

CONFIDENTIAL  
OPERATIONS AND MAINTENANCE  
MANUAL  
FOR  
35 MM SEQUENCE CAMERA

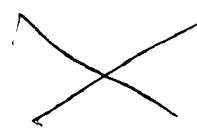


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CONTENTS

	<u>Page</u>
<u>SECTION I - DESCRIPTION OF EQUIPMENT</u>	1
1.1 General Description	1
1.1.1 Camera System	1
1.2 Detail Description	2
1.2.1 Camera Body	2
1.2.1.1 Contents	2
1.2.1.2 Datahead	2
1.2.1.3 Reflex Viewfinder	2
1.2.2 Magazines	3
1.2.3 Control Box and Cable	3
1.2.4 Low Light Level Cutout	3
1.2.5 Power Supply	4
1.2.6 Lens (58mm)	5
1.2.7 Tripod	5
1.2.8 Lens Support	6
 <u>SECTION II - INSTALLATION</u>	 7
2.1 Setting Up Procedure	7
2.1.1 Set Up Tripod	7
2.1.2 Fasten Camera to Tripod	7
2.1.3 Lens and Viewfinder Fastened to Camera	8
2.1.4 Control and Power Supply Cable and Battery	9
2.1.5 Magazine	11
2.1.6 Setting Data Clock	11
2.1.7 Sighting the Camera	12
2.1.8 Sighting the Sensor	13
2.2 Setting up Procedure for Operation with Mirrotel Mount	13
 <u>SECTION III - OPERATION</u>	 16
3.1 Selection of Lenses	16
3.2 Selection of F-Stop	16
Table I	17
3.3 Loading Magazines	18
3.3.1 100 Foot Magazine	18
3.3.2 400 Foot Magazine	21
3.3.3 1000 Foot Magazine	22
3.4 Automatic Exposure Control	23
3.5 Low Light Level Cut Out	24
3.6 Manual Operation	25
3.7 Automatic Operation with Sensor	26

  
CONTENTS (Continued)

	<u>Page</u>
<u>SECTION IV - THEORY OF OPERATION</u>	28
4.1 Camera	28
4.1.1 Mechanical	28
4.1.1.1 Shutter and Drive Mechanism	28
4.1.1.2 Shutter-Setting Mechanism	28
4.1.1.3 Film Drive Mechanism	29
4.1.2 Electrical	29
4.1.2.1 Drive Motor Controls (Cams and Switches)	29
4.1.2.2 Automatic Exposure Control	30
4.1.2.2.1 Photocell	31
4.1.2.2.2 Photocell Amplifier	32
4.1.2.2.3 Manual Operation	32
4.1.2.2.4 Automatic Exposure Control	32
4.2.2.3 Data Lamp and Data Cam Switch	33
4.2 Sensor Operation	33
4.3 Low Light Level Cutout	33
 <u>SECTION V - MAINTENANCE</u>	 35
5.1 Preventative Maintenance - General	35
5.2 Preventative Maintenance - Detail	35
5.2.1 Lenses	35
5.2.2 Magazine	35
5.2.3 Camera	36
5.3 Corrective Maintenance	36
Malfunction Table	37

APPENDIX

ILLUSTRATIONS:

- Figure 1 Camera System Components
- Figure 2 Camera System on Tripod
- Figure 3 Camera Body with Control Cover Removed
- Figure 4 Camera Body - Front View
- Figure 5 View of Camera with Cover Removed
- Figure 6 Shutter Assembly
- Figure 7 Data Head
- Figure 8 Data Head with Cover Removed
- Figure 9 Reflex Viewfinder
- Figure 10 Magazine Selection
- Figure 11 100 Foot Magazine Loading Scheme
- Figure 12 100 Foot Magazine with Cover Plate Removed
- Figure 13 400 Foot Magazine Loading Scheme
- Figure 14 400 Foot Magazine with Cover Plate Removed
- Figure 15 1,000 Foot Magazine Loading Scheme
- Figure 16 1,000 Foot Magazine with Cover Plate Removed
- Figure 17 Control Box and Cable
- Figure 18 Boresight
- Figure 19 Camera with Mirrotel Mount
- Figure 20 Camera Support Showing Knobs A, B, C, and D
- Figure 21 Camera Support - Bottom View
- Figure 22 Partial Schematic  
Tripod Instruction Manual  
Electrical Schematic

SECTION I - DESCRIPTION OF EQUIPMENT

1.1 GENERAL DESCRIPTION:

The Sequence Camera is designed to take single pictures at rates of up to 2 pictures per second. It may be operated manually, or automatically by an external sensor or trigger device. Manual operation may be performed at the camera or remotely by means of a control box at the end of a long cable. When operated automatically, the camera may be left unattended for long periods of time. It contains an automatic exposure device to assure the proper exposure of negatives over widely varying light conditions. When operating manually, the shutter can be set so that time exposures may be made with the camera.

1.1.1 Camera System:

The system consists of the following functional units:

- (a) Camera body with reflex viewfinder and data head
- (b) 100 ft. , 400 ft. , and 1000 ft. magazines of 35mm film
- (c) Control box and cable
- (d) Low light level cutout device
- (e) Battery power supply
- (f) 58mm lens
- (g) Tripod with pan head
- (h) Telephoto and Mirrotel lens supports
- (i) Cables, connectors, spare parts, tools, and instruction manual  
( Figs. 1, 2 and 19 )

1.2 DETAIL DESCRIPTION:

1.2.1 Camera Body:

1.2.1.1 Contents:


The camera body contains the motor drive for the shutter and film transport mechanism, the drive for the automatic exposure control, the automatic exposure control amplifier, the shutter, and the various gearing, cams and control switches necessary to perform the various camera functions. Power takeoff and mounting surface for the various magazines are located on the side of the camera body. A mounting surface and plug-in connector for the data clock are located on the side of the head. A coupling ring for the reflex housing is located on the front. On top, under a tamper-proof cover, are located the control knobs for the on-off switch, the exposure control automatic manual switch and the film ASA rating switch. At the back are the power connector and the control box connector. (Figures 3, 4 and 5)

1.2.1.2 Data Head:

The data head, which plugs into the side of the camera body, contains an electric clock and lights, which, when flashed by a cam switch within the camera, expose an image of the clock on the film through an optical system of lenses and mirrors. (Figures 7 and 8)

1.2.1.3 Reflex Viewfinder:

The viewfinder is a modified Leica Visoflex II and is clamped



onto the front of the camera body by means of a clamp ring. When viewing, a spring-return lever is depressed, which inserts a reflex mirror into the optical path behind the lens, to permit viewing and focussing. When the lever is released the mirror rotates out of the optical path. (Figure 9)

1.2.2 Magazines:

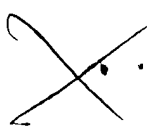
The 100, 400 and 1000 foot magazines are of the darkroom-loading type. All three magazines have footage indicators, and the 400 and 1000 foot magazines have indicators or "telltale" which rotate when the supply spool is feeding film. The pressure plates are removable to allow effective maintenance. (Figure 10)

1.2.3 Control Box and Cable:

The control box is located on the end of a short length of cable which plugs into the upper connector on the camera. It contains a push button switch with a locking device, and a two-position rotary switch marked "I" and "TB". The control box may be plugged in at the end of a long extension cable, permitting remote operation of the camera. (Figure 17)

1.2.4 Low Light Level Cutout:

The low light level cutout device plugs in between the camera and the battery power supply in the lower connector at the back of the camera. It works in conjunction with the automatic exposure control photocell to cut the power off from the camera and exposure control amplifier whenever the





light level falls below the point where properly exposed negatives may be obtained. When the light increases again, the power is automatically cut in.

1. 2. 5 Power Supply:

Since the successful completion of a mission depends to a great extent on the power supply used, it is of utmost importance to choose one with sufficient capacity. The required capacity is determined on the basis of the current drain of each of the system elements. The table included here lists the total energy consumed by these elements.

ENERGY REQUIREMENT  
TOTAL ENERGY PER MONTH  
AMP. HOUR AT 26 VOLT

	MAGAZINE		
	1000 Ft.	400 Ft.	100 Ft.
Camera & Mag.	1.20	.40	.10
Exposure Control Inactive 5MA	3.60	3.60	3.60
"    "    Active	.04	.04	.04
Data Recording Clock .25MA	.18	.18	.18
"    "    Lamp	.30	.06	.02
Low Light Level	.20	.20	.20
TOTAL	5.52	4.48	4.14

To this must be added the power requirement of the sensor if one is used. The battery rating should be a minimum of 25% greater than the sum total of all the requirements.

1.2.6 Lens:

The lens provided with the camera is a Zeiss Biotar F/2 with a focal length of 58mm. This lens is equipped with a Practina bayonet mount and must be used on the camera directly (without the VISOFLEX). In order to mount the lens to the camera, turn the bayonet in counter-clockwise direction as far as it will go. Insert the lens into the bayonet ring, making sure that the screwhead key on the lens lines up with the slot in the camera. With the lens squarely seated in the camera, turn the bayonet ring clockwise until it is tight. This lens is useful for general purpose small scale photography. Lenses with shorter or longer focal lengths can be used directly on the camera as long as they are equipped with a Practina bayonet mount. An operation requiring telephoto work is best accomplished with the help of the reflex viewfinder (modified VISOFLEX). The camera side of the reflex viewfinder comes equipped with a bayonet mount and interchanges with the 58mm Biotar Lens. The opposite side of the reflex viewfinder is provided with a threaded mount which is suitable for use with Leica lenses. Any short barrel Leica lens made for use with the VISOFLEX I can be utilized.

1.2.7 Tripod:

The tripod is a Quick-set industrial Hercules Model 5002, on

which is mounted a Hercules No. 5221 Geared Pan Head. The instruction manual for the tripod and head is included in the appendix of this manual.

1.2.8 Lens Support:

When lenses of long focal length (200 MM or more) are used, it is unwise to depend on the lens mounts as the sole means of support. Such lenses must be used in conjunction with the special lens support provided with the system.

The lens support incorporates into the camera base plate by means of the two support rails. An adjustable cradle, which can be positioned on these rails, clamps to the lens at any desired point.

## SECTION II - INSTALLATION

### 2.1 SETTING-UP PROCEDURE:

When the site at which the equipment is to be set up has been selected, set up the equipment in the following manner:

#### 2.1.1 Set Up Tripod:

Set the tripod and head up in the desired position with the tilt control wheel facing the direction in which the camera is to sight. (See tripod instruction section in appendix.) Next, loosen the horizontal fluted knob on the side of the pan head directly under the mounting plate and slide the plate toward the back exposing the vertical fluted knob directly under the plate. This knob is part of the mounting stud used to fasten the base plate carrying the camera and sensor to the tripod head.

Set base plate on the pan head plate making sure that the hole with the tapped insert is positioned over the mounting stud, and that the two locating pins on the camera base plate rest over the locating holes on the pan head. Turn the fluted knob under the pan head plate until the camera base plate is securely fastened flush on the pan head with the locating pins in the holes. Slide the head forward until the vertical fluted knob is in the center of the pan head assembly, and tighten it in position by turning the horizontal fluted knob located directly under the base plate until it is tight.

#### 2.1.2 Fasten Camera To Tripod:

Mount the camera on base plate by means of three captive

thumb screws.

2.1.3 Lens and Viewfinder Fastened To Camera:

If a lens requiring support is used, insert the short end of lens support rails into the holes in the base plate and push the rails in until the supporting tie-bar rests against the base. If difficulty is experienced in pushing the rails home, remove the allen wrench from the supporting strut on the tripod, and turn the set screws on both sides of the base plate outward. When the rails have been properly seated, fasten them in place by turning the set screws inward until they are tight, using the allen wrench supplied with the tripod. Slide lens clamp over the rails, and fasten it tentatively near the end of the rails, using the allen wrench supplied. If a short lens requiring no support is used, the rails are not needed.

Examine the threads on lens, and the mating threads on the reflex housing, and remove any dirt or dust particles from the threads. Insert the reflex housing aperture squarely into the lens thread and turn it gently clockwise until the threads on the lens engage the threads in the housing. Continue turning gently until the lens is threaded home in the housing. If any difficulty is experienced in engaging the threads, do not force the engagement. Withdraw the housing and start over.

Then turn the bayonet ring on the camera counter clockwise (facing the front of camera) as far as possible. Now insert the reflex housing and lens assembly or practina mount lens squarely into the mount. Make sure

that the key of either the reflex housing or practina lens mount fits into the notch in the camera and turn the ring clockwise until the assembly is firmly attached to the camera\*. If the reflex housing is not used, the camera can be sighted by using the bore sight. Line up small hole in the face of the bore sight with a pin located near the lower left corner of the focal plane plate of camera, and screw in captive thumb screw on the camera body into angle-bracket of bore sight. After the bore sight is securely in place, focus eye-piece (by moving back and forth) on reticle on ground glass. Now focus the lens in the usual manner.

#### 2.1.4 Control and Power Supply Cable and Battery:

Turn the control knob on the top of the camera to the "OFF" position. Set the battery on the ground near the tripod and connect the battery cable to the camera by twisting the connector on the cable clockwise onto the lower receptacle on the camera until it clicks in place. Now insert the cable of the hand control box in a like manner. Set the knob of the hand control box to "I" and the knob on the camera to "ON". By depressing the push button, the camera should begin operating as evidenced by a whirring and clicking noise and the small gear on the magazine side of the camera will be turning. When you are satisfied that the camera is operating, release the push button and the camera will shut itself off.

In case the camera does not operate, see the appropriate paragraph under the "Malfunction" section to determine the cause, first checking

\* See Figure 4

to see that the battery connector is properly seated in the receptacle.

To operate the camera with the sensor turn knob on top of camera to "OFF" and remove hand control box. The cable from the relay connects to the upper receptacle of the camera, in place of the hand control box and the cable from the relay connects to the terminal posts on the sensor. The terminals on the sensor are identified, and the terminal identification should agree with the cable wire identification marker for proper operation of the sensor. In order to check operation of the sensor, turn the sensor switch, located near the terminal posts, to the "ON" position with the switch handle pointing toward the rear of the sensor. Then turn the camera control switch on top of the camera to the "ON" position. Open the sensor lens diaphragm to maximum aperture and remove the lens cap. The camera should begin operating when the lens cap is removed, and should continue operating for about 30 seconds. If the light has not changed during the 30 seconds, and no motion has occurred in front of the lens during that time, the camera will shut itself off. When the lens cap is replaced, the camera should start operating again, and remain in operation for about 30 seconds before it shuts itself off and stays off.

If the sensor does not operate, check the cable connections, making sure that the camera switch is in "ON" position, that the sensor switch is "ON", and that the battery cable is connected to the camera, before referring to the malfunction table in the maintenance section.

If the sensor operates the camera satisfactorily, continue with

the set up procedure.

2.1.5 Magazine Installation:

Choose a magazine with the proper film capacity. Make sure that the magazine is loaded by checking the footage indicator, which indicates the feet of remaining unexposed film, and by seeing that there is a strip of film in the gate. Set the magazine in place on the side of the camera with the locating pin and gate projection on the camera in line with the hole and gate aperture on the magazine. Slide the magazine forward into place, and tighten the thumb screw on the side of the camera until the magazine is securely fastened on the camera. The magazine should seat flush on the camera mounting surfaces.

2.1.6 Setting The Data Clock:

Remove the data head from the camera by loosening the four captive screws on the data head with the screwdriver supplied in the tool kit. When the four screws are loosened, pull the data head straight back, so as not to bend the connector pins. When the data head is separated from the camera body, turn it so as to expose the clock dials. Remove the tool from under the clamp and set the sharp end in one of the holes in the upper or "day" dial. Turn the dial either clockwise or counterclockwise until the day of the month is in line with the index. Then set the lower or hour dial until the proper hour is in line with the index line. Set the hour dial to the nearest quarter hour. Advance the day dial according to the hour setting; that is, if the hour setting



is 12 and the day is 24, set the day dial half way between 24 and 25. After setting the dials, return the setting tool to its holder. (Figure 7)

Before replacing the data head, a check should be made to see if the data lamp is functioning. By setting the connector in the data head into the connector in the camera backwards, the data lamp will light and stay lit until the connection is broken. If the lamp fails to light in this position, replace lamp and repeat check.

To replace, align the pins of the data head with the connector receptacle of the camera, press straight down and fasten. The data head clock should not be set unless the battery cable is plugged into the camera.

#### 2.1.7 Sighting the Camera:

The camera is sighted through the reflex housing or bore sight. Remove the lens cap from the lens. Open the lens diaphragm to the largest aperture (smallest f number). Loosen the clamp knobs on the tilt and pan controls on the tripod pan head. Depress the mirror lever on the side of the reflex housing if used or attach bore sight (as explained in Paragraph 2.1.3), and look into the viewing eyepiece. Adjust the tilt wheel and pan wheel until the rectangle in the eyepiece covers the field desired. Turn the focusing ring on the lens until an object in the field in the target area is in sharp focus. Tighten the clamps on the tilt and pan controls and sight through the reflex housing or bore sight to make sure that the lens is still aimed at the desired target.

2.1.8 Sighting The Sensor: (The following paragraph applies if an optical sensor is used.)

Loosen the two thumb screws, one at the front of the sensor mount, and the other at the back. Look through the eyepiece, and turn the knob on top of the sensor clockwise so that you can sight through the lens. (If the image is dim, open the diaphragm of the sensor lens to its largest opening.) Swing the front of the sensor mount until the square in the sight covers the center of the rectangle viewed by the camera lens. Turn the focusing ring on the sensor lens until an object in the target area is in focus. When the sensor is properly sighted, release the knob on top of the sensor, and tighten down on the front and back thumbscrews. Check the field covered by the rectangle in the camera lens viewer and that covered by the sensor square. If the field covered by the sensor square is larger than that covered by the camera rectangle, unscrew the sensor lens and replace it with one that has a longer focal length. The sensor field covered by the square should be smaller than that covered by the camera rectangle.

2.2 SETTING-UP PROCEDURE FOR OPERATION WITH MIRROTEL MOUNT:

2.2.1 Unpack the camera support and set it on the mounting surface with the knobs A and B facing you. Tip the mount backward, exposing the knob underneath. Loosen the knob about 1/2 inch and rotate the lower leg clockwise (viewed from above), until the lower leg snaps into place at right angles to upper leg. Tighten the knob and set the mount down firmly in the supporting surface. (Figures 19, 20, 21)

2.2.2           Unpack the Mirrotel lens. Set the lens down on a firm supporting surface. Remove the small lens cap from the lens mounting ring, and store it. Unpack the reflex housing, lift the back of the lens up, and screw the reflex housing onto the lens, making sure that the threads are properly engaged. Do not force the engagement; if difficulty is experienced in threading the reflex housing on the lens, back off the housing and start again until the engagement is smooth and the housing threads easily onto the lens. It is advisable to make sure that there is no dust or dirt on the threads of either the lens or housing. Tighten the reflex housing on the lens by turning it as far as it will go.

2.2.3.           Set the lens on its side and remove the thumb screws from the bottom of the mounting bases of the lens. Place the lens on the mount with the front of the lens (large end) toward the right and the lens mounting bases on the sliding mounting surfaces. Adjust the space between the mounting surfaces to match the space between the mounting bases on the lens. Set the lens down firmly on the mounting surfaces, until the dowel pins on the mounting surfaces engage the holes in the mounting bases and the lens is firmly seated. Unscrew and remove knob A and insert the thumb screws up through the holes on the mounting surfaces into the lens bases and tighten them firmly.

2.2.4           Push the lens forward on the sliding base as far as it will go. Set the camera on support with holes on bottom of the camera aligned with thumb screws. Tighten thumb screws firmly so that camera is firmly fastened on mount.

2.2.5 Turn the bayonet ring on the camera counter-clockwise (facing the front of the camera) as far as possible and slide the lens toward the camera until viewfinder housing engages in the bayonet mount. Turn the ring firmly clockwise until the ring is tight.

2.2.6 Replace knob A and remove the cover from the front of the lens and store it.

2.2.7 Now proceed with steps described in paragraphs 2.1.4 to 2.1.8, ignoring references to the tripod.

### SECTION III - OPERATION

#### 3.1 SELECTION OF LENSES:

While only one lens is supplied with the camera system, lenses of various focal lengths may be used. The proper lens to use for any particular setup is dependent on the distance from the camera to the subject, and on how much of the subject it is desired to photograph. The coverage of any particular lens may be observed by viewing through the reflex viewfinder. The lens that provides the desired coverage at the subject-to-camera distance should be selected. If exact coverage is desired, it may be necessary to move the camera.

#### 3.2 SELECTION OF F STOP:

The lens F stop is selected on the basis of depth of field desired, film ASA rating, shutter speed, and the range of light variation prevailing during the time it is desired to take the pictures. If the camera is constantly attended, the problem is simplified by the ability of the operator to reset the diaphragm stop to stay within the automatic exposure system correction range for the film used. If the camera is to operate unattended, then the light range at which photography is desired should be measured with a light meter, and the F stop set so that the automatic exposure control would be able to compensate over that range. Table I will assist the operator in determining the F stop to be used for any situation.

The following example is given to indicate the manner in which the table may be used in order to set the F stop.

TABLE I

INCIDENT LIGHT ILLUMINATION RANGEFoot Candles

ASA	f 2	f 2.8	f 4	f 5.6	f 8	f 11	f 16
10	45 3,600	90 7,200	180 14,400	360 28,800	720 57,600	1,440 115,200	2,880 230,400
32	14 1,120	28 2,240	56 4,480	112 8,960	224 17,920	448 35,840	896 71,680
80	5.6 448	11.2 896	22.4 1,792	45 3,584	90 7,168	180 14,336	360 28,672
160	2.8 224	5.6 448	11.2 896	22.4 1,792	45 3,584	90 7,168	180 14,336
250	1.8 144	3.6 288	7.2 576	14.4 1,152	29 2,304	58 4,608	116 9,216
400	1.1 90	2.2 180	4.4 360	9 720	18 1,440	36 2,880	72 5,760

The film used has an ASA rating of 160 and the lens has an F stop range from F/2 to F/16. Previous measurements have shown that the light range at which it is desired to take pictures is from 80 to 2000 foot candles. Under the ASA 160 table, the exposure system is able to correct from 45 foot candles to 3584 foot candles in the F/8 column. Therefore, if the lens is set at F/8, the automatic exposure control would provide proper exposure for all light conditions between 45 and 3584 foot candles.

It must be remembered that the automatic exposure control can correct for light changes of only 80 to 1, and the lens opening and film type should be selected so that the correction range covers as much as the light variation as possible.

### 3.3 LOADING THE MAGAZINES:

All magazines must be loaded in complete darkness, especially when high speed film is used. It is suggested that loading the magazines be practiced in daylight using dummy film.

#### 3.3.1 100 Foot Magazine: (Fig. 11 )

The 100 ft. magazine film is supplied on a spool. The following procedure should be followed in loading the film spool:

3.3.1.1 Outside the darkroom, lay the magazine on a bench with the top cover up and the top of the magazine facing outward.

3.3.1.2           Open the magazine by turning the locking levers to the "O" position, and lift the cover off.

3.3.1.3           Slide the film guide located at the sprocket wheel at the lower right away from the sprockets.

3.3.1.4           Press the pressure plate inward and upward with the forefinger until it locks in position away from the gate aperture.

                  Looking down in the magazine, the supply spool spindle is on the left and the takeup spool spindle on the right.

3.3.1.5           Take the magazine and cover into the darkroom and set the magazine on the bench with the gate aperture facing to the right.

3.3.1.6           Hold the loaded spool up so that film feeds up from the bottom right. Reel off about a foot as leader.

3.3.1.7           Set spool on supply spindle with film feeding off to the right, and jiggle spool on the spindle until square hole in spool fits over square spindle and is solidly seated on spindle. When properly seated, the square spindle protrudes above the top surface of the spool.

3.3.1.8           Slip the leader between the guide roller and top wall of magazine near the supply spool, between upper right guide roller and corner, between the pressure plate and aperture, and around the lower right corner sprocket.

                  Fold over the edge of the film and slip the edge into the slit of the take-up spool. Seat the takeup spool on the takeup spindle, and rotate the takeup



spool counter-clockwise until the film pulls through the gate. Tighten the film over the sprocket roller, and push the film guide against the sprocket roller, making sure that the sprockets fit into the sprocket holes in the film. Rotate the takeup spool counter-clockwise to make sure that the film is feeding properly.

3.3.1.9 Push the pressure plate downward until it is released and presses against the film at the gate with the film between the plate and the gate.

3.3.1.10 Rotate the takeup spool a few turns and feel if the film feeds past the gate smoothly.

3.3.1.11 Set the magazine cover squarely on the magazine so that the locking pins fit into their receptacles. Push the cover down evenly, feeling the edges to see that the cover fits flush on the magazine. Turn the locking levers toward the rim in clockwise direction until they snap in place. Feel around the edge to make sure that the cover is on tight. The magazine is now loaded and may be removed from the darkroom. Caution: Do not depress the pressure plate when the film is in the magazine and out of the darkroom. Fogging will occur.

3.3.1.12 The footage indicator on the magazine indicates the feet of unexposed film remaining in the magazine. When loaded with 100 feet of film, the footage indicator will read 100. As the film becomes exposed and transported from the supply spool to the takeup spool, the indicator reading will decrease until it will read "0" when all the film is exposed and transported.

3.3.2 400 Foot Magazine: (Fig. 13)

The 400 foot magazine is similar to the 100 foot magazine with the exception that the film for this magazine is wound on a core, rather than on a spool.

3.3.2.1 Place the empty core on the takeup spindle with the male key up, so that the film leader faces the direction of rotation (counter-clockwise). Push the core down onto the film deck.

3.3.2.2 Press the pressure plate inward and upward until it locks in position away from the film gate.

3.3.2.3 Take the magazine into the darkroom and slide the supply core with the film over the spindle with the key on the core in line with the key way on the spindle. The film should unwind from the bottom toward the right.

3.3.2.4 Remove about a foot of leader and slide it between the guide rollers and the magazine wall, between the pressure plate and the film gate, between the sprocket wheel and its roller, under the dancer roller, and thence to the core. Fold over the end of the film and insert the end into the slit in the takeup core.

3.3.2.5 Push the pressure plate downward until it snaps into place with the film between the plate and aperture gate.

3.3.2.6 Rotate the takeup core counter-clockwise a few turns and feel if the film pulls through the gate smoothly with the sprockets engaging the sprocket holes in the film.

3.3.2.7 Replace the cover as described in Section 3.1.11 for the 100 foot magazine.

3.3.3 Loading 1000 Foot Magazine: (Fig. 15)

3.3.3.1 Remove cover by turning locking levers to "0" position and lift off.

3.3.3.2 Place an empty core on takeup spindle with male key up, so that film leader faces direction of rotation (counter-clockwise). Push the core down onto the film deck.

3.3.3.3 Press the pressure plate inward and upward until it locks in position away from the gate aperture. The top of the pressure plate should not protrude higher than the top of the magazine.

3.3.3.4 Take the magazine and cover into the darkroom, and set the magazine on the bench with the gate aperture facing away from the edge of the bench.

3.3.3.5 Take the film spool and set it on the supply spindle with the leader to the right unrolling from the bottom. Make sure that the key on the core fits into the key way on the spindle. Push the spool down flush on the film deck.

3.3.3.6 Unroll about a foot of leader and thread it, without twisting behind the spring loaded tension roller. Push it down between the pressure plate and gate.

3.3.3.7 Push the pressure plate downward until it snaps into place with the film in front of the plate.

3.3.3.8 Rotate the takeup core counter-clockwise a few turns and feel if the film pulls through the gate smoothly, with the sprockets engaging the sprocket holes in the film.

3.3.3.9 Set the magazine cover squarely on the magazine so that the locking pins fit into their receptacles. Push the cover down evenly, feeling the edges to see that the cover fits flush on the magazine. Turn the locking levers toward the rim (in a clockwise direction) until they snap into place. Feel around the edges to see that the cover is on tight. The magazine is now loaded and may be removed from the darkroom. Caution: Do not depress the pressure plate when the film is in the magazine and out of the darkroom. Fogging will occur.

#### 3.4 Automatic Exposure Control:

3.4.1 If the camera is to be used for unattended operation, under varying light conditions, it is essential that the automatic shutter control of the camera be activated. In order to do this, three settings must be made. First, the ASA selector knob must be set to the ASA rating which most closely

matches the film ASA rating. Then, the lens diaphragm must be set in accordance with instructions given in Section III, paragraph 3.2. The diaphragm must be properly adjusted in order to take full advantage of the camera's operating range. Doing so insures that the camera will continue to operate over the widest possible ambient light conditions.

Finally, when the above two settings have been made, turn the shutter control knob to the "automatic" position. The automatic shutter will now adjust itself to the prevailing light conditions. It will continue to adjust itself for the remainder of the mission.

The shutter will not readjust itself during the time that the camera is running. If unattended, continuous operation of the camera is desired, automatic exposure control can be achieved by operating the camera with an intervalometer. Any rate of up to 1-1/2 frames per second will provide sufficient time between cycles to allow the exposure control to set itself. This does not hold true when the ASA knob is set at 250 or 400. At these settings, the photocell response is too slow to permit corrective response between cycles.

### 3.5 Low Light Level Cut Out:

The use of the low light level cut out is recommended only when unattended operation is likely to result in film and power waste during night time. The type of sensor used is the determining factor. If a sensor such as a seismic type is used, it is likely to trigger the camera under any and all light conditions. In this type of system, the low light level should be utilized.

When using certain types of program timers or light sensors which do not operate under low light conditions, the use of the low light level cut out is superfluous and therefore not recommended.

### 3.6 Manual Operation:

It is possible to operate the camera manually at the installation or at a remote point. In either case, the camera must be adjusted as described in paragraphs 3.1 to 3.4 above.

In manual operation, the hand control is used in place of a sensor. At the camera, the hand control is simply plugged into the upper receptacle of the camera. For remote operation, an extension cable of appropriate length must be used. (Caution: Long extension cables, 100 feet or more, may cause a serious voltage drop in the system. This problem can be partially overcome by using wire heavier than 18 gauge.)

The selector switch on the hand control should be set at "I" for instantaneous exposures. If the diaphragm is properly set, the full range of shutter speeds will be utilized in the course of a day's operation. In other words, the shutter will operate at 1/400 second at maximum light conditions and 1/5 second at marginal operating conditions.

The extent of the operation depends not only on the subject illumination, but also on the subject motion and its distance from the camera. Shutter speeds of 1/25 second or under will yield blurred photographs when the subject is in motion and relatively close to the camera. Slowly moving subjects especially those that are further from the camera can be successfully photographed with shutter speeds 1/25 or less. In case of doubt, assume successful operation over the entire range of shutter speeds.

In those cases where the range of shutter speed and diaphragm setting do not permit satisfactory exposures with the film being used, it may be practical to utilize longer exposures. Under these circumstances, the hand control selector should be set at "TB" and the exposures can then be timed manually. Exposures with a duration of 1/2 second or longer can be secured with little difficulty. Depressing the exposure button opens the shutter; releasing it closes the shutter.

Note: Make sure the selector is returned to the I position when normal operations are to be resumed.

### 3.7 Automatic Operation with Sensor:

The camera may be automatically operated by means of a sensor. For automatic operation, remove the control box and cable and connect the sensor cable to the camera in place of the control box cable.

In order to operate the camera, the sensor must be able to close a contact connecting together the two wires in the cable. When set for instantaneous operation, the camera will continue to take pictures as long as the contact is closed, and will stop taking pictures when the contact is open.

The sensor cannot derive the power necessary for its operation from the camera cable. A separate cable must be used from the power pack to run the sensor, if it requires an external power source for its operation.

The camera "shutter" switch is usually set on "automatic" for sensor operation, and the low light level cut out device is used to conserve

battery power and film when there is insufficient illumination for acceptable exposure.

If the camera is to be sensor-operated for lengthy periods of time, sufficient battery power and film for the required time must be provided.



SECTION IV - THEORY OF OPERATION

4.1 CAMERA:

4.1.1 Mechanical:

The camera operations are performed by two 24 volt DC gearhead motors. One motor rotates the shutter and drives the intermittent film transport mechanism, while the other motor positions the shutter blade to control the shutter slit width for the automatic exposure control system.

The motors, gearing, shutter and photocell are located in the head, which is fastened to the camera body by means of screws. It is electrically connected to the body through a connector. (Fig. 6)

4.1.1.1 Shutter and Drive Mechanism:

The shutter consists of two blades rotating together at constant speed, one blade adjustable with respect to the other. The angle of the uncovered portion between the blades may be varied from 144 degrees to 1 degree 48 minutes. At a shutter speed of 2 revolutions per second, this is equivalent to shutter speed variation of from 1/5 to 1/400 second. (Fig. 6)

4.1.1.2 Shutter-Setting Mechanism:

The uncovered angle between the shutter blades may be set either automatically or manually. The moveable shutter blade is geared, through a spur gear differential to the drive motor. The uncovered angle

between the blades may be adjusted by controlling the differential arm angle. The cam which controls this angle is positioned during automatic operation by the control motor, or manually by pressing in and turning the shutter knob on the front of the camera. When the knob is depressed, the gear that drives the cam disengages from its mating gear and permits the cam to be adjusted by means of the knob. (Fig. 4)

#### 4.1.1.3 Film Drive Mechanism: (Fig. 5)

The film in the magazine is driven through the side of the camera by a protruding gear which meshes with a gear on the side of the magazine. The camera gear is connected to a four slot geneva, which is rotated by a pin geared to the drive motor. The geneva transmits the intermittent motion to the magazine, and the film is pulled past the aperture gate during camera operation. The shutter and geneva are synchronized so that during exposure the film is stationary. It is transported past the film gate only during the time that the shutter opening is not in front of the aperture.

#### 4.1.2 Electrical:

##### 4.1.2.1 Drive Motor Controls (Cams and Switches):

In the manual operation mode, power is applied to the drive motor through the normally open contact of the hand switch (S12) in series with the BORE & TIME CAM SWITCH. (See partial schematic, Figure 22 and Electrical Schematic.) In the automatic mode, the relay contacts of the sensor replace the hand switch.

Power is applied to the motor through the above paths from the OPERATE BUSS. The motor is therefore energized only when the LOW LIGHT LEVEL relay is not energized. The motor is dynamically braked by shunting it with a 30 OHM resistor through the END OF CYCLE CAM SWITCH (S5) or the BORE & TIME CAM SWITCH (S4). The end of cycle cam switch is also responsible for stopping the camera at the same point in the cycle. The BORE AND TIME CAM SWITCH (S4) function is to interrupt power and dynamically brake the camera motor halfway through the camera cycle whenever the Time Bore & Inst. Switch is in the Time Bore position. This opens the shutter and allows for time exposures and bo e sighting.

#### 4.1.2.2 Automatic Exposure Control:

The exposure control system is a closed loop servo system composed of a photo-electric cell, photocell amplifier, density wedge and drive motor. The photocell is part of a bridge circuit which yields a null point when the light reaching the cell is at a particular level. A change in the light level will cause the motor to be energized in one direction or the other (depending on whether the light level has increased or decreased). Since the density wedge is actuated by the motor, the light reaching the cell will be increased or decreased until the null point has been restored.

The density wedge is mechanically linked with the adjustable blade of the shutter so that the shutter opening is a function of the light being admitted into the camera.

**As shown on the electrical schematic, power is applied** to the SHUTTER BLADE SETTING motor only when the MANUAL-AUTOMATIC switch is in the AUTOMATIC position. When the TIME-BORE INST. switch in the hand control is in the INST. position (for instantaneous shutter speeds), the motor is driven in the appropriate direction until the photocell amplifier output is zero.

Limit switches S8 and S9 and their associated diodes CR1 and CR2 disconnect power from the motor just before the shutter blade reaches the end of its travel. When either limit switch is open, its diode permits power to be applied to the motor with opposite polarity only. This permits the shutter to be driven in the opposite direction when a change in light level reverses the polarity of the amplifier output.

When the TIME BORE INST. switch is in the TIME BORE position, power is applied to the SHUTTER BLADE SETTING motor directly from the OPERATE BUS. The motor then rotates until limit switch S9 is opened, thus de-energizing the motor. In this position, the shutter blade is wide open.

#### 4.1.2.2.1 Photocell:

The photocell circuit is basically a variable voltage divider circuit with the variable (photocell) resistance being determined by the light level. For each ASA setting a different value of resistance is switched into the photocell circuit so that the photocell amplifier control voltage remains within the proper limits.

4.1.2.2.2 Photocell Amplifier:

The photocell amplifier accepts a signal from the photocell circuit described above. It converts this input to a double ended output (push-pull) such that the voltage output is polarized in one direction whenever the input is above a specified level. Similarly, if the input is below the specified level, the output is polarized in the opposite direction. When the input is exactly at the specified voltage, the output is at null.

The output of the photocell amplifier is applied to the SHUTTER BLADE SETTING MOTOR as described in section 4.1.2.2.

The photocell amplifier derives its B+ power from the OPERATE BUSS and is therefore de-energized when the low light level cut out relay closes.

4.1.2.2.3 Manual Operation:

For manual operation of the shutter blade, the AUTO-MANUAL switch is set to the MANUAL position. This simply interrupts the circuit to the shutter setting motor. Changes in shutter speed settings must then be made manually.

4.1.2.2.4 Automatic Exposure Control:

The automatic shutter cam switch (S7) closes once per photo cycle thus interrupting B+ power to the photocell amplifier. This prevents the photocell amplifier from energizing the motor during the time when the photocell position is out of the light cone.

4.1.2.3 Data Lamp and Data Cam Switch:

Power for the Data Lamp is fed from the OPERATE BUSS through the DATA CAM SWITCH (s6). This switch is closed once per camera cycle by virtue of the DATA CAM. The light output of the Data Lamp is controlled by the amount of current flowing through it. This control is achieved by switching in appropriate resistors in series with the lamp. This function is automatically accomplished whenever the ASA switch is actuated. The variation in lamp light output is necessary in order to maintain constant exposure with the various films used in the camera.

4.2 Sensor Operation:

Refer to the literature supplied by the manufacturer of the sensor.

4.3 Low Light Level Cut Out:

The low light level cutout fixture senses the photocell voltage and interrupts all power to the OPERATE BUSS whenever the photocell voltage goes beyond a specified value. This value corresponds to a light level approximately two stops below the normal exposure at 1/5 second shutter speed. The interruption of power to the OPERATE BUSS also cuts the power to the photocell amplifier, thereby saving power.

Power to the low light level cut out is applied through the Open Shutter Switch S10. This switch opens at the same time as the limit switch S9 which is the position at which the shutter is wide open. Therefore, the low light level cut out operates only after the shutter has been fully opened.

SECTION V - MAINTENANCE

5.1 Preventive Maintenance - General:

The practice of preventive maintenance is necessary to keep the equipment in good working order and to prevent loss of vital information resulting from breakdown and malfunctioning of the equipment. It is recommended that a regular inspection and cleaning procedure be followed to keep the equipment in good working order.

5.2 Preventive Maintenance - Detail:

5.2.1 Lenses:

Clean all lenses and optical surfaces prior to use and before storage. Use a camels hair brush to remove all surface dust from lenses. If necessary, clean the lens surfaces, using lens cleaning fluid and lens tissues. When lenses are not in use, keep them covered with lens caps. Do not permit dust or sand particles to accumulate on any of the lens surfaces or mechanical parts. When lenses are not in use, put them in their cases and store them in a safe place.

5.2.2 Magazine:

Before film is placed in the magazine and after it is removed, shake out all loose film particles and remove any film deposits from the film gate and pressure plate with alcohol or carbon tetrachloride. This is necessary to assure proper operation of the transport mechanism and prevent scratching of the film.



5.2.3 Camera:

Thoroughly clean the camera after each period of prolonged use. Loosen and shake out all dust, dirt and sand from the camera mechanism. Run the camera with the side cover only removed and see that no parts are loose.

5.3 Corrective Maintenance:

In order to perform corrective maintenance, certain instruments and tools are necessary to help analyze the trouble and to correct it after it is found.

For analyzing electrical malfunctions, an ohmmeter, or continuity checker, is necessary. To make electrical repairs, wire cutter, pliers, solder and a soldering iron are necessary.

Mechanical malfunctions may be analyzed by observation. Various screwdrivers, allen wrenches, retaining-ring pliers, punches, hammer and pliers are necessary to make mechanical repairs.

The following malfunction table may be used as an assistance in locating trouble and correcting it. Frequently, trouble is caused by a combination of factors, and must be located by the process of elimination.

MALFUNCTION TABLE

Malfunction	Probable Cause	Corrective Action
Camera does not run when control switch is turned to "ON" and push button on control box is depressed	Power cable disconnected at camera or battery Broken wire in cable or connector Defective switch Discharged battery Burned out motor Blown fuse F1	Connect cable (1) Replace cable, or resolder wire connector pin (2) Replace switch (2) Recharge battery or replace with charged one (1) Replace motor (2) Replace fuse, first checking for shorts or jammed gearing in camera (1)
On automatic operation, sensor does not operate camera	Cables not connected between camera, sensor and timing relay Sensor not turned on Sensor lens cap not removed Sensor sensitivity too low Sensor defective Relay K2 defective	Check cable connections (1) Turn sensor switch to "ON" position (1) Remove sensor lens cap (1) Increase sensor sensitivity with sensitivity control, or open lens diaphragm to maximum (1) See sensor maintenance manual Replace relay (1)

MALFUNCTION TABLE (Continued)

Malfunction	Probable Cause	Corrective Action
Data clock does not run	Wire disconnected at connector or at clock motor	Check continuity between connector pins and clock (2)
	Defective connector	Replace connector (2)
	Defective clock motor	Replace motor (2)
Pictures appear on film, but no data	Wire in lamp circuit open	Check circuit continuity (1)
	Defective connector	Replace connector (2)
	Burned out lamp	Replace lamp (1)
	Defect in pulse switch	Replace switch (2)
Film transport operates, data appears on film, but no pictures	Lens cap on	Remove lens cap (1)
	Reflex mirror stuck (visoflex)	Release mirror lever (1)
	Diaphragm closed down too far	Take light reading and use proper F stop for light condition (1)
	Insufficient time	
	Auto exposure not functioning	Reset time knob
Shutter and film transport operate, but not pictures nor data on film	Defective film	Replace with fresh film of proper rating (1)
	A. S. A. Switch not set properly	Set A. S. A. switch to match film rating (1)

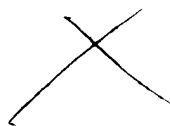
MALFUNCTION TABLE (Continued)

<u>Malfunction</u>	<u>Probable Cause</u>	<u>Corrective Action</u>
Drive motor turns and film transports, but shutter does not work	Pin holding shutter drive gear to shaft sheared	Repin gear to shaft (2)
Motor turns and shutter operates, but film does not transport	Magazine not seated on camera properly	Reassemble magazine on camera (1)
	Gearing between camera and magazine stripped	Replace gears on camera and/or magazine (2)
Motor turns, but shutter and film transport does not operate	Pin holding drive gear on motor shaft sheared	Repin gear to motor shaft (2)
Shutter does not change or move to correct position when light conditions change	Automatic shutter not on.	Turn shutter switch to automatic position (1)
	Amplifier not connected. Defective amplifier.	Plug in amplifier (1) Replace amplifier (2)
Shutter opens to 1/5 second opening during camera operation	Switch in Agastat defective.	Replace switch (2)
	Switch in control box defective	Replace switch (2)
Shutter does not open to 1/5 second opening when control box is set at time and bore position ("TB")	Defective switch	Replace switch (2)
Shutter setting motor turns but shutter setting does not change	Defective limit switch	Replace switch (2)
	Cam pin sheared	Replace pin (2)

MALFUNCTION TABLE (Continued)

Malfunction	Probable Cause	Corrective Action
Take-up indicator on 1000' magazine does not move	Loose drive belt (Fig. 16)	Replace drive belt to obtain take-up torque of 24 in-oz. (2)
Take-up indicator on 400' magazine does not move	Loose drive belt (Fig. 14)	Replace drive belt to obtain take-up torque of 20 in-oz. (2)
400' magazine vibrates during operation	Supply spool clutch too loose	Reset supply spool clutch to torque of 26 to 28 in-oz. (2)
Camera slows down or stalls with 400' magazine mounted	Supply spool clutch too tight	Reset supply spool clutch to torque of 26 to 28 in-oz. (2)
Camera slows down or stalls with 100' magazine mounted	Supply spool clutch too tight	Reset supply spool clutch to torque of 10 to 12 in-oz. (2)

- (1) Field Repair  
(2) Second Echelon Repair



APPENDIX



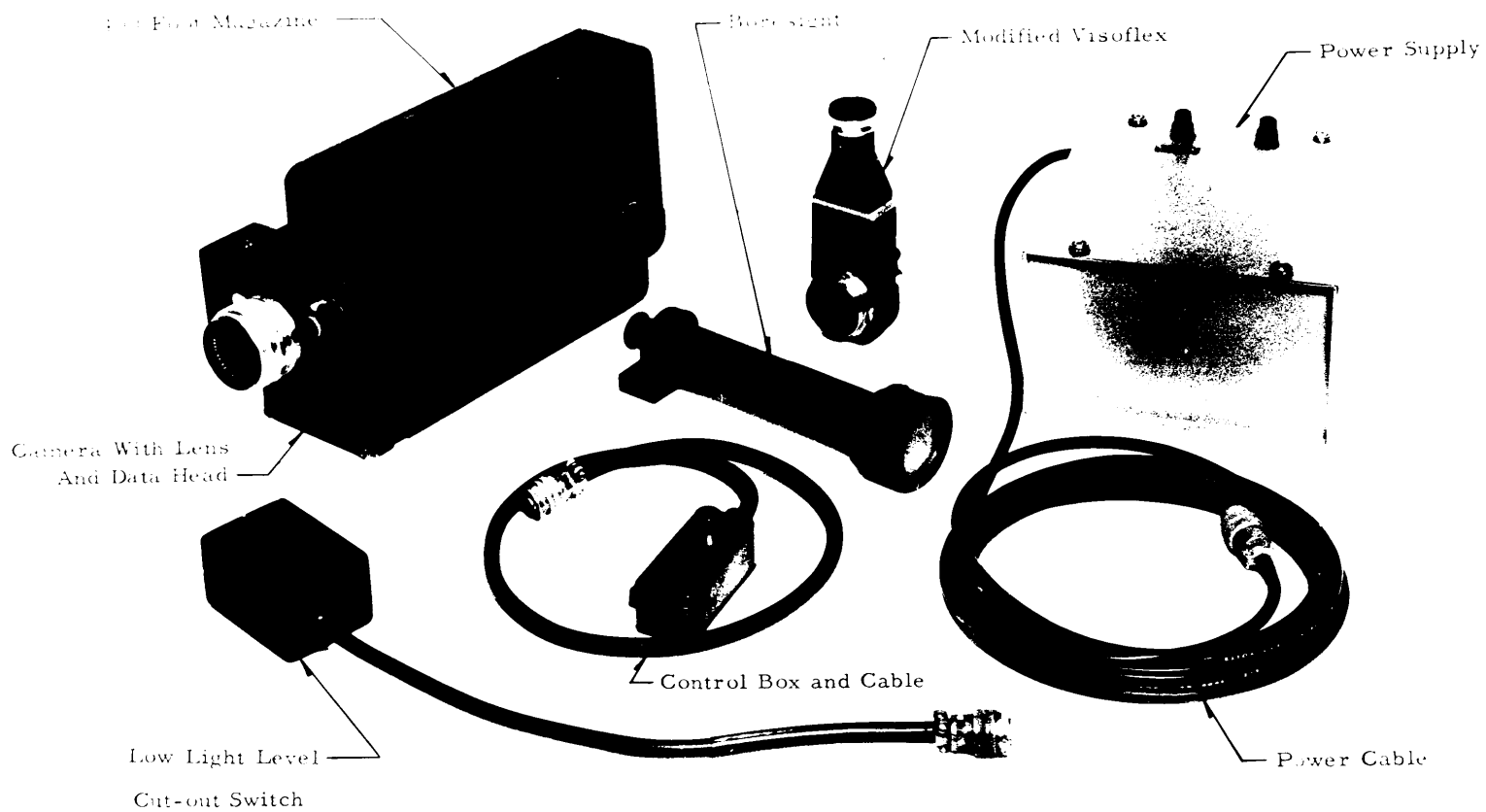
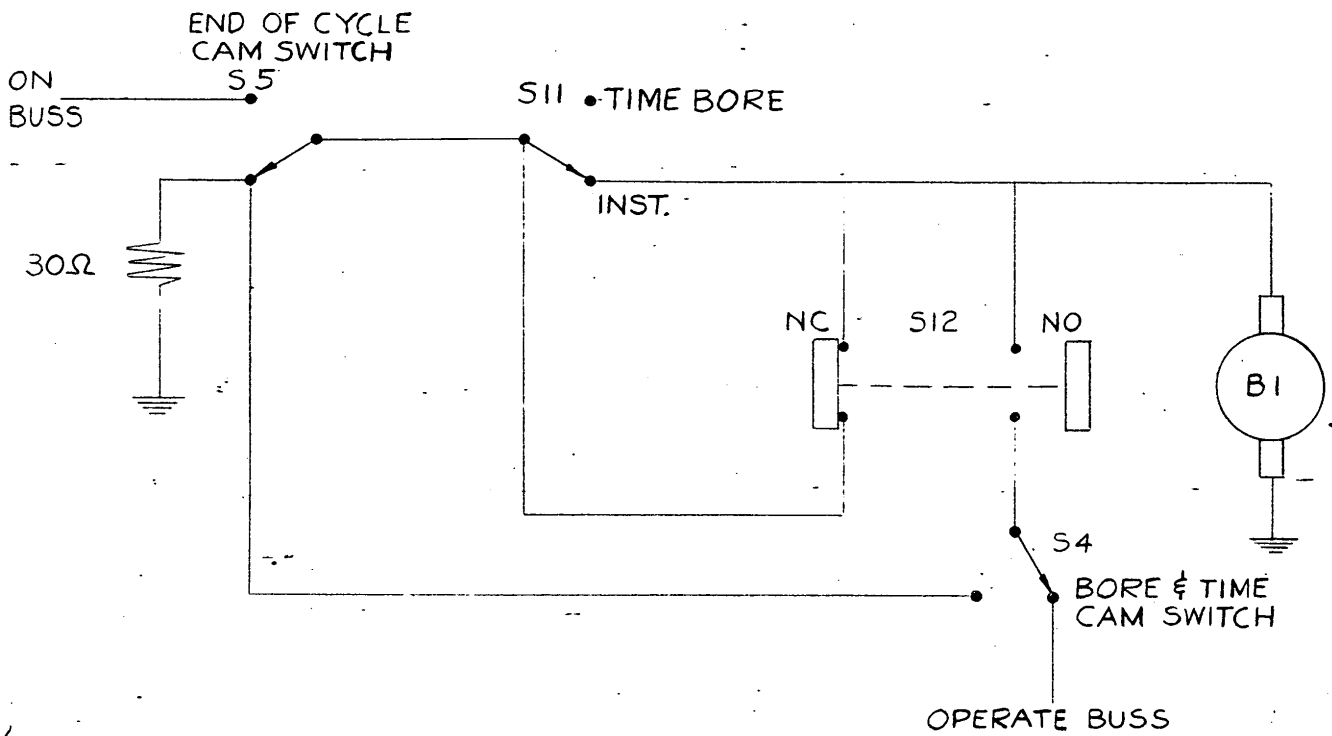


FIG. 1 - CAMERA SYSTEM COMPONENTS

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CLASSIFICATION

FIG. 22 PARTIAL SCHEMATIC



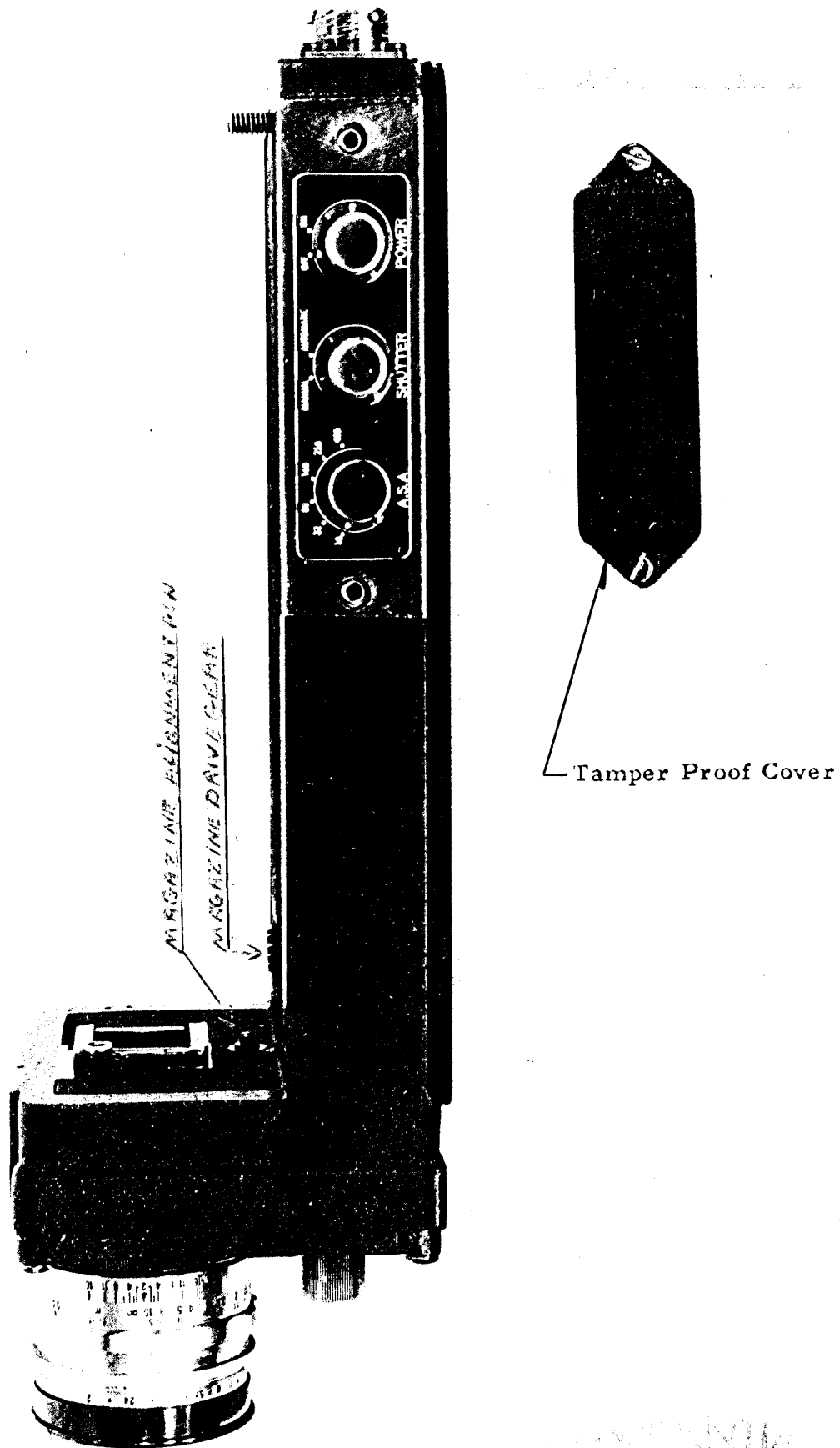
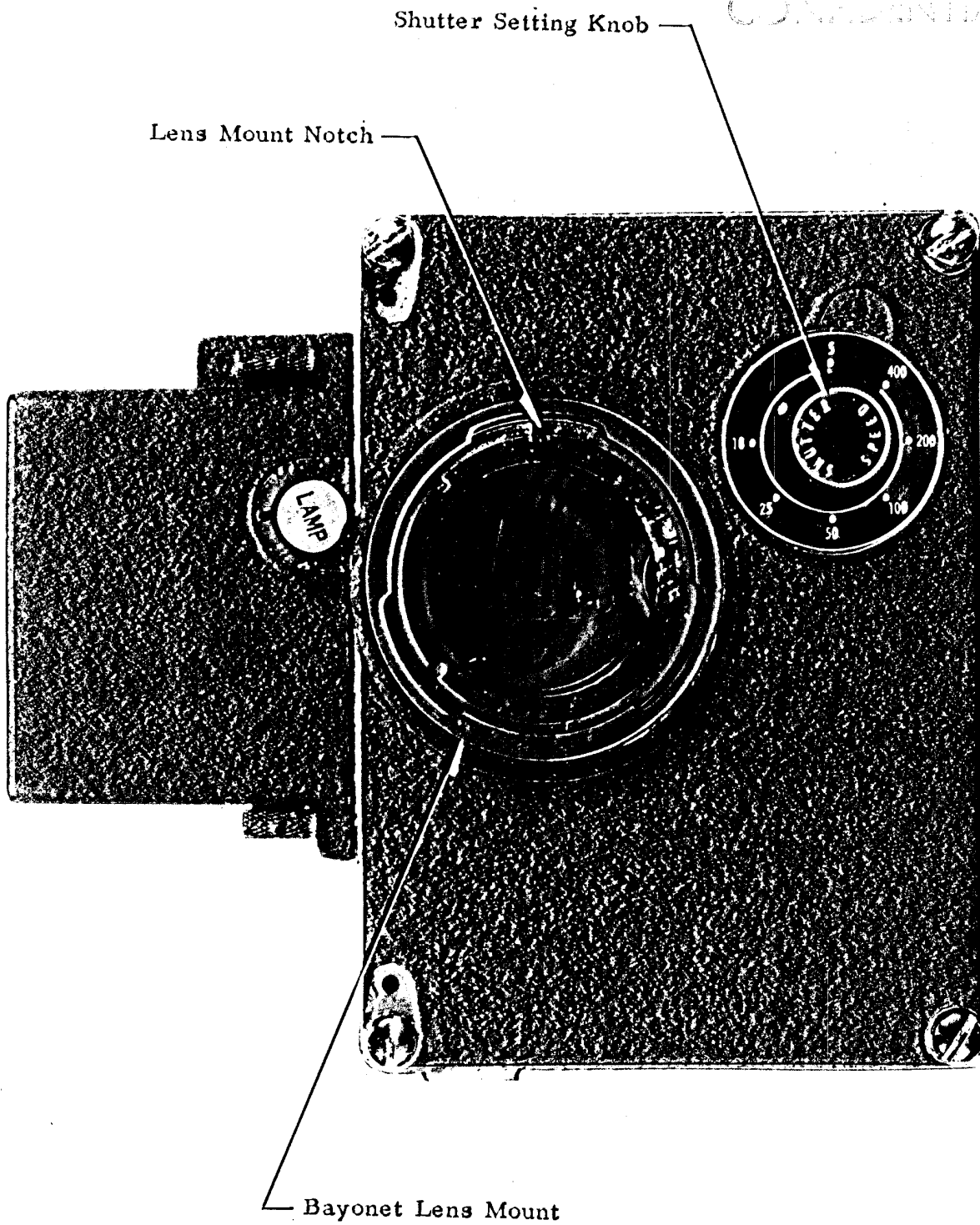


FIG. 3 - CAMERA BODY WITH CONTROL COVER REMOVED

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FIG. 4 - CAMERA BODY - FRONT VIEW

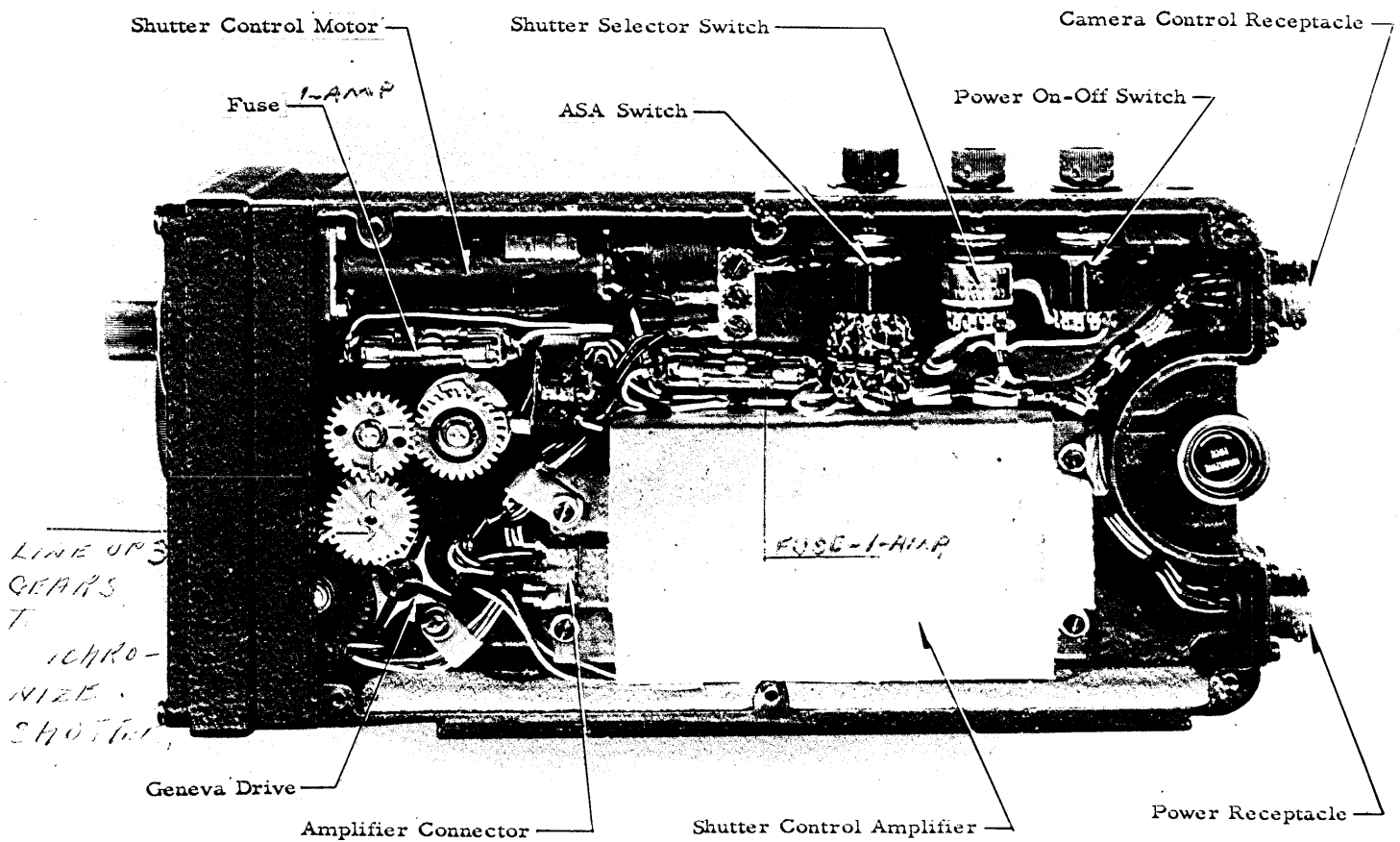


FIG. 5 - VIEW OF CAMERA WITH COVER REMOVED

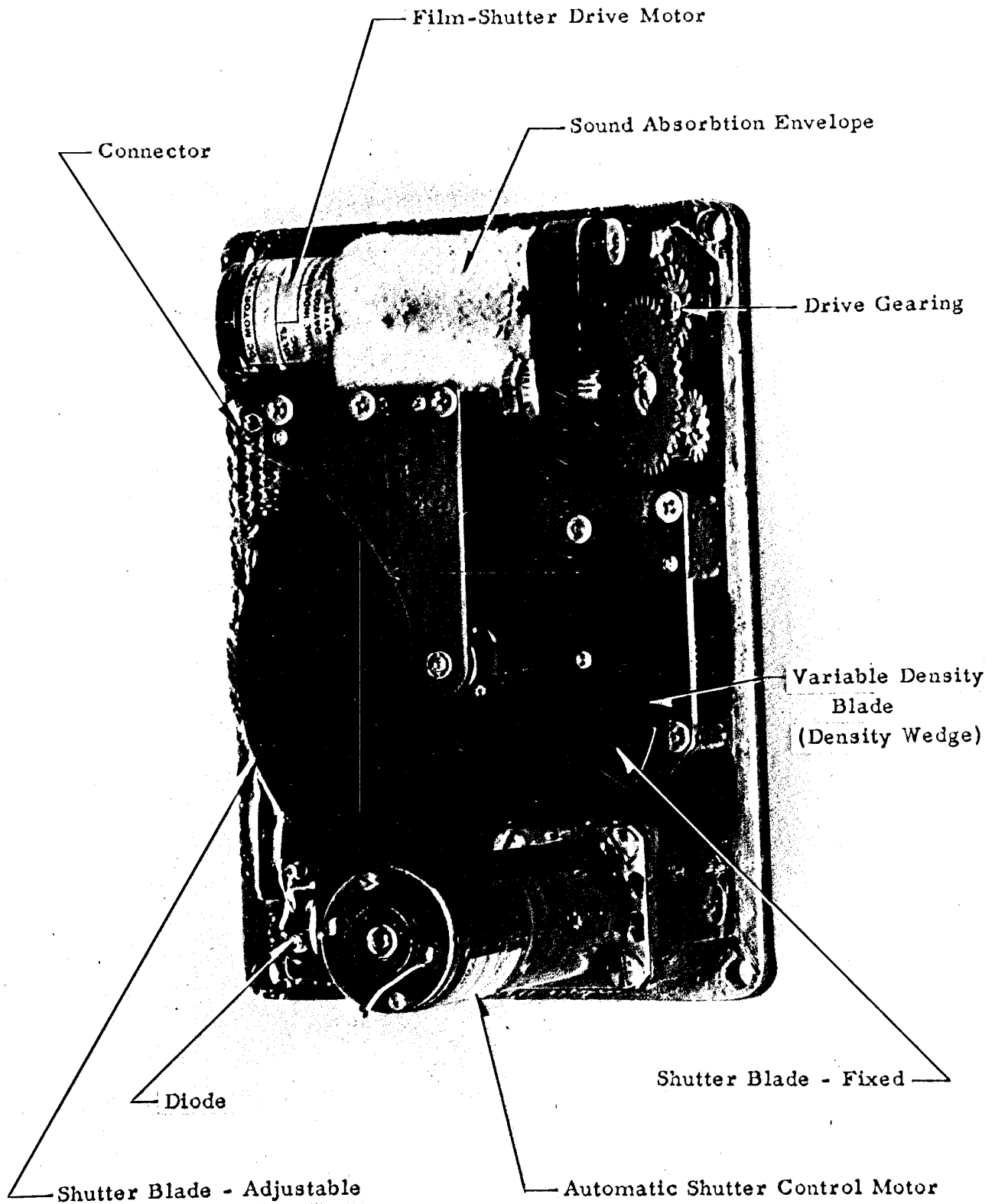
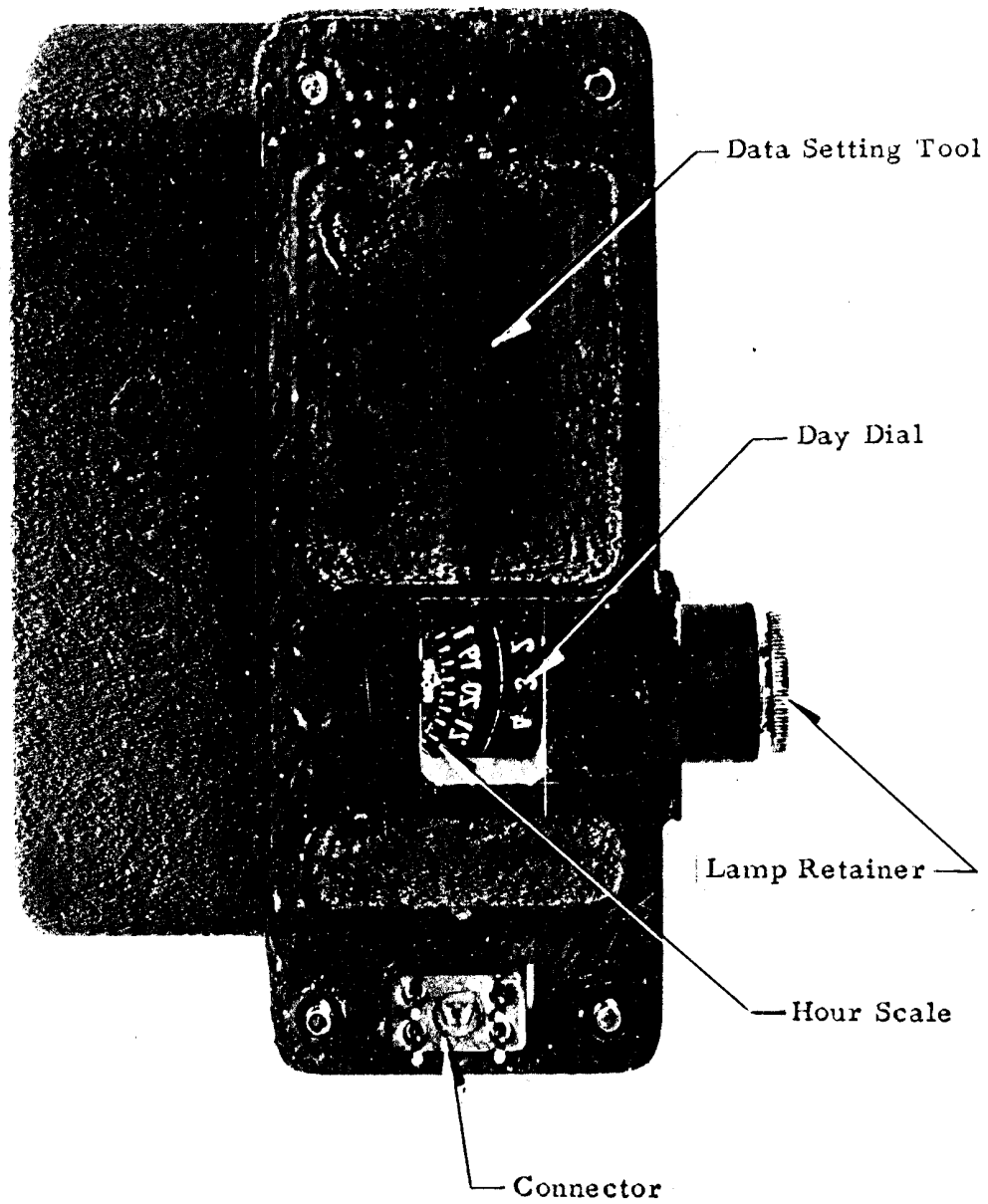


FIG. 6 - SHUTTER ASSEMBLY

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FIG. 7 - DATA HEAD

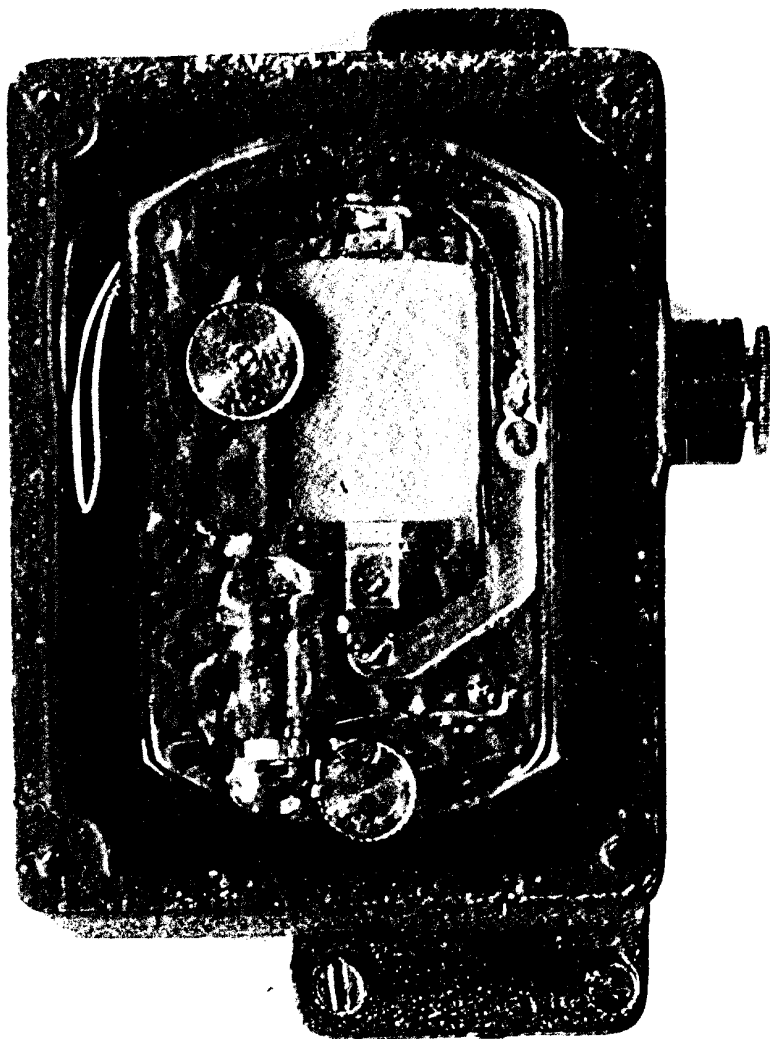


FIG. 8 - DATA HEAD - COVER REMOVED

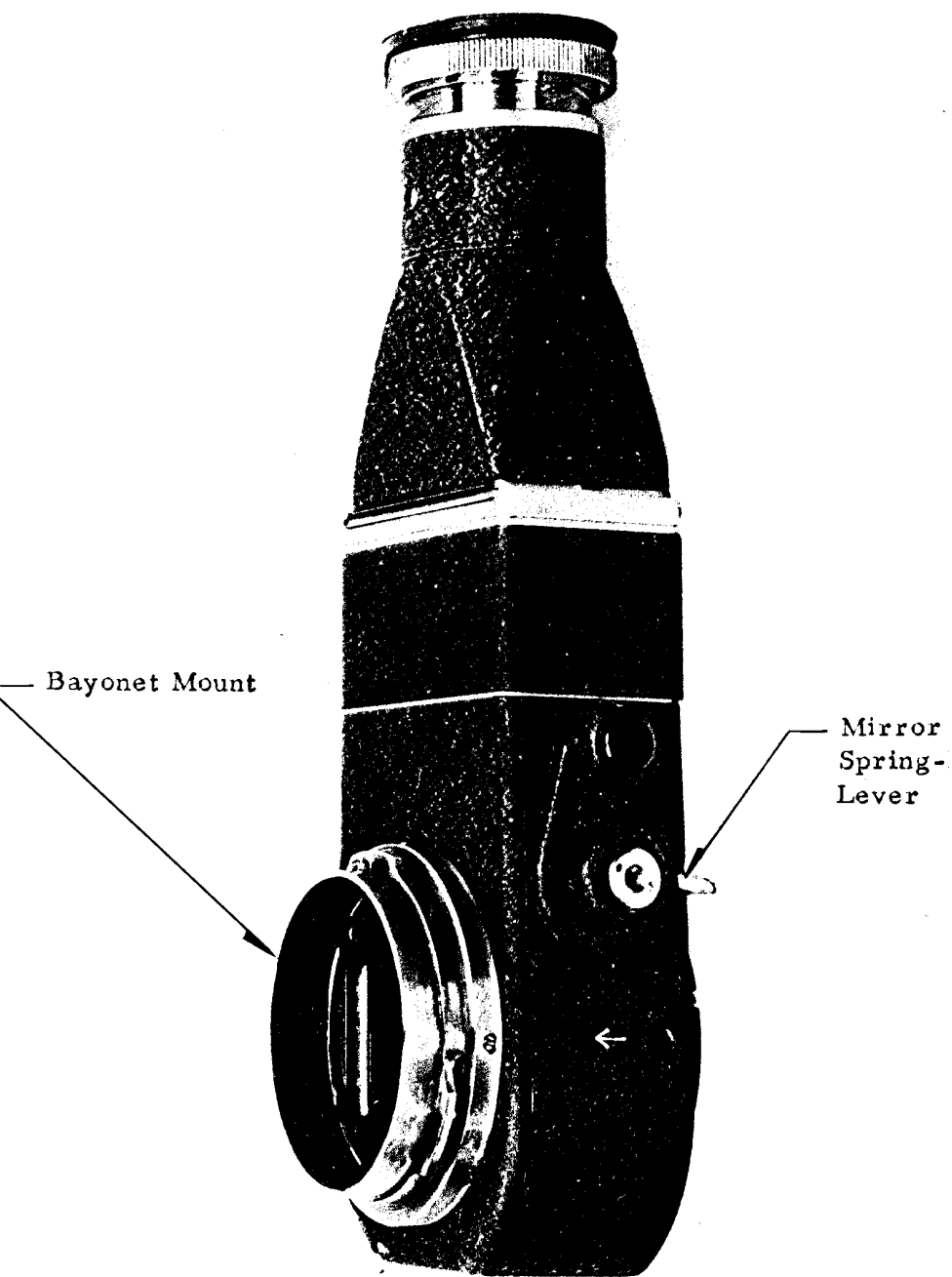


FIG. 9 - REFLEX VIEWFINDER (MODIFIED VISOFLEX)

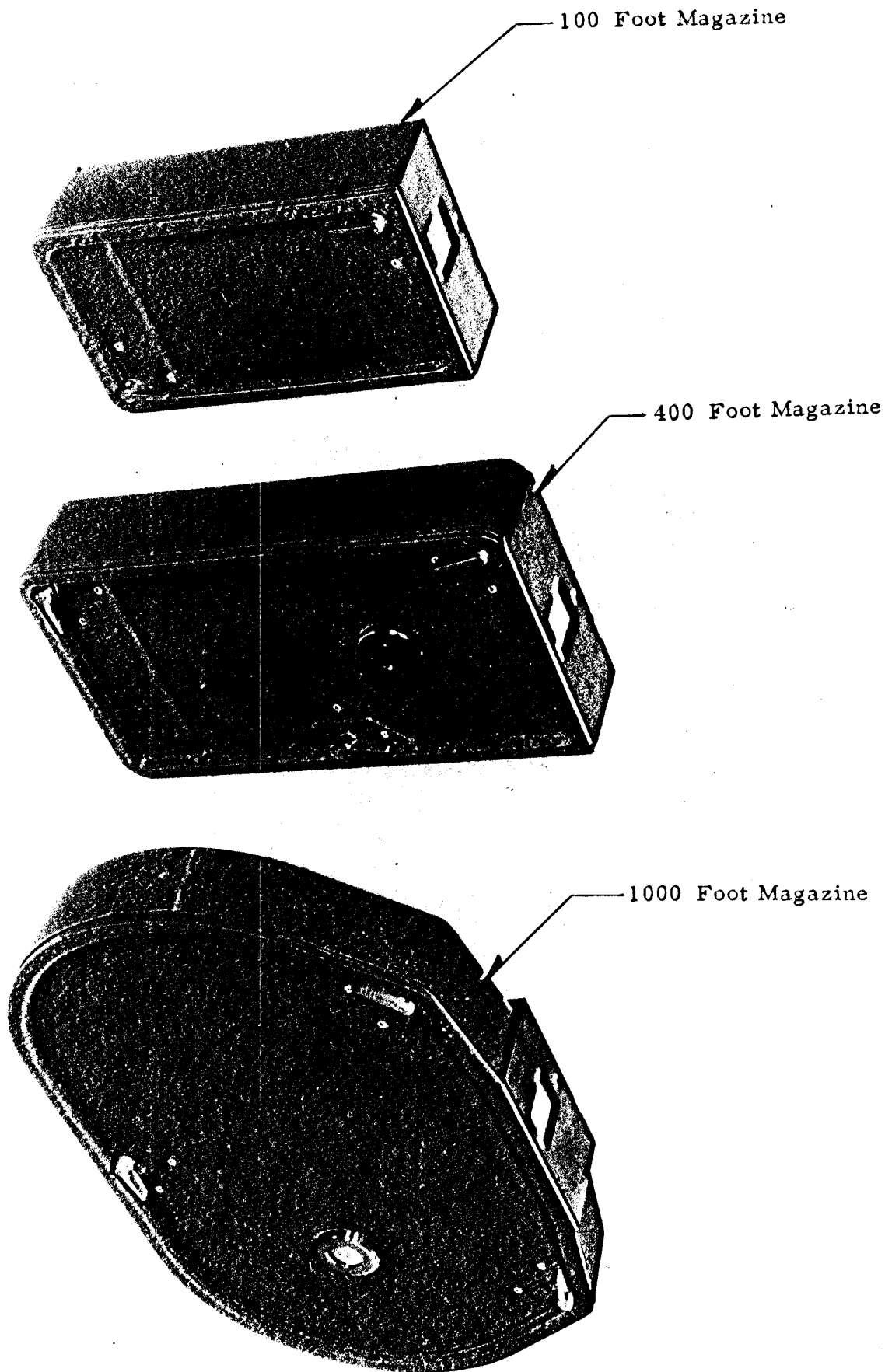


FIG. 10 - MAGAZINE SELECTION



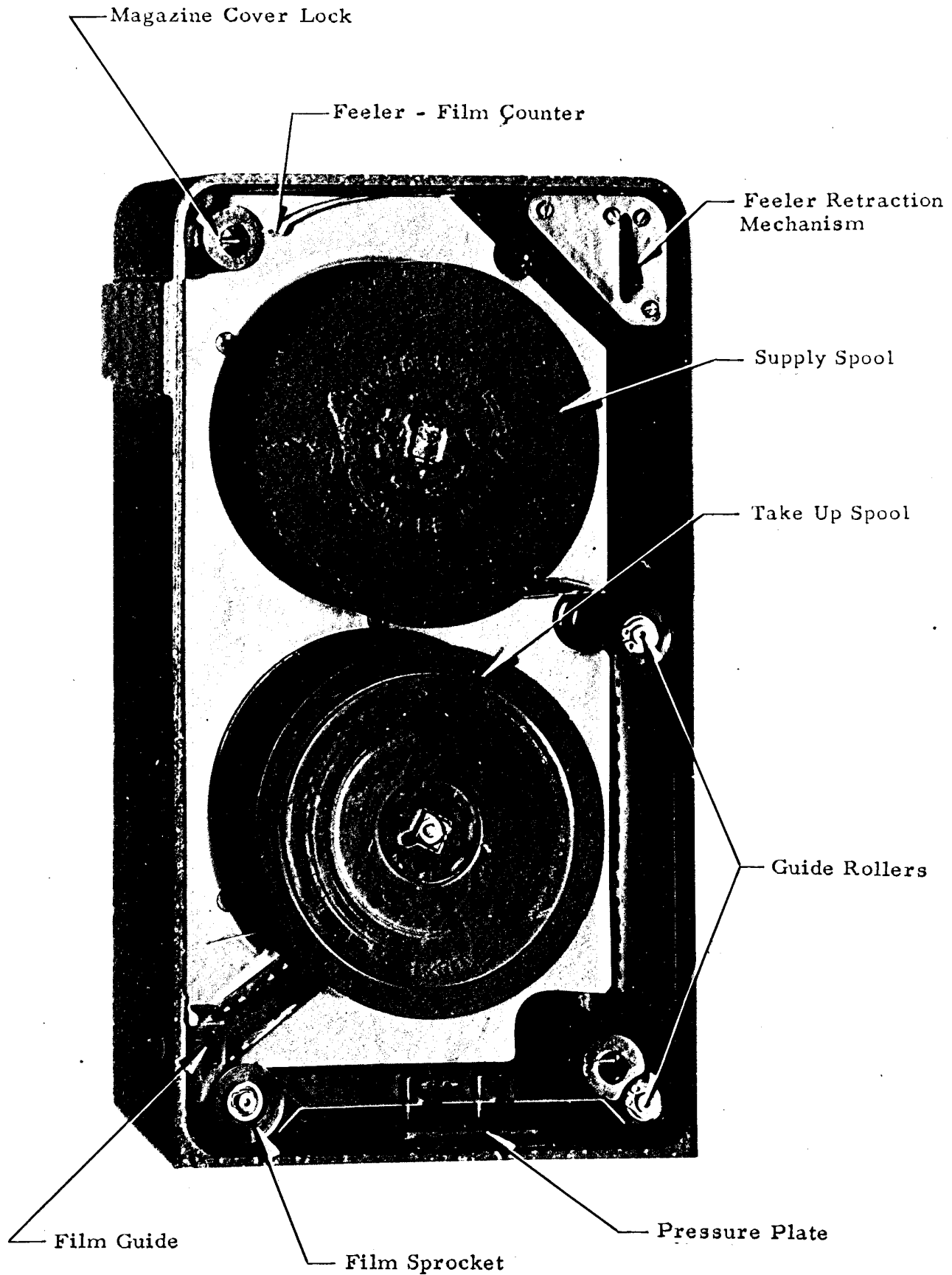


FIG. 11 - 100 FT. MAGAZINE - LOADING SCHEME

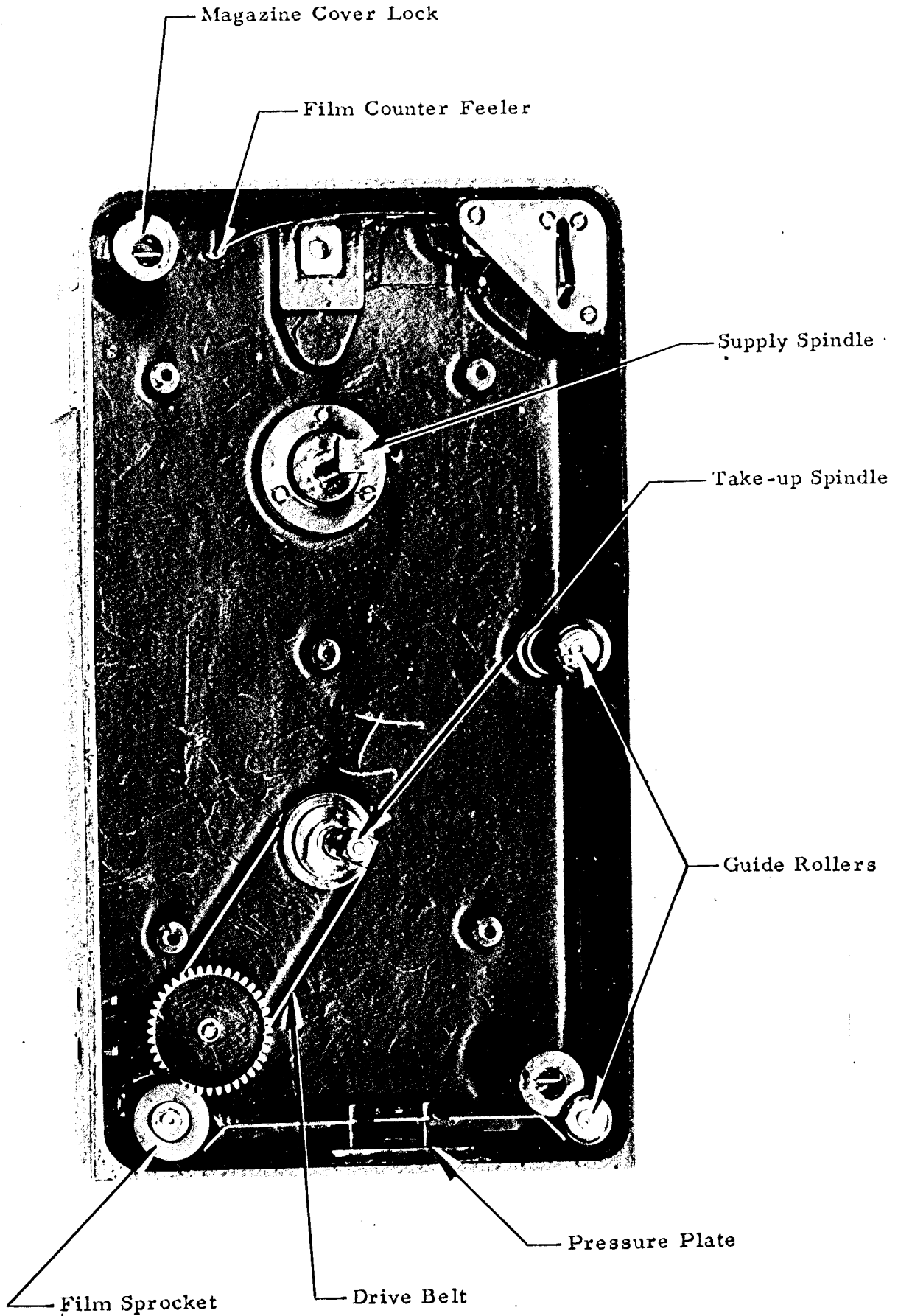


FIG. 12 - 100 FOOT MAGAZINE WITH COVER PLATE REMOVED

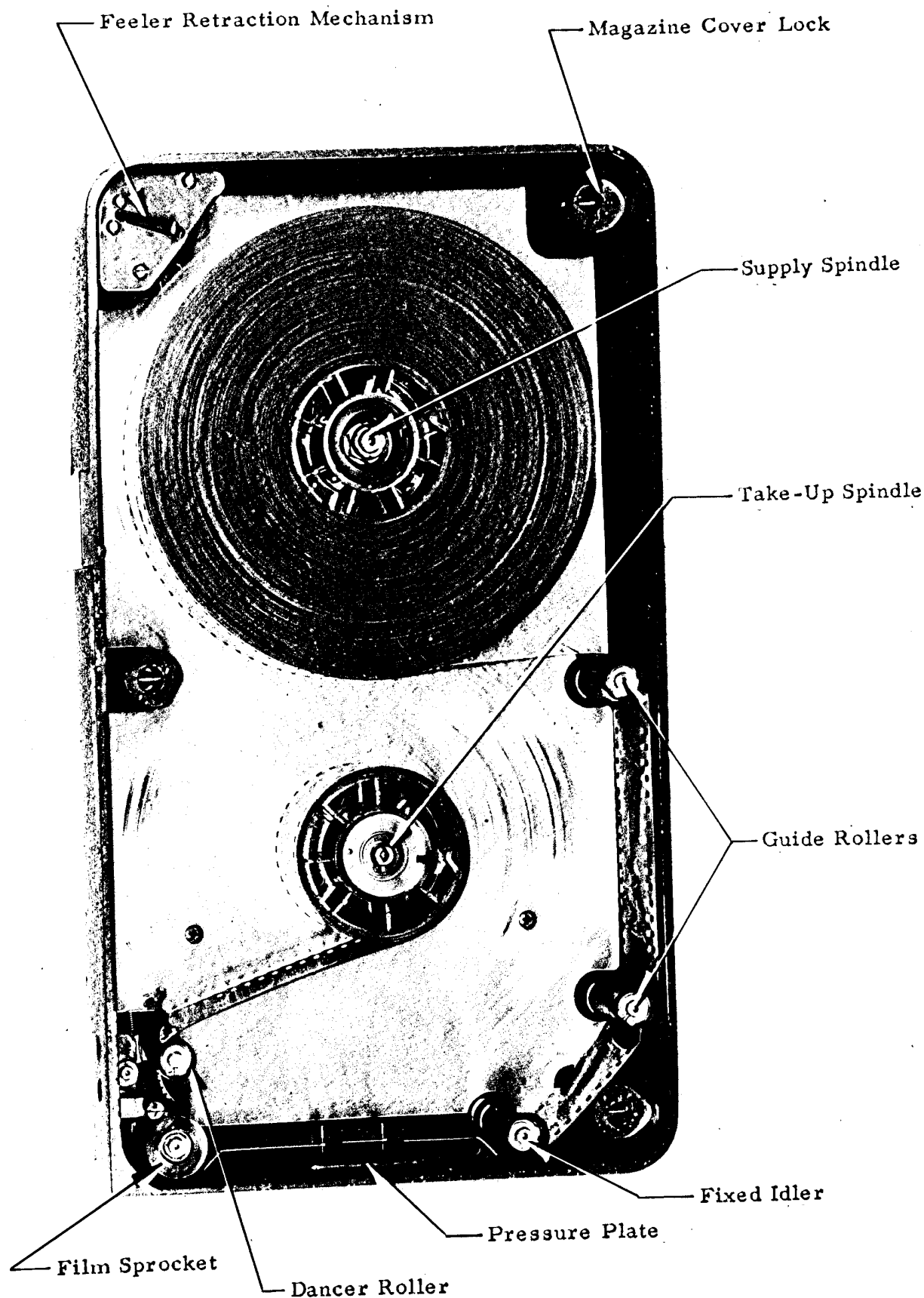


FIG. 13 - 400 FOOT MAGAZINE LOADING SCHEME

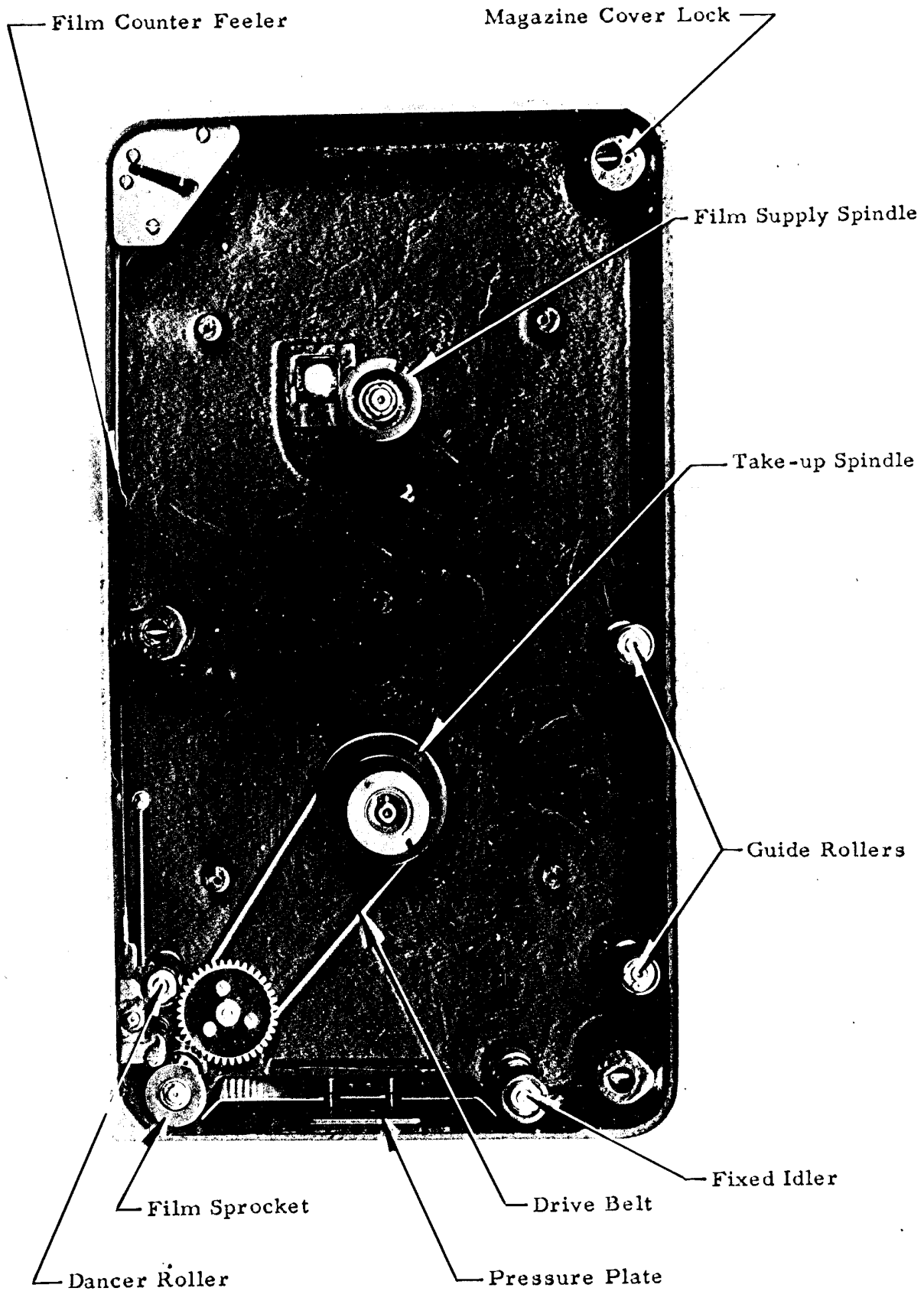


FIG. 14 - 400 FOOT MAGAZINE WITH COVER PLATE REMOVED

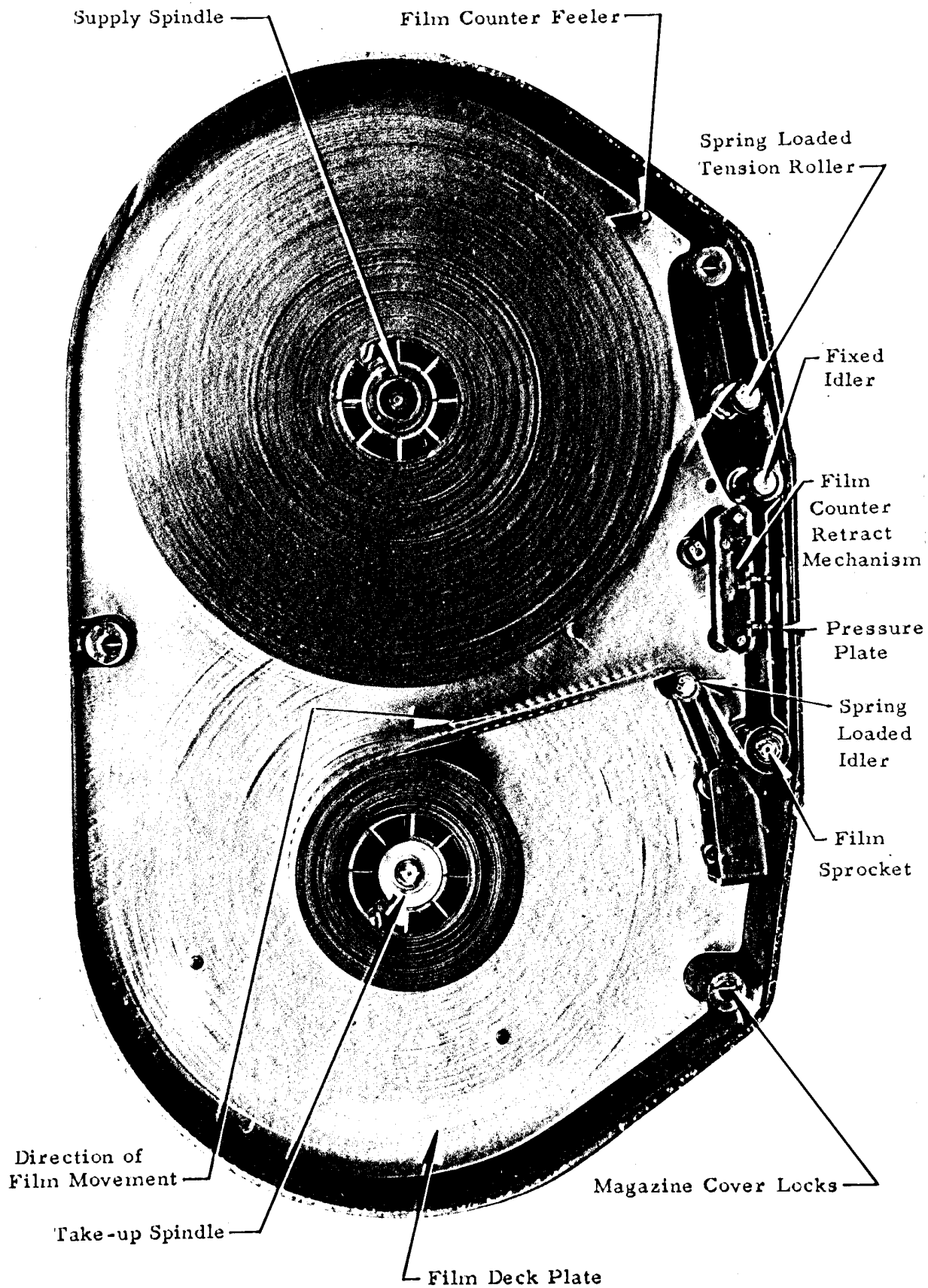


FIG. 15 - 1000 FT. MAGAZINE LOADING SCHEME

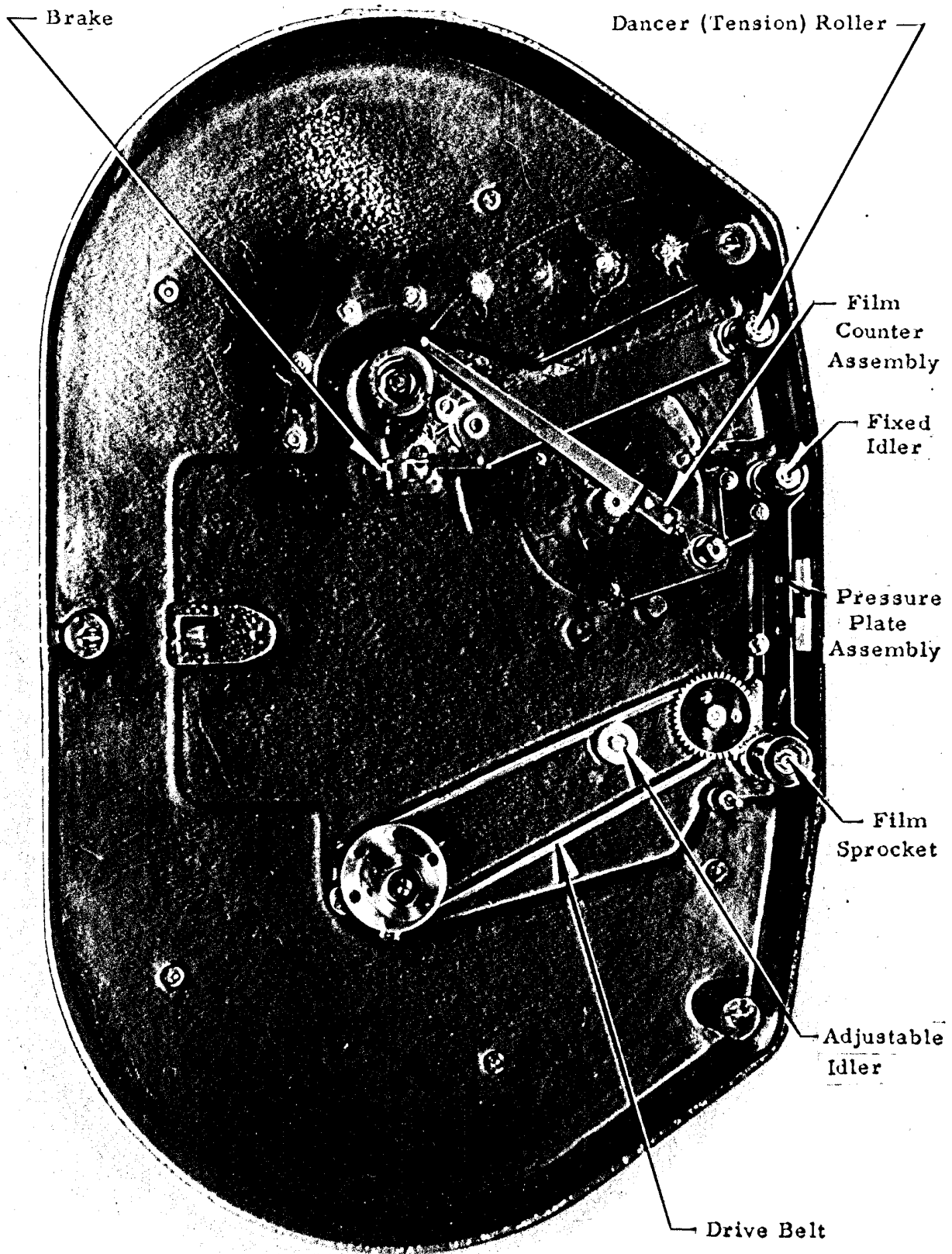


FIG. 16 - 1000 FT. MAGAZINE WITH COVER PLATE REMOVED

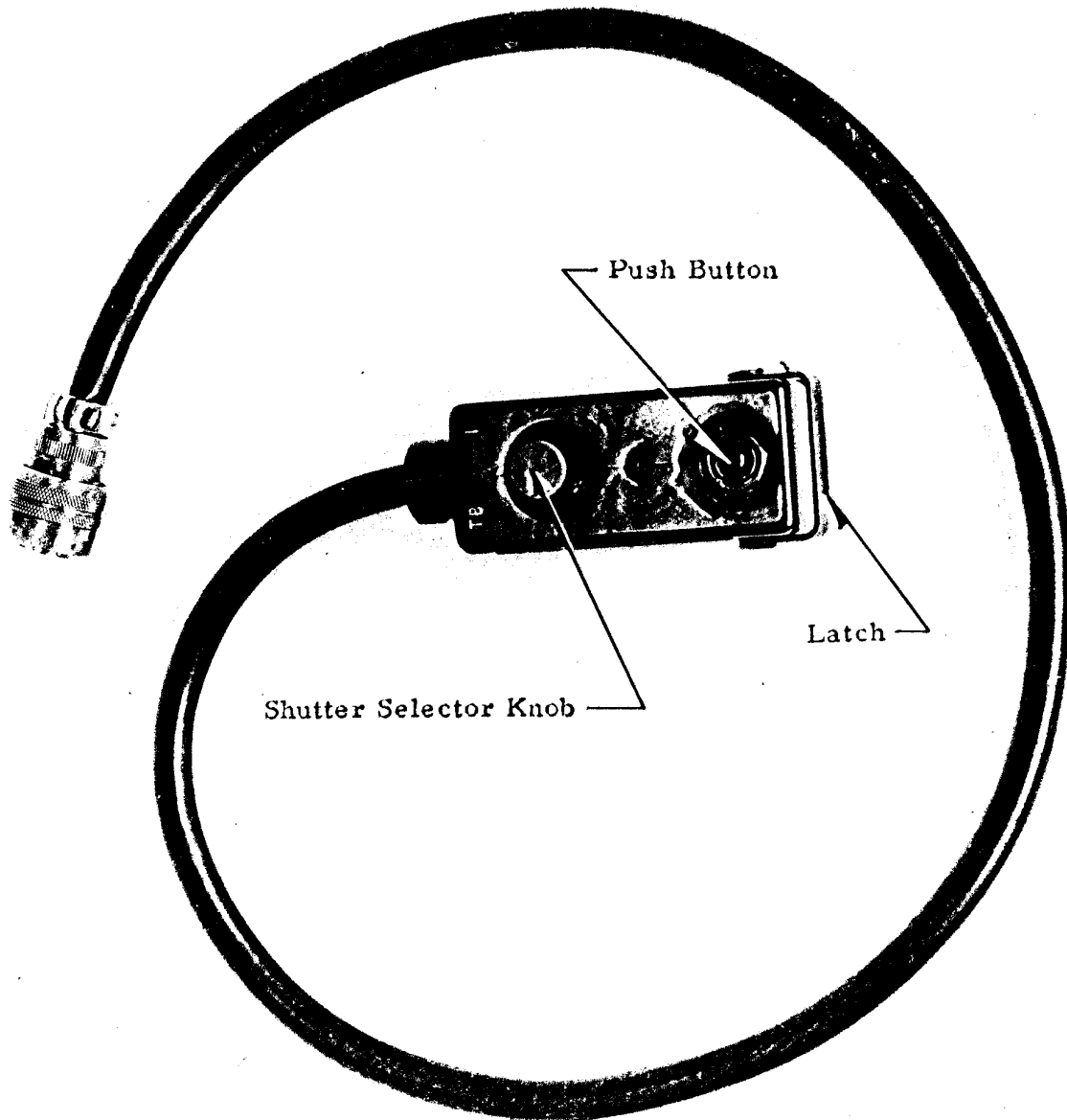


FIG. 17 - CONTROL BOX

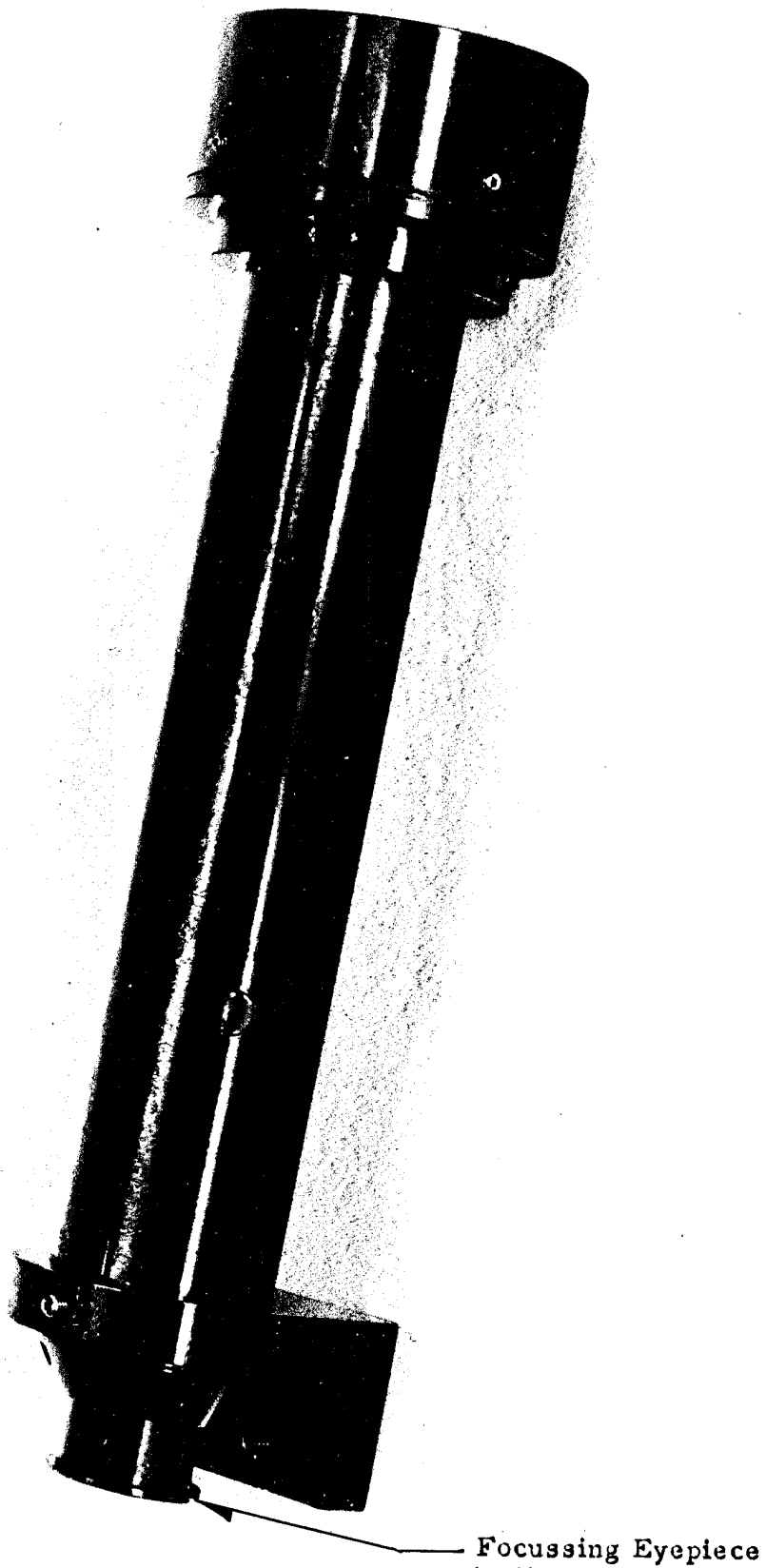


FIG. 18 - BORESIGHT



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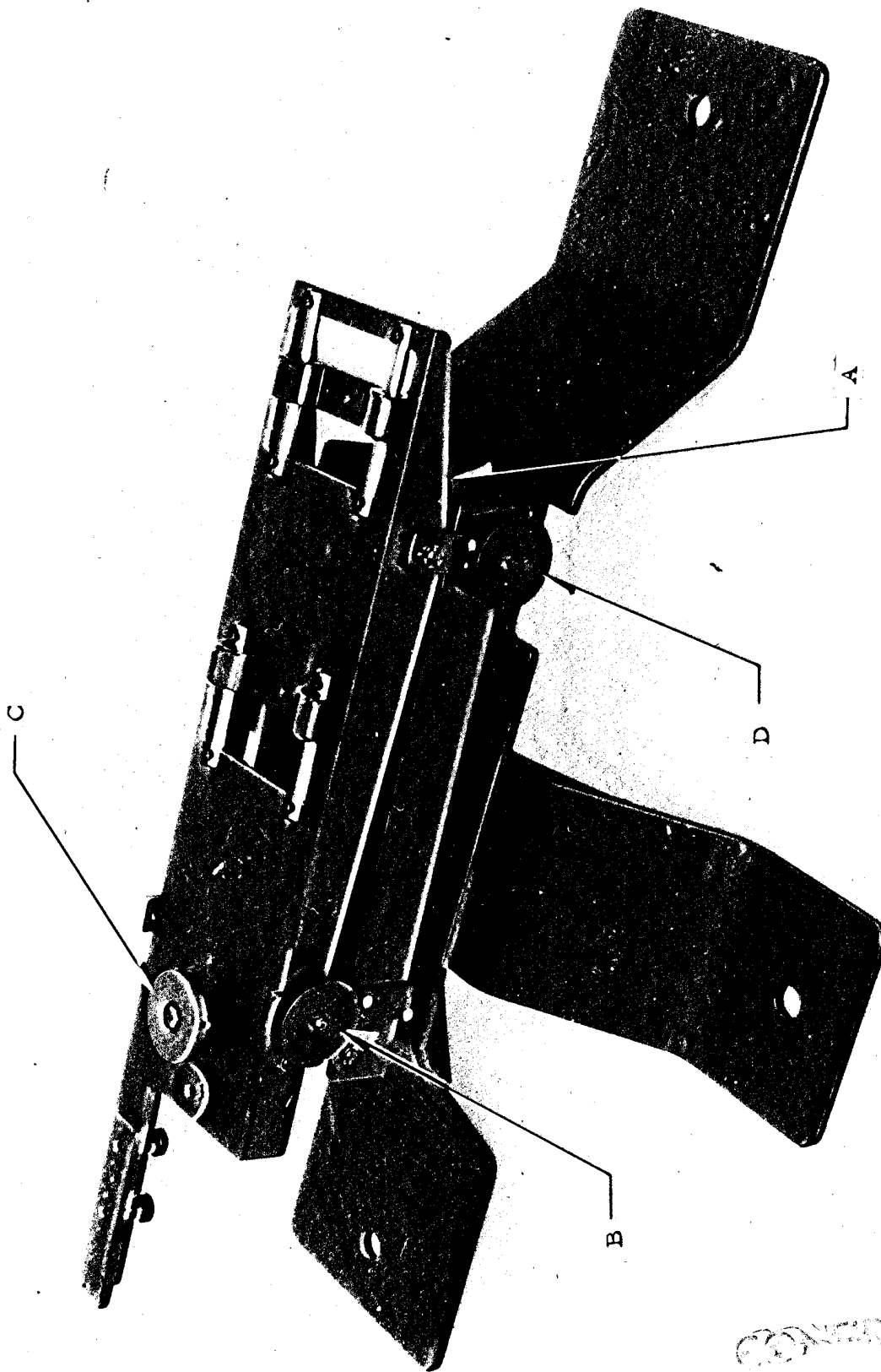
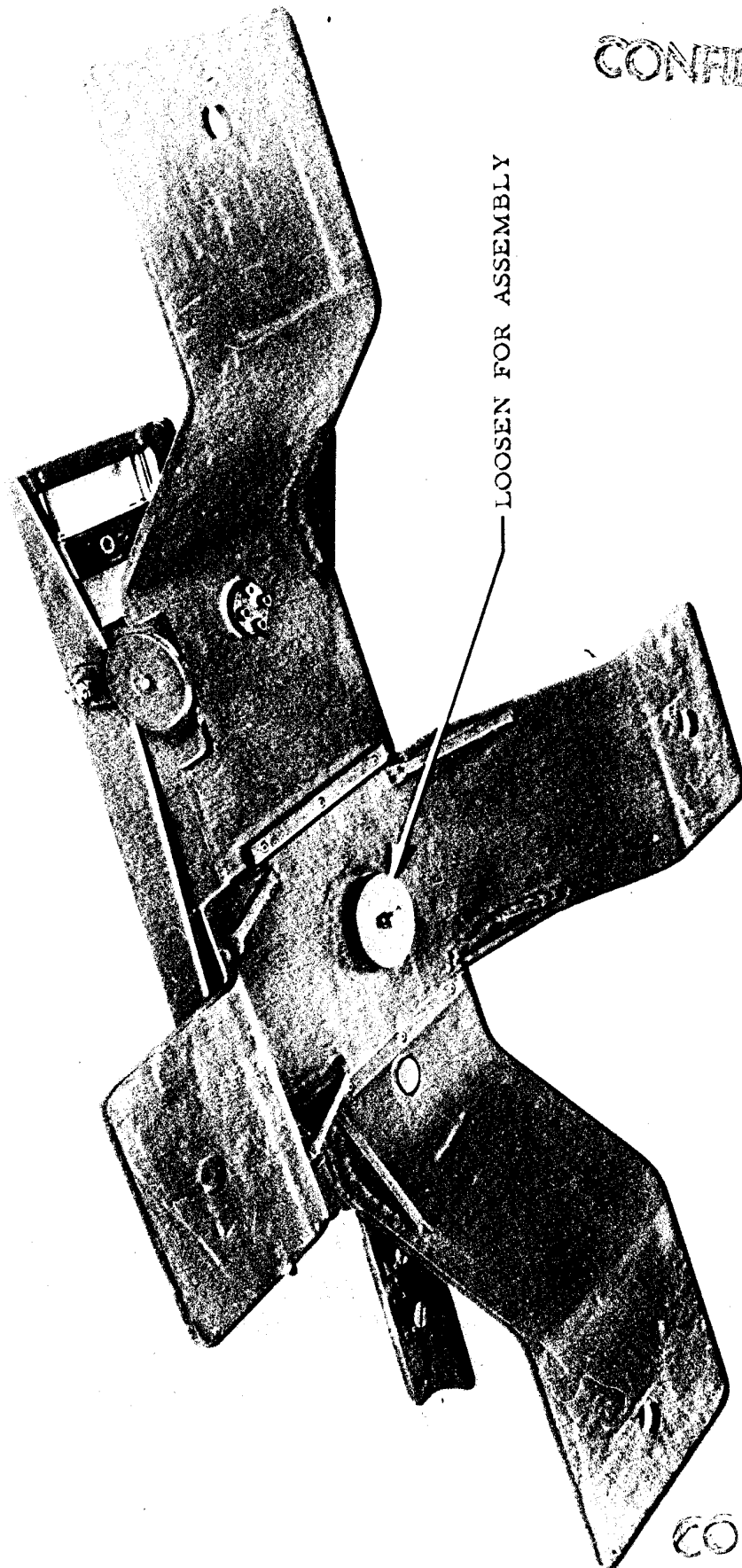


Figure 20 CAMERA SUPPORT SHOWING KNOBS A, B, C & D

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LOOSEN FOR ASSEMBLY

Figure 21 CAMERA SUPPORT - BOTTOM VIEW

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