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# **SERVICE INSTRUCTIONS**

## **SLOT-THREADING FILMOSOUND<sup>®</sup> PROJECTOR**

### **MODELS**

**1580A, AG, C, CS, CG**

**1680A, B, BC, E, EC, US**

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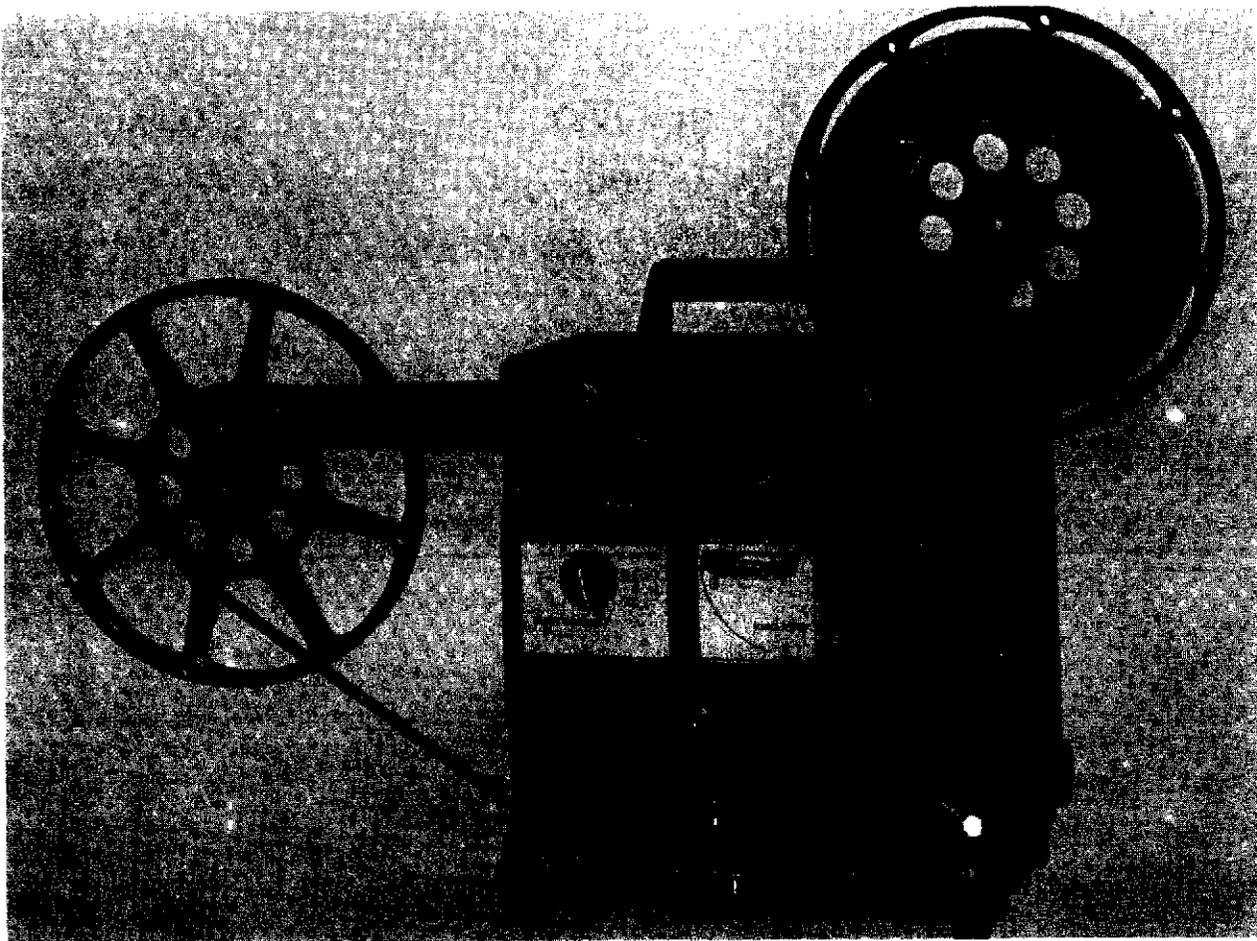
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## *Table of Contents*

	Page
INTRODUCTION . . . . .	1 - 4
DISASSEMBLY PROCEDURE . . . . .	5 - 12
REASSEMBLY PROCEDURE . . . . .	12 - 26
ADJUSTMENTS . . . . .	26 - 32
General Instructions . . . . .	26
Optical Alignment . . . . .	26
Adjusting the Intermittent Mechanism . . . . .	27
Adjusting the Reel Arms and Rewind Clutch . . . . .	30
Adjusting the Sound System . . . . .	30
Projector Speed Checks . . . . .	31
Gear Shift Tension Adjustment . . . . .	32
Idler Gear Backlash Adjustment . . . . .	32
Setting the Load Lever . . . . .	32
Adjusting Brake Arm Release . . . . .	32
TROUBLE SHOOTING . . . . .	33 - 36
PRODUCT IMPROVEMENTS . . . . .	37 - 40
General . . . . .	37
Correcting Film Skew . . . . .	37
Correcting Film Threading Problems . . . . .	39
Correcting Noisy Reverse Condition . . . . .	39
Correcting "No-Run" Condition . . . . .	40



Model 1580 Slot-Threading Filmosound® Projector

FEATURE DESCRIPTION LIST

Color .....	Charcoal gray and torquoise
Input Voltage:	
Model 1580 .....	120VAC, 60Hz
Model 1680 .....	100/110/130/200/220/240/250VAC, 50/60Hz
Film Transport .....	Slot-threading system with switch-controlled speeds of 18 and 24 fps in forward and reverse; high speed reel-to-reel rewind
Illumination .....	24 volt, 250 watt, 50 hour projection lamp (Type EMM) with normal and bright control
Audio System .....	Optical type with 4 volt DC exciter lamp (Type BAK) and silicon photocell pick-up
Amplifier .....	Plug-in printed circuit board with 10-watt R.M.S. output
Speaker .....	Built-in 16-ohm permanent magnet type
Weight:	
Model 1580 .....	32 pounds (70.5 Kg)
Model 1680 .....	34 pounds (75.0 Kg)
Available Accessories .....	(See Parts Catalog Introduction)

## *Introduction*

### GENERAL.

This Service Manual provides the necessary information for the repair and adjustment of Bell & Howell Company 16mm Slot-Threading Projectors, Models 1580 and 1680. Design and operating characteristics are listed in the Feature Description List on the preceding page. An illustrated Parts Catalog is included at the rear of the manual to identify replacement parts and to assist in the disassembly and reassembly of these projectors.

### DESIGN FEATURES

As noted in the following chart, this manual covers several variations of the Models 1580 and 1680 projectors. Each model has been "letter-coded" in the Parts Catalog so that replacement parts which are peculiar to a model, or models, can be readily identified.

Basically, all models in the 1580 series projectors are identical except for color, which affects the part numbers for such items as covers and trimplates. The most noticeable variation in the 1580 series is the Model 1580CS, which is equipped with a front cover and speaker assembly (Parts Catalog Figure 12). In like fashion, all models in the 1680 series projectors are identical mechanically and electrically identical. However, the Model 1680US is equipped with the front cover and speaker assembly shown in Parts Catalog Figure 12, and the Models 1680BC and 1680EC with the cover and speaker assembly illustrated in Figure 13.

The 1680 series projectors can be readily identified by the presence of a switch-controls panel located above the cord wrap on the back cover. On this panel are mounted the voltage selector switch and speed selector switch, features which are not provided in the 1580 series projectors. Also located on this panel is a receptacle for the line cord. In the 1580 series projectors, the line cord is wired into the projector.

MODEL	CODE	MODEL	CODE
1580A	A	1680A	F
1580AG	B	1680B	G
1580C	C	1680BC	H
1580CS	D	1680E	J
1580CG	E	1680EC	K
		1680US	L

### SLOT-THREADING OPERATION.

All projectors covered in this manual use the slot-threading system developed by Bell & Howell Company. With the Load Lever in position "1", the film is slipped beneath the large entrance roller (numbered "2"), around the upper and lower corners of the lens cover, around the lower guide roller (with the two clockwise arrows) and along the lower guide path beneath the lamphouse cover to the take-up reel. The projector has been designed to self-seat the film if threaded correctly. If the film is sufficiently out-of-line, moving the Load Lever to position "3" will automatically eject the film from the lower portion of the system. If this should occur, return the Load Lever to position "1" and rotate the take-up reel until the film is taut and realigned.

With the Load Lever in position "1", all systems except the projection lamp have power. This is to prevent damage to the film while film is not being transported. In position "3", all systems have power for projection and sound. An electric interlock has been provided to shut off all projector power when the Load Lever is moved to an intermediate position between "1" and "3".

### SPECIAL MAINTENANCE PRECAUTIONS.

Before beginning repair operations, check specific customer complaints against the Trouble Shooting charts for possible cause and suggested remedies.

The removal and installation of most projector parts can be accomplished with tools normally available in photo equipment repair shops. A pencil-type soldering gun should be available for electrical repairs, and the Bristol wrenches listed in the following chart will also be required. Special tools and gages necessary for projector alignments and adjustments are illustrated and listed in Figure A and its accompanying chart.

#### BRISTOL SETSCREW WRENCHES REQUIRED FOR MAINTENANCE

Setscrew Size	No. of Flutes	B&H Part No.	
		Handle	Wrench
No. 4-40	6	G1271-F1	G1271-X2
No. 6-32	6	STK3852-B	STK3863-B
No. 8-32	6	G165-F1	G165-X2

NOTE: Wrench G165-F3 is needed to tighten setscrew in tool handles.

## SERVICE INSTRUCTIONS

### CLEANING.

All film path areas must be kept free from emulsion build-up, or film jamming will take place during the automatic threading operation. Use Toluol, and/or an orange stick to remove emulsion from the film path areas, being careful not to scratch the surfaces. Pay particular attention to the film path parts of the soundhead cover and soundhead.

Do not use trichloroethylene solvents to clean plastic parts. Use a naphtha base cleaning fluid and be sure that grease is NOT wiped off critical areas of lubrication. Do not use solvents on these critical areas, especially in the auto-threading linkage, since lubrication is applied during assembly and it would be difficult to replace without disassembling the linkage. Use a soft lint free cloth when necessary to remove any accumulation of dust or film chips.

During periodic maintenance of the projector, the transport mechanism should be removed and thoroughly cleaned. Brush or blow out all large particles of dirt. Wash all moving parts except "Oilite" bearings with any good petroleum solvent. Wash "Oilite" bearings and the pull-down cams with naphtha. Wash the cam oilers in naphtha, and replace if not thoroughly cleaned by washing. Discard and replace the cam wiper and cam wiper wick. As soon as parts have been washed and dried, coat with a light film of the specified lubricant.

### LUBRICATION.

The Lubrication chart below indicates those parts and areas which are to be lubricated during reassembly. Specified lubricants are available from the Bell & Howell Company. Be sure that the part or area to be lubricated is clean before lubricant is applied and be careful not to over-lubricate. A drop or two of oil or a light film of grease will be adequate. Apply grease with a brush and wipe away excess lubricant with a lint-free cloth.

Felt pads and wicks should be placed in a shallow pan of the specified grease or oil and allowed to stand until saturated. Permit the excess lubricant to drain away before installing these felt parts.

### GENERAL REPLACEMENT DATA.

These projectors are designed for easy accessibility to and replacement of most major components. Inspection, lubrication and troubleshooting generally can be accomplished by removing the front cover, rear cover and/or the two covers beneath the base (items 2 and 5, Figure 5). Most of wiring connections for major electrical components are made by means of wire nuts or molded nylon connectors, thus minimizing unsoldering operations. Wiring connections and wire lead colors for the projectors are illustrated in the diagrams at the rear of the Parts Catalog.

The front cover is easily removed by unlatching the two top cover latches and lifting the cover from the projector. The rear cover (item 14, Figure 1A and item 12, Figure 1B) is secured to the projector base with three screws and to each projector end cap with two screws. When the screws have been removed, work the cover free carefully and avoid putting too much strain on the interconnecting leadwires. For greater accessibility to Model 1680 projector components (Figure 1B), remove the screws (18) and (20) that secure the speed selector switch (19) and the P.C. board bracket (21) to the switch plate (17).

**FUSE REPLACEMENT.** For Model 1680 projectors, the power input circuit is protected by a Type 4AT miniature fuse (item 17A, Figure 1B) which can be replaced simply by removing the fuseholder cap located on the switch and fuse plate near the top of the rear cover. The audio system of Model 1680 projectors is protected by four Type 2AT fuses (item 2, Figure 3B) located on a fuse board mounted directly above the drive motor. For Model 1580 projectors, the power input circuit is protected by a Type 3AG slo-blo fuse (item 1, Figure 3A) located above the rotary switch. The rear cover must be removed to gain access to the power input fuse of the Model 1580 and the audio system fuses of the Model 1680.

### DRIVE BELT.

Model 1580 Projectors (See Figure 3A). Remove the projector rear cover and disengage the drive belt (26) from the mechanism (upper) pulley. Disconnect all drive motor leadwires. Loosen the screws at the upper ends of both motor bracket straps (31) and lift the straps from the motor end bells. Raise the motor just enough to permit the belt to be passed beneath the motor toward the transformers. Be careful not to lift the motor so high as to damage the blower fan (25). Clean the belt pulleys with isopropyl alcohol and install the new belt by reversing the removal procedure. Reconnect all motor leadwires. When securing the bracket straps (31), make certain that the motor grounding strap bears against the left-hand bracket strap.

Model 1680 Projectors (See Figure 3B). Remove the projector rear cover and disengage the drive belt (1) from the mechanism and motor pulleys. Clean both pulleys with isopropyl alcohol and install the new belt, stretching it only enough to engage it on the pulleys.

**INTERNAL SPEAKER.** For all projectors, the internal speaker is mounted on the front end cap (Figure 2) and can be exposed for inspection and replacement by removing the rear cover. Make note of the speaker leadwire colors and disconnect the leadwire lugs from the speaker terminals. Then remove the four nuts from the molded studs of the front end cap and lift out the speaker.

TRANSFORMERS.

Model 1580 Projectors (See Figure 3A). Remove the projector rear cover. The power transformer (12) is bracket-mounted above the lamp transformer (19) and can be replaced by disconnecting its leadwires and removing the attaching hardware securing the upper ends of the brackets (15) and (16) to the transformer. However, the two inner screws (17) which attach the lamp transformer (19) are installed from the underside of the projector base, and the amplifier cover (5, Figure 5) and the amplifier (10, Figure 5) must be removed to expose these screws. Disconnect lamp transformer leads and remove the four mounting screws. Disassemble the power transformer (12) and brackets (15) and (16) from the lamp transformers.

Model 1680 Projectors (See Figure 3B). Remove the rear cover. The four screws (15) which secure the transformer (16) are installed from the underside of the projector base, and the amplifier cover (5, Figure 5) and amplifier (10, Figure 5) must be removed to gain access to these screws. Disconnect the nylon connectors to free the transformer leads and remove the screws (13) which secure the transformer ground lead to the front motor bracket. Hold the transformer firmly while removing the mounting screws.

DRIVE MOTOR.

Model 1580 Projectors (See Figure 3A). Remove the projector rear cover and disconnect all drive motor leadwires. Remove the screws (20) and (22)

and the right-hand blower housing (23). Loosen the setscrews (24) and remove the blower fan (25). Loosen the screws at the upper ends of both motor bracket straps (31) and lift the straps from the motor end bells. Carefully lift out the drive motor (33), disengaging the pulley (35) from the drive belt. When reassembling the pulley (35) to the new motor, insert a 1/4-inch spacer between the pulley and motor end bell. Lift up on the motor shaft to remove end play and hold the pulley against the spacer while tightening the two setscrews (34). Assemble the motor into the mounting brackets (39), looping the drive belt around the pulley and inserting the motor shaft through the left-hand blower housing (37). When securing the bracket straps (31), make certain that the motor mounting strap bears against the left-hand bracket straps. Assemble the blower fan (25) to the motor shaft, with the end of the shaft approximately 1/16-inch below the outer surface of the fan hub, and tighten the setscrews (24) securely. Reinstall the right-hand blower housing, tightening screws (20) first; then screws (22).

Model 1680 Projectors (See Figure 3B). Remove the projector rear cover. Remove the two screws (3) and lift the fuse board (4) and spacer (5) up out of the way. Disconnect the nylon connector to free the motor leads and remove the screws (13) which secure the motor ground lead to the rear motor bracket (19). Remove four screws (17) and lift the motor (18) and brackets (19) from the projector base, disengaging the drive belt from the motor pulley (21). Install the new motor in reverse fashion. Visually align the belt pulley and tighten the pulley setscrews (20). Then reinstall the drive belt around both pulleys.

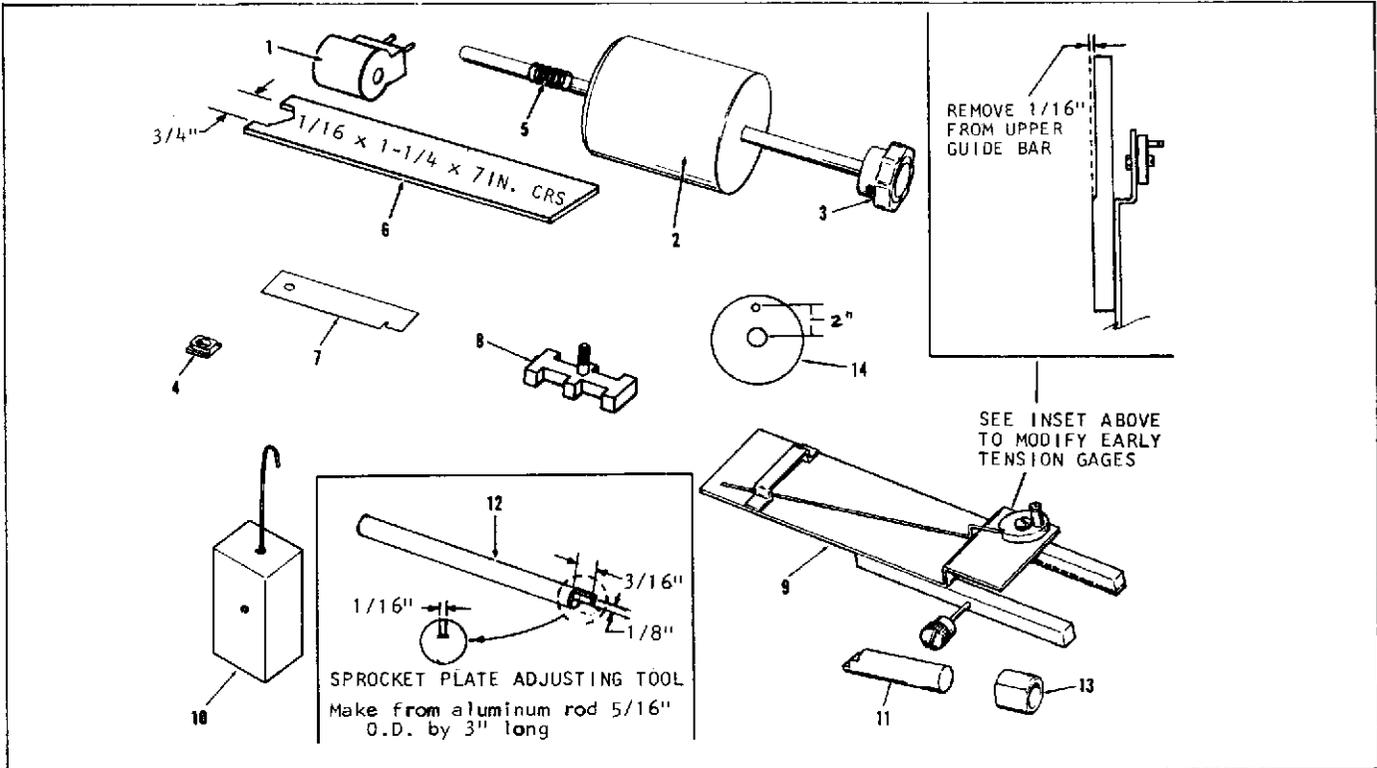
LUBRICATION CHART

Parts to be Lubricated	Lubricant
Machine surfaces (non-bearing) of all castings	Oil (P/N 07003)
Sprocket shafts (46 and 54, Figure 8)	Oil (P/N 08963)
Framer shaft (32, Figure 11) and bearing face of worm gear (25, Figure 11)	Oil (P/N 04978)
Felt oil pads in cams, and sliding parts (friction surfaces) not otherwise specified	Oil (P/N 070032)
The following items are to be lubricated sparingly with grease (see NOTE).	
All gear and pinion teeth, reel arm lock buttons, and (in Figure 11), cam wicks (8) and (13), shuttle link bearings (14A), in-out cam (17), cam follower (16A) and all pivot posts and bearings in the mechanism housing (33).	

NOTE: Grease P/N 070043 should be used to lubricate the worm gear and sprocket gears. Use general purpose grease P/N 070034 for all other areas

TEST FILM CHART

Test Film Part No.	Purpose
TFL-D1580-NX2	Centering and framing test loop
TFL-D1580-NX3	Buzz track test loop
TFL-D1580-NX4	7KHz azimuth test loop
TFL-D1580-NX5	400Hz power output test loop
TFR-D550-NX5	Audio-centering-framing test roll
TFS-D550-NX1	Loop restorer test strip (bad holes)
TFS-D550-NX5	Loop restorer test strip (elongated holes)



INDEX NO.	TOOL NO.	TOOL NAME	USE
1	S-1552-1-N1	Lamp Plug	Alignment of optical system (Figure H)
2	S-550-2-N1	Lens Plug	
3	S-550-2-N2	Alignment Rod	
4	S-550-2-N3	Aperture Plug	
5	P/N 6124	Tension Spring	
6	Make in Shop	Torque Wrench	Adjust rewind torque (make from 1/16 by 1-1/4 by 7 inch CRS)
7	S-550-5-N2	Stroke Gage	Measure shuttle stroke (Figure M)
8	S-09701-35-N2	Shuttle Height Gage	Check shuttle protrusion (Figure K)
9	S-552-4-N1	Shuttle Tension Gage	Adjusting shuttle tension (Figure L)
10	S-552-4-N2	Weight for Shuttle Tension Gage	Adjusting shuttle tension (Figure L)
11	S-550-8-N1	Alignment Tool	Aligning sound drum and photocell (Figure N)
12	Make in Shop	Sprocket Plate Adjustment Tool	Removing play from sprocket plate
	S-550-5-N1	Shuttle Stroke Target	Measuring shuttle stroke (Figure M)
13	S-552-2-N1	Loop Restorer Positioning Tool	Preset loop restorer
14	Make in Shop	Rewind Torque Reel (use P/N 014570)	Torque adjustment (paragraph 37, step c).
	Purchase	Push-Pull Torque Scale (Chatillon #LP-72) Master Gage Co., Chicago 60622	Torque adjustment (paragraph 37).

Figure A. Special Service Tools

## Disassembly Procedure

### 1. GENERAL PRECAUTIONS.

a. Be sure to use the proper size tools for disassembly and reassembly procedures. After removing attaching parts (screws, nuts, etc.), loosely re-install these parts to the removed part or tapped holes to prevent loss.

b. Cemented or adhesive backed parts are so noted in the parts lists and can be removed by prying up one edge with a knife blade. Be careful not to scratch surrounding areas, and remove traces of old adhesive with solvent before installing new parts.

c. When unsoldering is required to remove electrical parts, it is advisable to tag leadwires or make a rough sketch of leadwire connections to facilitate installation of the parts. Unsolder leads with a pencil type soldering gun, using a heat sink if available, or gripping the lead with a pliers to provide additional heat dissipation. Leadwire connections are shown pictorially in the wiring diagrams at the rear of the Parts Catalog.

d. When removing riveted parts for replacement, the old rivet must be drilled out with a drill equal to, or slightly smaller than, the diameter of the rivet to be installed. Refer to the parts lists for the rivet diameter.

