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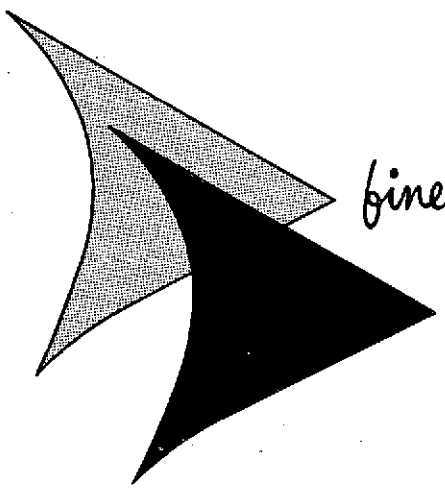
SERVICE INSTRUCTIONS

COMMERCIAL JAN PROJECTORS

DESIGNS 614CB, 614CBM, 614CBRM, 614CD



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Bell & Howell

GENERAL SERVICE DEPT.
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CHICAGO 45, ILLINOIS

PART NO. 620855A

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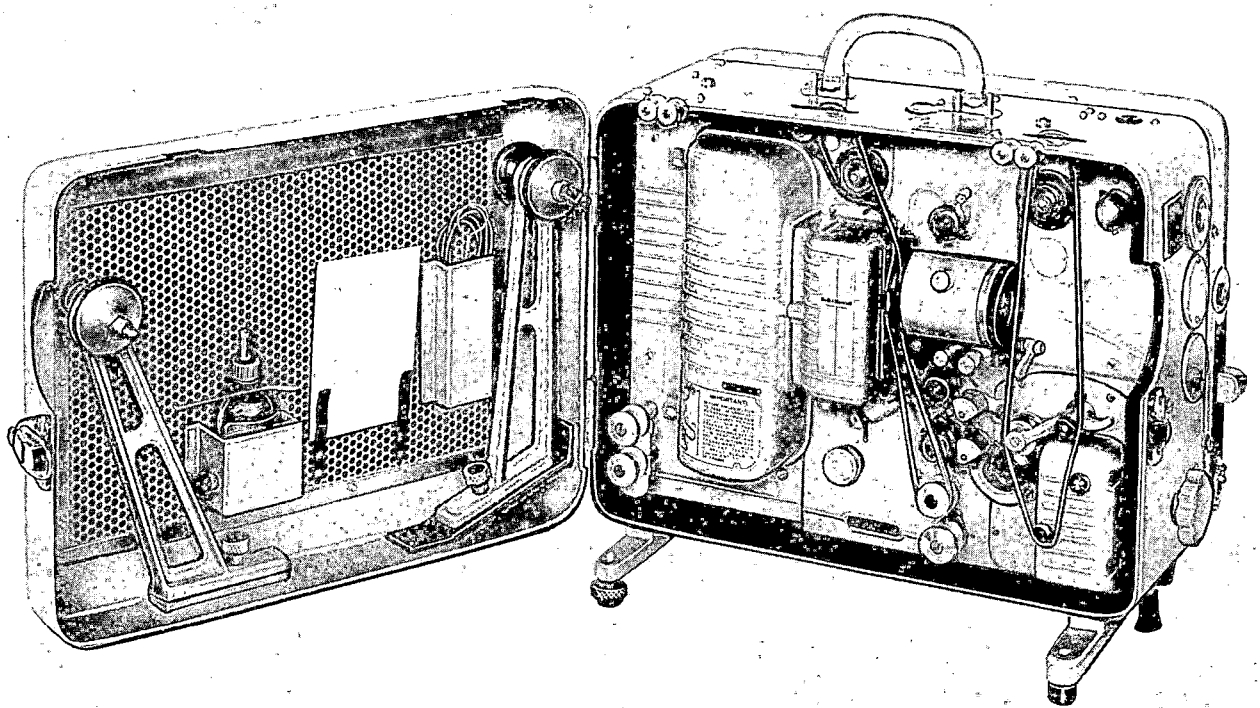


Figure 1. Design 614 CB Projector — Overall View

Introduction

This manual has been prepared to aid in servicing the Bell & Howell Design 614 16-mm Projector. Complete instructions for the disassembly, cleaning, repair, reassembly and adjustment of the projector are given in a step-by-step fashion. An illustrated parts catalog section is included at the rear of the manual to identify replacement parts for ordering purposes. The exploded view illustrations in the parts catalog section have been indexed in order of disassembly. The serviceman must use his own judgment in eliminating unnecessary steps of disassembly when making certain definite repairs.

Four models of the projector are covered in this book — 614CB, 614CBM, 614CBRM and 614CD. The 614CD is a commercial version of the projector presently being supplied to the Armed Forces. Although all four projectors are very similar in design and construction, the 614CD is outwardly distinguished by its twin line fuses (top front of projector case), fabric drive belts with adjustable tension rollers, lifetime lubrication system and newly designed case legs. Except when specifically noted, the general repair instructions contained herein will apply to all four models, with minor differences illustrated in the Parts Catalog exploded views by means of insets. Wiring schematics and the more complicated repairs and adjustments which are applicable only to the 614CD will be found in the addendum beginning on page 58.

The quality of service work performed will depend, to a large extent, upon the ability and ingenuity of the serviceman. Be sure to use the proper tools during actual disassembly and reassembly procedures, and be careful not to scratch or mar the equipment. During disassembly of the equipment, observe and remember the manner in which each part is installed. When a part has been removed, reinstall its attaching screws into their tapped holes to prevent loss and mix-up.

Take particular care when reassembling the projector. The customer expects his equipment to look and operate like new when it is returned. Touch up marred surfaces with matching paint (B-H SPEC No. 1148).

LUBRICANTS.

Due to the nature of the design of these projectors, it is imperative that only the following lubricants be used:

Oil — Bell & Howell Stock No. 611753
Grease — Standard Oil "Stanolith No. 42"

Internal lubrication for the 614CB, 614CBM and 614CBRM projectors is supplied through a one-point feed lubrication system. Oil is applied to the central oil well cup on top of the projector case and is fed through oil tubing to all bearings and to the intermittent mechanism reservoir. In 614CD projectors, the oil well cup and tubing have been removed. A felt pad below the shutter and shuttle camshafts is saturated with oil and feeds all parts of the intermittent mechanism through a system of felt wicks. Refer to the addendum sheets beginning on page 58 for wick replacement. CAUTION: Before returning a repaired 614CB, 614CBM or 614CBRM projector to customer, be sure to fill the oil well cup with 4 cc of oil and caution customer to check oil level before operation.

SPECIFICATION DATA

Film size	16-mm
Film reel capacity	2000 ft.
Film speed (CB and CBM)	16 and 24 fps
Film speed (CBRM and CD)	24 fps
Power supply	105-129 volts, 50-60 cycles
Power consumption	1300 watts
Projector lamp (25 hr. life)	1000 watt, 115-volt
Exciter lamp	6-volt, 1-amp
Threading lamp	120-volt, 6-watt
Photocell (614CB, CBM, CBRM)	Lead sulphide
Photocell (614CD)	germanium diode
Projector fuse (1 req'd)	15 amp
Amplifier fuse(2 req'd for 614CD)	0.8 amp, slow-blow
Drive motor (CB, CBM, and CD)	universal type with centrifugal governor
Drive motor (CBRM)	synchronous type
Ventilation	24-blade, motor driven, 3 in. diam. rotor
Amplifier input	0.4 volts
Power output	8 watts
Sound head output	high impedance
Tube complement (projector amplifier):	(2) 12AX7, (2) 6x4, and (3) 6AQ5
Tube complement (record amplifier):	(2) 12AX7, (1) 6x4, (3) 12AU7
Overall dimensions, complete projector:	14-1/2 in. high, 12-1/8 in. wide, 16-1/4 in. long
Approximate weight	48 lbs.

Disassembly Procedure

1. SPECIAL TOOLS.

The special tools illustrated in figure 2 are required to perform the overhaul procedures outlined in this handbook. Refer to the key to figure 2 for proper part number and nomenclature of tools.

2. GENERAL OVERHAUL INSTRUCTIONS.

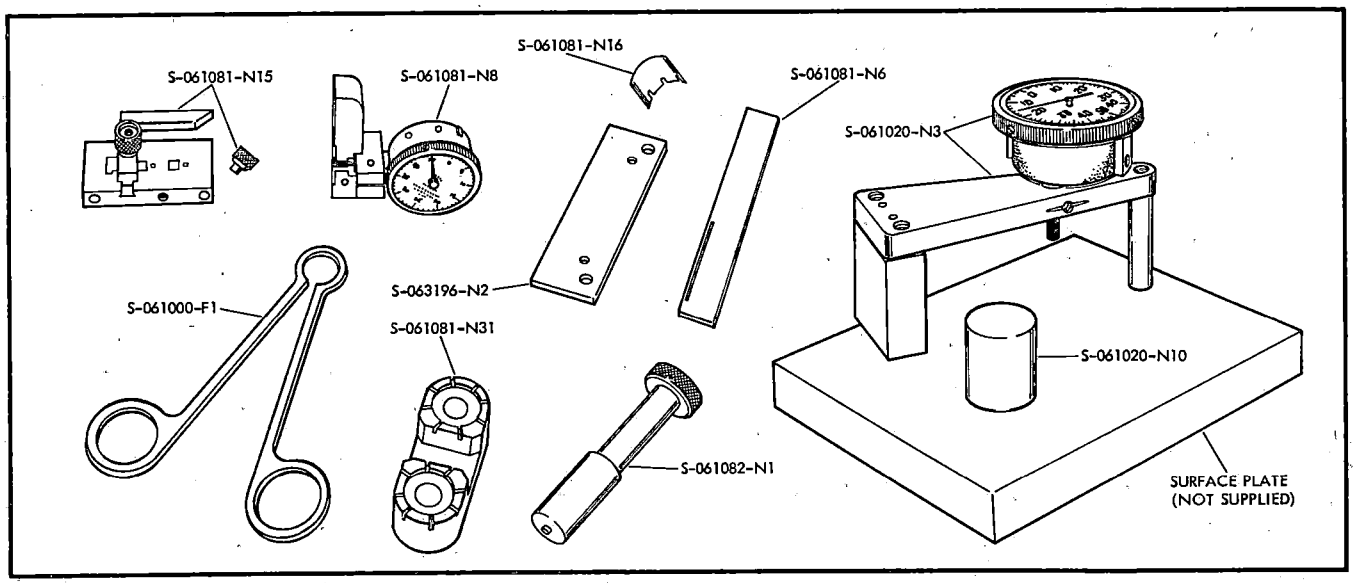
The following procedures provide for the complete disassembly of the projector, with each of its major components treated separately. Before performing all of the steps in the disassembly sequence, first attempt to localize the trouble by analyzing the customer's report with reference to the trouble shooting chart, the amplifier trouble analysis chart (Table III) and the equipment characteristics tests (Tables VII, VIII and IX). If a complete overhaul of equipment is indicated, perform the operations specified in the following paragraphs. Refer to the exploded views for disassembly of miscellaneous parts.

3. REMOVAL OF MAJOR COMPONENTS.

NOTE: Refer to the projector operation book for instructions pertinent to the removal of such items as the reel arms, pressure plate, aperture plate, condenser lens assembly, projection lamp parts, etc.

4. AMPLIFIER AND SPEAKER ASSEMBLY. (See Parts Catalog figure 1.) The amplifier housing is secured to the projector case by six screws (23) and lock washers (24) located at the top, front and bottom of the case and three screws (25) and lock washers (26) which also serve to fasten one edge of the switch plate (30) to the amplifier case. Remove these screws and carefully pull the amplifier away from the projector case until the leadwires are exposed. Disconnect leadwires as required, and separate the amplifier assembly from the projector case.

5. SWITCH PLATE ASSEMBLY. (See Parts Catalog figure 1.) Remove screws (28), lock washers (29) and junction box front plate (27). Remove screws (33 and 34), elastic cam lock stop nuts (35) and cable clamp (36) to free junction box. Unsolder fuseholder and receptacle leadwires within the junction box. Note wiring harness connections to various projector components. Two small, shielded wires from sound head assembly must be disconnected at the OFF-MOTOR-LAMP switch and unwound from harness. The ground terminal at one end of large, shielded harness is fastened to mechanism plate just behind projection lamp socket. Two leadwires must be disconnected from the lampholder behind the junction box. The



Part No.	Description	Part No.	Description
S-061000-F1	Sound optical tool	S-061081-N31	Sprocket synchronizing gage
S-061020-N10	Master block and plate	S-061081-N6	Shuttle alinement gage
S-061020-N3	Front cam shaft indicator gage	S-061081-N8	Shutter protrusion gage
S-061081-N15	Shutter and intermittent gage	S-061082-N1	Sound drum positioning gage
S-061081-N16	Sprocket film clearance gage	S-063196-N2	Aperture guide rail gage

Figure 2. Special Service Tools Required

two blower motor leadwires must be disconnected at the OFF-MOTOR-LAMP switch. Remove three switch plate screws (31) and lock washers (32), and carefully lift complete switch plate assembly (30), with wiring harness, from projector.

6. FRONT AND REAR MECHANISM PLATE. (See Parts Catalog figure 2.)

a. Loosen special hex nut (13) and remove loopsetter knob (14) from loopsetter rod.
b. Remove flywheel retaining screw (8) and carefully remove flywheel (7) from stabilizer shaft.
c. Check all leadwires and cables, loosening any cable clamps or freeing any leadwire terminals that might prevent removal of the mechanism plate.
d. Remove two binding head screws (16) and lock washers (17) and two hex head screws (26), lock washers (27) and flat washers (28) that secure the mechanism plate at the four vibration mounts.
e. Remove mechanism plate (15) through the door side of the projector — not through the amplifier opening.

7. DRIVE MOTOR ASSEMBLY. (See Parts Catalog figure 6.) Loosen set screw (14) and remove threading knob (13). Loosen the two screws in the idler roller bracket at the top of the drive motor, and shift bracket to the right to remove tension from drive chain (24). Disengage chain from sprocket above motor. Remove four screws (21), lock washers (22) and plain washers (23), supporting the drive motor to prevent it from falling. Carefully remove drive motor, disengaging drive chain from flexible drive coupling.

8. FEED AND TAKE-UP PULLEY ASSEMBLIES. (See Parts Catalog figure 16.) Loosen two screws (29) so that idler assembly (28) can be shifted to the right, thereby removing tension from drive chain (19). Slip drive chain from sprockets (17, 20 and 24). Loosen set screws (21 and 25), and remove sprockets (20 and 24), pulleys (22 and 26) and thrust washers (23 and 27) from mechanism plate.

9. LENS HOLDER ASSEMBLY. (See Parts Catalog figure 16.) Remove two screws (43), lock washers (44) and the lens holder stop plate (42). Slowly rack the lens holder assembly (45) forward by turning the knurled focusing knob on the lens mounting assembly (49) until the lens holder assembly is free. Be careful not to lose the friction button (46) and friction spring (47) located in a recess in the mounting assembly.

10. LENS MOUNTING ASSEMBLY. (See Parts Catalog figure 16.) Remove three screws (50 and 51) and one lock washer (52) and lift the lens mounting assembly (49) from the mechanism plate. Invert mounting assembly and permit guide disc (48) to drop into hand.

11. FEED REEL ARM ASSEMBLY. (See Parts Catalog figure 3.)

a. Remove nuts (3 and 4) and spring (5).
b. Tap out the driving pin (6) and remove spindle clutch assembly (7), clutch plate subassembly (8), and thrust washer (10). If necessary, press ball bearing (9) from clutch plate subassembly.
c. Remove spindle assembly (2), spindle pulley (11) and friction washer (12) from arm (15). If necessary, press thrust bearings (14) from arm.
d. Inspect parts for actual physical damage. Press bearings onto wooden dowels of snug fit and spin the bearing, noting any roughness in rotation which would indicate bearing balls or rollers with flat spots. Replace damaged parts.

12. TAKE-UP REEL ARM ASSEMBLY. (See Parts Catalog figure 4.)

a. Remove elastic stop nut (3), tension nut (4) and tension spring (5).
b. Tap out driving pin (6) and disassemble remaining parts from take-up arm (14).
c. Inspect parts for actual physical damage. Press the bearings onto wooden dowels of snug fit and spin the bearing, noting any roughness in rotation which would indicate bearing balls or rollers with flat spots. Replace all damaged parts.

13. SWITCH PLATE ASSEMBLY. (See Parts Catalog figure 5.)

Under normal circumstances, complete disassembly of the switch panel will not be necessary. Removal of parts for replacement can be accomplished by reference to Parts Catalog figure 5.

14. SOUND HEAD ASSEMBLY—614CB ONLY. (See Parts Catalog figure 7.)

NOTE: Refer to paragraph 29 for disassembly of sound head for 614CBM and CBRM projectors.

a. Remove retaining rings (3) and washers (4) and pull roller assemblies (1 and 2) from pivot studs (5). Refer to paragraph 15 for repair instructions for these roller assemblies.
b. Remove screw (8) and impedance roller assembly (7). Refer to paragraph 16 for impedance roller repair instructions.
c. Loosen set screws (10 and 11) and carefully withdraw stabilizer housing assembly (9). Refer to paragraph 17 for repair instructions for housing assembly.
d. Loosen cover screw (13) and remove lamp cover assembly (12). Move pin release cam (18) to extreme right-hand position, and lift out the exciter lamp (16). Lamp socket parts can be disassembled by removing lamp socket nut (17), screw (20) and lock washer (21), and three flat head screws (23).

CAUTION

The scanning lens (24) is pre-set by means of precision instruments for maximum efficiency and should not be disturbed unless it has been determined that this item requires replacement. If such is the case, remove screw (25) and withdraw the lens.

e. Loosen knob on photocell cover assembly (26) and lift off the cover. To remove photocell assembly

(37), take out screws (38) and lock washers (39) and disconnect cell leadwire lugs from terminal block (30).

f. Remove screws (31 and 34) and lock washers (32) to free terminal block (30). Note spacing collar (33) between terminal block and casting and hexagonal spacer nut (35) at front of terminal block. Disassemble remaining parts as required.

g. Replace all damaged parts. Photocell assembly replacement is determined by analyzing the accompanying customer report for the projector and by pretesting the equipment as instructed in the Test Procedure section, page 21.

15. JOCKEY ROLLER ASSEMBLY.
(See Parts Catalog figures 8 and 9).

NOTE: Both the upper jockey roller assembly and lower jockey roller assembly are covered by the following instructions. Except for the difference in roller housings, both assemblies are identical in construction.

a. Loosen set screw (2) and pull out roller shaft (3), thus freeing all parts of assembly. Do not press bearings (1 and 4) from housing (6) unless damaged.

b. Inspect roller for deep scratches, nicks or flat spots. Inspect shaft for bends and make certain that shaft bearing surfaces are not rough. Check housing for rough spots which might interfere with free rotation of roller.

16. IMPEDANCE ROLLER ASSEMBLY.
(See Parts Catalog figure 10.)

a. Loosen set screws (1 and 2) and unscrew the adjustable pivot pin (4). The slug (3) will drop into the housing (12) as pivot pin is withdrawn. Remove plain pivot pin (5) and lift roller (6) from housing.

b. Disassemble parts (7) through (11) from housing (12).

c. Inspect pivot pins (4 and 5) to make certain that tapered ends are not blunted or distorted. Check spring for broken ends. Make certain that bearings in roller are free of dirt, dust or other foreign substance. Inspect roller for deep scratches, nicks or flat spots.

17. STABILIZER HOUSING ASSEMBLY — CB, CBM, and CBRM only. (See Parts Catalog figure 11.)

CAUTION

Unless the tools mentioned in paragraph 39, step g, are available, do not attempt to disassemble the film scanning drum (2) and shaft (14) from the stabilizer housing.

a. Hold lock nut (10) with wrench and carefully remove sound drum nut (1). Pull film scanning drum (2) from shaft (14).

b. Remove screws (6) and carefully lift brackets (5), prism mount (8) and light pipe prism (7) from housing (15). Lift the prism gently from the mount.

c. Remove screws (12) and pull assembled shaft (14) from housing. Place wrench on flats of shaft, unscrew self locking nut (9). Unscrew lock nut (10) and remove lock plate (11) and bearing (13) from shaft. Remove bearing (3) and thrust washer (4) from housing.

CAUTION

Avoid placing fingers on ball races of bearing during removal, and do not use any tool that might cause damage to bearing. After removal, wrap bearing in clean cloth or tin foil.

d. Prism should be wiped with soft lint-free cloth. Inspect prism for chips, scratches or discoloration. Inspect film scanning drum for nicks or grooves. Make certain that stabilizer shaft is not bent in any way. Check ball bearing rotation; bearings should rotate freely and smoothly.

18. UNIVERSAL DRIVE MOTOR ASSEMBLY.
(See Parts Catalog figure 12.)

NOTE: Refer to paragraph 92 for synchronous motor repair.

a. Remove resistor and mounting bracket parts (items 1 through 7) and capacitors (8 and 30) from motor housing, unsoldering leadwires as required.

b. In order to remove motor gear housing assembly (11), it first will be necessary to remove the flexible coupling from the gear housing shaft. This can be done by loosening the coupling set screw closest to the end of the shaft and sliding off the coupling with attached chain sprocket. Take out three screws (12 and 14) and lock washers (13 and 15) and withdraw the complete gear housing. Temporarily assemble coupling to shaft and set this assembly aside. Repair instructions for the gear housing assembly are outlined in paragraphs 19 and 41.

c. Disassemble motor mounting bracket and parts (items 16 through 25).

d. Remove brush holder caps (26) and brush and springs assemblies (27). Brush holders (29) need not be removed.

e. Loosen two set screws (34), and remove governor (33) and governor brush and spring assemblies (35). Brush holders (37) need not be removed.

f. Remove bracket (41) and capacitor (38), unsoldering capacitor leads as required.

g. Drive out pin (45) and remove drive gear (46). Remove rear housing (42) and armature (49). Be careful not to lose the two bearing loading springs (50) from end of armature shaft.

h. Disassemble motor field (52) from housing (55). These parts are machined in assembly and must be replaced as an assembly.

i. Inspect bearings to make certain that they spin freely and smoothly and that they seat properly in the bearing recesses of the housing. Bearings must not be loose in bearing recess.

j. Check field coils for continuity with an ohmmeter.

k. Check armature for short circuit on a growler. Inspect armature winding for signs of burning, charring, or serious nicks and breaks. Examine commutator for excessive wear or badly burned commutator bars.

l. Inspect motor brushes for excessive wear (shorter

than 3/8-inch) and broken pigtails and springs. Inspect governor brushes for excessive wear (shorter than 3/16-inch) and broken pigtails and springs.
m. Check slip rings on back of governor for indication of a permanent open or short. Resistance on volt-ohmmeter should read "zero" with governor contacts closed; resistance should be infinite with contacts held open.
n. Check capacitors with electronic multimeter for leaks and shorts. Check resistor with voltohmmeter for proper resistance (150 ohms on CB projectors; 75 ohms on CBM projectors).

19. DRIVE MOTOR GEAR HOUSING ASSEMBLY. (See Parts Catalog figure 13.)

a. Loosen set screw in flexible drive coupling (1) to free the sprocket (2).
b. Disassemble remaining parts from housing (8).

20. BLOWER MOTOR ASSEMBLY. (See Parts Catalog figure 14.)

a. Disassemble the blower motor as shown in exploded view. Be careful not to lose the bearing loading spring (12) at the commutator end of the armature (10).
b. Inspect motor brushes for broken springs or excessive wear (shorter than 1/4-inch in length).
c. Check field coils for continuity.
d. Inspect winding of armature for signs of burning, charring, serious nicks or breaks. Examine commutator for out-of-round, excessive wear or burned spots.
e. Spin the ball bearings and check for smooth, quiet rotation.
f. Inspect blower wheel for bent or broken blades.
g. Check capacitor (250 volt) with ohmmeter for leaks or shorts.

21. REAR MECHANISM PLATE. (See Parts Catalog figure 15.)

a. Disassemble the rear mechanism plate, as required, by reference to the exploded view.
b. Remove dust and dirt from reflector by blowing air across the surface with a syringe bulb. Remove stains with cleaning tissue. If necessary, use a drop or two of denatured alcohol to remove oil film or fingerprints.

22. FEED AND TAKE-UP PULLEYS – CB, CBM and CBRM only. (See Parts Catalog figure 20.)

a. Disassemble the feed and take-up pulleys, being careful not to lose the bearing balls (4).
b. Inspect ears of pulley ratchet for excessive wear. Check bearing for smooth, free rotation. Inspect shaft for distortion or excess wear.
c. If shaft is worn to less than 0.247 inch in diameter, replace shaft.

23. APERTURE PLATE ASSEMBLY. (See Parts Catalog figure 23.)

a. Remove screws (2) and film rail (1).
b. Remove screws (4), film floating rail (3) and bracket spring (5). Washers (6) will drop free when rail (3) is removed.
c. Inspect sapphire jewel insets in rails for chipping. Inspect aperture plate subassembly for excessive wear at the plate rails.

24. LENS HOLDER ASSEMBLY. (See Parts Catalog figure 24.)

a. Disassemble as shown in exploded view.
b. Inspect fiber button on end of lens lock screw for good condition.
c. Inspect gear rack for broken teeth.
d. Check machined mounting surface of lens holder for wear and rough spots.

25. LENS MOUNTING ASSEMBLY. (See Parts Catalog figure 25.)

a. Disassemble by following the sequence outlined in figure 25.
b. Inspect focusing pinion (15) for chipped or broken teeth.
c. Inspect sliding track of lens holder mounting (23) for rough spots.

26. SPROCKETS, SPROCKET GUARDS AND GEARS. (See Parts Catalog figure 17.)

NOTE: The following procedure outlines the disassembly of only such parts as require special instructions. For purely mechanical disassembly procedures, refer to Parts Catalog figure 17.

a. Remove screws (2 and 3) and lock washers (4) and lift off gear cover (1) to expose gears.
b. Remove retaining ring (7) and spacer (8) and pull double idler gear (6) from gear stud (9). Remove retaining ring (11) and pull single idler gear (10) from gear stud (12). Pull sleeve (13) from shaft of gear (17).
c. To remove sprockets (14), loosen set screws (15) and pull sprockets and fiber washers (16) from gear shafts. Withdraw gears (17, 18 and 19) from rear of mechanism plate. Be careful not to lose film stops (20).
d. Film strippers (21) and sprocket guards (24) can be removed by taking out attaching parts (22 and 23) and (25 and 26), respectively. If necessary, disassemble sprocket guards (items 27 through 31) as shown in illustration.
e. Unhook spring (34) from rear arm (36), loosen set screw (37) and disassemble rear arm and loop-setter assembly (38) from mechanism plate.
f. Remove three screws (40) and lock washers (41) at rear of mechanism plate and lift off film slack adjusting assembly (39). Refer to paragraph 27 for repair instructions.
g. Removal of remaining parts is purely mechanical and can be accomplished by reference to Parts Catalog figure 17.
h. Inspect gears and sprockets for chipped or broken teeth.
i. Examine film contacting surfaces of sprockets and rollers for grooves, deep scratches, nicks and rough or flat spots.
j. Inspect film contacting surfaces of sprocket guards

and film strippers for rough spots.
k. Examine all springs for breaks in coils.
l. Inspect grooves of pivot bracket (31), in which the point of the locking rod (29) rides, for excessive wear and breaks. Inspect point of locking rod for excessive bluntness due to wear.

27. LOOPSETTER ADJUSTING ASSEMBLY.
(See Parts Catalog figure 17.)

a. Remove screw (44), loosen set screw (43), and disassemble all parts (45 through 49) from housing (50).
b. Inspect adjusting collar for broken teeth and small end of stop pin for excessive wear. Check springs for broken coils.
c. If pin end of stop pin (46) is rounded excessively or broken, replace both pin and adjusting collar. Replace other parts which are damaged. If pin (51) is broken off, replace adjusting rod and pin (48).

28. SHUTTER AND SHUTTLE MECHANISM.
(See Parts Catalog figure 18.)

a. Loosen set screws (2) and remove framer knob (1). Remove screws (4), lock washers (5) and shutter cover assembly (3). If shutter cover requires repairs, refer to Parts Catalog figure 26 for disassembly procedure.
b. Remove screws (7 and 7A) and lock washers (8) and lift off the cover (6). Disengage spring (9). Disassemble items (10) through (23) from mechanism plate. Note that parts (17) through (23) are furnished as a complete kit and must be replaced as a complete kit if any one part is damaged.
c. Loosen set screw (25) and remove sprocket (24). Remove screws (27), lock washers (28) and bracket (26). Remove screws (30) and lock washer (31) and disassemble parts (29), (32), (33), (34) and (35) from mechanism plate. Tie the shims (33) and (35) in groups and mark them so the same quantity can be installed during reassembly.
d. Loosen two set screws (37) and disassemble gear (36) and rear camshaft (38) from mechanism plate. Press drive shaft (46) from mechanism plate, and disassemble thrust collar (41), hub washer (45) and drive gear (43) from shaft. Remove screws (40) and plate (39).
e. Loosen set screw (48) and remove shutter gear (47) and shutter assembly (49) from mechanism plate. Disassemble shutter only if necessary for parts replacement.
f. Loosen set screws (51) in locking collar (50). Remove three screws (53) and lock washers (54) and withdraw bracket (52) and collar (50) from shaft (59). Remove screw (56), spring washer (57) and friction washer (58) to free the pivot bar (55). Unscrew shaft (59) from pivot bar.
g. Remaining disassembly can be accomplished by reference to Parts Catalog figure 18.
h. Inspect all parts for unusual wear or damage. The shuttle kit parts should be examined very closely for wear. Clean oiling system thoroughly.
i. Check gears for chipped or broken teeth.
j. Make certain that shutter blades are not bent.
k. Check camshafts to see if they are bent or otherwise distorted.

NOTE: Refer to the addendum material beginning on page 58 for 614CD lubrication system maintenance.

CAUTION

MECHANISM PLATE BEARINGS (Parts Catalog figure 27) should not be removed for replacement. Figure 27 is included only for factory parts identification. Special equipment is required to press in, broach and align the mechanism plate bearings, and these bearings will not be supplied separately to service stations. When bearings are worn to a point requiring replacement, the complete mechanism plate assembly (Part No. 061156) must be replaced.

29. SOUND HEAD ASSEMBLY—614CBM AND CBRM.
(See Parts Catalog figure 37.)

a. Remove retaining rings (1) and flat washers (2) and pull the jockey roller assemblies (3 and 4) from the jockey pivot studs (5). Refer to paragraph 15 for roller assembly repair.
b. Remove screw (7) and impedance roller assembly (8). Refer to paragraph 16 for impedance roller assembly repair instructions.
c. Loosen set screws (9 and 10) and carefully withdraw stabilizer housing assembly (11). Refer to paragraph 17 for stabilizer housing repair.
d. Loosen cover screw (12A) and remove lamp cover assembly (12). Move release cam (15) to extreme right-hand position, and lift out exciter lamp (13). Lamp socket parts can be disassembled by removing lamp socket nut (14), screw (16), lock washer (17) and three flat head screws (19).

CAUTION

The scanning lens (24) is pre-set by means of precision instruments for maximum efficiency and should not be disturbed unless it has been determined that this item requires replacement. If such is the case, remove screw (25) and carefully pull out the lens.

e. Note that the 614CBRM projector is equipped with a pilot lamp (25) and lamp socket (26) at the top of the sound head mounting plate.
f. Remove the tube shield (27) and the 12AY7 tube (28). If the input transformer (31), cable assembly (37) or tube socket (44) require replacement, unsolder leadwires as necessary and remove attaching parts as noted in the exploded views.
g. Remove the screw (45), lock washer (46) and photocell cover (47). Remove four screws (48) and lock washers (49) and disassemble the photocell (50) and mounting plate (51) from sound head. The terminal block (54) is secured with two round head screws (52) and lock washers (53).
h. Remove stop nut (55) and plain washer (56) and lift off retracting lever (57). The chassis subassembly (61) is secured with three round head screws (59) and lock washers (60). Refer to figure 38 for disassembly of chassis parts if inspection indicates that parts replacement is necessary.

30. PROJECTOR CASE ASSEMBLY.

Disassembly of projector case parts can be accomplished by referring to Parts Catalog figures 32 through 36. Disassemble only those parts which require replacement.

31. AMPLIFIER AND SPEAKER ASSEMBLY.

Actual physical replacement of amplifier and speaker parts can be accomplished by removing the amplifier and speaker assembly (paragraph 4) and referring to Parts Catalog figures 28 through 31 for identification of replacement parts. To determine which electronic parts require replacement, it first will be necessary to perform a complete trouble-shooting check as outlined in the Trouble Shooting Guide, and a circuit analysis of the amplifier as set forth in the Test Procedure section. Replace all faulty components.

Cleaning and Repair

32. CLEANING INSTRUCTIONS.

OPTICAL PARTS: Clean the projection lens, condensers, the reflector and the lens and mirror of sound optical system. The lens of the sound optical system is mounted in the boss on the sound head between the exciter lamp cover and the sound drum. The mirror of the sound optical system is located in the sound drum. (See figure 11, index 12.) The front and rear elements of the projection lens and sound optical lens should be cleaned. Do not attempt to take the lenses apart for any further cleaning. The cleaning should be done with either the Bell & Howell lens cleaning kit or Filmo lens cleaning tissue. If only a slight amount of dust has accumulated on the lenses, use lens cleaning tissue to remove the dust. If, however, any fingerprints, oil, grease or other accumulation of dirt is present, Bell & Howell Optikleen lens cleaning fluid should be wiped on the lens surfaces. Then clean thoroughly with lens cleaning tissue. Clean condenser lenses and reflector.

FILM HANDLING PARTS: Film handling parts include aperture plate, gate shoe, sprockets and other surfaces over which the film must pass. All of these parts should be cleaned with a soft cloth. If any dirt has accumulated and hardened, dampen the soft cloth and rub the dirt off. Follow this with a polishing with a dry, soft cloth. Be very careful not to scratch the polished surface. If any emulsion has collected, remove it with a toothpick or an orange stick cut to a knife edge. Dirt that may have accumulated between the teeth of the sprocket wheels should be cleaned out with a small, soft brush or soft cloth. Clean the aperture opening with the aperture brush.

MECHANISM PARTS: Any parts other than those already mentioned should be cleaned with a mixture of 1/3 carbon tetrachloride and 2/3 naphtha, to remove old grease and lubricating oil. Dry thoroughly. The most ideal method of drying is with compressed air. Where this method is not possible, dry with a clean cloth as much as possible and then allow parts to dry thoroughly in air.

33. GENERAL REPAIR AND REPLACEMENT.

MECHANICAL PARTS: The reconditioning of parts for possible re-use in the projector is not practical. Parts which have been physically damaged must be replaced with new parts.

TUBES: All tubes should be tested and replaced if not up to standard. Be sure to replace correct tube in the correct socket. All tubes and sockets are adequately marked.

ELECTRICAL CORDS: If at any time you find the rubber coated cords are sticky, shake a generous amount of talcum powder into a soft cloth and then pass the entire length of cord through it. The stickiness is due to long periods of storage and may be especially prevalent where the cord has been tightly wound.

FILM HANDLING PARTS: Minor scratches or burrs can be removed from parts which contact the film by polishing lightly with crocus cloth.

34. SPECIAL REPAIR INSTRUCTIONS.

DRIVE AND BLOWER MOTORS: If a motor commutator is out-of-round, has high spots or burned spots, it can be turned down in a lathe. Make the cut no deeper than necessary to correct the faulty condition. The ends of the commutator segments should not be less than 1/16-inch after the cutting operation.

LENS MOUNTING ASSEMBLY: The sliding track of the lens holder mounting must operate smoothly and evenly. Rough spots can be removed from the track with a very fine-cut file; then polish lightly with crocus cloth.

SHUTTLE MECHANISM: Note, in Parts Catalog figure 18, that shuttle parts (17) through (23) are supplied as a kit. If any one of these parts becomes damaged or excessively worn the entire kit must be installed.

Reassembly Procedure

35. FEED REEL ARM ASSEMBLY.
(See Parts Catalog figure 3.)

Reassemble the parts in reverse order of disassembly, noting the following special precautions:
a. Apply a very light coating of grease to both sides of the thrust washers (10) and to the two ball bearings (9 and 14).
b. After installing spindle tension nut (4), tighten this nut just enough so that, when the pulley (11) is held, the spindle can be turned manually.
c. Tighten elastic stop nut (3) up against spindle tension nut (4), but do not overtighten. Spindle (2) must turn freely and must have approximately 1/32-inch end play (in and out of arm).

36. TAKE-UP REEL ARM ASSEMBLY.
(See Parts Catalog figure 4.)

Reassemble the take-up reel arm in reverse order of disassembly, noting the following precautions:
a. Apply a very light coating of grease to both thrust bearings (13) and the ball bearing (11).
b. After installing spindle tension nut (4), tighten this nut just enough so that, when pulley (10) is held, the spindle can be turned manually.
c. Tighten elastic stop nut (3) up against spindle tension nut (4), but do not overtighten. Spindle (2) must turn freely and must have approximately 1/32-inch end play (in and out of arm).

37. JOCKEY ROLLER ASSEMBLY.
(See Parts Catalog figures 8 and 9).

NOTE: Except for the difference in roller housings, the upper and lower jockey rollers are identical in construction. The following reassembly procedure is applicable to both assemblies.

a. Place a drop of oil into each bearing.
b. Position roller (5) between bearings (4) and install shaft (3). Tighten set screw (2) just enough to hold roller to shaft. Make certain that roller rotates freely with a minimum of end play.

CAUTION

Do not overtighten set screw (2), as this could bend the shaft and cause the roller to rotate erratically.

38. IMPEDANCE ROLLER ASSEMBLY.
(See Parts Catalog figure 10.)

a. Place two drops of oil into the bearings at each end of the roller and allow oil to seep into the felt wick within the roller. Entire shaft of stud (10) and mounting face of adjusting nut (9) must be coated lightly with grease during reassembly.
b. Hold roller (6) in position between arms of housing with 5/32-inch wide roller groove closest to arm with plain (unthreaded) pivot pin hole. Insert pivot pin (5) and install set screw (1) so that cone point of screw engages groove in pivot pin.
c. Screw adjustable pivot pin (4) into place to a point where roller rotates freely with a minimum of end play. Insert slug (3), burr side up, into set screw hole, and install set screw (2). Re-check roller freedom of rotation and end play. End play must be barely perceptible (not in excess of 0.0005-inch). Tighten set screw (2).
d. Insert spring (11) so that bent end engages hole within housing (12). Lubricate stud (10), as instructed in step a, above, and insert stud through spring and housing. Outer bent end of spring must engage small hole in mounting flange face of stud. Lubricate nut (9), step a, above, and install nut, screw (7) and lock washer (8). Tighten screw just enough to hold parts together. This screw will be tightened after the sound optical system alinement tests (paragraph 81) are made, following reassembly of the projector.

39. STABILIZER HOUSING ASSEMBLY — CB, CBM and CBRM only. (See Parts Catalog figure 11.)

a. Apply a light film of grease to the bearing races, the bearing shoulders of the housing, and to the stabilizer shaft during reassembly.
b. Lubricate bearing (13), step a, above, and press bearing up against shoulder of shaft (14) by hand. Do not exert undue pressure during installation.
c. Install lock plate (11) and lock nut (10), tightening nut by hand. The lock nut holds bearing to shaft and must fit into groove of lock plate. With wrench engaging flats on stabilizer shaft, tighten lock nut (10) securely. Install and tighten self locking nut (9).
d. Lubricate shaft, step a, above, and insert partially assembled shaft into housing (15). Install three screws (12) just enough to hold lock plate (11) in place.
e. Insert thrust washer (4), concave side toward bearing (3), into front opening in housing (15). Lubricate bearing (3), step a, above, slide it over end of shaft, and gently press it into stabilizer housing and down against thrust washer (4).
f. Install film scanning drum (2) and nut (1). Hold lock nut (10) with wrench while tightening sound drum nut (1). Tighten the three screws (12) and rotate the shaft. Shaft must turn freely and must have an end play of approximately 0.015-inch.

CAUTION

Handle sound drum carefully at all times to avoid damage which might impair sound.

g. Place partially assembled stabilizer housing in a machinist's "V" block, and measure the true-running quality of the film scanning drum by rotating it against a trueness indicator. If possible, use a Starrett height gauge (No. 454A) and last word dial indicator (No. 711F) or similar equipment. The total indicator deviation on turned diameter of scanning drum must not exceed 0.0004-inch with the housing held stationary. If deviation exceeds 0.0004-inch, fine turn (do not grind) outside diameter of drum between centers of shaft until tolerance requirement has been met. Be sure to plug prism opening with a cotton and seal with tape before cutting in a lathe.

NOTE: Do not turn diameter of film scanning drum to a point greater than 0.010-inch of original diameter.

h. Remove tape and cotton from prism opening in stabilizer housing. Be sure that no stray strands of cotton remain in openings. Insert the prism (7) into mount (8) with clear areas of prism facing up. Insert mount into one of the brackets (5), again with clear prism areas facing up. Insert assembled parts into stabilizer housing with clear prism areas facing up and widest end of prism extending approximately 0.040-inch under the film scanning drum. Install remaining bracket (5) with four screws (6).

40. SOUND HEAD ASSEMBLY (614CB only). (See Parts Catalog figure 7.)

NOTE: Refer to paragraph 51 for reassembly of sound head for 614CBM and CBRM projectors.

a. Insert the stabilizer housing assembly (9) carefully into and through the mounting plate (43). Adjust position of stabilizer housing so that its light pipe prism will be perpendicular to the scanning lens when lens is installed. The inner face of the sound drum should extend 0.044-inch (±0.002-inch) beyond the centerline of the scanning lens, as shown in figure 3. This dimension is obtained by use of the sound drum adjustment gage, Tool Number S-061082-N1 (figure 2).

b. Insert sound drum adjustment gage as shown in figure 4, and move the stabilizer housing assembly in or out until inner face of sound drum just touches small projection on end of gage. Recheck to make certain that light pipe prism is perpendicular in relation to the scanning lens. Then install and tighten set screws (10 and 11) while maintaining the alinement.

c. Install terminal block (30) with screws (31 and 34) and lock washers (32). Make certain that screw (31) passes through terminal block and spacing collar (33). Install hexagonal spacer nut (35) on end of screw (34).

d. Install P. C. cell mounting plate (40) with screws (41) and lock washers (42), but do not tighten screws. Shift plate until center point of exposed light pipe prism is equidistant from the edges of the opening in mounting plate. While maintaining this alinement, tighten screws (41).

e. Note small round hole on one side of P. C. cell assembly (37). Mount cell assembly to cell mounting plate with small round hole facing light pipe prism. Install screws (38) and lock washers (39). Connect P. C. cell terminal lugs to upper two posts of terminal block. Terminal lugs of cable assembly (36) connect to the lower two posts of terminal block. Install cable clamp (27) and P. C. cell cover assembly (26).

f. Insert scanning lens (24) into opening in mounting plate with tapered end facing sound drum. Install and tighten screw (25) just enough to hold. Scanning lens must be finally adjusted after projector is reassembled.

g. Install exciter lamp socket parts (17 through 23). With pin release cam (18) in extreme right position, install exciter lamp (16); move pin release cam to the left (locking) position. Wipe fingerprints from lamp with clean cloth. Install the lamp cover assembly (12).

h. Install upper jockey roller assembly (1) and lower jockey roller assembly (4). Insert shaft of impedance roller assembly (7) through mounting plate until assembly is seated against plate. Install screw (8), tightening just enough to hold. This roller assembly should impart a five to six-ounce tension, or pressure, on the film as it passes around the sound drum. Lift roller end of impedance roller assembly with an ounce spring scale, and check the tension. The tension is adjusted by loosening screw (8) and rotating entire roller assembly within the mounting plate. Rotate assembly clockwise to decrease tension and counterclockwise to increase tension.

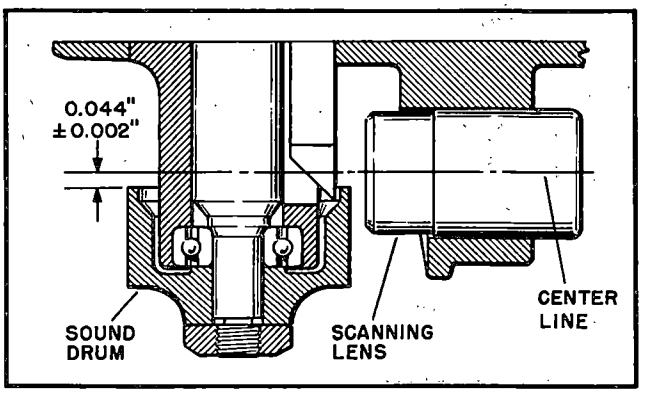


Figure 3. Positioning the Sound Drum

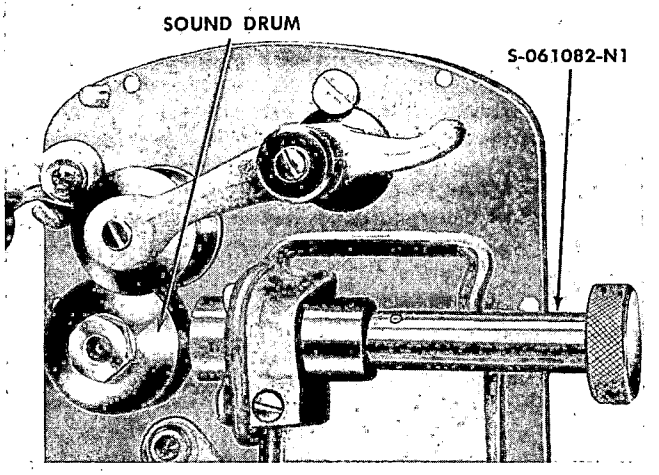


Figure 4. Using Adjustment Gage S-061082-N1

41. DRIVE MOTOR GEAR HOUSING.
(See Parts Catalog figure 13.)

a. Install fiber washer (6) on shaft (7) and assemble shaft into housing (8). Install cover (3).
b. Insert hub of sprocket (2) into coupling (1), noting that set screw must bear against flat of sprocket hub. Do not assemble coupling and sprocket to shaft until gear housing is fastened to drive motor (paragraph 42, step d).
c. After the unit has been reassembled, fill the gear housing with seven grams of grease or until the housing is filled to approximately one-third its depth. Also, the shaft bearings in the cover (3) and housing (8) should each be lubricated with four drops of oil.

42. UNIVERSAL DRIVE MOTOR.
(See Parts Catalog figure 12.)

NOTE: Refer to paragraph 92 for synchronous motor repair instructions and to paragraph 97 for 614CD motor instructions.
a. Apply a light coating of grease to the bearings (47 and 48) and to the drive gear (46) during reassembly.
b. Assemble motor field (52) into housing (55). Lubricate bearings (47 and 48), step a, above, and assemble them to armature (49). Slip two loading springs (50) onto commutator end of armature shaft with prongs against the bearing (48). Insert this group into front housing (55) until the bearing seats in the bearing recess.
c. Install rear housing (42) over ball bearing (47) on armature shaft and flush against front housing. Holes for screws (43) must line up with tapped holes in field coil retaining studs, and the tapped bosses on rear housing and front housing, for screws (19), must be alined. Secure the rear housing. Install drive gear (46) to end of armature shaft with pin (45). Lubricate gear (46).
d. Remove flexible coupling from gear housing assembly (11), and install gear housing assembly to rear housing with screws (12 and 14) and lock washers (13 and 15). Note that binding head screw (12) is installed below flexible coupling to allow clearance for drive chain around sprocket. It may be necessary to rotate gear housing shaft until worm gears engage, thus permitting gear housing to seat fully. Armature shaft must turn freely and when pressed inward and released, it must spring back due to the action of the loading springs (50).
e. When installing motor brushes, make certain that concave face of each brush matches diameter of commutator.
f. Install all electrical components, except the governor, making wiring connections as illustrated in figure 5 (CB, CBM, CBRM) or figure 39 (614CD).
g. Install motor mounting bracket parts (items 16 through 25) by reference to Parts Catalog figure 12.
h. Install governor brushes (35) and bracket (41). Place governor (33) on armature shaft. Governor should seat about 1/32-inch from each brush holder. Install and tighten two set screws (34). The motor speed adjustment will be made just before drive motor is installed to projector (paragraph 61).

43. BLOWER (VENTILATING) MOTOR.
(See Parts Catalog figure 14.)

Refer to figure 14 for proper reassembly of the blower motor, noting the following precautions:
a. Apply a light coating of grease to the outer diameter of bearings before installation.
b. Note that bearing loading spring (12) must be positioned inside the bearing recess of motor housing with the prongs up against the bearing.
c. When assembled, armature must revolve freely with a minimum of end play.
d. When installing blower wheel (1), maintain an exact clearance of 0.047-inch between blower housing cover (6) and inner face of blower wheel. Tighten blower wheel set screw securely and re-check clearance.

44. REAR MECHANISM PLATE ASSEMBLY.
(See Parts Catalog figure 15.)

a. Place a drop or two of oil on the roller bearing surface of the idler pulley stud (2) and on each of the idler shafts (17) during reassembly.
b. Reassemble the rear mechanism plate by reference to the exploded view. Be sure to perform required lubrication and avoid leaving fingerprints on the reflector (12). Note new eccentric design of 614CD adjustable pulley.

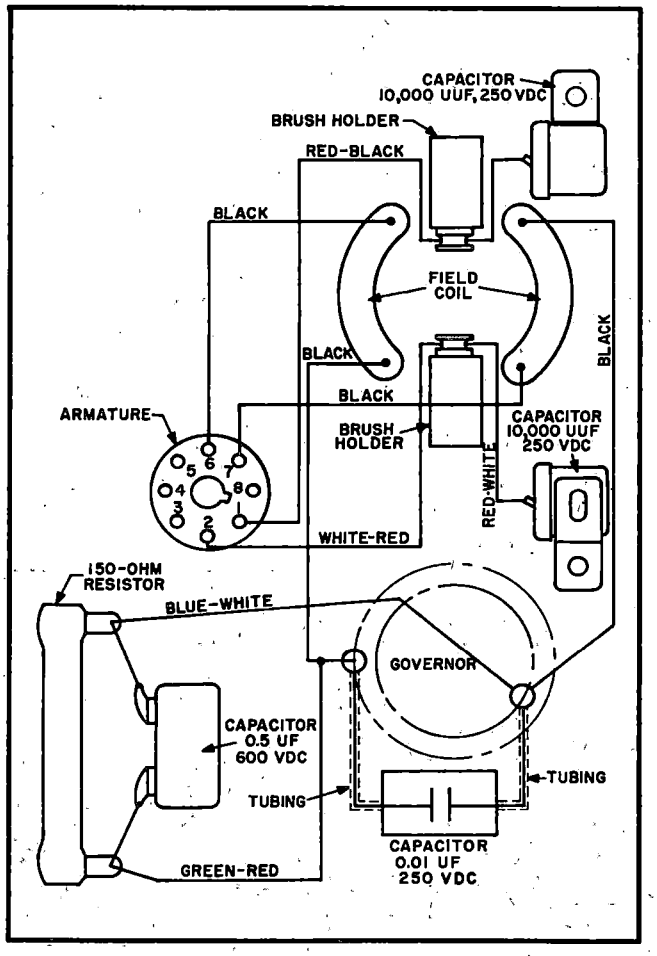


Figure 5. Drive Motor Wiring Diagram — CB, CBM, CBRM

45. FEED AND TAKE-UP PULLEYS – CB, CBM and CBRM only. (See Parts Catalog figure 20.)

a. Press bearing (6) into pulley (7). Place ratchet (5) within pulley with ratchet ears facing outward and place a bearing ball (4) into each of the three notches formed by the bending of the ratchet ears.
b. Carefully insert threaded end of shaft (1) through pulley until large diameter flange of shaft presses firmly against ratchet. The pin on the flange must engage the hole in the ratchet. Invert this assembled group and install extruded washer (3) and elastic stop nut (2).
c. The turning action of the shaft must be free in one direction and locking in the other, after nut (2) is tightened.

46. APERTURE PLATE ASSEMBLY. (See Parts Catalog figure 23.)

a. Secure film rail (1) to plate subassembly (7) with screws (2), tightening screws just enough to hold. The rail must be free to move. Place guide rail gage (Tool No. S-063196-N2) on aperture plate as shown in figure 6. Press down firmly on gage so that the two alinement pins on back of gage fit snugly into aperture plate mounting holes. Press gage upward (toward aperture plate handle) to lock the pins into mounting holes. Hold film rail up flush against the gage and tighten screws (2) securely.
b. Lay washers (6) over floating guide rail mounting holes in aperture plate, and place rail (3) on top of washers so that pin on underside of rail protrudes through hole in aperture plate. Install and tighten screws (4).
c. Invert aperture plate and place loop of spring (5) over floating film rail pin. Engage straight ends of spring in slots in under side of aperture plate.

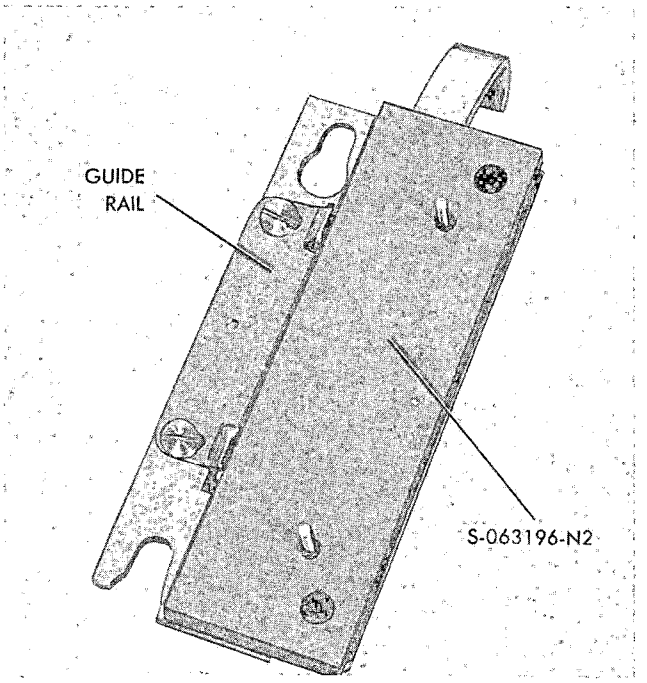


Figure 6. Adjusting Aperture Plate Fixed Guide Rail

47. LENS HOLDER ASSEMBLY. (See Parts Catalog figure 24.)

a. During reassembly, apply a light film of grease to the teeth of pinion (15) and the sliding track of lens holder mounting (23).
b. Fasten the top rail (20) to the mounting (23) with screws (21).
c. Invert mounting, place flat spring (19) in recess, and install retaining plate (16) with screw (17) and lock washers (18). Concave side of spring (19) must face into the recess.
d. Lubricate teeth of pinion (15), step a, above, and insert pinion into mounting. Install spring (13) on release rod (14) and insert rod into mounting. Install side rail (10) with screws (11) and lock washers (12).
e. Insert shaft of pressure plate holder assembly (1) through mounting. Install spring (5), collar (4) and push arm (3) onto end of shaft and secure parts with elastic stop nut (2).
f. Screw knob (9) onto release rod. Install washer (8), concave face against rail (10), onto focusing pinion shaft. Press knob (6) onto shaft and tighten set screw (7).

48. LOOPSETTER ADJUSTING ASSEMBLY. (See Parts Catalog figure 17.)

a. If adjusting rod pin (51) was replaced, new pin must be pressed in 0.046-inch below outer diameter of shaft. Place spring (49) on rod and insert rod into housing (50). The pin (51) must engage the approximate center of the slot in housing and the notch-out in end of rod must face toward curved radius of housing.
b. Insert spring (47) and stop pin (46) into small hole in housing and install adjusting collar (45) on shaft in such a manner that tip of pin engages teeth of collar.
c. Place retaining collar (42) on shaft and install, but do not tighten, set screw (43). Apply pressure to both ends of assembly until pin (51) is in center of slot in housing. Hold in this position while tightening set screw (43) against flat of shaft. Install screw (44).

49. SPROCKETS, SPROCKET GUARDS AND GEARS. (See Parts Catalog figure 17.)

NOTE: If the projector has been completely disassembled, the reassembly procedures outlined in paragraph 50 must first be accomplished before proceeding as directed below.

a. Assemble mounting (59) and spacer (61) into mechanism plate; install and tighten set screw (60).
b. Assemble rollers (58A) and screws (58B) to shafts of idler subassembly (58C). Assemble floating idler assembly (58) and tension lever (56) to mechanism plate with screw (57). Install bracket (53) with screw (54) and lock washer (55). Do not tighten screw. Hook spring (52) between bracket (53) and lower end of lever (56). Adjust bracket so that all slack is removed from spring, and tighten screw (54) securely.
c. Attach reassembled loopsetter adjusting assembly (39) to mechanism plate with screws (40) and lock

washers (41). Assemble loopsetter assembly (38) and insert its shaft through mechanism plate. Install arm (36) on end of loopsetter shaft, tightening set screw (37) down against flat on end of shaft. Hook one end of spring to mechanism plate with spring stud (35).

d. Apply a very light film of grease to locking rod (29), spring (30) and the lock rod point grooves in the bracket (31). When assembling sprocket guard into bracket, these two grooves should be at top of bracket (toward open face of guard). Install and tighten pivot screws (28). Press bracket down so that lock rod hole in shoe is accessible, and insert spring (30) and rod (29) into hole. Hold lock rod down with screwdriver while snapping bracket back up into position.

e. Install film stops (20) on flange of bearings in mechanism plate so that U-shaped edge of stop is centrally located in regard to sprocket guard mounting holes. Install gears (17, 18 and 19) and install washers (16) and sprockets (14) on gear shafts. Securely lock each sprocket with two set screws (15). Sprockets and shafts must turn freely with a maximum end play of 0.0005-inch.

f. Mount sprocket guards (24) either under or over sprocket as required, with two screws (25) and lock washers (26). Do not tighten screws. Raise guard away from sprocket and insert film clearance gage (Tool Number S-061081-N16) between sprocket and guard as shown in figure 7. Close guard against gage and tighten screws (25) securely. Open guard and remove gage. Repeat procedure for all three sprocket guards. Attach film strippers (21) with the screws (22) and lock washers (23).

g. Install sleeve (13) on protruding shaft of gear (17). Mount gears (6 and 10) to gear studs with retaining rings (7 and 11). Be sure spacer (8) is in place on gear stud (9).

h. Check to make certain that all shafts turn freely with no perceptible end play. Lubricate all gear teeth with grease and install gear cover (1) and its gasket (5) with six screws (2 and 3) and lock washers (4).

