SERVICE INSTRUCTIONS

RINGMASTER® II SOUND SLIDE PROJECTOR

MODELS
815A, 820A, 825A, 830A, 840A, 850A,
820AN, 830AN, 840AN, 850AN,
EXPORT MODELS
820AX, 830AX, 840AX, 850AX

BELL + HOWELL

VISUAL COMMUNICATIONS DIVISION

GENERAL SERVICE DEPT.
7100 McCORMICK ROAD
CHICAGO, ILLINOIS 60645

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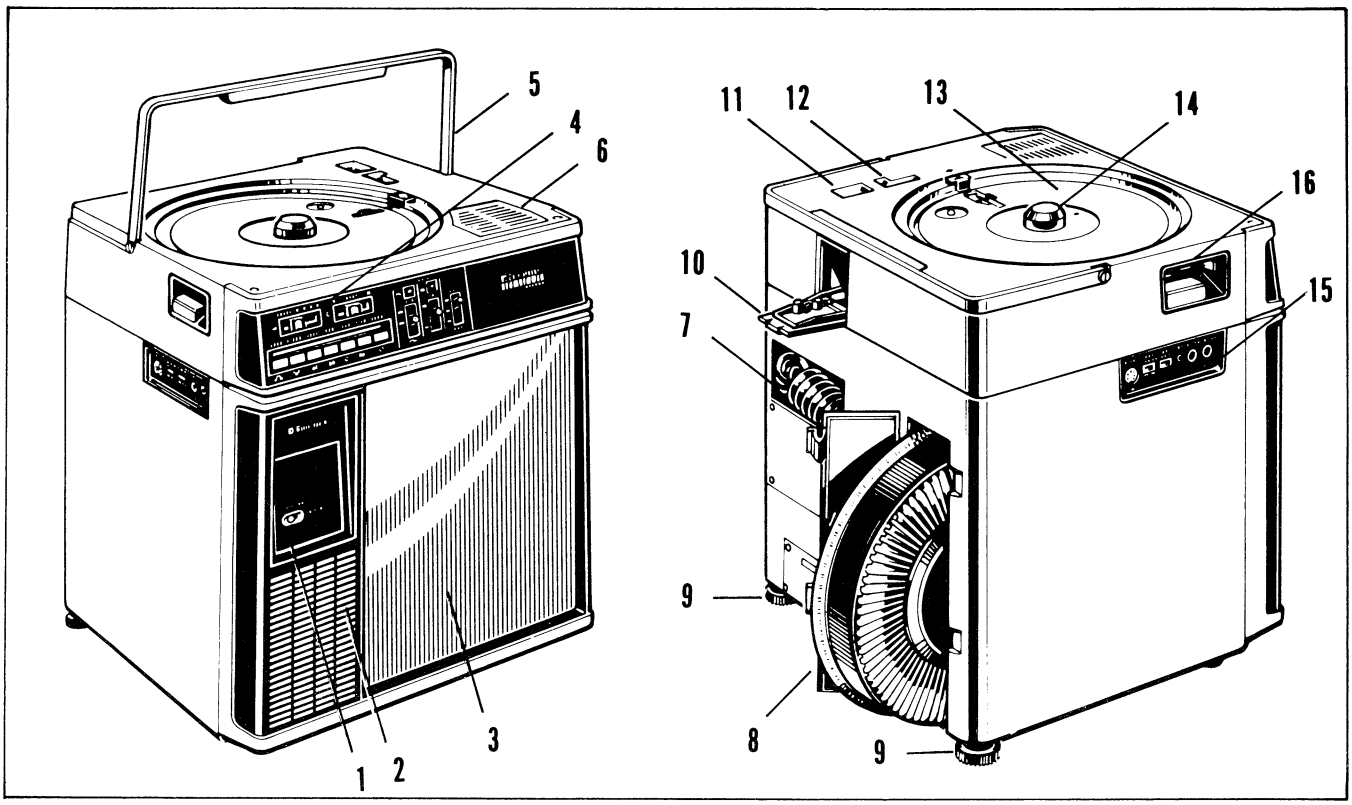


CONTROLS AND FEATURES

1 Special Features Control Panel — Not on all models; see paragraph 4 and Figures C and D for description information.

2 Built-In Speaker — 3" x 5"; automatically mutes when headphone or external speaker is plugged in.

3 Built-In Projection Screen — 10" x 10"

4 Master Sound/Projection Control Panel — See "Tape Recorder Controls" on following page for descriptions of controls.

5 Carrying Handle — Folds; lift to carry.

6 Projection Lamp Access Door — Unscrews with regular screwdriver but tied to the projector to prevent loss. See paragraph 20 for lamp replacement instructions.

7 Line Cord Storage Compartment — Keeps the line cord and projector together.

8 Slide Tray Storage Compartment — For spare slide tray; press door tabs to the left to open door.

9 Adjustable Tilt Feet — Located at the two rear corners of the projector to raise or lower the angle of slide projection on an external screen.

10 Front/Rear Projection Door — Position of door determines mode of projection; tightly closed for built-in screen and fully open for projection on an external screen.

11 Frame Filler® Control — Enlarges the projected image from Type 126 slides to fill the built-in screen or with the center portion of standard 35mm slides.

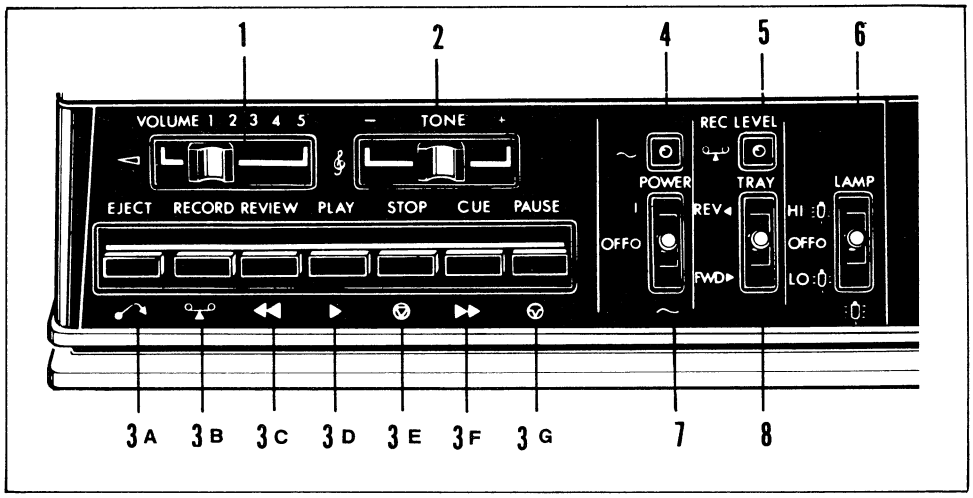
12 Focus Control — Adjust image for sharpness in either projection mode. All models except 815A are equipped with "auto-focus" which, after initial adjustment, automatically focuses all slides properly even if the slide tray may be loaded with intermixed mounts (plastic, cardboard and/or glass).

13 Slide Tray Carrier — Rotates slide tray. Note that slide tray can only be seated on the carrier when the tray's "0" position is aligned with the carrier's arrow.

14 Slide Tray Release Latch — Releases tray for removal at any time or position. Press latch toward the center to release the tray; if not at "home base" a slide will remain in the projector and must be removed.

15 Accessories Panel — See following page for descriptive information.

16 Cassette Loading Slot — Receptacle for cassette tapes.



TAPE RECORDER CONTROLS

1 — VOLUME slide control; sound is increased when control is moved to the right.

2 — TONE slide control; to adjust sound quality.

3 — TAPE RECORDER CONTROLS; see following items 3A through 3G for descriptions of the controls.

3A — EJECT pushbutton control; ejects tape cassette from it's loading slot.

3B — RECORD pushbutton control; when pressed simultaneously with "Play" button the system is placed in the audio RECORD mode.

3C — REVIEW (REWIND) pushbutton control; reverses tape quickly to a previously played portion for review or, when latched-in rewinds tape in the cassette (pops out automatically after tape is completely rewound).

3D — PLAY pushbutton control; starts forward tape transport. Interlocks with the "Record" pushbutton to prevent accidental tape erasures.

3E — STOP pushbutton control; stops tape transport.

3F — CUE (FAST/FORWARD) pushbutton control; advances tape quickly to a different tape section.

3G — PAUSE pushbutton control; stops tape transport when locked-in, press again to restart tape transport.

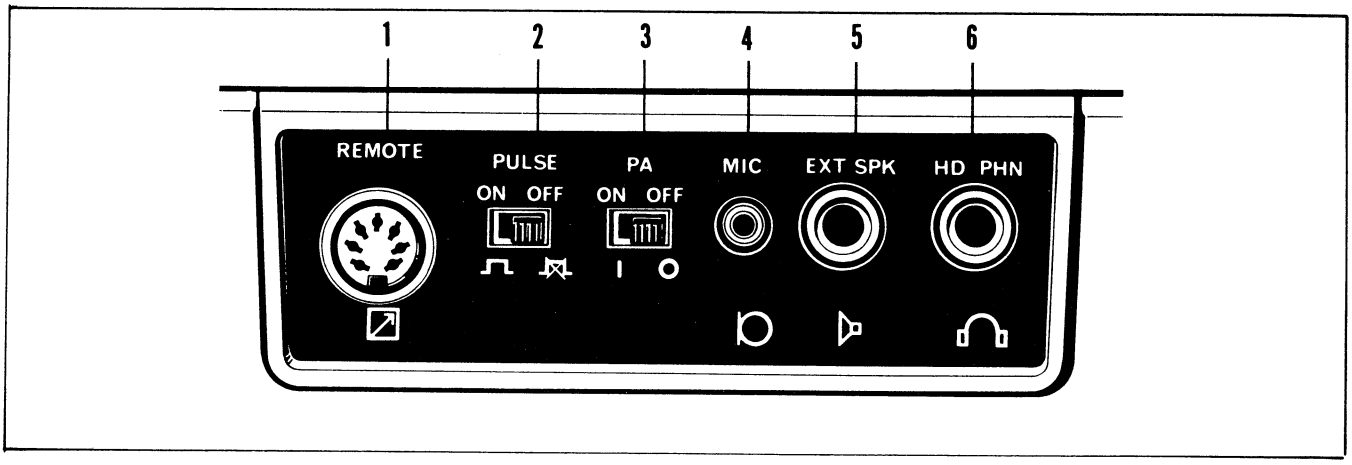
4 — POWER indicator light; glows red when power is turned ON.

5 — REC LEVEL indicator light; glows red when system is in the RECORD mode; blinks to indicate a recording is being made.

6 — LAMP switch control; a 3-position (HI-LO-OFF) projection lamp toggle switch.

7 — POWER switch control; main ON/OFF power toggle switch.

8 — TRAY pushbutton control; a manual forward/reverse "Slide Tray" switch that rotates the drive tray mechanism. When pressed momentarily in the desired direction the tray will rotate one slide at a time; when pressed and held, the tray will continue to rotate until the control is released. (Note: This control is not on the microprocessor models.)



ACCESSORIES PANEL

1 REMOTE Jack. . . . . 815A and 820 Models — Jack accepts an accessory remote control to advance/reverse slides and pause/play tape from a remote position.

825A Model & 830 Models — Jack accepts an accessory remote control to advance/reverse slides, pause/play tape from a remote position. Also accepts a "Pulsing Control" plug for recording 1000Hz slide advance pulses on blank tape.

840 Models — Jack accepts an accessory remote control to advance/reverse slides, pause/play tape and, after automatic cue stop, to restart the program from a remote position. Also accepts a "Pulsing Control" plug for recording 1000Hz slide advance and 150Hz cue-stop pulses on blank tape.

850 Models — Not available, these microprocessor units are equipped for optional infrared remote control.

2 PULSE Control Switch . ON/OFF switch; in the ON position, the pre-recorded 1000Hz (or 150Hz) pulses automatically control slide advance (or cue-stop). OFF position de-activates the automatic pulse-control feature.

3 PA Switch . . . . . ON/OFF switch; in the ON position, and with a microphone plugged into the MIC jack, the circuitry is converted for use as a public address system. (Note: PA switch must be in the OFF position when recording audio.)

4 MIC Jack (3.5mm) . . . . Jack accepts a microphone for recording audio when the "Record" and "Play" buttons are pressed simultaneously.

5 EXT SPK Jack (1/4") . . Jack accepts one external speaker only of proper impedance. 4 to 16 ohms accepted; 40 ohms recommended. Maximum output is 5 watts.

6 HD PHN Jack (1/4") . . . Jack accepts headphones with an impedance of 8 to 600 ohms for individual listening.

PRODUCT MODIFICATION

CAUTION

Replacement tape recorder deck modules (P/N 079000) must be modified for use on all 850 microprocessor models. Before assembling the replacement tape recorder deck to the slide projector, refer to the modification diagrams and follow the instructions outlined below.

The following parts and special tools are needed to perform the modification:

Part No.	Part/Tool
079195 . . .	2-Pin Connector/Cable Assy (1)
709667	Connector Lugs (2)
S-709926-1-FX1 or AMP Inc. 457445	Lead Extractor Tool
S-709667-2-F1 or AMP Inc. 90062	Crimping Tool

1 Remove the center switch (fwd/rev) from the right-hand side on the front of the tape recorder deck.

2 Clip the red, yellow and blue leads at the switch and unravel from the twisted harness crossing below the pushbuttons to termination at 3-pin plug P4. Secure the remaining leads.

3 Clip the blue lead at P4 and discard. Trim the yellow and red leads to 13 inches from P4. Strip the wire ends and lug with connectors (P/N 709667) securely crimping the lugs with a crimping tool.

4 Insert the 2-pin connector and cable assembly (P/N 079195) into P6 noting lead orientation (blue lead to pin 1).

5 Dress all four leads (yellow, red, blue and brown) from P4 and P6 toward cable harness near the front corner of the tape recorder deck and wire tie to the harness.

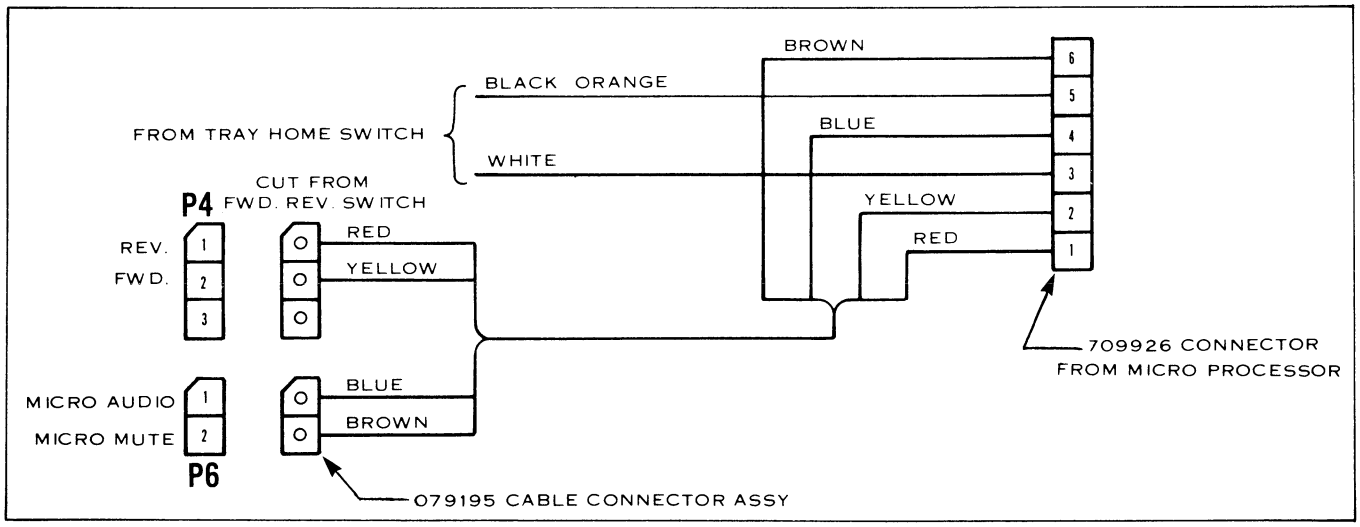
6 Cut jumper W-1 from the printed circuit board and discard. The modified tape recorder deck is now ready for placement into the projector.

7 Before removing the defective tape deck, refer to the disassembly/reassembly procedures and note the precautionary instructions and lead orientations for the 850 models. Then carefully remove the defective tape deck from the projector.

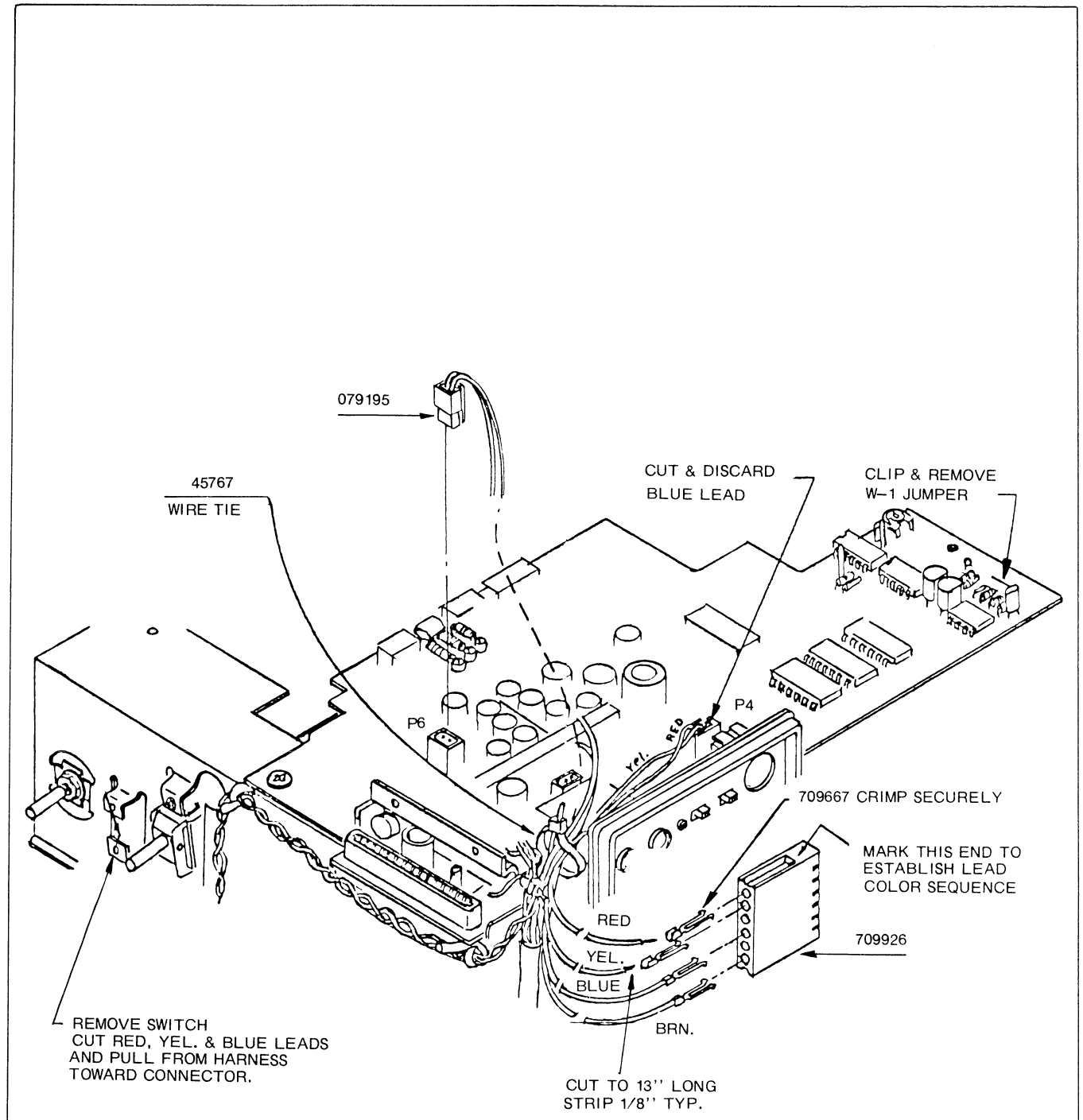
8 Mark the end of the microprocessor housing connector (P/N 709926) with a piece of red tape to establish lead color sequence (see Product Modification - Pictorial Diagram). Then use the lead extractor tool to remove the existing red, yellow, blue and brown leads from the connector.

9 Now refer to the schematic diagram below and insert the modified tape deck leads into the microprocessor connector.

10 Assemble the modified tape deck to the projector and complete the reassembly procedures as instructed torquing all screws fastening modules to 5 in-lbs. minimum.



Product Modification - Schematic Diagram



Product Modification - Pictorial Diagram

INTRODUCTION

1. GENERAL.

This service instruction manual has been prepared to aid the serviceman in the operation, repair, maintenance and adjustment of the Ringmaster® II Sound/Slide Projectors. For convenience, these sound/slide projectors will be referred to as "projectors" in all discussions common to the thirteen models covered herein. Instructions peculiar to a specific model or model series have been clearly noted.

These projectors are characterized by "flip-top" construction wherein all slide and audio control features are housed in the top deck assembly that is easily removed to allow total service access to the modular construction. The projectors are also designed for module replacement servicing and to that end require the tools normally found in most audio-visual repair shops. Module differences for all projector models are listed in the Parts Catalog manual Introduction section.

Important: It is suggested that the analytical discussions concerning the electrical systems be studied before beginning the service procedures. This "System Analysis" section has been located at the rear of the service manual to accommodate referenced block and schematic wiring diagrams and covers the electrical systems of the slide unit and tape recorder.

Because of our continuing programs of design and manufacturing improvements, minor revisions in Bell & Howell Company products do occur, therefore the repair and replacement procedures presented in this manual should be used only as a guide. Equipment modifications and revisions will be communicated by the use of Service Bulletins.

An illustrated Parts Catalog manual is included at the rear of this service manual to identify available replacement parts. Also included are pictorial and schematic wiring diagrams of the tape recorder and the slide projector electrical systems.

2. DESCRIPTION.

In general, most projectors are similar mechanically, in the design of the electronic systems and in outward appearance. A notable difference however, will be found in all microprocessor controlled 850 models. To familiarize the serviceman with the microprocessor models, descriptions of the keyboard keys and their functions and an explanation of the pre-programmed commands are given in the "Recording Procedures" section. A detailed analysis of the single chip microprocessor is given in the "Microprocessor Analysis" section.

All projectors may be used as a slide projector only or with a cassette tape for sound/slide operation. In addition, all models are equipped with a "play/record" tape deck for custon recording operations.

CAUTION — Replacement tape decks MUST BE modified for use on all 850 microprocessor models. For complete instructions and wiring diagrams covering the necessary modification procedures, refer to the "Product Modification" section in this manual.

All projectors, except the 815A model, are equipped with an automatic focusing feature that keeps different types and variations of slides in focus by monitoring and compensating for the position of the film. A beam

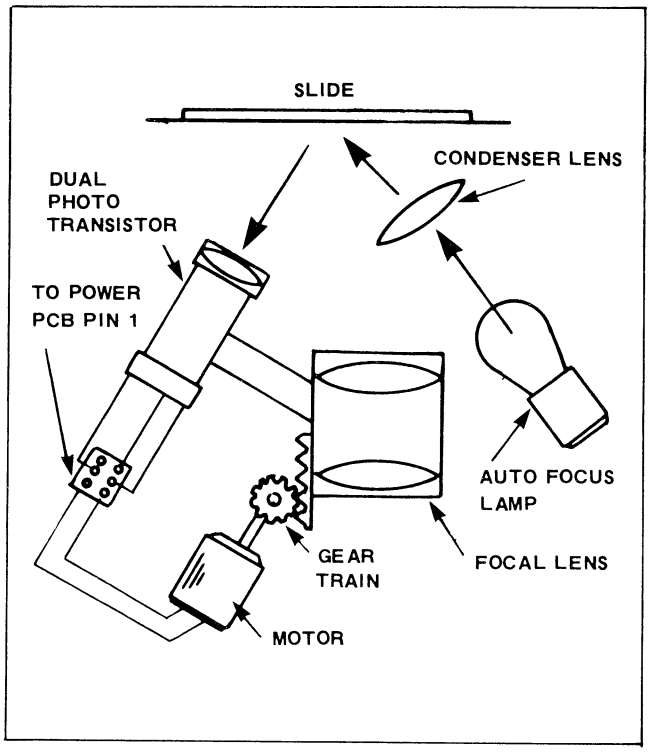


Figure A. Diagrammatical Layout of the Automatic Focusing System

of light from an internal autofocus exciter lamp is passed through a condenser lens and reflected off the film emulsion and onto a phototransistor cell. The reflection variance is electronically amplified to control a small DC motor which moves the focal lens in either direction to eliminate the variance and keep the image on the emulsion in proper focus (see Figure A).

All projectors play pre-recorded 1000Hz slide advance cassette programs. Only the 840 and 850 models however, will play pre-recorded cue-stop signals. Because only one side of a cassette tape is usable for sync. operation, all four tracks are used: tracks 1 and 2 play program audio and control tracks 3 and 4 play the 1000Hz slide advance signals and (where usable) the 150Hz cue-stop signals.

NOTE: Cassette tapes with microprocessor signals for cue-stop can only be used on the 850 models. If used on other models the signal is recognized as a pulse and will not stop on cue.

All projectors have built-in capability for recording audio on tracks 1 and 2 of the separate track system. Only the 830, 840 and 850 models have been designed to record 1000Hz slide advance pulses and only the 840 and 850 models for recording the 150Hz cue-stop (or pause) pulses on control tracks 3 and 4 of the separate track system. Refer to the "Recording Procedures" section for recording instructions, data and a diagram of audio/pulse recording requirements.

3. SPECIAL FEATURES CONTROL PANEL.

The special features control panel is located directly above the built-in speaker on the left front side of the projector. The following is a description of the features controls for each projector model.

815A and 820 Models. There are no special features controls on these projectors.

830 Models. These projectors have an internal option board located behind the feature control panel that allows recording of 1000Hz slide advance pulses. This 1000Hz board is controlled by a "Pulse Record" switch mounted on the front of the control panel (see Figure B). Refer to Parts Catalog manual Figures 27 and 28 for wiring diagrams of the 1000Hz option board.

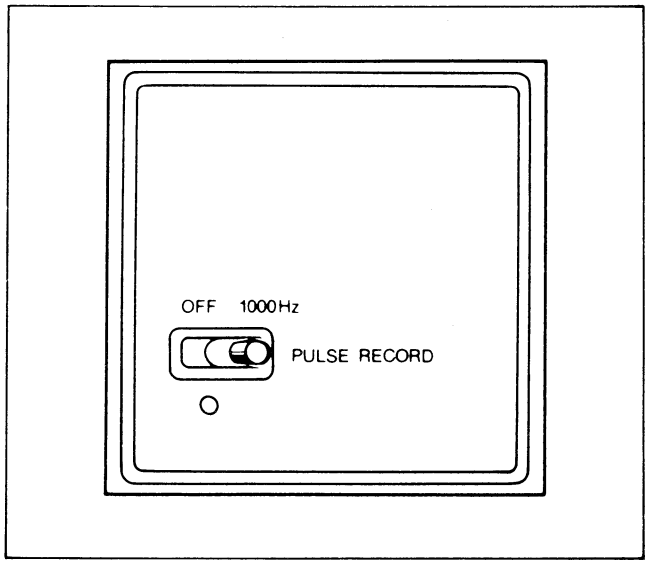


Figure B. Special Features Control Panel (825A Model & 830 Models Only)

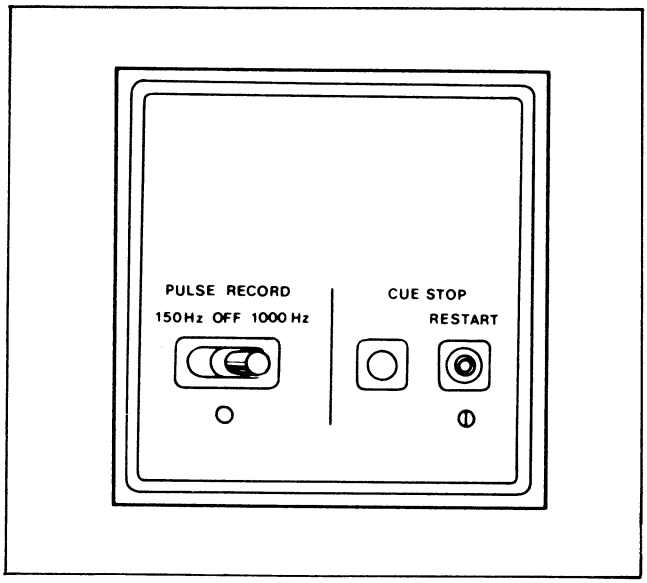


Figure C. Special Features Control Panel (840 Models Only)

840 Models. These projectors have an internal option board that allows recording of 1000Hz slide advance and 150Hz cue-stop pulses. This 1000Hz/150Hz board is controlled by a 3-position toggle switch mounted on the front of the control panel (see Figure C). Also mounted on the control panel are a red LED (to warn the operator that the projector is in the cue-stop mode) and a "Restart" pushbutton switch that, when pressed, deactivates the cue-stop system. Refer to Parts Catalog manual Figures 29 and 30 for wiring diagrams of the 1000Hz/150Hz option board.

850 Models. These projectors have a microprocessor option board that is controlled manually by a keyboard or automatically by the control track on a cassette tape. The keyboard is located at the left front side of the projector with a digital readout directly above it. The microprocessor is an integrated circuit that has been preprogrammed to recognize a variety of commands. Also built-into the electronic system is a infrared receiver for an optional infrared remote control transmitter accessory. Refer to Parts Catalog manual Figures 31, 32, 32A and 32B for wiring diagrams of the microprocessor option board and infrared receiver assembly.