2. REMOVAL OF COVERS (1580 Projectors, Figure 1A). Remove the parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Unlatch and remove the front cover assembly (1). If the cover itself is damaged, replace the complete cover assembly. If latching components are damaged, the rivets (1B) must be carefully drilled out.

NOTE: Refer to paragraph 16 for front cover/speaker disassembly (Model 1580CS only).

b. Loosen the knurled cover screw (5) and lift the exciter lamp cover (3) from the sound head. Disassemble the retaining ring (4) to remove the cover screw (5) from the cover.

c. Place the Load Lever in position "3" before attempting to remove the lens carrier cover assembly (7). Pull the cover straight from the thru mounting post. If the cover is loose or comes off too easily, check the condition of the thru compression rings (8).

d. Remove the four screws (10) that attach the cord wrap (11) to the rear cover (14). Remove the three screws (12) that secure the lower edge of the rear cover to the base; then the four screws (13) that secure the rear cover to the front and rear end caps. Disengage the line cord from the notch in the rear cover and lift the cover from the projector. The labels (15) and (17) and the control panel plate (16) are adhesive backed and need not be replaced.

e. Remove the two screws (19) at the top of the projector mainplate and lift the top cover assembly (20) from the projector. The cover mounting brackets (20B) and the carrying handle (20C) are secured with four screws (20A). If the latch strikers (20F) are damaged, rivets (20D) must be drilled out.

f. Items (23 through 26) normally are furnished as part of the complete mechanism assembly (item 29, Figure 5) and can be removed with that assembly if so desired (see paragraph 9). However, to prevent damage to these parts during other projector repairs, it may be advisable to remove them at this point. Pry the decorative insert (23) from the recess of the threading roller (25); then remove the retaining ring (24) and disassemble the threading roller (25) from the end of the sound drum shaft. Unscrew the loop restorer knob (26) from the shaft of the loop restorer arm.

3. REMOVAL OF COVERS (1680 Projectors, Figure 1B). Remove the parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Unlatch and remove the front cover assembly (1). If the cover itself is damaged, replace the complete cover assembly. If latching components are damaged, the rivets (1B) must be carefully drilled out.

NOTE: Refer to paragraph 16 or 17 for front cover/speaker disassembly (Models 1680BC/EC/US only).

b. Loosen the knurled cover screw (5) and lift the exciter lamp cover (3) from the sound head. Disassemble the retaining ring (4) to remove the cover screw (5) from the cover.

c. Place the Load Lever in position "3" before attempting to remove the lens carrier cover assembly (7). Pull the cover straight from the thru mounting post. If the cover is loose or comes off too easily, check the condition of the thru compression rings (8).

d. Remove the three screws (10) that secure the bottom edge of the rear cover (12) to the base; then the four screws (11) that attach the rear cover to the front and rear end caps. Pull the rear cover from the projector, taking care not to put too much strain on the leadwires to the switch and fuse plate (17). If any of electrical items on the switch plate are in need of replacement, unsolder or disconnect leads as necessary and remove the attaching parts for those items.

e. Remove the two screws (24) at the top of the projector mainplate and lift the top cover assembly (25) from the projector. The cover mounting brackets (25B) and the carrying handle (25C) are secured with four screws (25A). If the latch strikers (25F) are damaged, the rivets (25D) must be drilled out.

f. Items (27 through 30) normally are furnished as part of the complete mechanism assembly (item 29, Figure 5) and can be removed with that assembly if so desired (see paragraph 9). However, to prevent damage to these parts during other projector repairs, it may be advisable to remove them at this point. Pry the decorative insert (27) from the recess of the threading roller (29); then remove the retaining ring (28) and disassemble the threading roller (29) from the end of the sound drum shaft. Unscrew the loop restorer knob (30) from the shaft of the loop restorer arm.

4. REMOVAL OF END CAPS AND LAMPHOUSE (Figure 2). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. While observing through the drill hole in the underside of the raised boss of the front end cap, rotate the tilt knob (2) until the setscrew (1) is visible. Loosen the setscrew and disassemble the tilt knob from the end of the tilt worm shaft.

b. Swing open the lamphouse assembly (5) and pull the control knob (3) from the main switch shaft. Remove the three screws (4) which attach the hinge bracket of the lamphouse and the air deflector (6) to the mainplate. Washers (4A) are used only on the top and bottom screws. Do not remove the grip ring (3A) from the switch shaft.

c. Remove the retaining ring (8) and disassemble the exit roller (9) from the roller stud (10). Inspect the stud for nicks or burrs and, if damaged, unscrew the stud from the projector base.

d. Snap down the wire clamp that holds the projection lamp (11) in place and pull the lamp straight up from its socket. Do not wriggle or twist the lamp as this may distort the lamp contacts. Unless damaged and in need of replacement, do not remove the lampholder assembly (13). Special gages and fixtures are required to realign the lampholder. Three screws (12) secure the lampholder to the mainplate and two push-on wire connectors must be disconnected from the lamp holder terminals.

NOTE: Components which are mounted to the projector end caps (17) and (22) can be replaced without removing the end caps from the projector. These components will vary with the projector model being repaired, and variations are clearly indicated by the code letters in the "Usable on Code" column of the parts list. If either or both of the end caps is to be replaced, proceed as follows.

e. Disconnect leadwires from end cap electrical components. Tip the projector carefully to expose the underside of the base and remove the two screws (15) or (21) that secure the end cap assemblies (17) and (22) respectively to the base. Note the spacer (16) assembled to the screw (15) at the front corner location. Return the projector to the upright position and remove two each of screws (15) and (21) which are inserted through the mainplate and into the speed nuts of the two end cap assemblies. Lift off the end caps.

5. REMOVAL OF ELECTRICAL PARTS (Model 1580 Projectors) (Figure 3A). Before removing electrical components, note the manner in which the leadwires are routed and tied. The pictorial wiring diagrams at the rear of the Parts Catalog will assist in the proper reconnection of leadwires.

a. Lift the fuse (1) from the fuseholder. If the fuseholder (3) is to be replaced, unsolder the leads from the fuseholder terminals and remove the screw (2) that secures the fuseholder to switch bracket (5). Loosen the setscrew (4A) and withdraw the cam (4B) from the function switch shaft.

b. All leadwire connections to the rotary switch (8) are made by means of push-on connectors. If the switch is to be replaced, disconnect the leads and remove the three screws (4) that secure the switch bracket (5) to the mainplate; then remove the locking nut (6) and lockwasher (7) and disassemble the switch (8) from the bracket.

NOTE: If the two transformers (12) and (19) are not to be replaced but must be temporarily moved to gain access to other parts, such as the sound drum flywheel, this can be accomplished in the following manner: Tilt the projector to expose the underside of the base and remove the amplifier cover (item 5, Figure 5); then remove the two screws (17) inserted through the base and into the lamp transformer bracket. Return the projector to upright position and remove the screws (18) that secure the lamp transformer brackets to the tapped holes in the base. Carefully move the assembled transformers aside. Individual replacement of the transformers is covered in steps c and d, following. The amplifier cover (item 5, Figure 5) must be removed for access to the wiring connections (see appropriate wiring diagram).

c. To replace the power transformer (12), unsolder the leads of the power transformer from the appropriate pin terminals of the amplifier edge connector (item 9, Figure 5) and from the fuseholder (item 3, Figure 3A); then remove the twist

connector nut to free the remaining wire lead. Remove the two nuts (9), screws (10) and lock-washers (11) at the upper ends of the brackets (15) and (16) and lift out the power transformer. The brackets (15) and (16) are secured to the top of the lamp transformer (19) with two hex nuts (13) and screws (14) and need not be removed unless the lamp transformer is to be replaced.

d. To replace the lamp transformer assembly (19), first remove the power transformer (step c, preceding). Disconnect the transformer leads from the lampholder and rotary switch and from the twist connector nut. Tilt the projector to expose the underside of the base and remove the two screws (17) inserted through the base and into the lamp transformer brackets. Return the projector to upright position and remove the two screws (18) that secure the brackets to the base.

e. Remove the three screws (20) that attach the right-hand blower housing (23) to the left-hand blower housing (37). Note the wire tie-down on the top inner screw. Remove the two screws (22) that secure the right-hand housing to the base and lift off the housing. Loosen the two setscrews (24) in the fan hub and disassemble the blower fan from the motor shaft. The drive belt (26) can be removed at this point if desired.

f. If the line cord (29) is to be replaced, disconnect its black and white leads from the twist connector nuts and remove the screw (27) that secures the green ground lead to the projector base. Disassemble the Heyco bushing (28) from the bracket assembly (32) and remove the line cord. Free the leads of the thermal fuse and sleeve assembly (30) from the twist connector nuts and remove the fuse assembly from under the spring clip of the bracket assembly (32).

g. Loosen the nuts on the motor bracket straps (31) and disassemble the straps and bracket assembly (32) from the motor mounting brackets (39). Disconnect the red and blue motor leads from the starting capacitor on the rear end cap and free the yellow motor lead from the twist connector nut. The green motor ground lead is secured by one of the screws that attaches the front motor mounting bracket to the base. Lift the motor assembly (33) from the mounting brackets. Loosen two setscrews (34) and disassemble the motor pulley (35) from the motor shaft.

NOTE: The left-hand blower housing (37) and motor mounting brackets (39) need not be removed unless damaged and in need of replacement.

6. REMOVAL OF ELECTRICAL PARTS (Model 1680 Projectors, Figure 3B). Before removing electrical components, note the manner in which the leadwires are routed and tied. The pictorial wiring diagram at the rear of the Parts Catalog will assist in the proper reconnection of leadwires.

a. Slip the drive belt (1) from the mechanism and motor pulleys. Replace fuses (2) as necessary. Disconnect the leadwire lugs from the terminal pins of the fuse board (4). Remove two screws (3) that attach the fuse board to the motor mounting brackets and lift out the board.

b. Disassemble the capacitor (6) from the terminal lugs of the function switch (12). Disconnect the remaining leadwire lugs from the function switch and free the two leadwires from the wire clamp and sleeve (8) beneath the switch bracket screw (7). Loosen the setscrew (8A) and withdraw the cam (8B) from the front end of the function switch shaft. Remove the three screws (7) and withdraw the assembled switch and bracket from the projector mainplate. Remove the nut (10) and lockwasher (11) and disassemble the switch (12) from the bracket (9).

c. Refer to Figure 5. Carefully tip the projector so that the underside of the base is exposed and remove the five screws (item 4) that secures the amplifier cover (item 5) to the base. Remove the two screws (item 7) and spacers (item 8) that attach the amplifier (item 10) and disengage the amplifier from the edge connector (item 9) to expose the screws that secure the transformer to the base.

d. Hold the transformer (16, Figure 3B) securely while removing the four mounting screws (15) and return the projector to upright position. Remove the screw (13) that attaches the transformer ground lead to the front motor mounting bracket and disconnect the nylon leadwire connectors. Remove the nylon tie-wraps, as necessary, to free transformer leads and lift out the transformer.

e. Disconnect the motor leadwire nylon connector and remove the screw (13) that secures the motor ground lead to the rear motor mounting bracket. Remove four screws (17) and lift the motor (18) and brackets (19) from the projector base. Disassemble the brackets from the motor. Loosen the setscrews (20) and disassemble the pulley (21) from the motor shaft.

f. Disconnect the leads from the blower motor terminals. Remove the four screws (22) and lift the blower assembly (23) from the base. Remove three screws (23A) and separate the left-hand housing (23C) from the right-hand housing (23H). Loosen the setscrew (23D) and disassemble the fan (23E) from blower motor shaft. Remove three screws (23F) and lift the blower motor (23G) from the right-hand assembly.

7. REMOVAL OF REEL ARMS AND GEARS (Figure 4). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Remove the retaining ring (1) and disassemble the gear assembly (2) and, if present, the shim washer (3) from the rear reel arm shaft. This shim washer is occasionally required to align the

## SERVICE INSTRUCTIONS

gear teeth with those of the adjacent idler gear (24). Remove the second retaining ring (1) from the reel arm shaft.

b. Remove the retaining ring (4) and disassemble the spring tension washer (5), flat washer (6), reverse take-up clutch assembly (7), rewind gear (8) and retaining clip (9) from the front reel arm shaft.

c. Remove the retaining ring (10) from the projection of the take-up arm disc to free the loop end of the rewind cord assembly (11). Disconnect the hook end of the rewind cord from the extension spring (13) and disassemble both extension springs (12) and (13) from the projector. Remove the three screws (14) that attach the rewind cord bracket (15) and take-up arm disc (16) to the mainplate. Remove the three screws (17) that attach the front reel arm disc to the mainplate. The reel arms (19) and (20) can now be disassembled from the projector.

**CAUTION:** The lock buttons (21) and springs (22) will pop from position as the reel arms are removed. Be careful not to lose these items.

d. Remove the retaining rings (23) and disassemble the two large idler gears (24) and their washers (25) from the gear studs in the mainplate.

e. Remove the retaining ring (26) and disassemble the flat washer (27) and small idler gear (28) from the mainplate gear stud protruding through the rewind lever assembly (30). Note the manner in which the legs of the torsion spring (29) are engaged; then withdraw the rewind lever assembly from the stud and remove the torsion spring. Remove the two retaining rings (31) and disassemble the washers (32) and spur gears (33) from the studs of the rewind lever.

f. Remove the retaining ring (34) and disassemble the spring tension washer (35), D-hole washer (36), flat washer (37) and flywheel driver arm assembly (38) from the upper sprocket shaft. The drive gear assembly (40) and idler gear (41) are secured to the gear studs of the driver arm with retaining rings (39) and need not be disassembled unless in need of replacement. From the upper sprocket shaft, remove the drive gear (42), two mylar washers (43) and the idler gear and arm assembly (44). The idler gear (44B) need not be disassembled from the idler arm unless in need of replacement. Remove the retaining clip (45) from the sprocket shaft and disassemble the flat washer (46), rewind clutch assembly (47) and thrust washer (48) from the shaft.

g. If the lamp interlock switch (50) is to be replaced, unsolder the leads from the switch terminals and remove the two screws (49) that secure the switch to the mainplate. The flywheel drive arm stop (51) is screwed into a tapped hole in the mainplate and need not be removed.

8. REMOVAL OF BRAKE COMPONENTS (Figure 4A). Remove brake release components in the following manner, noting any special precautions.

a. Remove the two retaining rings (1) and disengage the ends of the brake release rod (3). Remove the rod with the torsion spring (2).

b. Unhook the tension spring (4) from the upper end of the brake arm assembly (9) and remove the cable (5).

c. Remove the screws (6) and washers (7) and disassemble the cam follower (8) and the arm assembly (9) and spring (10) from the tapped spacers (11) and cable sheave (12).

9. REMOVAL OF MECHANISM AND BASE COMPONENTS (Figure 5). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Tip the projector so that it is resting on its back edge (where the rear end cap is normally mounted). Remove four screws (1) and lift off the volume/tone control cover (2). The amplifier cover (5) is attached with five screws (4) and may already have been removed in earlier disassembly procedures.

b. Remove the two screws (6) that attach the edge connector (9) to the base and the two screws (7) and spacers (8) that attach the amplifier assembly (10) to the base. Refer to the appropriate wiring diagram for edge connector wiring connections to other projector components.

c. The complete volume and tone control assembly (12) is secured to the base with two screws (11). If either control (12E) or (12F) requires replacement, unsolder the leads from the control terminals; then pry off the control knob (12A) and remove the lock nut that secures the control to the bracket. The new control is provided with mounting parts.

d. Remove the retaining ring (13) from the end of the sound drum shaft. In some earlier models, you will find four flat washers (14) located between the ring groove and the flywheel (15). In current models, the ring groove is further from the end of the shaft and these washers are not required. Disassemble the flywheel, flat washer (16) and spring tension washer (17) from the sound drum shaft.

e. At the rear of the projector, disconnect the small edge connector (18) from the printed circuit board mounted at the bottom of the mechanism assembly. Move the exciter lamp release ring and lift the exciter lamp (19) from its socket. Wrap the lamp in tissue paper and set it aside.

f. Remove the screw (21) and washer (22) from the banana-slotted adjustment plate located above the exciter lamp area of the mechanism assembly (29). This plate is under spring tension and will

snap in a clockwise direction when the screw is loosened. Disassemble the gear adjustment bracket (26) from the mainplate and mechanism by removing the screw (23) and washer (24) from the left-side hole and the screw (25) from the right-side hole. Pry off the seal (27) located at the radial opening in the side flange of the mechanism housing. Support the mechanism assembly (29) while removing the two screws (28) at the rear of the mainplate. One is located near the center of the mainplate below the mechanism cut-out; the other just to the left of the sound drum shaft. Carefully lift the complete mechanism assembly from the mainplate. Be careful not to lose the torsion spring (30) assembled to the post adjacent to the roller in the lower left-hand corner of the mechanism assembly. Refer to Figures 8 through 11 for mechanism components and to paragraphs 12 through 15 for disassembly instructions.

g. The rubber feet (32) and flat washers (33) are secured to the corners of the base with screws (31). The tilt bar (35) is secured to the lower end of the tilt gear rack (42) with screw (34). Remove the screw (40) and gear rack adapter (41) and disassemble the gear rack (42) from the base. Remove the retaining ring (43) and lift out the gearshaft (44) and washers (45) and (45A). Tap out the spring pin (46) and lift out the tilt worm gear (47). Do not disassemble the mainplate (38) from the base (48) unless one or the other of these parts is damaged and in need of replacement.

h. Model 1680 Projectors Only. Remove mounting nut from the microphone jack (50) and disassemble the jack and washers (52) and (53) from the projector base. Unsolder the wire leads and the leads of the capacitor (51) from the jack terminals. The capacitor must be resoldered to the replacement jack. At the rear of the projector, disconnect the small edge connector (18) from the P.C. board of the soundhead. Disconnect the molded connector (56) from the pins of the servo-amplifier (55). Remove the two screws (54) and lift the servo-amplifier from the base.

10. **DISASSEMBLING THE FRONT REEL ARM** (Figure 6). Disassemble the front reel arm in the following manner, noting any special precautions.

a. Remove the two screws (1) and lift the reel arm cover (2) from the front arm (22). If shim washers (3) are located between the cover and reel arm mounting bosses, save shims for reassembly.

b. Remove the screw (4) and disassemble the feed spindle assembly (5) from the front reel arm. If spindle parts are damaged, loosen the setscrews (5A) and remove the gear (5B) and washer (5C) from the spindle (5D).

c. Remove the retaining ring (7) from the spring post in the reel arm to free the end of the torsion spring (10). Loosen the setscrews (8) and (8A) and lift the gear (9) and torsion spring (10) from the reel arm shaft (14). If damaged, disassemble the plastic sleeve (9A) from the gear hub.

d. Remove the two retaining rings (11) and disassemble the reel arm shaft (14) and washer (12) from the reel arm.

e. Remove the retaining ring (15) and withdraw the upper spur gear (16) from the gear shaft (20). Remove the two gear retaining clips (17), the washer (18) and the lower spur gear (19) and slide the gear shaft (20) from the bearing posts of the reel arm. Inspect the nylon bearings (21) and, if damaged, press them from the bearing posts.

11. **DISASSEMBLING THE REAR REEL ARM** (Figure 7). Disassemble the rear reel arm in the following manner, noting any special precautions.

a. Remove the two screws (1) and lift the reel arm cover (2) from the rear arm (31). If shim washers (3) are located between the cover and the reel arm mounting bosses, save shims for reassembly.

b. Press the take-up arm against the reel arm casting and slip the take-up belt (4) from the pulleys. Release the take-up arm slowly and catch the tension spring (5) as it drops free. Remove the screw (6) and disassemble the take-up spindle and pulley assembly (7) and shim washer (8) from the take-up arm. The take-up arm and rear reel arm are replaceable only as an assembly (31).

c. Remove the retaining ring (10) and large flat washer (11) from the end of the gear shaft (16). Remove the sleeves (12A) and (12B) from the hub of the gear (14). Loosen the gear setscrew (13) and disassemble the gear (14), the shim washer (15) and the gear shaft (16) from the reel arm.

d. Remove the retaining ring (17) from the spring post in the reel arm to free the end of the torsion spring (18) and lift the torsion spring from the hub of the upper face gear (27).

e. Remove the retaining ring (19) and slide the upper spur gear (20) toward the upper face gear (27) until the upper gear retaining clip (21) can be removed. Move the gear shaft (24) down until the upper spur gear (20) and washer (23) can be removed. Remove the lower gear retaining clip (21) and lower spur gear (22), and slide the gear shaft (24) from the bearing posts of the reel arm. Inspect the nylon bearings (25) and, if damaged, press them from the bearing posts.

f. Loosen the setscrew (26) and lift the upper face gear (27) from the reel arm shaft (30). Remove the retaining ring (28) and disassemble the reel arm shaft (30) and washer (29) from the reel arm (31).

12. **DISASSEMBLING THE MECHANISM** (Figure 8). Remove parts, as necessary, in the indexed order of disassembly, noting the following special precautions.

## SERVICE INSTRUCTIONS

a. Remove the four screws (1) and disassemble the fire shutter support bracket (2) from the mechanism housing. Remove the two screws (3) that attach the heat baffle (4) to the mechanism housing. Loosen the two setscrews (5) and disassemble the mechanism pulley (6) from the end of the camshaft.

b. Loosen two setscrews (7) and withdraw the load lever (8) from the load selector bushing. Disassemble the roller retainer (9) and entrance roller (10) from the post of the upper sprocket mounting plate.

c. Remove the screw (11) and disassemble the washer (12) and stabilizer roller (13) from the roller stud of the stabilizer arm assembly. Unscrew the lower lamphouse stop (14) from the tapped hole in the mechanism housing.

d. Remove two screws (15) and lift the impedance roller lifter assembly (16) from the lower right flange of the lens carrier. Note the manner in which the legs of the snubbing spring (19) are engaged before removing the screw (17) and spring retainer (18). Loosen the locking nut (20A) and disassemble the impedance roller assembly (20) from the post of the impedance roller arm. Note that impedance roller parts used on earlier Model 1580 projectors (items 21 through 24) are no longer available and must be replaced by current roller assembly P/N 016529.

e. When removing the two screws (27) that secure the printed circuit board (29) to the mechanism housing, note that a lockwasher (28) is used with only one of these screws. Unsolder the leads from the circuit board.

f. Loosen the screw (32) and carefully withdraw the optical slit assembly (33) from the bore of the mechanism housing. Loosen the setscrew (34) and carefully disassemble the light pipe retainer (35) and photocell assembly (36) from the mechanism housing. Remove the two screws (37) and withdraw the sound drum and shaft assembly (38) from the mechanism housing. Remove the two screws (39) and disassemble the exciter lamp contact assembly (40) and lamp release ring (41) from the mechanism housing.

g. Loosen two setscrews (42) and disassemble the upper helical gear assembly (43), tension washer (45) and grip ring (45A) from the upper sprocket shaft. Remove the upper sprocket assembly (46) and disassemble the thrust washer (47) from the shaft.

h. Loosen two setscrews (42) and disassemble the lower helical gear assembly (44) and spring tension washer (45) from the lower helical gear shaft (48). Remove the shaft from the mechanism housing with a slight rotary motion and disassemble the thrust washer (49) and retaining ring (50) from the shaft.

i. Loosen two setscrews (51) and disassemble the lower sprocket gear (50) and spring tension washer (53) from the lower sprocket shaft. Remove the lower sprocket assembly (54) and disassemble the thrust washer (55) and sprocket flange (56) from the sprocket shaft.

13. DISASSEMBLING THE MECHANISM (Figure 9). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Remove the retaining ring (1) and disassemble the disengagement plate assembly (2) from the shaft of the mode selector.

b. If the motor interlock switch (4) is to be replaced, disconnect the push-on connectors from the switch terminals and remove the two switch mounting screws (3).

c. Remove the grip ring (5) and disassemble the idler gear (6) from the idler gear shaft. Unhook and remove the counterbalance spring (7). Remove the screw (8) and disassemble the cap (9), the lower arm (10) and torsion spring (10A) from the mechanism housing. Remove the shoulder screw (11) and retaining ring (12) and lift the adjusting plate (12A), torsion spring (12B) and impedance roller arm (13) from the roller arm pivot (14). The roller arm pivot can be unscrewed from the housing with an open-end wrench.

d. Remove the retaining ring (15) from the ring groove at the upper end of the spring adjusting screw (18). Unscrew the adjusting screw from the mechanism housing, removing the bowed washer (16) and spring retainer (17) as they are freed.

e. Remove the grip ring (19) and disassemble the exit roller (20) from the stud of the snubber arm assembly. Remove the grip ring (21) and disassemble the washer (22) and film stripper (23) from the lower sprocket bearing. Remove grip ring (24), screw (25) and retaining ring (26) and lift the adjusting plate (27) from the shaft protruding through the sprocket plate. Remove the grip ring (28) that secures one loop of torsion spring (49) to the housing stud, and lift the assembled sprocket plate parts (29 through 47) from the mechanism housing. Remove grip ring (48) and disassemble the torsion spring (49) from the sprocket plate stud. The disassembly of lower sprocket plate components is purely mechanical and no special procedure need be followed.

f. Remove the retaining ring (50) and disassemble the washer (51), torsion spring (52) and snubber arm assembly (53) from the mechanism housing stud. Unscrew the snubber stop post (54) from the mechanism housing. Remove the retaining ring (55) and disassemble the retention pawl assembly (56) from the mechanism housing shaft.

14. DISASSEMBLING THE MECHANISM (Figure 10). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Remove the retaining ring (1) from the inner (left) end of the lower carrier guide pin (2). Withdraw the pin and second retaining ring (1) from the carrier and mechanism housing pivot holes with a slight rotating movement. Remove both retaining rings (5) from the upper carrier guide pin (6) and, while supporting the carrier assembly (3) with one hand, withdraw the upper guide pin with a slight rotating movement. Remove the lens carrier assembly from the mechanism housing and disassemble the shifting link (4) from the pivot hole in the lens carrier. See step b, following, for lens carrier disassembly.

b. Remove two screws (3A) and disassemble the pressure plate (3B), two springs (3C) and two spacers (3D) from the lens carrier. Unless visibly damaged and in need of replacement, do not remove the adjustment plate (3G), nor loosen its mounting screws (3E). Remove two screws (3H) and disassemble the focus shaft retainer (3J) and focus knob assembly (3K) from the lens carrier. Inspect the nylon bearings (3L) and, if badly worn, press them from the lens carrier.

c. Remove the retaining ring (7) and disassemble the torsion spring (8) from the entrance roller shaft. Remove the grip ring (9) and disassemble the torsion spring (10) from the sprocket and loopformer plate (21). Remove the screw (11), and disassemble the upper sprocket guard (12), guide roller (13) and torsion spring (14) from the sprocket guard pivot shaft.

d. Remove the grip ring (15) and disassemble the upper idler roller (16) from the sprocket guard roller shaft. Remove the screw (17) and disassemble guide roller (18) from the sprocket guard roller shaft. Remove the grip ring (19) and washer (20) and lift the sprocket and loopformer plate assembly (21) from the mechanism housing. Lift the assembled mode selector latch (24) and latch bracket (23) from the bushing of the plate assembly (21). Disassemble, if required, by removing the screw (22) that secures the latch to the bracket.

e. The grip ring (27) is used to captivate the leg of the torsion spring (29) on top of the mechanism housing boss. Remove the screw (25) and washer (26) and lift the mode selector bushing (28) from the selector shaft. Disassemble the torsion spring (29) from the shear form of the bushing.

15. DISASSEMBLING THE MECHANISM (Figure 11). Remove parts, as necessary, in their indexed order of disassembly, noting the following special precautions.

a. Remove two screws (1) and carefully lift the aperture plate assembly (2) from the mechanism housing. The aperture plate components can be

cleaned while assembled and disassembly is not necessary unless parts replacement is required. When removing slotted head screws, be very careful that the screwdriver does not slip and scratch the rails or aperture plate.

b. Unscrew the shutter nut (3) from the camshaft with an open-end wrench while gripping the flats of the camshaft with a second wrench. Disassemble the counterbalance weight (4), the shutter (5) and the shutter gasket (6) from the camshaft.

c. Disassemble the extension spring (7) and lubricating wick (8) from the shuttle arms. If the wick appears to be excessively dirty, remove it from the coils of the spring.

d. Disengage the shuttle (10) from the link bearings (14A) at the ends of the shuttle arms (14), and slide the pull-down cam (9) from the camshaft. Inspect shuttle teeth for excessive wear or damage. Remove both shuttle arm and stud assemblies simultaneously from the projector. Unless obviously in need of replacement, do not disassemble the ball and stud assemblies (12), shuttle link bearing (14A) or cam follower (14B) from the shuttle arms. The cam follower is staked into the recess of the shutter arm and can be reversed or turned end-for-end if badly worn.

e. Remove two screws (15) and disassemble the in-out bracket (16) and in-out cam (17) from the camshaft. The cam follower (16A) can be unscrewed from the nut staked to the in-out bracket. Check for the presence of the tension spring (16B). Remove two screws (18) and lift out the shuttle arm plate assembly (19). Inspect the bearing support (19A) and replace if the bearing surface is badly scratched.

f. Loosen the two setscrews (20) and disassemble the threading knob (21) from the end of the camshaft (23). Remove the retaining ring (22) from the recess in the long cast arm of the mechanism housing. Loosen two setscrews (24) in the worm gear (25). Tap lightly against the short end of the camshaft (23) to force the large ball bearing (27) from the bearing hole in the long cast arm. As the camshaft (23) is withdrawn, remove the worm gear (25). To replace the large bearing (27), remove the retaining ring (26) and disassemble the bearing from the shaft with a bearing puller. Remove two screws (28) and the loading spring (29) and press the small ball bearing (30) from the short cast arm.

g. The framer shaft stop pin (31) is pressed into the mechanism housing and need be pulled out only if the framer knob and shaft assembly (32) is to be replaced.

16. REPAIRING FRONT COVER AND SPEAKER ASSEMBLY P/N 016507 (Models 1580CS and 1680US) (Figure 12). No special instructions or precautions are necessary for the repair of the front cover

and speaker assembly except for removing and re-riveting the cover latches (4). The baffle and speaker assembly (8) is secured inside the cover with seven Tinnerman nuts (7), and the removal of the speaker and other components can be accomplished quite easily. A wiring connection diagram is included in Figure 12.

17. REPAIRING FRONT COVER AND SPEAKER ASSEMBLY P/N 016698 (Models 1680BC and 1680EC) (Figure 13). No special instructions or precautions are necessary for the repair of the front cover and speaker assembly except for removing and re-riveting the cover latches (4). The baffle and speaker assembly (8) is secured inside the cover with seven Tinnerman nuts (7), and the removal of the speakers

and other components can be accomplished quite easily. A wiring connection diagram is included in Figure 13.

18. TESTING AND REPAIRING THE AMPLIFIER ASSEMBLY. Amplifier circuit board repairs are not recommended except as an emergency measure and then only if qualified electronics personnel and test equipment are available. Using standard electronic shop test equipment and techniques, check the amplifier assembly and its components for continuity and for shorts and open circuits. Refer to the appropriate wiring diagram for voltages and ratings of components and for test points. If a faulty condition is traced to the amplifier, replace the complete assembly.

## *Reassembly Procedure*

### 19. GENERAL REASSEMBLY INSTRUCTIONS.

a. Before reassembling parts, be sure to clean them thoroughly. Metal parts can be immersed in a pan of non-flammable solvent or wiped with a cloth dampened with solvent; then blown dry with a low pressure jet of compressed air or dried with a lint-free cloth. Do not clean plastic or electrical components with solvent. Simply wipe plastic and electrical components with a clean, dry cloth. Clean optical parts with a good quality lens cleaner and lens tissue or a lint-free cloth.

b. When reassembly procedures include staking or riveting operations, it is wise to perform these operations before reassembling other parts. Be sure to support the major casting or plate solidly during staking operations to avoid distorting the casting or plate.

c. When installing electrical components, refer to the appropriate wiring diagram at the rear of the Parts Catalog for the proper connection of leadwires. Do not attempt amplifier component replacement. Refer to paragraph 18 for testing of the complete amplifier.

d. Most of the nameplates and the instruction plates are provided with an adhesive backing. Make certain that the area to which such parts are to be secured is thoroughly clean by wiping with a cloth dampened with solvent. Remove the protective paper backing and brush the adhesive with a mixture of three parts Tulouol to one part of trichloroethylene. When the adhesive is tacky, press the nameplate carefully but firmly in place. Wipe away any excess adhesive with a cloth dampened with solvent.

e. Lubrication instructions are provided in the Introduction section of this service manual. Do not over-lubricate. Apply grease and oil sparingly as indicated, and wipe away any excess lubricant with a lint-free cloth. Gears should be lubricated by specking the gear teeth and then running the projector for a few moments to distribute the grease. Where oil is indicated a drop or two will usually suffice.

20. REASSEMBLING THE MECHANISM (Figure 11). Reassemble Figure 11 parts in the following manner, noting any special precautions.

a. If it was necessary to replace one or more exciter lamp mounting pin parts, assemble the spring (33C) and bushing (33B) up into the opening in the casting; then insert the small end of the lamp mounting pin (33A) down through the spring and force it carefully through the tip of the bushing. Lightly grease the threads and pilot diameter of the framer knob and shaft assembly (32) and screw it down into the threaded hole in the top of the mechanism housing (33). Orient the stop pin (31) so its flat is toward the framer shaft and press or tap it into the small hole in the housing. Check the action of the framer shaft.

b. Lightly grease the bearing hole in the short cast arm of the mechanism housing and assemble the small ball bearing (30) into the bearing hole. Assemble the bearing loading spring (29) to the short cast arm so that its two formed lugs are in contact with the bearing housing. Align the screw holes and install and tighten the two screws (28).

c. Assemble the large ball bearing (27) over the unthreaded end of the camshaft (23) and press the bearing in place until seated against the shoulder of the camshaft. Assemble the retaining ring (26)

to the camshaft with the concave side of the ring toward the bearing. Press the retaining ring until it flattens against the bearing and snaps into the ring groove in the camshaft. This can best be accomplished with a metal tube approximately 4-1/2 inches long and whose inner diameter is slightly larger than the camshaft.

**NOTE:** If the retaining ring becomes distorted and is not firmly seated in the groove, carefully remove the ring and install a new one.

d. Lightly grease the bearing hole in the long cast arm of the mechanism housing. Loosely assemble the setscrews (24) to the hub of the worm gear assembly (25). Insert the unthreaded end of the camshaft through the greased bearing hole and assemble the worm gear to the camshaft, gear hub toward the short cast arm. Insert the end of the camshaft through previously assembled bearing (30), and assemble the large bearing (27) into the greased bearing hole. Use a metal tube and tap lightly until the bearing is seated against the shoulder in the mechanism housing cast arm. Assemble the retaining ring (22) over the camshaft, convex side toward the bearing. Using the metal tube, tap lightly with a mallet to seat the retaining ring in the ring groove of the cast arm. Assemble the threading knob (21) to switch bearing end of the camshaft and tighten the two setscrews (20).

e. Place the worm gear spacing gage (Figure A) between the hub of the worm gear and the short cast arm of the mechanism housing. Push and hold the worm gear against the spacing gage while tightening the worm gear setscrews securely; then remove the gage.

f. Turn the framer knob and shaft assembly to the extreme 'up' position. Screw the bearing support (19A) all the way into the staked nut on the shutter arm plate assembly (19). Assemble the plate assembly over the camshaft with the plate assembly tilted slightly to the left; then rotate the plate assembly clockwise until the prongs at the end of the framer arm engage the recessed portion of the framer shaft. Align the notches in the plate assembly with the screw holes in the cast arm and install and tighten the two screws (18).

g. Lightly oil the two pivots of the in-out bracket assembly (16). Assemble the in-out cam (17) to the bracket assembly so that the nylon pad of the cam follower (16A) will ride against the polished surface of the cam. Assemble the cam and bracket assembly over the camshaft and secure the bracket to the base of the long cast arm with the two screws (15). Tighten the screws securely.

h. If the lubricating wick (13) was replaced, saturate the new wick with oil and allow excess to drain away; then apply grease to both sides of the wick and assemble over the two shuttle arms (14). Assemble the ball and stud assemblies (12) to the ends of the shuttle arms with the hex nuts (11). Lightly

grease the two ball sockets on the shuttle arm plate assembly (19). Assemble the shutter arm group to the mechanism housing, guiding both shuttle arms simultaneously through the upper and lower shuttle guide shoe slots of the in-out bracket (16). Position the balls (12) in the sockets of the nylon pads of the plate assembly (19), and check to see that the tab of the wick (13) is contacting the in-out cam. Assemble the shuttle (10) to the notches at the ends of the shuttle arms. The shuttle teeth must extend toward the aperture plate position with the tooth "form" toward the camshaft.

i. Orient the in-out cam (17) so that the tab at the bottom of the cam engages the slot in the camshaft flange. Assemble the pull-down cam (9) to the camshaft so that the groove nearest the elongated holes in the inner face of the cam fits over the mating protrusion of the in-out cam. Squeeze the shuttle snugly against the shuttle link bearings (14A). Pack additional grease between the lubricating wick (13) and pull-down cam (9) and in the slots of the shuttle guide shoes. Saturate the round wick (8) with grease and assemble it into the center of the extension spring (7). Hook the ends of the spring into the notches of the shuttle arms, with the spring coil resting against the flat wick (13). Cams and shuttle arms are shown assembled in Figure B.

j. Back out the bearing support (19A) until its socket-like nylon pad rests squarely on the ball of the upper shuttle arm stud assembly (12). If the pad is slightly off-center, loosen the shuttle arm plate attaching screws (18) and shift the plate to obtain proper alignment. Adjustment of the lower ball can be made by loosening the hex nut (11) and shifting the ball stud (12) on the shuttle arm.

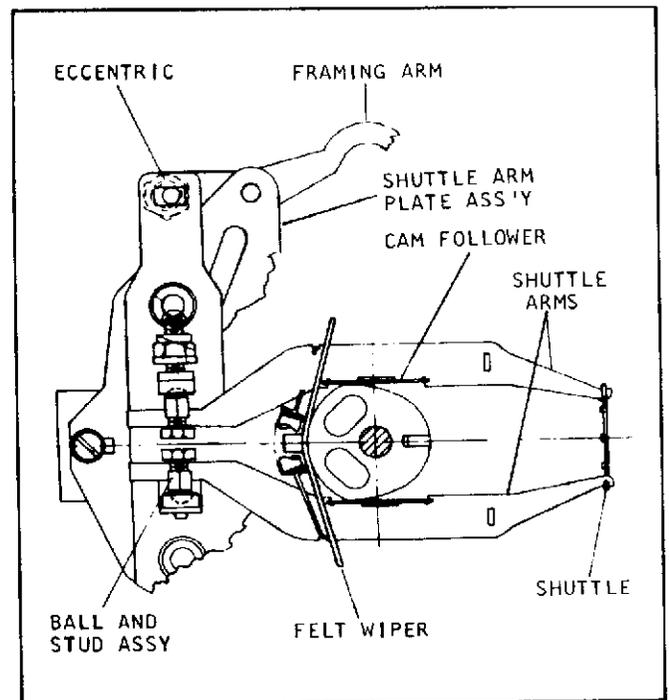


Figure B. Shuttle Arms and Cams Assembled

## SERVICE INSTRUCTIONS

k. Assemble the shutter gasket (6) over the camshaft and up against the pull-down cam, with the slot in the gasket aligned with the slot in the cam. Assemble the shutter (5) over the camshaft with the small diameter form down against the pull-down cam. Align the hole in the shutter with the hole in the gasket. Assemble the counterbalance weight (4) so that its formed lug engages the slots in the shutter, gasket and pull-down cam. Assemble the shutter nut (3) to the camshaft with its shoulder diameter down and seated in the inner diameter of the weight. Grip the flats at the end of the camshaft with an open-end wrench and tighten the shutter nut securely (12 in/lbs torque).

l. Assemble the side tension spring (2G) and film tension rail (2F) to the aperture plate (2H). The ends of the spring must engage the notches of the tension rail and the center of the spring must bear against the inner side of the pin staked to the aperture plate. Assemble the two bushings (2E) into the mounting holes of the rail and secure all parts with the spring retaining cover (2D) and two screws (2C). Secure the film guide rail (2B) to the aperture plate with two screws (2A). Manually rotate the camshaft until the shuttle teeth are retracted. Lift the aperture plate assembly (2) up into position against the mechanism housing and install the two screws (1) snugging up the screws enough to hold.

NOTE: Final alignment of the aperture plate and shuttle will be described in the Adjustment section of this manual.

21. REASSEMBLING THE MECHANISM (Figure 10). Reassemble Figure 10 parts in the following manner, noting any special precautions.

a. Lightly grease the entire mode selector post. Assemble the torsion spring (29) to the mode selector bushing (28), with the long end of the spring up and the spring coil over the formed tab of the bushing. Assemble the bushing and spring over the mechanism housing shaft, rotating slightly to distribute the grease. Engage the free end of the spring over the small boss of the mechanism housing and press the bushing in flush against the shoulder of the shaft. Retain the end of the spring on the mechanism housing boss with the grip ring (27). Assemble the washer (26) inside the mode selector bushing and over the end of the mode selector shaft. Assemble the screw (25) into the tapped hole in the shaft to retain the selector bushing.

NOTE: To facilitate the reassembly of mechanism components, the load lever (item 8, Figure 8) should be installed at this point. Preassemble the setscrews (7, Figure 8) to the lever and, with the lever pointing toward the aperture plate, insert the shaft into the mode selector bushing, the flats engaging the slot of the bushing. Tighten the two setscrews.

b. Hold the latch support bracket (23) with its formed tab down and the tapped screw hole toward you. Place the selector latch (24) on top of the bracket with its tab also down and toward you and with the screw hole in the bracket centered in the slot of the latch. Install and tighten the screw (22) to retain this position for later adjustment. Assemble the latch and bracket, formed tabs down, over the bushing diameter of the sprocket and loop-former plate assembly (21). With the load lever in the horizontal position, assemble this group of parts to the shaft in the upper right-hand corner of the mechanism housing (entrance roller shaft). The large diameter slot must locate over the upper sprocket bearing and the open slot must engage the pin of the mode selector bushing. Wipe both sides of the washer (20) with oil and assemble the washer and grip ring (19) to the upper sprocket bearing. There must be a minimum amount of end play in the sprocket plate.

c. Assemble the guide roller (18), counterbore out, to the roller shaft of the sprocket plate. Assemble the screw (17) into the threaded hole of the shaft until the screw head is located in the counterbore of the roller. Assemble the idler roller (16) to the shaft at the left end of the sprocket plate and secure the roller with the left end of the sprocket plate and secure the roller with the retaining ring (15). Spin both rollers to check for free rotation. Assemble the torsion spring (14) to the sprocket guard pivot shaft with the right angle leg inward and hooked over the left edge of the sprocket plate. Assemble the guide roller (13) to the sprocket guard (12), with the flat on the outer diameter of the roller toward the front of the guard. Assemble the sprocket guard and roller to the pivot shaft and install the screw (11) approximately two turns. Lift the outer leg of the spring (14) and release it on top of the sprocket guard. Disengage the inner leg of the spring from the edge of the sprocket plate and pull it to the right to engage it in the hole in the plate. Push the sprocket guard and roller in flush against the shoulder of the shaft and tighten the screw (11) securely. Lift and release the sprocket guard several times to check the spring return action. Assemble the torsion spring (10) between the sprocket plate and mechanism housing, with the loop end of the spring over the small mechanism housing boss (below the framer knob) and the straight leg inserted up through the triangular opening in the sprocket plate. Secure the loop end of the spring to the boss with the grip ring (9). Check the function of the spring by moving the load lever back and forth between the open and closed position.

d. Assemble the torsion spring (8) to the entrance roller shaft and down against the sprocket plate. Hook the small width end loop of the spring over the top of the sprocket plate and the large width end loop over the right edge of the assembled mode selector latch and bracket. Assemble the retaining ring (7) into the groove of the entrance roller shaft to secure the spring. Actuate the load lever to check the operation of the sprocket plate and mode selector latch.

e. Lightly grease the notches of the retainer (3J), the teeth of the focus knob shaft (3K) and the focus shaft support notches of the lens carrier (3M). Assemble the focus knob and shaft assembly and retainer to the lens carrier with the two screws (3H). Rotate the knob to check freedom of operation. Place the pressure plate (3B) on a protective pad, polished surface down and forked end of the pressure plate to the left. Carefully place the spacers (3D) and tension springs (3C) over the screw holes in the pressure plate. Insert the screws (3A) through the outermost holes in the adjustment plate (3G). Carefully guide the screws through the springs and spacers and into the tapped holes in the pressure plate, tightening them securely. Insert the adjustment plate inside the bore of the lens carrier assembly and loosely install the two screws (3E) with washers (3F). Insert the lens plug (Figure A) into the lens bore of the lens carrier, shifting the pressure plate until the rectangular boss of the plug enters the rectangular opening in the pressure plate. Hold the plug while tightening the two screws securely (8 in/lbs minimum); then withdraw the lens plug. Assemble the two nylon bearings (3L) into the guide pin bosses of the lens carrier, with the large diameter shoulder of the bearings to the outside of each boss.

f. Insert the ring-grooved end of the upper guide pin (6) through the upper guide pin bosses of the mechanism housing with a rotating movement. Assemble the retaining rings (5) into the ring grooves on either side of the inner boss. Assemble a retaining ring (1) to one end only of the lower guide pin (2). Lightly grease the long formed end of the link (4) and insert this end into the pivot hole of the lens carrier (inside surface, opposite the focus knob). Move the load lever to the "half-open" position and lift the lens carrier assembly (3) up into place. The shaft at the upper right corner of the lens carrier must engage the fingers of the mode selector arm and the slot in the right side boss against the upper guide pin. While holding the lens carrier in position, insert the lower guide pin through the mechanism housing boss, then through the carrier nylon bearings (use a rotating movement to ease pin through bearings), and finally into and through the second housing boss. Assemble the second retaining ring (1) to the inner end of the guide pin. Move the load lever back and forth from open to closed position to check the free movement of the lens carrier.

**22. REASSEMBLING THE MECHANISM (Figure 9).**  
 Reassemble Figure 9 parts in the following manner, noting any special precautions.

a. Assemble the retention pawl assembly (56) to the shaft in the lower left-hand corner of the mechanism housing. The long end of the pawl bushing must face out, away from the casting. Secure the pawl with the retaining ring (55). Screw the snubber stop post (54) into the tapped hole in the housing above and to the left of the retention pawl shaft.

b. Assemble the snubber arm assembly (53) to the shaft directly above the retention pawl shaft so that the extension of the arm rests on the top of the stop post. Install the torsion spring (52) to the shaft with the short leg in and hooked about the left edge of the snubber arm and the long leg beneath the stop post and hooked into the groove just behind the hex head of the stop. Secure the assembly with washer (51) and retaining ring (50).

c. Assemble the idler roller (35), large diameter flange down, to the larger shaft of the loop restorer arm assembly (37) and secure the roller with the grip ring (34). Place the large loop of the torsion spring (38) over the right side shaft of the loop restorer arm with the spring tangs toward the idler roller. Hook the inner tang through the slot in the restorer arm. Over the same shaft, assemble the loopformer roller plate (47), spreading the spring (38) so that the loop encircles the hub of the roller plate shaft. Hook the remaining spring tang over the top edge of the plate. Be sure that the small banana slot in the upper corner of the roller plate engages the short shaft to the right of the idler roller. Install the retaining ring (36) to retain the plate on this short shaft. Assemble the guide roller (33), counterbore up, to the restorer arm shaft. Assemble the washer (32) into the counterbore and secure all parts with the screw (31). Assemble this group of parts to the lower sprocket guard plate assembly (46) by engaging the hole in the lower left corner of the roller plate (47) over the shaft below and to the left of the large banana slot. With the roller plate seated on the sprocket plate, install the retaining ring (45) to secure all parts. Assemble the roller (44), counterbore up, to this same shaft and secure the roller with the screw (43). Assemble the torsion spring (42) to the shaft at the right of the banana slot, with the short tang of the spring down and into the small hole to the left of the long shaft. Push the loop of the spring over the shoulder of the shaft and down against the sprocket plate. Assemble the roller (41), long angle down, into the cavity of the sprocket guard (40). Install this assembly on the sprocket plate shaft until freely seated against the shoulder of the shaft. Use a spring hook to pull long tang of the spring to the left of the shaft and under the sprocket guard. Release spring hook so the tang of the spring hooks against side of sprocket guard. Secure the assembly with the screw (39).

d. Assemble one loop of the spring (49) to the small mechanism housing stud just to the left of the exciter lamp mounting boss. The remaining loop should extend to the right. Secure the spring loop to the stud with the grip ring (48). Lightly grease the area around the lower sprocket bearing, the elongated "banana" boss and the sprocket plate pivot post to the right of the banana boss. Also grease the lower formed end of the shifting link extending down from the lens carrier. Lift the complete lower sprocket plate assembly (29) up into position on the mechanism housing in the following manner: The hole at the "hump" of the sprocket plate to assemble over the sprocket plate pivot post; the shaft at

the far right end of the sprocket plate to be inserted through the free loop of the spring (49) and short elongated slot to the left of the exciter lamp boss; the lower formed end of the shifting link to protrude through the sprocket plate hole below and to the left of the pivot post; and the large, mating banana slots in the sprocket and loopformer roller plates to seat over and against the lower sprocket bearing. With the plate assembly fully seated, secure the free loop of the spring (49) by assembling the retaining ring (28) to the sprocket plate shaft. Assemble the adjusting plate (27) to the sprocket plate pivot post with center hole engaging the lower formed end of the shifting link and the banana slot centered over the tapped hole in the sprocket plate. Assemble the screw (25) into the tapped hole, snugging it up just enough to secure the adjusting plate. Assemble retaining ring (26) to the groove in the pivot post and grip ring (24) to the end of the shifting link.

e. Assemble the film stripper (23) with the flat side of the large diameter hole over the lower sprocket and the formed arm to the right. Assemble the flat washer (22) against the film stripper and secure these parts with the grip ring (21). Assemble the exit roller (20), large flange in, to the stud at the lower end of the snubber arm (53). Lift the arm slightly so the roller can seat against the shoulder of the stud, and secure the roller with the grip ring (19).

f. Loosen the screw (25) in the adjusting plate (27). Insert the pin end of the sprocket plate adjusting tool (Figure A) down into the slot of the sprocket plate and with the large diameter of the tool fitting into the adjustment plate hole above the slot. Slowly rotate the tool clockwise to the point where resistance is noted. Do not use force to rotate the tool beyond the point of resistance. Hold the tool steady while tightening the screw (25) securely (10 in/lbs minimum). Remove the adjusting tool.

g. Assemble the spring adjusting screw (18) down into the upper hole in the mechanism housing until the lower end is approximately halfway to the pivot hole in the floor of the housing. Hold the spring retainer (17) in line with the end of the screw and its formed end against the wall of the housing, open side down (see Figure C). Turn the screw into the threaded hole of the retainer until the end of the screw is approximately 1/4-inch from the pivot hole. Hold the bowed washer (16), convex side up, over the pivot hole and screw the adjusting screw down the rest of the way. Assemble the retaining ring (15) into the groove of the adjusting screw beneath the top wall of the housing.

h. Screw the impedance roller arm pivot (14) into the tapped hole of the mechanism housing until the hex shoulder is firmly seated against the housing. Assemble the impedance roller arm assembly (13) to the shaft of the pivot (14) and with the tapped center stud of the arm inserted through the slot in the housing. Assemble the spring (12B), long leg down, and the adjustment plate (12A) to the pivot

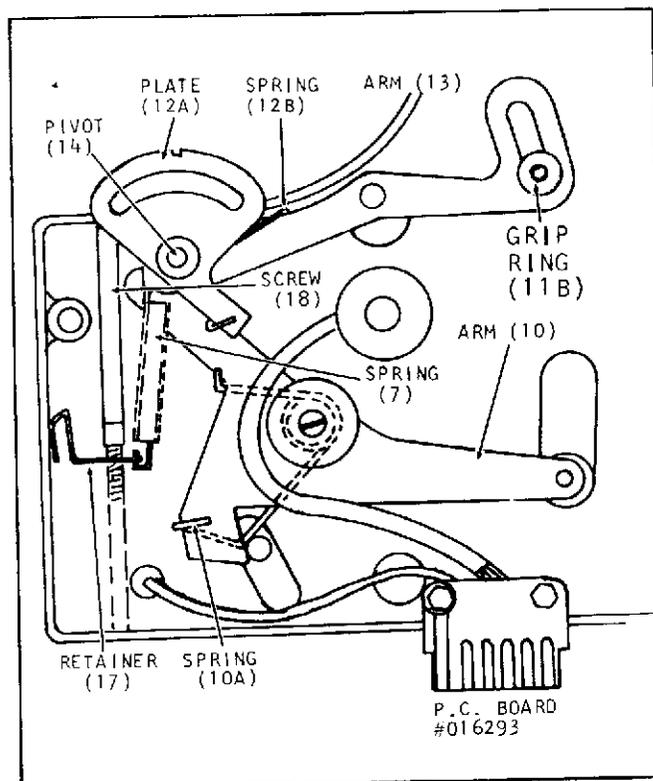


Figure C. Arms and Counterbalance Spring Installed

and secure with retaining ring (12). Hook spring legs as shown in Figure C. Secure slotted end of arm (13) with stud (11), washer (11A) and grip ring (11B).

i. Assemble the torsion spring (10A) and lower arm assembly (10) as shown in Figure C, with the long shaft at the end of the arm protruding through the large banana slot in the housing. Oil the inside of the cap (9) with a good quality silicone oil and assemble it over the large pivot bushing of the arm. Install the screw (8) into the tapped hole in the mechanism housing shaft and tighten securely. Hook the circular loop of the counterbalance spring (7) up through the hole in the end of the spring retainer (17); the other end over the hook-like tip of the stabilizer arm (see Figure C). Move the arm up and down to check spring engagement.

j. Lightly grease the mechanism housing idler gear shaft and assemble the idler gear (6), hub first, to the shaft. Insert a 0.005 inch shim between the hub of the gear and the mechanism housing and install the grip ring (5), pressing the ring against the gear until end play is removed.

k. Assemble the motor interlock switch (4), switch button facing up, to the housing with the two screws (3). Tighten screws just enough to retain the switch. Be sure that the switch button is positioned under the formed tab of the mode selector support bracket. Move the load lever counterclockwise so that the selector latch tab is positioned at the halfway point

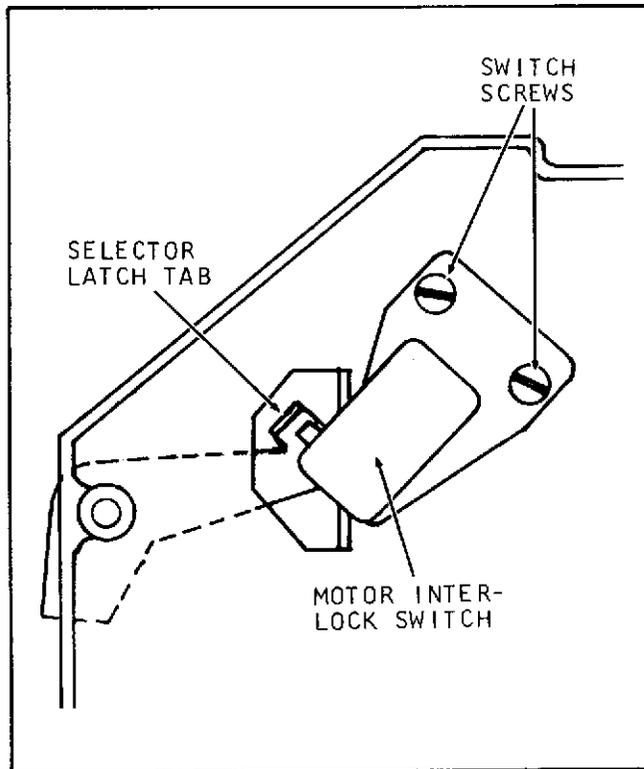


Figure D. Adjusting Motor Interlock Switch

on the radius of the mode selector arm (see Figure D). Loosen the two switch screws slightly and, with a 0.020 inch feeler gage between the switch button and tab, rotate the switch until the button contacts the feeler gage. Hold the switch securely to maintain this clearance while tightening the switch screws securely (6 in/lbs minimum).

1. Assemble the gear disengagement plate assembly (2) to the housing shaft below and to the left of the interlock switch. The long shaft of the plate assembly must be up and the short shaft must be protruding through the slot in the housing. Make certain that the short shaft does not interfere with the operation of the mode selector spring. Secure the plate assembly with the retaining ring (1).

23. REASSEMBLING THE MECHANISM (Figure 8). Reassemble Figure 8 parts in the following manner, noting any special precautions.

a. Assemble the sprocket flange (56), large diameter flange up, to the shaft of the lower sprocket (54). Assemble the thrust washer (55) to the sprocket shaft and down against the flange. Lubricate the end of the shaft with oil and insert the shaft into and through the lower bearing in the mechanism housing. Do not use force, and angle the flange to maneuver it past the film stripper. Assemble the tension washer (53) over the end of the sprocket shaft with the convex face against the bearing. Assemble the sprocket gear assembly (52), hub first, to the end of the sprocket shaft, mating its teeth with those of the idler gear (6, Figure 9). Hold a

0.005 inch feeler gage between the gear hub and bowed washer and push the gear to flatten the washer. Check to make certain that the seating of the sprocket flange (56) has not changed; then tighten the two setscrews (51) in the sprocket gear hub (14 in/lbs minimum). Remove the feeler gage and check to make certain that there is some end play in the sprocket shaft.

b. Assemble a retaining ring (50) into the groove at the end of the lower helical gear shaft (48). Assemble the thrust washer (49) to the shaft and down against the retaining ring. Lightly oil the shaft and, with the load lever fully counterclockwise, insert the shaft into and through the bearing above the lower sprocket with a slight rotary motion. Assemble the tension washer (45), convex side up, to the gear shaft. Hold the front end of the gear shaft while installing the lower helical gear (44), small diameter gear first. The teeth of the small diameter gear must engage those of the lower sprocket gear (52) and the idler gear (6, Figure 9); the larger helical gear teeth must mesh with the worm gear. If necessary, manually rotate the shutter counterclockwise until the teeth are engaged and the helical gear seated down on the tension washer. Insert a 0.005 inch feeler gage between the thrust washer (49) and the bearing in the housing. Push the gear against the bowed washer until the washer is flat and hold while tightening the two setscrews (42) in the gear hub (36 in/lbs minimum). Check for minimum end play.

c. Assemble a thrust washer (47) to the shaft of the upper sprocket assembly (46). Lightly oil the shaft and insert it into and through the upper sprocket bearing until it protrudes approximately 1/8 inch at the back of the housing. Assemble the tension washer (45), convex side out, and grip ring (45A) to the end of the shaft. Hold the upper helical gear assembly (43), hub out, in position with its helical gear teeth engaging the worm gear and push the sprocket shaft into the gear until the gear and the sprocket are seated. Insert a 0.005 inch feeler gage between the gear and the bowed washer and compress the sprocket and gear until the washer is flat. Hold while tightening the two setscrews (42) in the gear hub (36 in/lbs minimum). Check for minimum end play.

d. Lightly grease both surfaces of the lamp release ring (41) and assemble the ring to the exciter lamp contact assembly (40) with the contact forms up and the lamp release tab to the right. Lift the contact and ring up into position against the underside of the housing lamp boss and install and tighten the two screws (39) securely. Check to see that the lamp pins raise and lower as the ring tab is moved back and forth.

e. Hold the sound drum and shaft assembly (38) so that the two threaded screw holes are at the bottom. Carefully insert the shaft through the bore in the mechanism housing until the two screws (37) can be inserted up through the holes in the housing boss (front and back sides of housing) and threaded

into the sound head housing. Tighten screws securely. Preassemble setscrew (34) into the housing through the small opening just behind the optical slit bore. From the back side of the housing, assemble photocell and holder assembly (36) into the slot in the sound drum housing and slide it forward until the step of photocell holder is flush with the front side of mechanism housing. Insert light pipe retainer (35) into the slot in the mechanism housing until seated against the photocell holder. Hold the photocell and retainer while tightening preassembled setscrews (34) against the retainer (see Figure E). Rotate the sound drum to make sure there is no binding condition. Bring photocell wires and small printed circuit board (29) down around the stabilizer arm cap (9, Figure 9) and secure the board to the tapped bosses at the bottom of the housing. Lock washer (28) is used only under screw (27) closest to the exciter lamp area. Insert the loose yellow lead of circuit board through the small hole below exciter lamp boss and solder it to the exciter lamp terminal.

f. Turn screw (32) approximately three turns into the optical slit clamping hole. Assemble optical slit (33) into the bore until the end of the slit is approximately 1/16-inch from the sound drum. Rotate the slit until the two adjusting holes in the slit housing are up. Hold slit and tighten clamping screw (32).

g. Impedance roller parts used on earlier Model 1580 projectors (items 21 through 24) are no longer available and must be replaced by current roller assembly P/N 077182 (item 20). Assemble locking nut (20A) approximately half way up the threads of the impedance roller shaft and screw the shaft into the tapped stud of impedance roller arm (protruding through housing slot above the sound drum). Turn roller shaft in until roller and sound drum are aligned as shown in the lower view of Figure E. Then tighten nut (20A) securely to end of roller stud.

h. Assemble impedance roller lifter (16) to the flange at the lower right side of lens carrier, with the pointed end of the lifter to the right and the angle pointing down. Secure lifter with two screws (15) installed finger-tight. Loosely assemble snubbing spring retainer (18) to the lifter with screw (17). Assemble the straight center portion of snubbing spring (19) beneath the formed lip of the retainer with the long leg of the spring to the left and pointing down. Tighten retainer screw (17) to secure the spring.

i. Assemble lamphouse stop (14) through the hole in the arm of film stripper (23, Figure 9) and into the tapped hole in the mechanism housing. Tighten securely (10 in/lbs minimum). Assemble the stabilizer roller assembly (13), counterbore facing out, over the shaft of the stabilizer arm protruding through the vertical slot at the bottom center of the housing. Assemble washer (12) into the counterbore and install and tighten screw (11). Spin the roller to check freedom of rotation. With load lever in open position, assemble the entrance roller (10) to the mechanism housing shaft above and to the right of the load lever bushing. Press the roller down against the previously installed retaining ring. Press roller retainer (9) down

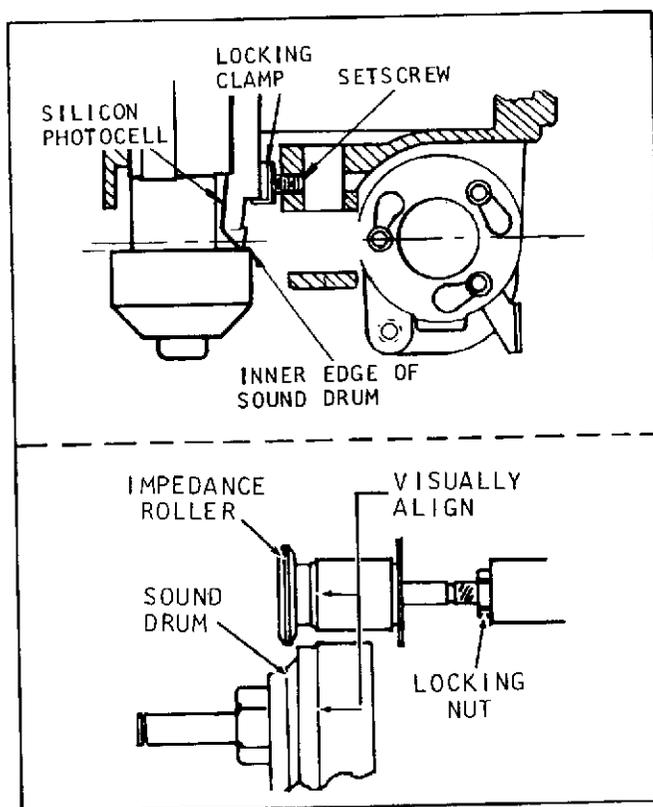


Figure E. Photocell, Sound Drum and Impedance Roller Installation

onto the shaft, making sure that the numeral "2" is right reading. Refer to paragraph 42 for load lever setting instructions.

j. At the back side of the housing, assemble mechanism pulley (6) to the end of the camshaft. Insert pulley spacing gage (Figure A) between the pulley hub and shutter nut and hold pulley against the gage while tightening the two pulley setscrews (5) securely (12 in/lbs minimum). Secure heat baffle (4) to mechanism housing with two screws (3). Secure support bracket (2) to mechanism housing with four screws (1).

#### 24. REASSEMBLING THE REAR REEL ARM ASSEMBLY (Figure 7). Reassemble the rear reel arm as outlined in the following paragraphs.

a. Apply one drop of oil to the unflanged end of the bearing in rear reel arm (31). Assemble retaining ring (28) to rear reel arm shaft (30) in the groove nearest the two narrow flats on the shaft. Assemble spacer washer (29) over the long end of the shaft and down against the retaining ring. Insert reel arm shaft through the reel arm bearing. Assemble face gear (27) to the reel arm shaft (30), gear teeth facing up, and tighten setscrew (26) against the flat of the shaft.

b. Assemble the nylon bearings (25) into the cast bearing arms of the rear reel arm, engaging the key tabs of the bearings with the cross-slots of the bearing holes. Assemble the lower gear (22) to that end of the gear shaft (24) where the flats are nearest the end. The gear face with the square recess must face

away from the cast bearing boss. Install the gear retaining clip (21). Insert the gear shaft through both nylon bearings (25). Assemble the washer (23) and gear retaining clip (21) to the end of the gear shaft. Install the upper gear (20), square recess facing inward to engage clip (21), and assemble the grip ring (19) to the end of the shaft. Insert a 0.010 inch feeler gage between the upper gear (20) and washer (23) and press the grip ring (19) in against the gear. Remove feeler gage.

c. Assemble the sleeves (12A) and (12B) to the hub of the face gear (14). The sleeves must rest down against the shoulder of the gear. Insert the small diameter end of the gear shaft (16) up through the hole in the lower end of the reel arm. Hold the shaft in place and assemble the washer (15), the face gear (14) and the large washer (11) to the gear shaft. Secure these parts with the retaining ring (10).

d. Install the setscrew (13) into the tapped hole in the reel arm casting near the lower end of gear shaft (16). Do not tighten the setscrew. Move the gear shaft (16) to engage the teeth of the face gear (14) with the lower spur gear (22) and tighten the setscrew (13). Rotate the face gear in both directions to check backlash. There should be approximately 0.005 to 0.018 inch backlash around the total gear circumference. If necessary, loosen the setscrew (13) and remesh gear teeth until proper backlash is obtained; then tighten setscrew securely.

e. Apply a light film of grease to all gear teeth and to the hub of the upper face gear (27). Assemble the torsion spring (18) to the hub of face gear (27) with the loop of the spring over the casting boss near upper spur gear (20). Secure the spring loop to the boss with the retaining ring (17). Rotate the upper face gear in both directions to make certain that the retaining ring does not restrict movement of the spring loop on the boss. Reposition retaining ring if necessary.

f. Apply one drop of oil to the mouth of the bearing in the take-up arm assembly. Assemble the washer (8) to the shaft of the take-up spindle (7) and insert the shaft through the take-up arm bearing. Install and tighten the screw (6). Assemble the take-up arm to the mounting pin in the reel arm. Assemble the take-up belt (4) around the spindle pulley and the rubber sleeve of the lower face gear (see Figure F). Insert the tension spring (5) into the recess in the take-up arm and compress the spring with a piece of shim stock while assembling the reel arm cover (2) to the reel arm. Install and tighten the two screws (1).

**25. REASSEMBLING THE FRONT REEL ARM ASSEMBLY (Figure 6).** Reassemble the front reel arm as outlined in the following paragraphs.

a. Assemble the washer (5C) and then the face gear (5B) down against the shoulder of the feed spindle (5D). Install but do not tighten the two setscrews (5A).

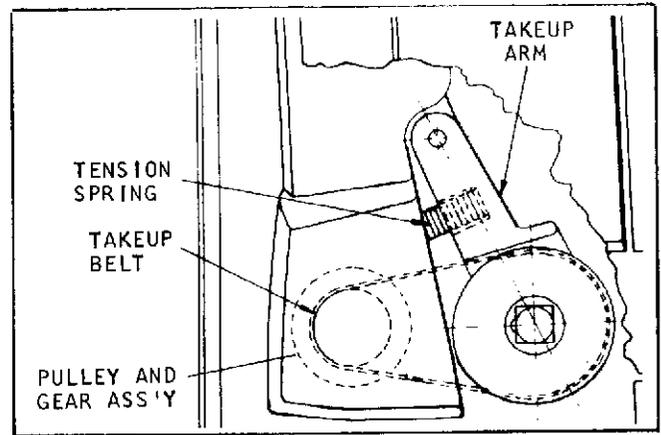


Figure F. Take-Up Arm Assembled

b. Place the reel arm (22) on the bench with the lower (spindle) end of the arm at your left. Assemble the nylon bearings (21) into the cast bearing bosses of the reel arm, engaging the key tabs of the bearings with the cross slots in the bearing bosses. Insert the gear shaft (20) through the nylon bearings from right to left, make sure that the end with the flats furthest from the tip of the shaft is at the right (upper end of the reel arm). Assemble the lower spur gear (19) to the left end of the shaft. The gear face with the square recess must face away from the cast bearing boss. Install the gear retaining clip (17) to the flats of the gear shaft. Assemble the washer (18) and the second gear retaining clip to upper end of the gear shaft (20). Assemble the upper spur gear (16) to the shaft, with the square recess of the gear engaging the retaining clip. Install the grip ring (15) on the end of the shaft. Insert a 0.010-inch feeler gage between the upper spur gear (16) and washer (18), and press the grip ring in against the gear. Remove the feeler gage.

c. Assemble the retaining ring (11) into the ring groove nearest the two flats of reel arm shaft (14). Assemble the washer (12) onto the shaft and down against the retaining ring. Place a drop of oil at the unflanged end of the reel arm upper bearing and insert the long end of the shaft (14) through the upper bearing. Make certain that the setscrews (8) and (8A) are not protruding into the shaft hole of the face gear (9) and that the sleeve (9A) is in place on the hub of the gear. Apply a light coat of grease to the gear teeth. Assemble the torsion spring (10) to the hub of the gear with the loop end of the spring furthest from the gear teeth. Assemble the face gear to the reel arm shaft while engaging the loop end of the spring over the spring boss of the reel arm. Secure the loop with the retaining ring (7) and tighten the gear setscrew (8) securely. The retaining ring (7) must not be so tight as to restrict movement of the spring loop when the face gear is rotated.

d. Apply one drop of oil at the flanged end of the reel arm lower bearing. Insert the shaft of the feed spindle assembly (5) down through the reel arm bearing. Install and tighten the screw (4) securely.

## SERVICE INSTRUCTIONS

e. Rotate face gears (5B) and (9) in both directions to check backlash. There should be approximately 0.005- to 0.018 inch backlash around the total circumference of each gear. By the trial and error method, loosen the gear setscrews (5A) or (8) and reposition the engagement of face gears with spur gears until proper backlash is obtained. Then tighten setscrews securely. Assemble the cover (2) to the reel arm and install and tighten the screws (1).

26. REASSEMBLING THE BASE COMPONENTS (Figure 5). Reassemble Figure 5 parts in the following manner, noting any special precautions.

NOTE: Items 50 through 56 are used only in Model 1680 projectors. Before reassembling the servo-amplifier (55) to the projector base, plug in the connector (56) and liberally coat the entire mounting surface of the servo-amplifier with grease (Bell & Howell Company P/N 100143). Secure the amplifier to the underside of the base with two screws (54). If the microphone jack (50) was replaced, reconnect the leads and the capacitor (51) as shown in the appropriate wiring diagram. Assemble the jack to the base with the washers (52) and (53) and secure the jack with the mounting nut.

a. Lightly grease the teeth of the worm gear (47), tilt gearshaft (44) and gear rack (42) before assembling these parts. Assemble the washers (45) and (45A) to the tilt gearshaft with the convex side of (45) toward the gear. Insert the shaft through the hole in the base and press against the gear to flatten the tension washer so that the retaining ring (43) can be installed. Fasten the adapter (41) loosely to the back with the screw (40). Assemble the gear rack (42) and worm gear (47) into the base, holding the worm gear between the two formed ears of the base and with worm gear, gearshaft and tilt rack teeth engaged. Position the adapter (41) so that the gear rack does not bind in the rectangular cut-out, and tighten the screw (40) securely.

b. If the mainplate (38) was disassembled from the base for any reason, lift the mainplate up into position against the uprights of the base. Loosely assemble the four screws (37); then tighten all screws alternately until snug. Torque all screws to 20 in/lbs minimum.

c. Apply a film of adhesive to the ends of the tilt bar (35) and press on the rubber feet (36). Wipe away excess adhesive. Attach the tilt bar to the lower end of the gear rack with the screw (34). Place the flat washers (33) and rubber feet (32) on top of the raised bosses of the base and secure the feet and washers with the screw (31).

d. Lift the mechanism and soundhead assembly (29) into position against the mainplate, carefully guiding the assembly into the contoured cut-out. It is especially important that the sound drum not be damaged during the installation. From the back

side of the mainplate, install the two lower mounting screws (28). One screw hole is located below the right lower corner of the large cut-out; the second is located directly to the left of the sound drum shaft. Tighten both screws securely (20 in/lbs minimum). Assemble the gear adjustment bracket (26) to the top of the mainplate, aligning the screw holes in the bracket with those in the mainplate and the mechanism housing. Install the hex washer head screw (25) in the right hand screw hole and the slotted pan head screw (23) with washer (24) in the left-hand screw hole. Tighten the screws securely. Activate the adhesive backing of the seal (27) with solvent and position the seal to cover the radial opening in the side flange of the mechanism housing. Smooth down the seal with a clean cloth. In the area just above the exciter lamp location, rotate the fan-like adjustment plate clockwise until its notch is at the 12 o'clock position and centered over the tapped hole in the plate. Install the screw (21) with washer (22) to secure the plate in this position. Assemble the torsion spring (30), hooked leg first, over the pivot stud of the retention pawl (lower left-hand corner of mechanism assembly). Engage the hook end behind the retention pawl, with the straight leg extending to the left and resting on the base. Install the exciter lamp (19) into its socket and lock in place with the release ring.

e. Assemble a flat washer (16) to the sound drum shaft and down against the crescent ring. Install the tension washer (17) with its convex side toward the sound drum and a second flat washer (16). Assemble the fly heel (15) to the shaft, with the knurl on the outer diameter toward the mainplate. Press the flywheel to compress the tension washer (17) and expose the ring groove in the end of the shaft, and install the retaining ring (13).

NOTE: In some earlier models, the ring groove is closer to the end of the shaft and four washers (14) must be installed between the pulley and the retaining ring.

f. Assemble the volume and tone control assembly (12) into the base and secure the control bracket to the tapped mounting bosses with the two screws (11). Make certain that the control knobs do not bind in the slots of the base. Refer to the appropriate wiring diagram.

g. Connect the small edge connector (18) to the printed circuit board mounted at the rear bottom edge of the mechanism housing. Dress the edge connector leads through the hole in the base casting and toward the amplifier board edge connector for soldering. Refer to the appropriate wiring diagram for wiring connections. Brush the amplifier contacts with alcohol and assemble the amplifier (10) to its edge connector (9). Apply heat sink compound (Dow-Corning No. 340 silicon) to the area of the amplifier bracket that will contact the base and position the amplifier and edge connector on the mounting bosses. Secure the connector with

the two screws (6). Assemble the spacers (8) to the screws (7) and use these screws to secure the amplifier bracket to the base.

NOTE: Do not assemble the covers (2) and (5) to the base until the projector has been completely assembled and adjusted.

27. INSTALLING BRAKE COMPONENTS (Figure 4A). Reassemble brake components in the following manner, noting any special precautions.

a. If removed, reassemble the spacers (11) and cable sheave (12) into the tapped holes in the projector mainplate. The location of these parts and the assembled positions of the brake components are shown in Figure F-1.

b. Assemble the brake arm spring (10) to the hub of the brake arm assembly (9) and secure the arm assembly to the lower spacer with a screw (6) and washer (7).

c. Secure release cam follower (8) to the upper bushing with a screw (6) and washer (7). If the switch cam (8B, Figure 3B) or (4B, Figure 3A) was not removed, engage the center point of the follower (8) with the cam rise before tightening the screw.

d. Assemble "V" end of tension spring (4) to one end of cable (5). Rotate switch cam to "project" position and engage other end of cable over notch in cam follower (8). Dress cable down around center groove of cable sheave (12); then to the left, stretching spring (4) just enough to engage upper notch in brake arm (9). Tension to effect proper brake release can be adjusted by engaging cable in outer or inner grooves of sheave.

e. Connect the lower arm of the brake release rod (3) to the brake arm assembly (9) as shown in Figure F-1. Assemble the upper loop of the rod and the torsion spring (2) to the protruding end of the lamp interlock switch actuating pin (Figure G) and retain these parts with the retaining ring (1).

28. INSTALLING REEL ARMS AND GEARS (Figure 4). Reassemble Figure 4 parts in the following manner, noting any special precautions.

a. Screw the threaded end of the flywheel drive arm stop (51) into the tapped hole in the mainplate (approximately halfway between the upper helical gear and left edge of mainplate). Tighten the stop securely (16 in/lbs minimum).

b. Solder the leads to the terminals of the lamp interlock switch. Assemble the lamp interlock switch (50) to the mainplate with the two screws (49), tightening the screws finger-tight. The switch button must be positioned above the pin of the mechanism gear disengagement plate protruding through the slot in the mainplate (see Figure G). With the switch screws loosened slightly, rest a 0.010 inch feeler gage on top of the protruding pin and adjust the switch until the switch button is in contact with the feeler gage. Hold the switch while tightening the two screws securely. Remove the feeler gage.

c. Assemble the idler gear (44B), hub facing out, to the stud of the gear arm (44C), and secure gear with retaining ring (44A). Assemble a thrust washer (48) to the upper sprocket shaft and against the hub of the upper helical gear. Assemble the

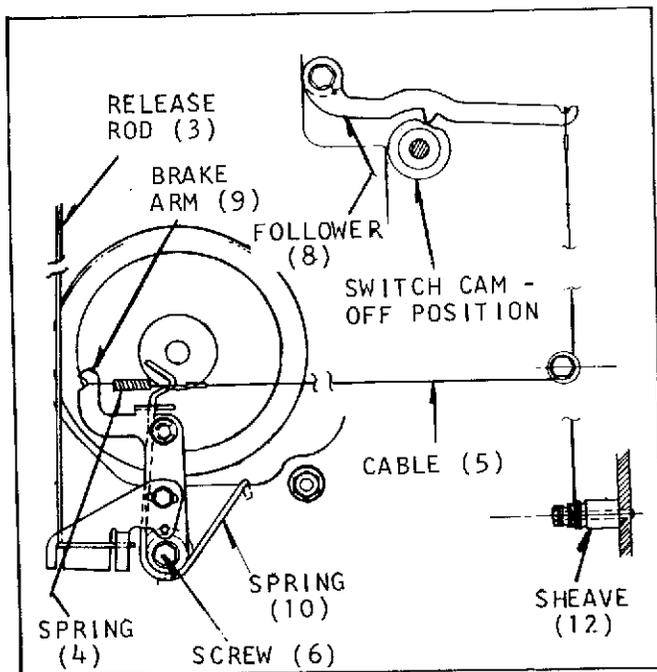


Figure F-1. Brake Component Installation

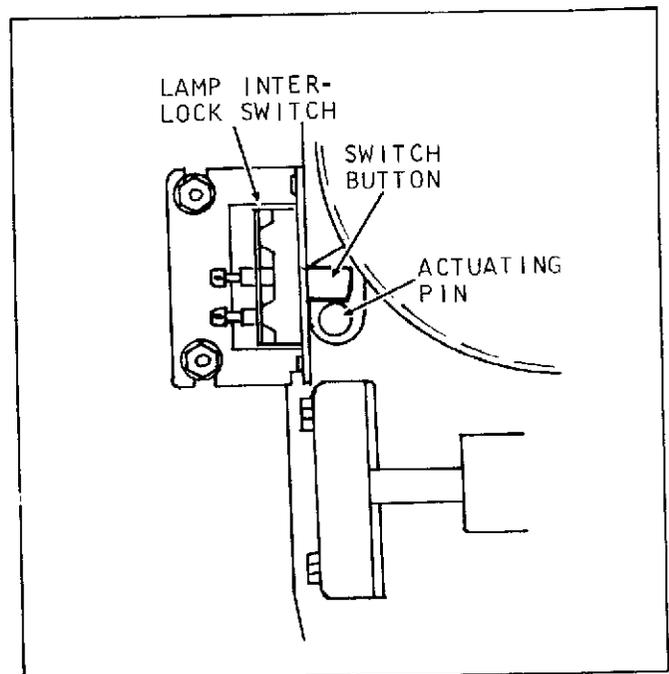


Figure G. Adjusting Lamp Interlock Switch

rewind clutch assembly (47) to the upper sprocket shaft, with the clutch adjusting nut in against the thrust washer. Lightly grease one face of the flat washer (46) and install the flat washer, greased face toward the clutch. Retain all parts by assembling the gear retaining clip (45) into the flats on the sprocket shaft. Lightly grease both sides of the idler gear arm (44C) around the large hole. With the gear (44B) facing out away from the mainplate, assemble the arm assembly (44) to the sprocket shaft with the large diameter hole over the hub of the clutch gear. Note that one hub of the drive gear (42) has a square opening. When the drive gear is installed, this opening must engage over the retaining clip (45) assembled to the sprocket shaft. Assemble a washer (43) over each hub of the drive gear (42) and install the gear over the retaining clip. Assemble the idler gear (41), hub facing out, to the inner stud of the flywheel driver arm (38) and secure the gear with a retaining ring (39). Assemble the rubber rimmed flywheel drive gear (40) to the outer stud of the driver arm, with the drive gear teeth engaging the teeth of the idler gear (41). Secure the drive gear with retaining ring (39). Assemble the large diameter hole of the driver arm over the large hub of the drive gear (42) and against the mylar washer (43), meshing the teeth of idler gear (41) with those of drive gear (42). The rubber rim of drive gear (40) should be adjacent to the rim of the flywheel. Assemble washer (37) to sprocket shaft and against driver arm. Install washer (36) with D-hole on small hub of drive gear (42). Assemble the tension washer (35), convex side out, to the sprocket shaft. Assemble the grip ring (34) to the sprocket shaft and, with a 0.010 inch feeler gage between the tension washer and gear hub, press the grip ring in until gage is held snugly. Remove the gage.

d. Assemble a gear (33) to each gear stud of the rewind lever (30), gear hubs toward the lever. Install the washers (32) and secure the gears and washers with the retaining rings (31). Assemble the coil of the torsion spring (29) over the shoulder of the bushing on the back side of the rewind lever. The straight leg of the spring must be in against the lever and resting down on the angled ledge; the hooked leg hanging down. Assemble the bushing of the lever to the mainplate shaft (to the left and slightly above the upper helical gear) and pivot the lever clockwise until the right-hand lever gear meshes with drive gear (42). Be sure that the free leg of the spring (29) is not trapped between the shaft and the lever bushing. Hook the end of the spring behind the left edge of the mainplate cut-out. Assemble the idler gear (28) to the shaft and press it down against the lever, meshing its teeth with those of both gears (33). Install the washer (27) and secure parts with the retaining ring (26).

e. Assemble a washer (25) to each of the two mainplate gear shafts to the left of the rear arm bearing hole. Assemble a large idler gear (24), gear hubs in, to each shaft, with gear teeth meshing. Install the retaining rings (23) to secure the gear.

f. Lightly grease the mounting flange surface of the rear reel arm assembly (20) and around the reel arm hole in the mainplate. Assemble the spring (22) over the shaft of the hold button (21) and assemble the button into the small hole to the right of the reel arm hole. Hold the button depressed while assembling the reel arm to the mainplate. Release the button, allowing it to project against the mounting flange of the arm, and keep the reel arm in the down position. Assemble the take-up arm disc (16) over the shaft and hub of the reel arm and in against the mainplate. The shear form in the center hole of the disc should be toward you and down. Assemble the rewind cord bracket (15) over the shaft and hub of the reel arm and against the disc, with the form up and the center hole notch over the shear form of the disc. Install the three screws (14) and tighten securely (14 in/lbs minimum). Manually depress and hold the hold button and move the reel arm up and down to check freedom of movement.

g. Lightly grease the mounting flange of the front reel arm assembly (19) and around the reel arm hole in the mainplate. Assemble the spring (22) over the shaft of the hold button (21) and assemble the button into the small hole to the left of the reel arm hole. Hold the button depressed while assembling the front reel arm to the mainplate. Release the button, allowing it to project against the mounting flange of the arm, and keep the arm in the down position. Assemble the reel arm disc (18) over the shaft and against the reel arm hub with the shear form up. Install and tighten the three screws (17) securely (14 in/lbs minimum). Manually depress and hold the hold button and move the reel arm up and down to check freedom of movement.

h. Assemble the long loop extension of spring (13) to the end loop of spring (12) and the crossover end of spring (13) through the metal end clip of the rewind cord assembly (11). Hook the free end of the spring (12) around the notch in the upper left-hand corner of the rewind lever (30). Stretch the cord to the right, behind the two large idler gears (24) and above the gear studs. Pull the cord with a long-nose pliers until the metal end loop can be placed over the shear form of the take-up disc (16). Assemble the grip ring (10) to the shear form to hold the cord in place. Check to make certain that there are no obstructions to proper cord operation.

i. Assemble the retaining clip (9) into the second groove from the end of the front reel arm shaft. Assemble the rewind gear (8) to the shaft with the square hole in the gear hub engaging the retaining clip. Assemble the reverse take-up clutch assembly (7) to the shaft with the lock nut end against the rewind gear (8). Install the flat washer (6) and the thrust washer (5), convex side out, to the shaft and secure all components with the retaining ring (4).

j. Assemble a retaining ring (1) into the second groove from the end of the rear reel arm shaft. Install the gear assembly (2) to the shaft, with the hex face of the gear toward the mainplate. Visually check the alignment of gear assembly teeth with the tooth width of the adjacent large idler gear (24). If necessary, add a shim washer or washers (3) to align gears properly. Secure the gear to the gear shaft with the second retaining ring (1).

**29. INSTALLING ELECTRICAL COMPONENTS (Model 1680 Projectors) (Figure 3B).** Reassemble Figure 3B parts in the following manner, noting any special precautions.

**NOTE:** The installation of electrical components will be simplified by making all electrical leadwire connections before securing the component to the projector base or mainplate. Refer to the appropriate wiring diagram for proper leadwire connections. Be sure to dress all leadwires out of the way of moving parts, using plastic tie-wraps where indicated.

a. Assemble the blower motor (23G) to the right-hand housing (23H), seating it all the way into the housing recess with the mounting holes aligned. Install and tighten the three screws (23F) securely. Loosely assemble the setscrew (23D) to the hub of the blower fan (23E). Assemble the fan, setscrew end out, to the blower motor shaft and, with the fan hub flush with the end of the shaft, tighten the setscrew securely. Assemble the left-hand housing (23C) to the right-hand housing and manually spin the fan to make sure there is no interference. Install and tighten the three screws (23A), using the retaining clamp (23B) with the upper right-hand screw. Connect the leads to the blower motor terminals and position the blower assembly (23) on the projector base with the mounting holes aligned. Install and tighten the four screws (22) and dress the leads with the clamp (23B).

b. Assemble the motor pulley (21) to the drive motor shaft and tighten the two setscrews (20) enough to hold. Assemble the motor mounting brackets (19) to the motor (18). Make sure that the pin-like projections of the motor rubber buffers are engaged in the slots at the top and bottom of each bracket opening and with the bracket mounting feet pointing out. Position the motor (18) on the projector base with mounting holes aligned and install and tighten the four screws (17) securely. Secure the motor ground lug to the tab of the rear bracket (19) with the screws (13) and connect the nylon motor lead connector to the mating connector of the wiring harness and dress leads, as necessary, with the tie-wraps removed at disassembly.

c. Tip the projector so that the transformer mounting screws (15) can be assembled from the underside of the base. Hold the power transformer (16) in position while installing and tightening the

four screws. Connect the nylon transformer lead connectors to the mating connectors of the wiring harness and dress leads, as necessary, with the tie-wraps removed at disassembly.

**NOTE:** Before proceeding with the reassembly of Figure 3B parts, return to paragraph 26 and install the amplifier, edge connector and covers as instructed in step g.

d. Assemble the function switch (12) to the bracket (9) with the lock washer (11) and lock nut (10). Connect all leads, including those of the capacitor (6), to the switch terminals (refer to appropriate wiring diagram for wiring connections. Be sure the plus (+) side of the capacitor is connected to terminal 2B. Position the bracket against the mainplate with mounting holes aligned and install the three screws (7), first assembling the retaining clamp (8) to the upper left-hand corner.

e. Assemble the cam (8B) to the shaft of the function switch and slide it toward the mainplate until the pivot point of the cam follower (item 8, Figure 4A) is centered in the cam rise. Hold the cam securely and tighten the setscrew (8A).

f. Assemble the fuse board (4) and its spacer (5) to the upper ends of the motor mounting bracket with the two screws (3). Install the fuses (2) and the drive belt (1). Visually align the belt groove of the motor pulley (21) with the mechanism pulley and tighten both motor pulley setscrews (20) securely.

**30. INSTALLING ELECTRICAL COMPONENTS (Model 1580 Projectors) (Figure 3A).** Reassemble Figure 3A parts in the following manner, noting any special precautions.

**NOTE:** The installation of electrical components will be simplified by making all electrical leadwire connections before mounting the component to the projector base or mainplate. Refer to the appropriate wiring diagram for proper leadwire connections. Be sure to dress all leadwires out of the way of moving parts, using wire ties where indicated.

a. Assemble the two motor mounting brackets (39) to the base with the screws (38). The mounting flanges of the brackets must face outward, away from one another. Assemble the front screw of the left-hand bracket loosely. The ground terminal of the motor must be retained by this screw. Secure the left-hand blower housing (37) to the base with two screws (36), and tighten screws securely.

b. Preassemble the bracket assembly (32) and two motor bracket straps (31). Assemble the motor pulley (35) to motor shaft, the pulley hub toward

the end of the shaft. Insert a 1/4 inch spacer between the inner face of the pulley and the motor end bell. Lift up on the motor shaft to remove end play and hold the pulley against the spacer while tightening the pulley setscrews (34). Lift the motor assembly (33) up into place in the cradles of the support brackets, guiding the motor shaft through the large opening in the blower housing. Leadwires of the motor should be at the front. Assemble the motor bracket straps (31) to the hook-like ends of the support brackets, with the fuse clamp of the bracket assembly (32) toward you. Tighten the bracket strap hex nuts to secure the straps. Assemble the fuse and sleeve assembly (30) under the spring clip of the bracket assembly (32), making sure that the fuse is touching the motor frame. Assemble the line cord (29) with Heyco strain relief (28) to the bracket assembly (32). Dress the green line cord wire from behind the bracket, over the motor, and secure the terminal lug to the base with the screw (27).

c. Slip the drive belt (26) around the motor shaft and loop the belt between the motor pulley and the large mechanism pulley. Assemble the blower fan assembly (25) to the motor shaft, the fan hub with setscrews toward the motor. Position the fan so that the end of the motor shaft is approximately 1/16 inch below the surface of the outer fan hub and tighten the two setscrews (24) securely against the flats on the shaft. Assemble the right-hand blower housing (23) to the left-hand housing and the base. Loosely install the two screws (22) to attach the housing to the base. Install three screws (20) and the leadwire tie-down (21) to secure the right-hand housing to the left-hand housing. Tighten these three screws; then tighten the two screws (22) securely.

d. Assemble the two brackets (19C) and (19D) to the lamp transformer (19E) with the bracket mounting flanges facing inward. Secure the brackets with the screws (19B) and hex nuts (19A). Position the transformer assembly (19) on the base with the mounting holes aligned. Insert the two screws (18) through the front slots of the brackets and into the tapped holes in the base, tightening them securely. Tip the projector to expose the underside of the base and insert the remaining two screws (17) through the drill holes in the base and into the tapped holes at the rear of the brackets. Tighten both screws securely.

e. Assemble the power transformer brackets (15) and (16) to the top of the lamp transformer with the two screws (14) and hex nuts (13). Orient the brackets as shown in Figure 3A and install the nuts finger-tight. Assemble a lockwasher (11) to each screw (10). Hold the power transformer (12) between the upper fingers of the brackets (15) and (16) and install the two screws (10) and hex nuts (9). Tighten all hex nuts (9) and (13) securely. Dress all lamp transformer leads down through adjacent hole in projector base ready for soldering to the amplifier edge connector terminals. Tie down the wires with the wire tie located at the base of the transformer.

f. Make all leadwire push-on connections to the terminal lugs of the rotary switch (8). Insert the switch shaft through the hole in the bracket (5), with two lugs aligning the switch properly. Install the lockwasher (7) and hex locking nut (6), tightening the nut securely (16 in/lbs minimum). Assemble the fuseholder (3) to the top of the bracket with the screw (2). Hold the fuseholder parallel with the bracket while tightening the screw. Lift the assembled switch and bracket up into place, guiding the shaft through the hole in the mainplate. Install and tighten the three screws (4) assembling a wire tie-down beneath the head of the upper left-hand screw. Solder the leads to the fuseholder terminals and assemble the fuse (1) into the fuseholder spring clips.

g. Assemble the cam (4B) to the shaft of the function switch and slide it toward the mainplate until the pivot point of the cam follower (item 8, Figure 4A) is centered in the cam rise. Hold the cam securely and tighten the setscrew (4A).

NOTE: Recheck all wiring connections against the appropriate wiring diagram. At this point, all wiring connections should be completed except those to the speaker and the speaker jack.

31. INSTALLING END CAPS AND LAMPHOUSE (Figure 2). Reassemble Figure 2 parts in the following manner, noting any special precautions.

a. Bring the shielded cables of the volume and tone controls up through the hole in the base behind the blower housing. Solder these cables and the speaker leadwires to the terminals of the speaker jack (19) as shown in the appropriate wiring diagram.

b. Lift the rear end cap assembly (22) up into position on the base, with the groove at the front side of the cap engaging the mainplate from top to bottom. Assemble two screws (21) from the front side of the mainplate and into the preassembled speed nuts (22E) in the end cap. Tilt the unit to expose the underside of the base and assemble the remaining two screws (21) into the lower two speed nuts of the end cap. Insert the shank of the jack (19) through the hole in the rear end cap. Secure the jack with locking nut (18).

c. Assemble the speaker (17C) over the four molded pins of the front end cap, with the speaker terminals at the top. Install a wire tie (17B) on the lower right-hand pin and secure the speaker with the Tinnerman nuts (17A). Lift the front end cap assembly (17) up into position on the base, with the groove at the front side of the cap engaging the mainplate from top to bottom. Assemble two screws (15) from the front side of the mainplate and into the preassembled speed nuts (17D) in the end cap. Tilt the unit to expose the underside of the base, and install the remaining two screws (15) into the lower two speed nuts of the end cap. The spacer (16) is used with the screw installed near the transformer location.

d. The lamp leads (one yellow, one white) should extend through a 1/2-inch hole in the mainplate near the lampholder mounting area. Assemble the lead push-on connectors to the lampholder terminals. Position the lampholder (13) against the mainplate and install the three screws (12) finger tight. Lamp and optical alignment will be performed after the projector has been fully assembled (see Adjustments). Assemble the projection lamp (11) temporarily into the lamp socket and snap the wire retaining clamp up into place.

e. Screw the exit roller stud (10) into the tapped hole in the lower left-hand corner of base until fully seated. Assemble the exit roller (9), large diameter flange in, to the stud and install the retaining ring (8). Spin the roller to check freedom of rotation.

f. No special instructions are required for re-assembling the lamphouse components. Assemble a washer (4A) to two of the screws (4) and, while holding the lamphouse bracket in position against the mainplate, loosely assemble these two screws at the top and bottom holes of the bracket. Install the third screw in the center mounting hole and tighten finger-tight. Slip the notched flange of the air deflector (6) down behind the bottom mounting flange of the bracket so that the notch engages the lower screw, and tighten the lower and upper screws finger-tight. With the lamphouse closed and latched, insert a screw driver through the switch knob opening and tighten the center screw securely; then open the lamphouse and tighten the remaining two screws. Press the grip ring (3A) onto the switch shaft, locating the ring so that its outer face is 7.2 cm from the surface of the mainplate. Align the flat of the control knob (3) with the flat on the switch shaft and press the knob onto the shaft until it contacts the grip ring. Close and open the lamphouse to check for interference.

g. Tip the projector up on its back end to expose the access hole in the tilt knob mounting boss of the front end cap. Rotate the tilt worm shaft until the flat on the shaft is visible in the access hole. Assemble the tilt knob (2) to the gear-shaft with its setscrew hole aligned with the flat. Dip the setscrew (1) in Loctite and assemble it to the hub of the knob, tightening it securely (14 in/lbs minimum).

**32. REASSEMBLING PROJECTOR COVERS (Model 1680 Projectors) (Figure 1B).** Figure 1B parts should be reassembled in the following manner, noting any special precautions.

a. Screw the threaded end of the loop restorer knob (30) into the shaft of the loop restorer arm and tighten with an open-end wrench. Assemble the threading roller (29) to the end of the sound drum shaft, small roller diameter down against the sound drum nut. Install the retaining ring (28). Peel the backing from the "clockwise arrow" insert (27) and carefully assemble the insert into the recess of the threading knob.

b. If a latch striker (25F) was replaced, be sure to support the top plate solidly when riveting the new striker in place. Assemble the carrying handle (25C) and brackets (25B) to the top cover and secure a bracket and each end of the handle with two screws (25A). Place the top cover assembly (25) on the mainplate and front and rear end caps, with the mounting brackets (25) behind the mainplate and aligned with the mounting holes. The side projections in the cover must slide beneath the end caps and engage into the end cap notches. If necessary, spread the end caps slightly to permit end cap engagement. Assemble the two screws (24) through the mainplate and into the cover mounting brackets (25B), tightening securely.

c. If the speed control P.C. board (23) was replaced, solder the leads to the new board shown in the appropriate wiring diagram. Note that the leads of the speed switch (19) are included. Adjust both control potentiometers on the board (18fps and 24fps) to their approximate mid-position settings. Orient the board to its bracket (21) as shown in Figure 1B, and secure the board to the bracket with the two screws (22).

d. If it was necessary to replace any of the electrical components of the switch and fuse plate assembly (17), refer to the appropriate wiring diagram for leadwire connections. On the front of the switch plate, adjacent to the opening for the voltage selector switch (17G), you will find a stamped triangular symbol. The voltage selector switch must be installed so that its identification mark is positioned behind this symbol. Be sure to assemble the insulators (17D) and (17J) to the voltage selector switch and the line input socket (17M) respectively, securing them with tie-wraps (17C) and (17H). Lift the assembled switch plate up into position against the rear cover and secure it with the four screws (16). Set the voltage selector switch at the required voltage setting and install the lock plate (15) with the screw (14). Secure the speed selector switch (19) to the switch plate with the two screws (18). The gray/red lead of the switch should be at the "18" fps position. Secure the P.C. board bracket (21) to the switch plate with the two screws (20). Secure the green/yellow ground lead of the line input socket to the projector base with the screw (14, Figure 3B).

**NOTE:** Do not install covers (1, 3, 7 and 12) until adjustments have been made as outlined in the following Adjustments section.

**33. REASSEMBLING PROJECTOR COVERS (Model 1580 Projectors) (Figure 1A).** Reassemble Figure 1A parts in the following manner, noting any special precautions.

a. Screw the threaded end of the loop restorer knob (26) into the shaft of the loop restorer arm and tighten with an open-end wrench. Assemble the threading roller (25) to the end of the sound drum shaft, small roller diameter down against

## SERVICE INSTRUCTIONS

the sound drum nut. Install the retaining ring (24). Peel the backing from the "clockwise arrow" insert (23) and carefully assemble the insert into the recess of the threading knob.

b. If a latch striker (20F) was replaced, be sure to support the top plate solidly when riveting the new striker in place. Assemble the carrying handle (20C) and brackets (20B) to the top cover and secure a bracket on each end of the handle with two screws (20A). Place the top cover assembly (20) on the mainplate and front and rear end caps, with the mounting brackets (20B) behind the mainplate and aligned with the mounting holes. The side projections in the cover must slide beneath the end caps and engage into the end cap notches. If

necessary, spread the end caps slightly to permit end cap engagement. Assemble the two screws (19) through the mainplate and into the cover mounting brackets (20B), tightening securely.

c. Assemble the cord wrap (11) to the rear cover (14) with four screws (10), tightening securely. Check to make certain that all nameplates are in position and set the rear cover aside until after all adjustments have been made. No special instructions are required for reassembling front cover components.

NOTE: Do not install covers until adjustments have been made as outlined in the following Adjustments section.

## Adjustments

### 34. GENERAL INSTRUCTIONS.

The alignment and adjustments covered in this section are necessary to the proper operation of the projector. Even though the projector may not have under-gone complete overhaul and repair, it is recommended that all adjustments be checked as a routine measure. Routine adjustments such as those applicable to sliding fits, clearances and end play have been covered in the reassembly procedures and are not repeated here except where they directly affect other adjustments or alignments.

All special tools and fixtures required to perform the adjustment procedures are illustrated in Figure A. In addition, special test films and electronic test equipment (vacuum tube voltmeter, volt-ohmmeter, oscillator and tachometer or Strobotac) are needed to check and adjust the sound system of the projector. For accurate results, connect the projector to a variac set at 120 volts, 60Hz.

### WARNING

Many of the procedures listed in this section require operation with the rear cover removed. To avoid shock hazards, disconnect the power and discharge the motor starting capacitor, when not required.

### 35. OPTICAL ALIGNMENT.

It is important that these alignments be performed in the following listed sequence (steps a and b). All special tools and fixtures required for optical alignment are shown in Figure A. These items are shown installed in the projector in Fig-

ure H. Be sure to turn the mechanism manually until the shutter blade is clear of the aperture opening, before inserting alignment tools.

#### a. Aligning the Aperture Plate.

- (1) Remove the projection lens from the lens carrier. Open the lamphouse and remove the projection lamp.
- (2) With the load lever in the "up" position, pull off the lens carrier cover. Then move the load lever down to the "load" position and disassemble the pressure plate from the lens carrier.

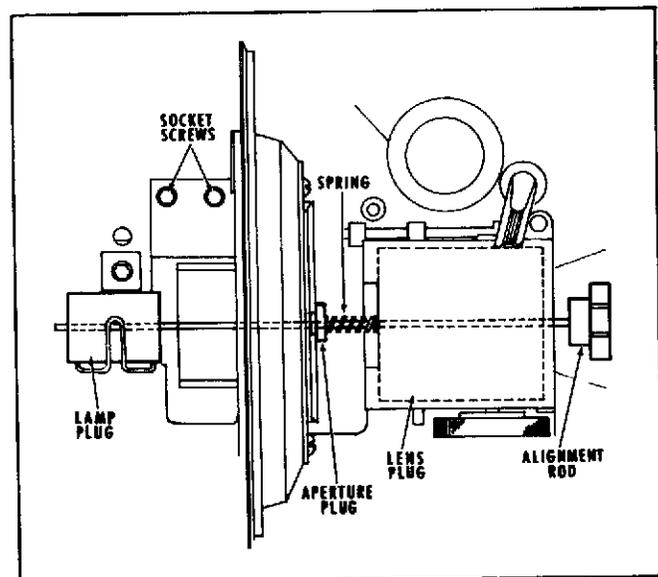


Figure H. Aligning the Optical System

- (3) Loosen the two aperture plate mounting screws just enough to permit movement of the aperture plate, and insert the aperture plug (Figure A) into the aperture opening. Close the lens carrier by moving the load lever up to horizontal.
- (4) Insert the alignment rod (Figure H) through the lens plug until the rod end protrudes enough to install the spring (P/N 6124). Insert the lens plug into the lens barrel until the tip of the alignment rod engages the aperture plug previously installed. Tip the projector carefully onto its back (lens opening facing up). The alignment rod must slide freely through the aperture plug without binding. If necessary, shift the aperture plate slightly until free rod movement is obtained; then tighten aperture plate screws.

b. Aligning the Lamp Socket.

- (1) Tip the projector back into its normal, upright position and reassemble the pressure plate to the lens carrier. Close the lens carrier by moving the load lever up to horizontal.
- (2) Loosen the lampholder mounting screws just enough to permit movement of the lampholder. Insert lamp plug (Figure A) into lamp socket and secure the lamp spring. Slide alignment rod completely into place until tip of rod engages the hole in lamp plug. Shift socket as necessary until rod slides freely in the lamp plug hole. Then tighten the screws securely and remove all tools.

36. ADJUSTING THE INTERMITTENT MECHANISM.

a. Checking Shuttle Tooth Side Clearance. Advance the mechanism manually until the shuttle is at the center of its stroke as shown in Figure J. The clearance from the edge of the shuttle slot to the inner end of the shuttle tooth (nearest the aperture opening) should be 0.007-inch minimum. From the edge of the shuttle slot to the outer end of the shuttle tooth, the distance should be 0.050-inch maximum. Check these clearances at both the upper tooth and lower tooth. If the clearances vary at the upper and lower teeth and inner clearance is less than 0.007-inch at either end, the following possible causes should be checked and corrected.

- (1) Aperture plate out of alignment. See paragraph 35, step a, Aligning the Aperture Plate.
- (2) Shuttle stroke incorrect. See paragraph 36, step d, Shuttle Stroke Adjustment.
- (3) Link bearing missing from end of shuttle arm. Partial disassembly required to remove shuttle arm and replace link bearing (refer to Disassembly section).

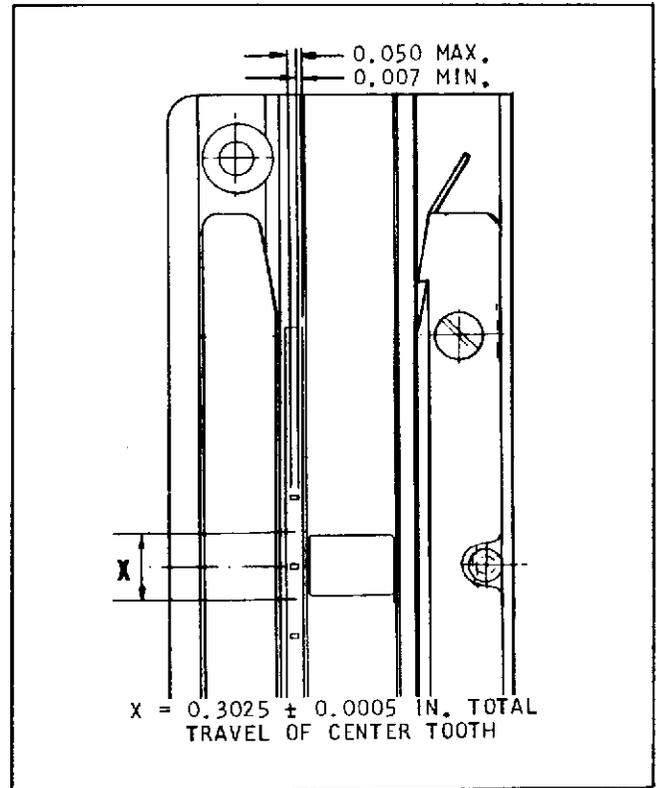


Figure J. Aperture Plate and Shuttle Tooth Clearances

- (4) Ball and stud assembly loose on shuttle arm. Reposition ball and stud assembly (Figure B) and tighten stud nut securely.

b. Checking Shuttle Tooth Height. Swing open the lens carrier and advance the mechanism manually until the shuttle is at the center of its stroke as shown in Figure J. Hold the shuttle tooth height gage (Figure A) by its knurled handle and place it against the aperture plate between the rails. The center ears, on either side of the gage handle, are the height gages. Slowly slide the gage downward. The "Go" ear should pass over the shuttle tooth without catching. Rotate the gage so that the "No-Go" ear is over the shuttle slot and once more slide the gage downward. The "No-Go" ear must not pass over the shuttle teeth. If the shuttle teeth are too high or too low, adjust height as follows.

NOTE: If the mechanism assembly is installed on the mainframe, it will be necessary to remove the lamphouse, the projection lamp and the lampholder before proceeding.

- (1) Turn the mechanism drive pulley by hand until the access holes in the shutter and the fire shutter support bracket are aligned as shown in Figure K.
- (2) Insert a No. 4 Bristol Wrench into these access openings and engage it in the socket of the in-out cam follower screw.

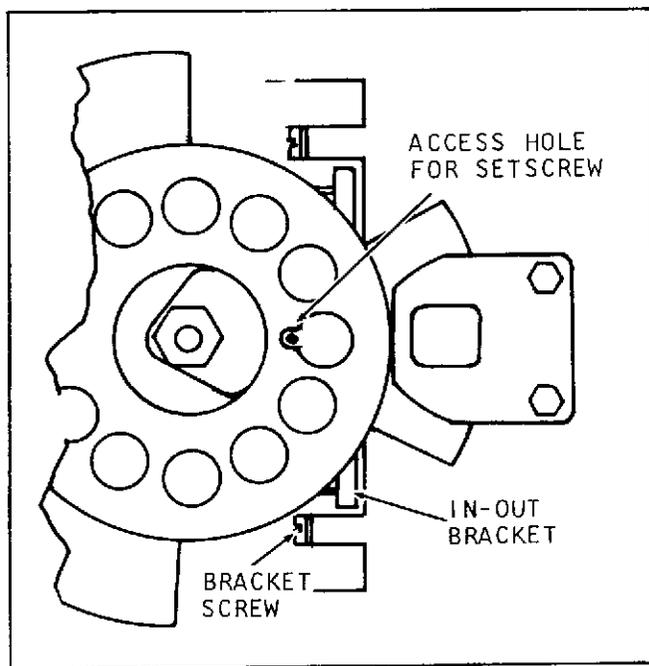


Figure K. Adjusting Shuttle Tooth Height

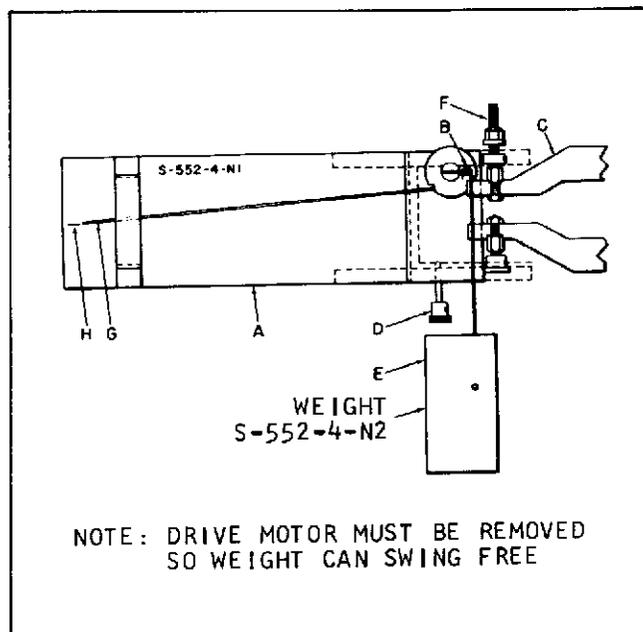
- (3) If the shuttle teeth were too low (No-Go ear passes over shuttle teeth), turn the cam follower screw counterclockwise to increase shuttle tooth height. If the shuttle teeth were too high (Go ear catches against shuttle teeth), turn the cam follower screw clockwise. It may be necessary to re-check shuttle tooth height with the gage several times before the proper height has been obtained.
- (4) If one of the teeth cannot be brought into tolerance by the above method, it may be necessary to loosen the screws which attach the in-out bracket (Figure K) and shift the bracket slightly. Tighten the mounting screws securely and check and adjust shuttle tooth height as outlined above.

NOTE: Upon completion of shuttle height adjustment, reassemble the lampholder and lamphouse and realign the lamp socket as outlined in paragraph 35, step b.

c. Checking Fit of Shuttle Arms to Pull-Down Cam (See Figure L). Remove rear cover and the projection lamp.

NOTE: If projector has just been lubricated, run for two or three minutes before proceeding with this adjustment.

- (1) Open film gate and turn projector mechanism by hand until shuttle teeth are retracted and have moved downward to approximately the center of the stroke (center tooth approximately on horizontal center line of aperture). Slip guide bars of tool SER-552-



NOTE: DRIVE MOTOR MUST BE REMOVED SO WEIGHT CAN SWING FREE

Figure L. Adjusting Fit of Shuttle Arms to Pull-Down Cam

4-N1 over casting to which shuttle mounting plate is attached (Figure L). When tool (A) is positioned so that stud (B) can bear on shuttle arm (C), tighten thumbscrew (D) just enough to hold tool in position. Engage hook of tool SER-552-4-N2 in slot of stud (B) as shown, and allow weight (E) to swing downward. Tilt projector, if required, so that the weight does not rub on any stationary parts.

- (2) Loosen upper bearing support assembly (F) approximately one turn. Rotate projector framer knob so that pointer (G) moves above witness mark (H). Then turn framer knob in the opposite direction until pointer (G) moves back down in line with mark (H).

NOTE: If adjustment of framer knob does not permit movement of pointer (G) as specified, it may be necessary to rotate the camshaft slightly to bring cam into proper position.

- (3) Carefully tighten upper bearing support assembly (F) while observing alignment of pointer (G) with witness mark (H). The instant that pointer (G) starts to move upward, stop turning support assembly (F).

CAUTION: Do not tighten the shuttle arms more than is specified in an attempt to remove cam noise. If the shuttle arms are excessively tightened for the purpose of reducing other noises, the life of the cam and the cam shoes will be reduced.

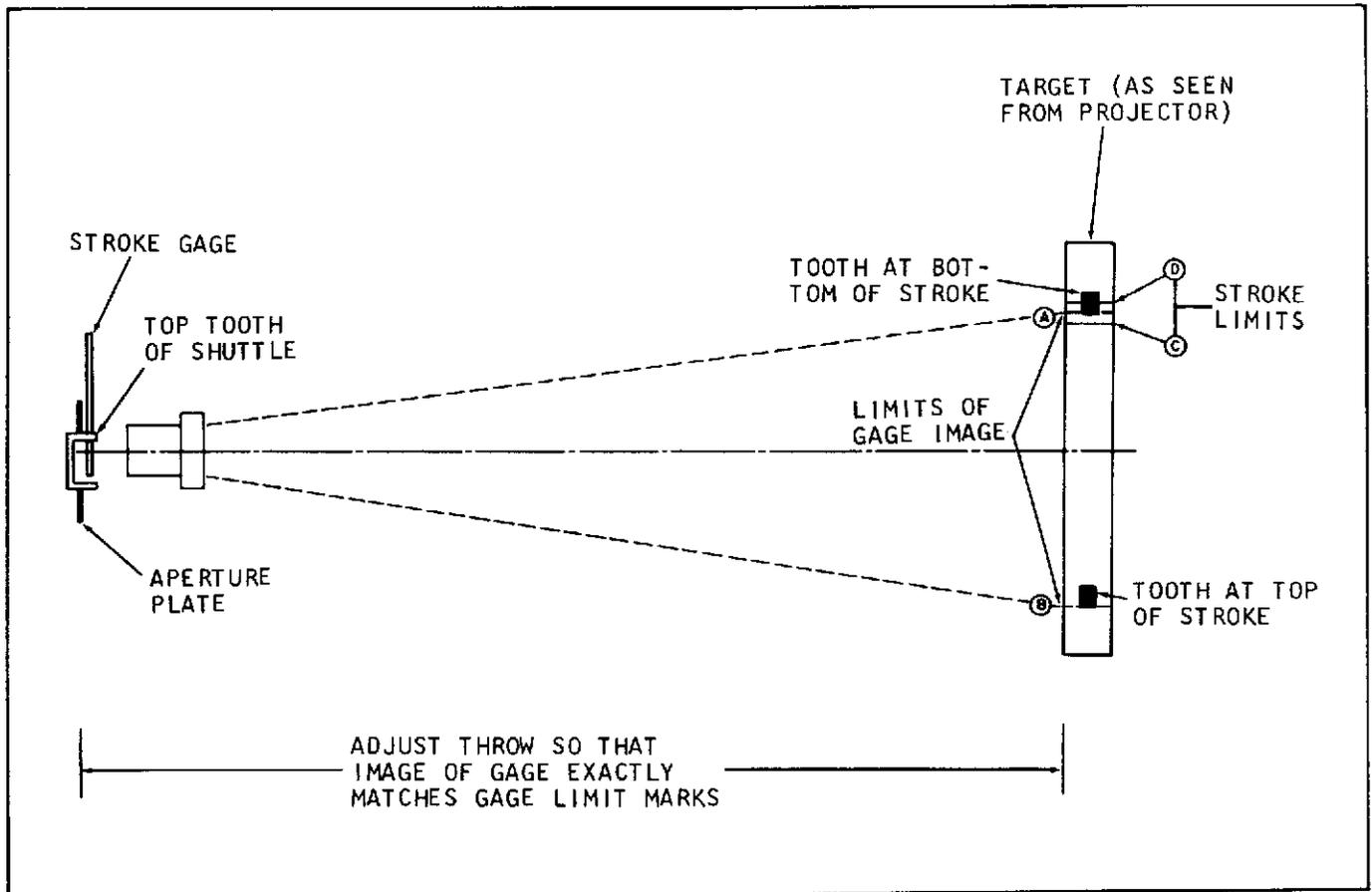


Figure M. Checking and Adjusting Shuttle Stroke with Target

d. **Checking Shuttle Stroke.** Normal shuttle stroke (vertical travel of shuttle teeth) is 0.3025 inches (Figure J). The most convenient means of measuring the stroke is to use the projector as an optical comparator. The step on the stroke gage (Figure A) is the length of the nominal stroke. When it is inserted in the aperture and projected, it provides a reference dimension with which the actual stroke can be compared. A sketch of a target is shown in Figure M. The A to B section is a 100 to 1 enlargement of the gage. The C and D lines represent 100 to 1 enlargements of the limits of tolerance.

(1) Procedure for Measuring Shuttle Stroke.  
(See Figure M.)

- (a) Move the load lever down to the load position. Remove pressure plate assembly from the lens carrier.
- (b) Set the framer knob at the mid-point of its over-all travel.
- (c) Suspend the target approximately 18 feet from the projector with center of target on same horizontal line as optical axis of projector. If room arrangement necessitates tilting projector, target must also be tilted so that angle

between target and optical axis is 90 degrees. If this is not done, "Keystone" error will be produced.

- (d) With the lens carrier open turn the projector mechanism by hand until shuttle is at bottom of stroke and shutter just clears aperture.
- (e) Insert stroke gage (SER-550-5-N2) in the aperture plate and lightly press it down against the top tooth of the claw. Close the lens carrier with the load lever.
- (f) Turn on the projector lamp and focus the image of the shuttle slot on the target. Move projector toward or away from the target until a sharply focused image of the step at end of stroke gage just reaches from line A to line B (Figure M).
- (g) Slide the stroke gage up out of field-of-view and turn mechanism pulley until center tooth of shuttle is at top of stroke indicated by image of tooth near line A. Adjust framer, if required, until projected image of edge of tooth just touches line A.

- (h) Turn mechanism pulley until center tooth of shuttle reappears at top of target. Rock mechanism pulley to find top of shuttle stroke. Edge of tooth used as reference in step (g) must fall between lines (C) and (D) (Figure M). If image falls between (C) and (A), stroke is too short. If image falls beyond (D), stroke is too long.

(2) Procedure for Adjusting Shuttle Stroke. Loosen the two shuttle plate mounting screws just enough to permit movement of the shuttle arm plate.

- (a) To lengthen the stroke, shift the shuttle arm plate toward the pull-down cam.
- (b) To shorten the stroke, shift the shuttle arm plate assembly away from the pull-down cam.
- (c) After adjusting stroke, recheck shuttle tooth side clearance as instructed in paragraph 36, step a, and readjust if necessary.

**CAUTION:** Do not attempt to eliminate film slap by setting stroke outside established tolerance. This will produce double image and/or jump with films having different shrink or stretch.

e. Framing Adjustment. Thread projector with film having proper frame line position. Project film and turn framing knob from one limit to the other. If at one limit a frame line is not visible, loosen nut on the framing eccentric located at top of shuttle arm plate assembly (Figure B) and turn eccentric until the frame line appears. Hold eccentric while tightening nut. Check adjustment by again turning framing knob from limit to limit while observing picture. When the eccentric is properly adjusted, either frame line can be projected and movement of film should be approximately equal at top and bottom of framer travel.

37. ADJUSTING THE REEL ARMS AND REWIND CLUTCH.

a. Front Reel Arm Adjustment (See Figure 6). Adjust end play of the shaft (14) to 0.008 inch  $\pm$  0.003 inch by positioning retaining ring (11) against an 0.008 inch shim. The backlash for both face gears should be between 0.005-inch (minimum) and 0.016-inch (maximum). Adjustment is made by loosening the face gear setscrews (5A), (8) and (8A) and repositioning the face gears (5B) and (9) as necessary.

b. Rear Reel Arm Adjustment (See Figure 7). Adjust end play of the shaft (31) to 0.008 inch  $\pm$  0.003 inch by positioning retaining ring (28) against an 0.008 inch shim. The backlash for both face gears should be between 0.005-inch (minimum) and 0.018-inch (maximum). The upper gear (27) is adjusted by loosening its setscrew (26) and repositioning the gear as necessary. The lower gear (14) is adjusted

by loosening the setscrew (13) in the tapped hole of the arm and shifting the shaft (16) in and out as necessary.

c. Rewind Clutch Adjustment. The rewind clutch system must be adjusted to produce a supply spindle torque of 5-1/2 to 6 inch-ounces when the rewind button is pressed during operation. Install an empty reel on the supply spindle and wrap several turns of a ten-inch film strip around the reel hub. Hook a spring scale to the free end of the film strip. Turn on the projector, rotate the "Motor-Lamp" switch to "Reverse" and press and release the rewind button at the top of the mechanism housing. The spring scale must register between 2.5 and 4.5 in.-lbs. When the rewind clutch system begins to slip. Take-up torque is adjusted by means of the take-up clutch assembly (item 7, Figure 4). Grip the flats on the inner face of the clutch with a wrench while loosening or tightening the nut on the clutch hub. Rewind torque (also 2.5 to 4.5 in.-lbs.) is adjusted by means of the rewind clutch assembly (item 47, Figure 4). This clutch is installed with the adjusting nut facing inward toward the mainplate, and a special wrench (item 6, Figure A) must be used for the adjustment.

38. ADJUSTING THE SOUND SYSTEM.

a. Photocell Alignment (Figure 8).

- (1) Loosen the setscrew (34), locking screw (32) and the two housing screws (37). Remove the exciter lamp and the optical slit (33).
- (2) Insert the sound drum alignment tool into the optical slit opening.

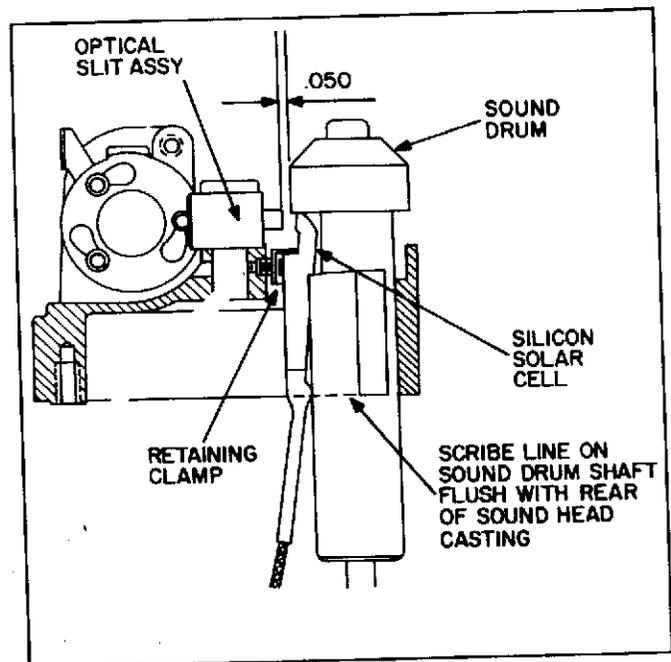


Figure N. Positioning the Sound Drum and Silicon Cell

- (3) Press the sound drum in until its inner face just makes contact with the first step, or bearing surface, of the alignment tool, and maintain this contact while tightening the two screws (37) securely.
- (4) Withdraw the alignment tool and, while looking into the optical slit mounting hole, shift the photocell (36) until its forward tip is flush with the inner face of the sound drum. Maintain this position while tightening the setscrew (34).

b. Stabilizer Roller Tension Adjustment (Figure C). The stabilizer roller at the right end of the stabilizer arm protrudes through the vertical slot in the mechanism housing. Adjust the long adjusting screw (18) until the counter-balance spring (7) applies enough tension to lift the roller slightly from the bottom of the slot.

c. Optical Slit Adjustment (Figure 8).

- (1) Insert the optical slit (33) into its opening in the soundhead. The adjusting holes in the barrel of the slit must be at top center.
- (2) Insert a 0.050-inch feeler gage between the tip of the optical slit and the sound drum and press the optical slit in against the feeler gage. Hold in this position while tightening the locking screw (32) just enough to hold the slit in place.
- (3) Thread the projector with 7000 CPS optical setting film and connect a 16-ohm, 10-watt load resistor and output meter to the speaker jack.

NOTE: A pair of hairpin tongs approximately 6 inches long and formed with the ends turned inward and tapered to engage holes in end of slit barrel are very useful in adjusting the optical slit. They can be made from 20 to 26 gage music wire or 1/16 inch diameter drill rod.

- (4) Set the volume control at approximately 12 o'clock position and start projector. Move slit toward or away from film, as required, to obtain an output reading. Rotate the slit to obtain peak reading and simultaneously move in or out until maximum output is obtained. If film was threaded with emulsion toward the optical slit, move slit toward film until output drops 1-1/2 to 2 DB. If emulsion is toward sound drum, move slit away from film to obtain 1-1/2 to 2 DB drop in output. Tighten slit clamping screw (32) securely to lock the adjustment.

d. Buzz Track Adjustment (Figure 8). The lateral position of the film at the "soundhead" location is controlled by the impedance roller (20). The precise distance of this roller to the surface of the mechanism housing is adjusted by turning the roller shaft in or out of the tapped hole in the housing.

- (1) Loosen the hex locking nut (20A) to permit roller shaft adjustment.
- (2) Connect a vacuum tube voltmeter with 8-ohm load to the speaker jack output, and thread the projector with buzz track test film.
- (3) Turn the rotary switch to "Forward-Run" position and adjust the volume control to a suitable listening level.
- (4) Adjust the lateral position of the impedance roller by screwing the shaft in or out until a minimum voltage output reading is obtained. Hold the shaft steady at this point and tighten the locking nut down against the roller arm stud. Remove the buzz track film and voltmeter.

NOTE: There are two types of buzz track film in common use. On one, the track spacing exceeds the length of the scanning beam, and the track can be positioned so that little or no signal is reproduced. On the other type, track spacing is less than the length of the scanning beam. This track should be positioned so that both tones are reproduced at approximately the same volume level.

39. PROJECTOR SPEED CHECKS. Speed of the projector is not adjustable. Therefore, speed checks are primarily for the purpose of determining that the equipment is operating properly and as a means of detecting excessive mechanism loads, damaged drive belt or similar conditions.

a. Methods of Measurement. Various devices and procedures can be used to check projector speed. The most common ones are as follows:

- (1) Photocell and Frequency Meter. Used to measure the number of pulsations of the projection beam per second. Pulsations per second is then converted to projector speed. This method is quite practical in large volume shops.
- (2) Strobatac or Similar Strobe Light. Usually synchronized with interrupter shutter of shuttle. Shutter makes one revolution per frame. Shuttle makes one stroke per frame.
- (3) Tachometer (Preferably Having a Speed Range with a Maximum Speed of 150-200 RPM). Used to measure RPM of the sprocket.
- (4) Strobe Disc. Attached to sprocket by means of suction cup or rubber foot. For viewing with light from 60 Hz source, disc should have 70 dots for sound speed, 93 dots for silent speed. Count number of apparent revolutions of pattern for one minute. If pattern drifts in direction of rotation, add to design speed to obtain true speed. If pattern drifts against rotation, subtract from design speed to obtain true speed.

- (5) Timed Loop. Make loop of exactly 120 frames. At sound speed splice will pass aperture 12 times per minute plus or minus the permissible variation in speed and the timing error.

b. Speeds at 120 Volts AC, 60Hz.

- (1) Sound Speed (24 FPS  $\pm$  2%).  
 Shutter - 1440 RPM  $\pm$  2%  
 Sprocket - 102.86 RPM  $\pm$  2%
- (2) Silent Speed (18 FPS  $\pm$  5%).  
 Shutter - 1080 RPM  $\pm$  5%  
 Sprocket - 77.1 RPM  $\pm$  5%

**40. GEAR SHIFT TENSION ADJUSTMENT.** When shifting from forward to rewind, or vice versa, the idler gear arm (Figure P) should pivot smoothly to effect the engagement of the idler gear with gear "A" or gear "B." This can be checked by rotating the drive belt pulley manually, first in one direction and then the other. If the pivoting action seems hesitant, increase the tension on the arm assembly by pressing the retaining ring more firmly on the spur gear shaft until the bowed washer (Figure P) is flattened against the face of the gear.

**41. IDLER GEAR BACKLASH ADJUSTMENT.** In both the forward and rewind positions, there must be a perceptible amount of backlash between the idler gear and gears "A" and "B," Figure P. As the idler arm pivots, a stop pin protruding at the upper end of the arm rides the slightly curved rim of the adjustment bracket from one limit stop to the other. Check gear backlash at both limit stops. If there is no backlash at one stop and too much at the other, loosen the adjustment bracket screws and shift the bracket slightly to balance the backlash in both positions.

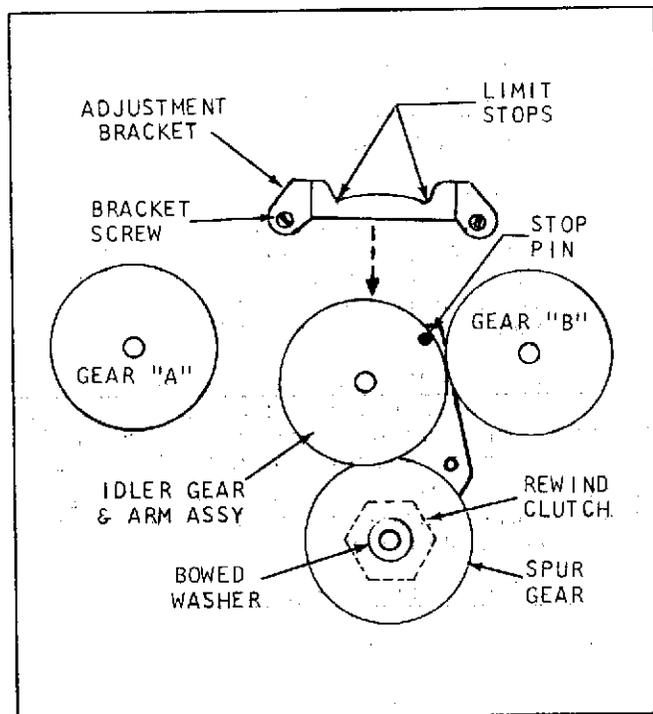


Figure P. Adjusting Gear Shift Tension and Backlash

**42. SETTING THE LOAD LEVER (Figure Q).**

Place the load lever in the open (down position) and loosen the setscrews that secure the lever into the mode selector bushing. Withdraw the lever from the bushing enough to expose the flat on the large diameter of the lever shaft. Hold the flat end of a No. 43 drill perpendicular to the ground flat of the lever and push the lever in until the shoulder of the flat is against the drill. Hold in this position while tightening the outer setscrew securely. Apply Loctite to the threads of the inner setscrew and tighten securely. Shift the lever to the closed (up) position and install the lens carrier cover. The load lever must be as close as possible to the cover but must be free to move without interference.

**43. ADJUSTING BRAKE ARM RELEASE.**

a. Place load lever in down (gate open) position and control switch at OFF, and loosen the brake arm screw (item 6, Figure F-1) slightly.

b. Hold a 0.047 inch (1.20mm) shim against the knurl of the flywheel and manually press and hold the neoprene brake roller against the shim while retightening the screw. Remove the shim and flex the cable release system by lifting the cable end of the cam follower (8, Figure F-1) and then releasing it.

c. Operate projector and check flywheel rotation. If neoprene roller slows or stops the flywheel, re-adjust clearance as above or adjust cable tension by engaging cable in a different groove of the sheave (item 12, Figure F-1).

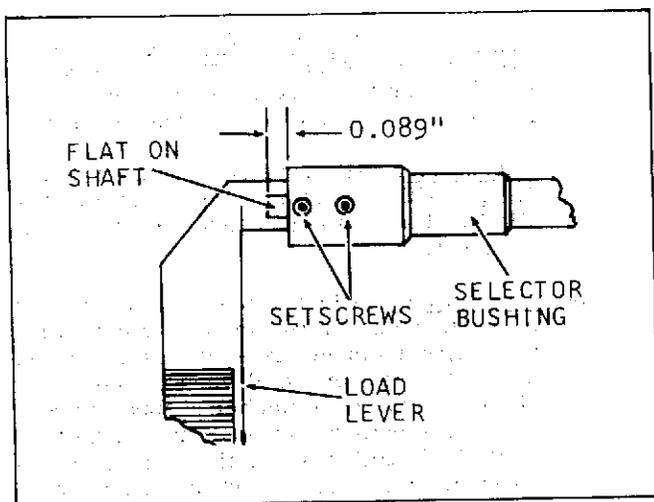


Figure Q. Setting the Load Lever

## *Trouble Shooting*

### 44. MISCELLANEOUS TROUBLES AND REMEDIES.

TROUBLE	PROBABLE CAUSE	REMEDY
Nothing runs	1. Defective rotary switch.	1. Replace switch.
	2. Damaged power cable.	2. Repair or replace cable.
	3. Loose connections.	3. Repair connections.
Motor hums but does not run	1. Starting circuit open or shorted.	1. Repair loose or transposed connections Replace defective capacitor and/or relay.
Motor runs but mechanism does not run	1. Damaged switch.	1. Replace switch.
	2. Transposed leads on main switch.	2. Connect leads to proper terminals.
	3. Drive belt broken or unhooked from pulley.	3. Replace or reinstall drive belt.
	4. Motor pulley loose on shaft.	4. Position pulley and tighten setscrews.
Rewind does not operate	1. Rewind clutch not engaging or clutch slipping.	1. Adjust (paragraph 37, step c).
Take-up does not operate	1. Take-up sprocket damaged.	1. Replace sprocket.
Feed spindle does not rotate	1. Dirt in reverse take-up clutch.	1. Clean clutch.
Gate will not lock	1. Latch spring set too close to lens mount stop.	1. Adjust latch spring.
	2. Pressure plate out-of-line.	2. Realign pressure plate.
Short lamp life	1. Line voltage in excess of lamp voltage.	1. Use lamp of correct voltage rating.
	2. Drive belt broken or disengaged.	2. Replace or re-engage belt.
	3. Dirt and lint clogging blower housing.	3. Clean.
Projector speed slow	1. Binding in the mechanism.	1. Free binding condition.
	2. Belt slipping.	2. Clean or replace belt.

## 45. PICTURE TROUBLES AND REMEDIES.

TROUBLE	PROBABLE CAUSE	REMEDY
Film jump	1. Damaged film.	1. Repair or replace.
	2. Loose shuttle arms.	2. Adjust and tighten (paragraph 36, step c).
	3. Dirty film aperture.	3. Clean film aperture.
	4. Damaged or lost pressure plate spring.	4. Replace spring.
	5. Pressure plate misaligned.	5. Realign pressure plate.
	6. Incorrect shuttle stroke.	6. Adjust (paragraph 36, step d).
Double image	1. Incorrect shuttle stroke.	1. Adjust (paragraph 36, step d).
	2. Excessive shuttle protrusion.	2. Adjust (paragraph 36, step b).
Weave (due to faulty aperture plate)	1. Sticking edge guide.	1. Clean guide.
	2. Side tension spring missing.	2. Replace spring.
	3. Fixed edge guide out of position.	3. Reposition guide.
Poor illumination	1. Optics out-of-line.	1. Realign (paragraph 35).
	2. Projection lamp wearing out.	2. Replace projection lamp.
Poor focus	1. Dirty lens and/or aperture.	1. Clean lens and/or aperture.
	2. Warped film.	2. Recondition or replace film.
	3. Pressure plate spring lost.	3. Replace spring.
	4. Bent pressure plate.	4. Replace pressure plate.
	5. Pressure plate out-of-line.	5. Realign pressure plate.
Frame line creeps	1. Framer eccentric loose.	1. Align and tighten (paragraph 36, step e).
Insufficient framing	1. Framer eccentric out of adjustment.	1. Adjust (paragraph 36, step e).
Trailer ghost	1. Shutter out-of-alignment.	1. Reassemble properly.

46. FILM TRANSPORT TROUBLES AND REMEDIES.

TROUBLE	PROBABLE CAUSE	REMEDY
Loss of loops	1. Damaged film.	1. Repair or replace film.
	2. Inadequate shuttle protrusion.	2. Adjust (paragraph 36, step b).
	3. Inadequate or excessive shuttle stroke.	3. Adjust (paragraph 36, step d).
	4. Pressure plate spring lost.	4. Replace spring.
	5. Pressure mounting plate screws loose.	5. Tighten mounting screws.
	6. Sprocket guards not closing.	6. Clean or adjust.
	7. In-out bracket spring broken.	7. Replace spring.
Excessive film slap	1. Damaged film.	1. Recondition or replace.
	2. Green film.	2. Age or buff film.
	3. Dirty pressure plate.	3. Clean pressure plate.
	4. Pressure plate rubbing on aperture plate guide rails.	4. Realign pressure plate.
	5. Incorrect shuttle stroke.	5. Adjust (paragraph 36, step d).
Splices jam in sprocket shoes	1. Bad splices.	1. Replace splices.
	2. Emulsion build-up.	2. Clean film path components.

46. SOUND SYSTEM TROUBLES AND REMEDIES.

Projector runs, no voltage at P.C. board	1. Loose connection.	1. Repair connection.
	2. Amplifier switch damaged.	2. Replace P.C. board.
Projector runs, voltage at P.C. board, but exciter lamp does not light	1. Exciter lamp cable disconnected.	1. Connect cable.
	2. Wrong exciter lamp used.	2. Replace with correct lamp.
	3. Projector rotary switch open or leads reversed.	3. Replace rotary switch or connect leads.
Voltage at P.C. board, exciter lamp lights, but no sound	1. Speaker jack disconnected or speaker jack switch open.	1. Connect leads. Repair or replace jack.
	2. Photocell cable disconnected or leads reversed.	2. Connect cable. Connect leads to proper terminals.
	3. Photocell out-of-line.	3. Realign (paragraph 38, step a).
	4. Dirt on end of photocell.	4. Clean photocell.
	5. Wrong exciter lamp used.	5. Replace with correct lamp.

## 47. SOUND SYSTEM TROUBLES AND REMEDIES (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
Low volume	1. Trouble in amplifier circuit board.	1. Check out the circuit board; replace if faulty.
	2. Wrong exciter lamp used.	2. Replace with correct lamp.
	3. Photocell out-of-line.	3. Realign (paragraph 38, step a).
	4. Dirt on photocell or slit.	4. Clean photocell and slit.
	5. Slit misaligned.	5. Realign (paragraph 38, step c).
	6. Buzz track misaligned.	6. Realign (paragraph 38, step d).
Distortion at all volume levels	1. Wrong exciter lamp used.	1. Replace with correct lamp.
	2. Trouble in amplifier circuit board.	2. Check out the circuit board; replace if faulty.
Crackling noises	1. Broken ground lead to mainframe.	1. Replace defective lead.
	2. Buzz track out-of-line.	2. Realign (paragraph 38, step d).
	3. Broken cable shield.	3. Repair shield or replace cable.
Wow or flutter	1. Stabilizer guide roller sticking.	1. Clean roller and roller shaft.
	2. Stabilizer guide roller spring broken, unhooked or lost.	2. Repair or replace spring.
	3. Loose flywheel.	3. Tighten flywheel.
	4. Damaged sound drum bearing.	4. Replace sound drum.
	5. Dirt causing guide roller arm pivot bearing to bind.	5. Clean and polish.
	6. Photocell or exciter cable rubbing against flywheel.	6. Reposition cables.
	7. Chips or dirt in take-up sprocket gear teeth.	7. Remove and clean sprocket gear.
Clicking noises	1. Dirt on sound drum.	1. Clean sound drum.
	2. Broken ground lead to mainframe.	2. Replace lead.
High frequencies fade (jumps focus)	1. Warped film.	1. Recondition or replace film.
	2. Dirt on sound drum.	2. Clean sound drum.
Hum	1. Ground wiring.	1. Correct grounded condition.
	2. Trouble in amplifier circuit board.	2. Check out the circuit board; replace if faulty.

## *Product Improvements*

The Bell & Howell Company is continually striving to improve the design and performance of all the products which we manufacture. As product improvements are tested and approved, the information required for making these improvements will be issued to all service stations. These "Product Improvement" sheets should then be inserted at the end of this section of your manual.

TOPIC I	- CORRECTING FILM SKEW	PG 39-40
TOPIC II	- CORRECTING FILM THREADING PROBLEMS	PG 41
TOPIC III	- CORRECTING "NO-RUN" CONDITION	PG 42
TOPIC IV	- CORRECTING NOISY REVERSE OPERATION	PG 43
TOPIC V	- CORRECTING SPROCKET NOISE	PG 44

TOPIC 1 - CORRECTING FILM SKEW

**SYMPTOMS:** Film skew is characterized by a loss of sound when the film "tracks off" of the sound drum at any place in the film length. To correct this condition, proceed as follows.

a. Refer to Figure A and thoroughly clean the impedance roller (item 3) and the sound drum (item 4) with Toluol and, if necessary, using an orange stick to loosen hardened emulsion.

b. Close the film track with the load lever. Grasp the adjusting plate (item 8) with thumb and forefinger as indicated in Figure A, and attempt to move the plate up and down. If the plate moves, proceed to step c, following. If the plate does not move, skip step c and proceed to step d.

c. If the plate moves, adjustment must be made with the sprocket plate adjusting tool (see Figure A, inset). Loosen the screw (item 9, Figure A) and insert the pin end of the adjusting tool down into the sprocket plate slot and with the large diameter of the tool fitting into the adjustment plate hole above the slot. Slowly rotate the tool clockwise to the point where resistance is noted. Do not use force to rotate the tool beyond this point of resistance. Hold the tool steady while tightening the screw (item 9); then remove the tool. Open and close the system with the load lever. Switch the projector to "forward" and the motor should run. If the motor does not run, refer to Topic No. III for correction.

d. With the film track "open," thread film through the system to the take-up reel. Check that the film lines up with the film track and tuck in where necessary. Close the system and turn the main control knob to forward only. Open the lamphouse and check the position of the stabilizer roller (item 5, Figure A). The roller must be centered in its slot when running. If necessary, adjust roller position by turning the adjusting screw located in the top of the mechanism housing in the approximate area of arrow (1), Figure A. Turn the screw clockwise to lower the roller; counterclockwise to raise the roller.

e. The impedance roller adjustment plate (item 2) should be positioned with its notch at approximately "12 o'clock." If adjustment is necessary to reposition the notch, push upward on the plate while tightening the screw that secures the plate. Grasp the impedance roller (item 3) between thumb and forefinger and lift the roller straight upward. The system must not bind. If binding occurs, readjust the plate (item 2) up or down until binding is eliminated.

**NOTE:** If the above procedure fails to eliminate film skew because binding at the impedance roller

and arm assembly (step e, above) cannot be eliminated, the following additional corrections should then be made. Projector models bearing serial number 2776001 and above will not be affected since they already include these improvements.

f. Replace the impedance roller assembly (item 20, Figure 8) with the new roller assembly P/N 077182. The new roller assembly is readily identified as being in three pieces rather than one machined piece as previously used. After installing the new impedance roller, check it for proper operation as follows: Place the load lever in the "load" position. Remove the screws (11, Figure A) and slide the lifter (12, Figure A) out from under the impedance roller. Grasp the impedance roller with thumb and forefinger and move the roller up and down. If the roller moves freely, adjust the roller as outlined in paragraph 23, step g, of the manual. Then reinstall and adjust the lifter as outlined in Topic No. III, step d.

**NOTE:** If installation of the new impedance roller does not eliminate the binding condition at that point, the shoulder screw that attaches the roller arm (item 13, Figure 9) to the back of the mechanism casting on earlier models must be replaced with the stud (9-11), washer (9-11A) and grip ring (9-11B). In order to accomplish this change, the projector mainframe must be detached from the base. Proceed as follows (steps g through k).

g. Remove the back cover, the speaker end cap, the lens carrier cover, the exciter lamp cover and the exciter lamp, and set these parts to one side.

h. Remove the two rear end cap screws located under the rear reel arm; then open the lamphouse cover and remove the two screws below the lamp assembly. These screws secure the rear of the mainframe. Free the front of the mainframe by removing (1) the screw located behind the exciter lamp and the impedance roller spring and (2) the screw located through a hole in the mainframe casting about two inches below the sound drum guide roller.

i. Lift the mainframe high enough to disconnect the edge connector from the exciter lamp P.C. board. Continue to lift the mainframe until the flywheel clears the base casting and the tilt foot. Be careful not to hit the flywheel or damage the small P.C. board.

j. Remove the flywheel from the sound drum shaft. Remove the early style shoulder screw attaching the rear end of the impedance roller arm and install the threaded stud P/N 709144 in its place. Secure the arm with the washer P/N 41605

and grip ring (P/N 31038), using a 0.004-inch (0.10 mm) shim gauge to provide proper clearance. Use a Waldes No. 02 grip ring pliers to assemble the grip ring. Reassemble the flywheel to the sound drum shaft and reconnect the edge connector to the small P.C. board.

k. Remount the main plate to the base and the rear end cap by reversing the screw installation (step h). Then reinstall the exciter lamp, front end cap and all covers.

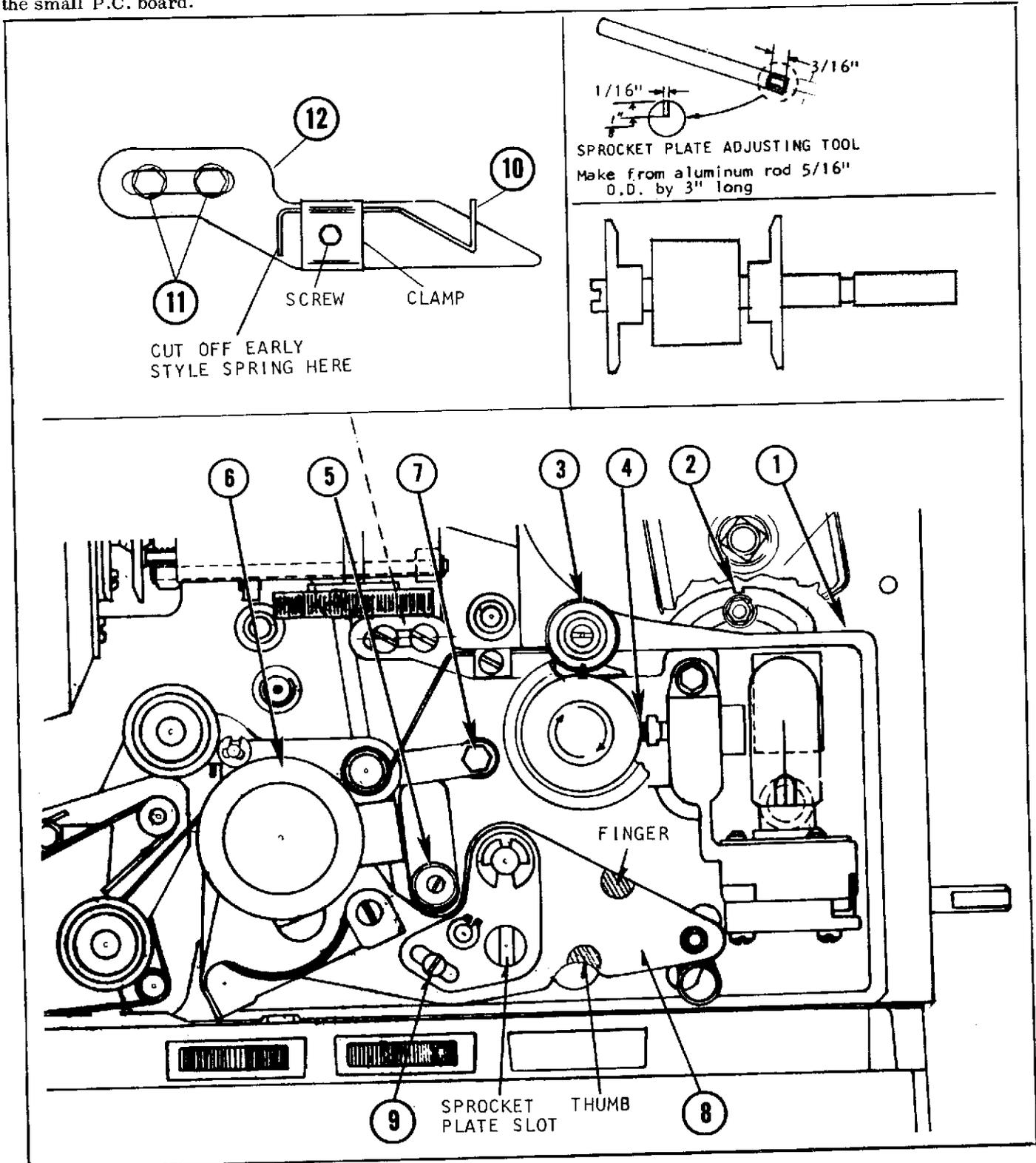


Figure A. Film Skew Correction

## TOPIC 11 - CORRECTING FILM THREADING PROBLEMS

**SYMPTOMS:** If the film does not easily enter the film slot or will not properly enter the film track as it is pulled through the projector, this condition may be corrected as follows.

a. Check the entire length of the film (including film patches) for places where the film may be catching on any area in the projector film path.

b. If the film appears to be catching at the lower sprocket guard, remove and check the exciter lamp cover P/N 016557. All current covers are provided with an additional tab (the cross-hatched area in Figure B). If the cover does not have this tab, replace it with a current cover. This cover should be replaced at no charge if the projector serial number is below 6247001.

c. If the film appears to be catching on the film stripper (behind the sprocket (6), Figure A), loosen the lamphouse stop (item 7, Figure A) and push and hold the stripper down while retightening the lamphouse stop.

d. If the film is catching on the impedance roller lifter spring (item 10, Figure A), cut off the rear leg of the spring at the point shown in Figure A so that there is a gap between the spring and the sound drum threading roller. Open the film gate with the load lever and loosen the roller lifter mounting screws (item 11, Figure A). Shift the lifter (12) so that the screws are laterally centered in the elongated lifter slot and the upper edge of the lifter is parallel with the lens casting. The right-hand finger of the spring should be positioned approximately under the center of the screw head of the impedance roller (item 3, Figure A) and the impedance roller shaft must not be touching the mechanism casting. Hold the roller lifter securely while tightening the two screws (item 11, Figure A).

e. If the film does not appear to be catching at any of the above points, follow the film skew correction procedure outlined in Topic No. 1.

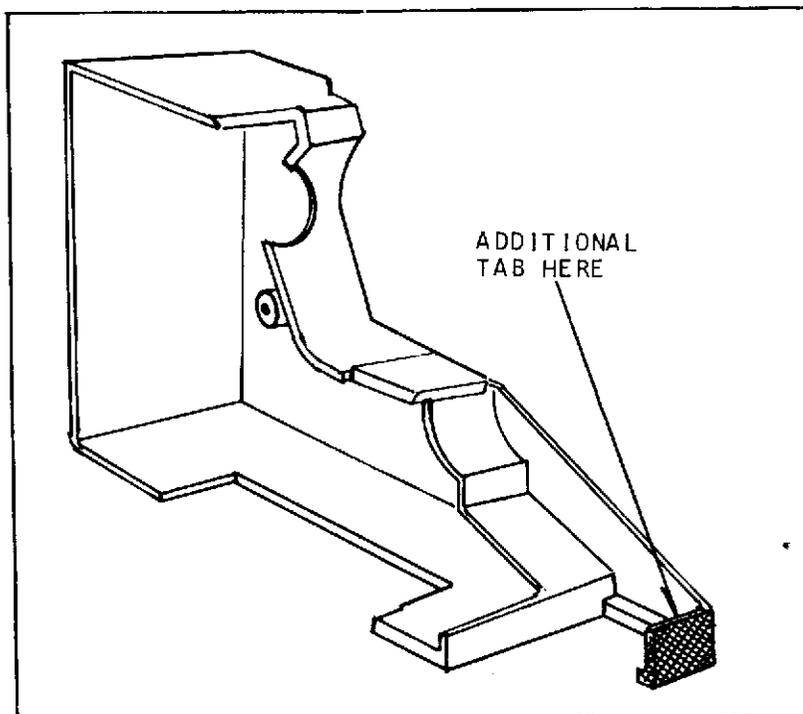


Figure B. Current Exciter Lamp Cover

### TOPIC III - CORRECTING "NO-RUN" CONDITION

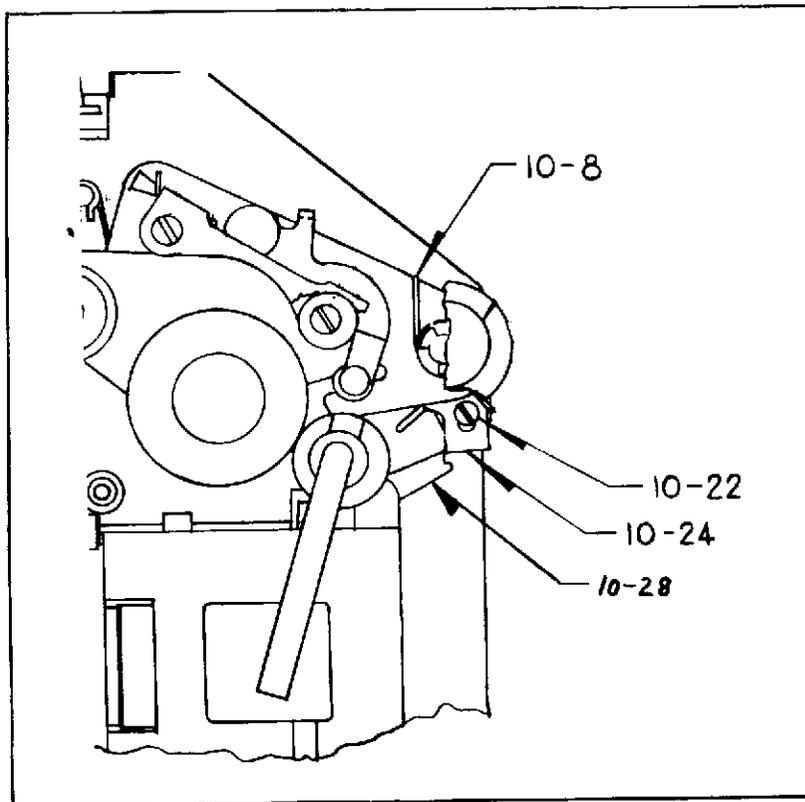
**SYMPTOM:** Film has been properly threaded and the load lever is at the No. 3 position (film path closed), but the projector fails to turn on when the control knob is turned to the "project" position. If you have verified the reliability of the electrical system (motor, switch, wiring connections, etc.), take the following corrective action.

a. First check visually to see that the lens carrier is fully closed. If the load lever is at the No. 3 position but the lens carrier is still not seated, check to see if something is interfering with the full seating of the lens carrier.

b. If the lens carrier is fully seated, check to see

that the mode selector latch (item 24 in Figure 10) is seated in the detent notch. If not, the latch must be readjusted so that it will properly activate the interlock switch. This is accomplished by loosening the screw (item 22 in Figure 10) and shifting the latch to engage the notch. Push the latch down until it just contacts the bottom of the notch and hold latch securely while retightening the screw.

c. The mode selector latch must detent in both the upper (locked) and lower (unlocked) notches and the projector motor should run in forward and reverse. If the motor still does not run, check the motor interlock switch adjustment as instructed in paragraph 22, step k, on page 17 of this manual.



Reference: Parts Catalog Figure 10

TOPIC IV - CORRECTING NOISY REVERSE OPERATION

**SYMPTOM:** If an objectionable noise occurs when the projector is run in reverse mode, the condition often can be remedied by resetting the stabilizer and impedance rollers as instructed in paragraph 49 (Correcting Film Skew). If this does not relieve the problem, proceed as follows.

a. Remove the rear cover from the projector to gain access to the gearing. Check to see if the projector model being repaired is equipped with the retractor lever (6B, Figure 9). If not, install the retractor lever as follows.

b. Remove the lower helical gear (44, Figure 8) and the existing idler gear (6, Figure 9). Save the retaining ring (5, Figure 9).

c. Assemble the bowed washer (6C, Figure 9); then the retractor lever (6B, Figure 9), positioning it as shown. Assemble the torsion spring (6A, Figure 9) to the idler gear (6, Figure 9), with the long spring leg down. Assemble the idler gear to the gear stud engaging the hook in the spring leg with the tab of the retractor lever and secure parts with the retaining ring (5, Figure 9). There should be an end play of 0.003 inch (0.08mm) in the gear. Turning the gear counterclockwise should cause the retractor lever to pull the stabilizer down.

d. Reassemble the projector and, with exciter lamp cover removed, run the projector in reverse. Observe to see that the stabilizer is pulled down away from the film.

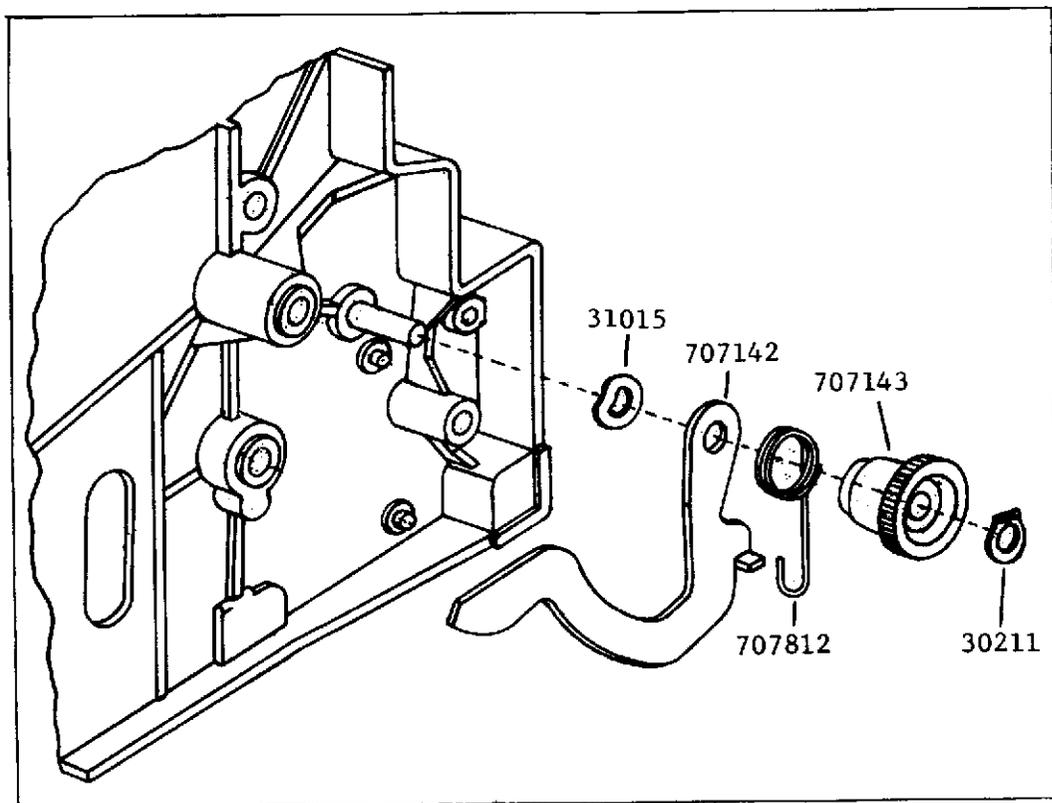
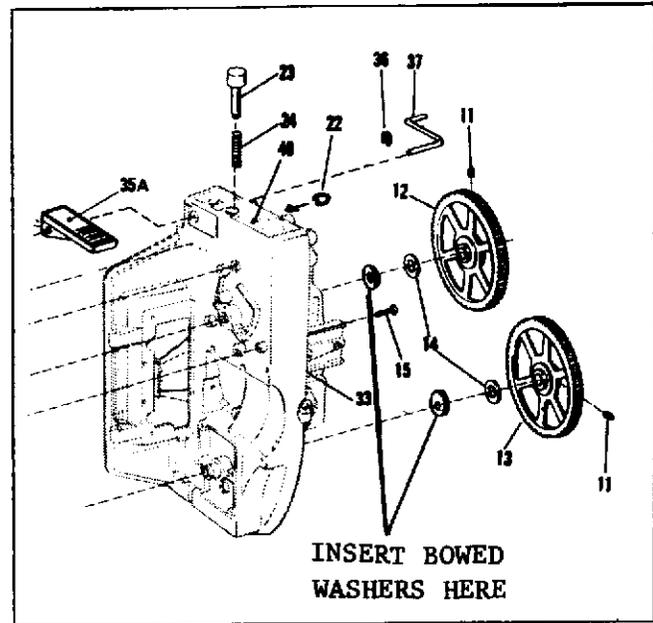


Figure C. Correcting Noisy Reverse Operation

## TOPIC V - CORRECTING SPROCKET NOISE

Noise problems emanating from the sprocket area of 1580 and 1680 Projectors can be reduced significantly by inserting one (1) bowed washer P/N 708640 between the sprocket gear washer and the end of the mechanism housing Oilite bearing on both upper and lower sprocket shafts as shown in Parts Catalog Fig. 8.



Reference: Parts Catalog Figure 8