism inside the camera while taking up the excess film. Operation of the camera movement at this time may cause serious damage. If the film is so tightly jammed that it cannot be taken up by rotating the pulley, it will be necessary to open the camera door and free the film before winding it up on the take-up core.

c. Open the camera door and remove the aperture and pressure plates. Examine the film aperture to be sure that no pieces of torn film are obstructing the light

passage. Examine the registration pins and pull-down claw to make certain they have not been bent. Examine the slots and holes in the aperture plate to make sure that punched pieces of film have not lodged there. Make certain that all torn pieces of film are removed from the camera.

d. Rethread camera as instructed in paragraph 3-20 and press buckle trip button on back of camera box.

3-42. **PACKING CAMERA PARTS.** The camera box must be racked over to photographing position to be installed in carrying case. (See figure 1-16.)

NOTE

Do not use force in packing the various items. Each carrying container is designed to receive its parts easily.

**SECTION IV
INSPECTION AND LUBRICATION**

4-1. SERVICE INSPECTION.

4-2. **GENERAL.** The most essential function of service inspection is to keep the camera clean. The operator must examine camera movement, sprocket, and idler roller assemblies thoroughly each time magazine is changed or door is left open, to make certain no dirt, grit or foreign material has entered mechanism that directly drives, guides and actuates film. Due to close tolerances, a small amount of dirt can cause damage which may result in faulty operation. Refer to Section V for cleaning instructions.

4-3. INSPECTION EACH TIME CAMERA IS USED.

a. Before loading film magazine, check magazine rollers for free rotation.

b. Check all sprocket film guides and idler rollers for free rotation.

c. Inspect aperture and pressure plates for film fragments, foreign particles, burrs, scratches and blemishes, being careful to detect any condition that would damage film or impede the passage of film through film groove. (See figure 1-7.)

d. Inspect camera lenses for etching, lint, dust and foreign particles.

4-4. 10,000-FOOT INSPECTION.

a. Test stability of each motor by operating camera at a selected setting of the speed control knob. Load the magazine and thread camera with blank film. Run film through camera for a measured length of time noting footage counter at the beginning and end of test run to obtain length of film. During run, record average tachometer reading. Frames per second calculated will agree with tachometer reading if motor and tachometer are working properly.

b. Check wiring in camera and cables for continuity.

c. Check operation of buckle-trip switch without film in camera by pushing buckle-trip switch to rear of camera with a pencil or other suitable instrument. Motor will shut off if buckle-trip switch is functioning properly.

d. Check operation of rack-over safety switch without film in camera. Rack camera from photographing to focusing position while motor is running. If the rack-over safety switch is functioning properly, motor will stop.

e. Check turret for ease of rotation, adjusting knurled friction nut at center of turret.

f. Inspect focusing-tube ground glass for scratches, dirt and blemishes. Handle ground glass by edges only as perspiration from the hand will etch the glass.

4-5. 50,000-FOOT INSPECTION.

a. Inspect oil on gibs of camera base and tracks of camera box. Inspect oil on locating plunger. Refer to paragraph 5-8 for lubrication instructions.

b. Check alignment of viewfinder mattes to assure accurate adjustment for each lens. Refer to paragraph 5-11 for adjustment instructions.

c. Check footage calibration on lens barrel by focusing on an object and measuring distance of object from film plane. Compare lens footage calibration with actual distance. Replace or return to factory for adjustment.

d. Check tension of magazine belt. Adjust or replace belt. Refer to paragraph 5-10 for adjustment.

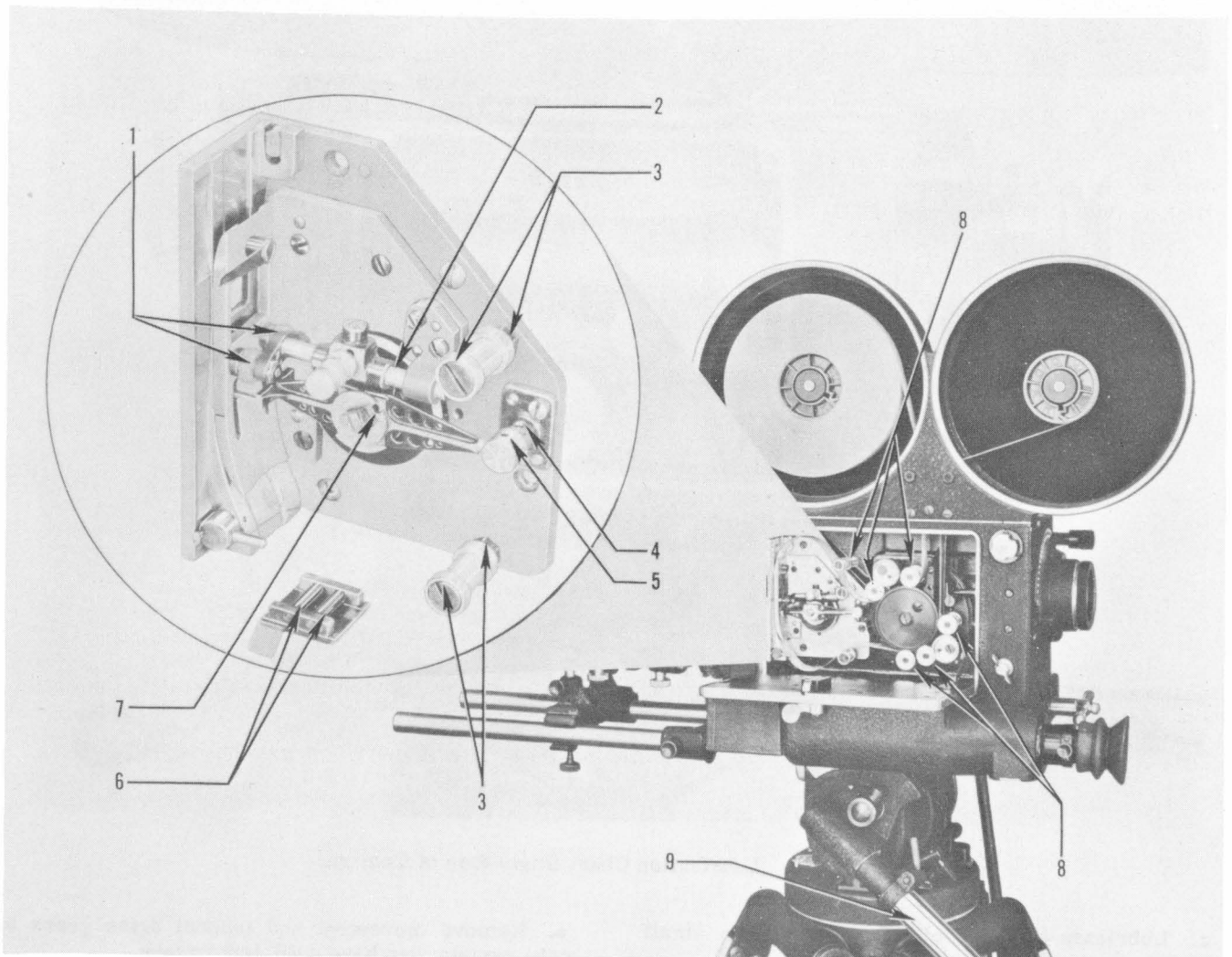


Figure 4-1. Lubrication Chart (Left Side of Camera)

4-6. 100,000-FOOT INSPECTION.

- a. Remove motor and inspect movement-shaft bearing for oil. When properly lubricated, the bearing is covered with a light coating of oil.
- b. Remove round metal cap covering sprocket drive. If grease is not visible, gears must be lubricated.

NOTE

Normally the movement and sprocket drives should not require lubrication until camera is completely overhauled.

- c. Inspect motor brushes. Replace if excessively worn.

NOTE

The left-hand brush for the high-speed motor is covered by a cap in the camera door. Remove cap to gain access to brush.

- 4-7. **LUBRICATION.** (See figures 4-1 and 4-2.) Use Mitchell Camera Oil supplied with camera for all lubrication points requiring oil. Petroleum jelly, white vaseline, or a neutral ball bearing grease in tube form can be used wherever grease is used. Lubricate only those points shown on figures 4-1 and 4-2. All other points of lubrication are of such a nature they should be serviced only when camera is completely overhauled.

- 4-8. **1,000-FOOT LUBRICATION.** Lubricate the movement every 1,000 feet and before every high speed run. See figure 4-1 for lubrication points.

4-9. 50,000-FOOT LUBRICATION.

- a. Lubricate idler rollers by placing one drop of oil on outer and inner side of each roller. If a roller binds, remove and clean it before oiling.
- b. Lubricate rack-over shift handle and locating plunger with one drop of oil.

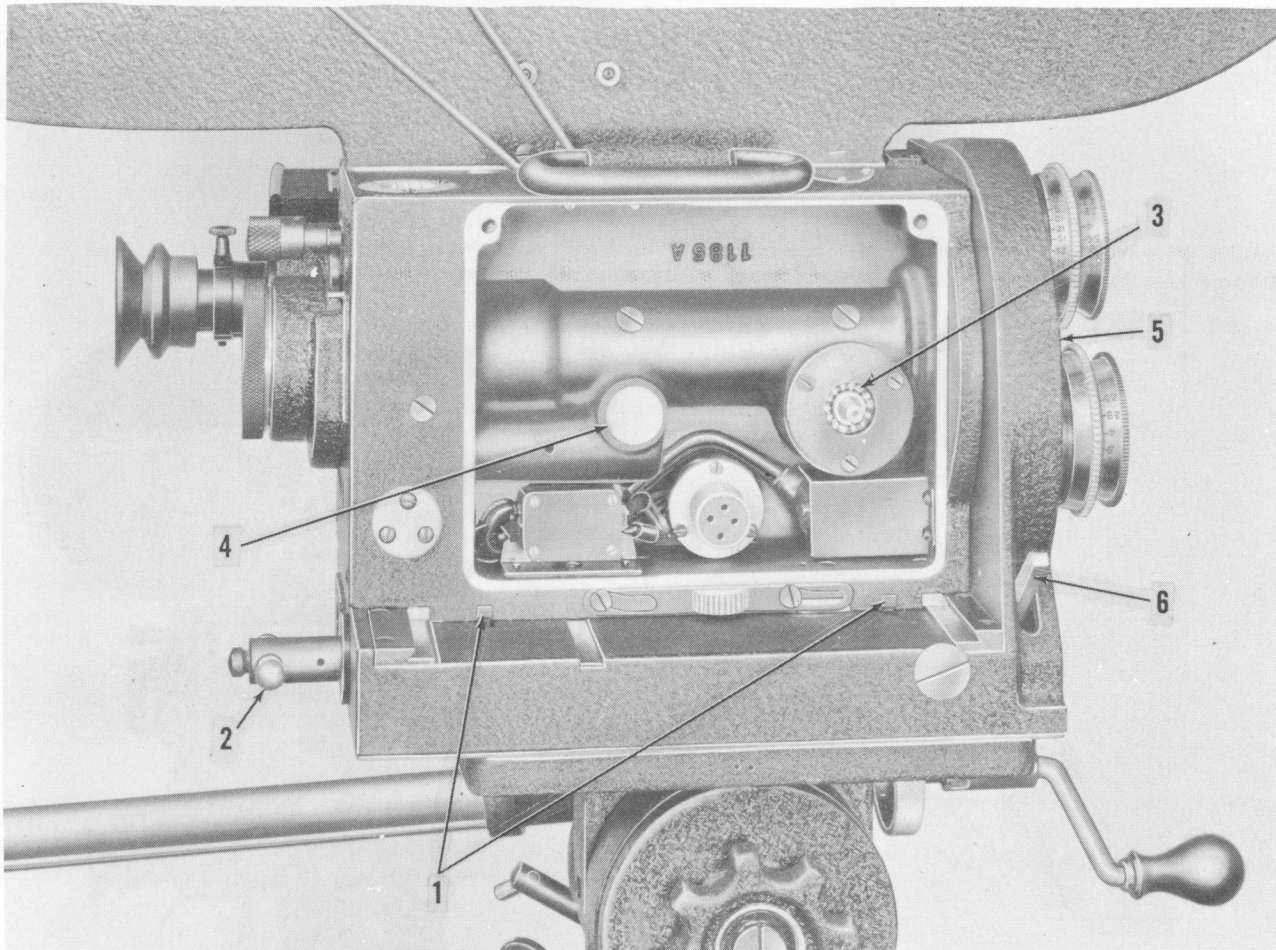


Figure 4-2. Lubrication Chart (Right Side of Camera)

- c. Lubricate turret center bearing with a small amount of grease.
- d. Place one drop of oil on turret locating pin.
- e. Place one drop of oil on each tripod leg clamp bearing.
- f. Inspect movement ball bearings and lubricate with oil if necessary.

a. Remove movement and inspect drive gears to make certain they have sufficient grease.

b. Remove metal cap, in right-hand compartment of camera box, protecting sprocket gears. Gears should be lightly coated with grease. If grease is required, remove sprocket and coat gears.

c. Lubricate shift handle, movement drive-shaft bearings, turret center bearing and locating pin (figure 4-2).

4-10. 100,000-FOOT LUBRICATION.

SECTION V MAINTENANCE

5-1. **CLEANING.** Satisfactory operation of camera over a long period of time is dependent mainly on keeping mechanism free of dust, dirt or other foreign material. Care and vigilance on part of operator is essential, since small particles of dust in the movement or on lens may cause scratches or spots on film that is otherwise properly exposed. Special care must be given all parts which have come in contact with salt water. Such portions of the camera equipment must be cleaned and oiled. The following paragraphs describe parts of camera which most frequently require attention.