4. MODES OF OPERATION (850 MODELS ONLY).

The built-in microprocessor option board may be controlled manually by the keyboard or automatically by the control track on a cassette tape. The modes of operation available are:

Manual Mode — Microprocessor receives all of its commands from the manually operated keyboard.

NOTE: In the manual mode, if a tape cassette is in place and the "Play" button is depressed, the keyboard is locked-out and slides cannot be manually advanced (or reversed) from the keyboard. As soon as the tape starts to play the projector goes into the automatic mode.

Automatic Mode — Microprocessor receives all of its commands from the pre-programmed control track on the cassette tape.

Pulse Record Mode — Microprocessor receives all of its commands (both audio and program) that the user has recorded onto a blank cassette tape.

Remote Infrared Mode — Microprocessor receives all of its commands from the optional infrared remote control transmitter accessory.

5. ELECTRICAL REQUIREMENTS.

Each model number has an assigned suffix letter which denotes usability. For example, suffix letter "A" has been assigned to all models made for domestic use, "AN" models are made for Japan and "AX" designates all other export (global) models. Electrical requirements for each model group are:

All "A" Models — Single input; 120VAC, 60Hz with an attached 3-wire line cord. Except Model 825A, attached 2-wire line cord.

All "AN" Models — Single input; 100VAC, 50/60Hz with an attached 2-wire line cord.

All "AX" Models — Multiple input; voltage selector allows the use of 110, 130, 150, 220, 240 or 260VAC, 50/60Hz to meet the requirements for global source voltages.

6. IMPORTANT SERVICE INSTRUCTIONS FOR THE 850 MODELS.

There are two important details to remember when servicing the 850 models:

(1) DO NOT ATTEMPT TO INSTALL A SLIDE TRAY UNTIL AFTER POWER HAS BEEN ACTIVATED —— These projectors have an automatic homing device that will return the slide tray carrier and the digital readout counter to the "0" position when the power switch is turned ON.

(2) REPLACEMENT TAPE DECKS FOR USE ON THE 850 MODELS MUST BE MODIFIED — All replacement tape decks have a forward/reverse switch that is not used on the 850 models. The forward/reverse operation has been programmed into the microprocessor to allow for random access to any slide in any direction (the tray will travel the shortest distance between slides). Refer to the "Product Modification" section for instructions and illustrations necessary to perform this required modification.

7. SPECIAL MAINTENANCE PRECAUTIONS.

The removal and installation of components is comparatively simple and, for the most part, requires only the tools normally available in most audio-visual repair shops (retaining ring pliers, multi-spline setscrew wrenches, assorted screwdrivers, hex socket wrenches, etc.). Where required, special tools and gauges are clearly noted in the instructions and in the service tools list at the end of this section.

Before proceeding in making repairs, perform the general operating tests outlined in the "Final Adjustments and Tests" section and check customer complaints against the Trouble Shooting chart. This will often provide a quick and simple solution to the cause of the trouble or malfunction.

When repairing equipment, be sure that the work surface is clean and clear. As parts are removed, group them in an orderly fashion to avoid confusion during reassembly. Clean dirt and old lubricant from parts (except electrical components) by washing them in solvent.

During reassembly, lubricate parts as noted in these service instructions and in the Parts Catalog illustrations. If possible, use only Bell & Howell Company lubricants as listed in the Service Tools and Supplies Chart. If recommended grease is not immediately available, use the best possible grade of ball bearing grease obtainable from local commerical sources. Where adhesive is specified to secure certain items, use the Bell & Howell Company adhesives listed in the Service Tools and Supplies Chart.

After the problem or malfunction has been repaired, perform the applicable procedures shown in the "Final Adjustments and Tests" section to insure satisfactory operation. Note: Adjustment procedures for the tape deck will be found in the separate "Tape Recorder Repair" section.

8. SERVICE TOOLS AND SUPPLIES LIST.

Almost all screw fasterners used on these projectors are hex or phillips head screws of various sizes and the setscrews are all hex type. The drivers and bits needed for these items are normally found in a service technicians tools and are not listed.

Tools that can be fabricated in the repair shop are illustrated in Figure D. All other service tools and supplies listed on the following pages are available from:

Bell & Howell Company
Visual Communications Division
Order Department
7100 North McCormick Road
Chicago, IL 60645

The following test cassettes can be ordered from:

Teac Co-Op of America
Audio Products Division
P.O. Box 750
Monte Bello, CA 90640

3KHz Wow Flutter . . . . . #MTT 111

333Hz Frequency Response . . . #MTT 112

1KHz Reference . . . . . #MTT 112B

6.3KHz . . . . . #MTT 113

10KHz Azimuth . . . . . #MTT 114

1KHz Playback Reference Sensitivity . . . . . #MTT 116L

B&H PART NO.	TEST CASSETTE	USED TO TEST
TCD 815-NX7	1000Hz Bandwidth GO Cassette:	
	Side A: 910Hz	All Models
	Side B: 1090Hz	All Models
TCD 815-NX8	1000Hz Bandwidth NO-GO Cassette:	
	Side A: 730Hz	All Models
	Side B: 1300Hz	All Models
TCD 815-NX9	150Hz Bandwidth GO Cassette:	
	Side A: 135Hz	840, 850 Models
	Side B: 165Hz	840, 850 Models
TCD 815-NX10	150Hz Bandwidth NO-GO Cassette:	
	Side A: 100Hz	840, 850 Models
	Side B: 205Hz	840, 850 Models
TCD 815-NX11	Music Test Tape (Side A Only)	All Models
TCD 815-NX12	Pulse Sensitivity Cassette:	
	Side A: 1000Hz Pulse Sensitivity	All Models
	Side B: 150Hz Pulse Sensitivity	840, 850 Models

8. SERVICE TOOLS AND SUPPLIES LIST (Continued)

LUBRICATION CHART

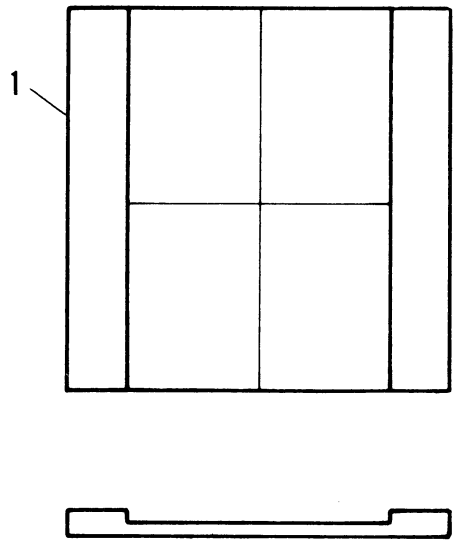
LUBRICANT	B&H NO.	USED ON
Lubriplate GR132 Grease G.E. Supply Co. Elmerst, IL	713279	Focus mechanism gears and sliding parts.
Versilube Silicon Grease G.E. Supply Co. Elmerst, IL	713280	Slide lift mechanism gears and sliding parts.
Watch Stem Grease W.F. NYE Inc. New Bedford, MA	713281	Tray drive motor gears and clutch ball.

The lubricants specified in the above chart may be obtained from B&H Company under the indicated part number or from the listed commercial vendor source.

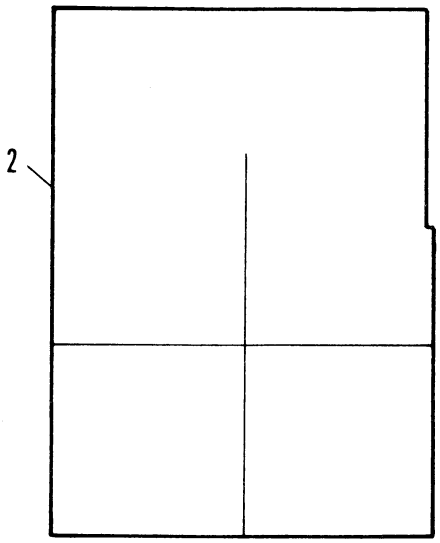
SPECIAL SERVICE TOOLS CHART

INDEX NO.	TOOL NO.	TOOL DESCRIPTION
	G9865-N7-1	Chattillon Gage
	S-016913 FX1	Pin Removal Tool
	S-709926-1 FX1	Lead Extractor Tool
	S-077754-1 FX3	Limit Slide
	S-077754-1 FX4	Limit Slide
	SD-840-1 NX1	Centering Slide
1	S-079036-5 N1	Scan Lamp Filament Setting Gage
2	SD-815-1 NX1	Target Slide
3	SD-850-1 NX1	Centering Overlay
4	SD-850-2 NX1	Angular Overlay
5	To Be Fabricated	Decal Removal Tool
6	To Be Fabricated	Automatic Focusing Travel Range Test Slide (see *)
7	To Be Fabricated	Projector Holding Fixture

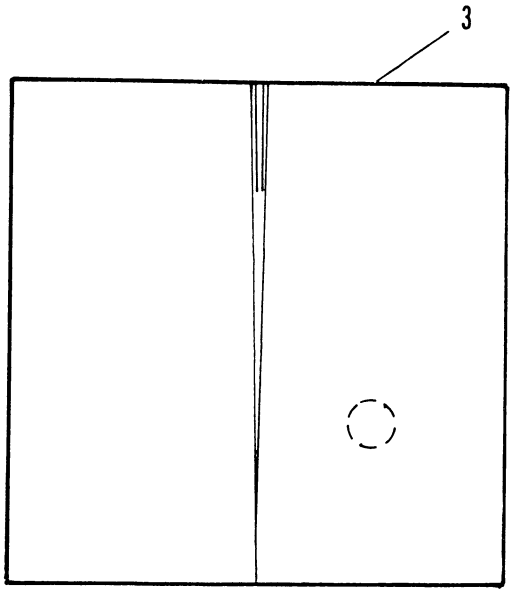
*Limit Slides S-077754-1 FX3 and FX4 may be purchased from Bell & Howell Company for use in place of this generic slide.



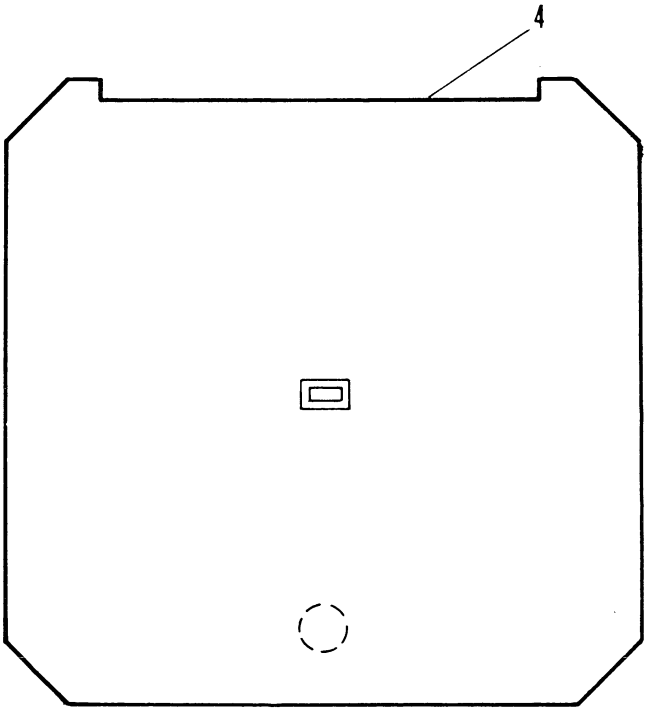
S–079036–5 N1 SCAN LAMP
FILAMENT SETTING GAGE
(A,F MODELS)



SD–815–1NX–1 TARGET
SLIDE ALL MODELS



SD–850–2NX1 ANGULARITY
OVERLAY ALL MODELS
NOT TO SCALE



SD–850–1NX1 CENTERING
OVERLAY ALL MODELS
NOT TO SCALE

Figure D. Special Service Tools (Sheet 1 of 2)

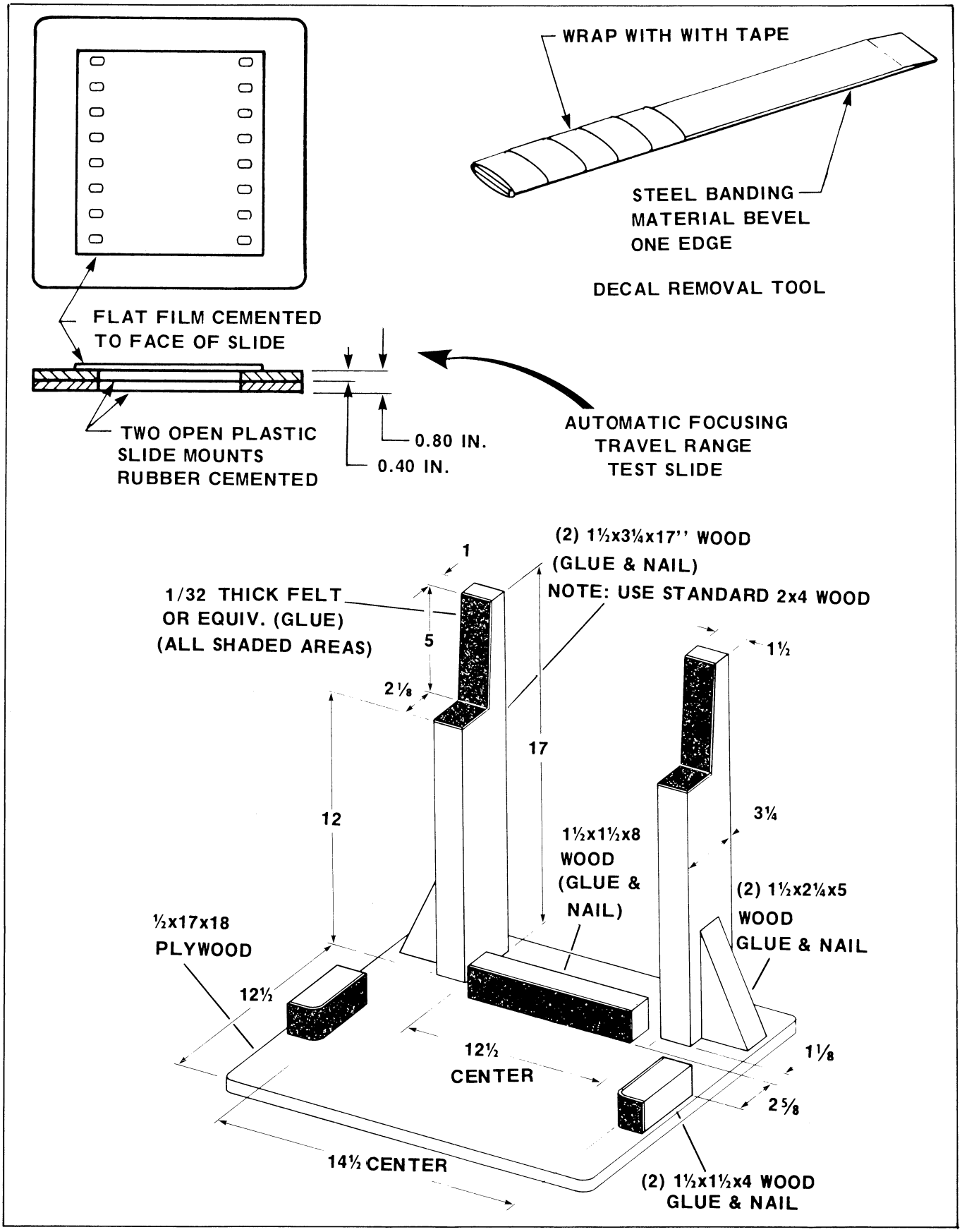


Figure D. Special Service Tools (Sheet 2 of 2)

FABRICATED

OPERATING AND RECORDING PROCEDURES

The following procedures apply to all projectors and cover the set-up of the slide unit and instructions for operating the projectors with pre-recorded sound/slide cassette programs.

9. THE SLIDE UNIT.

The slide unit is designed to project slides on a built-in viewing screen for small viewing audiences or on an external screen for larger groups. The position of the front/rear door at the back of the projector determines the slide projection mode; tightly closed for built-in screen projection and fully open for projecting slides on an external screen.

The slide units will accept 80- or 140-slide rotary trays which are available from the Bell & Howell Company as well as from other manufacturers. The system will accept most 35mm slides (plastic, cardboard and glass mounted) and 126 format slides in 2 by 2 inch mounts. Rotary trays loaded with slides for showing on conventional projectors are also ready for use on these slide units.

A. LOADING SLIDES INTO THE TRAY.

(1) Arrange the slides to be loaded in presentation sequence.

(2) Rotate the locking ring (top center of the slide tray) one-half turn counterclockwise to unlock and remove the ring.

(3) To make sure slides will project properly (correct side up and left to right) hold the slide upside down and backwards (see Figure E) and place one slide in each of the tray slots beginning with slot No. 1.

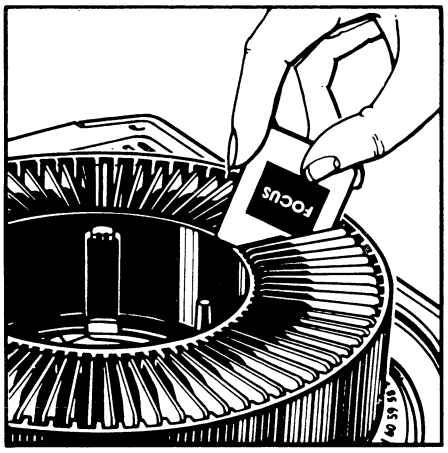


Figure E. Loading Slides Into the Tray

(4) If 140-slide trays are being used, be sure to follow any special instructions relating to slide mounts for use in the trays. For example, some tray manufacturers discourage the use of plastic slide mounts or other thick slides to ensure smooth operation.

(5) After all the slides have been loaded, replace the locking ring on the slide tray and rotate the ring one-half turn clockwise to lock the ring in place.

NOTE: Bell & Howell Company recommends the use of a high quality tray such as the Bell & Howell Company Rotary Tray (see Optional Accessories listed in the Parts Catalog manual "Introduction" section) or Kodak Carousel. Also remember that worn, damaged or bent slide mounts can cause jamming of the slide tray and should be replaced.

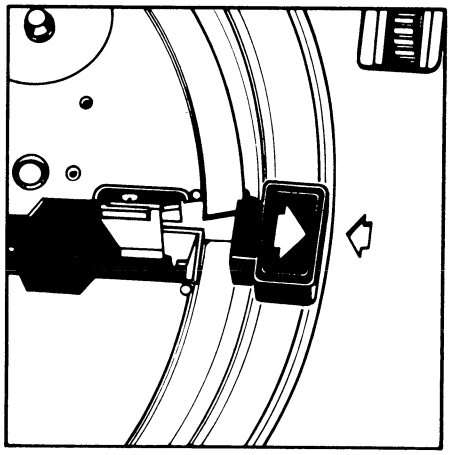


Figure F. Proper Line-Up of the Slide Tray Carrier Arrow and Projector Case Arrow

B. LOADING THE SLIDE TRAY ONTO THE PROJECTOR.

(1) Check to make sure the projector is plugged in and the voltage selector (AX models) is set at the proper voltage.

(2) All Except 850 Models. Turn the "Power" switch ON (notice that the red power indicator above the power switch now glows indicating the projector is ready to operate). As shown in Figure F, the slide tray carrier arrow must be in line with the projector case arrow for proper loading of the slide tray onto the projector. To line up the arrows, momentarily press (or hold) the "Slide Tray" switch (see Figure G) until the arrows are aligned.

(2) 850 Models Only. Turn ON the "Power" switch to activate the microprocessor's homing device which will automatically align the tray carrier's arrow with the projector case arrow for proper placement of the slide tray. Also, the red power indicator light will glow indicating the projector is ready to be operated.

NOTE: DO NOT attempt to install a slide tray on the microprocessor projectors until AFTER power has been activated.

(3) To properly position the slide tray onto the tray carrier, hold the slide tray so that it's "0" position is in line with the matched carrier-projector arrows and seat the tray firmly onto the carrier.

NOTE: The slide tray can only be seated on the carrier when the tray's "0" position is in line with the matched arrows.

The slide program is now ready for presentation without an accompanying tape cassette as described in subparagraph (C) below, or with a pre-recorded cassette program (see following paragraph 10 or 12 for operating instructions).

C. PROJECTING SLIDES WITHOUT SOUND.

With the "Power" switch ON and the slide tray seated on its carrier, complete the set-up and slide projection procedures as follows:

(1) Position the front/rear projection door to the desired screen projection mode and set the projection "Lamp" switch to HI or LO as required.

(2) Use the "Slide Tray" switch (or the key on the microprocessor keyboard) to project the first slide onto the screen and adjust the projected image for sharpness with the "Focus" control located on the top of the projector. (All projectors except the 815A model will, after initial adjustment, automatically focus all of the remaining slides properly.)

(3) All Except 850 Models. To complete the slide program, the remaining slides to be projected may be advanced/reversed using the "Slide Tray" switch or the remote control that has been plugged into the REMOTE jack on the accessories panel.

(3) 850 Models Only. To complete the slide program, several methods of operation are available to the user. These are: Pressing the key(s) on the microprocessor to manually advance/reverse the

slides, setting up the infrared transmitter for remote control of the projector or entering a command number into the microprocessor to automatically project the slides in timed sequence. Please refer to the "Microprocessor Command Chart" (paragraph 16(B) for a list of command numbers and commands programmed into the microprocessor.

10. SOUND/SLIDE OPERATION WITH PRE-RECORDED CASSETTE PROGRAMS (ALL EXCEPT 850 MODELS).

These projectors have been designed to accept all pre-recorded tape programs produced on cassettes in accordance with the American National Standards Institute (ASNI) specifications and which contain 1000Hz slide advance pulses. Most pre-recorded sound/slide programs do conform to these industry standards. The 840 models are also designed to accept an ANSI standard 150Hz cue tone as a pause or cue-stop.

To set-up the projectors for operation with a pre-recorded cassette program, perform the following procedures.

(1) Check to make sure the projector line cord is plugged into a grounded outlet and the voltage selector (AX models) is set for the proper operating voltage.

(2) Determine slide projection mode (built-in or external screen) and position the front/rear projection door accordingly.

(3) Move the "Pulse" control switch (accessories panel, left side of the projector) to the ON position.

(4) Check the cassette to see if the tape is rewound (tape is rewound if all tape is on the left side of the cassette when viewed from the top). Insert the tape cassette into the cassette loading slot.

NOTE: All operating controls mentioned in the following procedural steps are located on the master control panel (see Figure G) unless otherwise noted.

(5) Turn the "Power" switch ON. If the tape cassette must be rewound, push the "Review" button to rewind the cassette. (When the tape is fully rewound the review button will pop out automatically.)

(6) If a rotary slide tray has not been loaded onto the projector, refer to paragraph 9(B) for tray loading instructions.

(7) Move the "Volume" control to level 3 and adjust to an appropriate level once the program has begun.

(8) If the accessory remote control cord is being used, plug the remote control into the REMOTE jack on the accessories panel.

(9) Set the projection "Lamp" switch to HI or LO as required, and start the program by pressing and locking-in the "Play" button.

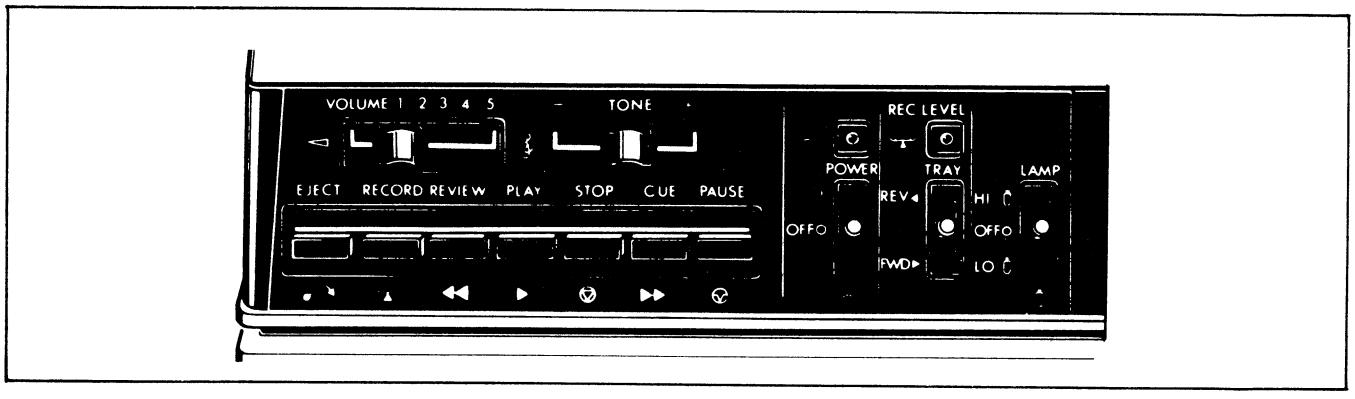


Figure G. Master Sound and Projector Control Panel
(All Except 850 Models)

If the sound track is out of sync with the slide program, refer to the instructions given in paragraph 11 to restore sound/slide synchronization.

To pause at any time during the program, press the "Pause" button which will lock in and stop the tape. To restart the program, press the "Pause" button again and the program will continue.

840 Models Only. When a cue-stop is reached on the pre-recorded tape, it will be necessary to press the "Restart" button on the special features control panel or on the remote accessory to de-activate the cue-stop and restart the program.

To stop the program and eject the cassette at any time, first press the "Stop" button and then the "Eject" button.

At the end of the program, rewind the cassette by pressing the "Review" button. While the cassette is rewinding, use the "Slide Tray" switch to rotate the tray until the arrows align, and then unlatch and remove the slide tray. Finally, turn all switches to OFF, disconnect the line cord and, if necessary, unplug the accessory remote control cord.

11. SYNCHRONIZING THE PRE-RECORDED CASSETTE PROGRAMS (ALL EXCEPT 850 MODELS).

If the sound track is out of sync with the slide program, place the projector in the PLAY mode and use the "Slide Tray" switch to advance (or reverse) the slides until synchronization has been restored.

If a specific part of the sound track does not match the slide program, place the projector in the PLAY mode. Then press the "Cue" (fast/forward) or "Review" (rewind) button until the approximate spot on the unmatched tape has been reached and press the "Stop" button. Now listen to the tape (still in the PLAY mode) for the specific part to be matched. If the tape is not at the correct location, repeat the searching process. Once the proper tape portion has been found, use the "Slide Tray" switch to advance (or reverse) the tray until the slides are in synchronization with the tape.

12. SOUND/SLIDE OPERATION WITH PRE-RECORDED CASSETTE PROGRAMS (850 MODELS ONLY — MICROPROCESSOR AUTOMATIC MODE).

The microprocessor units accept the ANSI standard 1000Hz cue tone to advance one slide and a 150Hz cue tone is accepted as a pause or cue-stop. Automatic operation of the microprocessor projectors is outlined below. Refer to Figure H and follow the procedures as instructed to set-up and operate the microprocessor projectors.

(1) If the slide tray is presently installed on the projector it must be removed before power is activated.

(2) If the remote infrared transmitter will be used, properly position the transmitter and set-up to operate.

(3) Check to make sure the projector line cord is connected to a grounded outlet and the voltage selector (AX models) is set for the proper voltage. Check the cassette to see if the tape is rewound and insert the cassette into the cassette loading slot.

(4) Determine slide projection mode and position the front/rear projection door accordingly. Move the "Pulse" control switch to the ON position and the "Volume" control to level 3.

(5) Turn the "Power" switch ON to activate the automatic slide tray homing device; then install the slide tray onto the projector. If necessary, press the "Review" button to rewind the tape (when the tape is rewound the review button will pop out automatically).

(6) Set the projection "Lamp" switch to HI or LO as required.

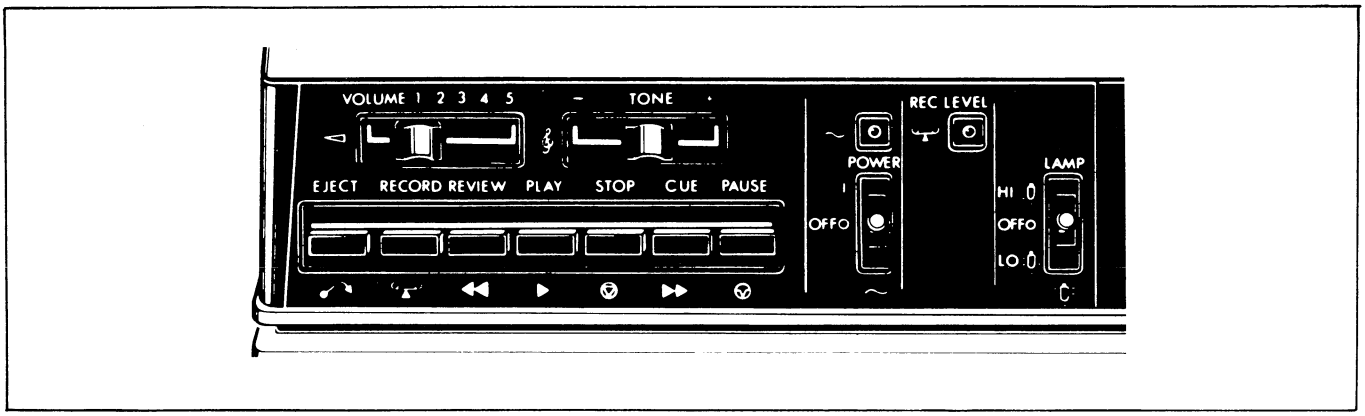


Figure H. Master Sound and Projector Control Panel
(850 Models Only)

(7) Begin the program by pressing and locking-in the "Play" button and, if necessary, reset the "Volume" control.

When a cue-stop is reached on the prerecorded tape or the "Pause" button has been pressed to stop the tape, it will be necessary to press the "Pause/Restart" key on the keyboard or the infrared transmitter accessory to restart the program.

To stop the program and eject the cassette at any time, first press the "Stop" button and then the "Eject" button.

NOTE: Slide numbers recorded between 0 to 80 will cause an 80-slide tray to rotate until the slide at that number drops into the slide receiver and appears on the screen. The same process holds for a recorded number between 0 to 140 when a 140-slide tray is being used. An invalid number (i.e. using a 140-slide tray with an 80 tray program) results in an audible beep to indicate the slide tray will not move, and a temporary 999 readout will appear on the digital readout display.

At the end of the program, rewind the cassette, make sure all switches are OFF and disconnect the line cord. Finally, remove the slide tray.

13. CREATING A CUSTOM SOUND/SLIDE PROGRAM.

Custom sound/slide programs may be produced for all projectors. The following instructions for preparing the programs are presented in a step-by-step format. First, the slide program instructions are presented followed by: audio recording on a blank cassette tape (for all models), pulse recording (830/840 models only) and pulse recording for the microprocessor models. If the serviceman is not familiar with the operation of the microprocessor 850 models, study the instructions given in paragraph 16 and the material presented in the "Microprocessor Analysis" section before attempting the recording procedures.

A. PREPARING THE SLIDE PROGRAM AND SCRIPT (ALL MODELS).

To prepare a custom slide program, arrange the slides in presentation sequence and load the slides into the tray Connect the projector line cord, set the voltage selector if necessary, and close the front/rear projection door. Turn the "Power" switch ON and then install the slide tray.

Turn the projection "Lamp" switch to LO. Use the "Slide Tray" switch - or press the key on the microprocessor keyboard - to advance the slides (if desired, remote

control(s) may be used to advance slides). As the slides appear on the screen, prepare a "script" for the audio and pulse recording procedures (the script prepared for the microprocessor 850 models should also contain the numbers of all wanted commands and slide changes). When the slide program has been completed, turn the projection "Lamp" and "Power" switches OFF and remove the slide tray from the projector.

B. CASSETTE TAPE RECORDING LEVELS.

Audio Recording Levels — For recording audio on tracks 1 and 2 of the separate track system, a recording level of -4dB, with reference to 250nWb/m at 315Hz is recommended.

Pulse Recording Levels — For recording pulses on control tracks 3 and 4 of the separate track system, a recording level of -6dB ±3dB, with reference to 250nWb/m at 315Hz with equalization is recommended.

C. RECORDING DATA.

Tape Speed — 1.875 in/s (4.76 cm/s).

Advance Pulse Frequency — A 1000Hz pulse is used for slide advance.

Cue-Stop Pulse Frequency — A 150Hz pulse is used for program stop. Frequency tolerances are ±6%, and total harmonic distortion of the pulses shall not exceed 10% (measured without equalization).

Cue-Stop Duration — 0.45 second.

Cue-Stop Spacing — Between the start of two adjacent slide advance pulses, 1.5 seconds minimum. Between the end of the cue-stop and the start of subsequent recorded material (audio or slide advance pulse), 2.0 seconds minimum.

14. RECORDING AUDIO (ALL MODELS).

All of the controls used for recording audio on tracks 1 and 2 of the blank cassette tape are located on the master control panel (see Figure K). Microphones are standard equipment on the 830, 840 and 850 models but are accessory items for the 815 and 820 models.

(1) Make sure the slide tray has been removed from the projector and the projection "Lamp" switch is in the OFF position. (If the slide unit is operative while a recording is being made, the microphone will pick up fan and slide changer noise, and hum will be recorded on the sound track.)

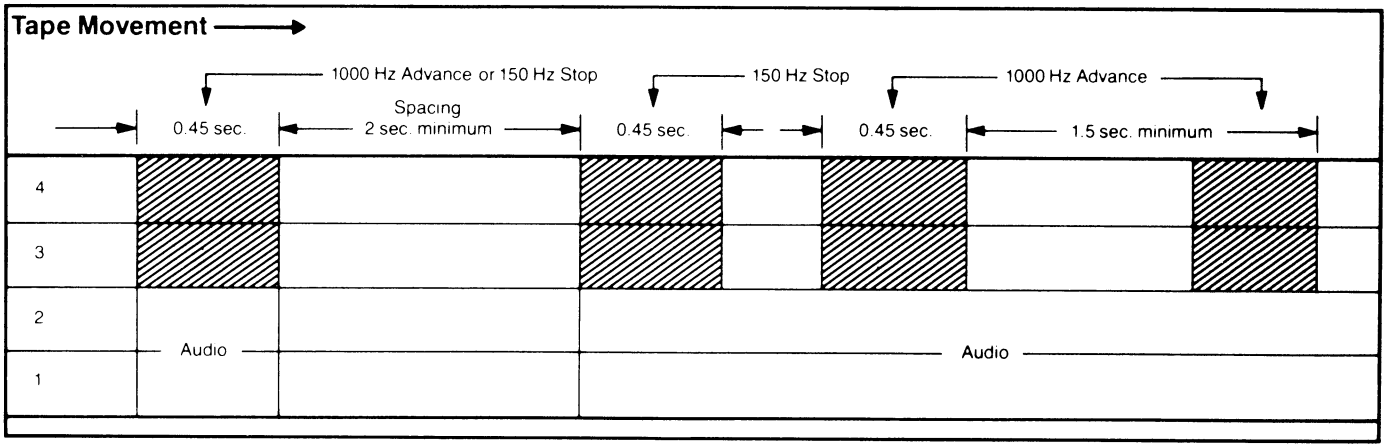


Figure J. Audio and Pulse Recording Specifications

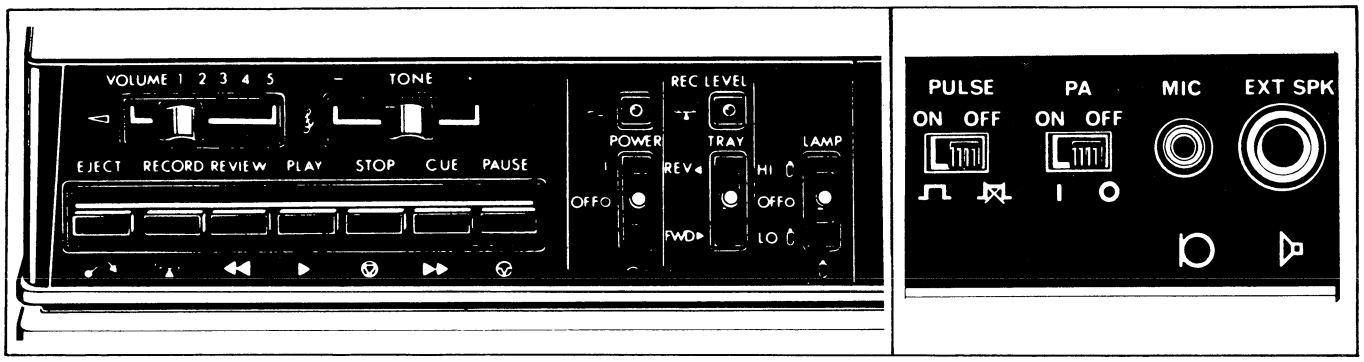


Figure K. Audio Recording Controls

(2) Insert the microphone into the MIC jack (accessories panel, left side of the projector). Load a blank, rewound cassette into the cassette loading slot and turn the "Power" switch ON.

(3) Press and lock-in the "Pause" button to place the tape mechanism in a "hold" condition. Press the "Record" and "Play" buttons simultaneously (the red "REC Level" indicator light above the slide tray switch will turn on, indicating the system is in the RECORD mode).

(4) To start tape transport, press and release the "Pause" button and then begin recording sound (the red "REC Level" indicator light blinks while recording). As the recording is being made, check slide sequence and content against the prepared "script."

(5) To correct a recording error, press the "Stop" button to stop the recorder. Press the "Review" button and rewind the tape to a point before the error. Then press the "Play" button and listen to the tape, pressing the "Stop" button just before the error. Now press the "Pause" button; then the "Play" and "Record" buttons simultaneously. Press and release the "Pause" button and record the correction.

(6) When the recording is completed, press the "Stop" button. Press and lock-in the "Review" button to rewind the tape. When the tape is completely rewound the mechanism will stop and the "Review" button will pop out automatically.

If desired, the custon sound/slide program is now ready for playback or for adding pulse(s) to the control track of the tape.

15. RECORDING PULSES (825A, 830 AND 840 MODELS ONLY).

As noted earlier, the 815A and 820 models are not equipped to record slide advance or cue-stop pulses. Please refer to paragraph 17 for pulse recording instructions for use on the microprocessor 850 models.

A. RECORDING 1000HZ SLIDE ADVANCE PULSES (825A, 830 AND 840 MODELS ONLY).

Adding automatic 1000Hz slide advance pulses in synchronization with a custom audio program is not a complicated recording operation. The separate track system allows recording of 1000Hz slide advance pulses on control tracks 3 and 4 of the cassette tape. The pulse recording controls mentioned in the following paragraphs are located on the master control panel (see Figure L). In addition, the special features panel "Pulse Record" control (Figure M) and a "Pulsing Control" plug connected to the REMOTE jack on the accessories panel are also used.

(1) Unplug and remove the microphone from the MIC jack. Insert the "Pulsing Control" plug into the REMOTE jack and switch the features panel "Pulse Record" control to the 1000HZ position (see Figure M). Turn the "Power" switch ON and press the "Review" button to rewind the tape if necessary.

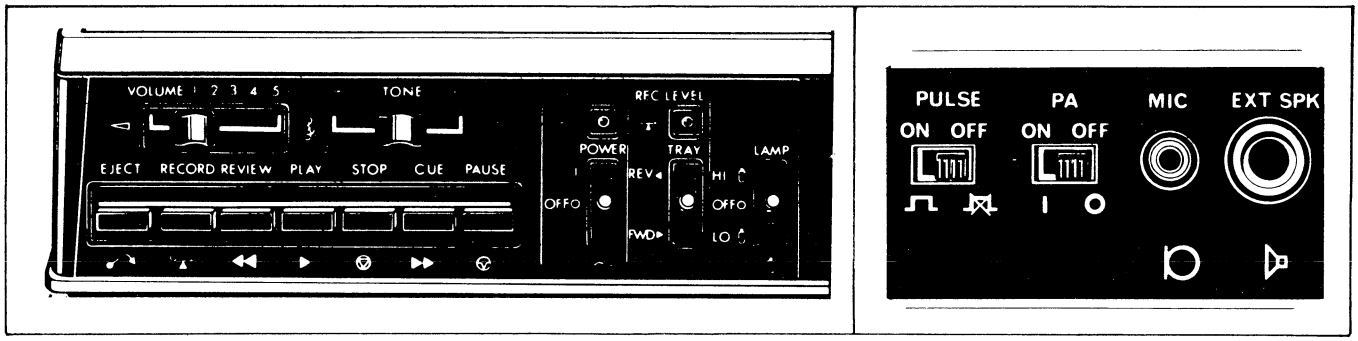


Figure L. 1000Hz Slide Advance Pulse Recording Controls
(825A, 830 and 840 Models Only)

(2) Use the "Slide Tray" switch to line-up the tray carrier and projector case arrows and install the slide tray. Move the projection "Lamp" switch to LO.

(3) Press and lock-in the "Pause" button and then the "Play" button. Before starting the pulse recording sequence carefully read the following CAUTION.

CAUTION

DO NOT PUSH the "Record" button to add slide advance (or cue-stop) pulses on the tape. The "Record" button is used ONLY for audio recording and if activated will ERASE the custom audio program.

(4) To begin pulse recording, repress the latched "Pause" button to start tape playback and slide projection. When the sound track reaches the point wanted to advance to the next slide, press the "Pulsing Control" button and the pulse being recorded will be heard through the speaker. (Note: With each press of the "Pulsing Control" button, a new slide will be projected and the automatic slide advance 1000Hz pulse will be recorded simultaneously.)

(5) A pause in the pulse recording operation may be initiated at any time. Simply press and lock-in the "Pause" button and the tape will stop. To restart the tape, press and release the "Pause" button.

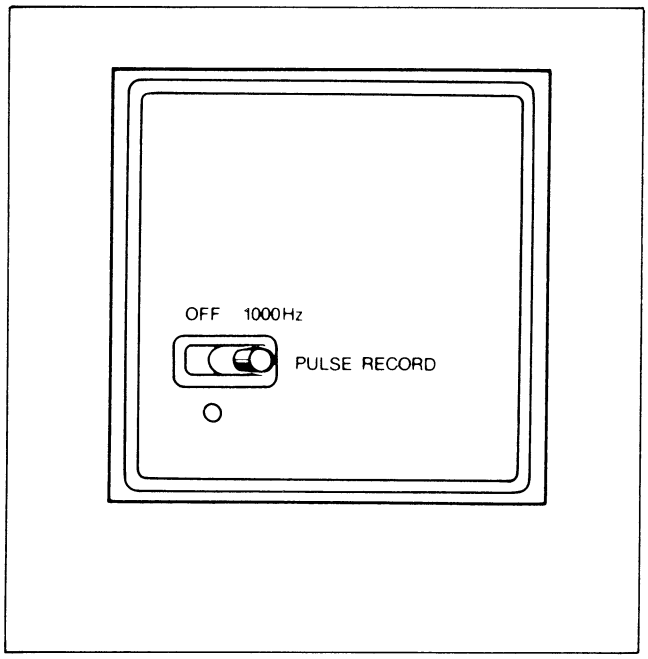


Figure M. "Pulse Record" Control Position
When Recording Slide Advance Pulses
(825A, 830 Models Features Panel Shown)

(6) To check for accuracy of the pulses already recorded or to replay the program, press and lock-in the "Pause" button. Turn the "Pulse Record" control and projection "Lamp" switches OFF. Press the "Review" button to rewind the tape. Use the "Slide Tray" switch and rotate the tray until the arrows align; then remove the tray and reposition the tray aligning the "0" position with the arrows and reseat firmly. Turn the projection "Lamp" ON and press the "Pause" button to restart the program.

B. RECORDING 150HZ (CUE-STOP) PULSES (840 MODELS ONLY).

The procedures for recording 150Hz (cue-stop) pulses are similar to the 1000Hz slide advance recording instructions. To record cue-stop pulses, refer to paragraph 15(A) and follow the recording instructions given in steps (1) through (6) noting the exceptions given below.

In Step (1) — To add 150Hz (cue-stop) pulses to tracks 3 and 4 of the custom cassette tape, the features panel "Pulse Record" control must be set in the 150Hz position as shown in Figure N.

In Step (4) — When the "Pulsing Control" button is pressed to record the cue-stop pulse, the recording signal will NOT be heard through the speaker.

C. PREVENTING ACCIDENTAL TAPE ERASURES.

The control track will AUTOMATICALLY BE ERASED any time the tape is being transported with the "Pulsing Control" plugged into the REMOTE jack and the "Pulse Record" control in the 1000Hz (or 150Hz) position. To avoid accidental tape erasures:

(1) ALWAYS unplug the "Pulsing Control" from the REMOTE jack and switch the "Pulse Record" control OFF when the custom recording operation(s) have been completed.

(2) CHECK the "REC Level" indicator light, if glowing red the system is in the RECORD mode and the tape will automatically be erased.

D. REPOSITIONING (RE-RECORDING) OR ERASING PULSES.

(1) Switch the "Pulse Record" control OFF.

(2) Press the "Cue" or "Review" button to find the spot to be repositioned (or erased) stopping the tape after the last correct pulse by pressing the "Pause" button.

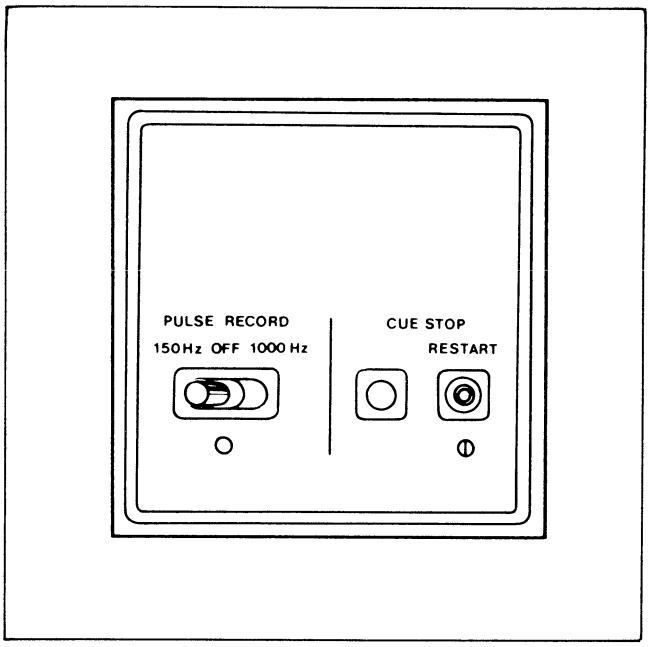


Figure N. "Pulse Record" Control Position When Recording Cue-Stop Pulses (840 Models Only)

(3) TO RE-RECORD PULSES, return the "Pulse Record" control to the 1000Hz (or 150Hz) position. Press and release "Pause" button and begin re-recording pulses by pressing the button on the "Pulsing Control."

(4) TO ERASE AN INCORRECT PULSE, return the "Pulse Record" control to the 1000Hz (or 150Hz) position. Press and release the "Pause" button. Permit the tape to advance beyond the point where the incorrect pulse is recorded and the pulse will be erased. Stop the tape after the erasure by pressing the "Pause" button.

When the pulse recording operation(s) have been completed, unplug the "Pulsing Control" and turn the "Pulse Record" and projection "Lamp" switches OFF. Press the "Review" button to rewind the tape. Press the "Eject" button to remove the rewound cassette. Turn the "Power" switch OFF, disconnect the line cord and remove the slide tray. Finally, mark the custom cassette and the slide tray to identify the program.

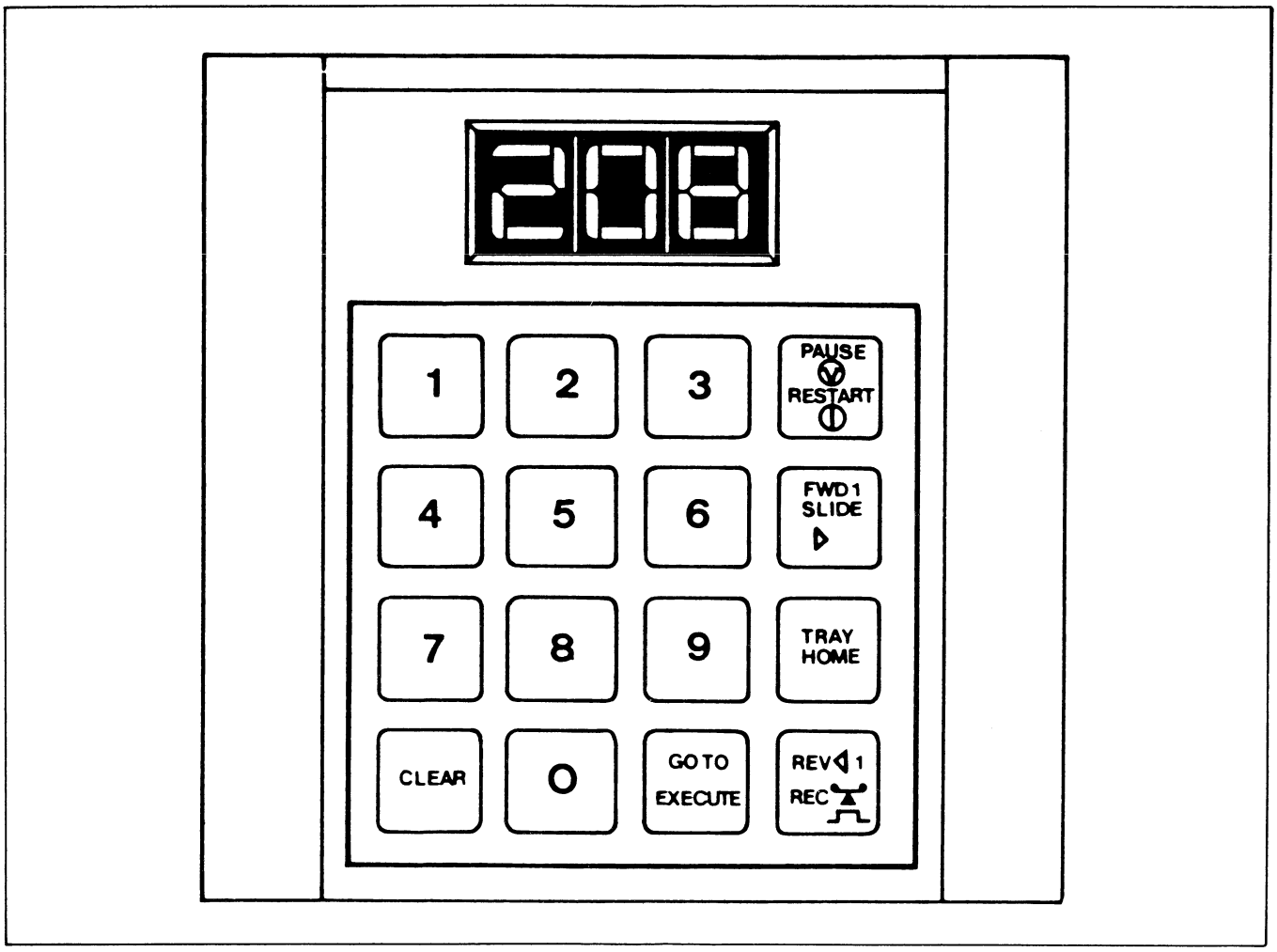


Figure P. Microprocessor Keyboard and 3-Digit Display

16. KEYBOARD AND COMMAND EXPLANATIONS FOR THE MICROPROCESSOR MODELS.

A. THE MICROPROCESSOR KEYBOARD.

The microprocessor keyboard and the 3-digit LED display directly above it, as shown in Figure P, is located at the left front side of the projector. The following lists the individual keys and describes the functions they will perform when pressed.

NUMERICAL Keys 0 through 9 — Enters numbers (calculator fashion) into the microprocessor and the 3-digit display.

CLEAR Key — Removes an unwanted number from the display.

GO TO EXECUTE Key — Directs the microprocessor to execute the command or find the slide number visible on the display.

PAUSE/RESTART Key — Stops and starts the tape recorder; also used to exit from certain command functions.

FWD 1 SLIDE Key — Advances the slide tray one slide.

TRAY HOME Key — Returns the slide tray to its "0" position.

REV 1/REC Key — A dual purpose key, reverses the slide tray one slide; also used for pulse recording (when pressed in combination with a command number already entered, it causes an encoded cue to be recorded on the control track of the tape.

B. MICROPROCESSOR COMMAND CHART.

Command No.	Command	Works in Manual Mode?
200	5 Sec. Auto Slide Advance	Yes
201	10 Sec. Auto Slide Advance	Yes
202	15 Sec. Auto Slide Advance	Yes
203	Indefinite Pause	No
204	5 Sec. Auto Pause	No
205	10 Sec. Auto Pause	No
206	15 Sec. Auto Pause	No
207	Keyboard Lockout	No
208	Keyboard Restore	No
211	Display Blank	No
212	Display Restore	No
213	Cue Record	Yes

NOTE: All commands listed above can be recorded and recognized by the microprocessor on play back EXCEPT #213.

C. COMMAND EXPLANATIONS.

#200 - 5 Second Automatic Slide Advance. When this command number is entered into the keyboard and the GO TO EXECUTE keyboard key is pressed, the slide tray advances one slide every five seconds. This timed sequence will continue until the projector is turned off or the PAUSE/RESTART keyboard key is pressed.

#201 - 10 Second Automatic Slide Advance. Same function as #200 except each slide advance is 10 seconds.

#202 - 15 Second Automatic Slide Advance. Same function as #200 except each slide advance is 15 seconds.

#203 - Indefinite Pause. This command number initiates a cue-stop (pause) of an indefinite duration. Three decimal points will appear in the readout display indicating the tape recorder and projector are in the PAUSE mode. To exit from the PAUSE mode, press the PAUSE/RESTART key on the keyboard.

#204 - 5 Second Automatic Pause. This command number initiates a cue-stop (pause) of five seconds. After this 5 second interval, the tape recorder and projector will automatically restart.

#205 - 10 Second Automatic Pause. Same function as #204 except the cue-stop interval is 10 seconds.

#206 - 15 Second Automatic Pause. Same function as #204 except the cue-stop interval is 15 seconds.

#207 - Keyboard Lockout. This command number locks out any input from the 16-key keyboard to ensure programming will not be interrupted by accidental entries.

#208 - Keyboard Restore. This command number will restore all keyboard functions. IMPORTANT: ALWAYS cancel a #207 with a #208 command number at the end of a program.

#211 - Display Blank. This command number causes the 3-digit readout display to go blank removing the distraction of the glowing display from viewers.

NOTE: In the MANUAL mode, the display will not go blank until after the tape recorder "Play" button is pressed. The display will remain blank as long as the tape recorder is in the PLAY mode.

#212 - Display Restore. This command number restores the readout display. IMPORTANT: ALWAYS cancel a #211 with a #212 command at the appropriate time.

#213 - Cue Record. When this command number is entered into the keyboard and the GO TO EXECUTE key is pressed, the "REC Level" red indicator light will glow indicating the projector is in the PULSE RECORD mode.

D. USING THE MICROPROCESSOR KEYBOARD.

All commands that have been pre-programmed into the microprocessor have an assigned number. These command numbers, the commands they will perform and the projector mode they are operative in are listed in the preceeding "Microprocessor Command Chart" (see paragraph 16(B)).

Two types of numbers are entered into the keyboard: command numbers and the numbers designating the location of the slides. The numerical keys are used to enter these numbers (calculator fashion) into the microprocessor and the 3-digit readout display. If an unwanted number is mistakenly entered, pressing the CLEAR key will remove that number from the display so that the correct number may be entered before the command is executed.

NOTE: Invalid command numbers, such as 209 and 210 not currently programmed into the microprocessor, will appear in the display but the microprocessor does not recognize them and will not respond to the entered command.

To enter a command number selected from the "Microprocessor Command Chart" or a slide number, first press the numerical keys corresponding to the number wanted. Then press the GO TO EXECUTE key which will direct the microprocessor to execute the command (or find the slide number) now visible on the 3-digit readout display.

Before adding pulses to the custom audio program, study the descriptive material covering keyboard key functions, pre-programmed commands and the command numbers listed in the chart to become familiar with the encoded cues.

17. PULSE RECORDING MODE (850 MODELS ONLY).

When the projector is placed in the PULSE RECORD mode, command and slide numbers may be recorded on the control tracks of the tape which will subsequently control the projector in the AUTOMATIC mode. The control tracks on the tape being used must be blank; if there are pulses of any kind on the control tracks of the custom tape cassette they will be erased.

A. SETTING UP THE MICROPROCESSOR PROJECTORS FOR RECORDING PULSES.

(1) Check to make sure the microphone plug has been disconnected from the MIC jack on the accessories panel and unlatch and remove the slide tray from the slide tray carrier.

(2) Set the accessories panel "Pulse Control" switch to the ON position. If necessary, load the tape cassette carrying the custom recorded audio into the cassette loading slot.

(3) Turn the "Power" switch ON and press the "Review" button to rewind the tape; then press the "Eject" button to remove the cassette from its slot.

(4) Adjust the position of the tape in the cassette by placing a pencil (or similar object) into the right-hand spindle hole and manually advancing the tape until the start of the brown oxide after the blank leader covers the central aperture of the cassette. Then reinsert the adjusted tape cassette into its loading slot.

NOTE: Proper adjustment of the tape in the cassette is important — if the tape is advanced too far, synchronizing the first slide change pulse with the audio commentary may not be possible. If the tape is not advanced far enough, the first instructions will not be recorded.

(5) Check to make sure each slide is in its correct slot if the slide program is to be projected while recording encoded cues (in the PULSE RECORD mode, fan and slide changer noise will not affect the recording).

(6) Seat the slide tray onto the projector and move the projection "Lamp" switch to LO.

(7) Using the numerical keys on the microprocessor keyboard, enter the command #213 (the Cue Record Command Number) into the display. Then press the GO TO EXECUTE key.

B. RECORDING ENCODED CUES.

(1) First press and lock-in the tape recorder "Pause" button to place the tape mechanism in a "hold" condition; then press and lock-in the "Play" button. The red "REC Level" light will glow to indicate the system is now ready to record encoded cues on the control tracks of the tape.

(2) Refer to the prepared "script" and enter the first slide or command number into the keyboard. Check the display to verify the number wanted has been entered. If incorrect, press the CLEAR key and enter the correct number

(3) To begin recording encoded pulses, repress the latched "Pause" button to start tape transport and slide projection. Then, watching the "script" and listening to the audio program, press the REV 1/REC key at the moment the command is to be obeyed later when played back in the AUTOMATIC mode (A beep, lasting about one-half second, will be heard through the speaker when the command is being accepted. The sound is a signal for the operator only and will not be recorded on the audio track of the tape.)

NOTE: When the REV 1/REC key is pressed after keyboard entry of a command number, the slide tray will automatically advance in response to the instructions being recorded. However, if a slide number has been entered into the keyboard, after pressing the REV 1 REC key the slide tray will immediately rotate and project the selected slide; confirming that the keyboard entry was correct.

(4) Continue until all instructions have been entered — first keying in the command or slide number and at the right moment, pressing the REV 1/REC key. If the interval between consecutive slides is so short that it is difficult for both these operations to be performed while the tape is running, take more time. Stop the tape with the "Pause" button and, at the right moment, pressing the REV 1/REC key.

(5) When all command and slide numbers have been entered, leave the PULSE RECORD mode by pressing the "Stop" or "Review" buttons on the tape recorder. The tape, when rewound, is now ready to control the microprocessor projector in the AUTOMATIC mode.

When the pulse recording procedures have been completed, turn the projection "Lamp" and "Pulse Control" switches OFF.

Press the "Review" button to rewind the tape and then the "Eject" button to remove the rewound cassette.

Turn the "Power" switch OFF, disconnect the line cord and remove the slide tray from the projector. Finally, mark the custom tape cassette and the corresponding slide tray to identify the program.

MICROPROCESSOR ANALYSIS

The microprocessor discussed in the following analysis is found only on the 850 model projectors. This single chip microprocessor is a multi-legged integrated circuit which was invented for the purpose of replacing a large number of digital logic gate arrays with a general purpose device which can be customized by the engineer to perform specific functions. This customizing technique is known as programming.

The single chip microprocessor known as type #3870 has a total of 40 pins. Eight of these pins provide the chip with power (+5VDC), ground, reset signals, oscillator signals, two dedicated inputs and a test pin signal. That leaves 32 pins which can be used as inputs or outputs depending on the programming. Each of these pins can be placed at one of two logic levels ("0" = 0 volts, "1" = +5 volts) in order to control functions in external circuitry connected to the pin. An example of this type of operation would be using the "1" level to turn on the bias oscillator in a tape recorder, and, conversely, using the "0" level to turn off the bias oscillator. The microprocessor in the 850 model projectors has been adapted so that the work of 105 individual integrated circuits can be done by this one chip. The advantages in size, cost and reliability are obvious.

The microprocessor in the 850 models has been given a set of instructions (the program) such that when the microprocessor is in operation it causes the 850 models to behave in an intelligent manner. Due to the fact that all type #3870 series microprocessors are general purpose devices, it is necessary (when power is turned on) to have in its programming a predictable starting point from which the microprocessor's action can commence. This part of the program is known as initialization and essentially sets up operating condition on each of the I/O pins immediately after power is applied. Once the initialization routine has been performed, the central processing unit (abbreviated CPU) within the microprocessor chip looks at the I/O pins to determine the status of certain switches in the external hardware. It is important at this time that the CPU knows that the slide tray is at slide 0; the tape recorder motor is not running; the 80/140 tray switch is in the 80 slide tray position; and that no one is touching the local keyboard on the front panel of the unit. The CPU at this time has only two tasks to perform: (1) make sure the proper slide number is on the display and, (2) periodically look at the keyboard to determine if a key is being depressed by the user. After power up and initialization, the microprocessor waits in this routine which services the display and the keyboard until one of the above mentioned external actions occurs. At the occurrence of an action, certain pins on the microprocessor are reconfigured to different logic states to suit the situation and cause responses appropriate to the input. Once a change in status on one of the input lines has been detected, the CPU determines which line changed and in turn goes to the appropriate place in the memory (program) to begin executing that part of the program which properly services the changed pin. An example of this would be a change caused by pressing the "Play" button on the tape recorder. The microprocessor senses the change (the tape motor starting) and automatically stops servicing inputs from the keyboard, expecting all inputs to come from the tape recorder burst channel.

The program contains a set of instructions for the CPU which cover each of the desired functions of the microprocessor. If we wish to decode bursts off tape, we have a routine (part of a program) which enables the CPU to do this. By putting all the routines together (linking) we eventually have a complete set of instructions for the CPU to hanhdle all functions of the equipment. This particular type #3870 microprocessor has a total of 2047 instructions in it's program. It should be born in mind that not all of these instructions are executed at any one time. The CPU is directed by the activity on the I/O pins and chooses the proper part of the program to execute. An example of this might be at the instant power

is turned on. The CPU is forced to start executing the instructions starting at memory space 0. As mentioned previously, the routine resident in the memory starting at this address is called initialization. The CPU will execute the instructions at address 0, 1, 2, 3, 4, 5, etc., until it has completed the initialization routine. An instruction at the end of the initialization routine then directs the CPU to the next routine (tray rotation and keyboard servicing). The CPU executes this routine and, if not told to execute another routine, waits at the end of the keyboard routine for a change of status at an I/O pin which directs it to another part of it's program.

Due to the fact that the CPU must execute instructions one at a time and in sequence, it must be told how much time it has to execute each instruction. This situation is analogous to our supervisors telling us we must have a certain piece of our daily work finished in some allotted time. We watch the clock on the wall to determine when this work must be done. The CPU also depends upon a clock to set it's pace. The 850 model projectors have a quartz crystal clock which divides one second into four million individual segments. This crystal is connected directly to the type #3870 microprocessor solely for its' use. This super accurate 4 megahertz frequency is divided by a factor of 2 (now 2mHz) for use as the CPU clock. During the execution of a program, the CPU is typically given one clock cycle (0.5 microseconds) to find the location of the next instruction, one clock cycle to fetch the instructions from the memory, and two to three clock cycles to carry out the instruction. The total time to fetch and execute an instruction is usually 2.5 microseconds. Therefore, it is possible for the CPU to execute up to 400,000 instructions each second. If we are executing a routine which is 200 instructions in length, we can calculate that the CPU can execute that routine in approximately 500 microseconds (1/2000th of a second).

Because the microprocessor executes its routine so rapidly, it should be obvious that events external to the microprocessor cannot exist for a very long time without being acted upon or corrected by the microprocessor. Given a microprocessor with appropriate programming to handle all expected situations, we have an extremely intelligent device (at least as intelligent as its programmer) which can cope very rapidly with any situation be it normal, abnormal, or emergency.

Aside from the fact that the CPU can set levels at its 32 I/O pins, it is also capable of making logical decisions, doing arithmetic, and determining proper sequences of operation all under program control. Arithmetic operations come into use when it is desired to move from slide number 6 to slide number 39. Some rapid calculation involving the number of slide septums between the starting point and ending point must be made so that the CPU knows how far to allow the tray to turn. A logical decision comes in play when the CPU has to decide which direction, forward or reverse, to use in order to take the shortest route to the desired slide. Logical sequencing is used when we update the slide number on the display after a forward one slide command or a reverse one slide command.

As mentioned above, it would require approximately 105 logic integrated circuits to duplicate the function of this one type #3870 microprocessor. While it is true that the equivalent hardware circuitry of all of these integrated circuits is incorporated within the microprocessor chip, in the programming of the 850 model projectors microprocessor, we have taken the complexity into account and provided the microprocessor/CPU with a means of testing itself and allowing the service technician to use simple tools to determine functionality of the microprocessor I/O pins and external components. This will be evident in the service manual supplement which will be for use with the 850 model projectors.

DISASSEMBLY PROCEDURES

18. GENERAL.

These Bell & Howell Company sound/slide projectors have been designed for module replacement servicing and require only the tools normally found in most repair shops. Module differences for the models covered in this manual are listed in the Parts Catalog "Introduction" section.

The disassembly procedures described in this section for dismantling the projector into major components will permit ready access to all functional subassemblies. Individual component servicing is covered in the "Repair and Adjustment" section and the "Reassembly Procedures" section covers replacement of the major components back into the projector.

19. GENERAL DISASSEMBLY INSTRUCTIONS.

Always disconnect the line cord before attempting to service the unit. Avoid fingerprints on the screen, lenses or mirrors. Fingerprints should be wiped off immediately using an appropriate cleaner and cloth. If these parts are to be removed, wrap them in protective paper or cloth.

When screws, nuts, etc., are removed, reassemble them loosely into their original holes or otherwise keep track of them to prevent loss or mix-up.

Never remove nameplates or labels unless they are damaged or defaced. When replacing these items, they may be pried up with a decal removal tool (see Figure D) or a knife blade and peeled off and, if necessary, use isopropyl alcohol on a cotton swab to loosen the adhesive. After removal, clean the entire label area using a lint-free cloth moistened with solvent being careful not to apply (or drop) solvent on plastic parts.

Serial number plates and U.L. labels cannot be supplied on a replacement basis unless the defective serial plate is returned with the request order.

If replacement of electrical components is required, refer to the appropriate wiring diagrams in the Parts Catalog manual to aid in identifying the proper disconnects. Whenever possible, disconnect wires at the faulty part to avoid disturbing the wiring harness.

When removing riveted parts for replacement, drill out the old rivets with a drill size equal to or slightly smaller than the rivet diameter.

Before beginning the following disassembly procedures, study the projector exploded view illustrations (Figures 1 and 2 in the Parts Catalog manual).

20. PROJECTION LAMP REPLACEMENT.

CAUTION! Avoid burns. Do not touch the lamp while it is hot. Wait until it cools. Then unplug the projector and loosen the screw holding the lamp access door. Remove the door and unlatch the lamp keeper spring. Gently pull out lamp and socket unit. Remove the lamp by gently wiggling it free from its white socket.

NOTE: For replacement, use an ANSI code DDM 19 volt, 80 watt lamp only.

Fit the replacement lamp (B&H P/N 708065) into the socket. Insert lamp and socket unit into its receptacle and replace lamp keeper spring. Replace door and tighten the screw.

21. TOP DECK ASSEMBLY REMOVAL (See Figure Q).

The top deck assembly is easier to work on if it is entirely removed from the projector. It will be necessary to disassemble the handle screws to remove the handle and insert assembly before the top deck assembly can be removed. Then disassemble the four top deck fastening screws and, referring to the appropriate wiring diagram as a guide, disconnect all interconnecting wiring. (Placing various colored tape on wire connectors and plugs as locators will be of aid during reassembly.)

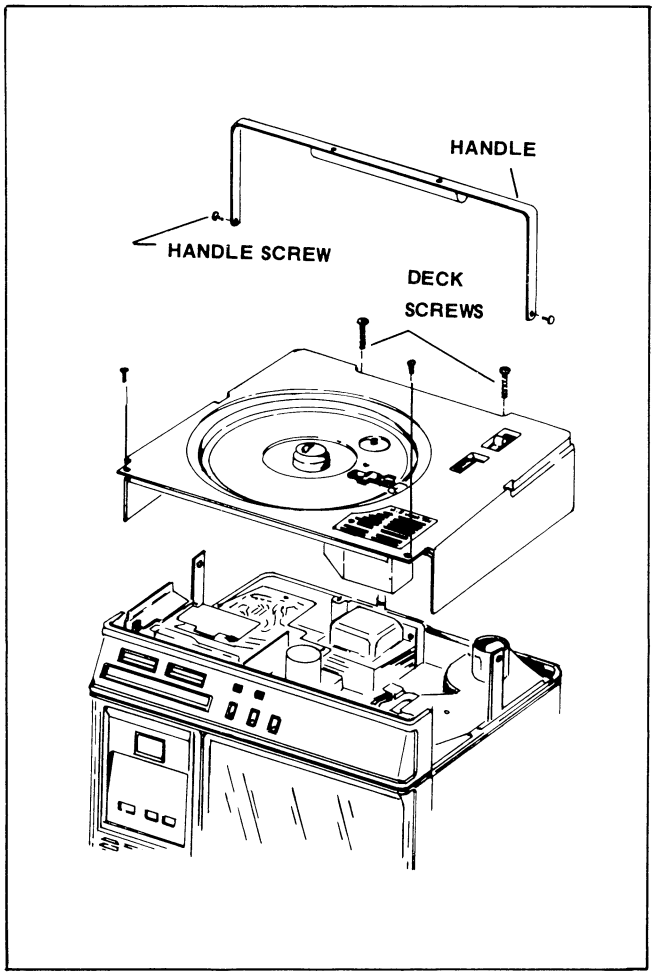


Figure Q. Top Deck Assembly Removal

22. BEZEL AND SCREEN REMOVAL (See Figure R).

Using a padded pliers, pull off the volume and tone control knobs. Disassemble the four screws holding the bezel assembly in place and carefully slide the bezel assembly from the unit. Disconnect the speaker cable from the speaker. Caution: On the microprocessor 850 models the grounding and connecting tails from the keyboard will disconnect from the option board, note this for reassembly.

Now remove the exposed bat switch discs from all switch handles and put them in an envelope or other safe place to prevent loss or misplacement

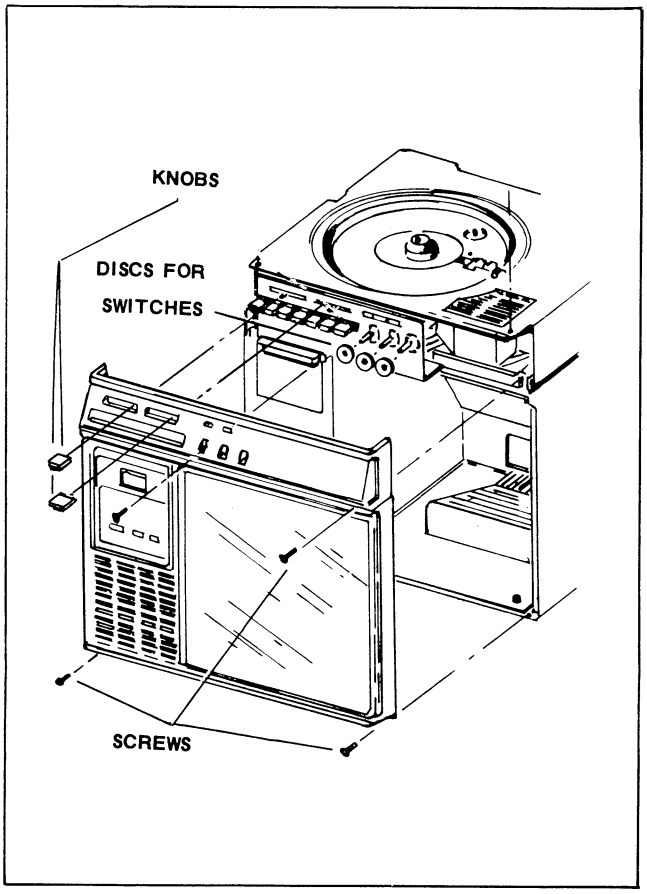


Figure R. Bezel and Screen Removal

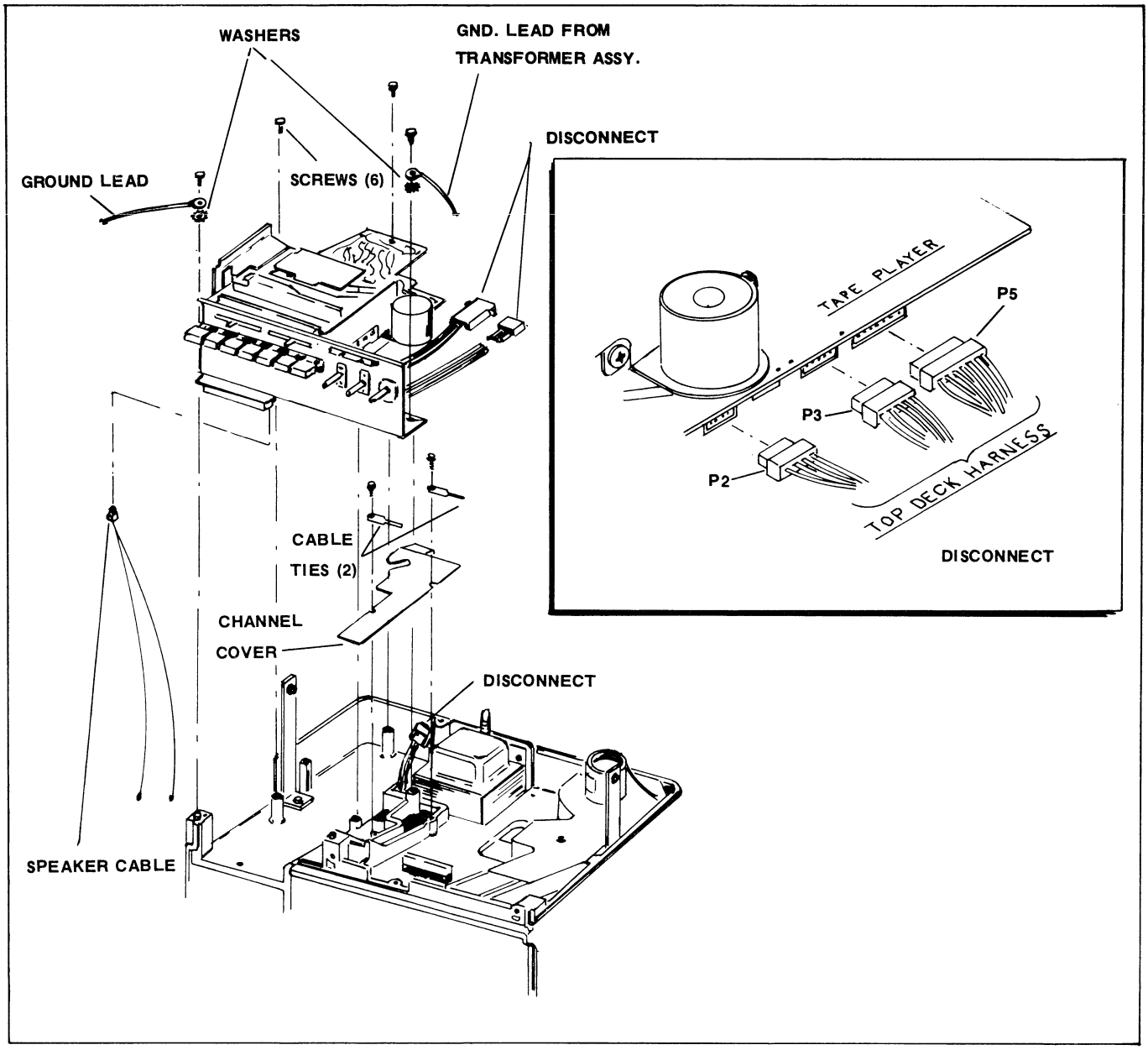


Figure S. Tape Deck Removal

23. TAPE DECK REMOVAL
(See Figure S).

First remove the two tape deck screws and washers securing the transformer and electrostatic ground leads. Then remove the four remaining tape deck fastening screws, the harness connectors and channel cover from the tape deck.

CAUTION

In order to remove the harness connectors P2, P3 and P5 from the tape deck it will be necessary to remove ALL SIX tape deck fastening screws.

Using extra care, pull the tape deck straight up to disengage it from the option board. Finally, unplug the speaker cable from the tape deck.

24. TRANSFORMER ASSEMBLY REMOVAL (See Figure T).

First disconnect the transformer leads from the power supply board and from the power switch in the channel of the lower housing as shown in Figure S. Once these disconnects are made, remove the five holding screws and lift the transformer and wiring plate assembly out of the lower housing. (One screw also fastens the tray storage door top hinge plate, note for reassembly.)

NOTE: All transformers for use on the "A" and "AN" models have attached line cords; export "AX" model transformers are wired to a voltage selector and do not have attached line cords.

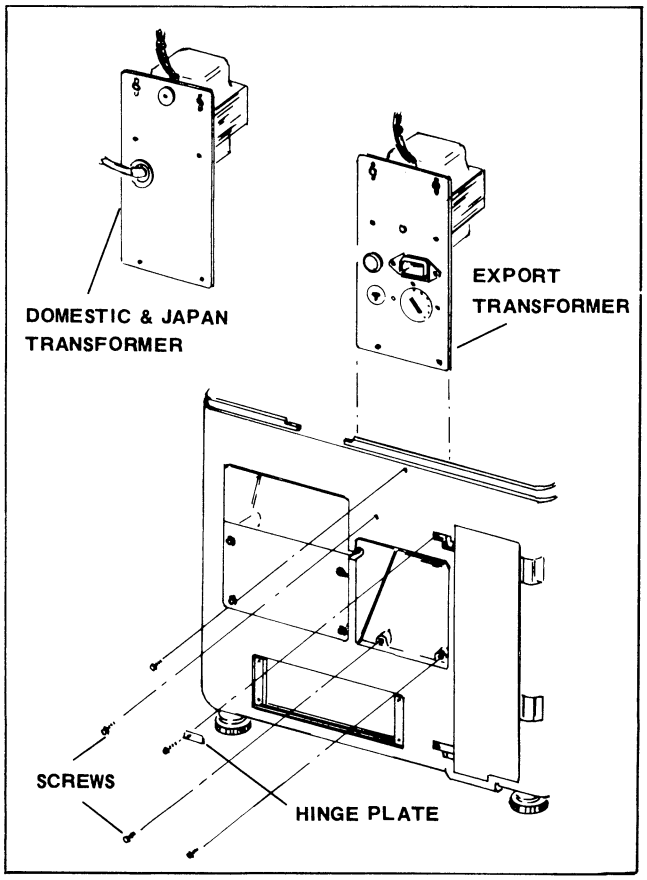


Figure T. Transformer Assembly Removal

25. OPTION BOARD REMOVAL (830, 840, 850 MODELS ONLY (See Figure U).

It is not necessary to remove the tape deck to disassemble the option board, but the bezel must be removed (see paragraph 22).

850 Models Only. Disconnect the microprocessor plug from the option board and the 3-pin connector from the infrared receiver printed circuit board (the 3-pin connector is located at the upper right corner of the receiver board, see inset, Figure U).

Disassemble the two screws at the bottom of the option board that go through the board and into spacers fastening the option board and shield to the lower housing. Once the screws and spacers are out of the way, gently pull down on the option board to free it from the socket in the tape deck. The speaker cable is wound around the left-hand spacer; note this for reassembly.

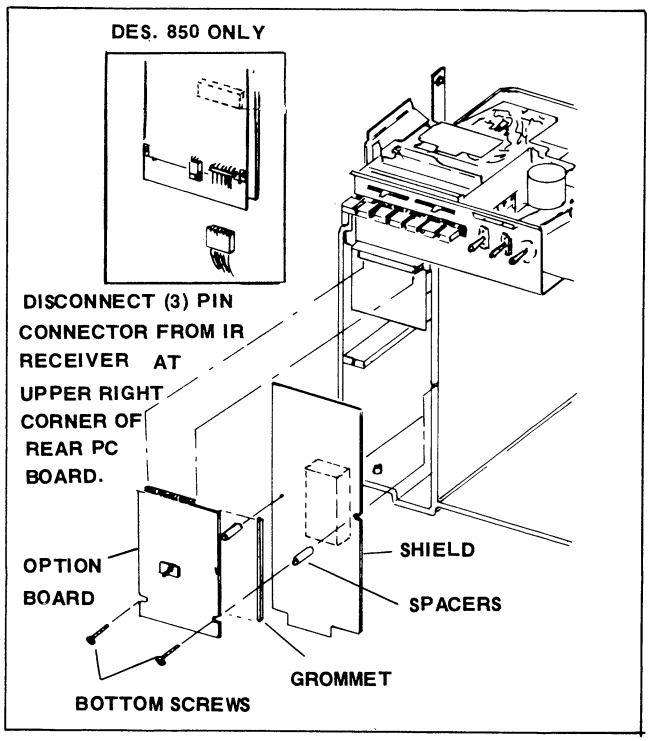


Figure U. Option Board Removal

26. LAMP BRACKET AND MIRROR ASSEMBLY REMOVAL (See Figure V).

There are four screws holding the lamp bracket and mirror assembly to the top deck. First disconnect the lamp socket from the projection lamp, then remove the four holding screws and the entire assembly is easily removed. (The projection lamp P/N 708065 is not a part of this assembly.)

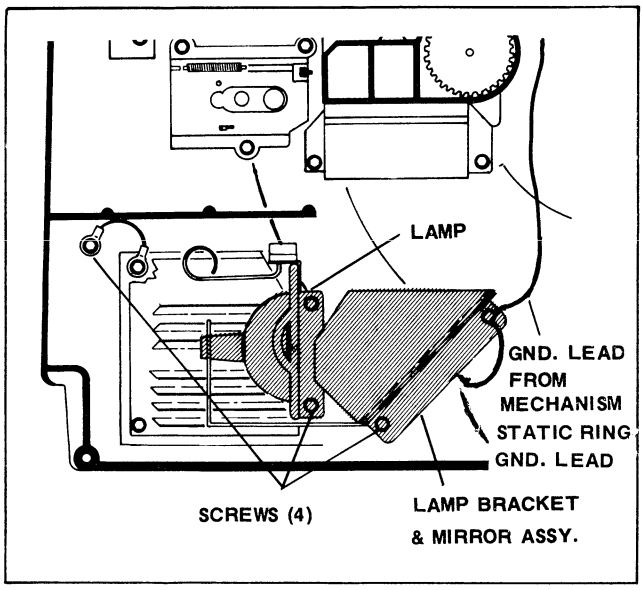
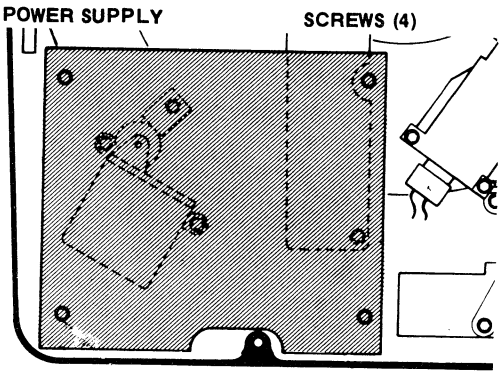


Figure V. Lamp Bracket and Mirror Assembly Removal

27. POWER SUPPLY ASSEMBLY REMOVAL (See Figure W).

Study the appropriate interconnect wiring diagram in the Parts Catalog manual before proceeding with the disassembly of power supply assembly. Then, making a note of where they connect, remove all connectors from their respective plugs on the power supply. Finally, remove the four holding screws and lift off the complete power supply.



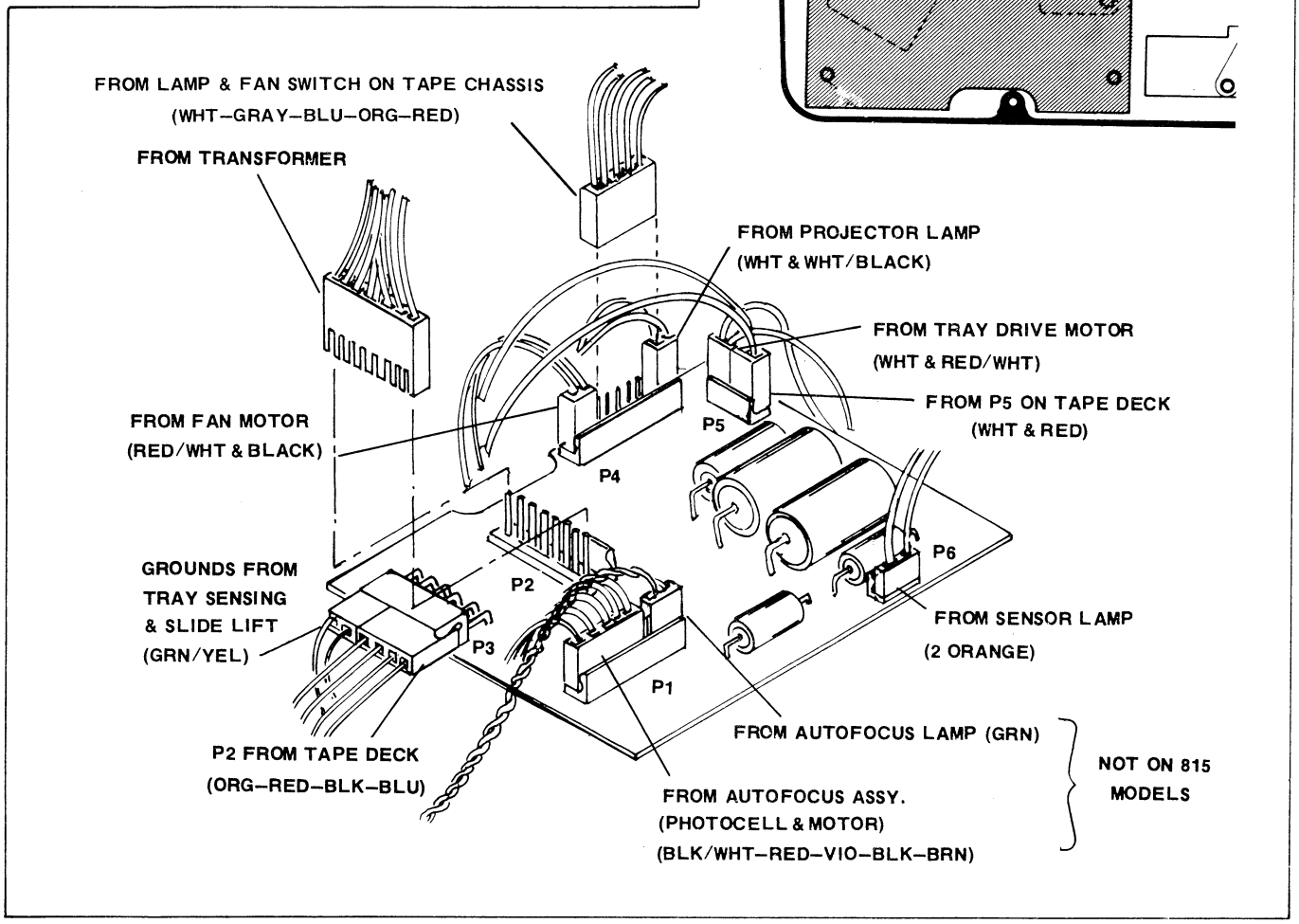


Figure W. Power Supply Assembly Removal

28. RING DRIVE MOTOR AND BRACKET ASSEMBLY REMOVAL (See Figure X).

To gain access to the ring drive motor and bracket assembly it will be necessary to remove the power supply as described in paragraph 27 above.

Remove the two screws fastening the ring drive motor and bracket assembly to the top deck. (See Figure X). Carefully disengage the ring drive motor gears and lift the entire assembly out of the top deck.

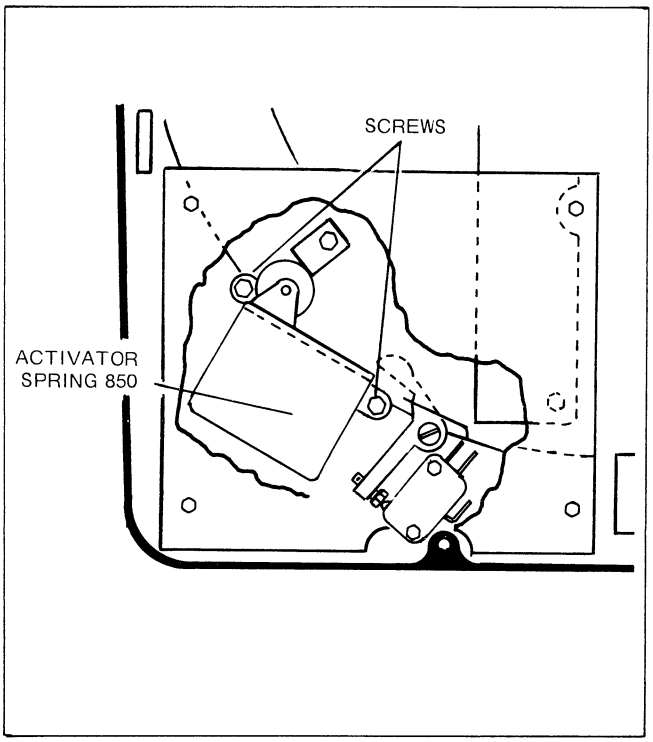


Figure X. Ring Drive Motor and Bracket Assembly Removal

29. LITE PIPE AND PHOTOCELL ASSEMBLY REMOVAL (See Figure Y).

NOTE: Because the lite pipe and photocell straddle the indexing ring on the ring drive assembly, care must be exercised in the removal and reassembly of the lite pipe and photocell assembly.

Disconnect the connector from the wiring harness plate and remove the connector's ground wire screws attached to the auto-focus bracket and harness plate.

Remove the three holding screws and gently raise the shifter to disengage. Then slide the lite pipe and photocell assembly away from the ring drive until it clears the ring and lift the entire assembly from the top deck.

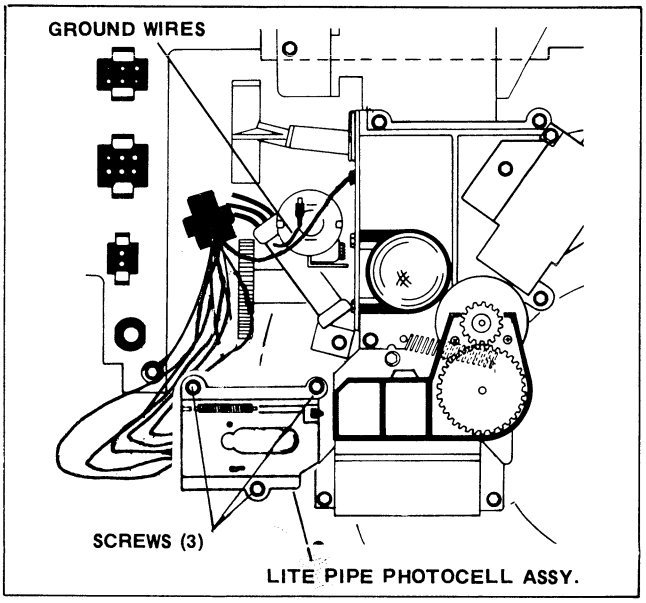


Figure Y. Lite Pipe and Photocell Assembly Removal

30. SLIDE LIFT MECHANISM ASSEMBLY REMOVAL (See Figure Z).

Before attempting removal of the slide lift mechanism, scribe lines into the top deck where the base of the slide lift mechanism is attached (this will be of assistance in alignment of the replacement assembly).

Disconnect the connector from its socket in the wiring harness plate and the ground lead wire from the lamp and mirror bracket assembly.

With a long-nose pliers disconnect the retractor spring from the boss on the base of the focus assembly as shown in Figure Z. Leave the other end of the spring attached to the retractor on the slide drop mechanism.

Disassemble the three holding screws and lift the assembly free of the top deck. Note the alignment notch and button between the focus mechanism and slide mechanism for reassembly.

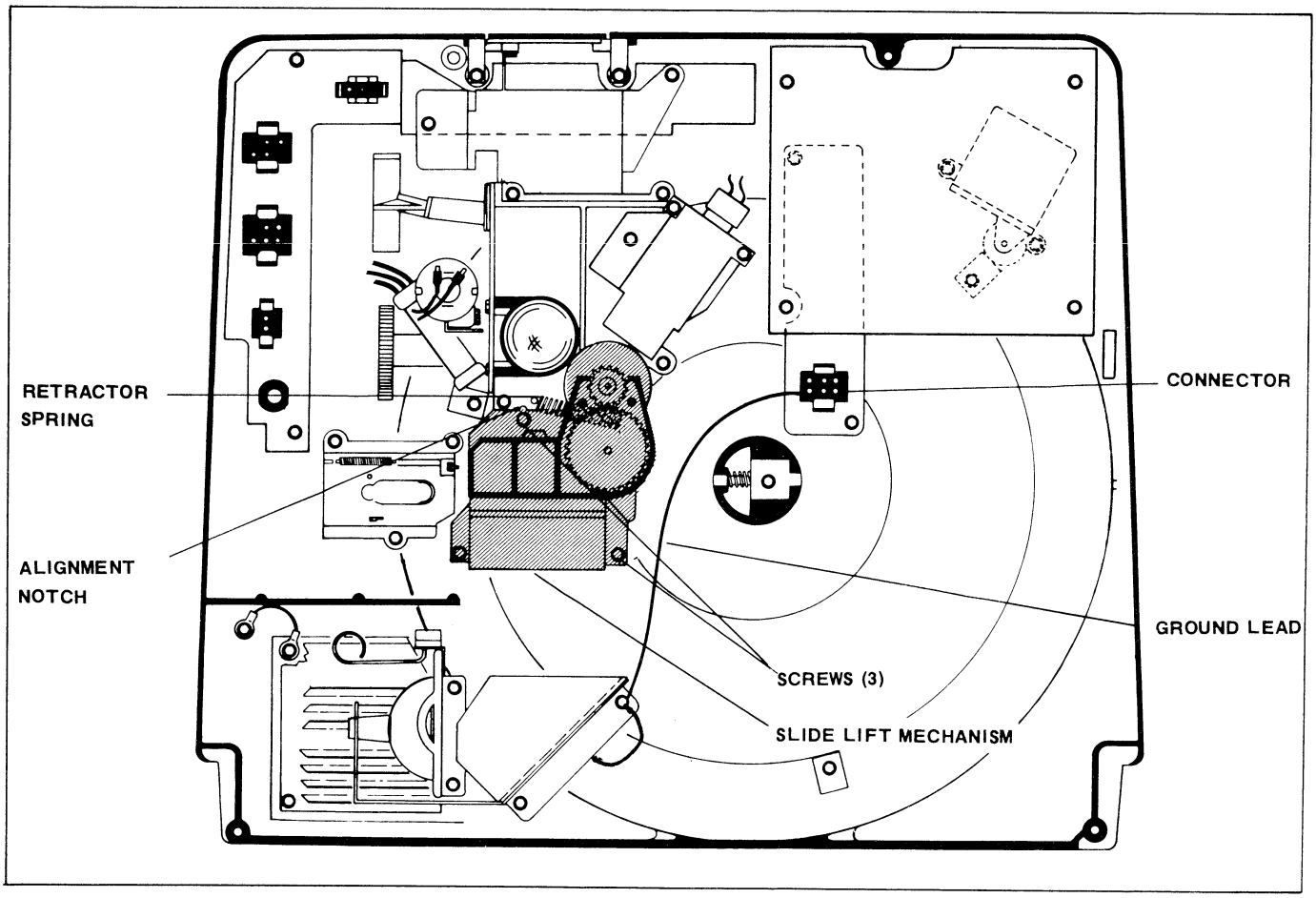


Figure Z. Slide Lift Mechanism Assembly Removal

31. FOCUS MECHANISM ASSEMBLY REMOVAL (See Figure AA).

Disconnect the motor and photocell lead connector from the socket in the wiring harness plate and the autofocus lamp connector from the socket on the power supply. (Note: The 815A models do not have an autofocus mechanism.)

Before attempting removal of the focus mechanism assembly, scribe lines into the top deck on all available sides of the focus mechanism base.

Disconnect the retractor spring from the boss on the mechanism assembly. Pull down the front throw door and disconnect the link and pin assembly by removing the two screws and the front throw door strap. Then remove the four holding screws and gently lift the entire focus mechanism assembly from the top deck guiding the link and pin assembly out carefully.

32. WIRING HARNESS REMOVAL (See Figure AB).

To remove the wiring harness, refer to Figure AB, View A and disassemble the fastening screws and remove the shroud and cable shield. Then disconnect all components fastened to the wiring harness connectors. Finally, remove the screws fastening the harness plate to the top deck as shown in View B and carefully dismount the wiring harness from the projector.

To replace a shorted or broken lead; either remove the damaged portion and carefully splice the lead or remove the entire lead and replace it with a lead of comparable color and length.

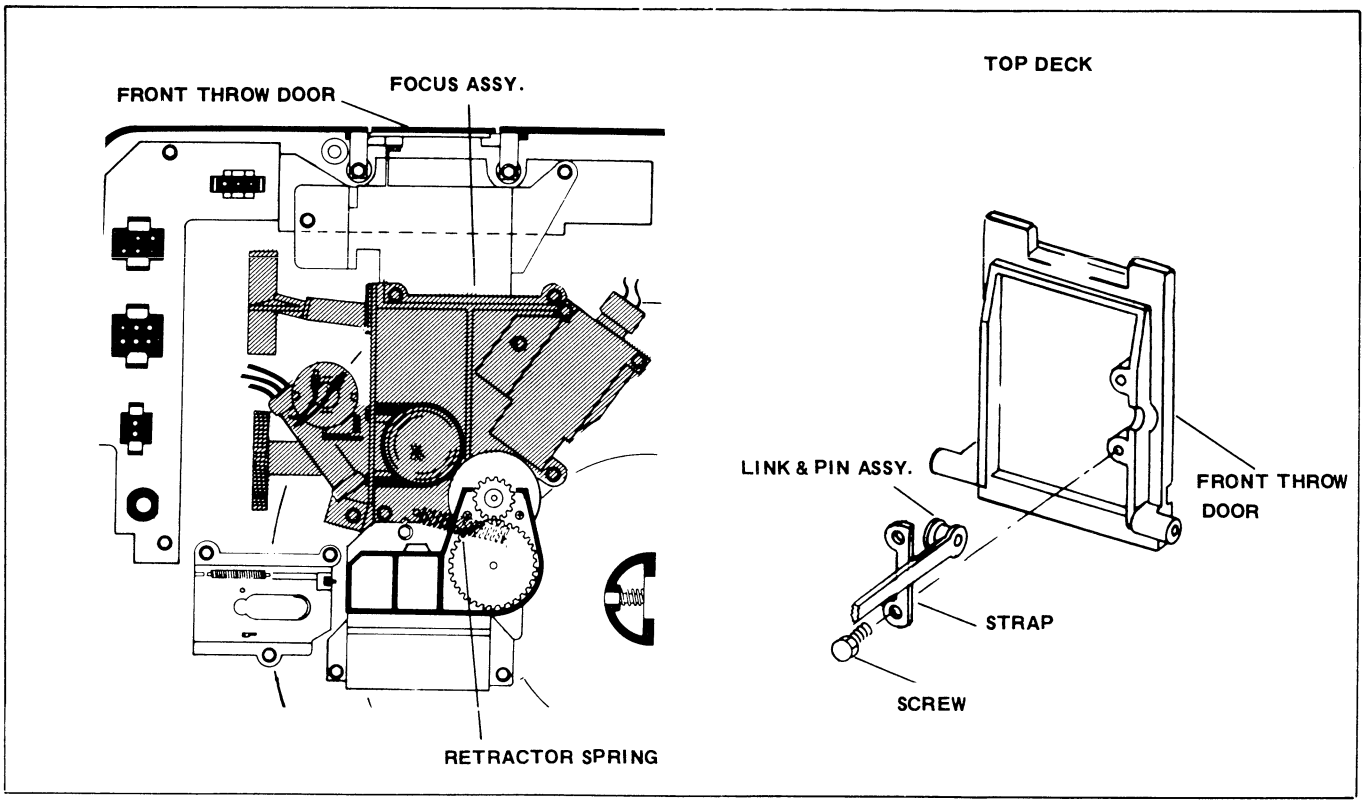


Figure AA. Focus Mechanism Assembly Removal

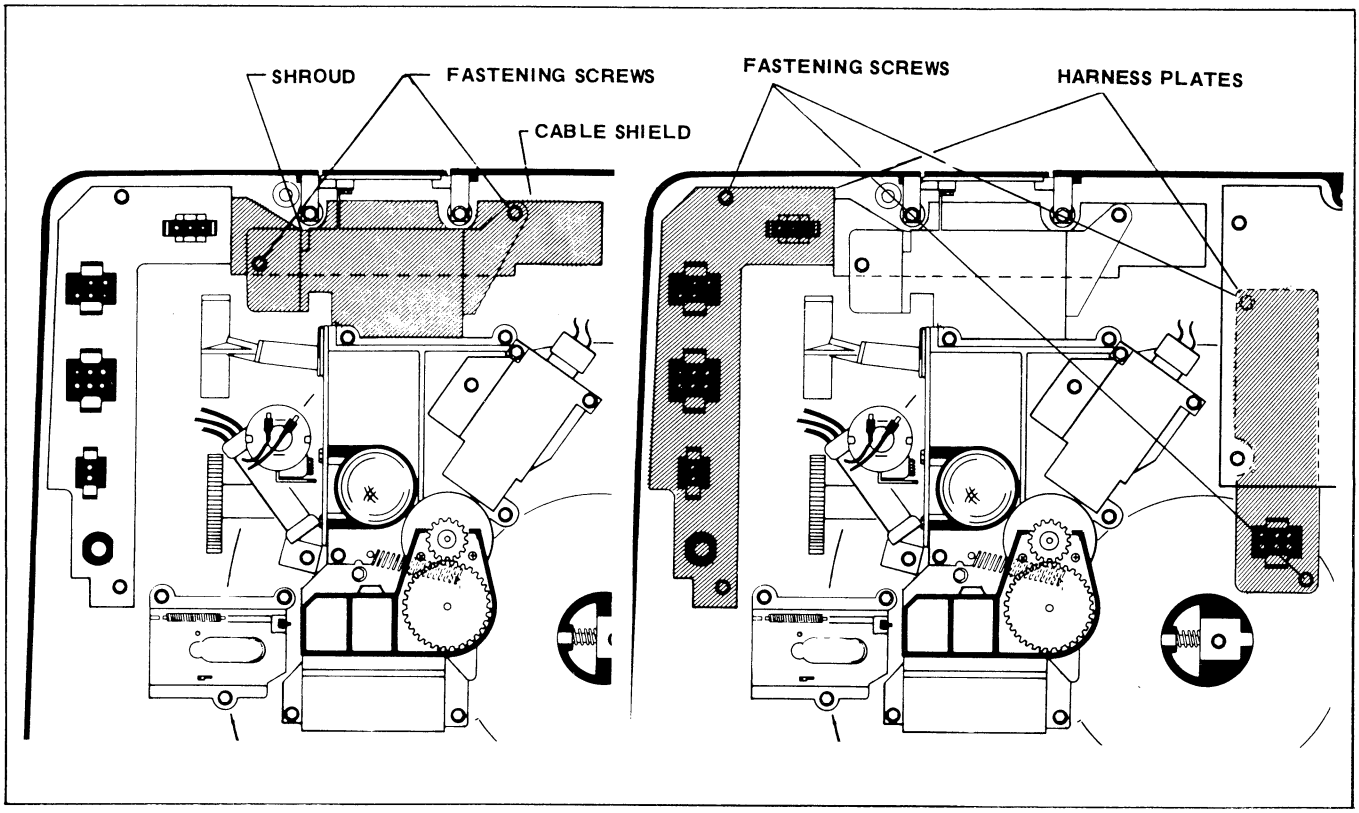


Figure AB. Wiring Harness Removal

REPAIR AND ADJUSTMENTS

33. GENERAL.

Because these projectors have been designed for module replacement servicing, this section will cover repair and adjustment procedures for individual components of the slide lift mechanism, ring drive and autofocus assemblies only. All other required adjustments will be noted and covered in the "Trouble Shooting" section. In addition, after the repair and/or maintenance procedures have been completed, all tests described in the "Final Tests and Adjustments" section should be performed to assure proper operation of the projector.

34. REPLACING THE SLIDE LIFT MECHANISM LEVELING SCREW AND GEAR ASSEMBLY.

When replacing the leveling screw assembly or motor and gear assembly, mesh the leveling screw gear with the elevate motor gear so that the gears rotate freely with minimum blacklash and no binding. Then speck each gear with B&H grease (P/N 713280).

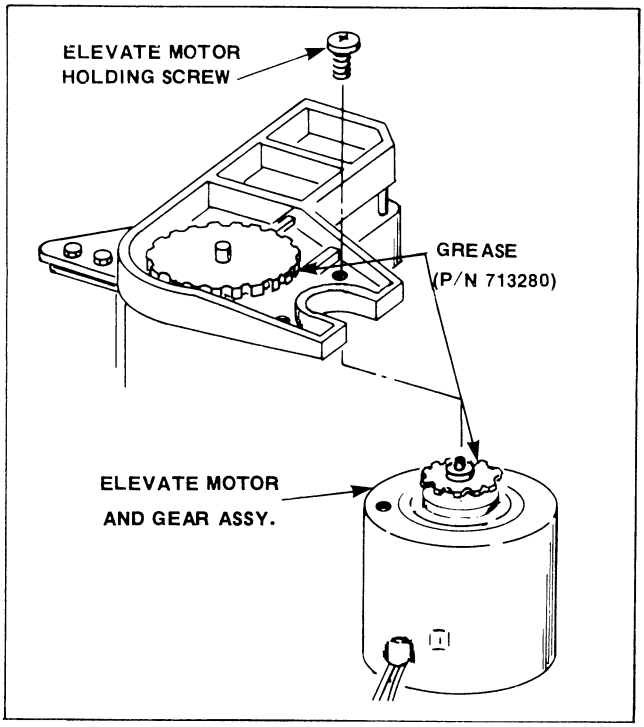


Figure AC. Slide Lift Mechanism Gear Adjustment

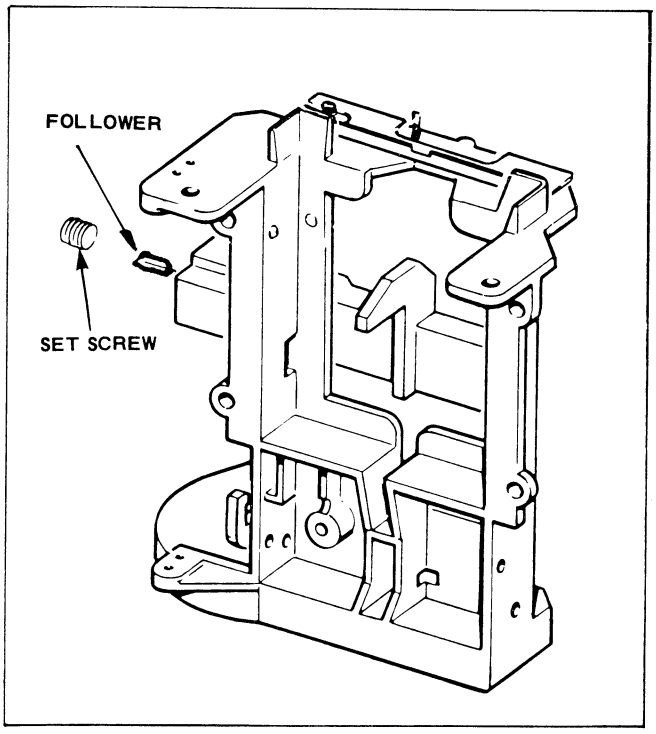


Figure AD. Follower Replacement and Adjustment

NOTE: If necessary, the assembled elevate motor has a small amount of "play" to allow the motor holding screws (see Figure AC) to be loosened and the motor moved slightly to accommodate gear mesh.

To replace the follower, carefully insert the follower into the threaded slide ejector hole taking care not to damage the threads. Using a round pin, gently push the follower all the way into the ejector hole making sure the small diameter enters the groove of the leveling screw.

Insert the setscrew into the follower and using the proper wrench turn the setscrew all the way in; then back-off 3/4 to 1 turn when using follower 713442. Back off 1/4 to 1/2 turn when using follower 712150. (Use light pressure when turning the setscrew into the follower, if too forceful the threads could be stripped.) To maintain this set position, apply Loctite to the head of the setscrew.

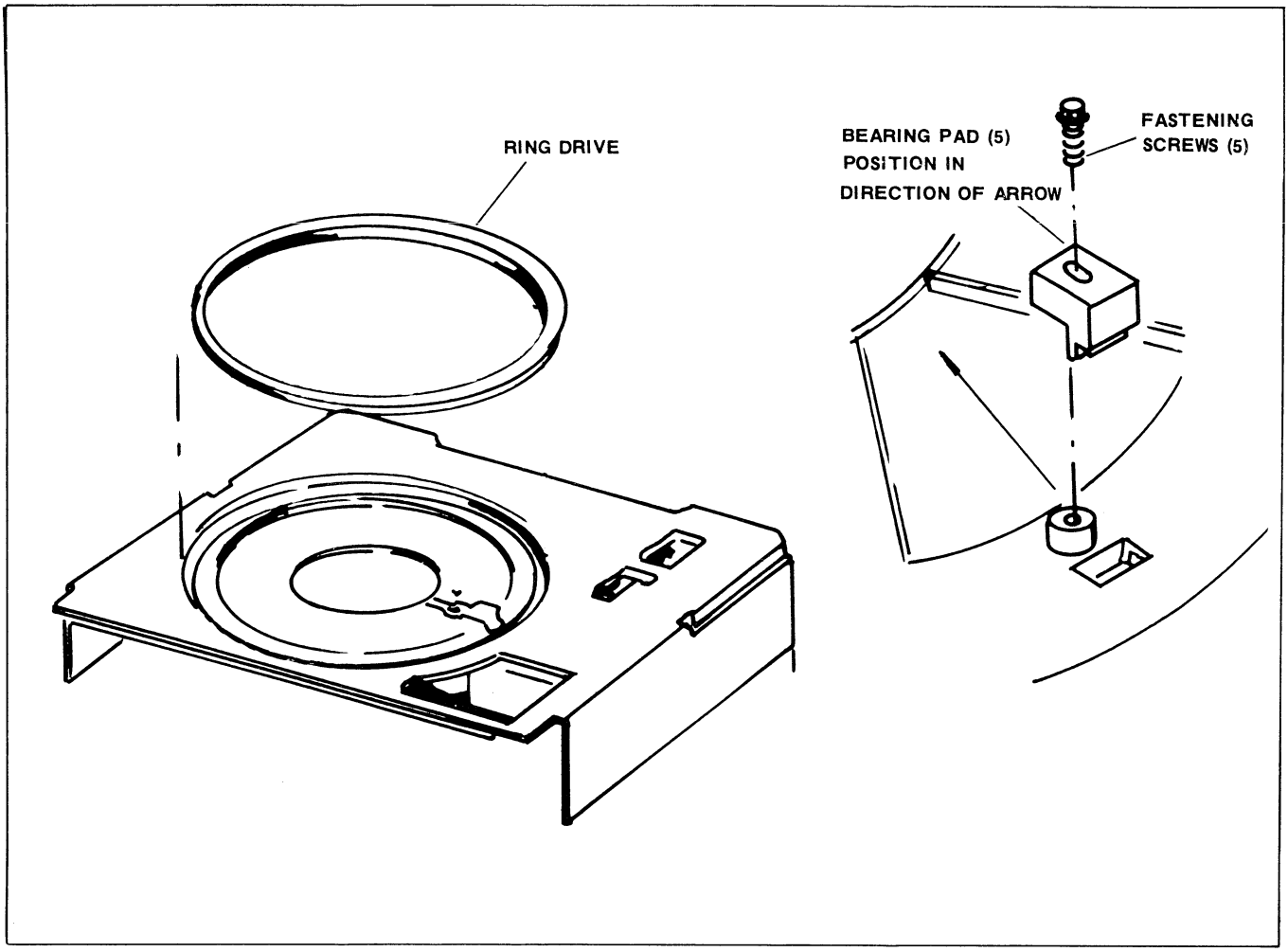


Figure AE. Ring Drive Assembly
Replacement and Adjustment

35. REPLACING AND ADJUSTING THE RING DRIVE ASSEMBLY (See Figure AE).

Set the replacement ring drive assembly into the recessed channel of the top deck taking care not to damage the perforated segments. While holding the ring drive in place, turn and lay the top deck upside down on the work bench. Insert the five ring drive bearing pads (P/N 712174) making sure the pads engage the inside flange of the ring drive.

Using light finger pressure, hold the bearing pad against the top deck and ring drive and assemble a fastening screw (P/N 712171) to each pad tightening the screws finger-tight. After all the pads are assembled, tighten each fastening screw to 6-7 in./lbs. torque making sure that the pads are in contact with the ring drive and that the ring drive is concentric in the recess of the top deck.

To check and adjust the ring drive assembly for proper installation, hook a Chatillon gage (P/N G9865-N7-1) to the ring drive lock and using a steady pull, pull the gage radially. The gage should read 1/8 to 5/8 lb., if not within this range, adjust the bearing pads as necessary.

NOTE: Because the ring drive assembly has been serviced, the ring drive lock must be adjusted for proper slide drop as described in paragraph 39.

36. SLIDE LIFT SWITCH ASSEMBLY ADJUSTMENT.

Adjustment of the slide lift switch assembly requires the projector to be fully assembled (except for the top deck screws and handle) and operational. Flip the top deck open and place it on the support fixture. Then connect the line cord, set the voltage selector (AX models) in the proper position and turn the "Power" switch ON. To adjust the elevate switches proceed as follows:

(1) Loosen both screws on the upper and lower elevate switch adjusting plates. Then position the switch bracket so that the square hole is centered in the triangular slot of each adjusting plate (see Figure AF, View A) and secure the switch bracket in this position by tightening the four loosened adjusting plate screws.

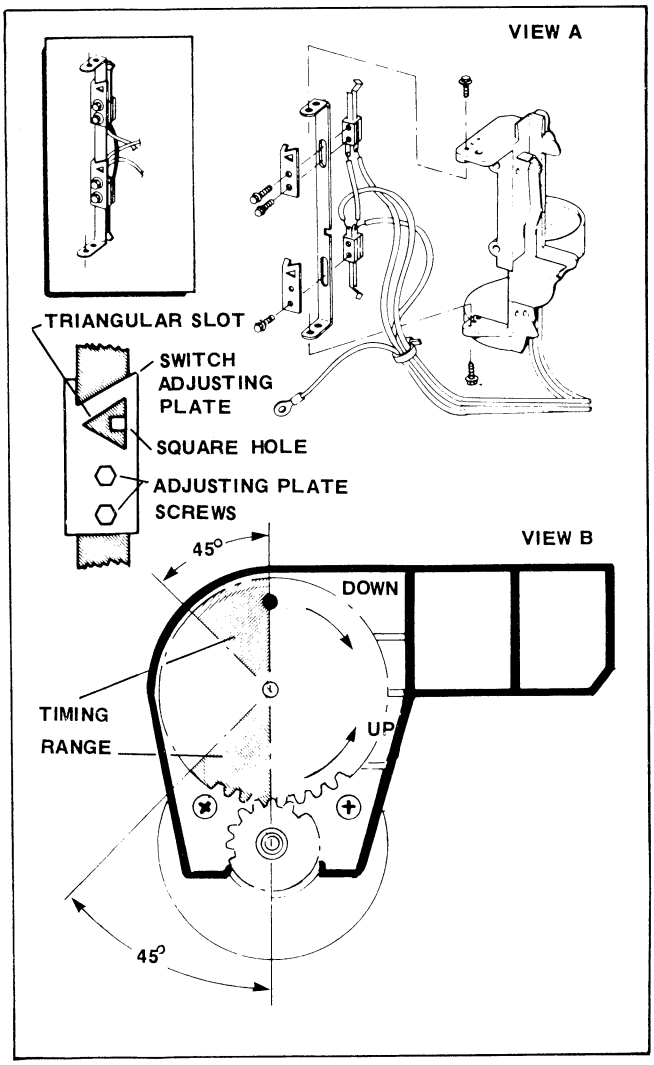


Figure AF. Slide Lift Switch Adjustment

(2) To check the setting of the lower elevate switch, press the "Slide Tray" switch momentarily so the slide mechanism comples one cycle. The follower must be positioned in the dwell of the leveling screw but must not bottom in the dwell. When the slide mechanism stops, note the location of the large gear timing hole. If the timing hole is within the 45° range (upper shaded area, View B) the lower elevate switch is properly set. If the timing hole is not in the upper timing range, continue the adjustment procedure as described in step (3) below.

(3) If the timing hole stopped to the right of the timing range, loosen the lower adjusting plate screws and move the adjusting plate down; if to the left, move the plate up and retighten the lower plate screws. Repeat the procedures in steps (2) and (3) as necessary to obtain the proper switch setting.

(4) To check the setting of the upper elevate switch, press and hold the "Slide Tray" switch while noting the location of the timing hole in the lower 45° timing range (lower shaded area, View B). If the timing hole is to the right of the lower timing range, loosen the upper adjusting plate screws and move the adjusting plate down; if to the left, move the plate up and retighten the upper plate screws. Repeat this procedure as necessary to obtain proper switch setting.

37. AUTOFOCUS LAMP ASSEMBLY REPLACEMENT AND ADJUSTMENT (All Except 815A Model).

The autofocus lamp assembly consists of the lamp, protective back cover and twin leadwires. Because the leads are soldered to the base of the lamp, the entire autofocus lamp assembly must be replaced (see Figure AG).

To remove a defective autofocus lamp assembly, first disassemble the single lamp shield screw and remove the shield. Next, unplug the autofocus lamp connector from P1 on the power supply board and disconnect the twin lamp leads from the connector housing.

Then, to open the clamp and release the lamp, disassemble the single hi-riser clamp screw and remove the defective lamp.

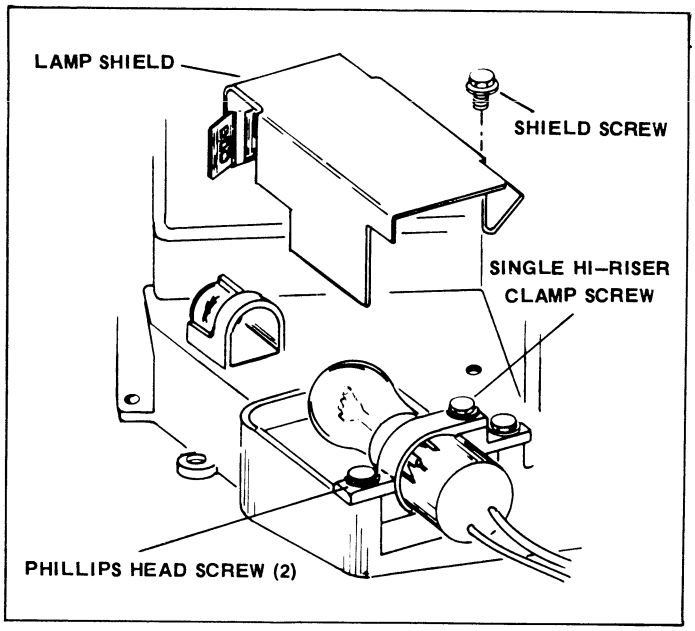


Figure AG. Auto Focus Lamp Assembly Replacement

Before installing a replacement autofocus lamp, check the filament for relative straightness as shown in Figure AH. Then install the lamp (reverse the disassembly procedure given above) but do not replace the lamp shield at this time.

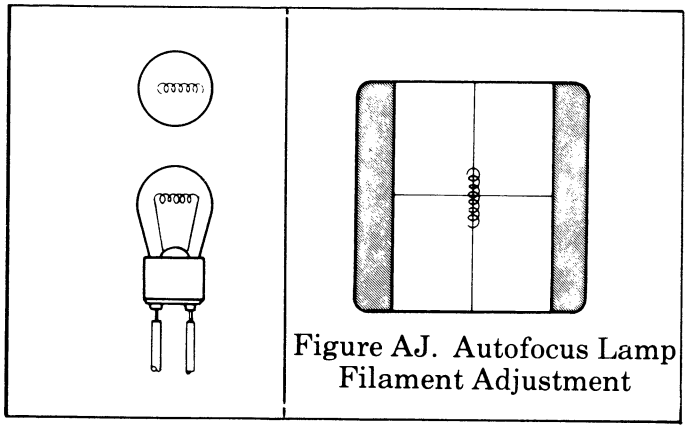


Figure AJ. Autofocus Lamp Filament Adjustment

Figure AH. Autofocus Lamp Filament

If no additional repair procedures are required, reassemble the projector so that it is operative but leave the top deck up in the support fixture. Then perform the following required autofocus lamp adjustments.

(1) Turn the "Power" switch ON and close the front/rear projection door. Insert the lamp filament focusing/centering slide (P/N S-079036-5 N1) and look through the lens. The lamp filament should look clear on the focus/centering slide (see Figure AJ). At this time the filament may be located on either side of the vertical line, but must be in focus and parallel to the line.

(2) To bring the filament into focus and position, loosen the hex washer head clamp screw and move the autofocus lamp back and forth until the filament is clearly focused and centered as close as possible on the vertical line of the focus/centering slide, then tighten the loosened hex washer head clamp screw.

(3) To align the autofocus lamp with the phototransistor, loosen the two phillips head clamp screws just enough to allow the autofocus lamp to be moved horizontally. With the focus/centering slide in the aperture, move the autofocus lamp from slide-to-side to align the notch on the phototransistor housing with the score mark on the focus bracket (see Figure AK). When the marks are in perfect alignment, tigthen both phillips head clamp screws.

To complete the autofocus lamp reassembly procedure, place the lamp shield over the autofocus lamp assembly and secure the shield to the top deck with the single shield screw.

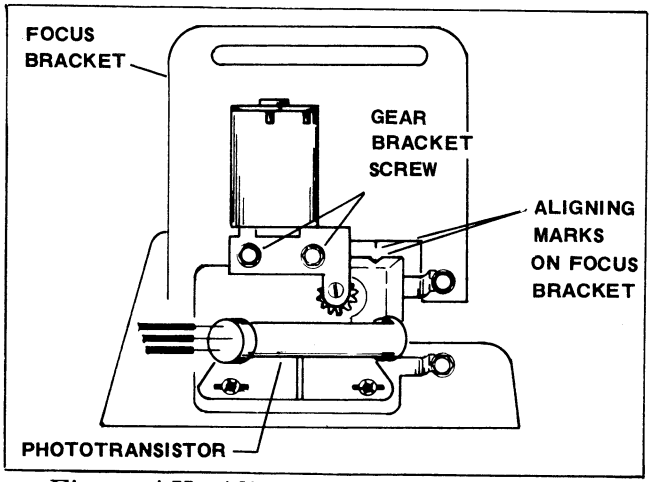


Figure AK. Alignment of Bracket Marks for Focus

38. PROJECTION LENS ADJUSTMENT (See Figure AL).

The projection lens assembly is factory preadjusted and aligned and unless the optics assembly was serviced or the projection lens replaced, the lens should not require adjustment. If adjustment is necessary however, proceed with care and caution as follows.

Insert a slide mount and check for focus uniformity on the built-in screen. Slightly loosen the lens carrier screw so the lens can be moved under some pressure. Using a tissue or treated soft cloth to prevent lens damage, move the lens so the image on the built-in screen is properly focused. When the image is in sharp focus, the focus knob should be in the middle of its travel.

Open the front/rear projection door to check front throw focus. Should the image be poorly focused, a sharp image may be obtained by using the focus knob.

NOTE: Whenever the lens position is changed, horizontal and vertical framing must be checked and readjusted if necessary. To perform the vertical and horizontal framing adjustments refer to the "Final Tests and Adjustments" section for instructions.

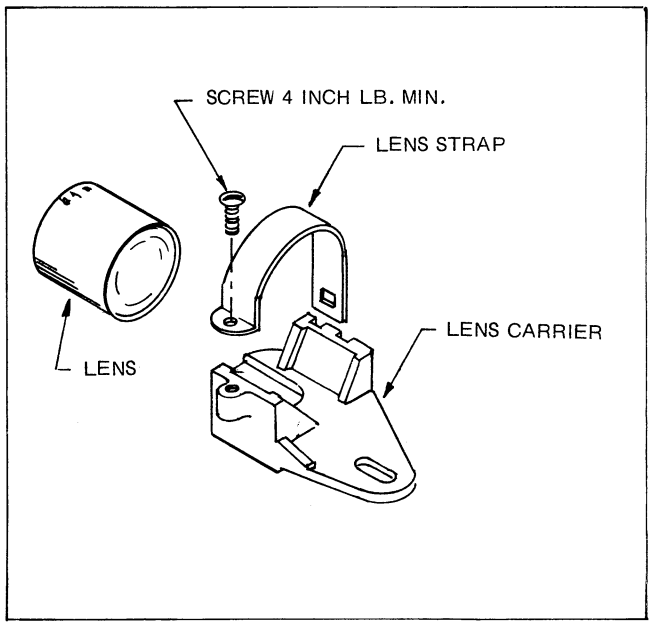


Figure AL. Projection Lens Adjustment

39. AUTOFOCUS MOTOR REPLACEMENT (All Except 815A Model).

To remove the autofocus motor and gear bracket assembly, disconnect the motor lugs at the motor and disassemble the two hex head washer screws from the focus bracket. The autofocus motor and gear train may be separated from the motor bracket by removing the two screws in the motor output side as shown in Figure AM.

To reassemble the autofocus motor, reverse the disassembly procedure described above making sure the gears are in proper mesh.

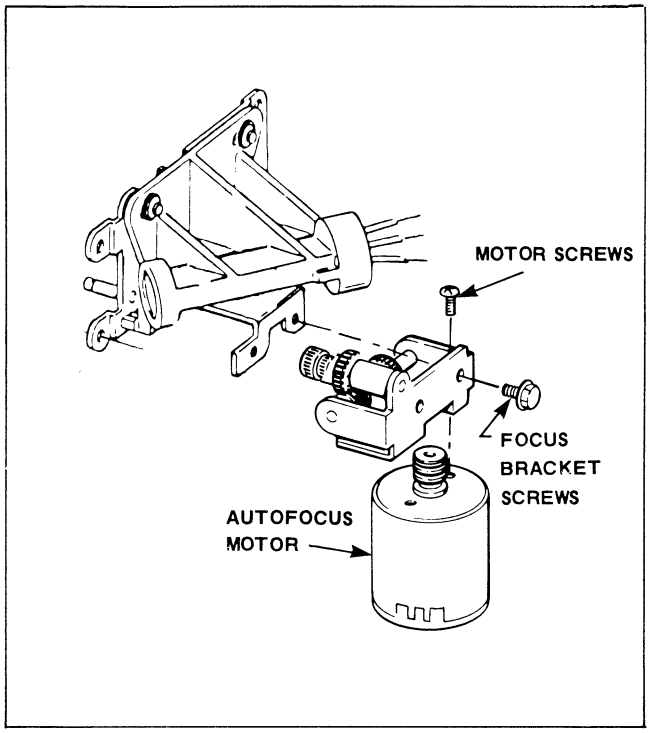


Figure AM. Autofocus Motor Replacement

40. RING DRIVE LOCK ADJUSTMENT.

Whenever the ring drive or lock have been serviced, it will be necessary to adjust the ring drive lock using the trial and error method described in the following paragraphs. Before this adjustment can be made however, the projector must be completely reassembled and operational.

To adjust the ring drive lock for proper slide drop, proceed as follows:

(1) Turn the projector "Power" switch ON and if not servicing a microprocessor model projector, align the slide tray carrier arrow with the projector case arrow. Using the decal removal tool (see Figure D) carefully remove the drive lock arrow nameplate and loosen the two screws shown in Figure AN.

(2) Move the ring drive lock so that the loosened screws are centered within their slots and lightly (without using pressure) tighten both screws.

(3) Seat a fully loaded 140- slide tray onto the tray carrier, close the front/rear projection door and set the projection "Lamp" switch to LO. Then cycle the slides and check to see if all slides are dropping into their proper positions.

(4) If the slides did not drop properly, adjust the ring drive lock by loosening the lock screws and moving the screws so that the screws are slightly off center in their slots (usually toward the screen) and lightly retighten the screws. Repeat the cycling procedure to check the adjustment and readjust if necessary.

(5) When the slides drop properly from the 140-slide tray, check slide drop using a fully laoded 80-slide tray (preferably loaded with glass mounted thick slides). Repeat the cycling and adjusting procedures described above and when the slides drop properly using either slide tray, tighten both screws and re-cement the arrow nameplate to the ring drive lock.

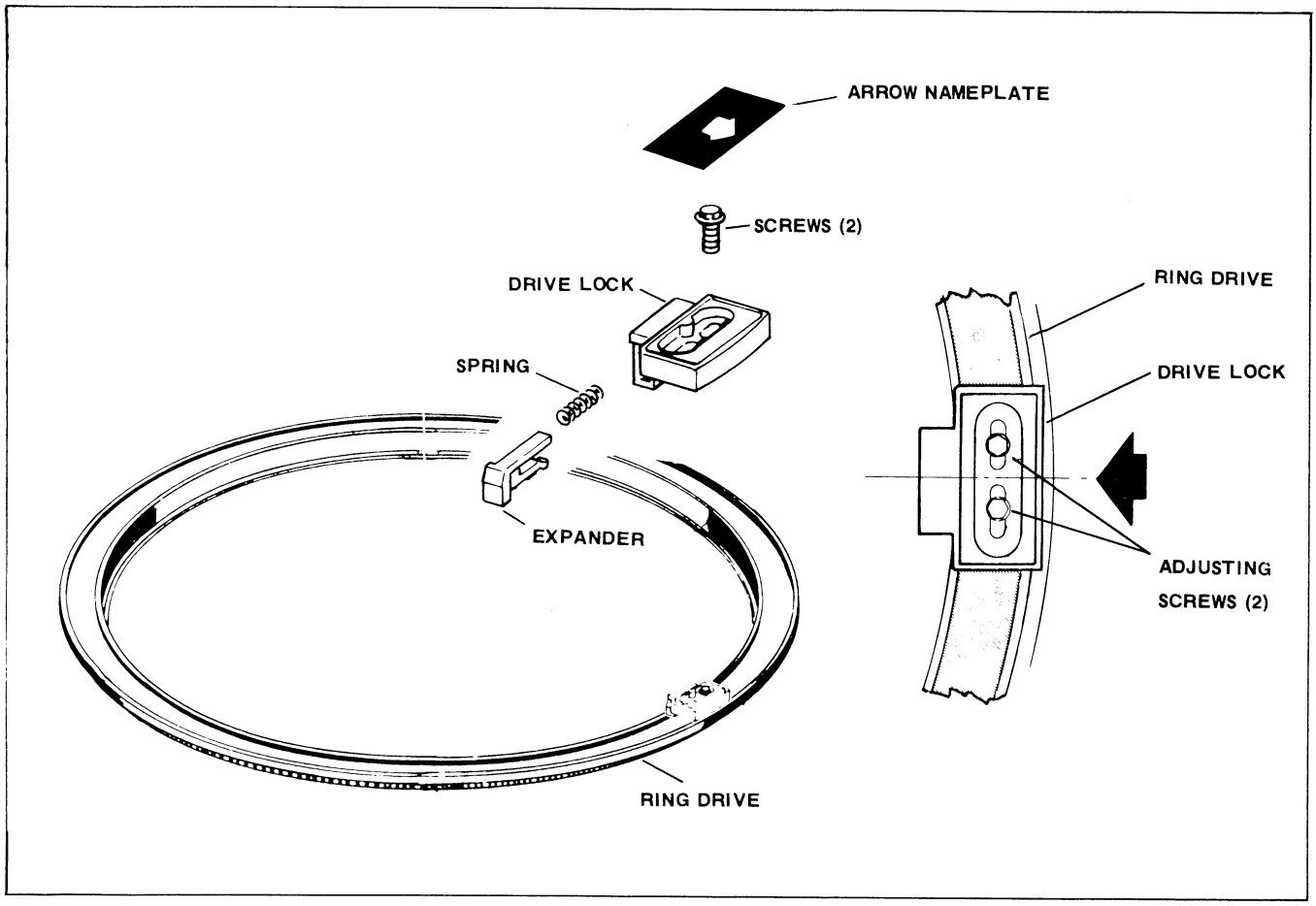


Figure AN. Ring Drive Lock Adjustment

REASSEMBLY PROCEDURES

41. GENERAL.

This section offers reassembly procedures based on the assumption of module replacement. Wherever possible, modules are removed to repair at another time and replaced with a new or repaired module.

This section is structured so that if something less than complete major component disassembly has taken place, reassembly may be started at that particular point and carried through to completion.

Before starting these reassembly procedures, recheck all serviced areas; make sure all optics and mirrors are clean, and complete as many wiring connections as is possible.

42. WIRING HARNESS REPLACEMENT.

The possibility of a wiring harness needing replacement is very remote. Normally a defective lead can be replaced by splicing or adding new wiring and clipping out the old. Any disconnects of modules should have been noted as advised in the "Disassembly Procedures" section. Check the appropriate wiring diagrams in the Parts Catalog manual and refer to paragraph 32 and Figure AB in the "Disassembly Procedures" section for replacement instructions if necessary.

43. OPTION BOARD REPLACEMENT.

Replacement of option boards is a simple matter of inserting the new board into the J1 socket of the tape recorder PC board; then fastening to the lower housing, being careful not to damage the board. On the 850 models, two connectors must be reattached, one to the microprocessor board and one to the infrared receiver board.

44. TRANSFORMER REPLACEMENT.

There are no special instructions regarding replacing the transformers except that one screw also fastens the top hinge for the tray storage door. Note that the connectors are mated in the housing channel.

45. TAPE DECK AND MAIN PC BOARD ASSEMBLY REPLACEMENT.

When replacing the tape deck and main PC board assembly, care must be taken not to damage the connector or PC board and that all baffles are in place to prevent light from leaking onto the screen. See the "Disassembly Procedures" section paragraph 23 and Figure S and the appropriate wiring diagrams in the Parts Catalog manual for proper connections.

46. FRONT BEZEL AND SCREEN REPLACEMENT.

Reassembly of the bezel calls for caution since connections must be made to the speaker and, in the 850 model, the ribbon connector from the microprocessor keyboard must be inserted into the microprocessor piggyback PC board. Be careful of switch handles from the option boards.

Replacement of the screen is a simple procedure. Care must be taken to replace the screen bumpers if they are damaged to protect the screen from damage.

47. TOP DECK ASSEMBLY REPLACEMENT.

No special precautions are required when replacing the top deck assembly except that all modules and harness connections

should be checked to make sure they are complete. Adjustments of modules, where necessary, are explained in the "Repair and Adjustments" section and the "Final Test and Adjustments" section.

48. SPECIAL PRECAUTIONS WHEN ASSEMBLING MODULES TO THE TOP DECK.

Using care, each module can be removed and replaced independently. Be aware of inter-related linkage and springs, and ground leads and electrical connections.

Caution must be observed when reassembling the lite pipe assembly. The lite pipe and photocell in the assembly must straddle the tray drive ring. Slide it in place carefully until the shifter drops into position and then fasten with the three holding screws. Depress the shifter button on the top of the deck and the lite pipe and photocell must slide (move) in the base of the assembly.

If either the focus mechanism or slide lift have been replaced, be sure the retractor spring that lies between these assemblies is properly assembled (See Figure Z).

In all cases of module replacement it is important that all connectors from the wiring harness and modules are properly assembled and that all ground wires are reassembled to the same area.

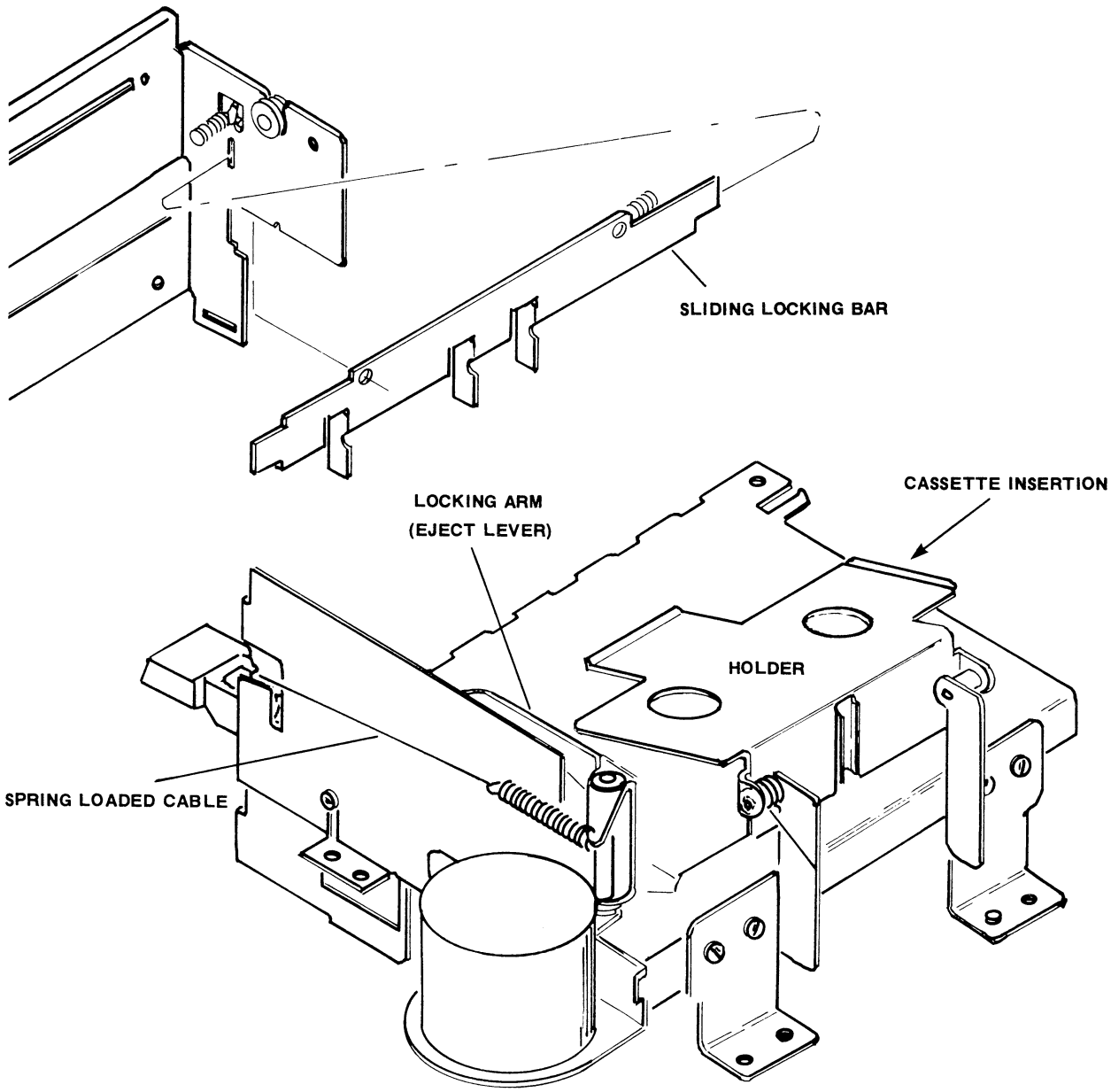


Figure AP. Cassette Insertion
Mechanical Components

TAPE RECORDER REPAIR

49. TAPE RECORDER MECHANICAL FUNCTIONS.

The following paragraphs describe the functions of the mechanical portion of the tape recorder during its various modes of operation.

A. CASSETTE INSERTION.

When a cassette is inserted into the guide (loading) slot on the side panel of the projector, it mechanically activates the locking arm (eject lever) that keeps the spring loaded cassette holder in the "receiving" position (see Figure AP). As the cassette moves the locking arm back, the spring loaded holder is released and both the cassette and holder drop into position while the spring loaded cable attached to the locking arm slides the locking bar back to allow the tape recorder "Review," "Play" and "Cue" buttons to be depressed.

B. PLAY MODE.

The PLAY mode is initiated when a tape cassette is inserted into the loading slot and the "Play" button is depressed. As the "Play" button is being depressed, the components shown in Figure AQ are mechanically activated in the following sequence.

(1) First, the activated play slider bar moves the head carrying bracket toward the cassette and the pinch roller assembly (activated by the moving head bracket) makes contact with the tape and the flywheel spindle while another part of the head bracket closes the record muting switch (S205).

(2) Next, the play slider bar activates a flat leaf spring (cassette retaining) that in turn closes the "Power" switch.

(3) Next, the play slider bar releases the brakes on the supply and take-up reels and, at the same time, moves the spring loaded locking bar so that it activates the idler to contact the flywheel drive spindle and take-up reel.

(4) To complete the sequence, a notch in the locking bar locks the "Play" button in place.

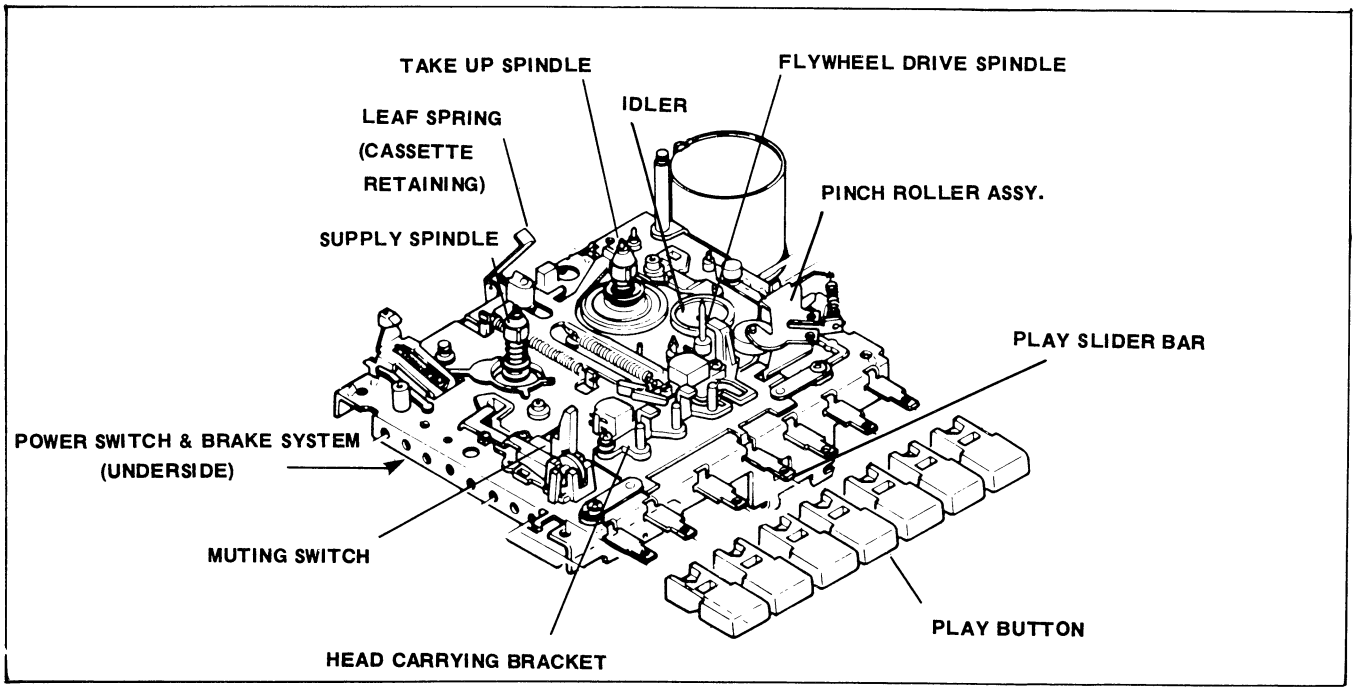


Figure AQ. Play Mode Mechanical System Components

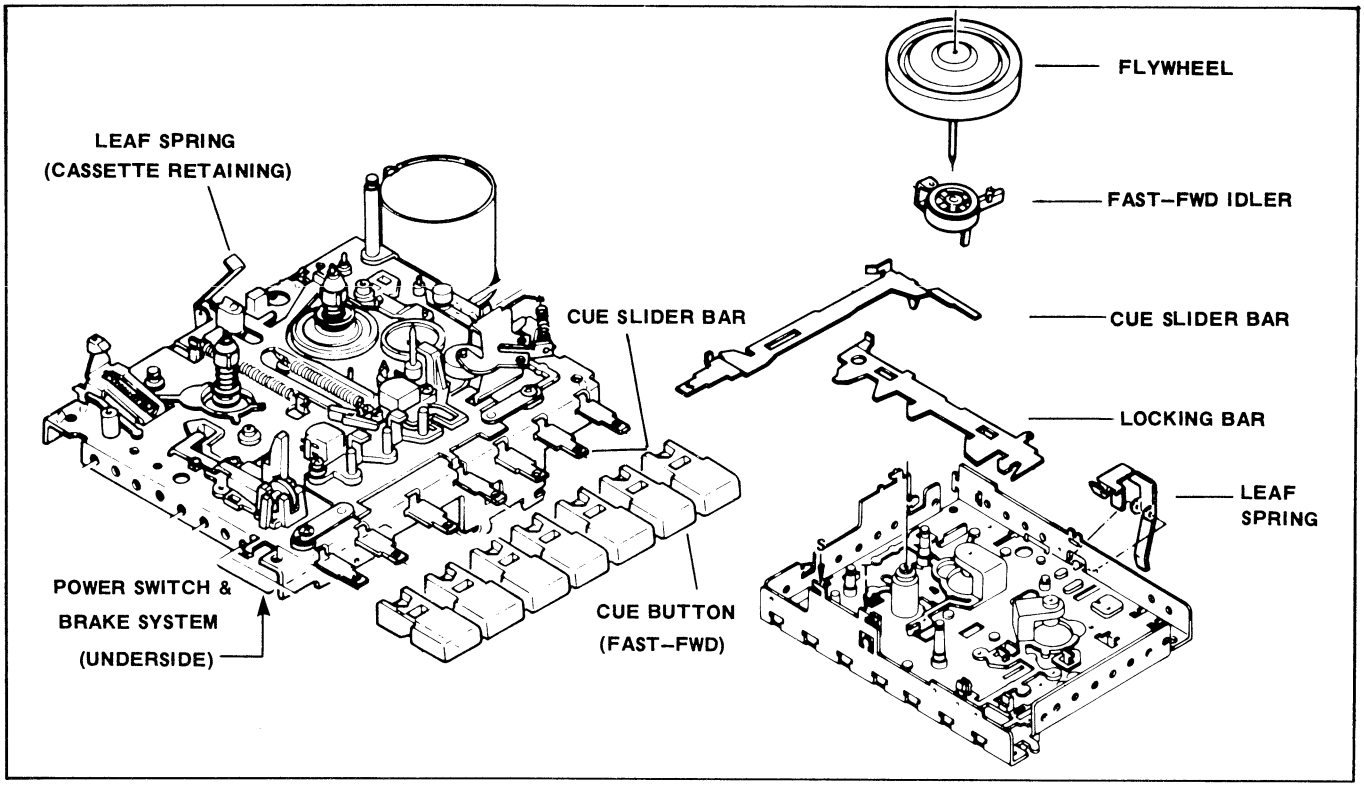


Figure AR. Cue Mode Mechanical System Components

C. CUE (FAST-FORWARD) MODE.

To effect the CUE mode of operation, the "Cue" button must be depressed and locked into position. As the "Cue" button is being depressed, the components shown in Figure AR are mechanically activated in the following sequence.

(1) First, the activated cue slider bar activates the cassette retaining leaf spring that in turn closes the "Power" switch and releases the brakes on the supply and take-up reels.

(2) Next, as the cue slider bar is recessing, a cam surface releases a spring loaded fast-forward idler to make contact with the flywheel.

(3) To complete the sequence, a notch in the locking bar locks the "Cue" button in place. Depressing the "Play" or "Stop" buttons deactivates the CUE mode system.

D. REVIEW (REWIND) MODE.

The REVIEW mode of operation is initiated when the "Review" button is depressed and mechanically the same action takes place as described for the CUE mode except that the rewind idler is pressed against the flywheel by action of the review slider bar (see Figure AS). The review slider bar also disengages the take-up reel and supply reel brakes and closes the "Power" switch. The supply spindle is belt driven by the rewind idler. At the end of the sequence, a notch in the locking bar locks the "Review" button in place. Depressing the "Play" or "Stop" button deactivates the REVIEW mode system.

E. PAUSE MODE.

The PAUSE mode is used in conjunction with the PLAY and PLAY/RECORD modes. Depressing the "Pause" button causes the spring loaded pause slider bar (Figure AT) to move the pinch roller away from the flywheel spindle and moves the drive idler away from the flywheel spindle and the take-up spindle. A

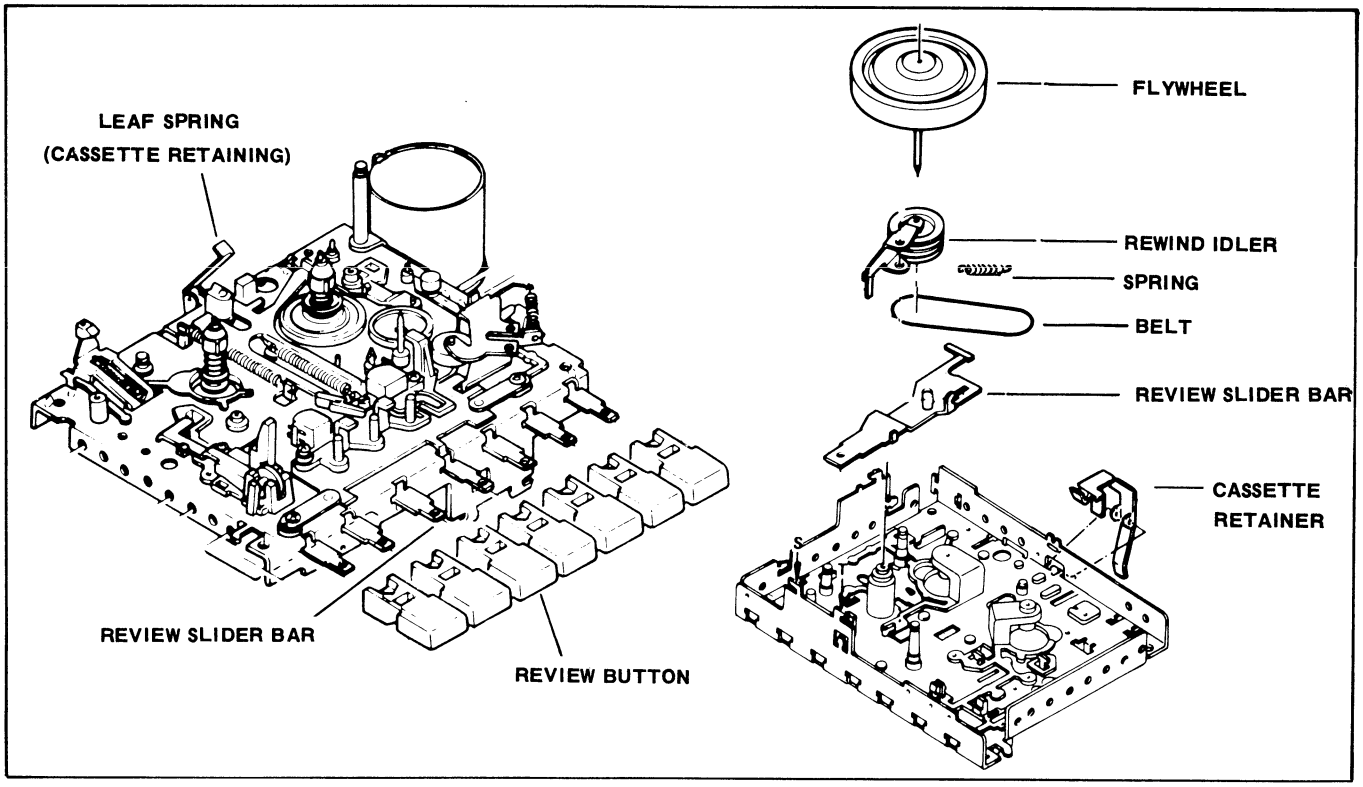


Figure AS. Review Mode Mechanical
System Components

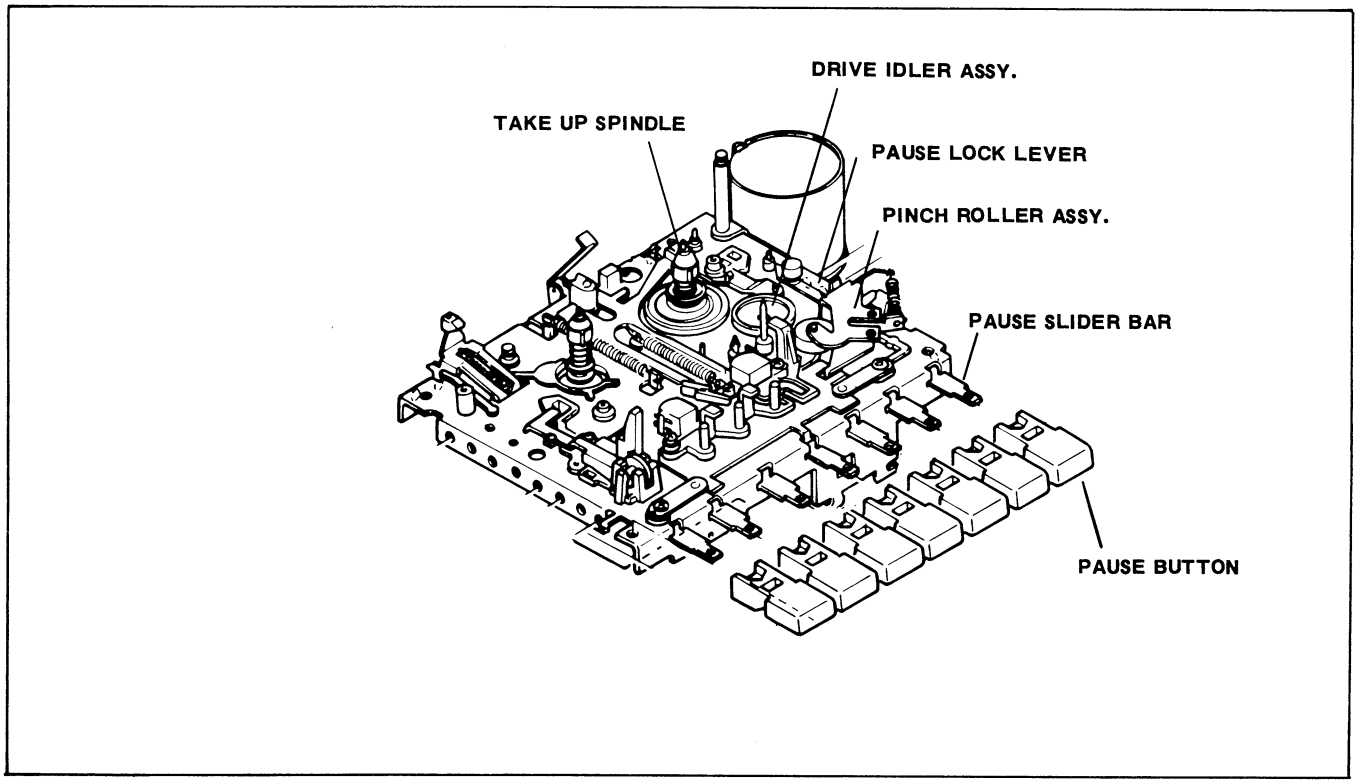


Figure AT. Pause Mode Mechanical
System Components

hook type spring loaded pause lock lever locks the "Pause" button in position. Reactivating (re-pressing) the "Pause" button unlatches the pause lock lever and the PAUSE mode is again ready to be initiated when needed.

F. RECORD MODE.

The RECORD mode is initiated when the "Play" and "Record" buttons are depressed simultaneously. The PLAY mode has already been discussed so only the RECORD mode will be explained here.

NOTE: In order to activate the RECORD mode, the knock-outs in the tape cassette must be intact. Knock-outs are only removed to preserve a previously recorded tape cassette to keep it from being erased or re-recorded and, if knock-outs are missing from the tape cassette, a mechanical lever will not allow the "Record" button to be depressed.

When the "Record" button is depressed, the "Cue," "Review" and "Eject" buttons are locked-out by the locking bar. the record slider (Figure AU) causes the following mechanical sequence to happen simultaneously:

(1) The record muting switch is closed.

(2) The record spring which is part of the record bracket attached to the record slider bar activates the "Play/Record" switch (SW201) on the tape recorder printed circuit board (see Figure 44, Parts Catalog manual).

(3) The locking bar locks the "Record" button in place. The RECORD mode system is spring loaded and is deactivated when the "Stop" button is depressed.

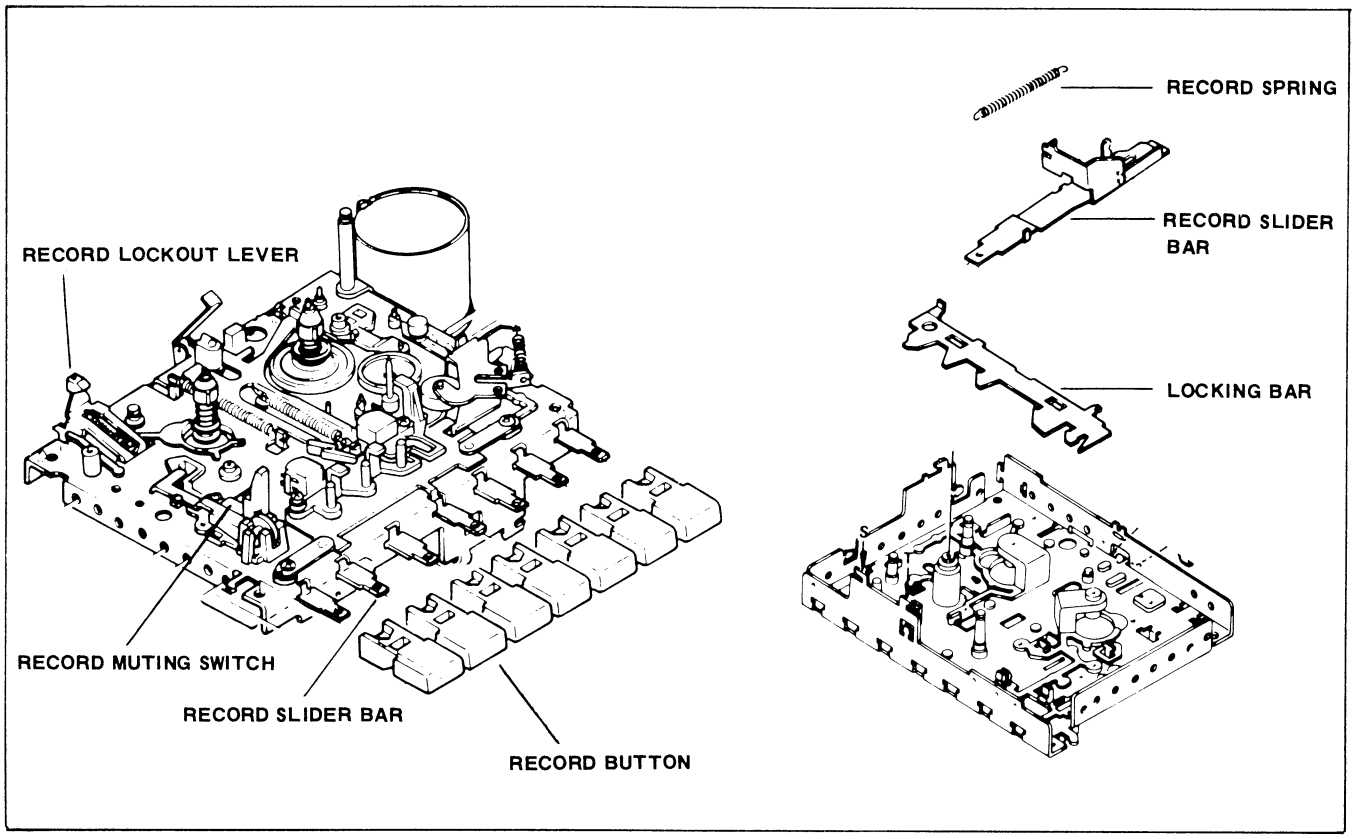


Figure AU. Record Mode Mechanical System Components

G. EJECT MODE.

The EJECT mode is a simple mechanism for ejecting the tape cassette. When the "Eject" button is depressed the eject slider bar (Figure AV) activates an eject lever that lifts the cassette holder. As the cassette holder is lifted, the locking arm (eject lever) is released and the spring loaded locking arm pushes the cassette partially out of the guide (loading) slot in the side panel of the projector. As this action takes place, the locking bar locks out all tape recorder buttons except the "Pause" button.

50. CLEANING AND LUBRICATING INSTRUCTIONS.

To insure maximum performance from the tape recorder, the tape heads, capstan and pressure roller should be cleaned whenever deposits of oxide and/or dust are observed. The accumulation of dust and oxide from magnetic tape on these vital parts of the tape recorder can rapidly reduce the efficiency of these parts and quickly decrease the life of the tape heads. When this occurs, the sound will become distorted and volume may decrease. Sync pulses could also be so low that slide advance would not be accomplished.

NOTE: Do not use household rubbing alcohol for cleaning purposes. Abrasives or metal tools should not be used to scrape oxide from the tape heads or other parts that contact the tape as this can causes scratches which could damage the tape. Also, be aware that head cleaning fluid interacts with plastic and care should be taken to avoid dropping or accidentally wiping head cleaner fluid on plastic parts of the tape recorder during the cleaning process.

A. CLEANING THE TAPE HEADS, CAPSTAN AND PINCH ROLLER.

To clean the tape heads, use a cotton swab dampened with a commercial head cleaner fluid and wipe off the recording (polished) surface of the heads. If some oxide particles remain on the heads, scrape them from the head with a wooden toothpick and clean once more with head cleaner fluid.

To clean the capstan and pinch roller, wipe

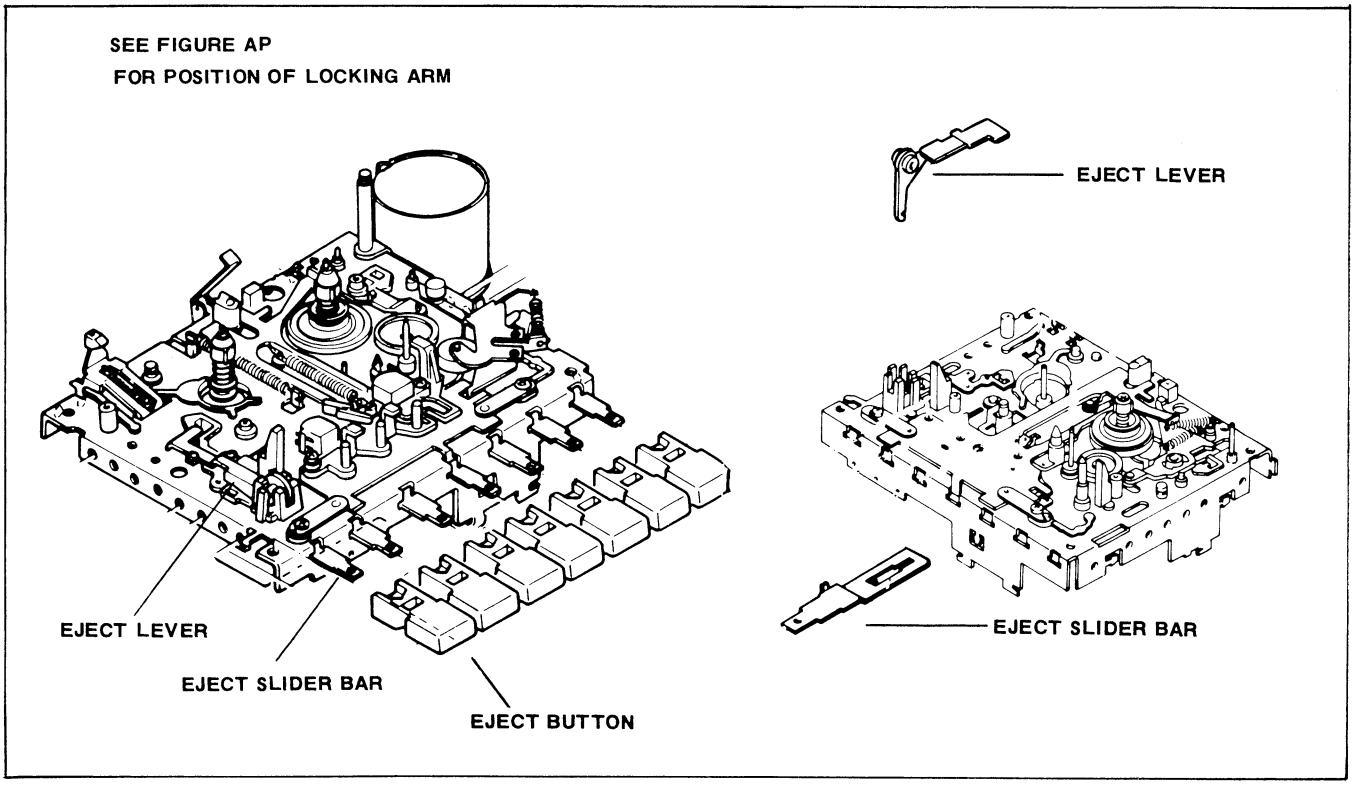


Figure AV. Eject Mode Mechanical System Components

them with a clean, lint-free cloth moistened with head cleaner fluid until the reddish-brown residue has been removed. Use a dry lint-free cloth to dry these parts and to remove loosened particles. Then finish the cleaning process by wiping out the cassette compartment.

B. DEMAGNETIZING THE TAPE HEAD, CAPSTAN AND GUIDE PARTS.

Place the tape recorder in the OFF mode and bring the top of the demagnetizing tool close to (but not in contact with) the head face. Slowly withdraw the demagnetizer away from the head before turning off the tool. The capstan and guide parts should also be demagnetized in the manner just described.

C. CLEANING AND LUBRICATING THE TAPE TRANSPORT MECHANISM.

After approximately 100 hours of operation, the drive belt, all pulleys, gears, belt grooves, all friction drive surfaces, brake shoes and brake friction surfaces of the turntable should be cleaned with a lint-free cloth moistened with methyl alcohol and wiped dry. After these parts have been cleaned, lubricate all sliding parts with a light grease containing graphite and all hubs, bearings, gears and spindles with a drop of good machine oil.

NOTE: Be careful not to apply too much grease or oil and remove excess lubricant where necessary. If lubricant is accidentally applied to the drive belts or to any of the friction drive surfaces, wipe if off immediately with a cloth dampened with methyl alcohol.

51. TAPE RECORDER MECHANICAL ADJUSTMENTS.

The gages used to perform the mechanical adjustments described in the following paragraphs are obtainable from commercial sources but are not available from the Bell & Howell Company. The head gage (MAZ-0057) is used to check and adjust the play/record head and erase head. These heads and their assembled components are illustrated in Figure 41 of the Parts Catalog manual.

A. PLAY/RECORD HEAD ADJUSTMENTS.

To check and adjust the play/record head proceed as follows:

(1) Insert the head gage into the cassette loading slot and depress the "Play" button.

(2) To check head height for proper adjustment, refer to Figure AW and note the location of the attached gage chip in the tape guide. If the chip is not located in the guide as shown (or is touching the guide), the height of the play/record head must be adjusted as follows.

(3) Move the gage chip into proper alignment with the tape guide by adjusting the special washer assembled to the screw underneath the play/record head. (Special washers may be added or removed as required to obtain proper positioning of the gage chip in the tape guide.) After head height has been adjusted, proceed to step (4) and check head lateral distance.

(4) To check and adjust head lateral distance for proper cassette contact, refer to Figure AX and note the location of the attached gage chip. If the chip is not between the "MIN" and "0" position marked on the gage, adjust the record/play head by turning screw (A) to move the chip so that it falls within the proper range ("MIN" and "0").

B. ERASE HEAD ADJUSTMENTS.

The erase head height and lateral distance checks and adjustments are identical to those just described for the play/record head except to note the following.

In step (3), special washers are adjusted on both erase head screws (Figure AW) to obtain proper erase head height.

In step (4), both screw (B) and screw (C) shown in Figure AX are used to adjust the gage chip to fall between the "MIN" and "0" range marked on the head gage.

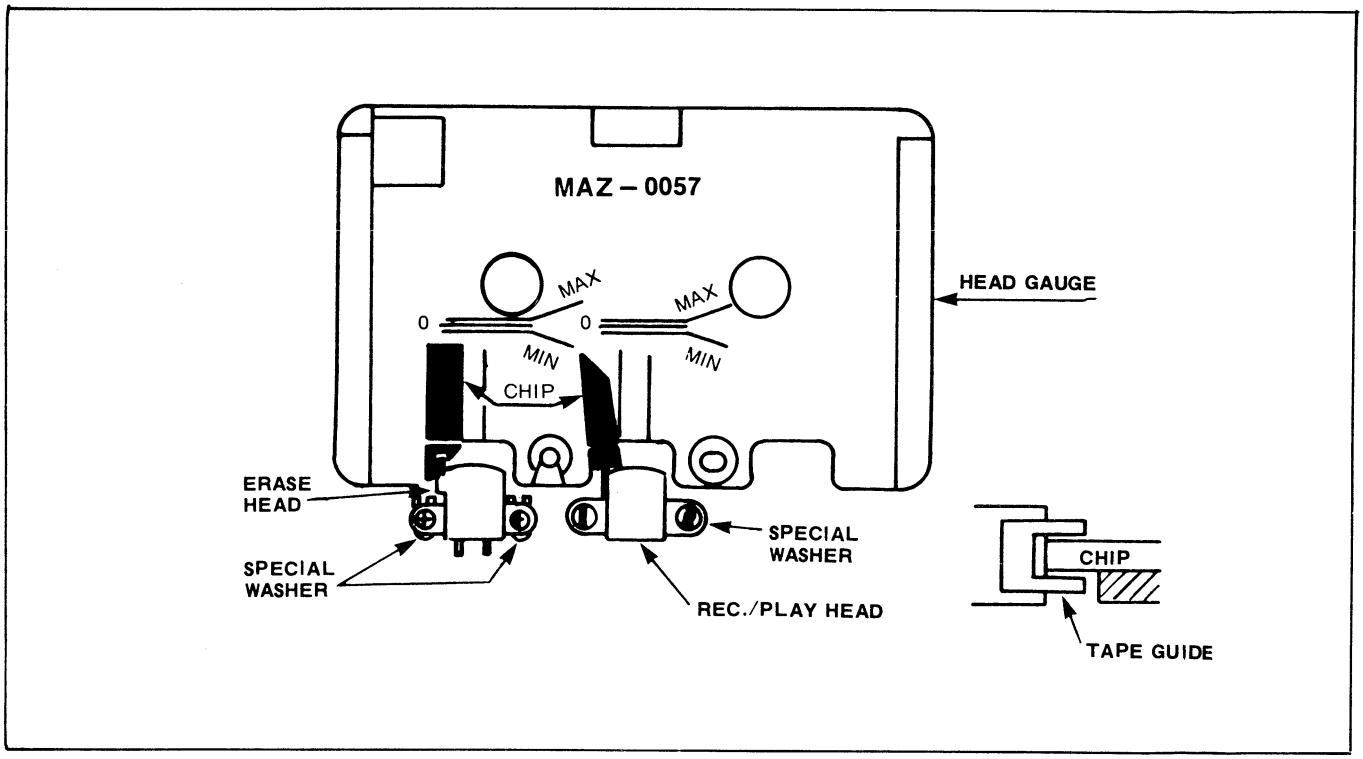


Figure AW. Head Height Adjustment for the Play/Record Head and Erase Head

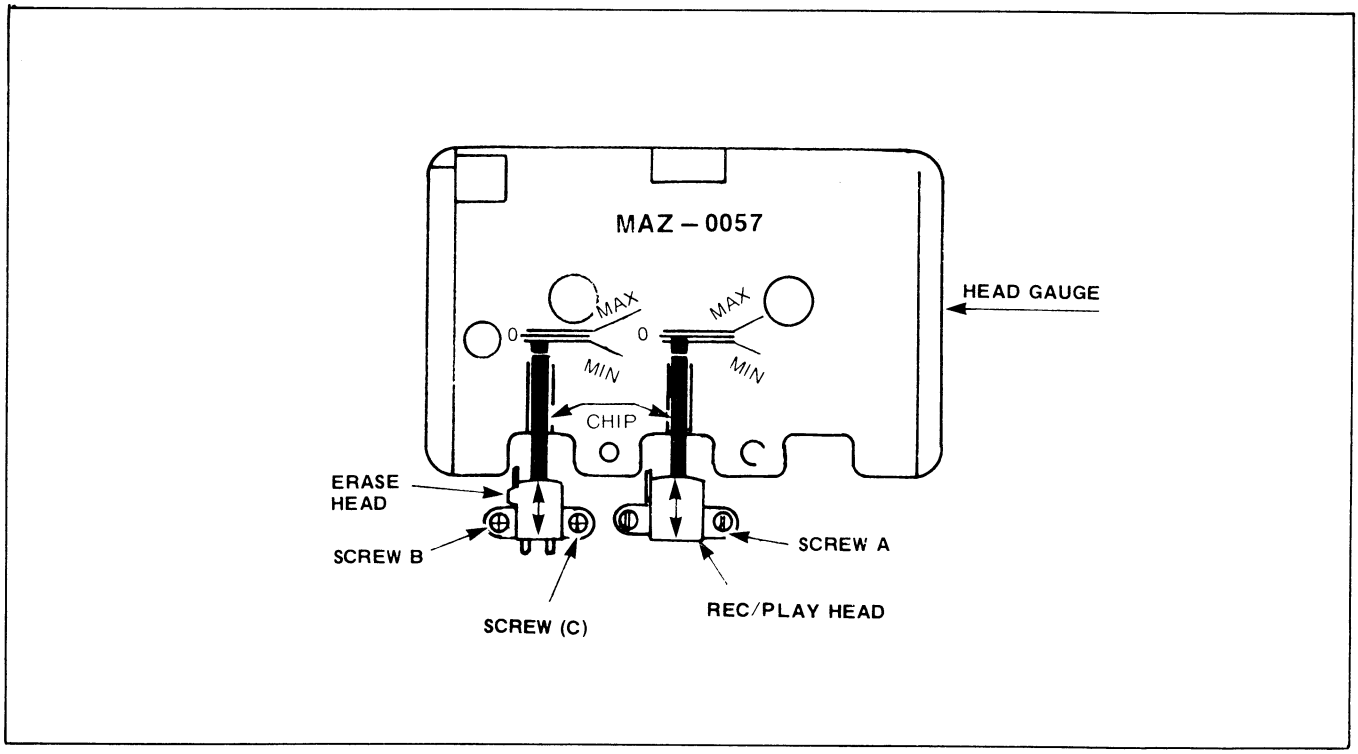


Figure AX. Head Lateral Clearance Adjustment for the Play/Record Head and Erase Head

C. PINCH ROLLER TENSION ADJUSTMENT.

With the tape recorder in the PLAY mode, measure for a clearance of 0.012-inch (0.3mm) between the pinch roller and roller activating lever. If the activating lever requires adjustment, refer to Adjustment Point A, Figure AY and bend the lever in the direction of the clear arrow on the diagram to obtain proper lever clearance.

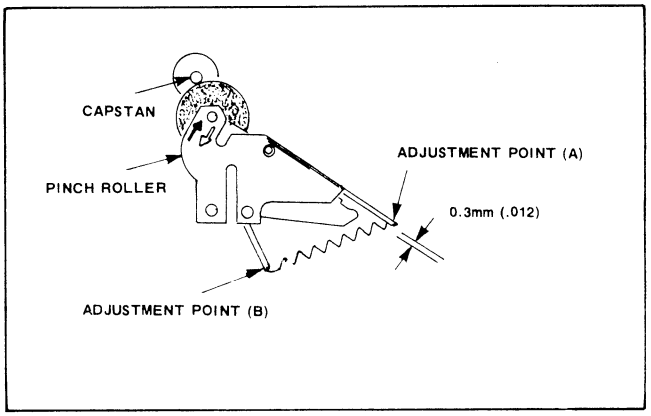


Figure AY. Pinch Roller Adjustments

When the tape recorder is in the PLAY mode, the pressure of the pinch roller before it comes in contact with the capstan and begins to rotate should be 390 ±30 grams. To measure the pressure of the pinch roller at this point, use a Chatillion gage and when the pinch roller is approximately 0.008-inch (0.2mm) away from the capstan check the reading on the gage. If the reading was not within the 390 ±30 grams range, refer to Adjustment Point B, Figure AV and bend the lever in the direction of the striped arrow on the diagram. Then recheck the new lever setting as described above and readjust if necessary.

52. TAPE RECORDER ELECTRONIC ADJUSTMENTS.

Before performing the following electronic adjustments, make sure the accessories panel "Pulse Control" and "PA' switches are in the OFF position, and move the "Volume" and "Tone" controls to maximum output.

A. HEAD AZIMUTH ADJUSTMENT.

Connect an AC VTVM with a 4-ohm dummy load to the external speaker jack. Insert a 10KHz test tape cassette (TEAC #MTT—114) into the cassette loading slot and depress the "Play" button. While the test tape is being played, turn the play/record head azimuth screw (Figure AZ) until a maximum output reading is shown on the AC VTVM.

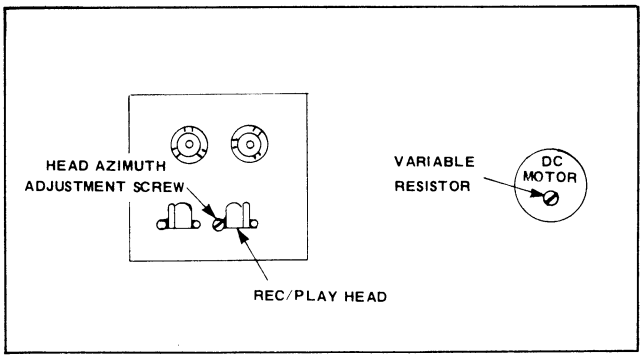


Figure AZ. Head Azimuth and Tape Speed Adjustments

B. TAPE SPEED ADJUSTMENT.

Connect a frequency counter with a 4-ohm dummy load to the external speaker jack. Insert a 3KHz test tape cassette (TEAC #MTT-111) into the cassette loading slot and depress the "Play" button. When the central portion of the test tape is reached, adjust the tape speed by turning the variable resistor on the DC tape motor (Figure AZ) until the frequency counter reads 3KHz (±2%).

C. RECORD BIAS LEVEL ADJUSTMENT.

Refer to Figure BA and connect an AC VTVM to test pins TP1 and TP2 (ground). Press and lock-in the "Play" and "Record" buttons simultaneously and then adjust VR201 for a reading of 33mV (±20%) on the AC VTVM.

D. RECORD BIAS FREQUENCY ADJUSTMENT.

Refer to Figure BA and connect a frequency counter to test pins TP3 and TP2 (ground).

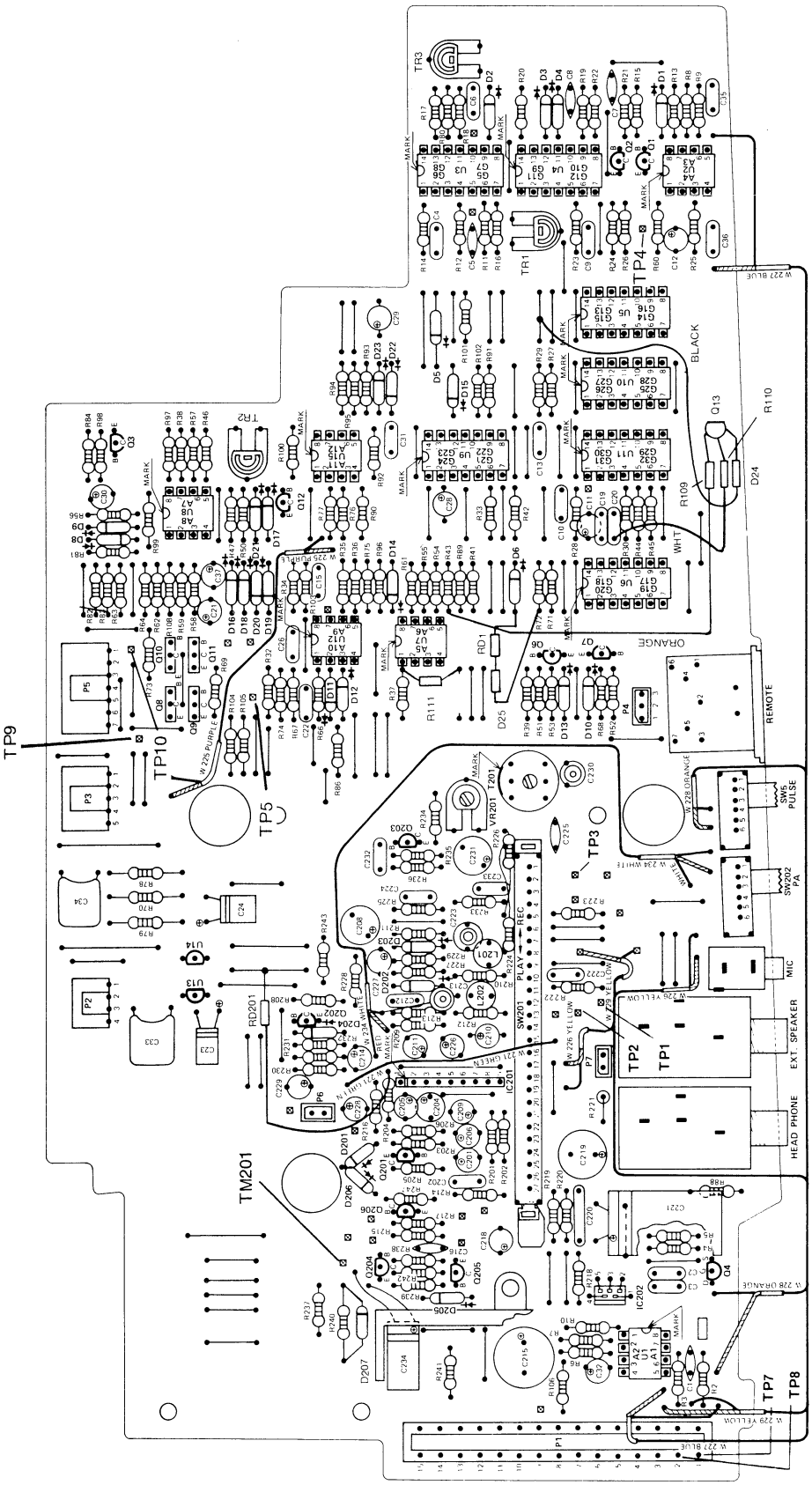


Figure BA. Tray Motor and Digital Filter Test Points (Component Side, Main PC Board)

Press and lock-in the "Play" and "Record" buttons simultaneously and then adjust the bias oscillator coil (T201) to obtain a reading of 50.2KHz (±1KHz) on the frequency counter.

E. TRAY MOTOR OVERLOAD ADJUSTMENT.

Referring to Figure BA, connect a DC voltmeter to test pins TP4 and TP5 (ground) and a dummy load (20 ohms, 5 watt resistor) to test pins TP4 and TP6. Move the accessories panel "Pulse Control" switch to ON. While watching the DC voltmeter move the "Slide Tray" switch to the forward position and check for a 0.5VDC reading. Then adjust TR2 until the DC voltmeter reads "OV" two seconds after the "Slide Tray" switch is placed in the forward position. If the limiter circuit functions during the test, check the test pin connections and the dummy load for possible malfunction and repeat the test.

F. DIGITAL FILTER UPPER/LOWER SIDE ADJUSTMENT.

With the "Pulse Control" switch in the ON position, refer to Figure BA and adjust the digital filter as follows:

(1) Connect an audio signal generator, frequency counter and AC VTVM to test pins TP7 and TP8 (ground). Then apply a 500Hz signal and adjust the input level so that the output reading on the AC VTVM is 50mV.

(2) Connect a DC voltmeter to test pins TP4 and TM201 (ground.)

(3) Adjust the frequency of the audio signal generator to 800Hz (±20Hz) and trim TR3 so that the output becomes +12V from -12V (or -12V from +12V) (see Figure BB).

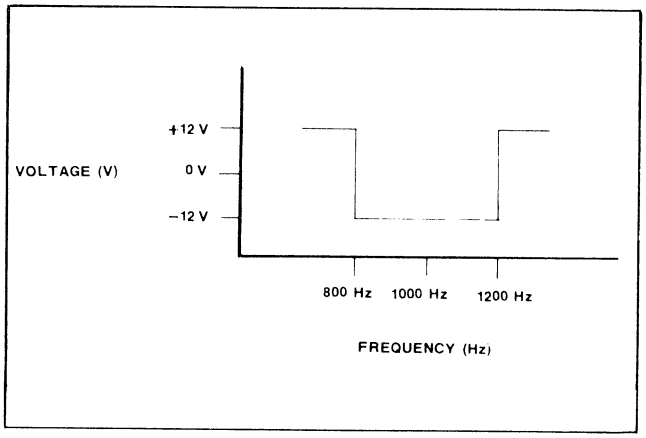


Figure BB. Digital Filter Optimum Sensitivity Adjustment

(4) Adjust the frequency of the audio signal generator to 1200Hz (±20Hz) and trim TR1 so that the output becomes +12V from -12V (or -12V from +12V).

(5) Repeat steps (3) and (4) as necessary to obtain optimum adjustment.

FINAL TESTS AND ADJUSTMENTS

53. GENERAL.

This section presents various checks, tests and adjustments which are best undertaken when the projector is assembled or almost completely assembled. Only adjustments that can be made easily will be explained in this section and, in most cases, these adjustments can be made by removing the top deck module and placing it on the support fixture. This allows full power to be applied to the projector and complete access to all modules. For all adjustments not covered in this section refer to the "Trouble Shooting" and/or "Repair and Adjustment" sections.

54. FINAL INSPECTION AND CHECKS.

When beginning the following projector checks and inspection, keep the projector completely assembled but remove all top deck module holding screws.

Check the projector for proper serial plate, overall appearance and inspect the stationary feet, tilt feet, screws and finish.

Connect an appropriate variac and voltmeter to the projector ("A" models, 120VAC 60Hz; "AN" models, 100VAC 50/60Hz or "AX" models, 110VAC 50/60 Hz). Turn the projector "Power" switch ON and check for a red glowing power indicator light (LED).

"AX" Models Only. With 110VAC 50/60 Hz applied line voltage, index the voltage selector switch through all voltage settings to check circuit continuity in each position. The projection lamp should light but be dimmer in higher voltage positions, if it does not, disconnect the line cord and replace the transformer as described in paragraph 44. Then return the voltage selector switch to the 110V position, reconnect the line cord and continue the projector checks as follows.

Check the front/rear projection door by opening and closing the door to check for excess binding and proper function. Then open and close the slide tray storage compartment door to check latch function.

Inspect the top of the projector for appearance. Check handle secureness and appearance and check function and freeness of the drive ring lock and tray retractor.

Open the projection lamp access door and check that all wires are clear of the lamp and for secureness of the lamp retainer. Reassemble the door.

55. LITE PIPE AND PHOTOCELL ASSEMBLY CHECK.

Inspect the lite pipe and photocell assembly for accumulation of "flake-off" from the use of cardboard slides and make sure to clean the assembly if necessary.

Check to make sure that the lite pipe moves freely by slowly pressing down on the shifter button. (See Figure BC). As the button is slowly depressed, a slight "step" should be felt in its motion. When slowly released and depressed again, the step should be felt again. If the button did not behave as described, refer to paragraph 69 in the "Trouble Shooting" section.

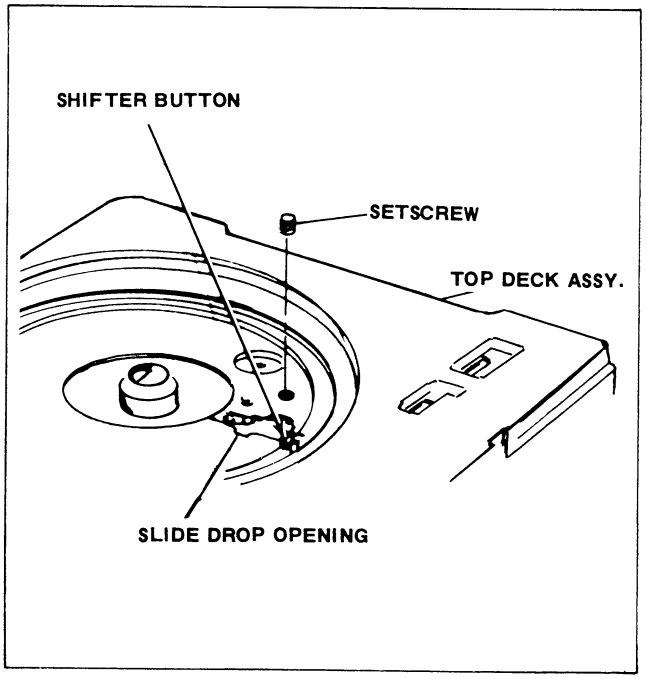


Figure BC. Checking Lite Pipe Operation

56. RING DRIVE ASSEMBLY TEST.

Operate the ring drive both forward and reverse, checking for noise. If excessive, assemble a 140-slide tray onto the slide tray carrier and recheck. Return to "home base," remove the 140-slide tray and assemble an 80-slide tray onto the carrier and check again. If the ring drive and slide tray continues to run, runs intermittently or will not move, remove the slide tray and refer to the "Trouble Shooting" section (paragraph 69) for probable causes and remedies.

57. SLIDE LIFT AND DROP TEST.

Turn the "Power" switch ON and if necessary align the case/carrier arrows and seat a loaded 140-slide tray onto the tray carrier. If the projector will not advance the 140-slide tray, the retractor in the slide receiver may not be activating. Refer to paragraph 69 in the "Trouble Shooting" section to resolve the problem; then continue the test as follows.

All Except 850 Models. Close the front/rear projection door and set the projection "Lamp" switch to LO. Momentarily press the "Slide Tray" switch in the forward position to "drop" the first slide. Then cycle the tray to advance to and drop slide 30. Next advance and drop each remaining individual slide through slide 40. To complete the test, move the "Slide Tray" switch to the reverse position and hold in reverse to slide 30. Slide 30 should drop into viewing position. If the slides did not drop into their proper positions, refer to the "Repair and Adjustments" section and adjust the ring drive lock as instructed in steps (4) and (5) of paragraph 40. If the ring drive lock is not the problem, refer to paragraph 83(B) in the "Systems Analysis" section and to the "Trouble Shooting" section electrical tests (paragraph 78).

850 Models Only. Close the front/rear projection door and set the projection "Lamp" switch to LO. Enter slide number 1 into the keyboard/display and press the GO TO EXECUTE key to "drop" the first slide. Next enter slide number 30 and EXECUTE to advance to and drop slide 30. Then press the FWD 1 SLIDE key and advance and drop each remaining slide through number 40. To complete this test, re-enter slide number 30 and EXECUTE to return to and drop slide 30.

Press the TRAY HOME key to return the slide tray to its "home" ("0") position. press the FWD 1 SLIDE key and advance slides 1-2-3; press the REV 1/REC key and reverse the slides 3-2-1. Enter slide number 79 and EXECUTE; then enter slide number 140 and EXECUTE. The slide tray should rotate clockwise to reach and project slide number 79 and counterclockwise to reach and project slide 140 (the microprocessor has been preprogrammed to calculate the shortest distance between slides and to rotate the slide tray accordingly). Now press the TRAY HOME key and the slide tray should rotate counterclockwise and return to its "home" ("0") position.

If the slides did not drop into their proper positions, refer to the "Repair and Adjustments" section and adjust the ring drive lock as instructed in paragraph 40, steps (4) and (5). If the slide tray did not rotate the shortest distance to the slide or did not return to its "home" position, refer to the "Trouble Shooting" section for probable causes, electrical tests and adjustments to correct these problems.

NOTE: The slide lift mechanism timing gear is set at the factory but may be out of timing range if the projector slide mechanism components were serviced. To check for proper gear timing and to adjust the slide lift switch assembly if necessary, refer to the "Repair and Adjustments" section paragraph 36, steps (2) through (4).

58. FOCUS TESTS AND ADJUSTMENTS.

To test the projectors manual and automatic focusing systems for proper focus requires the use of Bell & Howell Company Limit Slides S-077754-1 FX3 and S-077754-1 FX4 (or generic test slides of comparable quality). For convenience, the limit slides will be referred to as FX3 and FX4 in the following test instructions.

Manual Focusing Test and Adjustment —815A Model Only. Set the projector up for projection on the built-in screen and insert the FX3 limit slide into the slide aperture with the "Lamp Side" toward the projection lamp. Switch the "Expander" control (frame filler) to enlarge the image and with the "Focus" control adjust the image for sharpness (the lens must be capable of focusing on the slide with some overtravel). Repeat the test using the FX4 limit slide. Remove the FX4 limit slide and insert the FX3 slide. Open the front/rear projection door, set the "Lamp" switch to HI and focus the image on an external screen and check for manual focus overtravel. Remove the FX3 slide and insert the FX4 slide and repeat the test. If adjustments are required, remove the FX4 limit slide, return to the built-in screen projection mode and move the "Expander" control to its "normal" position.

To adjust for proper manual focus, insert a "good slide" and adjust the prime focus lens for the best cornering compromise. Then switch the "Expander" control to expand the image and if necessary, readjust the image for best cornering compromise.

Automatic Focusing System Test — All Except 815A Model. Set-up the projector for rear screen projection and insert the FX3 limit slide into the slide aperture with the "Lamp Side" toward the projection lamp. Switch the "Expander" control to enlarge the image and with the "Focus" control adjust the image for sharpness (the lens should focus on the slide with some overtravel). Check the image for proper focus only at the center (corners may be fuzzy). Remove the FX3 slide and insert the FX4 limit slide and the lens must refocus the image with no overtravel. (Note: There should be lens overtravel anytime either the FX3 or FX4 limit slides are manually focused.)

Check the FX4 limit slide image for "center" and then repeat both the FX3 and FX4 limit slide tests with the projector placed in the front projection mode and the projection "Lamp" switch set on HI. If the autofocus system requires adjustment, place the top deck up against the support fixture and perform the adjustment procedures described in paragraph 37. For electrical tests, refer to the "Trouble Shooting" section.

59. HORIZONTAL AND VERTICAL FRAMING CHECKS AND ADJUSTMENTS.

To perform the horizontal/vertical framing checks and adjustments the following required Bell & Howell Company special service tools are used:

Centering Slide SD-840-1 NX1
Centering Overlay SD-850-1 NX1
Angular Overlay SD-850-2 NX1
Wrench (Long Hex No. 4-40) STK-11985

The framing specifications when the "Expander" control is in the "normal" position are, ±1/16 inch vertically and ±1/8 horizontally; and in the "expanded" position, ±1/8 inch vertically and ±3/16 inch horizontally.

With the projector assembled and set-up for projecting on the built-in screen, check for proper framing as follows:

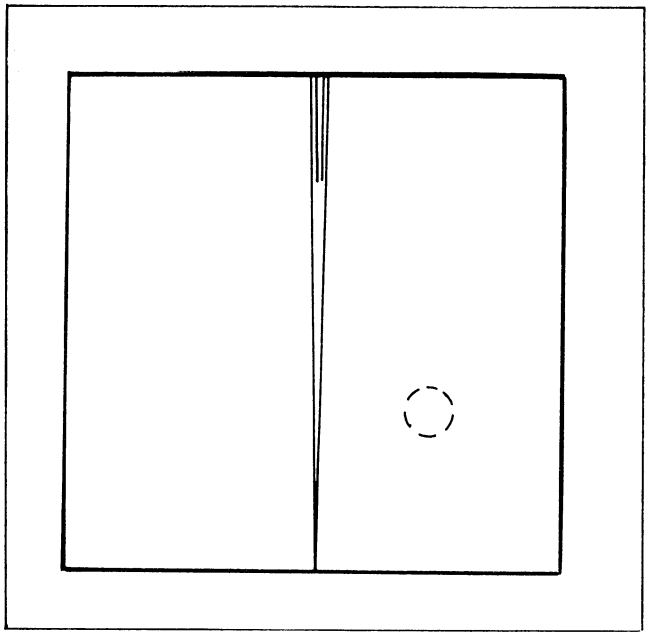


Figure BD. Checking Vertical Framing with Angular Overlay (SD-850-2 NX1)

Insert the centering slide into the slide aperture and focus the slide. Place the angular overlay against the screen to check image "tilt." The vertical image must not exceed the ±1° "V" on the overlay with the point of the "V" centered on the line as shown in Figure BD. Now place the centering overlay (Figure BE) against the screen and check the image for horizontal and vertical framing (centering).

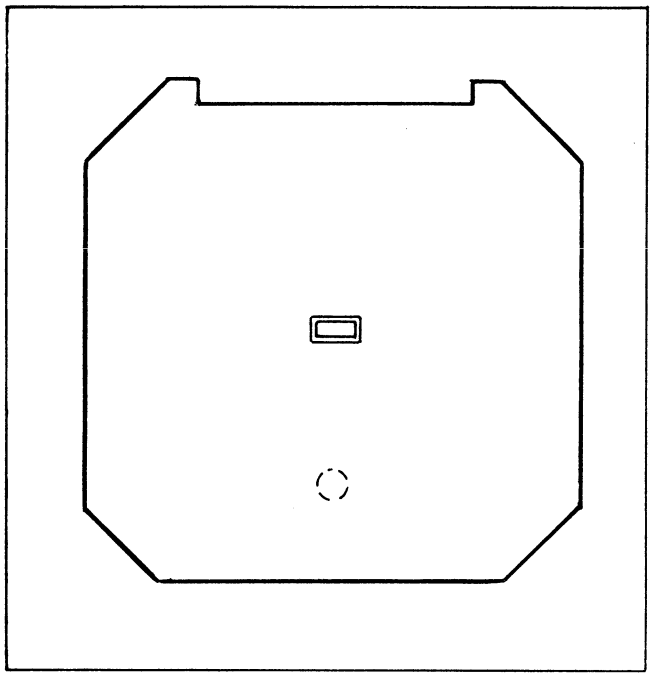


Figure BE. Checking Horizontal Framing with Centering Overlay (SD-850-1 NX1)

Repeat the framing checks with the projector set-up with the "Expander" control set to expand the image. If the image requires adjustment, there are two setscrews used to adjust the first mirror assembly (vertically or horizontally) for proper alignment of the image on the built-in screen.

Vertical Alignment — The setscrew in the top deck assembly (Figure BF, View A) controls vertical framing. To align the image vertically, use the long No. 4-40 hex wrench and turn the top deck setscrew as needed to center (raise or lower) the image on the screen.

Horizontal Alignment — The setscrew controlling horizontal framing is part of the first mirror assembly (see Figure BF, View B). This setscrew controls the movement of the first mirror within the first mirror assembly and is accessible through the front/rear projection door as follows.

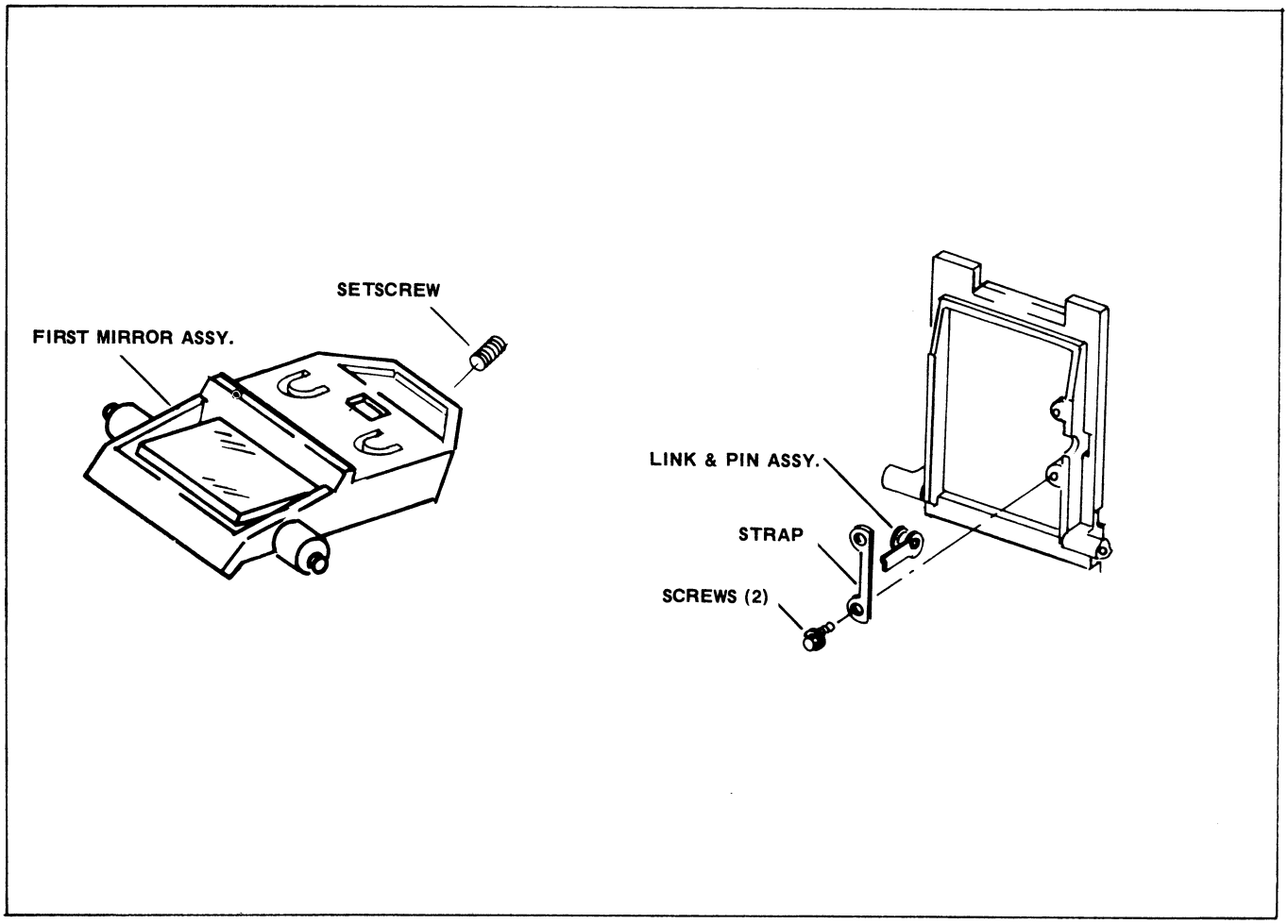


Figure BF. Adjusting Horizontal and Vertical Framing

Open the front/rear projection door all the way. Refer to Figure BF, View B and remove the two screws and strap holding the link and pin assembly. To gain access to the first mirror screw, push the linkage into the projector to move the lens back into the "rear" screen position. Then use the long No. 4-40 hex wrench and turn the setscrew clockwise (or counterclockwise) as needed to horizontally frame (center) the image on the built-in screen.

Move the linkage into the front/rear projection door and then push it back into the "rear" screen position and recheck the adjusted horizontal alignment; readjust if necessary. When the alignment procedures have been completed, reassemble the link and pin assembly to the front/rear projection door by replacing the strap and both screws before closing the door.

60. PROJECTION LAMP CHECK.

To check the projection lamp for proper illumination, use a horizontal and a vertical Gepe slide to check for browning in both positions. Switch the projection "Lamp" switch from LO to HI and back to LO and note if illumination changes accordingly. If browning occurs in either position, all optical surfaces shoul be cleaned. After the optical surfaces have been cleaned, repeat the Gepe slide check in both positions (horizontal and vertical) and if browning persists replace the projection lamp as described in paragraph 20.

NOTE: All of the following checks, tests and adjustments that remain to be performed require the projector to be completely assembled and operational.

61. SLIDE FORWARD/REVERSE AND PULSE ADVANCE CHECK (ALL EXCEPT 850 MICROPROCESSOR MODELS).

Load a slide tray with ten slides (five cardboard and five glass). Turn the projector "Power" switch ON, use the "Slide Tray" switch to line-up the case/carrier arrows and seat the slide tray onto the tray carrier.

To check slide forward/reverse operation, use the "Slide Tray" switch and run the ten slides in the "Forward" position and then in the "Reverse" position. Plug the remote control into the accessories panel REMOTE jack and press the remote control buttons to advance and reverse the ten slides.

To check 1000Hz slide advance operation, insert the test tape cassette TCD 815 NX11 into the cassette loading slot and move the "Pulse" control switch to ON. Check to make sure the PA switch is OFF. Then press the tape recorder "Play" button and the slides should advance automatically. Press the remote control "Pause" button and the tape and slides must stop. (If testing an 840 model projector, the slides should also stop when the tape reaches a cue-stop signal.) If problems exist in any of these areas, check the "Trouble Shooting" section for probable causes and adjustments.

When the slide tests or adjustments have been completed, press the "Review" button to rewind the test cassette and use the "Slide Tray" switch to realign the case/carrier arrows. Turn the "Pulse" control OFF, press the "Eject" button to remove the test cassette, unplug the remote control and remove the slide tray from the projector.

62. AUDIO CHECKS.

Inspect the appearance of the volume/tone controls. Load a tape cassette with recorded audio into the cassette slot, press the tape recorder "Play" button and check the volume/tone controls for proper opration while listening to the sound through the internal and then an external speaker. Check the headphone jack with the external speaker (sound should be at reduced volume). After completion of the tests, rewind and remove the audio tape cassette and unplug the headphone.

Check the public address system by plugging the microphone into the MIC jack and lowering the volume control setting. Move the accessories panel PA switch to ON and speak into the microphone while increasing the volume to check PA function. Turn the PA

switch OFF and speak into the microphone to confirm the switch setting and then unplug the microphone. (If feed-back problems occurred when testing the PA system, the tests were performed too close to the projector.)

If there was defective or intermittent sound in any of the audio tests, inspect the audio section on the tape recorder PC board for shorts, open foil or blown components. If the problem is not found on the tape recorder PC board, refer to the "Trouble Shooting" section for other probable causes and solutions.

63. PULSE SENSITIVITY TESTS.

It is not necessary to have the slide tray seated on the carrier to perform these tests. