

RCA  
PG-201  
16mm  
PROJECTOR

### General Description

jector for public address or for playing phonograph records, by plugging a microphone or a pickup unit into a receptacle provided in the input circuit of the amplifier.

## TECHNICAL AND DIMENSIONAL DATA

**Tube Complement (MI-1363)**

Photocell	RCA-927
Input	RCA-6J7*
Voltage amplifier	RCA-6C5
Amplifier-phase inverter	RCA-6SN7-GT
Output (two tubes)	RCA-6L6-G
Rectifier	RCA-5U4-G
Oscillator	RCA-6F6

\*A 6J7-G or a 6J7-GT may be used if it is shielded.

### Amplifier Fuse

2-ampere

### Amplifier Load Impedances

4, 8, and 250 ohms

## Loudspeaker

Permanent magnet, 10-inch cone

Cable 50 feet long

## WEIGHTS AND DIMENSIONS

Approximately 28 kc

### Power Required

105 to 125 volts, 50-60 cycles, 135 watts

<i>Proj.-</i>	<i>Loud-</i>
<i>Amplifier</i>	<i>speaker</i>
(MI-1342-A)	(MI-1387-A)

20 watts at less than 5% r.m.s. distortion between 400 and 2,500 cycles, with 117 volts on the power transformer primary

Length, overall, carrying case	20"	18¼"
Height, overall, carrying case	16"	18"
Width, overall, carrying case	9¼"	11"
Shipping weight, pounds	66	36½
Equipment weight, pounds	57	28½

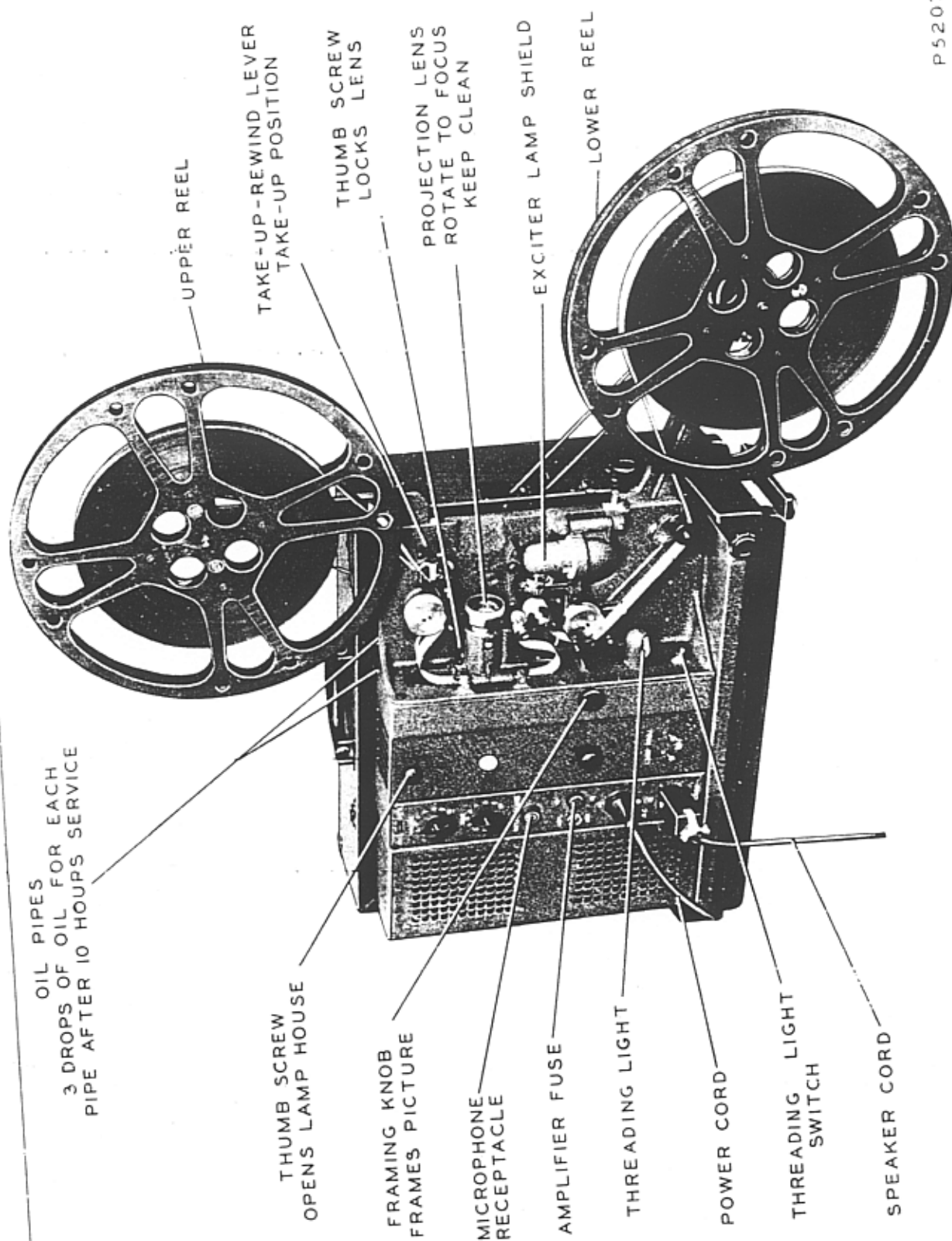


Figure 2—Projector Ready for Operation

### Contents of Carrying Cases

3. After the carrying cases have been removed from the shipping cartons and before any of the packing material is thrown away, the contents of the two cases should be checked against the itemized packing lists contained in the carrying cases to assure that nothing is missing. The cases should contain:

#### a. Projector-amplifier case

- 1 Projector-amplifier, with all tubes and lamps in place except the projection lamp, which is packed in the speaker case
- 1 Projection lens, 2-inch focal length, in its holder

- 1 Brush
- 2 Spring belts, one for each reel, in place
- 1 Detailed packing list
- b. Loudspeaker case
  - 1 Loudspeaker, attached to case
  - 1 Projection lamp
  - 1 Exciter lamp (spare)
  - 1 Fuse, 2-ampere (spare)
  - 2 Reel arms, upper and lower
  - 1 Reel, 1,600 foot capacity
  - 1 Power cord
  - 1 50-foot speaker cable, on bobbin
  - 1 Bottle of oil, with applicator
  - 1 Microphone connector
  - 1 Instruction book
  - 1 Itemized packing list

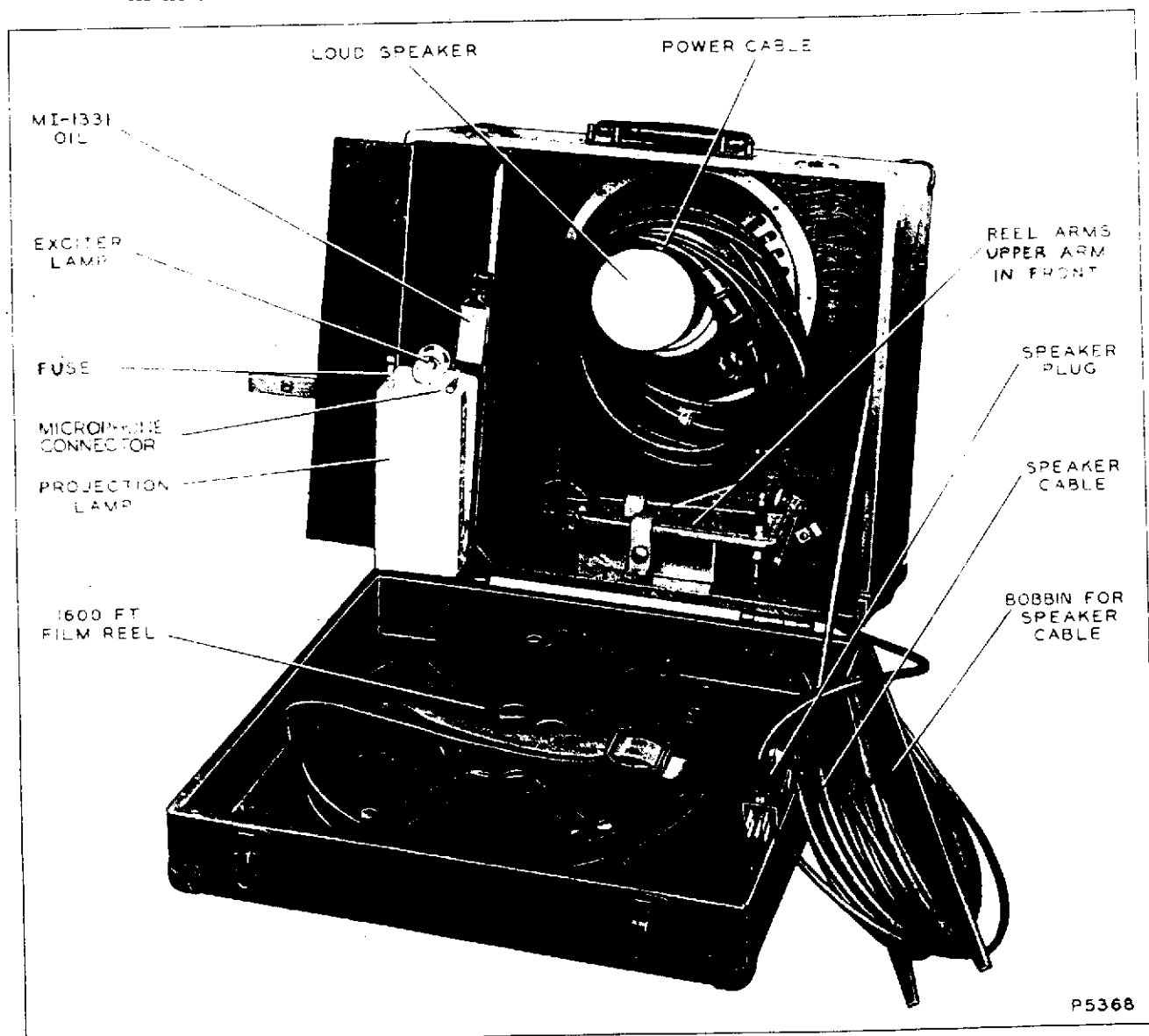


Figure 3—Loudspeaker Case and Contents

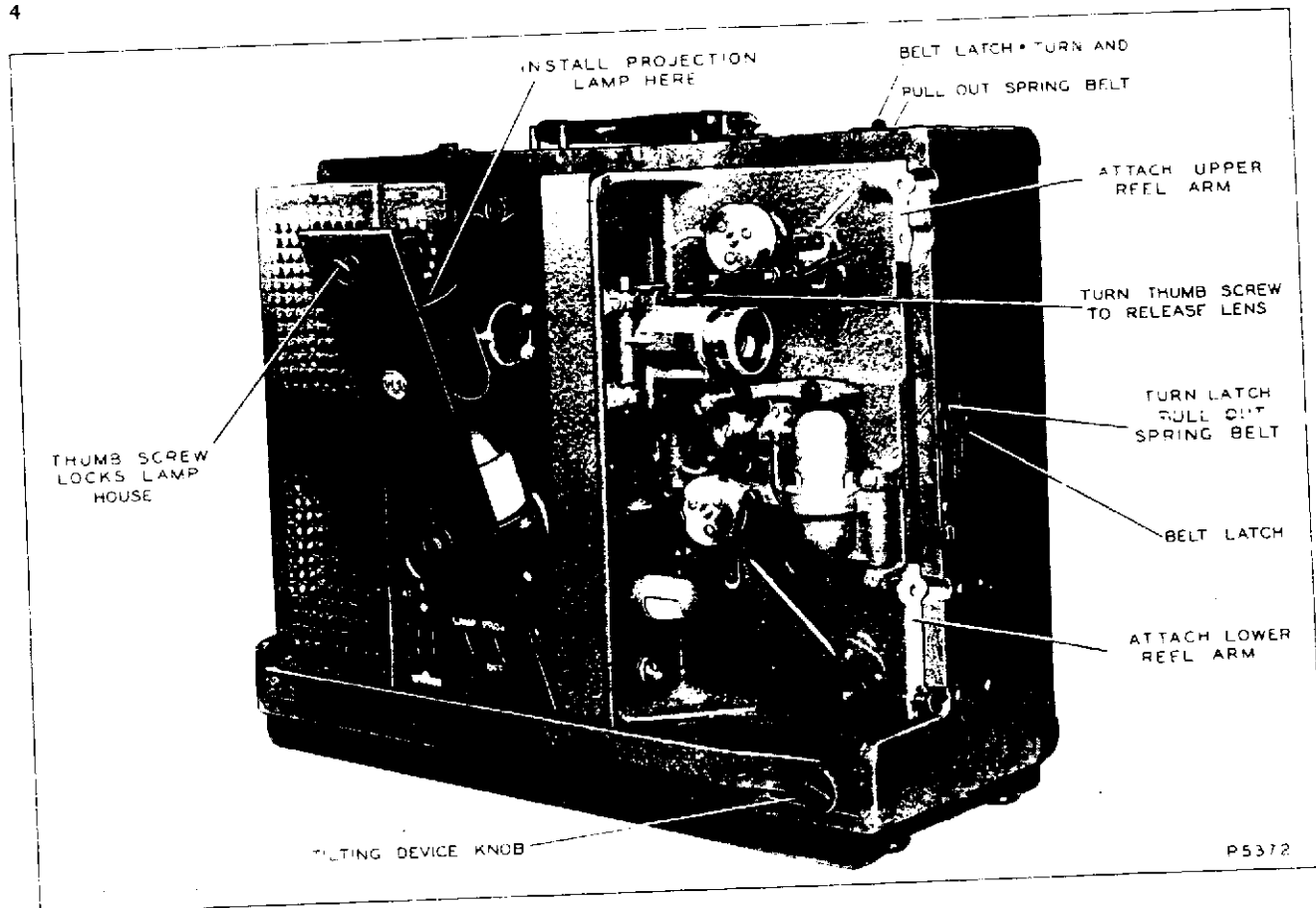


Figure 4—Setting Up Projector

# Operation

## Setting Up Equipment

4. Arrange the equipment in the projection room as shown in figure 1. Place the projector-amplifier, with its front cover removed, on a steady table in front of a projection screen at a suitable distance. (For detailed information refer to figure 1 and to Utilization.) Remove all loose parts from the speaker case (fig. 3) and place them on the table within reach of the operator. Close the speaker case; unwind the speaker cable, and place the speaker near the screen, as shown in figure 1.