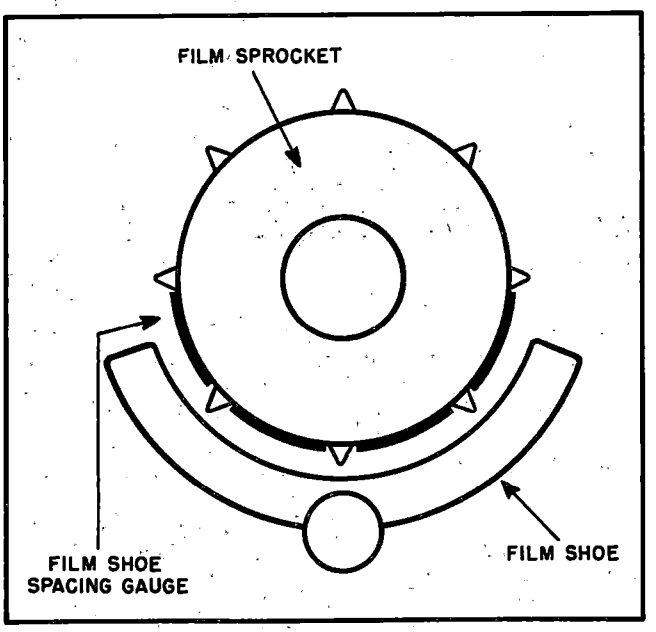


Figure 7. Using Sprocket Shoe Film Clearance Gage

If a new gasket (5) is being used, a one-inch section must be cut from it to provide movement clearance for the arm (36) as it protrudes from the casting. The two long screws (3) are installed through the holes closest to the blower motor mounting location.

50. SHUTTER AND SHUTTLE MECHANISM. (See Parts Catalog figure 18.)

a. On 614CB, CBM and CBRM projectors, lubricate wick (65) and pad (68B) before assembling. Refer to paragraph 96 for 614CD lubrication parts reassembly.

b. Screw shaft (59) into pivot bar (55) and attach bar to mechanism plate with screw (56) and washers (57 and 58). Spring washer (57) must be installed with cup face toward bar. Hold collar (50), beveled face up, in place between arms of bracket (52) and slide bracket and collar up onto shaft (59). Secure bracket with screws (53) and lock washers (54). Slide collar up until it touches bracket and tighten set screws (51).

c. Fasten bracket (26) to mechanism plate with screws (27) and lock washers (28). Do not tighten screws. Insert drive shaft (46) through bracket and into bearing in mechanism plate. Make certain that drive shaft is alined squarely in both bearings, shifting bracket (26) if necessary. Then tighten screws (27). Withdraw shaft from mechanism plate to permit installation of collar (41), gear (43) and washer (45) on shaft. Press shaft back into mechanism plate until end of shaft is flush with front face of mechanism plate bearing. Press gear and washer toward mechanism plate until washer bears against flange of bearing. Tighten two set screws (44) securely. Move collar (41) until it touches bearing in bracket (26) and tighten its set screws (42) securely. Shaft should turn freely with a minimum end play of 0.003-inch. Secure sprocket (24) to shaft with set screw (25).

d. Fasten mounting plate (39) to mechanism plate with three screws (40). Install shim washers (35) on front camshaft (34) and insert camshaft through its bearing in the mechanism plate. Place master block (Tool No. S-061020-N10) on surface plate with front camshaft indicator gage (Tool No. S-061020-N3) positioned above it as shown in figure 8. With stem of gage just touching the master block, adjust indicator until pointer reads "zero". Place indicator gage on machined surface of mechanism plate as shown in figure 9. With stem of gage just touching end of front camshaft, indicator should read "zero". Add or remove shims (35) on front camshaft until condition is met.

e. Install nylon shim (33A), shims (33) and gear (29) on front camshaft, alining slot in gear with slot in camshaft. Assemble lock ring (32) into slot in gear and camshaft and install screw (30) and lock washer (31). Camshaft must revolve freely with no noticeable end play. If necessary, shim washers (33) must be added or removed until these conditions are met.

f. Assemble rear camshaft (38) and gear (36) to mechanism plate. Hub of gear must face away from mechanism plate. Tighten set screws (37) just enough to hold the gear.

g. Before installing shutter (49), check to make certain that heads of screws (49B) are centrally located in their elongated slots and are tightly screwed in

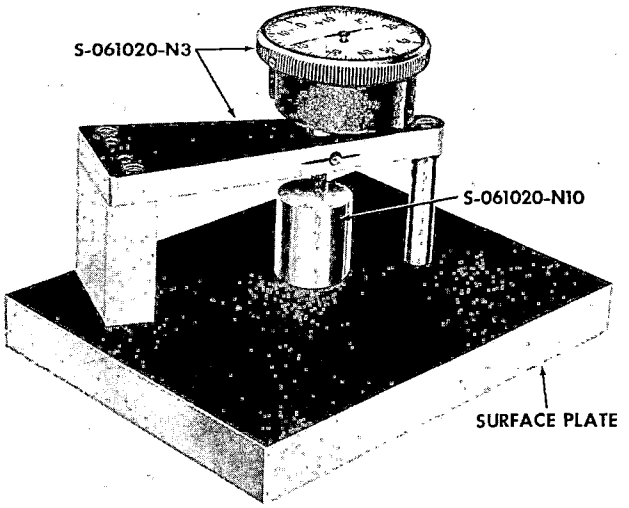


Figure 8. Setting the Camshaft Indicator Gage

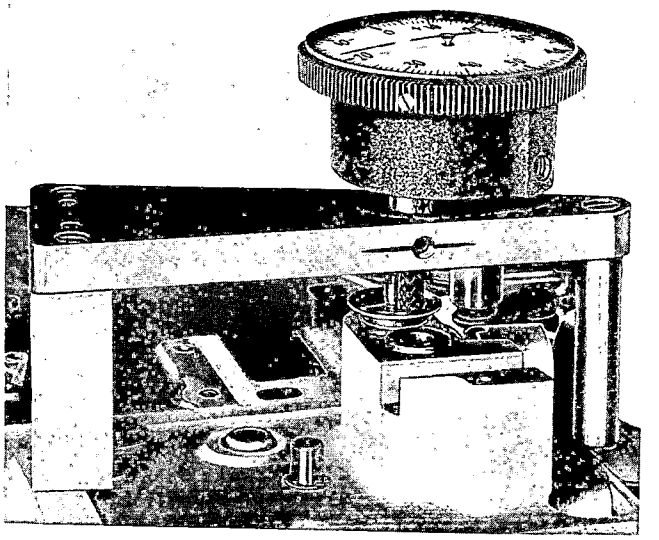


Figure 9. Setting Camshaft with Gage

place. Install shutter and shutter gear (47), tightening set screws (48) just enough to hold. Hub of gear must face mechanism plate.

h. Turn front camshaft (34) and rear camshaft (38) until the registration pin is to the right of the shaft (when facing mechanism plate). Rotate the shutter until the shutter blades form a parentheses ( ) above the camshafts. Install shutter and intermittent gage (Tool No. S-061081-N15) as shown in figure 10, and lock gage in place by installing knurled nut (A) on front camshaft. Loosen knurled nut (B) and raise the gage bar up against shutter blades. Tighten knurled nut (B) to hold gage bar in this position. Tighten set screws (37 and 48) securely, remembering that both camshafts and the shutter must revolve freely but with a maximum end play of 0.0005-inch. Remove the gage.

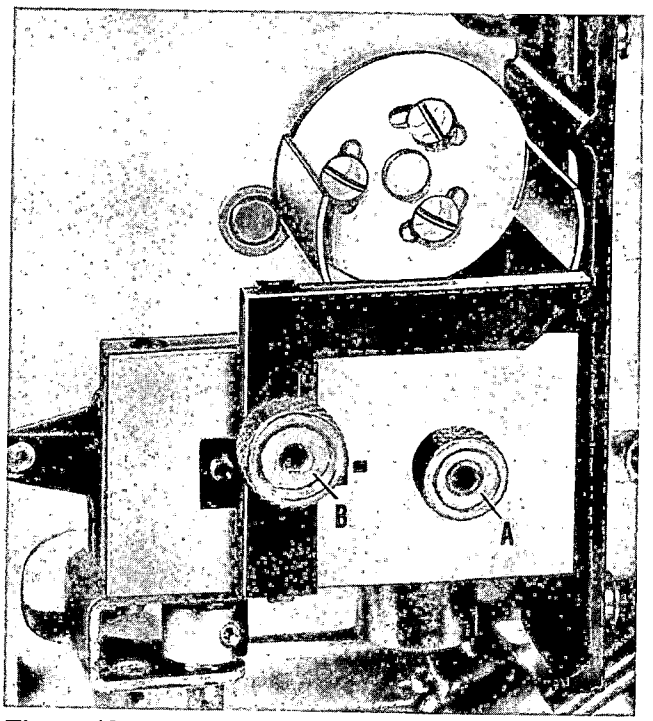


Figure 10. Synchronizing the Shutter and Intermittent Mechanism

i. Fasten mounting bracket (60) to mechanism plate with screws (61), lock washers (62) and flat washers (63). Do not tighten screws until aperture plate mounting bracket has been alined (paragraph 63).

j. Install front cam (18) on front camshaft (34). Install rear cam (17), retaining washer (16) and cam lock stop nut (15) on rear camshaft (38). Install spacer (22) and bushing (21) on shaft of pivot bar (55). Hook spring (9) into hole in end of shuttle (23) and install shuttle over cams and pivot bushing. Sapphire jewel inset in center shuttle tooth must be on bottom of tooth when shuttle is installed. Hook free end of spring (9) into hole in bent arm at rear of mounting plate (39). Install spacer (20) over outer diameter of pivot bushing (21) and install washer (19) up against bushing. Secure these parts with elastic stop nut (14). Install lubricating disc (12) to front cam shaft, with pin in camshaft entering small hole in disc. Install counterweight (11), inserting its pin into large hole in disc (12). Secure these parts with special nut (10). Place one drop of oil on each cam and on parts mounted to pivot bar (55). Do not install covers (6 and 3) or knob (1) until the shuttle has been properly adjusted (paragraph 63).

51. SOUND HEAD ASSEMBLY—614CBM AND CBRM. (See Parts Catalog figure 37.)

NOTE: In the reassembly of the chassis subassembly parts shown in figure 38, only the installation of the rotary switch (item 17) requires special attention, as follows: Install switch, but do not tighten switch nut. Mount switch plate (16) to switch shaft with threaded stud of plate towards top of chassis. Tighten two set screws (15). When remaining chassis parts have been assembled, hold switch plate (16) in exact vertical position and rotate switch (17) until central detent position is located. Then tighten switch nut.

a. Refer to Parts Catalog figure 37. Secure chassis subassembly (61) to sound head mounting plate (64) with three screws (59) and lock washers (60). Install terminal block (54) with screws (52) and washers (53).

b. Insert stabilizer housing assembly (11) carefully into and through mounting plate (64). Insert scanning lens (24) just enough to hold. Rotate the stabilizer housing until its light pipe prism is perpendicular to the scanning lens center line.

c. Insert sound drum adjustment gage as shown in figure 4, and move the stabilizer housing in or out until inner face of sound drum just touches small projection on end of gage. Recheck to make certain that light pipe prism is perpendicular in relation to scanning lens, and tighten set screws (9 and 10) securely.

d. Install retracting lever (57) with stop nuts (55) and plain washers (56). Install photocell mounting plate (51) with screws (48) and lock washers (49), but do not tighten screws. Shift plate until center point of exposed light pipe prism is equidistant from the edges of the opening in the mounting plate. Maintain this alinement while tightening screws (48).

e. Note the small, round hole in one side of the photocell assembly (50). Attach the photocell assembly to the mounting plate with this hole facing the light pipe prism, tightening the two screws (48), with lock washers (49), securely. Connect photocell terminal lugs to the two inner terminal block screws. The two outer screws of the terminal block are used to connect the terminal lugs of the cable assembly (37). Install photocell cover (47) with screw (45) and washer (46).

f. Install the tube socket (44), leadwire assembly (38), cable assembly (37), and input transformer (31), making the wiring connections as illustrated in figure 30 (614 CBM sound head schematic) or figure 31 (614 CBRM sound head schematic). Install tube (28) and shield (27).

NOTE: The 614 CBRM projector is equipped with a pilot lamp (25) and socket (26) to indicate recording operation. Install these parts and connect leadwires per figure 31. In the 614 CBM projectors, the lamp socket opening is closed with a button plug.

g. Install shield (22) with screws (21). Install the exciter lamp socket parts (13 through 20). The lamp socket leadwire shielding is grounded to the sound head mounting plate with screw (16) and washer (17). The short socket leadwire is soldered to the rotary switch (figure 30 or 31) and the long leadwire is inserted up through the cable opening in the sound head chassis.

h. Install the upper and lower jockey roller assemblies (3 and 4) onto studs (5) with washers (2) and retaining rings (1). Insert shaft of impedance roller assembly (8) through the mounting plate until assembly is seated against the plate. Install screw (7), tightening just enough to hold. The impedance roller assembly should impart a five to six ounce tension, or pressure, on the film as it passes around the sound drum. Lift roller end of impedance roller with an ounce spring scale and check the tension. Tension is adjusted by loosening screw (7) and rotating the entire roller assembly within the mounting plate — clockwise to decrease tension, and counter-clockwise to increase tension. Tighten screw (7) after adjusting.

i. With pin release cam (15) in extreme right position, install exciter lamp (13) and move release cam to the left (locking) position. Wipe fingerprints from lamp with a clean cloth, and install lamp cover (12).

j. Sound head assembly installation is outlined in paragraph 58. If the scanning lens was removed or replaced, it will be necessary to perform the alinement adjustments outlined in paragraph 85.

52. INSTALLATION OF MAJOR COMPONENTS.

NOTE: Refer to projector operation book for instructions pertinent to the installation of such items as the reel arms, pressure plate, aperture plate, condenser lens assembly, projection lamp parts, etc.

53. LENS MOUNTING ASSEMBLY.
(See Parts Catalog figure 16.)

a. Make certain that lens holder rails of mounting are free from dirt and grit and that they are lubricated with a film of grease.

b. Attach lens mounting assembly (49) to mechanism plate with two screws (50) and the screw (51) and lock washer (52). Insert guide disc (48), spring (47) and friction button (46) into proper holes in lens mounting.

54. LENS HOLDER ASSEMBYLY.
(See Parts Catalog figure 16.)

a. Install lens holder assembly (45) on lens mounting assembly and slide holder in about halfway. Press down on friction button (46) and slide lens holder inward as far as it will go.

b. Turn focusing knob to engage pinion teeth with focusing rack on underside of lens holder. Press the side rail (item 10, Parts Catalog figure 25) flush against the assembly and tighten the side rail mounting screws securely. Turn focusing knob back and forth; lens holder should move freely without excess slack.

c. Loosen set screw in focusing knob, press knob in against its spring washer, and tighten set screw. With lens holder racked all the way into the mounting, attach lens holder stop plate (item 42, Parts Catalog figure 16) with screws (43) and lock washers (44).

55. FEED AND TAKE-UP PULLEYS.
(See Parts Catalog figure 16.)

a. Apply a very light film of grease to both sides of washers (23 and 27) and assemble pulleys (22 and 26) and their washers to mechanism plate.

b. Install sprockets (20 and 24) on pulley shafts, hubs facing outward, and secure with set screws (21 and 25) turned down tightly against flats on pulley shafts. Each group should rotate freely with a minimum (not more than 0.0005-inch) of end play. Engage drive chain (19) with teeth of both sprockets.

c. Install drive sprocket (17) to feed sprocket shaft, hub facing outward, and secure with set screws (18).

d. Fasten assembled drive chain idler assembly (28), loosely to mechanism plate with screws (29), flat washers (31) and lock washers (30). Adjust position of idler roller bracket so that there is a small amount of slack in drive chain, and tighten screws (29) securely. Proper installation of chain and sprockets

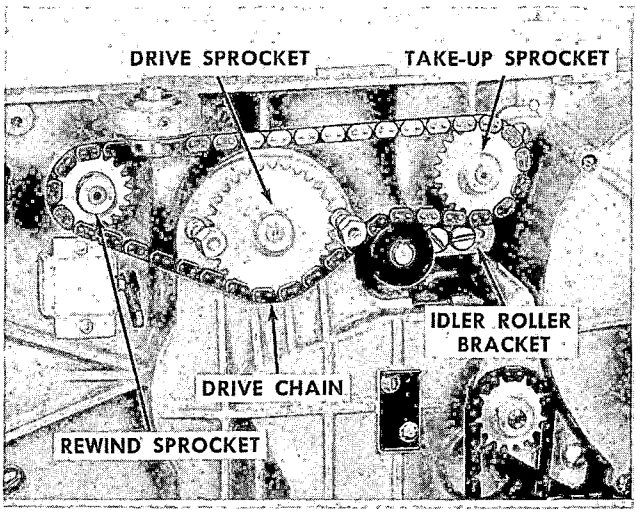


Figure 11. Drive Chain and Sprockets Installed

is shown in figure 11.
e. Apply a coating of grease to entire length of drive chain.

56. REAR MECHANISM PLATE. (See Parts Catalog figure 6.) Attach rear mechanism plate assembly (28) to front mechanism plate assembly (31) with attaching screws (29) and lock washers (30).

57. BLOWER MOTOR AND COVER ASSEMBLY. (See Parts Catalog figure 6.) Fasten the blower motor and cover assembly (25) to rear mechanism plate with seven screws (26) and lock washers (27). Wiring connections will be made after all major components have been installed.

58. SOUND HEAD ASSEMBLY.
(See Parts Catalog figure 6.)

a. Insert assembled sound head (10) into its mounting on the mechanism plate and secure in place with seven screws (11) and lock washers (12). The upper and lower jockey rollers should be held in a raised position during insertion of sound head assembly so that they will rest on their respective stop studs after installation.
b. Wiring connections will be made after all major components are installed.

59. FRONT AND REAR MECHANISM PLATE INSTALLATION. (See Parts Catalog figure 2.)

a. Carefully insert the partially assembled front and rear mechanism plate (15) into the projector case (29). Vibration mounts at top of mechanism plate must be alined with two screw holes in top of case so that screws (16) can be installed. Mounts at front and rear edges of mechanism plate must be positioned below brackets within projector case so that hex head screws (26) can be installed.
b. Install all hardware parts (18 through 28) and make certain that all shielded ground wire cables (item 15, Parts Catalog figure 6) are properly connected.
c. Secure the flywheel (7, Parts Catalog figure 2) to the sound head stabilizer shaft with screw (8).
d. Install fuseholder (2) and fuse (1).
e. Install special nut (13) and knob (14) on upper end of loopsetter rod. Knob should extend about 3/32-inch above surface of case. Tighten nut up against bottom of knob.
f. Install lampholder (item 3, Parts Catalog fig. 16.)

60. SWITCH PLATE ASSEMBLY.
(See Parts Catalog figure 1.)

a. Install switch panel casting of switch plate assembly (30) to rear edge of projector case with three screws (31) and lock washers (32).
b. Thread the heavy shielded cable properly within the projector case near the top of the mechanism plate. Proper wiring connections are shown in the projector schematic wiring diagram, figure 27, 28, 29 or 41.
c. Note that one branch of the heavy shielded cable, containing two black leadwires, must emerge through the projection lamp socket opening on the front side of the mechanism plate. The shielding, at this point, is grounded to the mechanism plate just above the opening by a screw, flat washer and lock washer. Also, make the connections to the lampholder in the upper left-hand corner of the mechanism plate and intertwine the small shielded wires from the sound head around the heavy shielded cable and over to the switch panel. Connect blower motor leadwires as shown in the proper projector wiring schematic.
d. Install the projection lamp parts (10 through 14), making the proper wiring connections.
e. Install the condenser bracket portion of the switch plate assembly (30) with the screws (33 and 34) and lock nuts (35). Make the wiring connections to the fuseholder and the pins of the power receptacle. Recheck all wiring connections against the proper schematic wiring diagram to make certain that they are correct.

61. DRIVE MOTOR ASSEMBLY.
(See Parts Catalog figure 6.)

a. Connect projector power cable between power receptacle and 105 to 129-volt AC power source.
b. Connect motor plug to its receptacle on inside of switch plate assembly, and turn OFF-MOTOR-LAMP switch to MOTOR position.

NOTE: Step c, following, applies only to the universal-type drive motor. When installing the synchronous drive motor, step c is eliminated completely and continue with steps d and e.

c. With motor running, check the motor speed by means of a tachometer on the motor armature shaft. Motor speed should be 5554 revolutions-per-minute. To adjust motor speed, loosen adjustment nut (B), figure 12, on the governor. Turn adjustment screw (A) clockwise to increase speed or counterclockwise to decrease speed. Tighten nut (B) securely after adjustment has been made. Turn switch to OFF position.
d. Disconnect motor plug, and install motor (20) to mechanism plate with four screws (21), lock washers

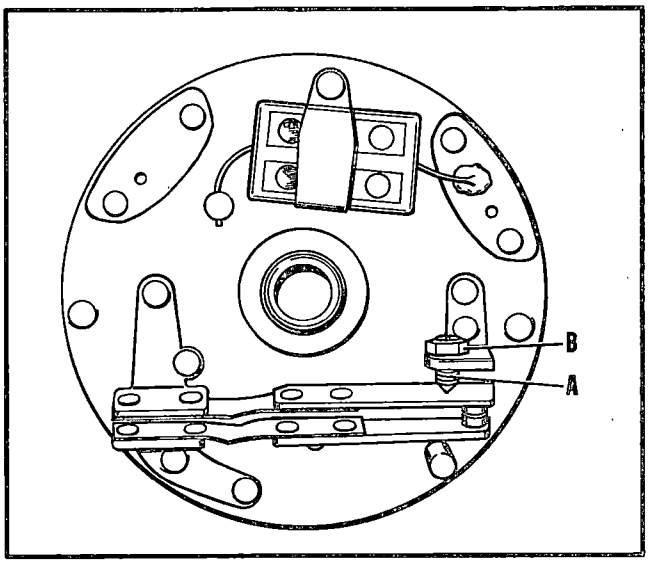


Figure 12. Drive Motor Governor Adjustment

(22) and plain washers (23). While motor is being installed into place, drive chain (24) should be hooked around sprocket on motor gear housing shaft and the sprocket to the right of loopsetter rod. There should be a small amount of slack in the drive chain. This slack is obtained by positioning the motor properly and by adjusting the position of the idler pulley bracket at the top of the motor casting. Be sure to tighten all screws securely after adjustment.

e. Install threading knob (13) with set screw (14). With the shuttle tooth at maximum protrusion position, the words "THREADING KNOB" should be in a horizontal plane. Reconnect motor plug.

62. AMPLIFIER AND SPEAKER ASSEMBLY. (See Parts Catalog figure 1.)

a. Lift assembled amplifier and speaker assembly (22) as close as possible to projector to permit connection of jack plug to photocell input connector and leadwire spade lugs to proper projector terminals. See amplifier schematic wiring diagram, figure 32, 33, or 42.

b. Lift amplifier and speaker assembly carefully up into position and press into place against projector case. Install six screws (23) and lock washers (24) at top, front and bottom of amplifier, and three screws (25) and lock washers (26) at rear edge of switch panel casting.

63. ADJUSTING SHUTTLE AND APERTURE PLATE MOUNTING BRACKET.

a. For proper operation, the center tooth of the shuttle must protrude 0.031-inch (+ 0.002, - 0.001-inch) beyond the surface of the aperture plate. Attainment of this precise dimension requires that the aperture plate mounting bracket (item 60, Parts Catalog figure 18) be alined in a straight perpendicular plane in relation to the horizontal position of the shuttle. In order to perform this adjustment, it is necessary to remove the lens holder assembly (paragraph 9) and lens mounting assembly (paragraph 10) from the mechanism plate. Leave the aperture plate in the projector.

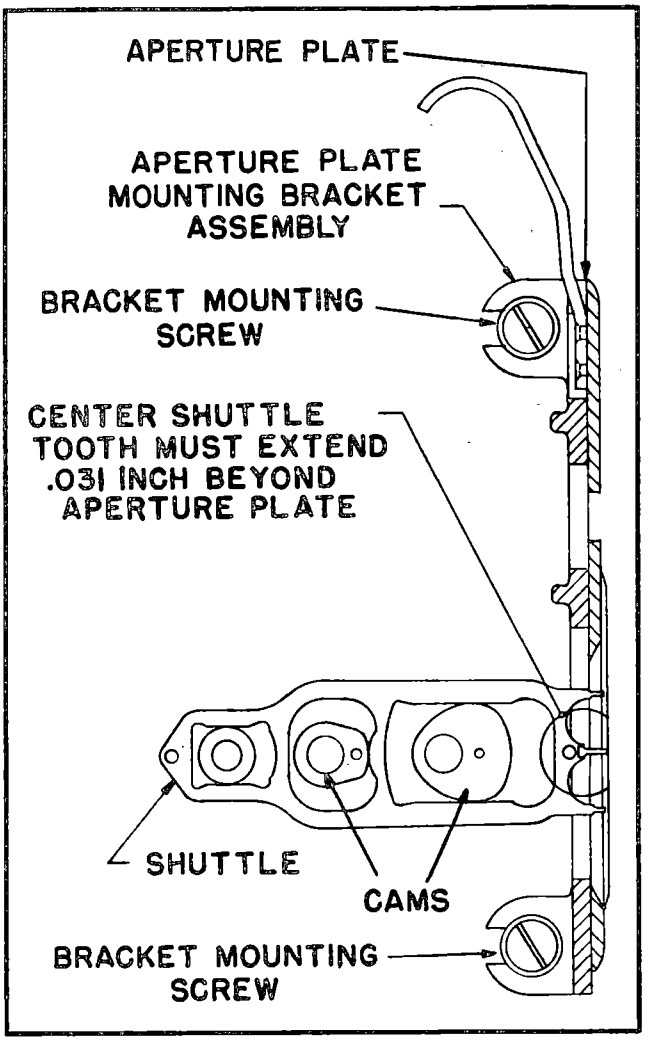


Figure 13. Horizontal Position of Shuttle and Cams

b. Turn threading knob clockwise until the center shuttle tooth is at its maximum protrusion position. The cams should be parallel to the shuttle as shown in figure 13.

c. Place shuttle alinement gage (Tool No. S-061081-N8, figure 2) on a surface plate with gage plunger contacting the plate. If necessary, loosen gage dial set screw and rotate dial until indicator points exactly to "zero" reading. Then tighten dial set screw.

d. As indicated in figure 14, place gage against aperture plate with gage plunger contacting center shuttle tooth. The gage indicator reading should not be less than 30 nor more than 33 (indicating a protrusion of 0.030 to 0.033-inch).

e. To adjust shuttle tooth protrusion, the aperture plate mounting bracket must be moved back (away from the lens) to increase the amount of protrusion or forward (toward the lens) to decrease the amount of protrusion. Before tightening aperture plate mounting bracket screws, check by eye to make certain that bracket is perpendicular to horizontal line through

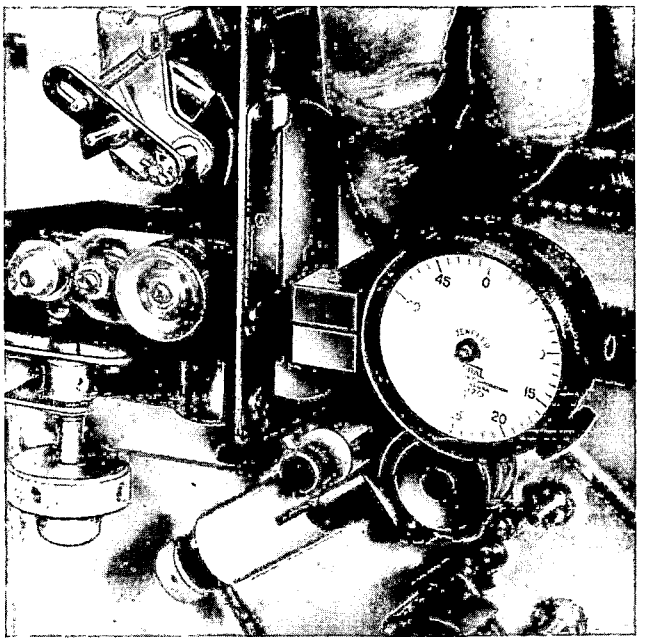


Figure 14. Checking Shuttle Tooth Protrusion with Indicator Gage

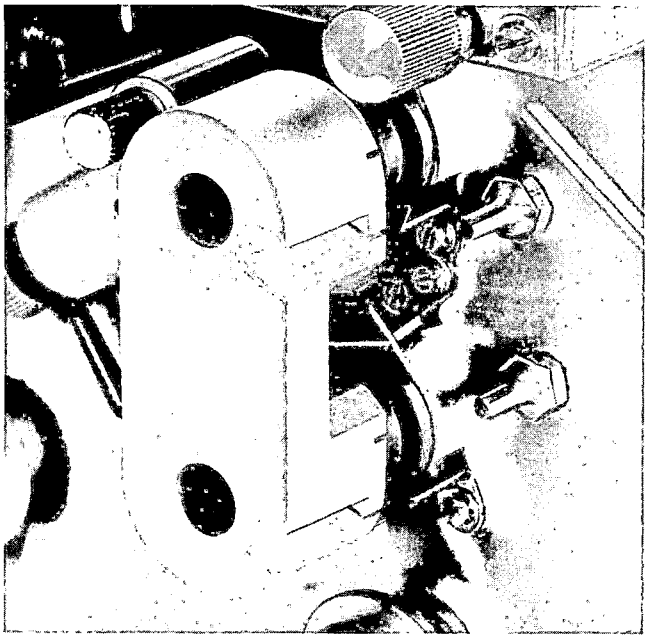


Figure 15. Using the Sprocket Synchronizer Gage

cams and shuttle.

f. After tightening screws, recheck shuttle tooth protrusion with indicator gage to make certain that the proper dimension has been maintained.

g. Before reinstalling lens holder and mounting, adjust the shuttle for proper film perforation clearance as instructed in paragraph 63.

64. ADJUSTING FILM PERFORATION CLEARANCE.

a. Place the shuttle alinement gage (Tool No. S-061081-N6, figure 2) flat against the aperture plate with the opening in the gage at the bottom and away from mechanism plate. Gage should rest flush against the fixed film guide rail of the aperture plate.

b. Turn threading knob clockwise slowly, and check movement of shuttle teeth. All three teeth should enter the opening in the gage without striking either side of the opening.

c. If shuttle teeth strike the gage, remove the aperture plate and adjust position of fixed guide rail as instructed in paragraph 46. Reinstall aperture plate in projector and repeat gage check (step b, above). If shuttle teeth continue to strike gage, the front camshaft adjustment (paragraph 50, step d) was not made properly during reassembly.

d. Refer to Parts Catalog figure 18. Install shuttle cover (6) with screws (7 and 7A) and lock washers (8). Note that the one long screw (7A) is inserted in lower left-hand corner of shuttle cover. Install shutter cover (3) with screws (4) and lock washers (5). Secure framer knob (1) to shaft (59) with set screws (2).

65. SYNCHRONIZING LOWER FILM SPROCKETS.

a. Turn threading knob clockwise until center shuttle tooth is at its maximum protrusion position.

b. Loosen the set screw in each of the lower film sprockets until sprockets can be turned. Rotate both film sprockets until one of the set screws in each is accessible at the right side of the sprocket.

c. Place sprocket and shuttle synchronizer gage (Tool No. S-061081-N31, figure 2) over sprockets as shown in figure 15. Teeth on both sprockets must enter grooves in the gage, and the gage must be in exact perpendicular position as shown in figure 15.

d. With gage held in proper engaging position, tighten accessible set screw in each sprocket. Remove gage and tighten remaining set screws. Check sprocket end play; end play must not exceed 0.0005-inch.

66. FILM TAKE-UP TENSION ADJUSTMENT.

NOTE: In the event that the take-up spindle (2, Parts Catalog figure 4), pulley (10) or friction washer (9) were replaced, a run-in period of 15 to 16 hours will be required before the film take-up adjustment can be performed.

a. Mount the feed and take-up reel arms to the projector by means of their thumb screws, and attach the spring belts to both reel arm pulleys.

b. Wrap three feet of 16-mm film around the hub of an empty 400-foot film reel and install reel on take-up arm spindle. Tighten elastic stop nut on end of take-up spindle against the tension nut and attach hook-end of 18-ounce spring scale to end of film as shown in figure 16.

c. Start motor and read the scale. Tension exerted on film should be 8 ounces. If necessary, adjust the tension nut on take-up spindle by tightening the elastic stop nut until correct reading is obtained.

d. Stop the motor and remove scale and film, but leave the film reel installed. Tie the reel to reel arm with string or wire to apply tension to take-up arm during run-in period. Start projector and let it run for a period of at least 16 hours. Remove wire or string from reel and arm after run-in period.

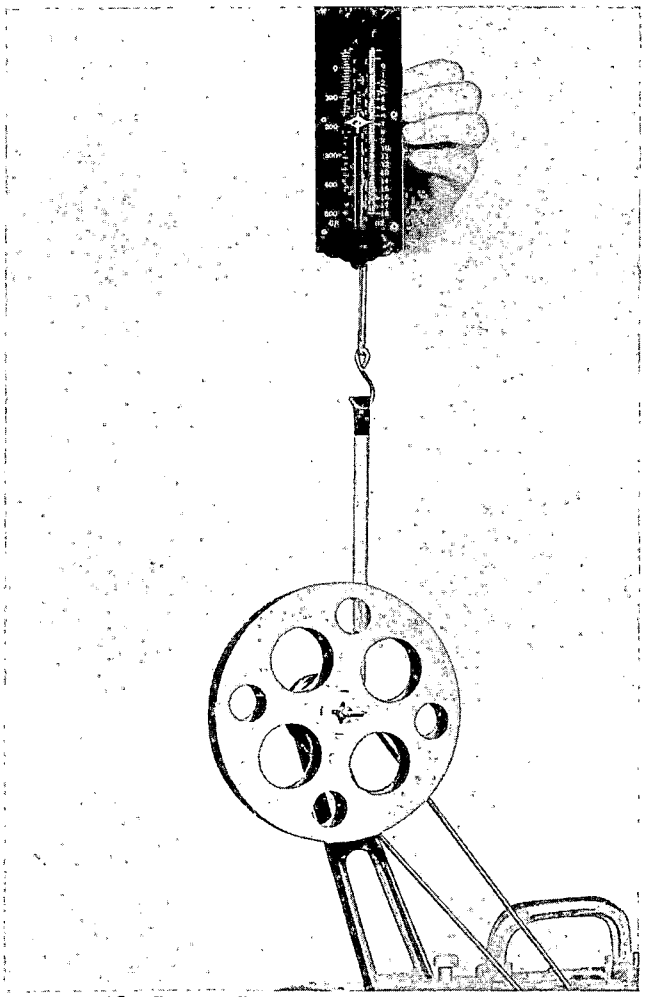


Figure 16. Spring Scale Adjustment for Film Take-up Tension

e. Wrap the three-foot length of film around hub of empty 400-foot film reel on take-up spindle and attach hook-end of scale to end of film (figure 16). Tighten or loosen elastic stop nut and tension nut on spindle until reading on scale is 6 to 8 ounces.

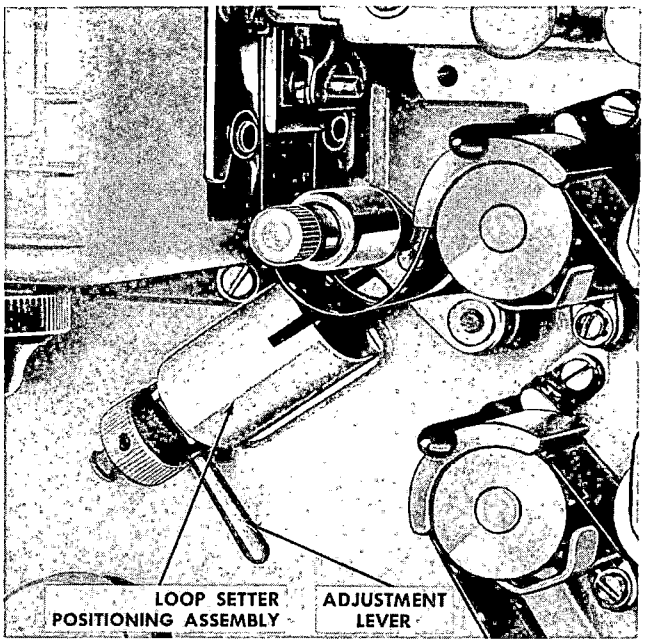


Figure 17. Film Slack Lever Adjustment

The tension now is set to accommodate all size film reels from 400-foot to 2000-foot capacity.

67. LOOPSETTER ADJUSTING ASSEMBLY ADJUSTMENT. (See figure 17.)

a. Move the film slack adjustment lever over its entire course and observe the action of the loopsetter assembly. The loopsetter assembly should move up and down. If movement does not occur, proceed as follows:

b. Insert a screwdriver between retaining collar and its truss head screw and apply pressure against head of screw. Loosen set screw while holding the screwdriver in this position. Ease up on the pressure of the screwdriver so that the adjusting rod (48, Parts Catalog figure 17) moves upward approximately 3/64-inch; then tighten the set screw securely.

68. LOCALIZING COMMON SOUND TROUBLES.

69. PROJECTOR MOTOR AND PROJECTION LAMP FUNCTIONING NORMALLY, BUT NO SOUND. With film properly threaded in the projector, the following control settings and conditions must be established for sound operation:

a. ON-OFF amplifier toggle switch in the ON position.

b. Speaker selector switch in the LOCAL position, if an external speaker is not being used.

c. Volume control in the mid-position.

d. OFF-MOTOR-LAMP switch in the LAMP position.

e. Proper sound head button depressed.

NOTE: If the above mentioned operating conditions have been established and no sound is present, proceed as directed in paragraph 70.

70. CHECKING THE PROJECTOR TO LOCATE SOUND FAILURE. The projector sound system consists of the exciter lamp, photo cell and associated light path elements. The method for checking is as follows:

a. When the OFF-MOTOR-LAMP switch of the projector is rotated to the LAMP position, the exciter lamp should light. This may be determined by the jewel opening on the exciter lamp cover. If the lamp does not operate, replace is with one known to be good. If the new lamp does not light, replace the 6AQ5 oscillator tube (V205) in the amplifier.

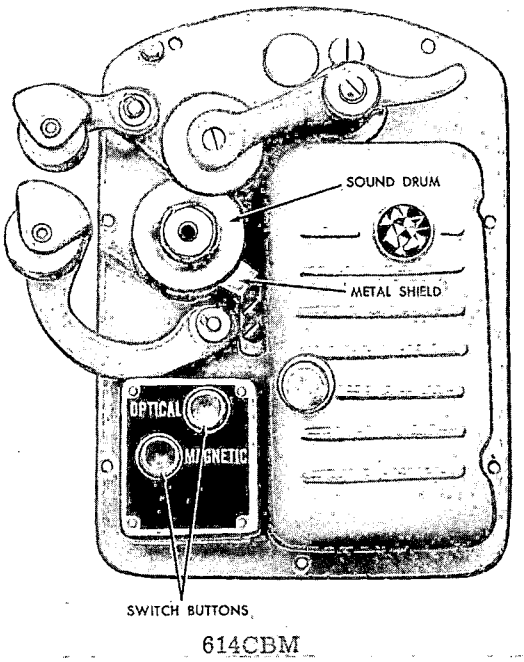
b. With no film in the projector and the volume control at the mid-position, insert a piece of cardboard or heavy paper between the sound drum and sound lens, obstructing the optical light path. This should produce a "plop" in the speaker. Failure to do so may be the result of a bad photo cell, an open or shorted photo cell cable, misalinement of the light path, an improperly functioning amplifier or loudspeaker, or an obstruction such as oil, dirt, or a piece of broken film. The photo cell should last at least three years with normal use.

c. Failure to obtain sound after the above checks indicates the trouble is in the amplifier or loudspeaker. Proceed as directed in paragraph 71.

CAUTION

Never attempt to remove or adjust the scanning lens of the sound optical system unless special adjusting equipment and trained personnel are available.

71. CHECKING THE AMPLIFIER AND LOUDSPEAKER. If the amplifier pilot lamp does not operate, this indicates that either the lamp is de-



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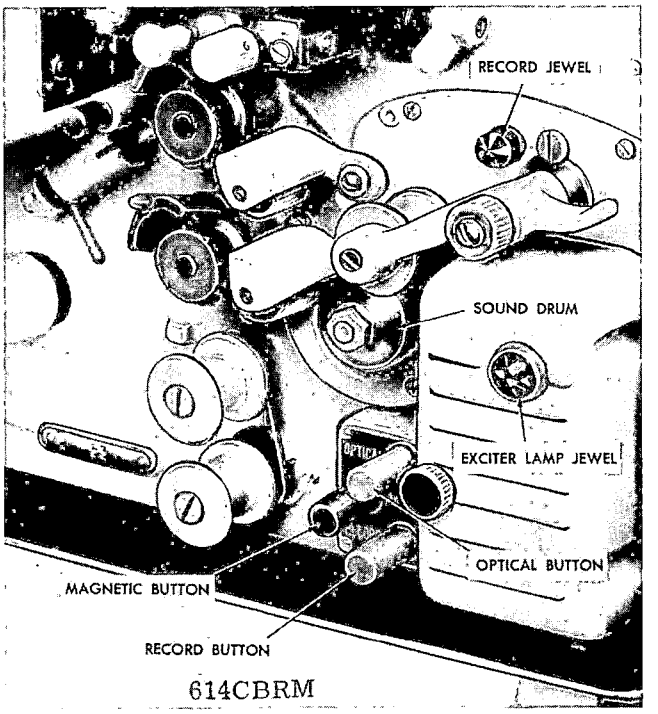


614CBRM

Figure 18. Sound Heads for CBM and CBRM Projectors

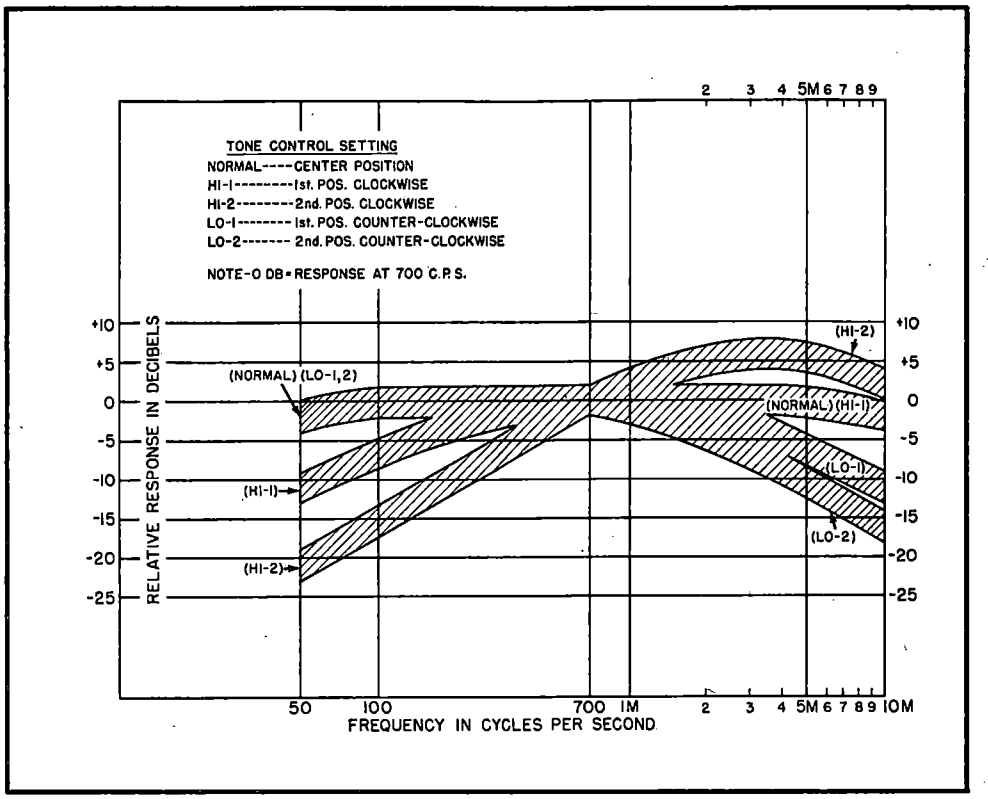


Figure 19. Tone Control Frequency Response Characteristics

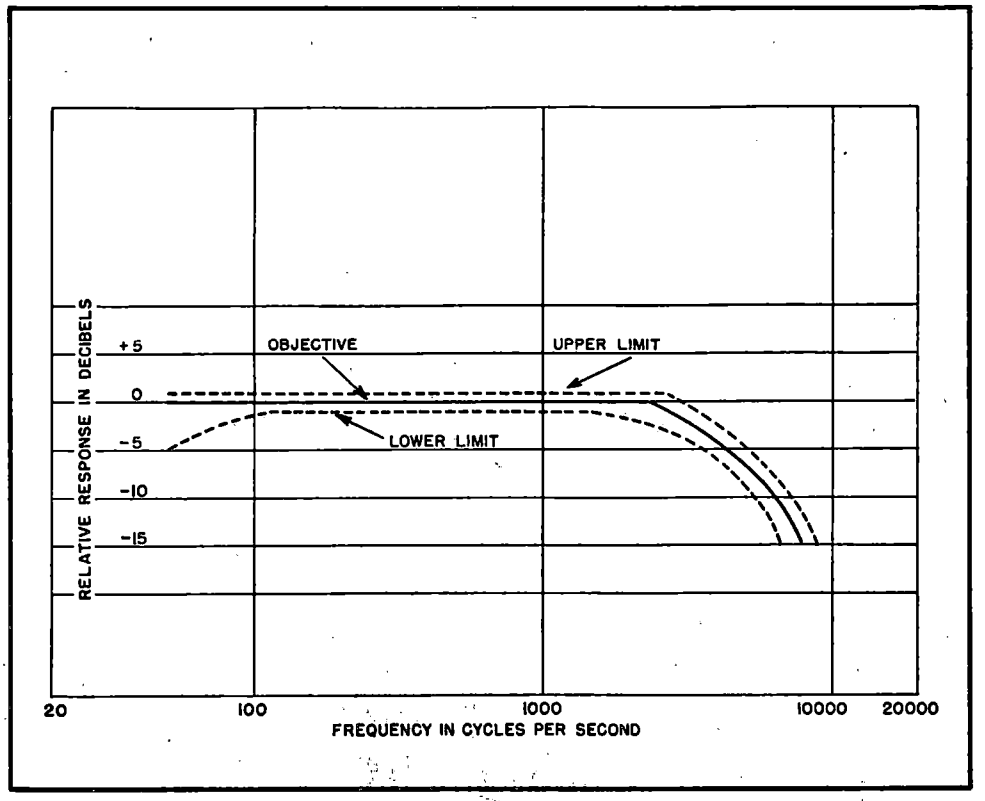


Figure 20. Projector Frequency Response Characteristics

fective or that no filament power is present at the amplifier. If the tubes do not heat up after allowing approximately one minute for warm up, no a-c power is being delivered to the amplifier. The fuse (F201) should be checked or replaced to eliminate it as a possible source of the trouble. If the pilot lamp and tube filaments are operating normally but no sound is available, proceed as follows:

a. With no film in the projector and with the OFF-MOTOR-LAMP switch in the MOTOR position, and with the volume control fully clockwise, move the 6AQ5 output tube (V204) in and out of its socket. Noise from the speaker as the tube pins make and break contact with the socket is an indication that the speaker and output tube are operating.
b. Repeat step a with the 6AQ5 output tube (V203). Noise as heard above indicates that tube is good.
c. If no noise was heard when either output tube was moved check the speaker connections and speaker selector switch. If the connections are intact and the switch is in the proper position, replace the 6X4 rectifier tubes (V206 and V207).
d. If noise was heard in steps a and b, repeat step a with the 12AX7 driver tube (V202). A similar noise of greater intensity should be heard. Failure to produce noise at this point would indicate a bad 12AX7 driver tube. Repeat the same procedure with the 12AX7 input tube (V201).

72. AMPLIFIER TROUBLE ANALYSIS.

73. TESTING PRECAUTIONS. When performing the tests, the following points must be observed in order to insure correct measurements.

a. A 20,000 ohm-per-volt meter must be used for d-c measurements. Lower resistance instruments will result in significantly lower readings.
b. All voltage and resistance readings are to be made between circuit ground and voltage points on figure 32 (CB), 33 (CBM, CBRM) or 42 (CD).
c. Measurements of input signal voltage must be carefully made. Parasitic pick-up of hum, etc., will cause erroneous readings.
d. Particular attention must be paid to common grounding of the oscillator and distortion analyzer when distortion measurements are made.
e. All measurements should be made with the amplifier operating from 115-volt, 60-cycle supply, otherwise readings shown in figure 21 will be erroneous.

74. AUDIO FREQUENCY MEASUREMENTS. Performance of the amplifier, with respect to the audio frequency signal, cannot be determined without a steady amplitude input signal. This may be supplied from three different sources:

a. When a projector, known to be operating satisfactorily, is available, 400-cycle test film may be used to supply the audio frequency signal for all amplifier emergency audio frequency performance measurements. The film can be used in the form of a loop about 3 feet in length, if desired.
b. When a complete malfunction of the audio channel exists, this same 400-cycle film can supply the test tone essential for point to point checkings.
c. In the absence of 400-cycle test film, a normal 16-mm print of good quality will do. Definite audio frequency measurements cannot be made with such film, however.

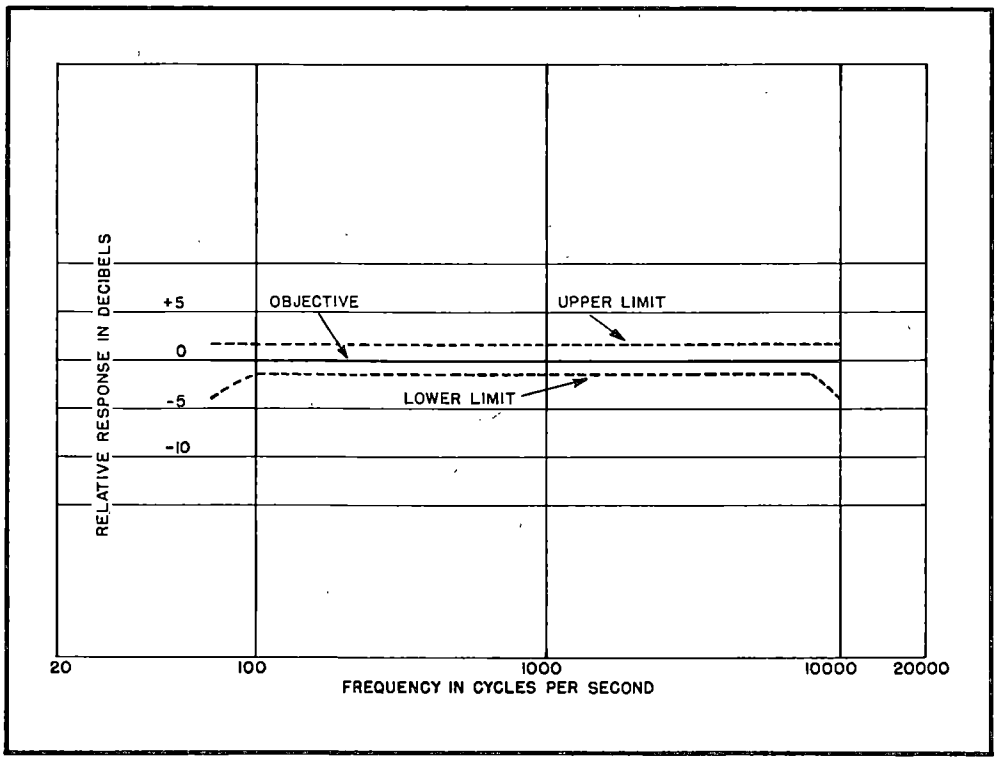


Figure 21. Amplifier Frequency Response Characteristics

75. OVERALL FREQUENCY RESPONSE MEASUREMENTS. Measurements of the overall frequency response of the system, including the projector, cannot be made without multi-frequency test film. This measurement should be made whenever the sound system is repaired, and the overall response should never exceed limits shown in figure 20.

NOTE: Color prints may be released for use with the emulsion on either side of the film base. Reproduction must be the same in either position for best intelligibility. Frequency response curves should be made by running the film normally, and then reversing the test film and running it through the projector. In both cases, the resulting curves should fall within the limits shown in figure 20.

76. AUDIO FREQUENCY CHARACTERISTICS AND DISTORTION MEASUREMENTS. The amplifier audio frequency characteristics and distortion measurements cannot be made without an audio frequency signal generator of low distortion and an audio frequency distortion analyzer of good quality. All amplifier characteristics tests may be conducted with this equipment.

After a major overhaul, or for periodic performance checks, perform all tests listed in Table VIII, Amplifier Characteristics Tests.

When measuring the performance of the tone control, the amplifier output power should be set at a level of 2 watts at 700 cycles (5.67 volts across 16-ohm load); otherwise, the amplifier power output stage will be overloaded and erroneous readings result.

77. TUBE VOLTAGE MEASUREMENTS. This data is given in Table II near the end of this Section. It includes all pertinent normal voltage and resistance conditions involved in the correct functioning of the amplifier. Measurements are made with correctly functioning tubes. It is necessary, therefore, that all of the tubes be checked prior to installation in the amplifier, otherwise readings taken may be erroneous. Conversely, if means of checking tubes are not available, voltage readings (taken at points indicated in Table II) could be used for determining tube condition in a correctly functioning amplifier. Note the following precautions.

a. A-C signal voltages must be measured with a high impedance vacuum tube voltmeter, otherwise readings will be in error.
b. The amplifier should be terminated in a correct value load resistor (16 ohms) in lieu of the external loudspeaker for making output power measurements.

78. AMPLIFIER SCHEMATIC VOLTAGE DATA. The following data serves to clarify the voltage data given on the amplifier schematic, figure 32, 33, or 42.

a. The d-c power supply points for measurement are given for points which would not appear on the tube terminal test points chart. Refer to Table IV for 614 CB, CBM, CBRM or Table X, page 58A for 614CD.
b. Circuit malfunctions are rapidly identified by measuring the voltage drop occurring across the individual resistors in the direct current power distribution network. A higher voltage drop than given in the voltage drop table indicates either increased resistance or an abnormally increased current flowing through that portion of the circuit.

79. LOCALIZING LOUDSPEAKER TROUBLES.

a. Remove loudspeaker by reference to Parts Catalog figure 28. The length of the speaker cable will permit the speaker mounting panel to be placed on a bench for service. Disassemble speaker from mounting panel.
b. Check the loudspeaker cone for holes or cracks. Apply equal pressure to all sides of the cone and gently push the cone with the fingers to make sure that the voice coil is not rubbing in the air gap. Be careful that this inspection does not of itself further damage the loudspeaker.
c. Unsolder the connection from the terminals of the loudspeaker. Check loudspeaker resistance with an ohmmeter. The d-c resistance of the voice coil should read approximately 8 ohms.

80. PROJECTOR SET CHARACTERISTICS TESTS.

After major overhaul, or after disassembly and repair, the Type 614 projector should meet all of the performance characteristics tests outlined in paragraph 81 (Sound Optical System Alinement Tests) and in Tables VII, VIII and IX at the end of this section. When making these tests, the following precautions should be noted.

a. All tests should be made at 115 volts ac, 60 cycles, unless otherwise specified.
b. Be sure to observe the testing precautions outlined in paragraph 73.

81. SOUND OPTICAL SYSTEM ALINEMENT TESTS.

82. PRELIMINARY SYSTEM CHECK.

a. Connect the equipment as for normal operation. Be sure all components are in operating condition. Turn the GAIN (Volume) control on amplifier panel to an intermediate position and turn the TONE control to NORMAL. Turn amplifier switch to the ON position. Turn OFF-MOTOR-LAMP switch to LAMP position. The red jewel on the exciter lamp cover should glow, indicating that the exciter lamp is operating.
b. Make the thump test by inserting a clean white card approximately one inch wide between the sound optical unit (sound lens) and the sound drum. Move card back and forth in this position to interrupt the scanning light beam from the sound optical unit to the photo conductive cell. If the sound system is operating satisfactorily, a thumping sound will be heard in the loudspeaker.
c. If thumping sound is not heard, then the alinement of the sound optical prism or the sound drum were not made in accordance with the directions given in paragraphs 39 and 40. Recheck these alinements. Repeat thump test until thumping sound is heard in the loudspeaker and continue with the following adjustment procedures.

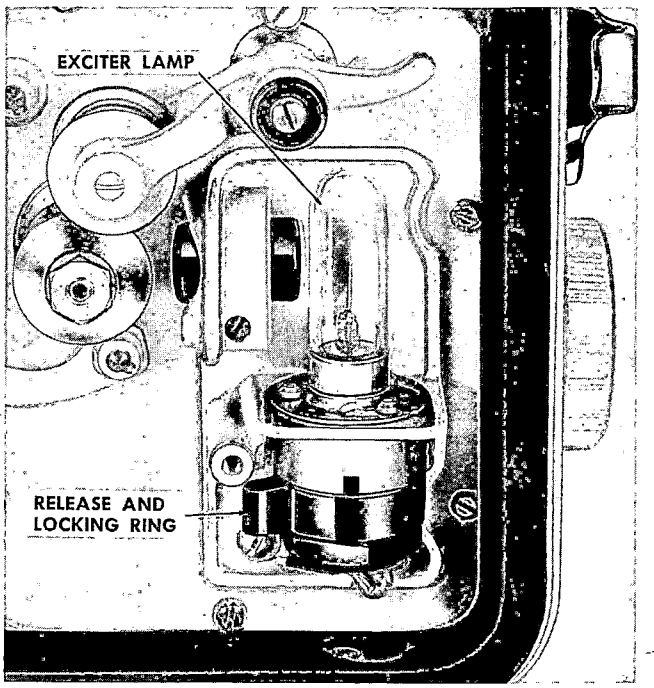


Figure 22. Sound Head Alinement Adjustments

83. BUZZ-TRACK TEST FILM ADJUSTMENT.

a. This adjustment determines if the film guide adjustment roller (figure 22) is in proper lateral position in relation to the scanning beam. Thread projector with three-foot loop of buzz-track test film. The emulsion side of the film should face the exciter lamp. Operate the equipment as for regular film. Be sure the amplifier and loudspeaker are connected. Turn up the amplifier volume control about half-way. Set tone control in position marked NORMAL. Turn OFF-MOTOR-LAMP switch to the LAMP position.

b. If the position of the film guide adjustment roller is in proper lateral position in relation to the scanning beam, the low signal (300 cycle) and the high signal (1000 cycle) will (1), not be heard in the loudspeaker, or (2), there will be a faint reproduction of equal intensity from both the low signal (300 cycle) and the high signal (1000 cycle).

c. If the low signal (300 cycle) is reproduced strongly, loosen the binder head screw (2), figure 22, and turn the knurled scanning adjustment nut (3) in a counterclockwise direction until the signal is very faint or is not heard.

d. If the high signal (1000 cycle) is reproduced strongly, loosen the binder head screw (2), figure 22, and turn the knurled scanning adjustment nut (3) in a clockwise direction until the signal is very faint or is not heard.

e. Stop projector and remove the loop of test film.

84. ADJUSTMENT FOR UNIFORMITY OF SCANNING BEAM ILLUMINATION.

a. Thread projector with a loop of test film for determining uniformity of scanning beam illumination (1000 cycle). There are two types of this test film: field type and laboratory type.

b. Connect a "volume indicator" or "output" meter preferably carrying a decibel or "VU" scale, across the output terminals of the amplifier to read the output level of the 1000-cycle tone. Usually, the most convenient point for making the connection is at the loudspeaker. Turn OFF-MOTOR-LAMP switch to the LAMP position. The position of the sound track, relative to the ends of the light beam at any instant, is shown by the animated diagram appearing in the picture area of the film. Read the output level of the 1000-cycle tone. As long as the variation does not exceed ± 1.5 db, the projector has satisfactory uniformity of scanning beam illumination.

d. Greater variations than ± 1.5 db in the output may be caused by dirt on the exciter lamp, the sound optical unit or the optical light pipe prism, or by deformation of the exciter lamp filament, or by misplacement caused by a bent or loose socket, etc. Clean the sound optical elements and make repairs or replacements as needed to correct the unevenness of the scanning beam illumination so as to bring the variation within the ± 1.5 db limit.

85. FOCUS AND AZIMUTH ADJUSTMENT (PRECISION ALINEMENT).

a. Thread projector with a loop of precision type (7000 cycle) film for scanning beam focusing and azimuth adjustment. Emulsion side of film should face the exciter lamp. Replace loudspeaker with an 8-ohm non-inductive resistor. Connect oscilloscope across the output circuit of the amplifier. Remove exciter lamp cover and exciter lamp. Place the sound optical unit adjustment tool (Tool No. 061000-F1, figure 2) over the sound optical unit as shown in figure 23. Remount the exciter lamp in its socket.

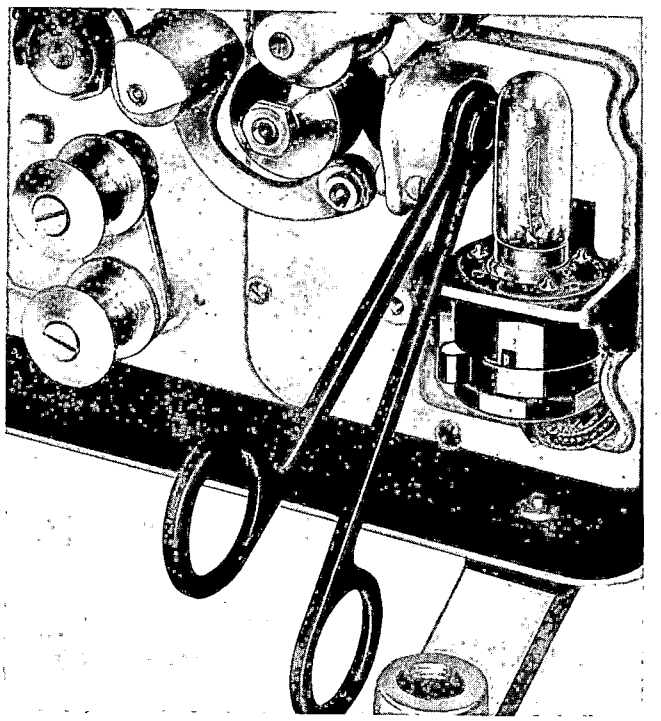


Figure 23. Focusing the Scanning Lens

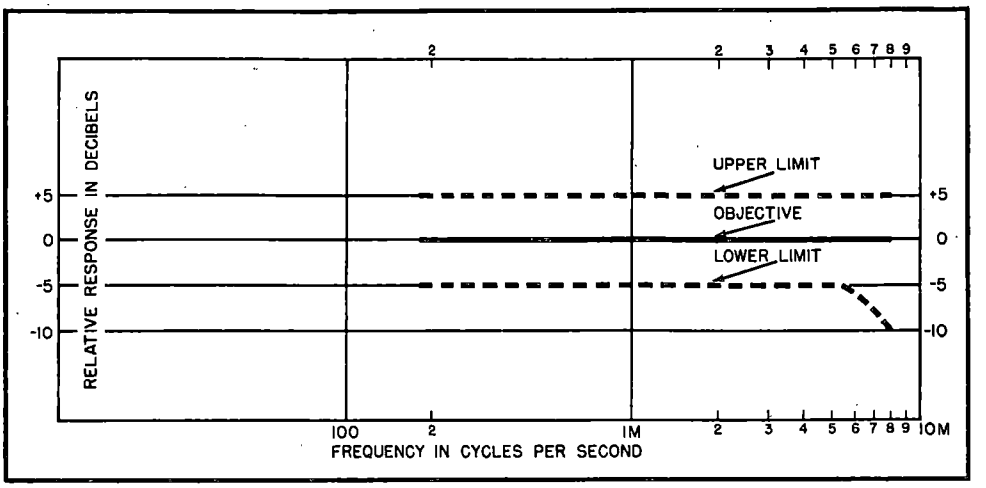


Figure 24. Loudspeaker Frequency Response Characteristics

b. Loosen the fillister head screw (4), figure 22. Set tone control in position marked NORMAL. Turn volume (GAIN) control to an intermediate point, position marked "4". Turn the OFF-MOTOR-LAMP switch to LAMP position.

c. Using the adjustment tool, adjust the position of the sound optical unit by moving it closer to or farther away from the exciter lamp, and then by rotating the sound optical unit until a reading of maximum output and minimum distortion is obtained on the meter. Be sure that the true maximum point of output is reached. There are several points where the output will increase and then decrease again, but there is only one true optimum point of maximum output and minimum distortion.

d. When the sound optical unit is properly adjusted, tighten fillister head screw (4, figure 23) carefully, and make sure that the reading on the meter does not decrease during the process.

e. Repeat operation with shiny side of 7000 cycle film facing exciter lamp. Reading should be the same as in the first test.

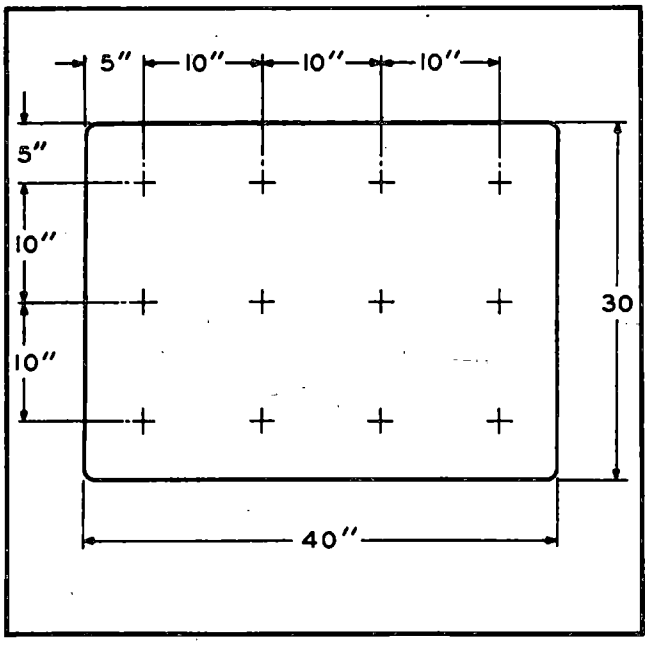


Figure 25. Light Measurement Diagram

86. STEADINESS OF SOUND REPRODUCTION (FLUTTER).

a. Thread projector with a roll of 3000 cycle flutter test film. Connect flutter indicator to output of amplifier. Set tone control in position marked NORMAL and volume (GAIN) control in an intermediate position.

b. Turn OFF-MOTOR-LAMP switch to LAMP position. Calibrate flutter indicator. Needle of flutter indicator should read at calibrate position on meter.

c. With OFF-MOTOR-LAMP switch in LAMP position, read the flutter indicator as soon as 6 feet of film have passed through the projector. The total flutter should be less than 0.25 percent.

d. The cause for excessive flutter may be in the sound mechanism, the picture mechanism, the take-up mechanism or the motor assembly.

87. CHECKING PHOTOCELL OUTPUT.

a. Operate the projector with 400 cycle signal level test film, terminating the amplifier with a 16-ohm,

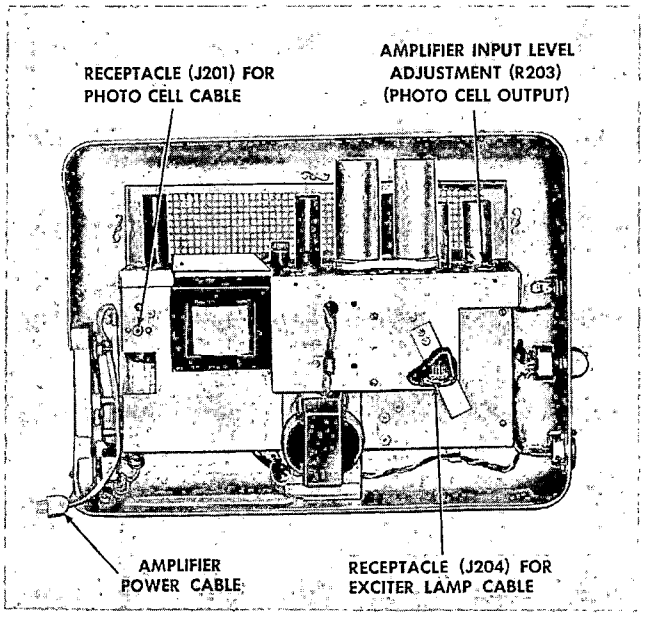


Figure 26. Rear View of Amplifier Removed from Projector

10-watt, non-inductive resistor in place of the loudspeaker. This wire-wound resistor is used for the sake of convenience. If an 8-ohm, 10-watt, wire-wound resistor were used, it would be necessary to substitute this resistor for the built-in loudspeaker.

b. When the 16-ohm resistor is connected to receptacle J203 (pins 1 and 3), be sure to set the loudspeaker selector switch to the REMOTE SPEAKER position.

c. With TONE control in the normal position (NOR), turn the VOLUME control fully clockwise. With a screwdriver, adjust the control shaft of R203 (figure 26) so that 8 watts of audio power is being delivered to the 16-ohm resistive load (11.3 volts rms).

d. Reduce the output power by 20 db (decibels) by rotating the VOLUME control counterclockwise until the voltage across the 16-ohm load is 1.13 volts.

e. Return the power output to 8 watts (11.3 volts) by adjusting the control shaft of R203.

TABLE I. PROJECTOR CIRCUIT VOLTAGES
(Refer to figures 27, 28 and 29)

Test Point	Symbol	Name of Part	Measure across Terminals	Correct Voltage
1	E103	Threading lamp	Socket	120 v ac
2	E104	Threading lamp	Socket	120 v ac
3	E105	Projection lamp	Socket	120 v ac
4	E102	R-F line filter	R-F line filter	120 v ac
5	J104	Drive motor receptacle	1-2 6-7	35 v ac 85 v ac
6	J103	Power receptacle	1-3	120 v ac
7		Ventilating Motor	Term. 11 of SW103 to top lug of threading lamp socket	120 v ac

TABLE II. TUBE AND OUTPUT TRANSFORMER MEASUREMENTS

NOTE: All d-c voltages should be measured with a 20,000 ohms-per-volt d-c meter with no signal. All a-c voltages should be measured with a vacuum tube voltmeter. In either case, the negative probe must be connected to the chassis, which is common ground for the amplifier. Connect a 16-ohm, 10-watt resistor across pins 1 and 3 of receptacle J203 to take the place of the remote loudspeaker, and turn the loudspeaker selector switch to the position marked REMOTE SPEAKER ON. For the a-c measurements, the sensitivity of the amplifier is checked; therefore, a 400-cps signal voltage of 18 mv is fed to the amplifier through the microphone jack J202 with the volume control fully clockwise. Resistance measurements are made with no power applied to the amplifier. If measurements do not meet requirements shown, refer to Table III (Amplifier Trouble Analysis Chart) for the probable cause of trouble. Whenever a d-c voltage reading is a value lower than that given in the table, other d-c voltages should be checked to make sure that the condition is not general. If a generally low d-c voltage condition exists, refer to Table IV (D-C Supply Voltage Drop) to localize the d-c power supply default.

Tube	Test Point	Pin	D-C Volts	A-C Volts	Resistance
V201 (12AX7)	1	1	110	1.3	1.5 Meg.
	2	2	0	0.056	1.0 Meg.
	3	3	1.2	0.037	5600
	4	4	—16	3.1*	160
	5	5	—16	3.1*	160
	6	6	140	0.058	1.5 Meg.
	7	7	0	0.018	56K-556K†
	8	8	1.5	0.017	10K
	9	9	—16	3.1*	160

(cont. on page 28)

TABLE II. TUBE AND OUTPUT TRANSFORMER MEASUREMENTS (cont)

Tube	Test Point	Pin	D-C Volts	A-C Volts	Resistance
V202 (12AX7)	10	1	210	9.8	1 Meg.
	11	2	13	10	670K
	12	3	35	10	115K
	13	4	—16	3.1*	160
	14	5	—16	3.1*	160
	15	6	125	9.8	1.5 Meg.
	16	7	0	1.1	500K
	17	8	1.4	1.1	6200
	18	9	—16	3.1*	160
V203 (6AQ5)	19	1	—11	9.8	500K
	20	2	0	0	0
	21	3	—16	3.1*	160
	22	4	—16	3.1*	160
	23	5	260	160	1 Meg.
	24	6	250	0	1 Meg.
	25	7	—11	9.8	500K
V204 (6AQ5)	26	1	—11	9.8	500K
	27	2	0	0	0
	28	3	—16	3.1*	160
	29	4	—16	3.1*	160
	30	5	260	160	1 Meg.
	31	6	250	0	1 Meg.
	32	7	—11	9.8	500K
V205 (6AQ5)	33	1	—35	150RF	5100
	34	2	0.5	110RF	15
	35	3	—16	3.1*	160
	36	4	—16	3.1*	160
	37	5	250	1.1RF	1 Meg.
	38	6	250	1.1RF	1 Meg.
	39	7	—35	150RF	5100
V206 (6X4)	40	1	—20	265	260
	41	2	0	0	Inf.
	42	3	—16	3.1*	160
	43	4	—16	3.1*	160
	44	5	0	0	Inf.
	45	6	—20	265	260
	46	7	280	8	1 Meg.
V207 (6X4)	47	1	—20	265	260
	48	2	0	0	Inf.
	49	3	—16	3.1*	160
	50	4	—16	3.1*	160
	51	5	0	0	Inf.
	52	6	—20	265	260
	53	7	280	8	1 Meg.
T201	54	5	0	8	0.60
	55	6	0	11.3	1.0

*These voltages must be measured with a high impedance voltmeter (vacuum tube type) with a large capacitor in series with the meter lead to block the d-c component of the voltage. A reading under any other circumstances will be meaningless.

†Resistance from this pin to ground will depend upon setting of R203 and therefore the resistance reading may be anywhere within the limits given.

TABLE III. AMPLIFIER TROUBLE ANALYSIS CHART

NOTE: This chart is coordinated with the tube and output transformer measurements (Table II), and the test points listed below are the same as the test points listed in Table II. For example, if a check of test point 1 in accordance with the tube and output transformer measurements table should show a d-c measurement of zero volts instead of 110 volts, an a-c measurement of zero volts instead of 1.3 volts, and an infinite resistance measurement instead of 1.5 megohms, a reference to test point 1 in the table below will indicate that resistor R209 is open. High voltage or resistance is any measurement from above normal to infinity; low voltage or resistance is any measurement from zero to below normal.

Test Point	Test Condition Indicating Trouble	Capacitors Open	Capacitors Short	Resistors Open	Misc.
1	D-C voltage high and Resistance normal			R208,R207	
	D-C voltage low and A-C voltage low and Resistance low		C214b,c		
	D-C voltage low and A-C voltage low and Resistance high			R209	
2	A-C voltage low	C203			
	D-C voltage high		C203		
	Resistance high			R207	
3	D-C voltage high and Resistance high			R208	
6	D-C voltage high and A-C voltage low and Resistance normal			R203,R204, R205	
	D-C voltage low and A-C voltage low and Resistance low		C214b,c		
	D-C voltage low and A-C voltage low and Resistance high			R206,R225, R226	
7	D-C voltage high		C202		
	A-C voltage low	C202			
	Resistance high			R203,R204	
8	D-C voltage high		C207	R205	
	Resistance high			R205	
10	D-C voltage high and A-C voltage low			R216,R217 R218	
	D-C voltage low and A-C voltage low and Resistance low		C214c		
	D-C voltage low and A-C voltage low and Resistance high			R219,R226	
11	A-C voltage low	C211			
	D-C voltage high		C211		
	Resistance high			R216,R218	
12	D-C voltage high and Resistance high			R217,R218	

TABLE III. AMPLIFIER TROUBLE ANALYSIS CHART (cont)

Test Point	Test Condition Indicating Trouble	Capacitors Open	Capacitors Short	Resistors Open	Misc.
15	D-C voltage high and A-C voltage low			R214	
	D-C voltage low and A-C voltage low and Resistance low		C214c		
	D-C voltage low and A-C voltage low and Resistance high			R215, R226	
16	A-C voltage low	C208			
	D-C voltage high		C208		
	Resistance high			R213	
17	D-C voltage high and Resistance high			R214	
	A-C voltage high			R222	
19, 25	A-C voltage low	C212			
	D-C voltage low		C216c		
	Resistance high and increased D-C voltage			R220	
	Decreased neg. D-C or positive D-C voltage		C212		
23	D-C voltage high and A-C voltage low			R220	
	D-C voltage low and A-C voltage low and Resistance low		C216a		
	D-C voltage low and A-C voltage low and Resistance normal		C216c	R228	
	D-C voltage low and A-C voltage low and Resistance high				T201 Open
24	D-C voltage low and Resistance low		C214a		
	D-C voltage high and Resistance high			R226	
	D-C voltage low and Resistance high			R227	

TABLE III. AMPLIFIER TROUBLE ANALYSIS CHART (cont)

Test Point	Test Condition Indicating Trouble	Capacitors Open	Capacitors Short	Resistors Open	Misc.
26,32	A-C voltage low	C213			
	D-C voltage low		C216c		
	Resistance high and incr. D-C voltage			R221	
	Decr. neg. D-C or Pos. D-C voltage		C213		
30	D-C voltage high and A-C voltage low			R221	
	D-C voltage low and A-C voltage low and Resistance low		C216a		
	D-C voltage low and A-C voltage low and Resistance high				T201 Open
	D-C voltage low and A-C voltage low and Resistance normal		C216c	R228	
31	D-C voltage low and Resistance low		C214a		
	D-C voltage high and Resistance high			R226	
	D-C voltage low and Resistance high			R227	
33,39	D-C voltage low and Resistance low and RF voltage low		C217		
	D-C voltage low and Resistance high and RF voltage low			R231	
	D-C voltage low and Resistance normal and RF voltage low	C218			
34	Resistance high and RF voltage low				L201 Open
37,38	D-C voltage low and Resistance low		C219,C220		
	D-C voltage low and Resistance high			R230,R228	
40,45	A-C voltage low and Resistance high				T202 Open Secondary

TABLE III. AMPLIFIER TROUBLE ANALYSIS CHART (cont)

Test Point	Test Condition Indicating Trouble	Capacitors Open	Capacitors Short	Resistors Open	Misc.
46	D-C voltage low and A-C voltage low and Resistance low		C216a		
	D-C voltage low and A-C voltage low			R229	
47,52	A-C voltage low and Resistance high				T202 Open Secondary
53	D-C voltage low and A-C voltage low and Resistance low		C216a		
	D-C voltage low and A-C voltage low			R229	

NOTE: The following test points are for checking filament voltages:

4, 5, 9, 13, 14, 18, 21, 22, 28, 29, 35, 36, 42, 43, 49, 50	A-C voltage low	C221,C222	

TABLE IV. D-C SUPPLY VOLTAGE DROP

Circuit Element	Normal Voltage Drop (± 10%)
R228	20
R229	16
R227	10
R226	15
R225	5
R224	155
R223	85

TABLE V. D-C RESISTANCES

NOTE: The following chart lists the d-c resistances of the various transformers and inductors used in the amplifier.

Symbol	Part	Measure Between Terminals	Resistance in Ohms
T201	Output Transformer	1-2	450
		2-3	370
		4-5	0.6
		5-6	0.4
T202	Power Transformer	1-2	4.5
		3-4	64
		4-5	68
		6-7	0.09
		7-8	0.08
L201	Oscillator Coil	Gr-ye	5
		Ye-Blk	0.3
		Secondary	0.085

TABLE VI. A-C VOLTAGES

NOTE: The following chart lists the 60 cycle alternating current voltages as appearing at various terminals within the amplifier.

Symbol	Part	Measure Between Terminals	Approx. A-C Voltage
V201	12AX7 tube	4-9	6.3
		5-9	6.3
V202	12AX7 tube	4-9	6.3
		5-9	6.3
V203	6AQ5 tube	3-4	6.3
V204	6AQ5 tube	3-4	6.3
V205	6AQ5 tube	3-4	6.3
V206	6X4 tube	3-4	6.3
V207	6X4 tube	3-4	6.3
R201	Pilot Lamp	Not Marked	6.3
T202	Power Transformer	1-2	115
		3-4	265
		4-5	265
		3-5	530
		6-7	3.1
		7-8	3.1
		6-8	6.3

TABLE VII. PROJECTOR CHARACTERISTICS TESTS

NOTE: All tests to be made at 115 volts ac, 60 cycles, with 1000-watt, 115-volt projection lamp.

Test	Procedure	Correct Indication
1. Uniformity of screen illumination.	1. With new 1000-watt lamp inserted in projector operate projector on 115 volt, 60 cycle, ac without film. OFF-MOTOR-LAMP switch in LAMP position.	1. Light appears on screen.
	2. Focus aperture on screen so that the projected image of aperture is 40 inches wide and 30 inches high.	2. Edges of aperture appear sharp. No patches or bands showing variation of color or brightness appear.
	3. With illumination meter (employing one photo-electric cell) measure illumination at center of screen and at four corners (2 inches from edge of screen).	3. At no corner should illumination be less than 60 per cent of illumination at center of screen.
	4. Compute average illumination of four corners.	4. Average illumination at four corners should be not less than 70 per cent of illumination at center of screen.
2. Light output.	1. This test should be performed following the test for uniformity of screen illumination.	1. Light appears on screen in sharp focus.
	2. Divide illuminated area into 12 equal squares. Mark centers of these squares.	2. Figure 25 shows layout for light measurements.
	3. With illumination meter (employing one photo-electric cell) measure illumination at all 12 points. Complete average illumination (sum of measurements divided by 12).	3. Average screen illumination in foot candles.
	4. Multiply above result by area of projected image of aperture (8.33 sq. ft.).	4. Light output should be not less than 525 lumens.
3. Picture unsteadiness.	1. Focus aperture on screen so that projected image of aperture is 40 inches wide. Be sure projector is mounted on vibration free base.	1. Image of aperture on screen should be absolutely motionless.
	2. Thread projector with reel containing at least 80 ft. of picture-unsteadiness test film (target film). Turn OFF-MOTOR-LAMP switch to LAMP position.	2. Image of picture-unsteadiness test film should be focused sharply on screen.
	3. With a 6-inch scale, measure at the screen the vertical displacement of the image of the hole in the picture-unsteadiness film.	3. Vertical unsteadiness of a period shorter than one second should not exceed 0.2 per cent of the picture width in a new projector. It should not exceed 0.25 per cent of the picture width on a projector having been operated for 500 hours.
	4. Measure the horizontal displacement of the image of the hole in the unsteadiness test film.	4. Horizontal unsteadiness having any period whatsoever should not exceed 0.2 per cent of the picture width either in new projectors or projectors operated for 500 hours.

TABLE VII. PROJECTOR CHARACTERISTICS TESTS (cont)

Test	Procedure	Correct Indication
4. Framing mechanism.	1. With projector running with picture-unsteadiness film, as above, operate the framing mechanism so that the picture is framed correctly on the screen.	1. Framing lines on picture should be at edge of image.
	2. Turn the framing knob as far as it will go clockwise. Measure displacement of image on screen.	2. Image of hole should move up 2-5/8 inches or more. Edge of projected image, as defined by aperture, should not move at all.
	3. Turn framing knob counterclockwise until image is framed properly.	3. Framing lines on picture should be at edge of image.
	4. Turn framing knob as far as it will go counterclockwise. Measure displacement of image on screen.	4. Image of hole should move down 2-5/8 inches or more. Edge of projected image, as defined by aperture, should not move at all.
5. Travel Ghost	1. Thread and operate projector with travel ghost test film. Projector should be focused at a distance to give a picture image 40 inches wide. Operator should view image on a matte white screen, at a distance of 6-1/2 feet.	1. There should be no appearance of light streaks or vertical tails added to the projected images of the transparent areas on the test film.
6. Film speed	1. Turn OFF-MOTOR-LAMP switch to MOTOR position. Check speed of feed sprocket with tachometer.	1. Speed should not be less than 178.2 and not more than 181.8 rpm.
7. Film tension	1. Be sure OFF-MOTOR-LAMP switch is in the OFF position. Place empty 2000 ft. reel on spindle of take-up arm.	1. Reel should be firmly latched on spindle.
	2. Attach strip of film to reel hub. Wind several turns of film around hub.	2. Film should be wrapped securely on reel.
	3. Place the hook end of a spring scale through the film strip. Turn on the motor.	3. Scale sould read not more than 8 ounces, not less than 6 ounces.
	4. Turn off the motor. Place empty 2000 ft. reel on feed reel arm.	4. Reel should be firmly latched on spindle.
	5. Attach strip of film and spring scale as in 2 and 3 above.	5. Scale should read not more than 8 ounces.
8. Film life	1. In a room well protected from dust, thread the projector with a 12 ft. loop of newly processed and lubricated sound and picture film in good condition, having a shrinkage not greater than 0.3 per cent. Film should be supported in its return path, in as near a normal position as possible, by free running rollers of such construction as to have a negligible tendency to damage the film.	1. Film should be touching all parts of the projector mechanism that it touches in normal operation.
	2. With a 750 watt lamp in projector, turn OFF-MOTOR-LAMP to the LAMP position.	2. Projector should run.
	3. Allow loop of film to pass through picture mechanism 2000 times. After this, observe the quality of the projected picture and sound.	3. Quality of projected image and the sound should not be affected.

TABLE VII. PROJECTOR CHARACTERISTICS TESTS (cont)

Test	Procedure	Correct Indication
8. Film life (cont)	4. Examine film perforations.	4. Perforations should not show evidence of excessive wear.
	5. Splices will be replaced as may be necessary during the test. The life of 10 well made splices will be noted, and the average number of passages of the 10 splices will be computed.	5. The average life of the splice should be more than 1000 passages through the projector mechanism, with light source energized (750 watt lamp).
9. Tilt mechanism.	1. Turn tilt knob counterclockwise as far as it will go.	1. Projector should be tilted 10 degrees from horizontal.
	2. Turn tilt knob clockwise to an intermediate position.	2. Angle of tilt should decrease and projector should remain securely in position.
	3. Turn tilt knob clockwise as far as it will go.	3. Projector should return to horizontal position and remain there.
10. Noise of projector mechanism.	1. Mount projector in a substantially free space on a small stand. Mount the sound level meter so that the microphone is 3 feet from the vertical axis, passing through the picture aperture and in a horizontal plane with the aperture. Take readings at 45 degree intervals beginning with position in front of the projector. Operate projector with newly processed sound and picture film with the meter at curve setting "A." Read the sound level. Make these measurements in a very quiet room.	1. The noise should be less than 60 decibels.
11. Lateral positioning of film scanning light beam (accuracy of buzz track adjustments).	1. Thread projector with buzz track test film. With loudspeaker connected to amplifier, turn GAIN (Volume) control on full. Operate the equipment.	1. No sound of a 300 cycle or 1000 cycle note shall be heard in the loudspeaker, or the 300 and 1000 cycle note shall be reproduced at an equally faint intensity.
12. Uniformity of scanning beam illumination.	1. Thread projector with a loop of uniformity of sound track test film (100 cycle). Measure the output of projector with an output meter.	1. If variation in output is not more than ± 1.5 db, projector has staisfactory scanning beam illumination.
13. Focus and azimuth adjustment of scanning light beam (quick adjustment).	1. Thread projector with sound-focusing test film, field type (5000 cycles). Operate projector as for a normal sound film. Adjust sound optical unit.	1. Loudness of tone in loudspeaker indicates correct adjustment.
(precision adjustment)	2. Thread projector with sound focusing test film, precision type (7000 cycles) so that emulsion side faces exciter lamp. Connect output meter to output of amplifier. Turn tone controls to NORMAL. Turn GAIN (Volume) control until a reading is obtained on output meter. Adjust sound optical unit.	2. Focus and azimuth adjustment correct when maximum reading on output meter is obtained.