5-2. **CLEANING LENSES.** The lenses must be inspected regularly and cleaned when necessary to prevent the possibility of diffused or fuzzy images due to dust, finger marks, condensation or other obstructions on the glass surfaces. A lens or any other optical glass on the equipment should be handled as little as possible because the surfaces are easily scratched by dust or etched by acid present in perspiration. Always handle the lenses by their mounts. Other glass parts, such as the ground glass in the focusing tube, should be handled by the edges. Clean only those surfaces that need cleaning. Do not dismantle a lens to clean the inner elements. To clean glass surfaces, proceed as follows:

a. Remove all loose dust from glass surface with an air syringe or camel-hair brush. Do not use brush used for cleaning camera.

b. Inspect surface carefully to make sure that there are no fingerprints, condensation, or oil streaks on glass.

c. If glass surface is smeared or streaked, dampen a sheet of lens tissue with lens cleaner, and wipe glass surface gently to remove stains. Allow lens to dry and then inspect it for cleanliness. If some stains persist, repeat procedure.

CAUTION

Use extreme care and gentleness when working on coated lens surfaces.

d. After cleaning, remove any lint by gently brushing the surface of glass with a clean camel-hair brush.

5-3. **CLEANING CAMERA BOX.** The interior of camera must be cleaned after each period of use. Cleaning is usually done with an air syringe to blow off loose dust, a camel-hair brush to dislodge clinging foreign material, and a lintless cloth for wiping polished surfaces. To clean camera interior, proceed as follows:

a. Place camera in a room which is free from drafts and dust. If the cleaning must be performed on location, use a clean canvas to protect mechanism while camera door is open.

b. Open camera door and remove aperture plate and pressure plate.

c. Use air syringe to blow all loose dust from mechanism and corners of the box.

d. Use camel-hair brush to get into corners and around sprocket and guide rollers. Make sure that all bits of emulsion or film are removed.

d. Wipe polished metal surfaces carefully with soft, lintless cloth, being careful not to catch cloth on teeth of sprocket or on other sharp projections.

f. Remove with camel-hair brush, any threads or foreign material that may have been loosened from cloth in mechanism and interior of box.

g. Close camera door to keep camera interior clean while cleaning aperture plate and pressure plate.

5-4. **CLEANING APERTURE PLATE.** Clean aperture plate every 1,000 feet. To clean proceed as follows:

a. Turn manual turning knob until claw is retracted.

b. Disengage registration pins by turning throw-out knob.

c. Remove aperture plate from camera by turning locking lever at bottom and sliding plate out. (See figure 5-1.)

d. Clean aperture and film race with a camel-hair brush.

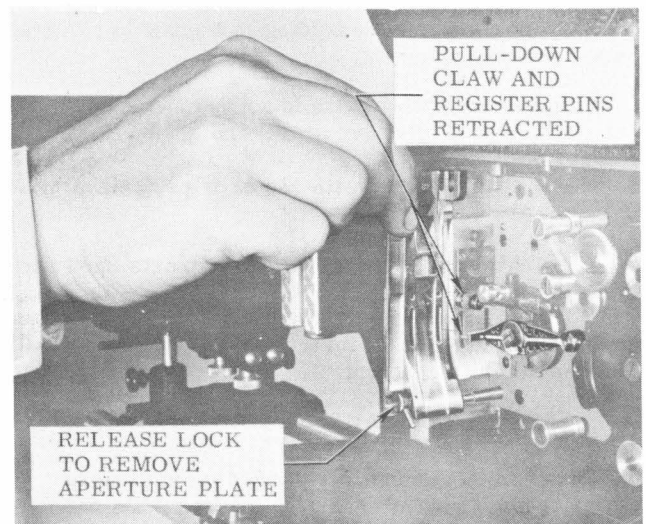


Figure 5-1. Removing Aperture Plate

Section V
Paragraphs 5-5 to 5-9

e. Remove accumulated emulsion from film race, registration pin holes, and pull-down claw travel slots by using an orange stick, or any other type of pointed, soft, wooden prod.

f. Blow through registration pin holes and claw slots with an air syringe.

g. Polish film race with heel of the hand. Place a drop of oil on film race and rub in thoroughly with thumb or heel of the hand to remove all excess oil. The hand must be free of grit and perspiration. Be sure that registration pin holes and claw slots are free of oil.

h. Reinstall aperture plate in camera.