## Installing Projection Lamp

5. Open the lamp house (fig. 2) and insert the projection lamp in the socket attached to the lamp-house door (fig. 4). Line up the wide and the narrow flanges on the base of the lamp with the corresponding recesses in the socket. Press down firmly on the lamp and turn it clockwise (about 90°) until it locks in place. Avoid getting fingerprints on the clear portions of the lamp for they will burn into the glass and permanently mar the lamp. Close the lamp-house door and lock it with the thumbscrew.

NOTE: Except during shipment, the projection lamp is kept in its socket in the lamp house. A spare lamp should be kept on the projection table during operation and in the speaker case between shows.

## Mounting Reel Arms and Reels

6. Attach the reel arms to the frame of the projector where shown in figure 4. (They fit in only one way.) Lock them with the captive thumbscrews. Turn the latches that hold the spring belts inside the projector case, pull out the belts (fig. 4), and put them over their respective reel pulleys. Put the empty reel on the lower reel arm, moving the projector forward until the reel clears the front

edge of the table (fig. 1). Place the full reel on the upper reel arm.

## Preliminary Adjustments

7. The following preliminary adjustments should be made before the machine is threaded:

a. Turn all switches to OFF. Wrap the power cable once around a table leg (to prevent accidental disconnection) and then insert the plug into the a-c receptacle on the amplifier panel. Plug the other end into the nearest electrical outlet of the proper voltage and frequency.

b. Turn on the PROJ. switch. Wait until the motor is running and then turn on the LAMP switch.

c. Shift the projector sideways until the light beam points to the screen and turn the tilting-device knob (fig. 4) until the beam centers on the screen in the vertical direction.

d. Release the lens by turning the thumb-screw (fig. 2) on top of the lens holder. Focus the projector, first by sliding the lens back and forth in its holder and then by rotating it until the edges of the lighted area on the screen are as sharp as possible. Turn off the LAMP and PROJ. switches.

## Threading Projector

8. White guide lines on the frame of the projector (fig. 5) show the proper path of the film through the machine. (Also see diagram in projector cover.) The two film loops, one above and the other below the film gate, must be maintained for proper operation. Detailed threading procedure follows:

a. Set the take-up-rewind lever in the take-up position and open the two sprocket shoes and the film gate.

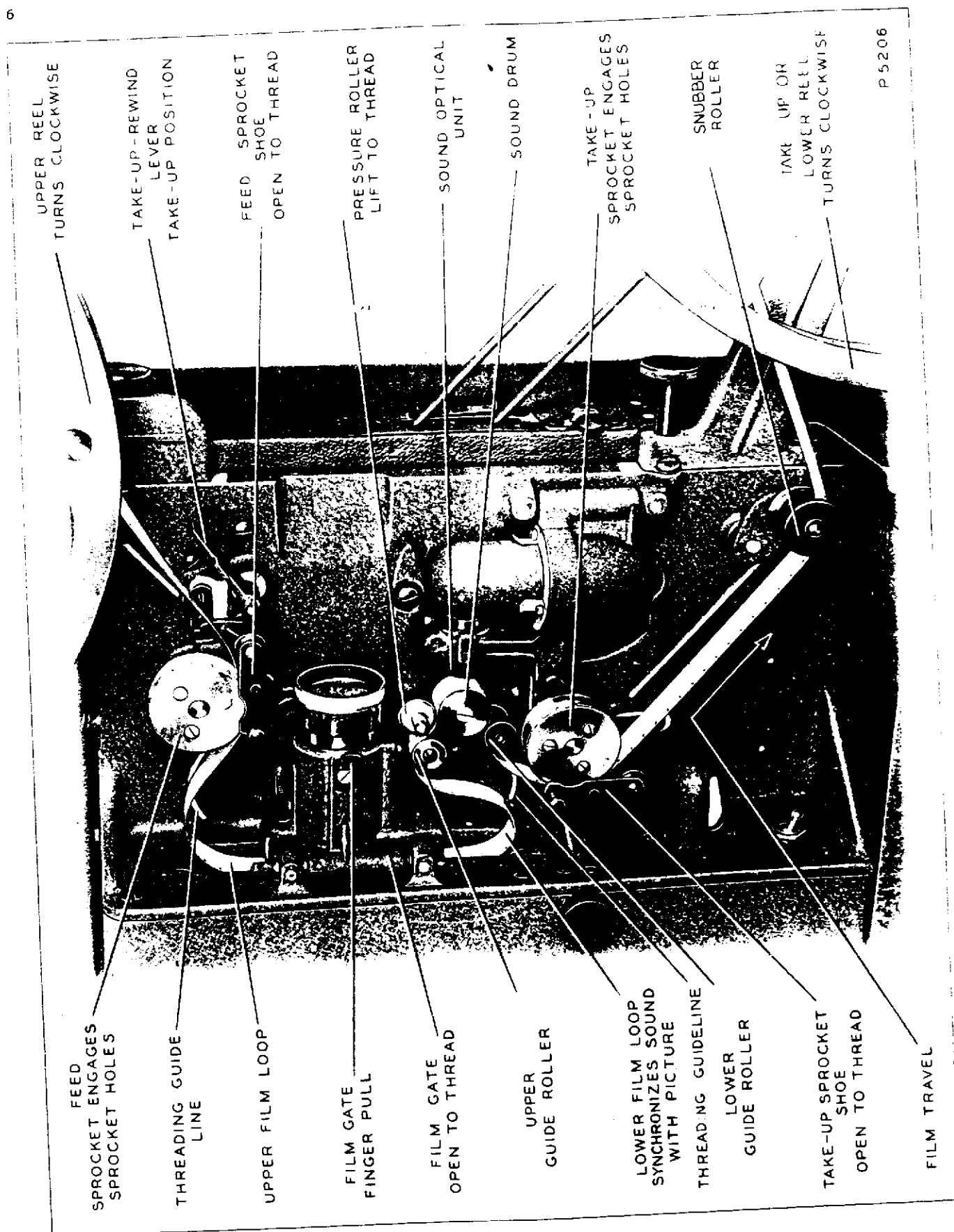


Figure 5—Projector Correctly Threaded

**NOTE:** In opening the film gate use the finger pull provided for this purpose. Avoid fingering the glass surface of the projection lens. If the lens is touched accidentally, clean it immediately as directed in Maintenance.

b. Place the film (about 3 feet from the end) flat on the aperture plate behind the film gate, with the sprocket holes toward the gate hinge. Close the film gate.

c. Allowing for proper length of upper film loop, slip the film between the feed sprocket and the shoe. Make sure that the sprocket teeth engage the sprocket holes in the film. Close the shoe.

d. Allowing for proper length of lower film loop, run the film over the upper guide roller, between the pressure roller and the sound drum, around the sound drum, and over the lower guide roller.

e. Slip the film between the take-up sprocket and the shoe. Make sure that the sprocket teeth engage the holes in the film. Close the shoe.

f. Run the film under the snubber roller and thence to the hub of the take-up reel. Insert the end of the film in the slot in the hub and turn the take-up reel by hand to remove slack in the film. Lift reel slightly. This will prevent reel rolling backward when released.

### Running the Show

9. When the machine has been threaded, proceed as follows:

a. Plug the loudspeaker cable into the **SPEAKER** receptacle and turn the **VOLUME** control to zero. Turn on the switch marked **AMPL.** When the exciter lamp lights, turn on the **PROJ.** switch. Wait until the motor is running and then turn on the **LAMP** switch.

b. Focus the picture as sharply as possible by turning the projection lens in its holder. Lock the lens when the picture is sharp.

c. Frame the picture, if necessary, by turning the knob marked **FRAME** (fig. 2).

d. Turn up the volume to the desired level and adjust the tone control for most pleasing sound. Be sure that **MIC-FILM** switch is in **FILM** position. Let the projector run to the end of the picture.

e. Stand by for possible readjustments. Occasionally, when old and worn film is being shown, the intermittent pull-down claw fails to engage

the sprocket holes in the film, with the result that the film moves past the aperture with a continuous rather than intermittent motion. The picture then is not clear and the projector makes a clicking noise. The difficulty can be remedied, without stopping the machine, by placing a finger inside and above the lower film loop and pressing downward on the film until the loop has the required length.

f. As soon as the last picture frame has passed the film gate, switch **OFF** the projection **LAMP** and return the **VOLUME** control to zero. Let the machine run until all the film is on the lower reel. Then turn **OFF** the **PROJ.** switch.

### Rewinding

10. All film which has been run through a projector must be rewound before it can be shown again. Rented films are usually rewound by the firm from which they are obtained, but frequently the projectionist must rewind. Figure 6 shows how to do it.

a. Unwind about 3 feet of film from the lower reel and place the end of the film in the slot in the hub of the upper, empty reel. Do not twist the film. Turn the upper reel counterclockwise by hand to take up all slack in the film.

b. Set the take-up-rewind lever in the rewind (left) position. Turn on the **PROJ.** switch and let the machine run until all the film is on the upper reel. Then turn **OFF** the **PROJ.** switch. If no more reels are to be rewound immediately, return the take-up-rewind lever to the take-up (right) position.

### Use With Microphone

11. The amplifier and the loudspeaker can be used for making announcements during a show or between reels if a high-impedance microphone, such as RCA MI-6207 or MI-6228, is connected to the input of the amplifier. For making this connection, a **MICROPHONE** receptacle is provided on the amplifier panel and a suitable microphone connector is supplied with the equipment. After the microphone connection has been made, the **MIC-FILM** switch at the top of the amplifier panel is set in the **MIC** position for making announcements and in the **FILM** position for reproducing the sound on the film. Different adjustments of the tone and volume controls may be required in the two positions of the **MIC-FILM** switch.



### Use With Record Player

12. The amplifier and the speaker can also be used in conjunction with a record player for playing phonograph records, by connecting the output of the record player into the microphone receptacle. The record player should have a high-impedance pickup and the cable from the pickup

should be provided with a microphone connector like the one supplied for the microphone. The output of the pick-up must be attenuated in the ratio of about 10 to 1 before it can be impressed on the amplifier without overloading the first tube. Refer to paragraphs 56-59 for details of voltage attenuator.

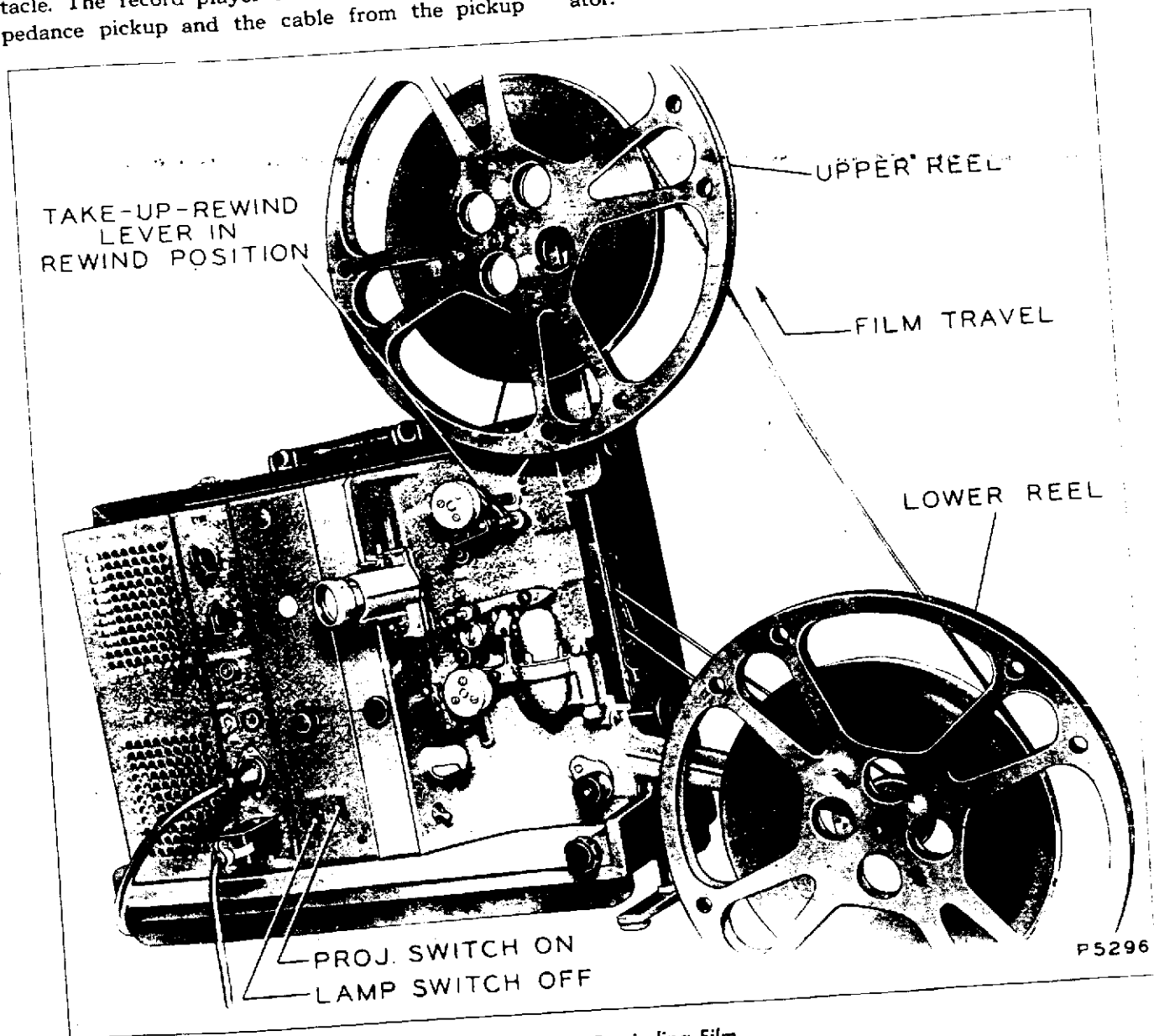


Figure 6—Rewinding Film

# Maintenance

## Routine Oiling

13. Just before putting the projector into operation for the first time, or after it has stood idle for a period of 30 days or more, put two or three drops of the MI-1331 oil supplied with the machine into each of the two oil pipes terminating on top of the projector frame (fig. 2). When operating the projector continually, put this amount of oil into each pipe every 10 hours of operation, or more frequently if inspection indicates the need of lubrication. Do not use too much oil, for the excess may reach the optical or the film-carrying surfaces of the machine, where it would cause picture blurring and sound distortion.