TABLE VII. PROJECTOR CHARACTERISTICS TESTS (cont)

Test	Procedure	Correct Indication
14. Steadiness of sound reproduction (flutter)	1. Thread the projector with a reel of 3000 cycle flutter test film. Connect flutter indicator to output of amplifier. Operate equipment. Calibrate flutter indicator.	1. Needle of flutter indicator should be read at calibrate point on meter.
	2. Turn off the motor. Turn flutter indicator switch to READ.	2. None.
	3. Turn on the motor. Read the flutter indicator as soon as practicable after 6 feet of film has passed through the projector.	3. Total flutter should be less than 0.25 per cent.
15. Projector electrical frequency response characteristic test.	1. With scanning light beam properly focused, set treble and bass tone controls at "Normal." Terminate the amplifier in an 8 ohm non-inductive resistor. Operate projector with a multi-frequency test film. Measure the output level at each frequency noted.	1. The responce frequency characteristic should be between the dotted limits shown on Figure 20.
	2. Repeat test with sound track on other side of film.	2. Result should be as in 1 above.
16. Line voltage and frequency variation test.	1. Turn the OFF-MOTOR-LAMP switch to the MOTOR position and to the OFF position 20 times at a line voltage of 108 volts (55 cycles).	1. Motor should start each time.
	2. Repeat operation as in 1 above but at a line voltage of 122 volts (65 cycles).	2. Motor should start each time.
	3. Run projector with sound picture film at line voltage of both 108 and 122 volts, using a 750 watt lamp.	3. Light output and sound quality should be satisfactory.

TABLE VIII. AMPLIFIER CHARACTERISTICS TESTS

NOTE: Refer to figure 21 for Amplifier Frequency Response Characteristics

Test	Procedure	Correct Indication
1. Adequacy of Reserve Amplification.	1. Run projector with a 400 cycle test film. Set amplifier tone control to NOR (NORMAL) and the VOLUME control at a point 20 decibels below maximum output (Mid-Position). Connect 16 ohm, non-inductive resistor to remote loudspeaker receptacle J203, pins 1 and 3.	1. Amplifier should deliver 8 watts of audio power to load resistor (11.3 volts rms across 16 ohm load).
2. Electrical Power Output and Distortion.	1. Disconnect the photo cell input plug from J201. Using the Hewlett-Packard 200B oscillator (or equivalent) as a source of signal, inject a 180 mv. signal into J202. With the same volume control setting as in test (1) measure the harmonic content of the amplifier output with a Hewlett-Packard 330B Distortion Analyzer at frequencies of 100, 400, 1000, 2000, 3500, 5000, and 6000 cycles per second. The input impedance of the Hewlett-Packard 330B Distortion Analyzer is high enough (600 ohms) so as not to disturb the 16 ohm load on the amplifier.	1. The amplifier should develop 8 watts of audio power and the total distortion should not exceed 2.0% at any of the frequencies tested.

TABLE VIII. AMPLIFIER CHARACTERISTICS TESTS (cont)

Test	Procedure	Correct Indication
3. Frequency Response Characteristics.	1. At rated gain, (volume control setting of tests (1) and (2)), vary the input frequency from 70 to 8000 cps, keeping the amplitude of the input signal at 18 mv.	1. The output of the amplifier should fall within the limits of Figure 21 for any frequency tested, providing that the input signal is held constant with respect to amplitude and that the amplifier is terminated in a 16 ohm non-inductive load. The measured response should have a slope approximating the slope of the desired curve.
4. Output Voltage Regulation.	1. Inject a 1000 cycle sine wave as in test (2), resulting in 8 watts being delivered to the 16 ohm resistive load (11.3 volts). Remove the load.	1. Removal of the load should not cause the output voltage to increase in excess of 4 db. (Open circuit voltage should not exceed 17.9 volts at rated gain with 180 mv. on grid of V201a.)
5. Noise Test.	1. Reconnect the photo cell cable plug P102 to J201. With the projector running without film, set the tone control to "NOR" and the volume control to Maximum (Fully clockwise). Measure the voltage appearing across the 16 ohm resistor load at the output of the amplifier.	1. The voltage measured is the total electrical noise generated by the projector and amplifier and should be at least 40 db below the rated output of 8 watts. (40 db below 8 watts across 16 ohms corresponds to a voltage of 0.113 volts).
6. Tone Control Action.	1. With an input signal of 18 mv into the microphone jack (J202) and the volume control adjusted for 2 watts of power output across the 16 ohm load resistor (5.67 volts), determine the frequency response curve by varying the input frequency. The curve will be a plot of output in decibels vs frequency. 2. Rotate the tone control fully counterclockwise and obtain a new response curve as above. 3. Rotate the tone control in a clockwise direction and obtain another response curve.	1. The resulting response curve must approximate the design objective, Fig. 19 (within ±2 db). 2. The new response curve should show attenuation of frequencies above 700 cycles with an attenuation of 10 db (±2 db) at 5000 cycles at maximum position of the control. Fig. 19. 3. Accentuation of frequencies above 700 cycles should result in the form of a broadly tuned peak with a boost of 6 db (±2 db) at 3500 cycles when the control is fully clockwise. In addition, frequencies below 700 cycles shall be attenuated with an attentuation of 12 db (±2 db) at 100 cycles. Fig. 19.
7. Dielectric Test.	1. Disconnect the power leads to the amplifier. Remove all tubes. Connect one lead of the 900 volt dielectric test set to one power lead. Connect other end of dielectric tester to any metal part of amplifier. Turn ON set for one minute.	1. No short circuits or breakdowns should be indicated in the amplifier.

TABLE IX. LOUDSPEAKER CHARACTERISTICS TESTS

Test	Procedure	Correct Indication
1. Sound Output Pressure	1. Set up loudspeaker under free field conditions and impress an 8 watt warble signal across the input taps. Measure the sound output pressure on the loudspeaker axis at a distance of 10 feet employing a signal warbled over band from 800 to 1250 cps. The signal shall be warbled with a linear change of frequency on a logarithmic scale with respect to time.	1. The loudspeaker shall be capable of producing a minimum output pressure of 88 decibels (Ref. 0.002 dyne per cm)
2. Frequency Response Characteristics.	1. Set up loudspeaker under free field conditions and impress a constant voltage signal (of such value as to deliver 2 watts at 800-1250 cps. warble) across the input terminals at a frequency varied from 80 to 8000 cps. Measure the sound output pressure on the loudspeaker axis at a distance of 10 feet.	1. The frequency response characteristics should fall within the limits of Figure 24. Sharp peaks and dips may extend beyond these limits providing the width of these peaks and dips at the limits is less than 1/10 octave with no more than one such extension per octave. The sound output pressure over the 800-1250 cycle warble band will not necessarily be the zero reference on Fig. 24.
3. Load Characteristic test.	1. Set up loudspeaker under free field conditions and impress an 800-1250 cps warble frequency across the terminals. Vary the amplitude of this signal from zero to 8 watts. Measure the sound output pressure for each value of test voltages on the speaker axis at a distance of 10 feet and the power input to the speaker (volts & amperes) as the amplitude is varied.	1. The load characteristics (sound pressure output versus volt-ampere input) plotted on logarithmic scales should be essentially a straight line. The maximum deviation from a straight line should be 1.5 db at 8 watts.

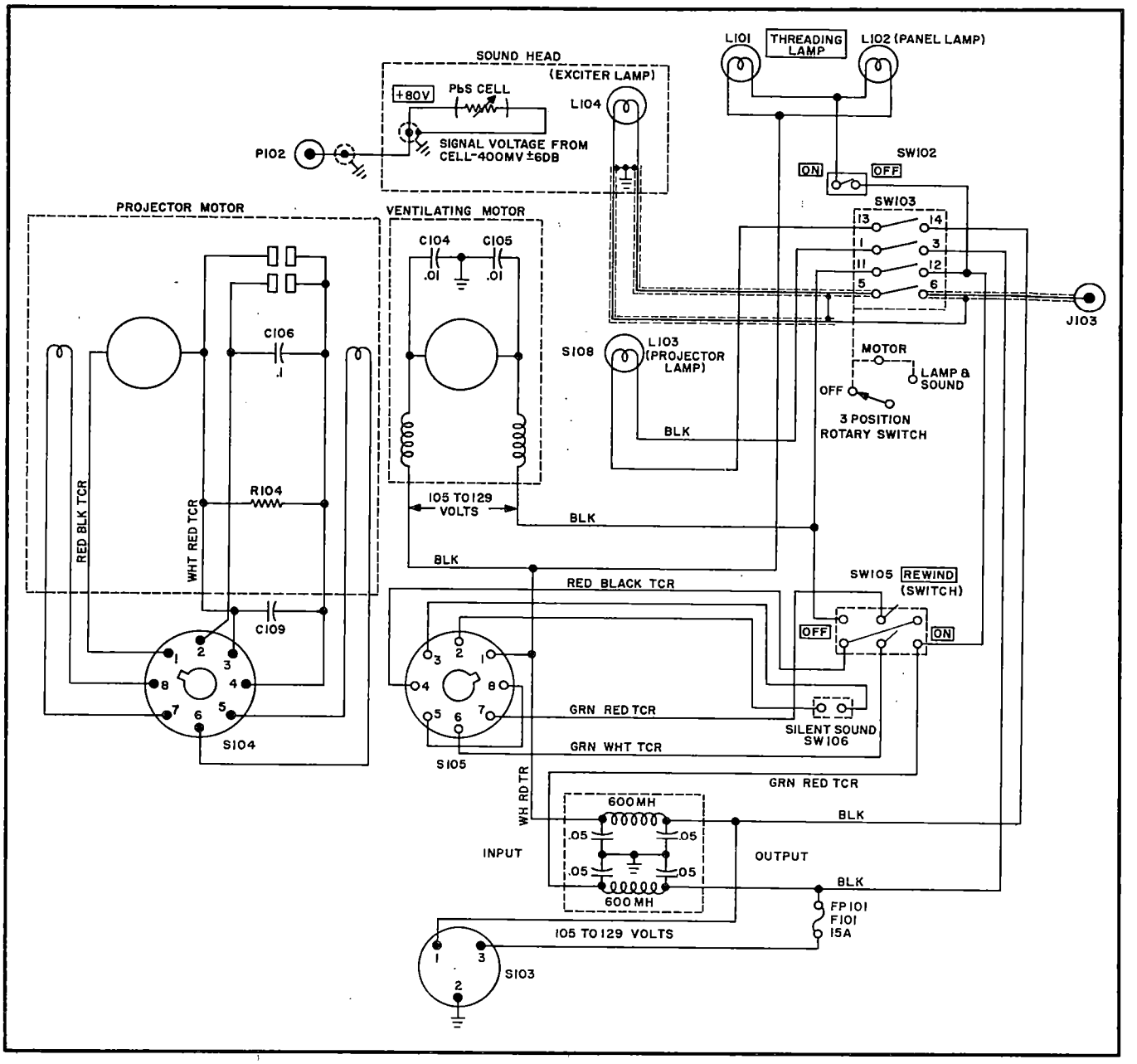


Figure 27. 614 CB Projector Schematic Wiring Diagram
(See figure 41, page 58B, for 614CD Projector Schematic)

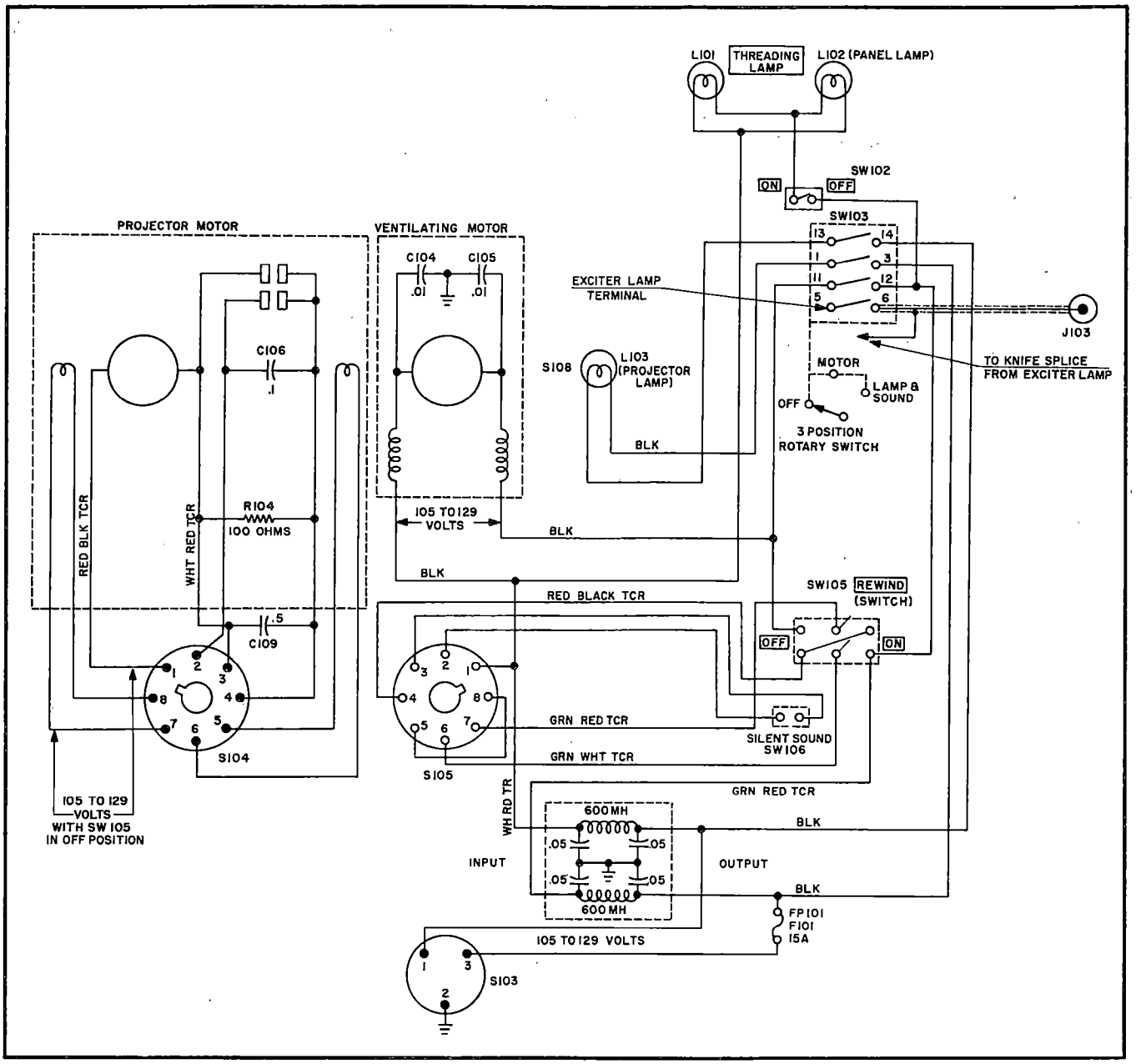


Figure 28. 614 CBM Projector Schematic Wiring Diagram

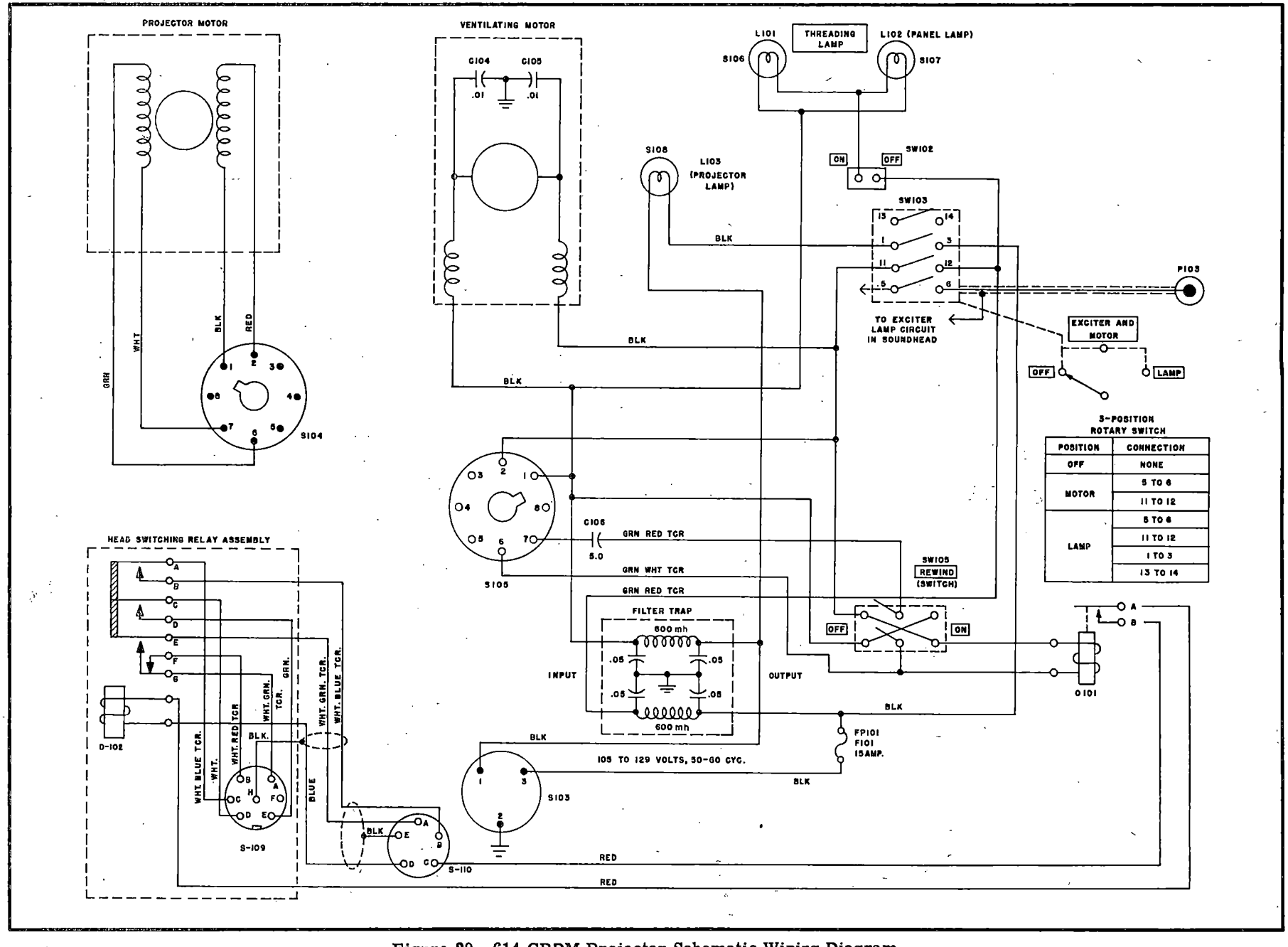


Figure 29. 614 CBRM Projector Schematic Wiring Diagram

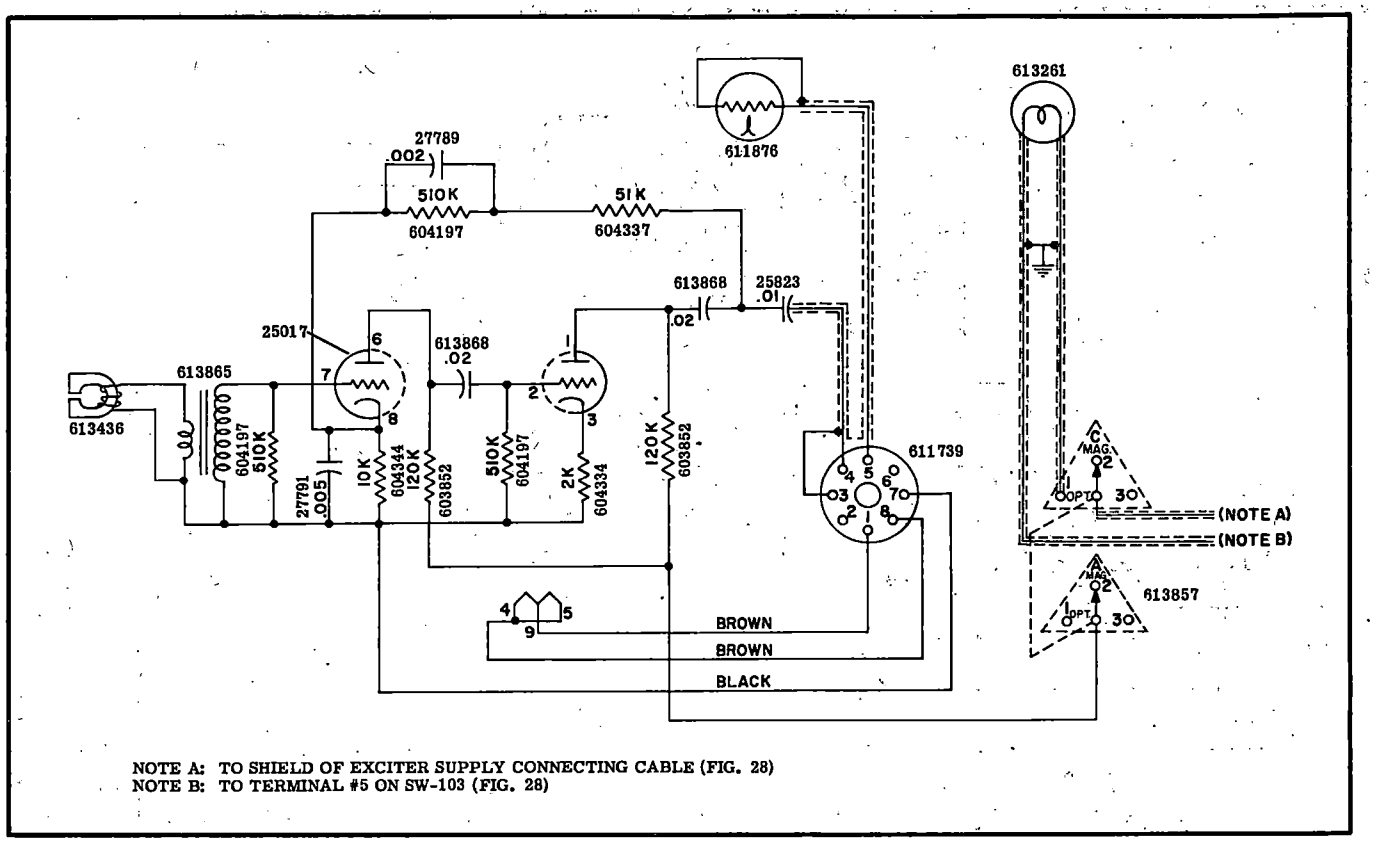


Figure 30. Magnetic-Optical Sound Head Schematic (614 CBM)

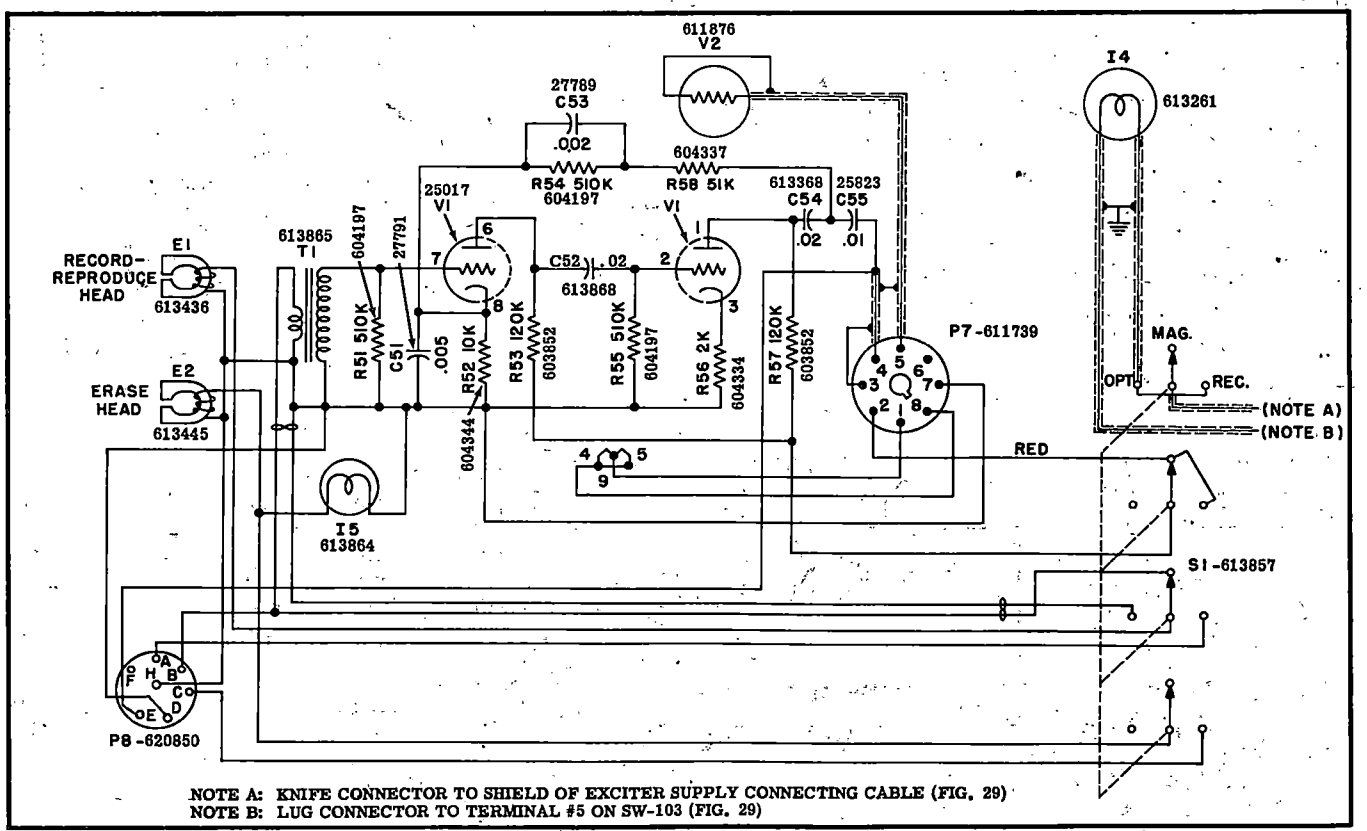
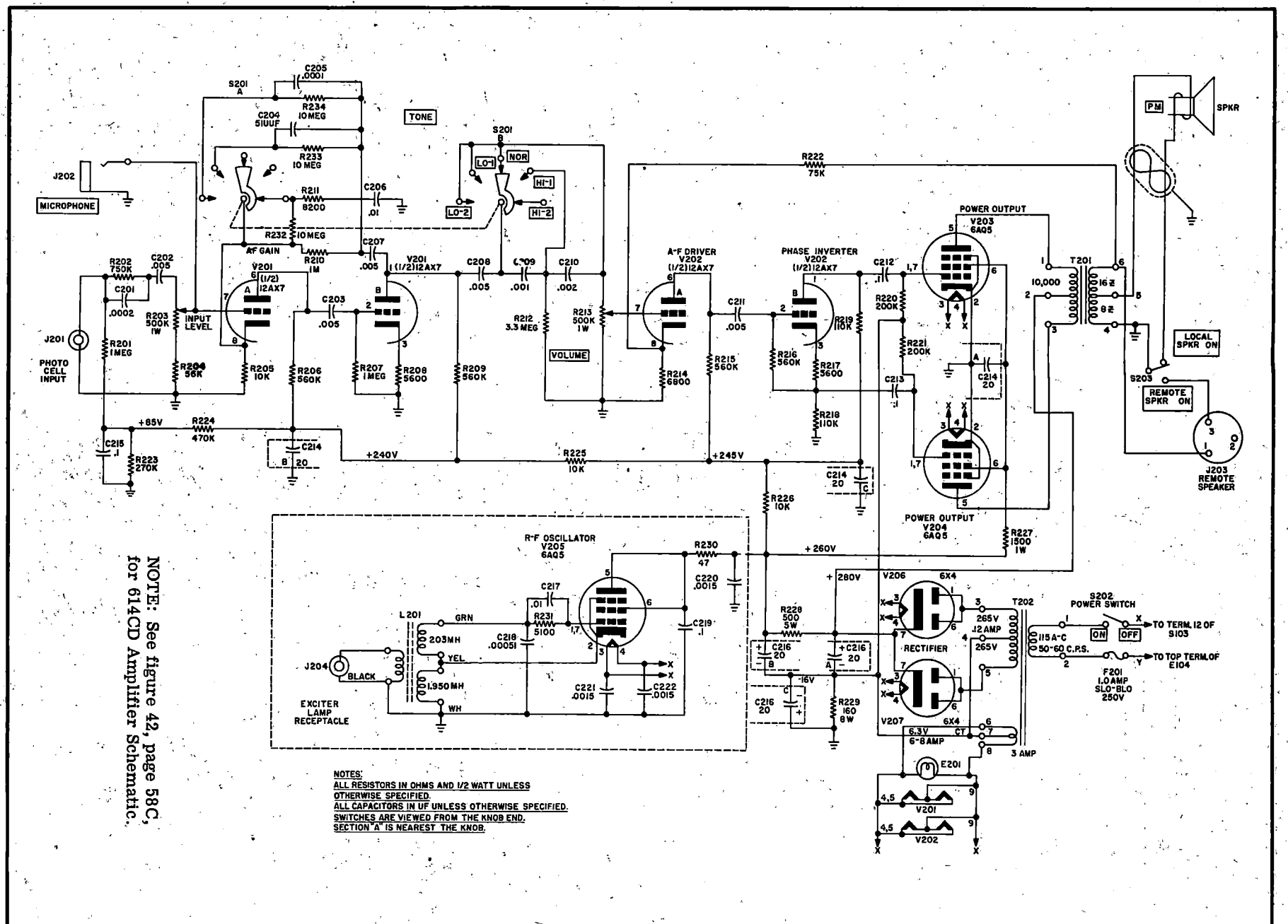


Figure 31. Magnetic-Record Sound Head Schematic (614 CBRM)



NOTES:
ALL RESISTORS IN OHMS AND 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL CAPACITORS IN UF UNLESS OTHERWISE SPECIFIED.
SWITCHES ARE VIEWED FROM THE KNOB END.
SECTION "A" IS NEAREST THE KNOB.

NOTE: See figure 42, page 58C, for 614CD Amplifier Schematic.

Figure 32. Amplifier Schematic Wiring Diagram (614 CB)

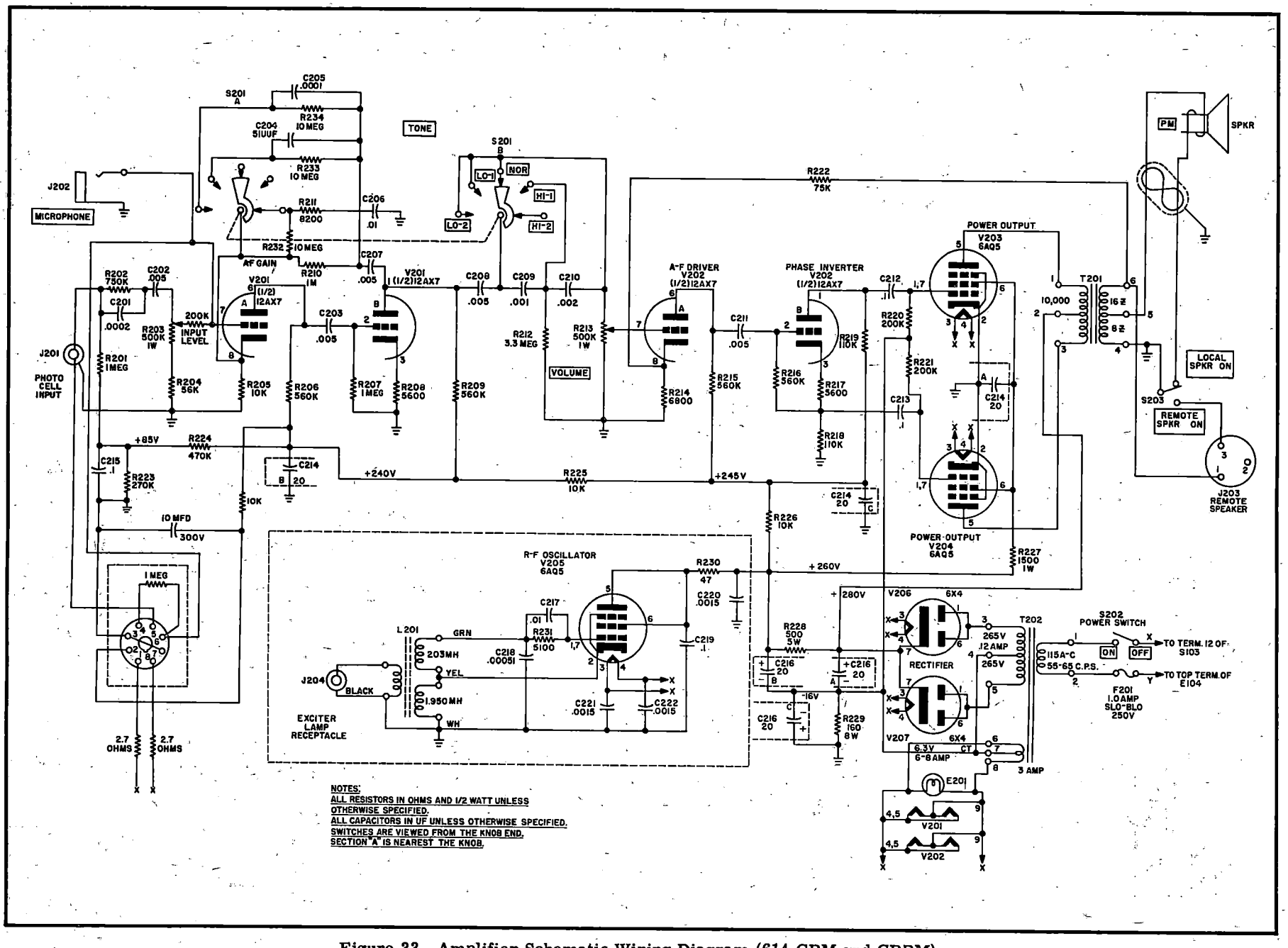


Figure 33. Amplifier Schematic Wiring Diagram (614 CBM and CBRM)

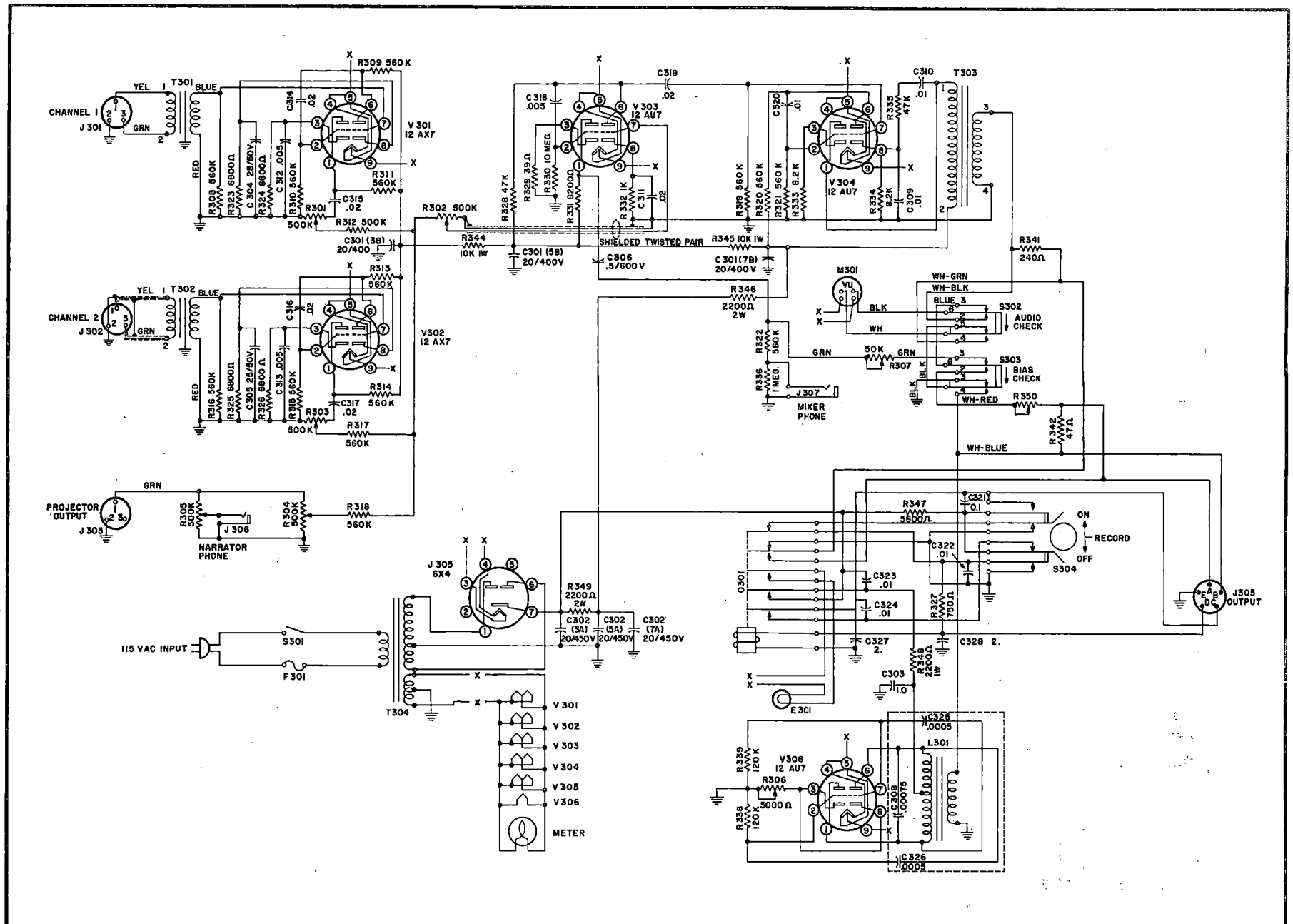


Figure 34. Record Amplifier Schematic Wiring Diagram

Trouble Shooting Chart

Trouble	Probable Cause	Remedy
1. Amplifier operates, but projector motor does not run, projection lamp does not light.	1. Projector fuse blown. 2. Faulty OFF-MOTOR-LAMP or amplifier OFF-ON switch.	1. Replace fuse. 2. Repair or replace switches.
2. Projector motor runs, projection lamp lights, but amplifier does not operate (no sound from loudspeaker).	1. Amplifier not turned on. 2. Amplifier fuse blown. 3. Defective tube(s). 4. Exciter lamp burned out. 5. Photo-cell cable not connected from projector to amplifier. 6. Internal amplifier trouble.	1. Turn amplifier OFF-ON switch to ON position. 2. Replace with good fuse. 3. Replace defective tube(s). 4. Replace exciter lamp. 5. Connect cable to receptacle J204. 6. Check circuit (para. 72); repair or replace defective parts.
3. Projection lamp lights, motor will not run.	1. Loose connection in motor circuit, or open circuit. 2. Worn out or sticking motor brushes. 3. Dirty governor points. 4. Worn out or sticking governor brushes. 5. Faulty OFF-MOTOR-LAMP switch. 6. Defective governor or motor. 7. Defective motor wiring. 8. Dirty commutator.	1. Check all connections to motor and repair as necessary. 2. Remove brushes and clean; replace if necessary. 3. Clean governor points with ignition file. 4. Remove brushes and clean; replace if necessary. 5. Repair or replace with new switch. 6. Repair or Replace. 7. Check continuity of wiring and replace defective wires. 8. Clean with crocus cloth.
4. Motor operates but projection lamp does not light.	1. Lamp burned out. 2. Switch not turned to lamp position. 3. OFF-MOTOR-LAMP switch defective. 4. Lamp not seated correctly in socket, contact poor. 5. Defective projector wiring.	1. Replace with new lamp. 2. Turn OFF-MOTOR-LAMP switch to LAMP position. 3. Replace defective switch with new one. 4. Check to see that lamp is inserted properly. 5. Check projector wiring circuit, repair defective wires.

Trouble	Probable Cause	Remedy
5. Motor runs, mechanism does not.	1. Drive chain not engaged on motor chain sprocket or main drive chain sprocket.	1. Engage chain on sprockets.
	2. Drive chain sprocket loose on shaft.	2. Tighten chain sprocket to shaft.
6. Motor speed varies or projector runs too fast. (universal motor only)	1. Governor not adjusted.	1. Adjust governor to give correct motor speed. (para. 61).
	2. Governor points pitted or not making good contact.	2. Clean with ignition file. Replace with new governor if badly worn or not making good contact.
	3. Electrical wiring.	3. Check motor governor circuit; replace faulty parts.
7. Picture not framed.	1. Framer control not adjusted properly.	1. Turn framer control until picture is in frame.
	2. Film itself out of frame.	2. Check projector with film with proper frame line.
8. Fuzz projecting in picture area.	1. Dirt in aperture opening.	1. Clean aperture using brush supplied. CAUTION: Projector must be stopped.
9. Picture not sharp on screen. One side or entire picture may not be sharp.	1. Improperly focused.	1. Focus lens.
	2. Projection lens dirty, oily or finger-spotted.	2. Clean lens.
	3. Pressure plate and/or aperture plate worn.	3. Replace defective plates.
	4. Pressure plate not seated firmly against film in aperture channel.	4. Push pressure plate closing handle.
	5. Defective projection lens.	5. Replace lens.
	6. Film loops too short.	6. Rethread projector with proper sized loops.
	7. Insufficient pressure plate tension.	7. Replace with new pressure plate.
10. Picture indistinct, illumination low.	1. Line voltage lower than lamp rating.	1. Use lamp with voltage equal to voltage of line supply.
	2. Lamp improperly seated in socket.	2. Reinsert lamp correctly.
	3. Lamp old, black and ready to burn out.	3. Replace lamp.
	4. Dirty reflector, condenser lenses, projection lens.	4. Clean these optical elements.
	5. Lamp position adjustment incorrect.	5. Adjust lamp socket position for maximum light.
	6. Film underdeveloped; opaque.	6. Recommend print be withdrawn from circulation.

Trouble	Probable Cause	Remedy
10. Picture indistinct, illumination low. (cont)	7. Old, dirty, or wrong type of screen.	7. Wash dirty screen. If canvas screen, replace with matte white screen material.
11. Projector fails to take-up film properly.	1. Belt off pulley on take-up arm or off take-up ratchet pulley in projector.	1. Loop belt on pulley(s).
	2. Bent or stretched take-up belt.	2. Replace with new belt.
	3. Slippage in take-up ratchet pulley assembly.	3. Disassemble and repair take-up ratchet pulley assembly (para. 22 and 45).
	4. Two lock nuts on take-up arm too tight or too loose.	4. Adjust accordingly.
	5. Film not attached to hub of reel.	5. Attach film securely to hub.
	6. Take-up reel bent and jammed on arm.	6. Replace reel.
	7. Take-up reel slipping on spindle.	7. Latch reel securely.
	8. Oilite bronze washer in take-up assembly is worn.	8. Replace washer.
12. Projector fails to rewind film properly.	1. Plunger on feed reel arm set in improper position.	1. Plunger should be IN for rewinding.
	2. Spring belt off pulley.	2. Loop belt over pulley.
	3. Two lock nuts on feed reel arm too tight or too loose.	3. Adjust accordingly.
	4. Slippage in rewind ratchet pulley assembly.	4. Disassemble and repair rewind ratchet pulley assembly (para. 22 and 45).
	5. Bent or stretched rewind belt.	5. Replace with new belt.
	6. Oilite bronze washer in feed reel arm assembly is worn.	6. Replace washer.
	7. Defective rewind switch.	7. Repair or replace defective switch.
13. Picture unsteady; jump or weave.	1. Improper slitting of film; poor filming of picture.	1. Check with film known to be in good condition.
	2. Improper threading.	2. Rethread projector correctly.
	3. Pressure plate not seated firmly against film in picture channel.	3. Push pressure plate closing handle.
	4. Many consecutive film perforations damaged excessively.	4. Remove damaged section of film and splice.

Trouble	Probable Cause	Remedy
13. Picture unsteady; jump or weave. (cont)	5. Poorly made splices.	5. Check film, remake splice(s).
	6. Sprockets not turning properly.	6. Check screws holding sprockets. Tighten if necessary. Check sprocket gears for defects. Replace defective gears.
	7. Sprocket shoes fit too loosely causing film to jump off.	7. Adjust clearance between shoe and sprocket, to tolerance of two thicknesses of film (para. 49, step f).
	8. Worn parts in intermittent mechanism; broken shuttle tooth or last tooth slapping film.	8. Replace defective parts.
	9. Center shuttle tooth not protruding far enough through aperture plate.	9. Adjust mechanism as directed in paragraph 63.
	10. Insufficient pressure plate tension.	10. Replace pressure plate.
	11. Worn sprocket teeth.	11. Replace defective sprocket.
	12. Caked emulsion excessive on aperture and/or pressure plate.	12. Remove caked emulsion with aperture brush; piece of wood, alcohol.
14. Film scratched.	1. Dirt or emulsion on aperture and/or pressure plate.	1. Clean, using aperture brush furnished; alcohol, toothpick.
	2. Dirt or emulsion on film shoes, sprockets, film rollers.	2. Clean, using aperture brush furnished; alcohol, toothpick.
	3. Worn film handling parts; pressure plate, aperture plate, film sprockets, shoes, rollers.	3. Replace worn parts with new ones.
	4. Sticking or binding film rollers.	4. Remove rollers and clean shaft. If worn or if they still bind, replace with new ones.
	5. Nicks and scratches on contact surfaces of film path; film rails, rollers, sound drum, pressure plate, sprockets, film shoes.	5. Rub part with crocus cloth. If nick or scratch is deep replace parts with new ones.
15. Excessive film wear. Torn or damaged film splices. Damaged or torn perforations.	1. Film shoes fit too snugly around sprockets.	1. Adjust clearance between inner shoulder of shoe and inner edge of sprocket shoulder to .015 inch; two film thicknesses (para. 49, step f).
	2. Worn or damaged shuttle teeth.	2. Examine shuttle teeth for undercut surfaces; if badly worn, replace with new shuttle. (Rotate 180°)
	3. Sprocket teeth badly worn.	3. Examine sprocket teeth for undercut surfaces. Replace sprocket if badly worn.

Trouble	Probable Cause	Remedy
16. Excessively noisy projector operation.	1. Film clicking resulting from badly worn sprocket teeth.	1. Examine sprocket for excessive wear. If wear is noticeable replace with new sprocket. (Rotate 180°)
	2. Film slap due to improper pressure plate tension.	2. Replace pressure plate.
	3. Inherent mechanical noise.	3. Examine intermittent mechanism for defective parts. Check gears and rotating parts for nicks or worn surfaces. Replace defective parts if needed.
17. Picture travel ghost. Vertical lines observed on screen above and/or below white objects.	1. Defective projection lamp.	1. Replace lamp.
	2. Projection lamp out of adjustment.	2. Adjust lamp to maximum brilliance with lamp adjustment levers.
	3. Shutter out of time with intermittent mechanism.	3. Adjust shutter to synchronize with intermittent (para. 50, step h).
18. Picture satisfactory, sound weak.	1. Volume control not tuned up or defective.	1. Turn up volume; if control is defective, replace.
	2. Sound optical system dirty.	2. Clean.
	3. Amplifier tubes defective.	3. Check tubes, replace defective tubes.
	4. Photo cell out of adjustment, loose or defective.	4. Correct adjustment; tighten. If still defective replace with new photo cell. To check photocell output see paragraph 87.
	5. Exciter lamp defective.	5. Replace exciter lamp.
	6. Power transformer defective.	6. Repair or replace.
	7. Loudspeaker cable defective.	7. Check cable, repair or replace.
	8. Loudspeaker defective.	8. Check loudspeaker, correct defects or replace loudspeaker unit.
	9. Poor film sound track.	9. Turn up volume, adjust tone control to compensate as much as possible for poor film.
19. Picture satisfactory, but no sound.	1. Amplifier switch not in ON position.	1. Turn switch to ON position.
	2. Loudspeaker not connected.	2. Connect loudspeaker to amplifier.
	3. Loudspeaker selector switch in wrong position.	3. Place switch in correct position.
	4. Photo-cell amplifier cable defective or disconnected.	4. Check cable.

Trouble	Probable Cause	Remedy
19. Picture satisfactory, but no sound. (cont)	5. Exciter lamp burned out.	5. Replace exciter lamp.
	6. Amplifier tubes defective.	6. Check tubes, especially the 6AQ5 exciter lamp oscillator tube V205. Replace defective tubes.
	7. Speaker defective.	7. Check speaker, replace if needed.
	8. Defective photocell.	8. Check cell output (para. 87). Replace cell, if necessary.
	9. Internal amplifier trouble.	9. Check amplifier circuit.
	10. Motor-Lamp switch defective or loose switch connections.	10. Check; repair or replace switch.
	11. Absence of sound record on film (silent picture).	11. Check film to be sure it has sound track.
	12. Wrong sound head button pressed.	12. Depress proper button fully.
20. Sound is wavy. (Flutter)	1. Improper threading.	1. Correct threading.
	2. Dirt on sound drum, and rollers in soundhead assembly.	2. Clean sound drum, clean all rollers.
	3. Film guide rollers sticky or jammed.	3. Examine rollers to see that they turn freely. If not, remove rollers and clean bearings and shafts. If they stick after cleaning replace with new ones.
	4. Damaged sound drum.	4. Replace stabilizer housing.
	5. Sound drum binds.	5. Check for defective bearings and replace if necessary.
	6. Improper tension of film around sound drum.	6. Adjust tension of impedance roller in soundhead (para. 40, step h).
	7. Flywheel improperly balanced. (Damaged)	7. Replace flywheel.
	8. Sound drum shaft bent.	8. Replace if defective.
	9. Unsteady speed of motor.	9. Check motor and governor. Repair or replace.
	10. Misalinement of film rollers.	10. Check lateral alinement of film rollers to determine if they are causing binding or buckling of the film. Replace defective parts.
	11. Overwidth film.	11. Check with film known to be good.

Trouble	Probable Cause	Remedy
21. Distorted sound reproduction.	1. Bad sound track.	1. Adjust tone control, if trouble persists, replace film.
	2. Defective tubes.	2. Check, replace bad tubes.
	3. Worn film sprockets.	3. Replace defective sprocket.
	4. Sound film guide adjustable roller out of alignment.	4. Check adjustment of roller with buzz-track test film.
	5. Defective exciter lamp.	5. Replace exciter lamp.
	6. Bad connections in projector or amplifier wiring.	6. Sectionalize and localize trouble, and repair.
	7. Defective amplifier.	7. Localize trouble, repair or replace defective parts.
	8. Defective loudspeaker.	8. Check loudspeaker for damaged cone. Replace defective parts; replace loudspeaker if defective.
	9. Sound optical system out of adjustment.	9. Check adjustment of sound optical system. (para. 81).
	10. Overwidth film	10. Check with good film.
22. Microphonics—Denoted by continuous bell or string-like noises.	1. Defective tube.	1. Check and replace as needed.
	2. Defective exciter lamp.	2. Replace with new lamp.
	3. Defective photo electric cell.	3. Replace with new photo-conductive cell.
23. Popping noise from speaker when operating with film.	1. Dirt on back edge of sound drum.	1. Clean thoroughly.
	2. Dirt on sound lens or light pipe.	2. Clean thoroughly.
	3. Poor sound track on film.	3. Check by reproducing film of known sound quality.
	4. Dirty sound track.	4. Return to film exchange.
24. Crackling or frying noise in loudspeaker.	1. Governor contact points badly pitted.	1. Burnish governor contact points, with ignition file.
	2. Governor brushes arcing.	2. Examine governor brushes to see that pigtails are not broken and that brushes are long enough. Replace defective brushes.
	3. Motor brushes defective.	3. Examine motor brushes as in 2, above.
	4. Defective volume and tone control.	4. Rotate control, if noise appears and disappears, replace controls.

Trouble	Probable Cause	Remedy
25. Excessive hissing and buzzing sounds in loudspeaker.	1. Film badly scratched.	1. Adjust tone controls.
	2. Speaker loose.	2. Tighten speaker.
	3. Speaker cone cracked or has holes in it.	3. Replace speaker.
	4. Defective photo cell.	4. Replace photo cell assembly.
26. Excessive hum in loudspeaker.	1. Defective tube(s).	1. Check, replace defective tubes.
	2. Defect in amplifier circuit, bad condenser, etc.	2. Check circuit and repair as needed (para. 72).
	3. Stray light penetrating inside exciter.	3. Lock exciter lamp cover securely.
27. Inadequate volume.	1. Volume control not tuned up sufficiently.	1. Turn up volume control.
	2. Poorly recorded sound track.	2. Equipment cannot adjust.
	3. Dirt or oil partly obstructing sound optical system.	3. Clean sound optical elements.
	4. Defective amplifier tube(s).	4. Check, replace defective tube(s).
	5. Defective photo cell.	5. Replace photo-cell.
	6. Dirty or defective exciter lamp.	6. Clean lamp; if trouble persists replace exciter lamp.
	7. Low line voltage.	7. Check line voltage.
	8. Photo-cell potentiometer R203 out of adjustment.	8. Adjust R203 for correct photo-cell output (para. 87).
28. Tone unsatisfactory.	1. Tone control not adjusted properly for film being shown.	1. Adjust tone control.
	2. Film itself may be at fault.	2. Check by reproducing film of known sound quality.
	3. Defect in amplifier.	3. Check and replace defective tubes and other parts.
	4. Poor acoustic conditions.	4. Attenuate lows to help cut down reverberation.
29. Sound O.K. from film, silent from microphone.	1. Defective microphone.	1. Check microphone connector plug and cable.
30. Ringing noises from loudspeaker when amplifier volume control is at low volume position.	1. Defective tube.	1. Check, replace defective tube.
31. Ringing noises from loudspeaker when volume control is at high level position.	1. Defective exciter lamp.	1. Replace exciter lamp.

Trouble	Probable Cause	Remedy
32. Amplifier fuse blows.	1. Shorted tube or tubes.	1. Check and replace defective tubes.
	2. Defective amplifier wiring, or component parts.	2. Localize trouble; repair and replace defective parts.
	3. Loose fuse terminals.	3. Secure terminals.
33. Projector fuse blows.	1. Defective projector wiring, including power cable.	1. Check continuity of electrical wiring in projector for short circuits or grounds. Repair or replace defective units.
	2. Short-circuited lamp or lamp socket. Blows fuse only after lamp has been turned on.	2. Check continuity of electrical wiring. Replace defective units. If lamp is defective, replace projection lamp.

Authorized Modification Kits

The modification kits listed below are available for field service installation, and the following instructions include repair procedures for the service of these items.

Hour Counter Kit (Part No. 063382)
48-Frequency Shutter Kit (Part No. 067323)
Synchronous Motor Kit (Part No. 030012)

88. INSTALLING HOUR COUNTER KIT.

a. Remove the amplifier-loudspeaker assembly as instructed in paragraph 4.
b. Refer to figure 11. Take out the two screws that attach the idler roller bracket and remove the complete idler roller assembly. Loosen the set screws in the hub of the drive sprocket, and pull the sprocket from its shaft. This sprocket will be replaced by the new sprocket supplied in the kit, but the sprocket set screws should be retained. Do not remove the spacer located behind the sprocket.
c. Remove and save the two round head screws and lock washers located on either side of the drive sprocket. Remove the drive chain.
d. Install the new drive sprocket on the shaft, press the sprocket up against the spacer, and tighten the set screws securely. Install the drive chain and idler roller assembly. Before tightening the idler roller bracket mounting screws, shift the bracket until the drive chain will have only a small amount of slack.
e. Screw the two hex-headed mounting studs from the kit into the tapped holes on either side of the newly installed drive sprocket. Do not use lock washers with these studs. Tighten studs securely.
f. Place the counter drive mechanism in position with the fork fingers of the mechanism pinion hub engaging the two holes in the face of the drive sprocket and the mounting ears alined with the tapped holes in the hexagonal studs. Install and tighten the two round head screws and lock washers previously removed (step c).
g. The hour counter is supplied with a slotted arm (index no. 11, Parts Catalog figure 16) that engages a pin on the drive disc of the counter mechanism. When all digits are perfectly alined across the face of the counter, this arm must be set on the hour counter shaft as shown in the inset of Parts Catalog figure 16. When the arm is properly set, tighten the drive arm screw (index no. 12, Parts Catalog figure 16).
h. Refer to Parts Catalog figure 16, and fasten the counter (8) to the rear of the mechanism plate with the two screws (9) and lock washers (10). When positioning the counter against the mechanism plate, be sure to engage the pin of the drive disc with the slot in the counter arm. Apply a light coat of grease to the counter arm slot. Set the counter to 00000 by oscillating the arm.
i. Install the amplifier (paragraph 62).

89. COUNTER DRIVE MECHANISM REPAIR.
(See Parts Catalog figure 19.)

DISASSEMBLY.

a. Remove screw (2), washer (3) and cover (1).
b. Remove four screws (7) and lock washers (8) and separate gear train plate assembly (6) from housing (29).
c. Remove retaining ring (5) and cam and gear assembly (4) from cam gear stud (13). If necessary, drive stud from plate (14). Pry pinion (10) carefully from pinion hub assembly (9) and remove hub and shoulder washer (11). If necessary, press sleeve bearing (12) from plate (14).
d. Loosen set screw (16) and remove drive disc (15).
e. Loosen set screw (18) so that ratchet worm gear (17) is loose on shaft (19) within the housing (29). Pry retaining rings (20) from grooves in shaft, and pull shaft from housing, catching gear (17) as it falls free.
f. Unhook and remove spring (21). Remove remaining parts (22 through 28) from housing as shown in the exploded view.
g. Clean all parts and dry thoroughly before reassembly. Inspect all parts for actual physical damage—stripped screw threads, chipped or broken gear teeth, bent shafts, and so forth. Replace damaged parts.

REASSEMBLY.

a. During reassembly, apply a light coating of grease to all gear teeth and to the bearing surfaces of the pinion hub assembly, cam gear stud and output shaft.
b. Apply a very light film of oil on the mounting stud which will receive the ratchet wheel (22). Install parts (22) through (28) on the stud within the housing (29). Place two drops of oil between washer (25) and ratchet wheel (22). Note that the quantity of shims (26) must be determined to limit ratchet wheel end play to 0.001 to 0.003-inch.
c. Hook spring (21) between hole in housing (29) and hole in lower end of ratchet arm (27).
d. Insert output shaft (19) into housing, installing gear (17) on shaft while doing so. Install retaining rings (20) on shaft inside housing to prevent shaft from sliding out. Center the teeth of gear (17) with worm of ratchet wheel (22) and tighten set screw (18) against flat of shaft (19). Install drive disc (15) on end of shaft, tightening set screw (16) against flat of shaft. Place four drops of oil at the two points where output shaft protrudes through housing, allowing oil

to run down into the housing.

e. Press sleeve bearing (12) and cam gear stud (13) into mounting plate (14). Bearing flange must be flush against mounting plate. Large diameter of stud (13), at base of gear shaft portion, must protrude 3/64-inch (±0.010-inch) above surface of plate. Insert pinion hub (9) through sleeve bearing (12) and install shoulder washer (11), with shoulder facing out, and pinion (10) on pinion hub. Pinion hub must turn freely with the pinion pressed in place.

f. Install cam and gear assembly (4) on gear shaft of stud (13), securing with retaining ring (5). While pressing lower end of ratchet arm (27) toward drive disc (15), assemble the gear train plate assembly (6) to housing (29) and install screws (7) and lock washers (8). Upper finger on ratchet arm must bear against cam hub of gear (4). Place one or two drops of oil between ratchet arm finger and cam hub.

g. Make certain that ratchet fingers (riveted to housing and ratchet arm) are engaging teeth of ratchet wheel. Install cover (1), screw (2) and lock washer (3).

90. INSTALLING 48-FREQUENCY SHUTTER KIT.

a. Remove the amplifier-loudspeaker assembly as instructed in paragraph 4.

b. Remove the "SOUND-SILENT" switch (index no. 41, Parts Catalog figure 5), disconnecting the switch leadwires from terminals 2 and 3 on the octal socket (index no. 26, Parts Catalog figure 5). Press the button plug (part no. 16299) into the "SOUND-SILENT" switch opening in the switch plate.

c. Use a short jumper wire to connect terminals 2 and 3 of the octal socket (index no. 26, Parts Catalog figure 5).

NOTE: Refer to Parts Catalog figure 18 for proper sequence of parts assembly.

d. Disconnect drive chain from sprocket (24). Loosen set screw (25) and remove the rewind sprocket (24).

e. Remove two screws (27) and lock washers (28) and disassemble bracket (26), collar (41), and mechanism drive gear (43) from drive shaft (46). Install the new drive gear (part no. 061053) in place of old drive gear, and reassemble collar and bracket to mechanism plate. Proper installation and adjustment of these parts is outlined in paragraph 50, step c.

f. Loosen set screws (48) and remove shutter gear (47). Install new shutter gear (part no. 061052) on shutter shaft, and tighten set screws securely.

g. Remove framer knob (1) and shutter cover (2) to expose the shutter. Remove three screws (49B) and lift out the old shutter (49A). Install the 48-frequency shutter (part no. 620032) to the shutter shaft; make certain that the heads of screws (49B) are centrally located in the elongated slots.

h. Check the synchronization of the shutter and intermittent mechanism as instructed in paragraph 50, step h. Then reinstall shutter cover (2) and framer knob (1).

i. If a binding condition is noted when the threading knob is turned, loosen the drive shaft bracket screws (27) and reposition the bracket until binding condition is relieved. Tighten screws.

j. Hook drive chain around sprocket (24). Adjust position of idler roller assembly (at top of drive motor) until there is only a slight amount of free slack in the drive chain.

k. Install the amplifier (paragraph 62).

91. CONVERTING FROM UNIVERSAL TO SYNCHRONOUS DRIVE MOTOR.

a. Remove the amplifier-loudspeaker assembly as instructed in paragraph 4.

b. Remove the "SOUND-SILENT" switch (index no. 41, Parts Catalog figure 5), disconnecting the switch leadwires from terminals 2 and 3 on the octal socket (index no. 26, Parts Catalog figure 5). Press a button plug (index no. 40, Parts Catalog figure 5) into the switch opening in the switch plate.

c. Connect white-red leadwire between pin 2 of octal socket (S105, figure 27) and terminal 11 of MOTOR-LAMP switch (SW103, figure 27).

d. Remove green-red leadwire which connects lower-left terminal of rewind switch (SW105, figure 27) to terminal 12 of MOTOR-LAMP switch (SW103, figure 27). Connect a jumper wire, with sleeving, between lower-left and upper-right terminals of the rewind switch (SW105, figure 27).

e. Remove green-red leadwire which connects pin 7 of receptacle (S105, figure 27) to upper-center terminal of rewind switch (SW105, figure 27).

f. Remove jumper wire (blue-white) from between pins 5 and 8 of receptacle (S105, figure 27) and connect this same jumper wire between pins 1 and 4 of the receptacle.

g. Remove threading knob, universal drive motor and drive chain from projector.

h. Cut out the sponge rubber lining on the bottom of the case to permit the capacitor to be mounted as shown in figure 35. Two holes must be added in the bottom of the projector case as shown in figure 35. Mount capacitor with attaching parts shown in Parts Catalog figure 2. Connect one capacitor

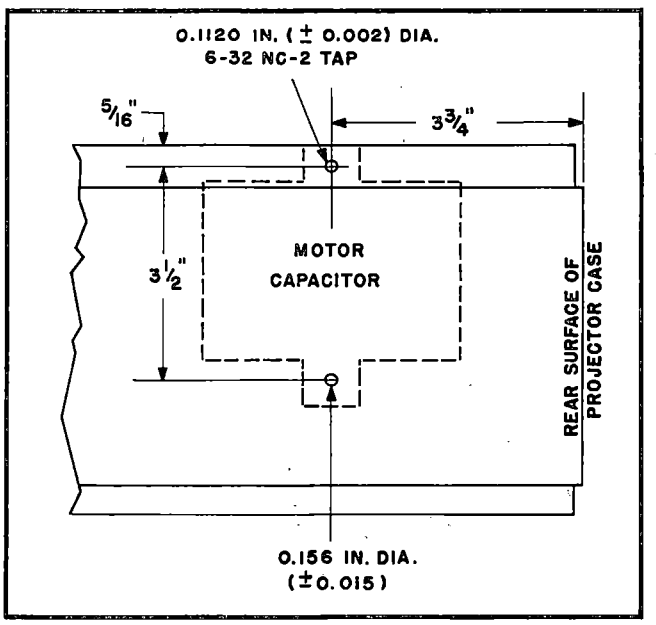


Figure 35. Drilling Template for Motor Capacitor Mounting (Case Viewed from Underside)

leadwire to terminal 7 of the octal receptacle (S105, figure 27) and the other capacitor leadwire to upper center terminal of rewind switch (SW105, figure 27).

i. Install synchronous motor, new drive chain (part no. 613495) and new threading knob (part no. 620481) to mechanism plate. Adjust idler roller assembly at top of motor to obtain just a small amount of slack in the drive chain,

j. Reinstall the amplifier (paragraph 62).

92. SYNCHRONOUS DRIVE MOTOR REPAIR. (See Parts Catalog figure 39.)

DISASSEMBLY.

a. Remove three screws (1) and lock washers (2) and the upper screw spacer (3) and lift gear housing assembly (4) from motor. Loosen the set screw in flexible drive coupling (4A) and withdraw the coupling and the sprocket (4B) from gear shaft. Remove screws (4C) and lock washers (4D) and disassemble cover (4E) and gear and shaft (4F) from gear housing (4G).

b. Remove nuts (5), lock washers (6) and flat head screws (10) and the nuts (5), lock washers (7), plain washers (8) and round head screws (9) that fasten the motor mounting bracket (11) in place. Disassemble the bracket only if parts require replacement.

c. Remove screws (15 and 17), washers (16), adapter plate (18) and spacers (19).

d. Remove screws (20), lock washers (21) and plain washers (22) and disassemble mounting plate (23) and motor shield (24) from motor. If necessary, remove drive gear (25B) from motor shaft.

e. Capacitor (30) mounts in the bottom of the projector case and is easily removed.

f. Inspect all parts for physical damage. Motor (25) must be replaced as a complete assembly.

REASSEMBLY.

a. Lubricate the bearings in the gear housing cover (4E) and housing (4G) with four drops of oil each. Insert gear and shaft (4F) into housing and install cover (4E). Insert hub of sprocket (4B) into coupling (4A), noting that coupling set screw must bear against flat of sprocket hub. Slide sprocket and coupling onto shaft and tighten remaining coupling set screw against flat of shaft.

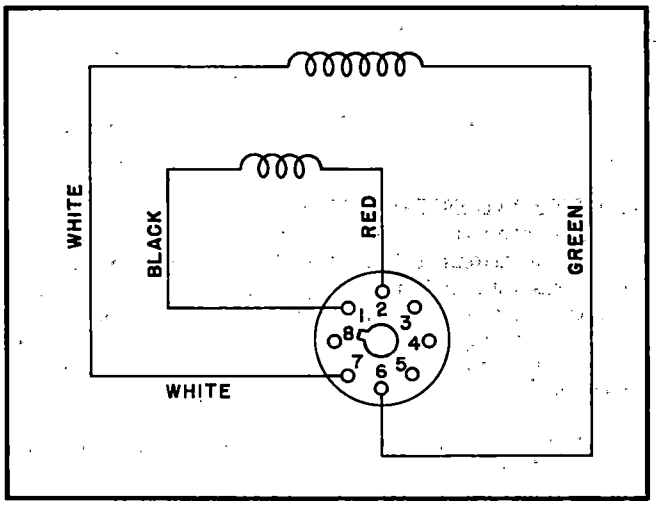


Figure 36. Synchronous Motor Wiring Diagram

b. Assemble shield (24) and mounting plate (23) to motor (25), installing screws (20), lock washers (21) and plain washers (22).

c. Install adapter plate (18) with screws (15 and 17), lock washers (16) and spacers (19).

d. Install mounting bracket assembly (11) with the attaching parts (5 through 10). Note that the free end of grounding strap (14) is held by one of the flat head screws (10).

e. Fill gear housing (4) with seven grams of grease, or until gear housing is filled to approximately one-third its depth. Install gear housing assembly to adapter plate (18) with screws (1), lock washers (2) and the upper screw spacer (3). It may be necessary to rotate the gear housing shaft until gears (4F and 25B) engage, thus permitting housing to seat fully.

f. Install capacitor (30) to bottom of projector case with attaching parts (26 through 29). Check synchronous motor wiring diagram (figure 36) and projector schematic wiring diagram (figure 29) for all wiring connections.

93. GENERAL INSTRUCTIONS. Except for minor differences readily noted by reference to the exploded view illustrations in the Parts Catalog, the repair instructions outlined in the preceding sections of this book will apply in most instances to the 614CD projector. For major design differences, however, refer to the following paragraphs for specific repair instructions.

94. SOUND HEAD STABILIZER HOUSING ASSEMBLY. (See Parts Catalog figure 11A.)

Except for the retaining ring method of securing the bearings, this stabilizer housing assembly is almost identical to that used in the CB, CBM and CBRM projectors. Note these differences and refer to paragraphs 17 and 39 for disassembly and reassembly instructions respectively.

95. FEED AND TAKE-UP PULLEY ASSEMBLIES. (See Parts Catalog figure 19A.)

Refer to Parts Catalog figure 19A and disassemble the pulley assemblies in the indexed order of disassembly. Note that these pulley assemblies have identical parts and differ only in the method in which the retainer (4), steel balls (5), spring (6) and cam (7) are installed. Figure 37 illustrates the method of assembly as viewed from the lock nut end. The clutch cam (7) need only be turned over (inverted) and the spring (6) installed on one side or the other of the clutch ball retainer ear to convert the pulley from take-up to feed, or vice versa. As viewed from the lock nut end, the take-up pulley must turn freely in a clockwise direction and must lock when turned counterclockwise. The feed pulley must lock when turned clockwise and must turn freely counterclockwise.

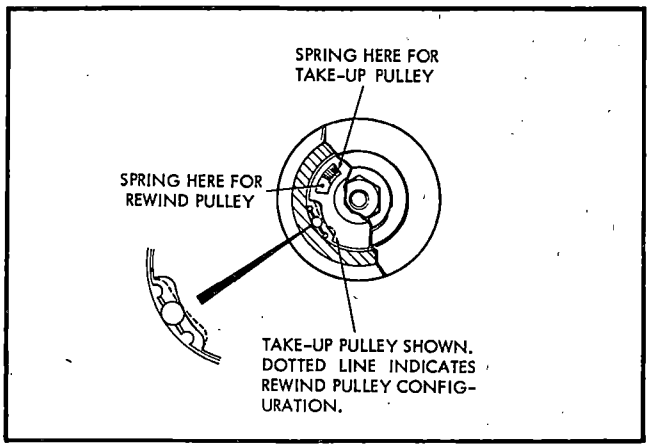


Figure 37. Method of Pulley Reassembly

96. LUBRICATION SYSTEM MAINTENANCE. The newly designed life-time lubrication system of the 614CD projector will provide proper, regulated lubrication of all intermittent mechanism parts without renewal of oil during normal operation. However, when servicing projectors which require extensive overhaul, it is suggested that all lubrication wicks be replaced. A complete lubrication kit (Bell & Howell part no. 067482) is available and consists of a gear stud oil wick (item 9A, Parts Catalog figure 17), shuttle cover (item 6, Parts Catalog figure 18),

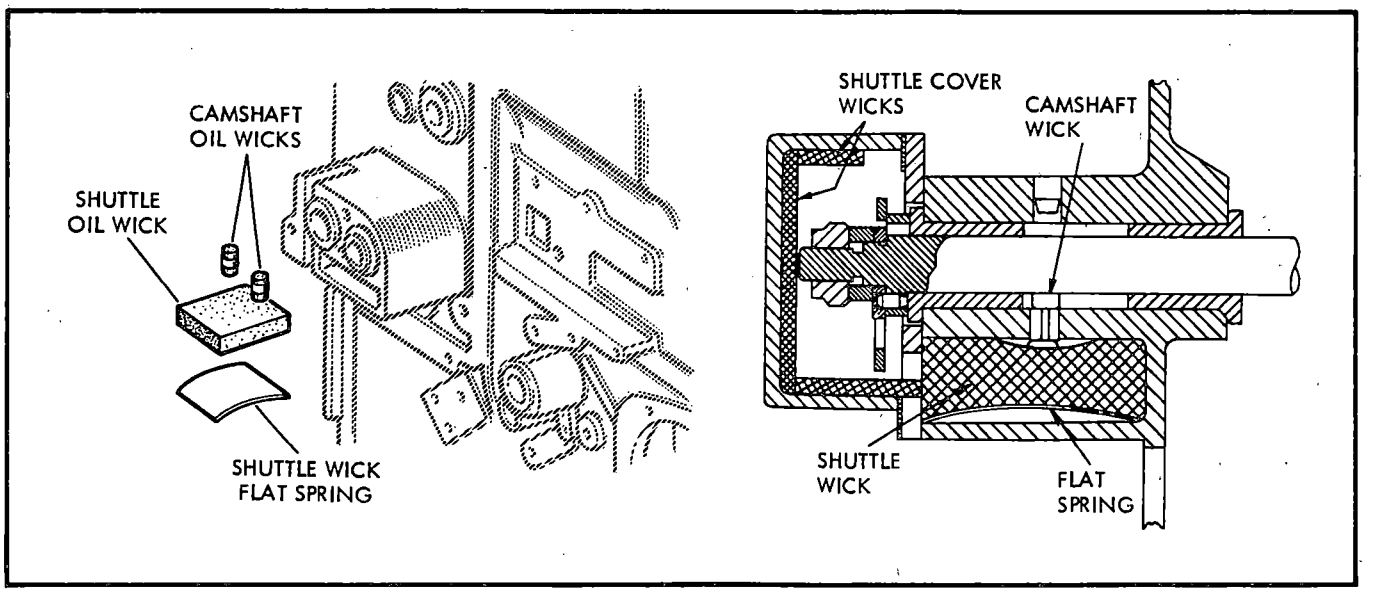


Figure 38. Lubrication System for 614CD Intermittent Mechanism

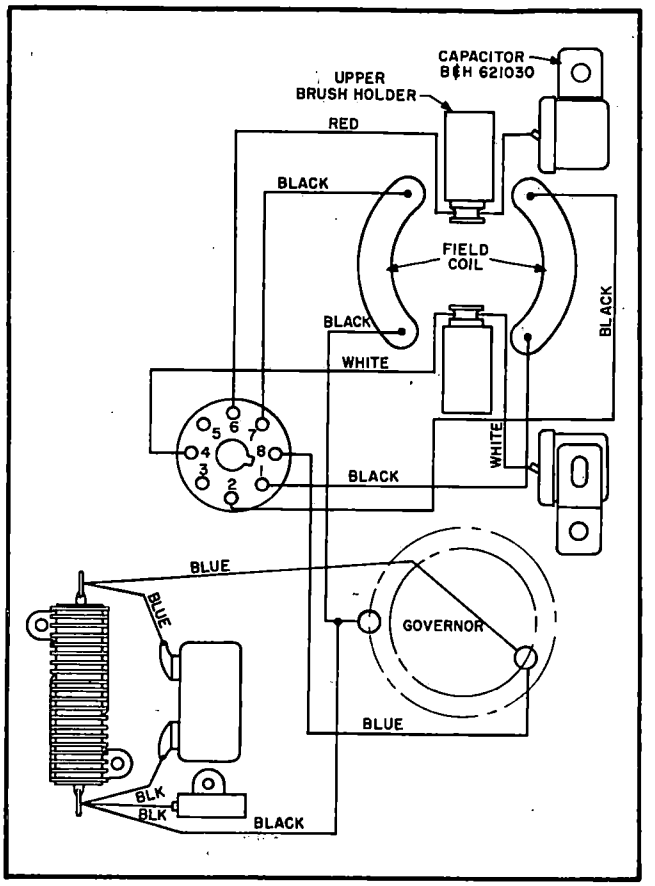


Figure 39. Drive Motor Wiring Diagram (614CD)

shuttle oil wick (item 69, Parts Catalog figure 18) and two camshaft wicks (item 71, Parts Catalog figure 18). These kit parts have been properly prelubricated. Figure 38 illustrates the proper installation of camshaft and shuttle wicks.

97. UNIVERSAL DRIVE MOTOR. Except for some of its electrical components and the method of wiring, the drive motor for the 614CD is identical to that used in the 614CB, CBM, CBRM projectors. Refer to paragraph 18 for disassembly instructions. However, when reassembling the motor (paragraph 42), be sure to refer to figure 39 for proper wiring hookup of components.

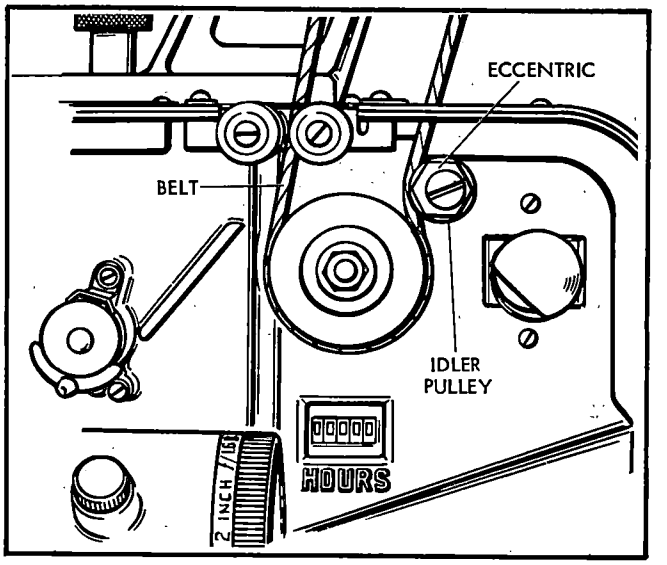


Figure 40. Fabric Belt Tension Adjustment

98. FABRIC BELT TENSION ADJUSTMENT. Proper belt tension is maintained by loosening the screw which attaches the idler pulley and eccentric bearing (figure 40) and rotating the bearing. When properly adjusted, it should be possible to hold the take-up reel during operation and the belt should continue to drive the clutch. The feed reel belt is properly adjusted if the belt does not falter when the feed reel is touched lightly during operation.

TABLE X. D-C SUPPLY VOLTAGE DROP

Circuit Element	Normal Voltage Drop (± 10%)
R228	10
R240	10
R236	17
R226	15
R225	10
R224	222
R223	25

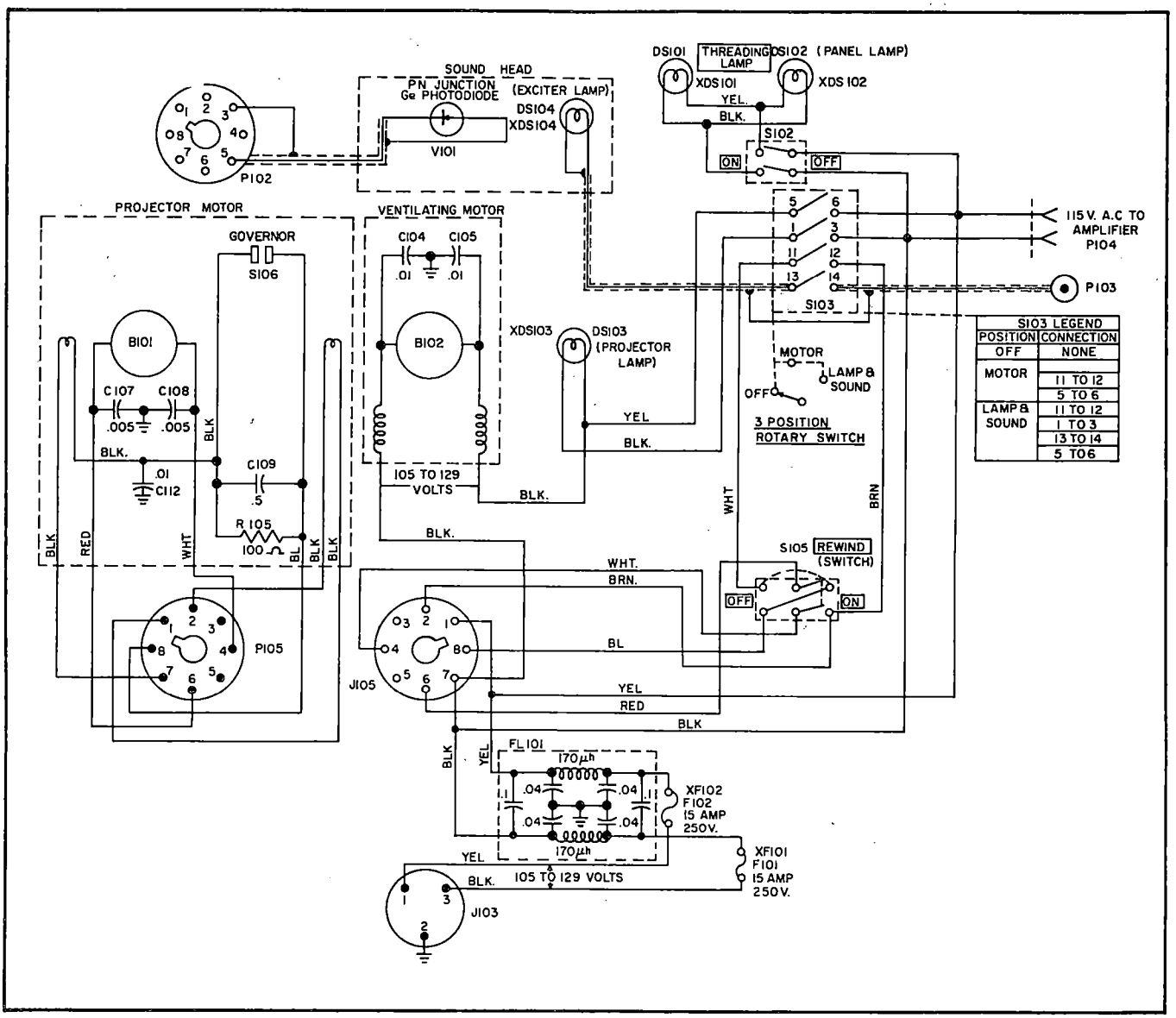


Figure 41. Design 614CD Projector Wiring Diagram

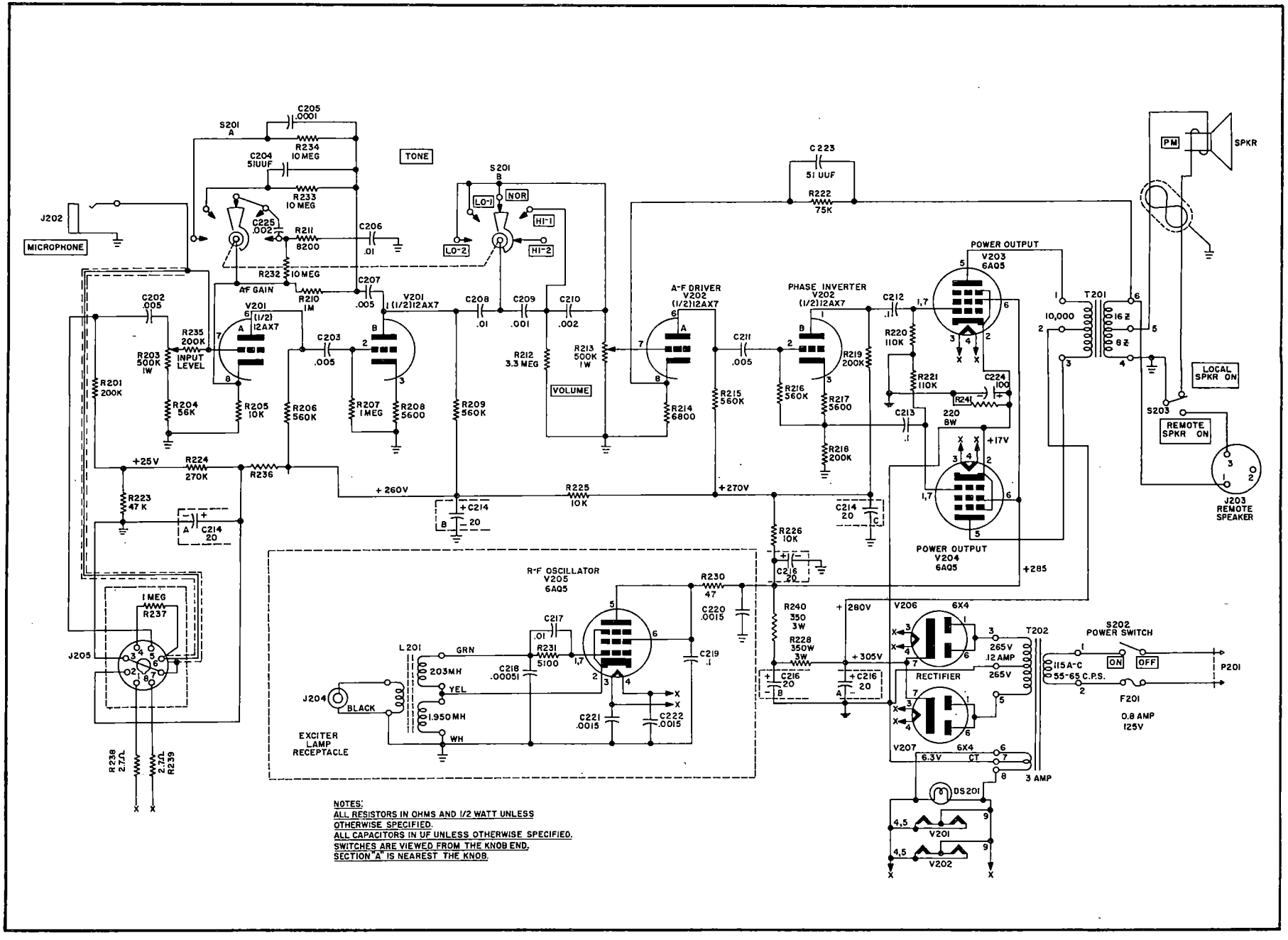


Figure 42. Amplifier Schematic Wiring Diagram (614CD)