5-5. **CLEANING PRESSURE PLATE.** The pressure plate must be inspected and cleaned each time aperture plate is cleaned. To clean pressure plate, proceed as follows:

a. Remove pressure plate from camera by swinging pressure spring upward and lifting plate out.

b. Remove all loose dust and bits of emulsion with a camel-hair brush.

c. Wipe the forward side of plate with ball of the thumb to remove all loose dust and bits of emulsion.

d. Test rollers to see they revolve freely in plate. If rollers show a tendency to stick, immerse pressure plate in cleaning solvent, revolving rollers while in the fluid. Dry plate thoroughly with clean, lintless cloth; then use an air syringe to evaporate solvent that may be adhering to roller bearing pins. When plate is dry, apply a minute amount of oil to roller bearings with a toothpick. Wipe off all excess oil.

e. Reinstall pressure plate in camera.

5-6. **CLEANING MOVEMENT.** Movement must be kept clean at all times, using air pressure or a camel-hair brush. If salt water, sand or any other foreign material enters movement it should be thoroughly cleaned as follows:

a. Remove and clean aperture and pressure plates.

b. Remove three screws holding movement to camera box and lift out movement.

c. Immerse movement parts in solvent and clean them with a soft brush. Remove all oil and grease.

d. Blow all parts dry with air or wipe them dry if air is not available.

e. Lubricate movement by oiling all points shown in figure 4-1.

f. Time movement as instructed in paragraph 5-9 when replacing in camera.



Whenever movement is removed from camera box it must be retimed with shutter. Do not attempt to operate camera if movement and shutter have not been placed in proper synchronization.

5-7. **CLEANING FOCUSING TUBE GROUND GLASS.**

a. Open sliding door of focusing tube.

b. Insert pencil eraser in front of tube and slide ground glass from slot.

c. Clean glass as directed in paragraph 5-2.

d. Clean lens behind the ground glass with an air syringe, lens tissue and cleaner.

e. Reinstall ground glass into slot, handling glass by edges only. Frosted or ground portion of glass must be installed facing toward front of camera.

f. Close sliding door.

5-8. **CLEANING RACK-OVER MECHANISM.** (See figure 1-6.) The rack-over mechanism should be inspected every 50,000 feet and cleaned when necessary. Clean as follows:

a. Set camera on a table and remove one of the rack-over stop screws at side of base.

b. Rack camera box off base with shift handle, disengaging gears from shift racks. While shifting camera, hold in button on end of handle so locating plunger will not engage. Gently ease camera box off base.

c. Place camera box on its side so rack-over gears are accessible.

d. Use a soft cloth dampened with solvent to remove all lubricant from gears and gear tracks.

e. Clean the upper surface of base and lower surface of camera box thoroughly with solvent. Dry surfaces well.

f. Lubricate rack-over gears with grease.

g. Fit camera into gibs of base and ease it onto base until rack-over gears engage shift racks. Hold shift handle with ears at about 10:20 of a clock face just as gears start to mesh with shift racks under camera box. This will bring handle into the horizontal position when camera box is in focusing position.

h. Rack camera fully on base; then reinstall stop screw.

5-9. **TIMING THE MOVEMENT.** The camera movement must be timed as it is replaced in camera. The timing operation consists of synchronizing movement and shutter so shutter is closed when film is in motion and open when film is registered and motionless in front of aperture. To time movement, proceed as follows:

a. Set the shutter to zero degrees by shifting the shutter and dissolve lever on the rear of the camera.

b. Remove one lens. Insert finger in movement drive shaft hole and turn the driven gear on shutter shaft until

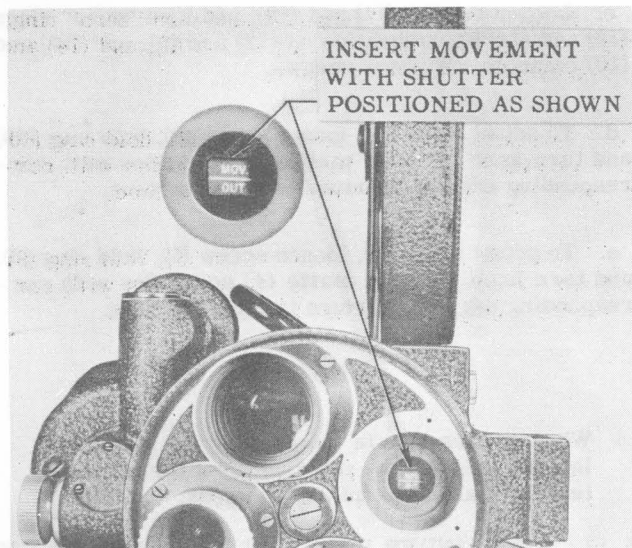


Figure 5-2. Shutter Position for Timing

"MOV OUT" is seen through the camera aperture as shown in figure 5-2.

c. Set pull-down lever in engaged position and in line with scribed mark on register plate. (See figure 5-3.)

d. Insert movement in camera. Do not allow position of movement or shutter to change until gears are meshed.

e. Due to spiral on gears, shutter will rotate as movement is inserted. When movement is all the way in, with pull-down claw still in line with scribed mark, "MOV IN" will show in aperture (figure 5-4), and movement will be correctly timed with shutter.

5-10. ADJUSTING SPROCKET CLUTCH. (See figure 5-5.) The sprocket clutch permits slippage between the magazine belt drive pulley, which is an integral part of

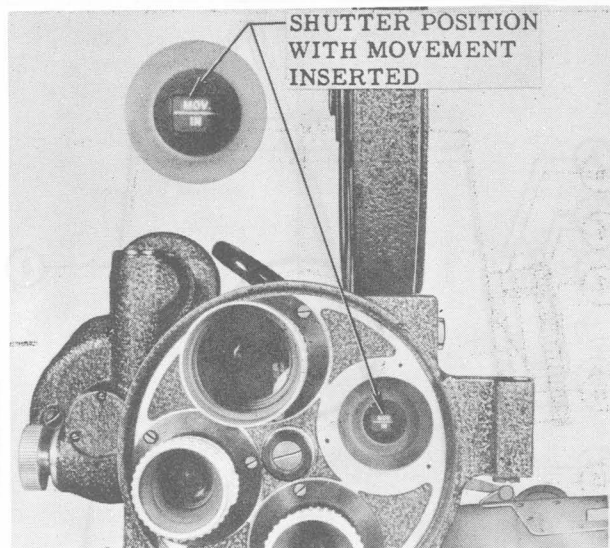


Figure 5-4. Shutter Position for Timing

the sprocket assembly and the sprocket itself. This slippage occurs whenever magazine belt is too tight to permit customary amount of slippage at magazine take-up pulley. As a rule it is better to have the sprocket clutch adjusted a little tight, rather than loose. A loose clutch adjustment may cause slippage under normal operating conditions and prevent the take-up drum from turning at proper speed, which results in film buckling. A tight clutch will do no damage to the equipment. Adjust the clutch as follows:

a. Remove screw at side of sprocket.

b. Insert a sharp instrument such as a scriber into screw hole and engage it with the indentations on clutch adjusting plate.

c. Turn plate clockwise to increase clutch tension; counterclockwise to decrease clutch tension.

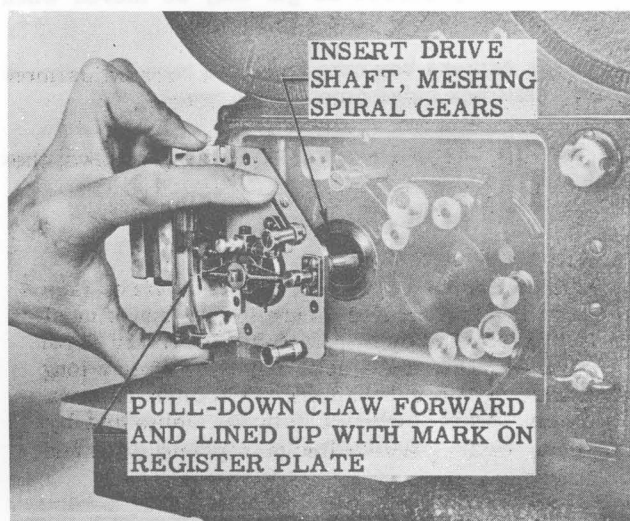


Figure 5-3. Installing Movement

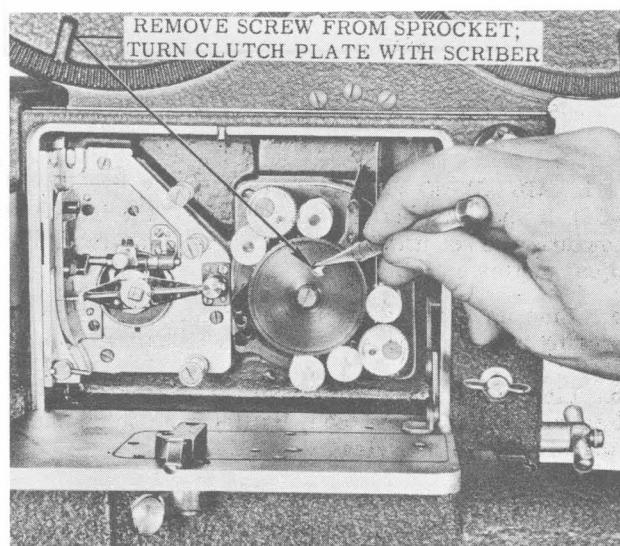


Figure 5-5. Adjusting Sprocket Clutch

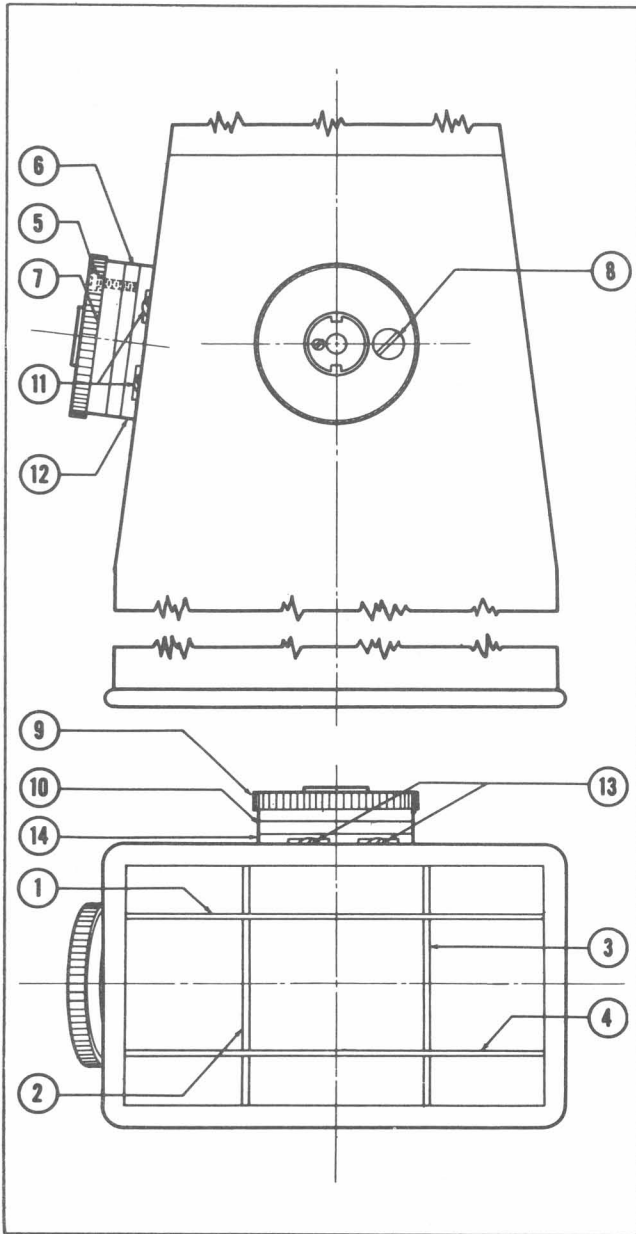


Figure 5-6. Adjusting Viewfinder Mattes

5-11. **ADJUSTING VIEWFINDER MATTES.** (See figure 5-6.) If upon inspection it is found that the mattes in viewfinder do not match the field of camera lens in use, adjust mattes as follows:

- a. Line up crosshairs in viewfinder with those on focusing tube as is done for parallax adjustment.
- b. Line up mattes (1) and (3) with corresponding edges of aperture in focusing tube, by lining up on the same object in the field of view.

c. Loosen screws (11) and (13), and turn "zero" rings (12) and (14) so calibration on (12) and (6), and (14) and (10) coincide. Tighten screws.

d. To adjust matte (2), loosen screw (8), hold ring (10) and turn knob (9) until matte (2) coincides with corresponding edge of aperture in focusing tube.

e. To adjust matte (4), loosen screw (5), hold ring (6), and turn knob (7) until matte (4) coincides with corresponding edge of aperture in focusing tube.

NOTE

When mattes are in adjustment for one focal length, they will be in adjustment for all focal lengths marked on adjusting knobs.

5-12. **VIEWFINDER VERTICAL ADJUSTMENT.** If horizontal crosshair in viewfinder does not line up with corresponding line in focusing tube, adjust viewfinder as follows:

- a. Loosen the locking nut for vertical-adjustment screw.
- b. Turn vertical-adjustment screw, moving viewfinder up or down, to properly position horizontal crosshair.
- c. When viewfinder is in proper vertical adjustment, tighten vertical-adjustment screw locking nut.

5-13. **ADJUSTING REAR GIB.** If camera becomes loose on base or sticks when shifting its position, rear gib may require adjustment. This gib is secured by four screws set in elongated holes, permitting forward and backward movement of gib. Small setscrews at rear side of base may be turned in or out to adjust gib. Gib is adjusted as follows:

- a. Remove camera box from base.
- b. Loosen top screws so gib may be moved when adjustment screws at back are turned.
- c. Slide camera box onto base and turn adjustment screws until box rides smoothly in tracks.
- d. Remove camera box and tighten top screws; then replace box on gibs.

NOTE

Camera depth, (distance between turret face and film) is a critical dimension as lenses must be recalibrated by manufacturer if camera depth changes. Gibs and tracks may wear after a long period of time, changing .900-inch camera depth. This condition may be remedied by having lenses recalibrated or replacing gibs and tracks.

5-14. SERVICE TROUBLES AND REMEDIES.

5-15. TROUBLES ENCOUNTERED DURING OPERATION.

TROUBLE	PROBABLE CAUSE	REMEDY
FILM WILL NOT ENTER RACE IN THREADING	Registration pins not retracted.	Retract pins by turning throwout knob on movement.
	Pull-down claw not retracted.	Retract claw by turning manual knob on motor.
CAMERA DOOR WILL NOT CLOSE	Sprocket film guides not closed.	Turn sprocket film guide knobs to position rollers on sprocket.
BLURRED IMAGE OR NO IMAGE IN FOCUSING TUBE	Magnification adjustment in middle position.	Move knob entire distance in direction desired.
MOTOR WILL NOT RUN	Buckle trip switch not closed.	Push buckle trip reset.
	Insufficient power at source, poor plug connections or defective cable.	Check power input line and power source. Look for damaged or corroded pins on plugs.
	Camera not in photographing position.	Rack camera over.
	Temperature too low for proper operation.	Test motor off camera. If motor runs but will not drive camera, it may indicate that camera parts have tightened due to cold. Provide means for warming camera.
FILM DOES NOT TAKE UP	Sprocket clutch slipping.	Tighten clutch.
	Take-up belt broken or slipping.	Replace or tighten belt.
	Film not entering take-up core properly.	Check film in take-up drum. If scenes have been shot, open drum in dark room to correct trouble.
FILM BEING SCRATCHED	Dirty aperture plate.	Clean aperture plate.
	Pressure plate rollers jammed.	Clean and lubricate pressure plate.
	Loop too large or too small.	Correct loop size.
	Dirty magazine or dirty magazine rollers.	Clean magazine.
FILM BEING TORN	Improper threading.	Check upper and lower loops.
FILM BEING PUNCHED OR PERFORATIONS BEING TORN	Improper threading.	Rethread properly.
	Emulsion dust pile up around registration pins.	Remove movement. Clean emulsion from registration pin area in accordance with paragraph 5-6.
TRIPOD UNSTEADY	Leg brackets loose on head.	Tighten nut on leg brackets.
FRICITION HEAD OPERATES ERRATICALLY	Sand or foreign material in clutch.	Overhaul friction head.

5-16. TROUBLES APPARENT ON EXAMING PROCESSED FILM.

TROUBLE	PROBABLE CAUSE	REMEDY
NO IMAGE ON FILM	Shutter entirely closed.	Check shutter setting.
	Lens cap not removed.	Remove lens cap.
PICTURE INCORRECTLY FRAMED	Viewfinder not adjusted correctly for parallax.	Check parallax adjustment.
	Viewfinder matte adjusting knobs not set to match lens in use.	Set adjusting knobs properly.
	Viewfinder matte adjusting knobs incorrectly calibrated.	Recalibrate viewfinder adjusting mattes. Refer to paragraph 5-11.
FAULTY FOCUS	Lens not correctly calibrated.	Return to factory for recalibration.
	Lens element loose.	Return to factory for tightening.
FILM FOGGED	Magazine covers not securely screwed in.	Check covers and tighten.
	Camera door not completely closed.	Check door latch and door edges for light leak. If door is sprung, camera must be overhauled.
	Loose or worn magazine light trap rollers.	Replace magazine.
PICTURE FUZZY OR BLURRED	Lens out of focus	Check focus.
	Registration pins dirty	Remove movement and clean in accordance with paragraph 5-6.
PICTURE FLICKER	Excessive variations in line voltage.	Check with voltmeter.
	Loose electrical connections.	Check connections.
	Film loops too small.	Rethread and adjust loops properly.
PICTURES UNSTEADY	Registration pins not clean.	Remove movement and clean in accordance with paragraph 5-6.
	Tripod not steady.	Be sure tripod is securely positioned before taking.
FRAMES IMPROPERLY EXPOSED, UNEVENLY SPACED, OR VERTICALLY BLURRED (DOUBLE IMAGE)	Camera out of synchronization.	Time (synchronize) camera as instructed in paragraph 5-9.
HARMONIC BEAT (PICKET FENCE EFFECT IN PAN SHOTS)	Shutter closed down too far.	Keep shutter open 90 degrees or more for pan shots.

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