## Cleaning of Equipment

14. If the projector is to give consistently good performance, it must be kept clean at all times. Toward this end, it should be subjected to routine and periodic cleaning. After 1000 hours of operation, or whenever the operation is not normal, the machine should be inspected by the dealer.

a. *Routine Dusting.* Every time the projector is put into operation after a long period of idleness, or whenever the parts appear dirty, the following critical points should be dusted with a soft, lintless cloth or a camel's-hair brush:

- (1) Reflector
- (2) Condenser (fig. 7)
- (3) Picture aperture
- (4) Projection lens
- (5) Photocell
- (6) Exciter lamp
- (7) Sound optical unit

b. *Periodic Cleaning.* Once every 50 hours of operation, or more often if conditions indicate the need of it, the following steps should be taken:

- (1) Remove all dust from the larger surfaces of the projector.

- (2) Clean the two sprockets with the bristle brush supplied, moistened with carbon tetrachloride. Make sure that all dust and emulsion deposits are removed from the teeth.

- (3) Remove the film gate. (This can be done by lifting the hinge pin (fig. 8) against the spring holding the pin down.) Inspect the aperture plate and the film shoe very carefully. Remove any accumulated emulsion and other dirt with a soft cloth, or if necessary to reach into the corners, with a flat-pointed toothpick. After all visible dirt is removed, feel over the entire surfaces of both the aperture plate and the pressure shoe to make sure that nothing abrasive remains.

- (4) Clean the sound drum with a soft cloth moistened with carbon tetrachloride. Be particularly careful to remove all dirt from the back edge of the drum. Avoid touching the sound optical mirror.

- (5) Clean the pressure roller with a soft cloth moistened with carbon tetrachloride.

- (6) Remove the condenser lens (fig. 7) and clean it as follows:

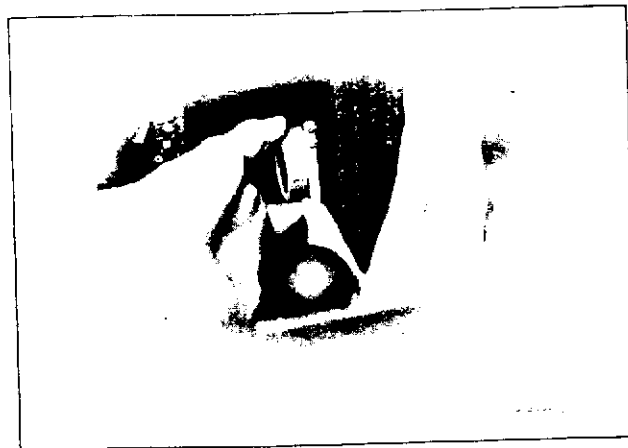


Figure 7—Removing Condenser Lens

(a) Brush off the outside lens surfaces with a camel's-hair brush.

(b) Gently swab these surfaces with lens tissue or a soft, lintless cloth moistened with lens cleaning fluid. Wipe dry and avoid leaving any lint.

(7) In a similar manner clean the reflector mounted opposite the condenser lens.

(8) Take out and clean the projection lamp. Leave no fingerprints on the clear areas of the lamp.

(9) Remove the projection lens from its holder and brush off any dust with a camel's-hair brush. If necessary to clean the lens more thoroughly, follow the directions given in b(6) above. Be especially careful **not to leave any dust or lint** on the lens surfaces. Replace the lens in its holder and secure it with the thumbscrew (fig. 2).

(10) Open the optical bracket and swing it out of the way. Remove the exciter-lamp cover. With a camel's-hair brush remove all dust and lint from the photocell, the optical mirror, and the two small lenses on the optical unit. Be very careful with the mirror, for it may be dislodged by rough handling.

(11) Remove the exciter lamp and clean it in the same manner as the projection lamp. Put the cover on the exciter lamp and fasten the sound optical bracket in its original place.

NOTE: All lenses in this equipment have been given a coating to improve their light transmission efficiency. Rough treatment of the lens surfaces will damage this coating and impair the quality of the lenses.

### Normal Replacements

15. Lamps, tubes, and fuses must be replaced occasionally. Whenever this is to be done, pull the power plug out of its receptacle on the amplifier panel. In order to avoid long and annoying delays due to failure of components, a complete set of tested spares should be available at all times. Parts most likely to require replacement are: amplifier fuse, projection lamp, exciter lamp, and amplifier tubes.

a. *Projection Lamp.* This lamp may have to be replaced because it has blackened or because it has burned out. If it burns out during operation, allow ample time for the old lamp to cool before attempting to remove it from its socket. The lamp cools fastest with the projector motor running and

the lamp-house door closed, for then the forced cooling draft is operative. *Do not forget to pull out the power plug before proceeding.*

(1) Open the lamp-house door to remove the old lamp. Press down firmly on the lamp, turn it to the left (about 90°), and pull it out.

(2) Clean the new lamp with a lintless cloth. Then insert it in the projection lamp socket and seat it properly. Avoid getting fingerprints on the clear area of the lamp.

(3) Should the light on the screen be uneven after the new lamp is installed, a readjustment of the position of the lamp is necessary. Proceed as follows:

(a) Remove any film from the projector.

(b) Hold a white card, of a size about 8½x11 inches, at arm's length in front of the projector, and focus until the edges of the lighted area on the card are as sharp as possible.

(c) Loosen the locknut (fig. 8) so that the adjusting screw is released.

(d) Move the projection lamp back and forth with the thumbscrew until the illumination on the card appears to be uniform. Then tighten the adjusting-screw locknut.

NOTE: A shadow band along one side of the illuminated area indicates that the lamp has been moved too far in one direction.

(e) If this adjustment fails to produce uniform illumination, use another projection lamp.

b. *Exciter Lamp.* This lamp is of the pre-focused type and should require no adjustment after it has been seated properly in its socket. To replace it, refer to figure 8 and follow the directions below.

(1) Loosen the thumbscrew (fig. 8) that holds the sound optical bracket to the projector frame and swing this bracket away from the frame.

(2) Remove the exciter lamp shield by tilting it away slightly from the optical unit, and raising it out of the clamping fingers.

(3) Turn the lamp to the left until the holes in the flanges on the lamp base line up with the pins in the lamp socket. Then lift the lamp out.

(4) Insert a new lamp in the socket so that the holes in the base flange are over the pins in the socket. Turn the lamp to the right until it

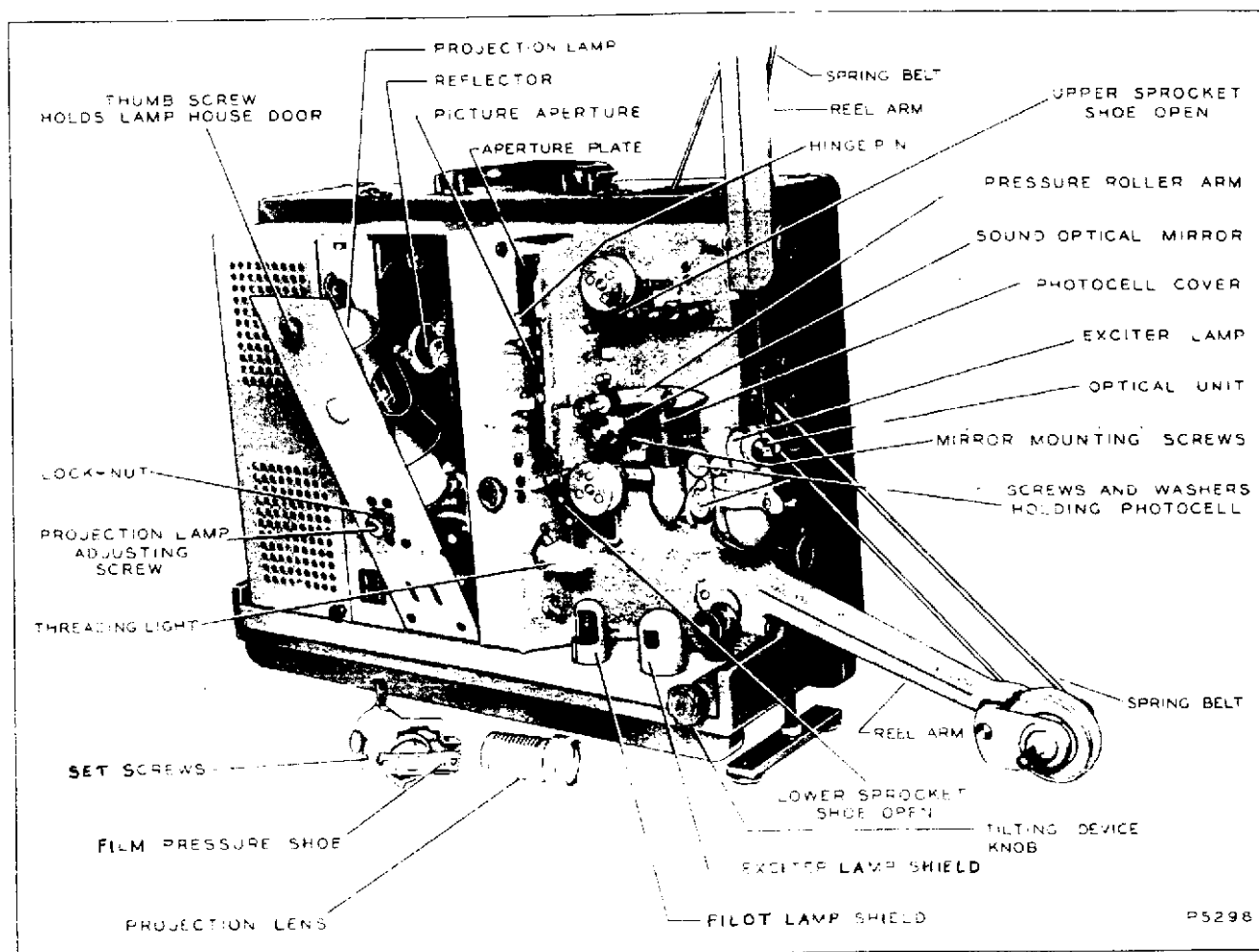


Figure 8—Cleaning and Maintaining Projector

locks in place. (Shaking it slightly makes rotation easier.)

(5) Clean the lamp inserted and then replace the shield.

c. *Photocell.* To replace the photocell, proceed as follows (fig. 8):

(1) Open the sound optical bracket as in b above. This permits access to the photocell.

(2) Remove the two machine screws which hold the photocell bracket in place.

(3) Pull the photocell bracket away from the projector frame. Remove the photocell cover and the photocell.

(4) Insert a new photocell in the socket and clean the glass with a soft, lintless cloth.

(5) Replace the photocell cover, making sure that the index slot in the cover lines up with the pin in the bracket, and press down firmly.

(6) Replace the photocell bracket and secure it with the two machine screws. Be sure the photocell bracket or cover does not touch the frame, thereby hindering the shock mounting.

(7) Close the optical bracket and fasten it with the thumbscrew.

d. *Projector Threading Lamp.* This lamp is provided with an ordinary candelabra screw base and is replaced like any other screwbased lamp.

(1) Remove the lamp cover by pressing the cover to close the narrow gap and pulling it straight out from the socket.

(2) Replace the old lamp with a new one.

(3) Replace the lamp cover.

e. *Amplifier Tubes.*

(1) To reach the amplifier tubes, remove the cover, which is held by two thumbscrews (fig.

9) and two rivets. To disengage the rivets, lift the cover straight up after the two screws have been removed.

(2) Release the two 6L6-G tubes and the 5U4-G rectifier from their base clamps.

(3) Test all tubes and discard any found to be unsatisfactory.

NOTE: If tubes are to be replaced during a show, replace all tubes about which there is any doubt with tubes known to be good. Later test the tubes removed. It is helpful to realize that if the exciter lamp glows with full brilliance, the 6F6 oscillator and the 5U4-G rectifier must be good.

(4) Tighten the three tube base clamps and replace the cover.

NOTE: A complete set of tubes for this amplifier is available as MI-1363. At least one such set should be within reach of the operator at all times during operation. If metal tubes are not available, G and GT type tubes of equivalent characteristics may be used. However, if a 6J7-G or 6J7-GT is used, it must be covered with a suitable, grounded shield.

f. *Amplifier Fuse.* The fuse is mounted on the amplifier panel and is accessible from the outside. It is of the screw-in type and its rating is 2 amperes. A fuse of higher rating must not be used.

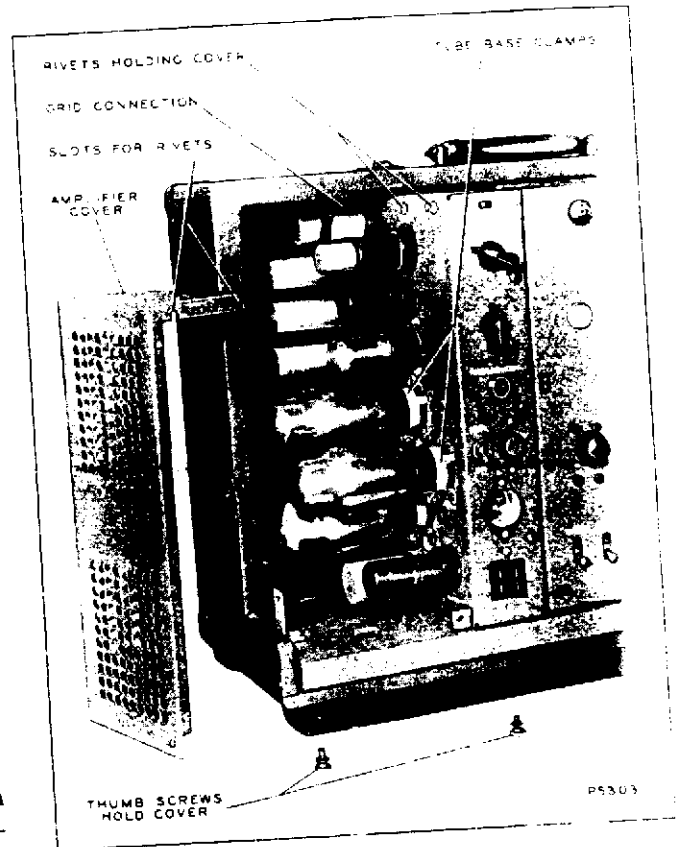


Figure 9—Replacing Amplifier Tubes

# Utilization

## Choice of Focal Length of Lens

16. The focal length of the lens supplied with the Type PG-201 equipment is 2 inches. This is an average value which meets projection conditions in most instances. Frequently, however, it may be necessary to depart considerably from average conditions. A large picture, for example, may be desired in a small room, calling for a lens of short focal length, or a small picture may be wanted at a long distance away, calling for a lens of long focal length. In order to meet all projection conditions, a set of lenses of different focal lengths should be available to the operator.

17. The projection table in figure 1 gives the relationship between picture size and projection distance for lenses of six different focal lengths. This table is based on the approximate relation: focal length (in inches) of the lens is  $\frac{3}{8}$  of the ratio of the projection distance (in feet) to the width (in feet) of the picture. As an example of the use of this relation, let it be required to find the focal length of the lens for use in a small room where the distance between the lens and the screen is 24 feet and the screen is 6 feet wide. The ratio of 24 feet to 6 feet is 4, and  $\frac{3}{8}$  of 4 is  $1\frac{1}{2}$ . Therefore the lens should have a focal length of  $1\frac{1}{2}$  inches. If a lens of the computed focal length is not available, the lens having the nearest focal length should be used.

## Placement of Equipment and Spectators

18. If all the spectators in the room are to have an unobstructed view of the screen both the screen and the projector should be raised well above the heads of the audience. The top of the table upon which the projector stands should be at least  $4\frac{1}{2}$  feet high so that the beam of light will pass above the heads of those who sit directly in front of the projector, and the lower edge of the screen should be at least as high as the heads of

the persons sitting nearest to the screen. While for ordinary usage the loudspeaker may be placed on the floor near the screen and facing the audience, as shown in figure 1, better results can be secured by raising it up to the lower edge of the screen.

19. When a matte screen is used, no one should sit closer to the screen than two screen widths nor farther from it than six screen widths, and no one should sit outside an angle of  $30^\circ$  from the center line. At  $40^\circ$  either side of the center line the width of the picture appears equal to its height and beyond this angle the distortion resulting from wrong perspective becomes excessive.

20. When a beaded screen is used, no one should sit closer to the screen than  $2\frac{1}{2}$  screen widths nor farther from it than six screen widths. In this case, however, no one should sit outside an angle of  $20^\circ$  either side of the center line. Beyond the  $20^\circ$  angle the brightness of the screen falls off rapidly. Also, when a beaded screen is used, the screen should not be raised too far above the heads of the spectators, for those sitting closest to the screen may then view it at an angle greater than  $20^\circ$  in the vertical direction.

## Choice of Screens for PG-201

21. The PG-201 as shipped will satisfactorily illuminate matte screens from  $3\frac{1}{2}$  to  $7\frac{1}{2}$  feet wide and beaded screens from  $7\frac{1}{2}$  to 12 feet wide. On larger screens the illumination becomes so low that fine details in the picture are hard to see, the highlights become weak, and the gray tones appear black. On smaller screens the illumination becomes so strong that the black portions of the picture appear gray and the highlights become dazzling. On still smaller screens, flicker appears in the highlights of the picture. Accordingly, noticeable flicker during projection is a sure sign that

# PROJECTION LAMP REQUIRED VS SCREEN TYPE AND SIZE

	Lamp Wattage	Life Hours	Picture Width in Feet			
			Matte Screen		Beaded Screen	
			Recommended	Permissible	Recommended	Permissible
CVS	200	25	2½	2-4	5	4-5½
CXK	300	25	3.3	2½-4½	6	5-7
CZX	500	25	4	3-6	7	6-9
DDB	750	25	5-6	3½-7½	9	7½-12
DFD	1000	10	6-7	4½-8½	10-12	9-13
<p>NOTE 1: Noticeable flicker when picture is being projected means that there is too much light for good picture quality.</p> <p>NOTE 2: When lenses of lower speed than f/1.6 are used, lamp wattage requirements must be multiplied by the square of the ratio of the f rating of the new lens to 1.6. Thus f/1.85 requires 1.33 times lamp wattage; f/2, 1.5 times; f/2.5, 2.5 times; f/2.8, 3 times.</p>						

the screen is entirely too bright for satisfactory picture quality.

22. Screens of sizes other than those recommended above may be used if the 750-watt lamp supplied is changed to one of appropriate wattage. Lamps ranging from 100 to 1000 watts may be used with the PG-201 under various conditions. For example, a 100-watt lamp is adequate for a 30-inch by 40-inch beaded screen in a darkened room. A small beaded screen may be used with the standard 750-watt lamp if considerable daylight is on the screen. Such stray light, of course, reduces the picture quality or contrast between light and dark areas.

23. A matte screen should always be used whenever a sufficiently bright picture can be obtained, because it presents a more uniform brightness to the entire audience. A beaded screen appears four or five times brighter than a matte screen along the line from the center of the screen to the projector, but its brightness falls off rapidly as the observer moves away from this center line. At 20° the beaded screen is about equivalent to a matte screen. Thus the picture quality of a beaded screen is not the same throughout the audience.

24. The lamp and screen recommendations given above are based on the use of the standard 2-inch, f/1.6 coated projection lens. A lens of longer focal length will have a larger f rating, and therefore will require a lamp of higher wattage to cover the same area on the screen with the same illumination. Additional pertinent information regarding lamps, screens, and lenses is given in the table above.

## Control of Volume and Tone

25. The volume and tone controls should be readjusted when necessary to compensate for variations in recording level and for differences in the acoustic conditions of the room. The volume should be loud enough for all persons of normal hearing to hear without strain and yet not unpleasantly loud. The tone should be readjusted for best intelligibility of speech and most pleasing quality of music. Whenever possible, the operator should preview the pictures he plans to show in order to acquaint himself with their peculiarities.

## Improvement of Projection Technique

26. In order to avoid accidental interruptions and disturbances of sound and picture during a show, the observance of the following points of projection technique are worth while.

a. *Securing Cables.* The power and speaker cables should be arranged so that they cannot be disconnected by persons stumbling over them. A simple way of preventing such disconnections is to wrap the projector end of each cable once around a leg of the projection table before the cable is plugged into its receptacle on the amplifier panel.

b. *Replacements.* While interruptions due to burn-out of lamps, tubes, and fuses are occasionally unavoidable, the resulting delays in service need not be protracted if tested replacements are instantly available. A complete set of tested tubes for the amplifier should be available for substitution when symptoms indicate tube trouble. Usually, it takes less time to replace a whole set of tubes than to find a single defective one. Incidentally,

the oscillator and the rectifier tubes need not be replaced if the exciter lamp glows with normal brilliance. Since the projector lamp, the exciter lamp, and the amplifier fuse can burn out at any time, tested spares of these also should be ready on the projection table whenever a picture is being shown.

c. *Checking Threading.* On 16-mm film the emulsion is sometimes on one side and sometimes on the other. Therefore its location is not a reliable guide for determining whether or not the film on a reel is wound correctly. A more conclusive way of judging is to note the relationship between the sprocket holes and the pictures. If the film to be shown is placed on the upper reel arm so that the reel turns clockwise as the film un-

winds, the sprocket holes should be toward the operator and the pictures should be upside down. If these conditions are met, the film is wound properly and is ready to be shown. On the other hand, if the sprocket holes are away from the operator, or if the pictures are right side up, the film is not wound correctly, and must be rewound before it can be shown.

d. *Refocusing.* Occasionally, two sections of film of opposite type in respect to emulsion location are spliced together to produce a continuous show. When the splice of such sections passes the aperture, the emulsion changes sides, with the result that the picture jumps out of focus. Refocusing is then necessary to restore the sharpness of the picture.



# Theory of Operation

## Introduction

27. A sound motion picture film contains two types of record: one, a series of instantaneous photographs taken in rapid succession of a moving subject and the other, a record of the sounds associated with or appropriate to the motion of that

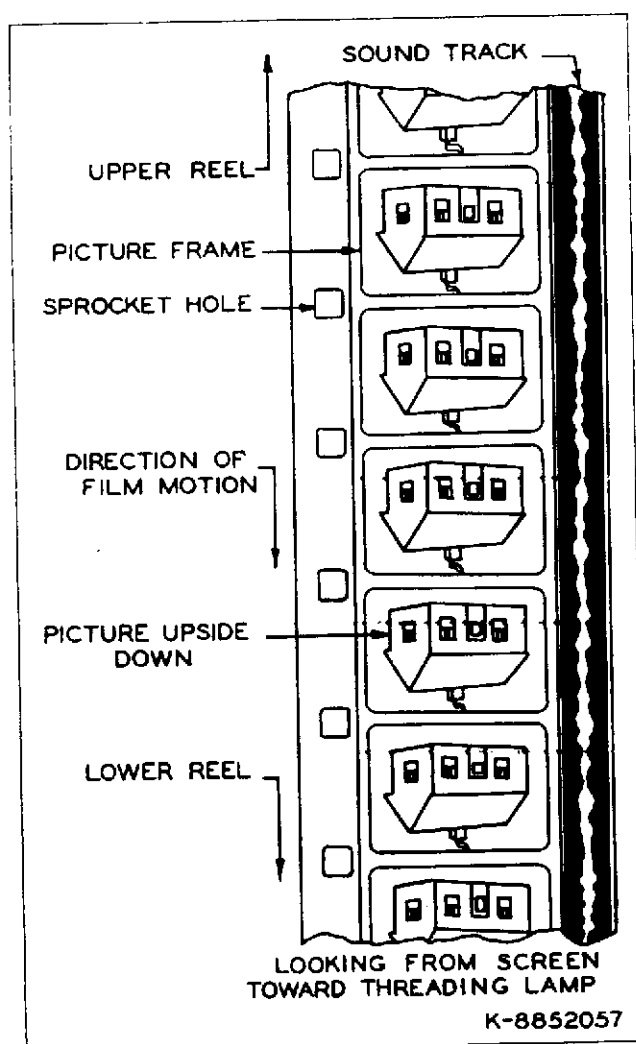


Figure 10—16 mm Sound Motion Picture Film

subject. Figure 10 represents a short section of such a film. The large rectangles in the center represent the individual photographs, the dark band at the right edge represents the sound track, and the wavy white line in the middle of the dark band represents the sound record.

28. When such a film is shown, the photographs are projected on a screen in the order they were taken and at the same rate. The sound is reproduced through an amplifier and a loud-speaker and is synchronized with the action in the picture. The effect of the rapid presentation of a large number of slightly different pictures in proper sequence gives the illusion of a continuously moving picture and the simultaneous reproduction of appropriate sounds strengthens the realism.

## Formation of Images

29. The projection of motion pictures on a screen is based on the principle of the formation of an image by a convex lens. This principle is illustrated in figure 11. Let AB represent any lighted subject, for example an illuminated film. Some of the rays of light from A are intercepted by the lens and are brought together at point A1 on the opposite side of the lens. For simplicity, only two rays are shown, one passing through the edge of the lens and the other through its center. Point A1 is the image of point A. In a similar manner, point B1 is the image of point B in the object. Every point in the object is represented by a point in the image.

30. For a given distance between the lens and the film there is only one screen distance at which the picture will be sharp. Light rays from a point in the film meet at a point on the screen in the plane  $S_0-S_0$ . If the screen is either nearer to the projector, as  $S_1-S_1$ , or farther from it, as  $S_2-S_2$ , these rays do not all strike the screen at the same

point and therefore produce a blur. But for any screen distance there is a corresponding film-to-lens distance which will give a sharp picture. In practice it is usual to choose the screen distance to give the desired sized picture and then to move the lens in or out until the picture is sharpest. This is done by rotating the projector lens-barrel.

31. The screen should be at right angles to the lens axis. Tipping the screen as indicated at  $S_3$ - $S_3$ , results in a picture which is out of focus at the top and at the bottom, although it may be sharp at the middle. Figure 11 also shows that the rays cross as they pass through the lens; therefore the image on the screen is inverted with respect to the film. In other words, the picture on the film should be upside down.

### Projection of Motion Pictures

32. In a motion-picture projector each frame of the film is projected in the same manner as the single object in figure 11. It is not held long, however, but is merely flashed on the screen for a small fraction of a second. It is immediately followed by the next frame on the film, which is shown for an equally brief interval. In sound-motion-picture projection, 24 frames are shown every second. But this does not imply that each frame is held on the screen  $1/24$  of a second. The actual time is about  $1/2$  of this, for the screen is darkened twice per frame, once while the film is moving forward and again while a frame is being held stationary in the projector. If the light were not cut off while the film is in motion, the picture on the screen would be streaked and blurred; and if it were not cut off at least once while each frame is still, an annoying flicker would result.

33. The light is cut off by means of a two-segment shutter placed between the source of light and the film aperture. This shutter revolves once for each frame, or for each complete cycle of the intermittent film-forwarding mechanism. The segment that interrupts the light beam while the film is in motion is known as the "pull-down" blade and the other as the "anti-flicker" blade.

### Motion-Picture Projector

34. Figure 12 shows a functional diagram of a typical sound-film projection system.

a. The reflector on the left of the projection lamp increases the utilization of the light from the lamp by reflecting much of the back radiation into the spaces between the heated filaments of the lamp and therefore in the direction of the film.

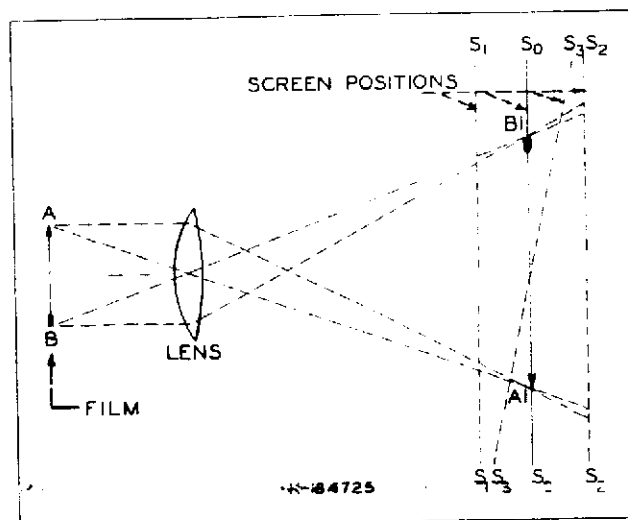


Figure 11—Formation of an Image

b. The condenser lens concentrates the light on the aperture. The shutter, already discussed, is placed between the condenser and the aperture, where it not only darkens the screen when required but also protects the film against the heat from the lamp.

c. The aperture is a rectangular opening in a metal plate. Its purpose is to limit the illumination to that portion of the film which is occupied by the picture.

d. The upper reel holds the film to be run through the projector.

e. The feed sprocket, turning at constant speed, unwinds the film from the upper reel and maintains a loop of film above the film gate.

f. The film gate holds the film flat against the aperture and keeps the picture in focus. It consists of a mounting for the projection lens and of a flat pressure shoe with a rectangular opening somewhat larger than the aperture. The shoe holds the film against the aperture plate and maintains a constant pressure on the film. The film gate assembly is hinged to the frame of the projector so that it can be swung away from the aperture.

g. The pull-down claw pulls the film into position in front of the aperture intermittently at the rate of 24 frames per second. Each time the claw moves down, it advances the film one frame. During this motion the pull-down blade of the shutter cuts off the light from the screen. While the claw moves back up, one frame of the film is held stationary in the aperture and is projected

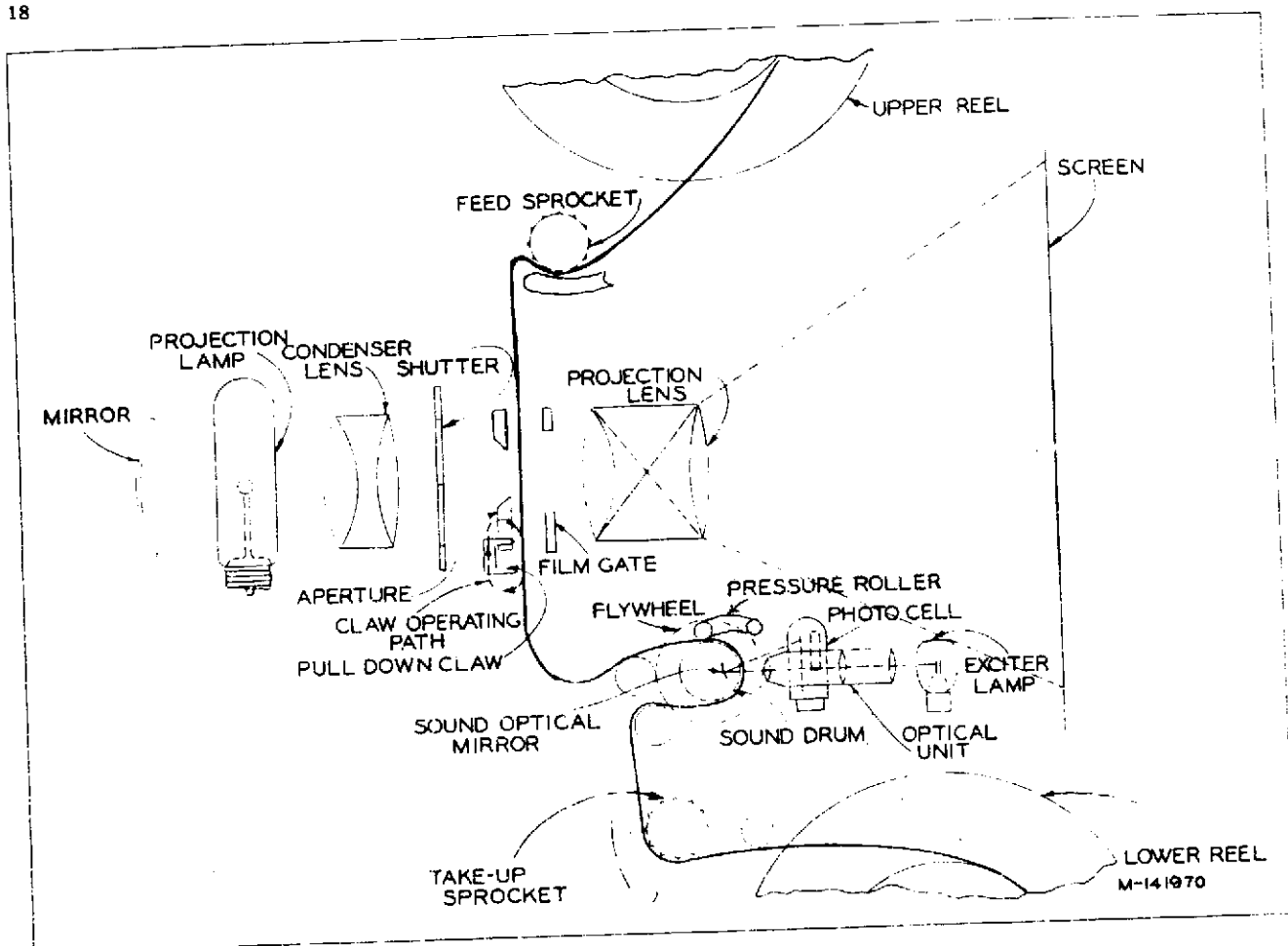


Figure 12—Functional Diagram of Projector

on the screen, except as it is interrupted once by the passage of the anti-flicker blade across the light beam.

h. The projection lens forms on the screen an enlarged image of the strongly illuminated frame at the aperture, as has already been explained.

i. The lower reel receives the film that has passed through the projector. This reel is driven by a friction clutch, whose slippage between the reel and its drive mechanism is controlled by the weight of film on the reel in order to maintain an even tension on the film regardless of the diameter of the roll of film on the reel.

j. The take-up sprocket, like the feed sprocket, turns with a uniform velocity and therefore helps to keep the film moving at a constant speed. In addition, it serves to maintain a loop of film of proper length below the film gate. Without this loop, the film would not pass the aperture intermittently.

### Sound Optical System

35. The sound optical system is also outlined in figure 12.

a. Between the film gate and the take-up sprocket, the film first passes over a guide roller and then around the sound drum, which is coupled to a damped flywheel or "rotary stabilizer." This stabilizer forces the film to move at a uniform speed, which is essential for good sound reproduction.

b. A pressure roller and an idler roller insure that the film wraps around the drum sufficiently to prevent the film from slipping on the drum and to maintain a constant distance between the sound track and the sound optical unit.

c. The optical unit concentrates the light from the exciter lamp into a line about 0.001 inch wide. This line is slightly longer than the width of the sound track. The optical unit is adjusted so that the line comes to a sharp focus at

the emulsion side of the film and so that its center coincides with the center of the sound track. The point on the sound track where this line is focused is the scanning point. This portion of the film overhangs the back edge of the sound drum.

d. The light that passes through the sound track falls on the sound optical mirror, whence it is reflected into the photocell mounted directly behind the optical unit.

### Scanning and Sound Reproduction

36. The right-hand margin of figure 10 illustrates a typical sound track of the variable-width type. The black areas are opaque, the white transparent. The width of the transparent area may vary from nothing up to the limits of the opaque band, depending on the instantaneous strength of the sound recorded. It is the variation in the width of the transparent area from point to point along the track that is of importance. When this variation does not exist, no sound has been recorded on the film and none can be produced from it.

37. When a sound track of variable width passes the scanning point, light from the exciter lamp goes through the film only where it is transparent. Since the width of the scanning line is constant, the amount of light going through the sound track at any point is directly proportional to the width of the transparent area at that point (that is, to the utilized portion of the scanning line). This width varies continuously as the film moves past the scanning point. Therefore, the amount of light that goes through and ultimately reaches the photocell varies in the same manner.

38. The variations in the light that enters the photocell are converted into equivalent variations in the current in the associated circuit. One element of that circuit is a high resistance which is connected between the control grid and the cathode of the first tube in the audio amplifier. The voltage drop caused by the varying current through this resistor is the input signal to the amplifier, and this signal varies in precisely the same manner as the record on the sound track. After the signal has been amplified sufficiently, the loudspeaker converts it into sound.

39. The sound associated with an individual frame is not recorded on the sound track directly opposite that frame, but at a point 26 frames farther ahead. This displacement of the sound track relative to the picture is necessitated by the requirement that, for proper synchronization of sound and picture, the sound record must

pass the scanning point when the picture is at the aperture. (This 26-frame displacement between sound and picture is a standard for 16 mm sound film approved by the Society of Motion Picture Engineers.)

40. Any light varying at an audio-frequency rate will give rise to sounds in the loudspeaker if such light enters the photocell. Thus if the photocell is exposed to the light from a lamp operated from a 60-cycle line, a 120-cycle tone will issue from the loudspeaker, for the intensity of that light varies at a rate twice that of the frequency of the lamp current. It is clear from this fact that the exciter lamp cannot be operated with 60-cycle current, for if it were, a loud 120-cycle tone would result. The lamp can, however, be operated with alternating current of a superaudible frequency, which is done in this equipment.

### The Amplifier

41. The circuit diagram of the amplifier is given in figure 13. The amplifier has provision for two sources of signals: a photocell and a high-impedance microphone or phonograph pickup. Either may be selected with switch S-2, which is labeled MIC-FILM on the amplifier panel.

42. When the switch is in the MIC position, the load on the photocell is so small compared to the required value that the photocell is virtually short-circuited. When the switch is in the FILM, or open, position, the microphone is out of the circuit and R-1 is connected across the photocell. R-1 has sufficient resistance, 560,000 ohms, to cause an adequate signal voltage to be impressed on the grid of the 6J7 tube (V-1) when the varying photocell current flows through it.

43. The photocell must have a d-c voltage applied in series with itself and its load if any current is to flow. This voltage is derived from the grid of the 6F6 oscillator tube (V-7). To make certain that this voltage does not contain any ripple, it is well filtered by a high resistance R-23 and a large condenser C-15. In addition, a voltage regulating resistor R-2 minimizes the variations in the photocell voltage due to variations in the plate supply voltage.

44. The volume is controlled with a potentiometer in the grid circuit of the second tube (V-2) and the tone with a center-tapped potentiometer connected in a compensation network in the grid circuit of the third tube (V-3). This control provides a range of tone balance between high and low frequencies which is adequate to correct for

the variations in sound characteristics and reproducing conditions usually encountered. The third tube (V-3) in the circuit is a typical phase inverter, which provides a balanced input voltage to the push-pull output tubes (V-4) and (V-5).

45. Inverse feedback from the secondary of the output transformer to the cathode of the phase inverter tube is employed to reduce distortion to a negligible value. The values of capacitors C-24 and C-9 are such as to provide appropriate tone equalization of the sound output.

46. The 6F6 (V-7) is a high-frequency oscillator which serves two distinct purposes in the circuit: to supply current for the filament of the exciter lamp and high d-c voltage for the photocell circuit. The frequency generated is about 28 kc

and is determined by the capacity of condenser C-23 and the inductance of the coil connected in shunt with this condenser. The high-frequency current for the exciter lamp is obtained from the winding between terminals 1 and 4.

#### **Loudspeaker**

47. The loudspeaker is of the dynamic type, with a permanent magnet field, a voice-coil impedance of 8 ohms, and a cone diameter of 10 inches. The speaker cone is provided with a cap over the central pole piece to keep dust and iron particles out of the spaces between the voice coil and the pole faces. The speaker is fed from the push-pull output stage of the amplifier through a step-down transformer and a 50-foot speaker cable.

# Service and Repair

## Introduction

48. This section is not to be construed as an invitation to the general operator of the PG-201 equipment to perform his own service and repair. It is meant, rather, to be a guide for the service man who has acquired special skill in the adjustment and repair of the equipment and who is provided with the necessary tools for doing the work. Many adjustments discussed, especially those involving the sound optical system, are critical and should not be undertaken by inexperienced persons, for they could easily turn a minor maladjustment into a serious one. However, many items in the Trouble Location and Remedy Chart are useful to the operator and maintenance man as well as to the service man. Reference to this chart in the event of trouble might in many instances suggest simple remedies to the operator.

## Preparation for Servicing or Repair

49. For some adjustments and replacements it is necessary to remove the projector-amplifier from the carrying case and to dismount the amplifier and the lamp house from the assembly. Proceed as follows:

a. In removing the projector-amplifier from the carrying case:

(1) Disconnect all cables from the unit and remove the two reel arms.

(2) Remove the four oval-head screws (three in the base and one on top) that hold the projector-amplifier mechanism to the case.

(3) Disassemble the take-up and rewind belts by unscrewing the ends at the junction points. (One end must be twisted about four turns with respect to the other before the ends will part.)

(4) Remove the knob from the tilting device.

(5) Slide the mechanism outward until it clears the case.

b. To remove the amplifier from the assembly:

(1) Remove the amplifier cover (fig. 9).

(2) Remove the six amplifier-mounting screws that hold the amplifier to the bottom plate. Pull the amplifier away from the lamp house.

(3) Disconnect the three sets of leads, noting how they are connected, and also the ground lead.

c. To remove the lamp house from the projector frame:

(1) Remove the two screws B (fig. 15) from the front and the single screw from the rear of the projector frame.

(2) Disconnect the three wires from the terminal board.

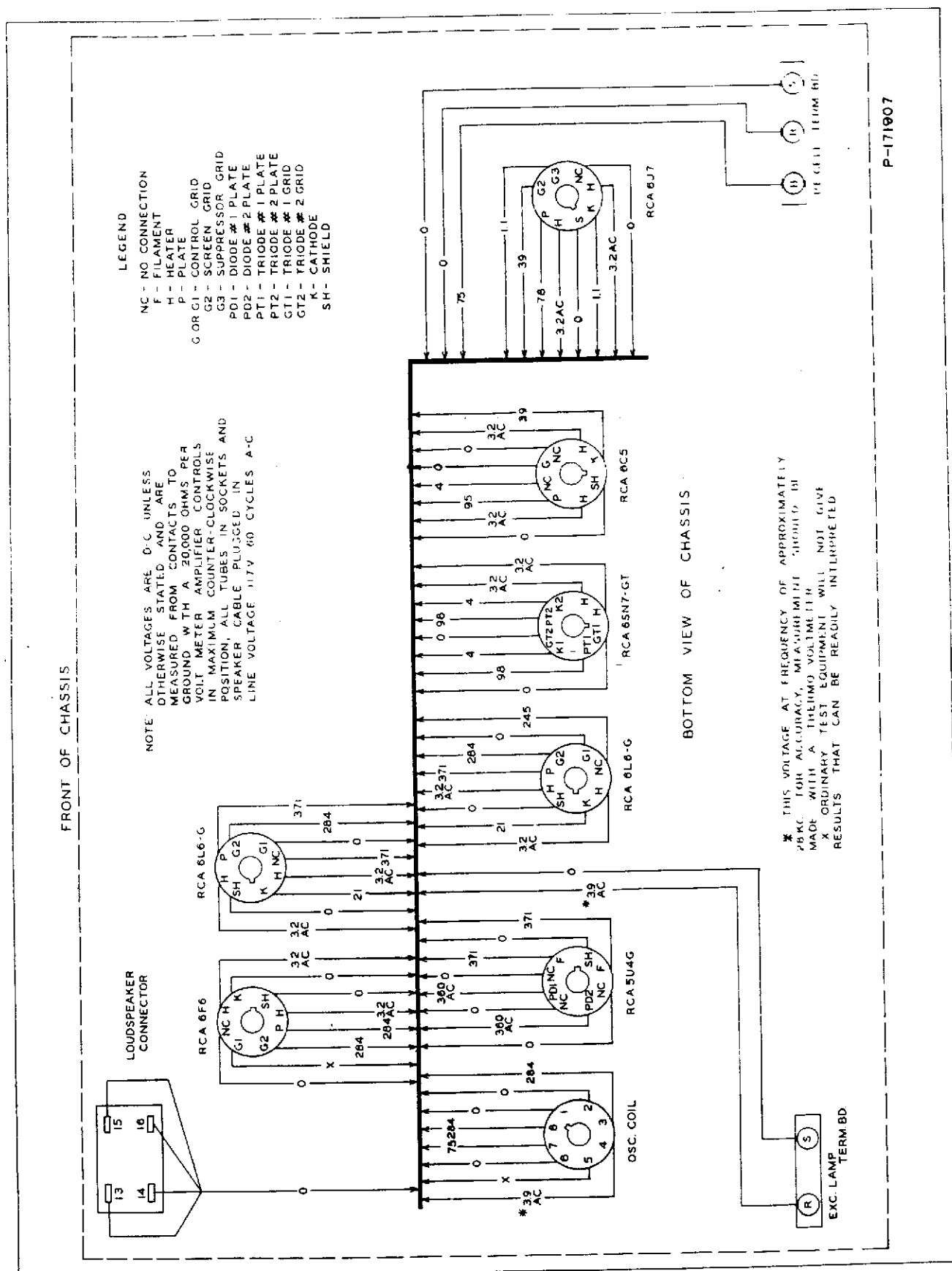
(3) Remove the lamp house by pulling it gently toward the rear of the machine, avoiding damage to the blower or the motor shaft in doing so.

## Amplifier Service Data

50. Trouble in the amplifier is usually due to defective parts, open leads, or shorted conductors. When the defect has been found, it is remedied either by substitution of a good part or by repairing the short or open. Isolation of the trouble is facilitated by voltage and resistance measurements.

a. *Amplifier Voltage Data.* The socket-voltage diagram (fig. 14) shows the normal voltages between ground and the various terminals in the amplifier, when the voltages are measured under the conditions specified on the diagram. Any large deviations from these values, if they cannot be







# CONTINUITY TEST TABLE

Showing Measured Resistance from Terminals to Ground

Terminal No.	1	2	3	4	5	6	7	8
RCA 6J7.....	0	0	**	**	1800	Inf.	0	1800
RCA 6CS.....	0	0	**	Inf.	0.5 meg*	**	0	2700
RCA 6SN7GT.....	0.6 meg	**	2200	18M	**	2200	0	0
RCA 6L6G (Front)	0	0	**	**	0.27 meg	**	0	188
RCA 6L6G (Rear)	0	0	**	**	0.29 meg	**	0	188
RCA 6F6.....	0	0	**	**	56M	Inf.	0	0
RCA 5U4G.....	Inf.	**	Inf.	70	Inf.	70	Inf.	**
Oscillator Coil.....	0	Inf.	**	0	140	Inf.	Inf.	**

Photocell term. board.....S-0 ohms, R-0.56 meg., B \*\*  
Exc. lamp term. board.....0 ohms both terminals  
A-C input receptacle—AMP switch ON, PROJ switch OFF, 2.5 ohms  
Microphone receptacle—MIC or FILM position, with center term. out, 0 ohms, with center term. pushed in, 100M ohms.  
Loudspeaker receptacle—0 ohms on 13, 15, and 16; 6 ohms on 14.  
\*Volume control maximum clockwise.  
\*\*Do not measure. Ordinary test equipment will not give results that can be interpreted readily.  
Inf.—Open circuit or infinite resistance.  
NOTE: All controls in extreme counterclockwise position, except as noted in the table. All tubes in sockets and loudspeaker cable plugged in. Connections made to photocell and exciter lamp terminal boards.

explained by a change in the supply voltage, indicate trouble where they occur. In order to reach all the terminals for making the measurements, it is necessary to remove the amplifier from the frame of the projector. Tape the two black a-c leads to keep them apart, for they will be connected across the power line during the voltage measurements.

b. *Amplifier Resistance Data.* Normal resistance values in the amplifier are shown in the continuity test table above. Large deviations from the tabulated values indicate trouble. Be sure the

power is turned off before any resistance measurement is made.

51. The Trouble Location and Remedy Chart given below is designed to aid the operator of the equipment in finding the cause of troubles which may occur and in applying the proper remedy once the cause has been found.

**CAUTION:** If the chart indicates anything more serious than changing tubes, lamps, fuses, spring belts, or cleaning or oiling or the like consult the dealer immediately.

## TROUBLE LOCATION AND REMEDY CHART

Description	Possible Cause	Remedy
a. Loses both film loops.	(1) Feed-sprocket shoe out of adjustment.	Adjust as explained in par. 52c.
b. Loses lower loop.	(1) Dirty claw. (2) Broken sprocket hole. (3) Film binding in gate. (4) Bad splices. (5) Claw out of adjustment.	Remove dirt and emulsion from claw. Splice film. Check for thick splices. Check side pressure springs. Repair film. Adjust as explained in par. 52e.
c. Loses upper loop.	(1) Film pressure shoe too loose.	Adjust as explained in par. 52d.

<i>Description</i>	<i>Possible Cause</i>	<i>Remedy</i>
d. Projector mechanism noisy.	(1) Claw out of adjustment. (2) Shutter bearing loose. (3) Projector belt frayed. (4) Claw not engaging sprocket holes.	Adjust as in par. 52e. Replace bearing. Replace belt. See if lower loop is lost. Restore as in par. 52e.
e. Tears sprocket holes.	(1) See a and b above. (2) Film may be brittle.	Follow instructions under a and b. Humidify.
f. Travel ghosts.	(1) Shutter out of adjustment.	See par. 52r.
g. Picture motion unsteady.	(1) Improper threading. (2) Side pressure springs on aperture plate too weak.	Check loops for proper length. Replace springs.
h. Picture indistinct or illumination low.	(1) Projection lens dirty. (2) Condenser lens dirty. (3) Reflector dirty or damaged. (4) Projection lamp black or blistered.	See par. 14. See par. 14. Clean as in par. 14 or replace. Replace the lamp.
i. Film scratched.	(1) Film shoe dirty, damaged. (2) Sound drum pressure roller dirty. (3) Emulsion hardened on film-gate shoe. (4) Aperture plate dirty or damaged. (5) Guide rollers dirty or sluggish.	Clean or replace. Clean. Remove emulsion. Clean or replace. Clean.
j. Picture, but sound weak or absent.	(1) AMPL switch OFF. (2) Fuse burned out. (3) Loudspeaker not connected. (4) VOLUME control not set properly. (5) Photocell defective.	Turn switch on. Replace fuse. Check speaker connections. Adjust control. Replace.

Description	Possible Cause	Remedy
j. (continued)	(6) Radiotrons defective. (7) Exciter lamp burned out. (8) Photocell not seated properly in its socket. (9) MIC-FILM switch on MIC. (10) Loudspeaker defective. (11) Oscillator coil burned out. (12) Power transformer defective. (13) Sound optical unit improperly adjusted. (14) Sound optical unit dirty. (15) Sound mirror dirty. (16) Sound mirror out of adjustment.	Test and replace defective tubes. Replace. Remove and reseal correctly. Turn switch to FILM. Repair or replace. Replace coil. <del>Replace transformer</del> Adjust as explained in par. 52a and b. Clean as in par. 14. Clean as in par. 14. Adjust as in par. 52b.
k. Sound but no picture.	(1) Projection lamp burned out. (2) LAMP switch OFF.	Replace. Turn switch on.
l. Tone unsteady—"wows".	(1) Sound-drum shaft or bearings loose. (2) Pressure roller under faulty tension. (3) Pressure roller dirty. (4) Sound drum damaged. (5) Flywheel damaged. (6) Sound drum dirty. (7) Guide rollers sticky.	Replace bearings. Adjust or replace spring. Clean. Replace. Replace. Clean. Clean. Lubricate with microfine graphite.
m. Tone distorted.	(1) Defect in amplifier.	Check and replace defective tubes or parts.
n. Sound intermittent.	(1) Intermittent open or short in electrical circuit.	Locate defect and repair.

<i>Description</i>	<i>Possible Cause</i>	<i>Remedy</i>
o. Hum level high.	(1) Defective tube. (2) Defect in amplifier—open grid or open filter condenser.	Replace tube. Locate defective part or connection. Repair or replace.
p. Reproduction noisy.	(1) Radiotrons defective. (2) Switches defective. (3) Volume control defective. (4) Loose connections. (5) Defective filter condensers. (6) Poor contacts between Plugs and sockets	Replace defective tubes. Replace. Replace. Find and repair. Replace. Repair or clean.
q. Microphonic.	(1) Radiotrons* defective (likely to be the 6J7).	Test tubes. Replace those defective.
r. Sound on FILM—silent on MIC.	(1) Microphone defective. (2) Microphone plug or receptacle defective. (3) MIC-FILM switch defective.	Replace. Repair or replace. Repair or replace.
s. Sound on MIC—silent on FILM.	(1) Sound optical system defective. (2) Exciter lamp out. (3) MIC-FILM switch on MIC.	See j above. Replace. Set switch on FILM.
t. Silent on MIC and FILM but projection lamp is on.	(1) AMPL switch OFF. (2) Loudspeaker disconnected. (3) Amplifier defective.	Turn switch on. Check and connect. Check and replace defective parts.
*Trademark "Radiotron" Reg. U. S. Patent Off. by RCA Mfg. Co., Inc.		

### Service Adjustments

52. The adjustments discussed in this paragraph should be attempted only by those who have the required skill and equipment.

#### a. Optical Bracket Assembly.

(1) *Exciter Lamp and Socket.* The exciter lamp is of the prefocused type. It requires

no adjustment when it is seated properly. If the socket is to be replaced, proceed as follows:

(a) Remove the three screws P (fig. 15) and lift the lamp socket out of the bracket.

(b) Disconnect the two leads from the socket and connect them to the new socket, insulating adequately with rubber tape.

(c) Replace the socket in the bracket and tighten in place. Be sure that the leads are not shorted.

(2) *Lateral Positioning of Sound Light Beam.* To center the light beam on the film sound track proceed as follows:

(a) Thread a loop of buzz-track film with the emulsion side of the film toward the exciter lamp.

(b) Operate the projector as for regular sound film.

(c) Open the optical bracket and loosen jamb nut on the adjusting screw. Close bracket, hold tightly, and adjust the thin screw with a No. 6 Allen wrench until no sound is heard in the speaker. Tighten jamb nut without moving the adjustment.

(d) Check to see that the machine is in adjustment after tightening.

(3) *Focusing light beam on sound track.*

Incorrect focus of the light from the exciter lamp on the sound track results in loss of volume and of high-frequency response. To make the adjustment:

(a) Thread a 6,000-cycle test-film loop in the projector, with the emulsion side toward the exciter lamp.

(b) Connect the output meter across the loudspeaker voice coil.

(c) Operate the projector as for regular sound film.

(d) Turn the tone-control knob to give maximum high-frequency response and turn up the amplifier volume until a reading is obtained on the output meter.

(e) Break the seal T and loosen the clamping screw until the sound optical unit can be shifted with a light drag against the bracket.

(f) Insert the eccentric wrench (RCA No. K-185142) into the hole U and insert the small pin (RCA No. K-180001-9) in hole V. Adjust, simultaneously, the horizontal position of the sound optical unit by turning the wrench and the rotational position with the pin until maximum output is indicated by the meter.

(g) Tighten the screw T carefully and make sure that the reading on the output meter does not decrease during the process.

(4) *Vertical Positioning of Sound Light Beam.* When this adjustment is required, proceed as follows:

**CAUTION:** This adjustment should not be attempted unless an output meter is available.

(a) Release the two pivot pins X by loosening the two setscrews W.

(b) Raise or lower the sound optical bracket until the axis of the sound optical unit passes through the center of the sound optical mirror.

(c) Push the lower pivot pin against the bracket, without disturbing the adjustment effected in a (4) (b), and lock the pin with the setscrew.

(d) Push the upper pivot pin against the bracket and lock the pin with the setscrew.

**NOTE:** This is a critical adjustment and should not be attempted unless the original adjustment has been disturbed.

b. *Sound Mirror Assembly.* It is important that the sound mirror be set so that it reflects to the cathode of the photocell all the light reaching it from the film track. A slight adjustment for the mirror is provided by the clearance between mounting screws Y and the respective mounting holes in the mirror assembly. If the mirror becomes loose or breaks away from the bracket, it is best to replace the entire mirror bracket assembly. To replace, proceed as follows:

(1) Remove the projector from the case. Do not remove the lamp house or the amplifier.

(2) Loosen the thumbscrew D and swing optical bracket away from the projector frame.

(3) Remove the projection lens and film gate by raising the hinge pin E.

(4) Lift pressure-roller arm Z and tie it securely to the upper sprocket bearing.

(5) Prevent the sound-drum shaft from rotating and remove the screw and washer from the flywheel side of the sound-drum shaft assembly.

(6) Withdraw the sound-drum shaft from the operating side of the projector. Take care not to damage or lose the spacers, the spring, or the bearings of the drum-shaft assembly, or to damage the flywheel.

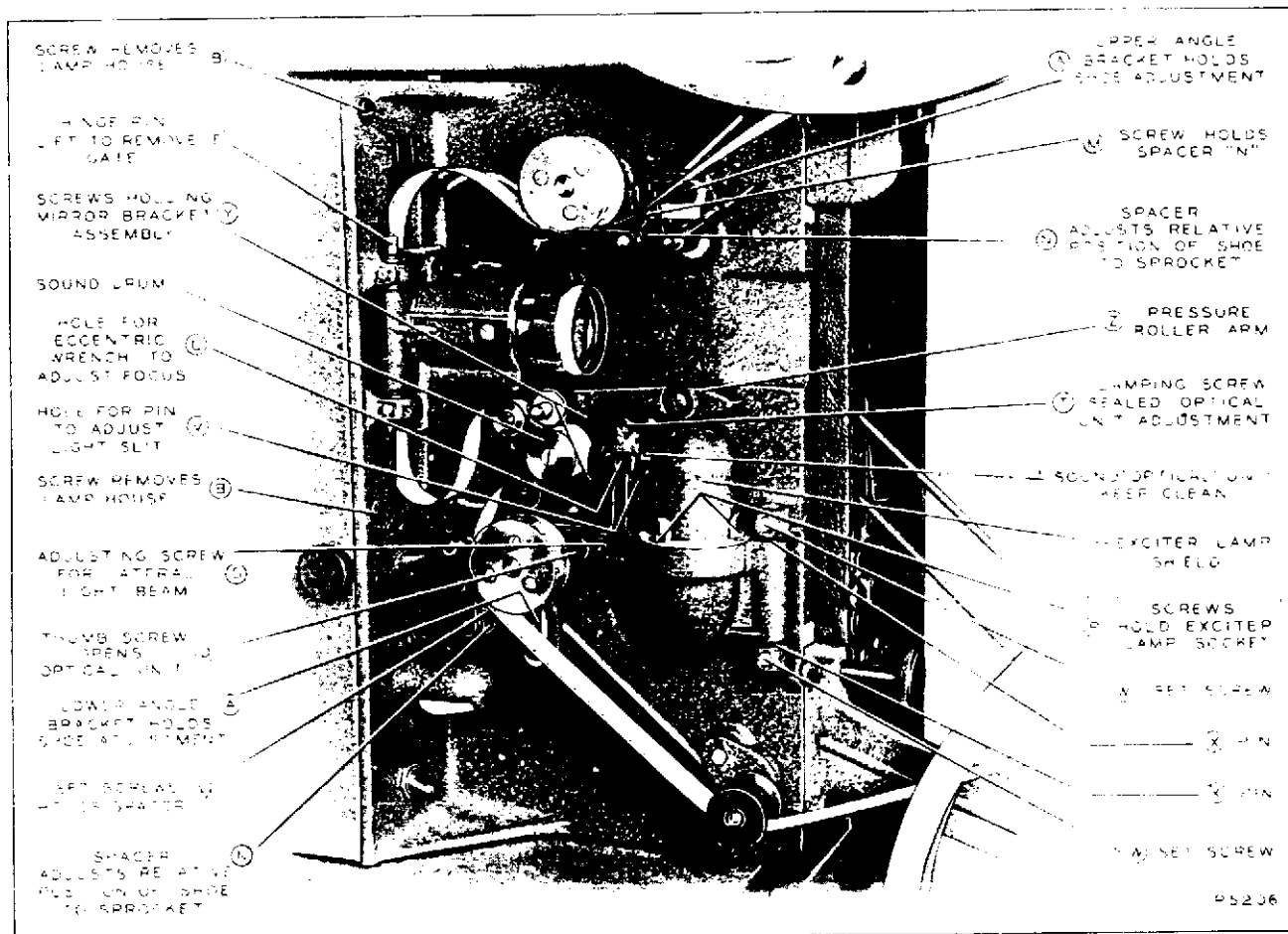


Figure 15—Operating Side of Projector for Servicing

(7) Take out the three screws Y while holding the mirror bracket assembly and then remove the assembly from the projector.

(8) Assemble the new sound-mirror bracket with the three screws Y, leaving them just loose enough so that the bracket can be rotated slightly by hand.

(9) Assemble the short spacer on the drum shaft. Do not allow dirt to get between the drum and the spacer.

(10) Insert the drum-shaft assembly through the front ball bearing and assemble in this order: the long spacer, the flywheel, the spring, and the back bearing, which should be inserted from the back side after the sound drum is pushed in as far as it will go.

(11) Again keep the drum shaft from rotating and lock the assembly with the retaining washer and screw.

(12) With the optical system turned ON, rotate the mirror bracket slightly to obtain the maximum reflected light on the photocell cathode. When this position is determined, tighten the three screws to hold the bracket in place.

(13) Check to see that the adjustment was not disturbed by the tightening.

c. *Sprocket-Shoe Assemblies.* If the film is to pass smoothly around the sprockets and at the same time retain its proper position, it is necessary that the film shoes be adjusted properly. Proceed as follows to adjust them:

(1) By moving the spacer N until the sprocket teeth engage the sprocket holes in the center, make sure that the shoe does not rub on either side of the sprocket body.

(2) Tighten the setscrew M that holds the shoe on the pivot. (Note correct position of set screw M before tightening.)

(3) Adjust the film clearance between shoe and sprocket as follows:

(a) Place a double thickness of film between the sprocket and the shoe and close the shoe. Allow the spring to hold it in place.

(b) Place the angle bracket A against the shoe stop nearest the sprocket and tighten the screws on the angle bracket.

(c) Open the shoe and remove one thickness of film.

(d) Close the shoe and check to see that the film is not damaged on the edges and that the film is free on the sprocket. The shoe should hold the film so that the sprocket teeth engage the center of the sprocket holes.

d. *Film Pressure Shoe.* In order that the film be held properly against the aperture plate and that the film be maintained under the required tension, it is necessary that the film pressure shoe (fig. 8) exert the correct pressure on the film as it passes through the film gate. This pressure can be checked and adjusted as follows:

(1) See that the pull-down claw is in the withdrawn position so that it will not engage the sprocket holes in the film.

(2) Place a section of regular film in the film gate with the emulsion side toward the film shoe. See that the gate is closed securely.

(3) With a 16-ounce spring scale hooked through a sprocket hole, pull the film through the gate. The drag indicated by the scale should be from 4 to 5 ounces. If the reading differs much from this, remove the film gate and proceed as follows:

(a) Loosen the set screws (fig. 8) that hold the two plunger assemblies just enough to withdraw the shoe and the two plungers from the plunger bushings, without releasing the bushings.

(b) Remove the pressure springs from the plunger bushings.

(c) Insert a new spring in each plunger bushing after cleaning the bushings thoroughly.

(d) Apply one drop of light (SAE No. 10) oil on each shoe plunger.

(e) Assemble the plungers to the shoe and insert the plungers into the plunger bushings. Each plunger must move in and out very freely.

(f) Tighten the setscrews to hold the assembly in place.

(g) Check for freedom of movement. The film shoe must move in and out very freely. If it is displaced by finger pressure at any point on the shoe, the shoe must return to its original position by itself.

(4) Replace the film gate on the projector.

e. *Film Pull-Down Claw.* (Refer to fig. 16) The pull-down claw, which imparts the intermittent motion to the film in synchronism with the shutter, must be adjusted properly if pictures of the finest quality are to be obtained. To adjust, remove the projector from the case and the lamp house from the frame of the projector. Then proceed as follows:

(1) *Positioning Intermittent Body.* Line up the centers of the framing pivot, intermittent eccentric, cam shaft, and the adjusting screw for the in-and-out cam in a horizontal position. (A straight-edge will help in making the alignment.) When all these centers are lined up, the claw will be halfway down in the stroke, and should be in this position for adjusting depth and lateral location.

(2) *Up-and-down motion.*

(a) Loosen screws A and B, which hold the gear plate. If necessary, turn the shutter and the flywheel to reach the screws.

(b) Move the gear plate C as far to the right as possible. Then tighten screw A temporarily.

(c) Place a strip of film in the gate and close the gate.

(d) Rotate the flywheel D by hand, clockwise, and note whether the claw moves the film down each time the claw moves down.

(e) If the film does not move down, again loosen screw A and move the gear plate to the left one division of the scale above the gear plate. Tighten screw A. Again rotate the flywheel and note the action of the claw on the film. If the claw still does not engage the sprocket holes in the film, move the gear plate to the left another scale division and repeat the test.

(f) When the position of the gear plate is found where the claw engages the film sprocket holes, move the plate to the left an additional two and one-half scale divisions and tighten both screws A and B to lock it securely.

(g) Since this adjustment is quite critical, it should whenever possible be made with a claw gauge plate (RCA No. K-184787-1) provided in the repair kit. To make this adjustment, proceed as follows:

1 With centers lined up as in (a) above, loosen screws A and B, move the gear plate as far to the right as possible, and tighten screw A temporarily.

2 Place the projector on its back so that the aperture plate is in a horizontal position and rest it on a support so as to prevent damage to the shutter and gears.

3 Place the gauge plate against the aperture plate between the fixed film guide and the side pressure shoes with its serrated edge engaging the claw teeth.

4 Rotate the flywheel D by hand clockwise until the claw recedes and again protrudes through the aperture plate. When the claw comes out it will not line up with the serrations in the gauge plate but will push the plate away from the aperture.

5 Set the projector upright and move the gear plate to the left one division of the guide scale. Again lay the projector on its back and repeat operations 3 and 4.

6 Repeat this procedure until the claw no longer pushes the gauge plate outwards but instead engages the serrations in the gauge each time the claw moves forward.

7 When this has been accomplished, return the gear plate one-half division to the right and lock it securely by tightening screws A and B.

8 Recheck the adjustment with the gauge plate to be sure that the adjustment was not disturbed by the tightening.

9 Moving the gear plate to the right decreases the claw travel and moving it to the left increases it.

(3) *Lateral Adjustment of Claw.* Adjust the lateral position of the claw when the claw is halfway down with the eccentric pivot E (fig. 16) until the claw clears the sprocket hole in the film by about 0.012 to 0.016 inch. To permit this adjustment, loosen the two Allen setscrews that hold the eccentric. The claw should be placed so that it is just inside the straight portion of the sprocket hole and just clears the curved corner of the hole. The eccentric pivot must be in its lowest position

before this adjustment is started. For an exact adjustment proceed as follows:

(a) Locate the claw approximately halfway down and line up the eccentric pivot E in a horizontal position. The claw should then be exactly in the halfway down position. If it is not, adjust the position with the framing knob.

(b) Insert the claw gauge plate (thick portion) between the fixed film guide and the claw. The gauge should just slip in and out without forcing or appreciable play.

(c) Adjust to proper clearance as described above with the eccentric pivot. Tighten the two setscrews after the proper adjustment is obtained.

(d) The gauge should slip out of place by its own weight. Check for excessive play by holding the upper end of the gauge with the left hand and attempting to swing the lower end of the gauge sideways to see that there is not excessive clearance between the fixed guide, gauge, and claw.

The pull-down claw must engage the sprocket holes throughout its downward travel and the film must run smoothly with the framing adjustment set in any position.

(4) *In-and-out motion.*

(a) Remove the flywheel D by loosen-

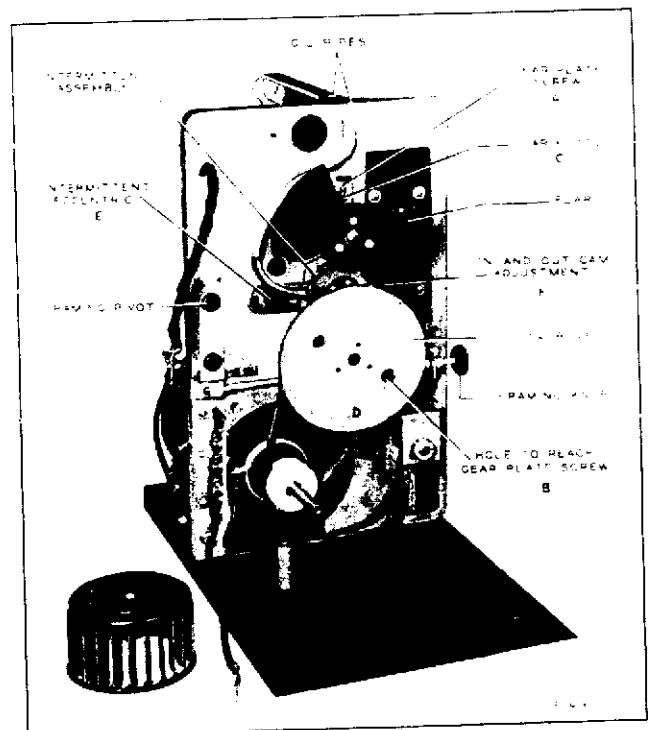


Figure 16—Adjusting Pull-down Mechanism



ing the two setscrews and forcing the belt off the pulley while turning the flywheel and pulling it from the shaft.

(b) Turn the shutter blades so that the setscrews and the locknut on the in-and-out cam gear can be reached.

(c) Loosen the locknut to permit adjustment of the setscrew. Adjust the claw so that it protrudes through the aperture plate from 0.035 to 0.040 inch. After the proper adjustment is found, lock the setscrew with the locknut.

(d) Exact adjustment can be made with the claw gauge plate as follows:

1 Place the gauge plate against the aperture plate between the fixed guide and side pressure shoes, with the serrated edge of the gauge toward the side of the aperture through which the claw protrudes.

2 Adjust the setscrew F until the claw teeth are just flush with the surface of the gauge plate. Be sure to lock the setscrew in this position with the locknut. This adjustment should be such that the setscrew is directly above the cam follower on the claw body.

3 The adjustment can be facilitated by feeling along the surface of the gauge with the blade of a small ruler or screwdriver.

f. *Shutter and Pull-Down Mechanism.* When it becomes necessary to synchronize the shutter with the intermittent gear, proceed as follows:

(1) Assemble the shutter gear and intermittent gears with the timing hole and countersink coinciding.

(2) Assemble the shutter blade on the three screws so the index hole in the shutter lines up with the hole in the shutter gear.

(3) Assemble the three nuts to hold the shutter blade and tighten.

(4) After this adjustment, if travel ghost is noticeable, refinement of the adjustment can be made by loosening the three nuts holding the shutter blade and rotating the shutter blade slightly on the three elongated holes.

(5) If the travel ghost is seen at the top of the picture, the shutter is lagging behind the claw operation and the blade should be rotated slightly in a clockwise direction.

(6) If the travel ghost is seen at the bottom of the picture, the shutter is leading and should be rotated slightly counterclockwise.

(7) Tighten the three nuts firmly to keep the shutter blade from shifting.

#### g. *Pressure Roller.*

(1) With the spring scale used in 52 d (3), lift the pressure roller until the roller just leaves the drum. Take the scale reading. Lower the pressure roller until it is just ready to touch the drum. Take another reading. The average of the two readings should be 8 ounces.

(2) Should the pressure be incorrect, remove the arm and bend the spring slightly. Install the arm and test the pressure as above. Readjust if necessary.

### Installing Take-up or Rewind Belts

53. Proceed as follows:

a. Remove the projector-amplifier from the case.

b. Put the spring belts around their respective pulleys.

c. Place the projector-amplifier partly inside the case and put the belt ends through the openings provided on the top and front of the case, making sure that the belts are not crossed.

d. Grasp the protruding ends of one of the belts and give one end a reverse twist of four turns.

e. Screw the smaller end of the belt into the larger end.

Four turns will just cancel the reverse twist previously given the belt and will leave the belt without any tendency to curl.

f. Put the second belt together in the same manner.

g. Ease the projector into the case, without damaging the belts in the process.

h. Replace the four oval-head screws and knob on the tilting device.

### Internal Cleaning of Condenser Lens

54. Occasionally it becomes necessary to clean the interior surfaces of the condenser lens in addition to the routine maintenance cleaning of the exterior surfaces. When this is necessary, remove the lens from its mounting and take it apart as shown in figure 17. Clean the condenser surfaces, especially the interior, with lens tissue or with absorbent cotton moistened in carbon tetrachloride. Assemble the lens in the order indicated in figure 17.

### Servicing the Loudspeaker

55. The more common troubles experienced with the loudspeaker are loose terminal connections, open or shorted voice coil, damaged diaphragm, foreign particles in the gap, and voice coil off center and rubbing.

a. Check terminal connections and tighten them if they are loose.

b. Test the voice coil with an ohmmeter connected across the speaker terminals. The voice coil should measure about  $5\frac{1}{2}$  ohms. If this test indicates that the voice coil is defective, replace the cone and the voice coil as follows:

(1) Remove the loudspeaker assembly from the case. Four machine screws hold it.

(2) Remove the cable clamp and disconnect the cable from the unit by unsoldering the leads from the two solder-type terminals on the under side of the cone housing.

(3) Unsolder the voice coil leads from the lugs on the cone housing. Be sure to note how these leads are connected.

(4) With a sharp knife, cut the paper cone away from the metal rim of the cone housing.

(5) Remove the two fillister-head machine screws that hold the voice coil and cone assembly in place, and withdraw the coil and cone assembly from the loudspeaker.

**CAUTION:** Use extreme care to prevent iron filings or other foreign matter from entering the air gap between the core and the top plate. Any such foreign material will restrict the motion of the voice coil and impair the performance of the loudspeaker. Mask the air gap with scotch tape after the cone has been removed.

(6) Scrape all cement, the two gaskets, and the remaining cone material from the metal rim of the cone housing.

(7) Cement the four thin gasket segments in place against the rim of the cone housing. Coat the surface of this new gasket with cement just prior to installing the new cone.

(8) Remove the scotch tape. Drop the new cone in place, taking care approximately to center the voice coil in the air gap and to line the slots for the fillister-head machine screws removed in (5).

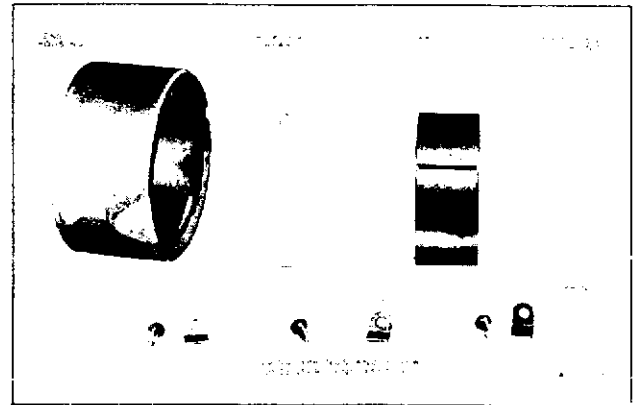


Figure 17—Assembling Condenser Lens

(9) Center the voice coil in the gap by means of shims placed between the core and the voice coil.

(10) Press the cone down all around the rim, thus firmly cementing it in place.

(11) Replace and tighten the two machine screws that hold the centering device in place. Remove the shims.

(12) Make sure that the voice coil is properly centered and then cement the dust cap in place to prevent foreign particles from entering the air gap.

**NOTE:** Iron filings and other magnetic material found on the magnet can be removed by pressing the sticky side of adhesive or scotch tape against the particles and then removing the tape.

(13) Cement the four heavy gasket segments to the rim of the cone.

(14) Replace the loudspeaker in the case.

**NOTE:** When the only defect in the loudspeaker is that the voice coil is not centered, it is only necessary to loosen the two screws that hold the centering device and then center the cone.

### Preparation for Record Playing

56. The output of a phonograph pickup is im-

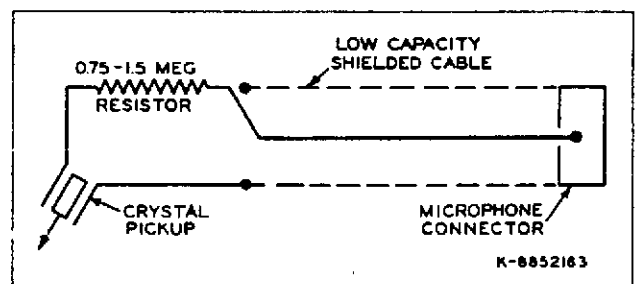
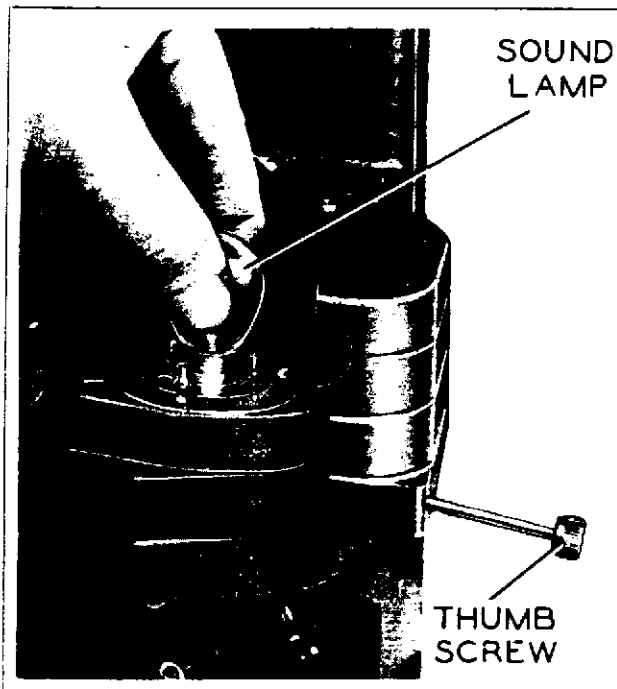


Figure 18—Voltage Divider for Use with Pickup





**Figure 12—Replacement of Sound Lamp**

forefinger. Cleaning the back edge of the sound drum from the left side minimizes the chance of disturbing the optical mirror behind the drum.

## Replacements

The amplifier fuse, the projection lamp, and the sound lamp are the most likely components to require replacements during a show.

a. *The fuse (fig. 7)*, which is mounted at the top of the amplifier panel, can be replaced without removing the amplifier cover. Unscrew the red cap (a dime may be used), put in a 2-ampere fuse *only*, and replace the holder.

b. *The projection lamp (fig. 11)*. If the lamp burns out during a show, turn OFF the projector and the lamp switches. Remove the lamp as was explained under Cleaning, paragraph b (1), but do not attempt to remove the lamp with the bare fingers. To install a new lamp, line up the wide and narrow flanges on the base of the lamp with the socket slots and insert the lamp. Press down and turn to the right until it "clicks" into place. Avoid getting fingerprints on the clear portions of the lamp. Turn the projector switch to PROJ., the lamp switch to LAMP, and resume the show.

c. *The sound lamp (fig. 12)*. Open the sound optical bracket. Grasp the sound lamp with the

## TECHNICAL DATA

### PROJECTOR

#### Power Required

1025 watts (with 750 w. lamp)  
1275 watts (with 1000 w. lamp)  
105 to 125 volts  
50/60 cycles (MI-1305)  
25 cycles (MI-1305-A)

#### Projection Lamp

750-watt, T12P, 115 volts

#### Sound Lamp

¾-ampere, 4-volt, prefocused, S-8, double contact

### AMPLIFIER (ONLY)

#### Power Required

105 to 125 volts, 100 watts  
50/60 cycles  
25 cycles  
D. C. (Use a 150 watt inverter for D. C. operation)

For further technical information, consult your dealer.

### Tube Complement

Phototube	RCA-921
Input	RCA-6J7
Voltage Amplifier	RCA-6J5
Amplifier-Phase Inverter	RCA-6SN7-GT
Output (two tubes)	RCA-6V6-GT
Oscillator	RCA-6V6-GT
Rectifier	RCA-5Y3-GT

#### Amplifier Fuse

2 ampere

### WEIGHTS AND DIMENSIONS

#### Dimensions, Overall

	Proj.-Ampl. (MI-1305) (MI-1307)	Loud- speaker (MI-1306)
Length, carrying case	15 ⅞ inches	19 ⅞ inches
Height, carrying case	15 ¼ inches	15 ¾ inches
Width, carrying case	9 ⅞ inches	9 inches

#### Weight

Shipping	45 lbs.	34 ½ lbs.
Equipment	39 lbs.	27 lbs.

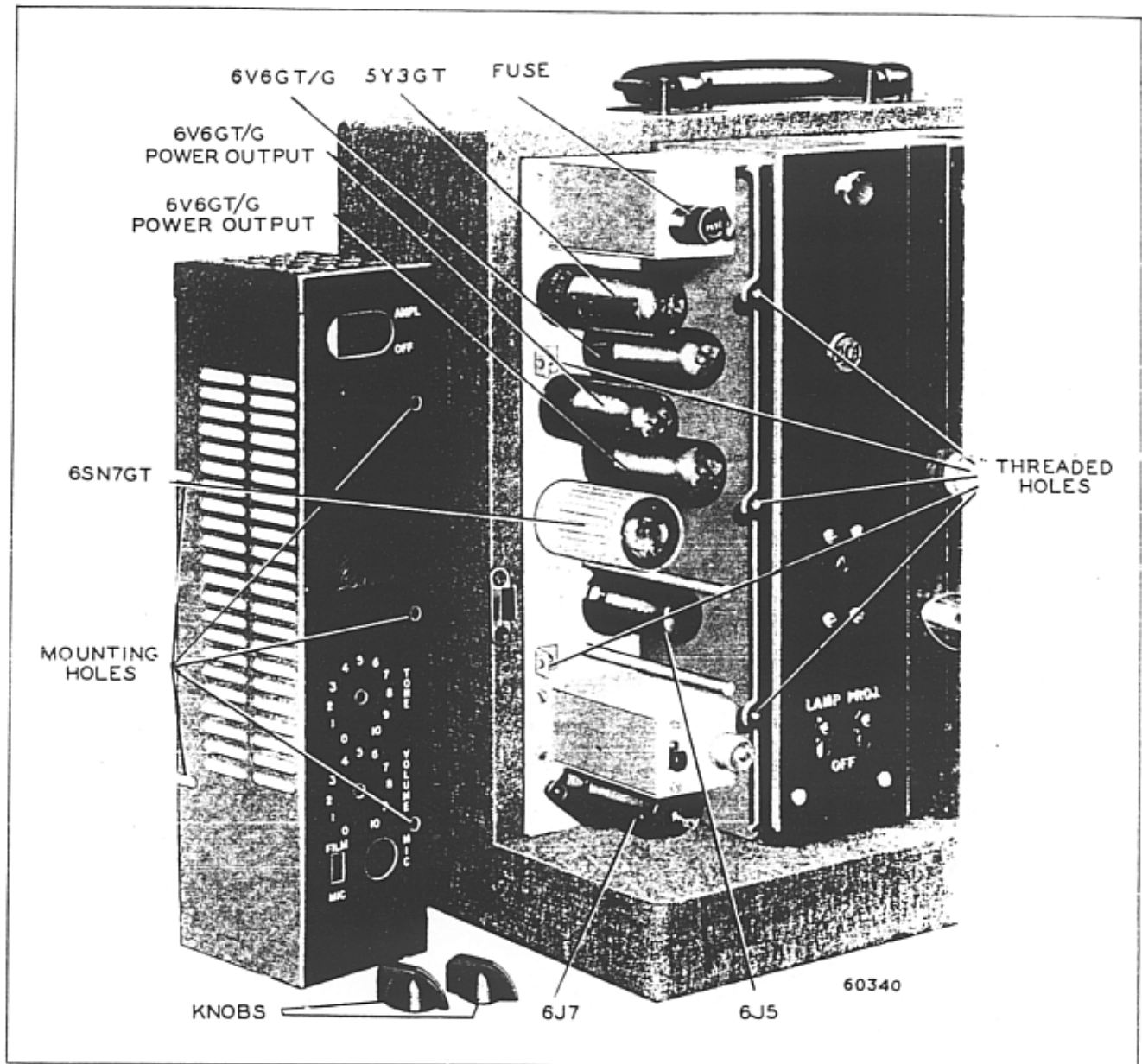


Figure 13—Removing Amplifier Cover for Tube Replacement

left hand as shown, lift it slightly, and turn it to the left. In putting the new lamp in, line up the notch in the lamp flange with the hole in the socket. Push it down against the socket base and turn it to the right until it snaps into place.

Should any of the tubes require replacement, they can be reached by removing the cover of the amplifier as shown in figure 13.

#### Service Adjustments

If the equipment requires more thorough servicing than that discussed above, it should be taken to an RCA 16 mm Motion Picture Equipment Dealer, who will have complete factory servicing facilities at his disposal. The dealer should also be consulted for supplies and accessories.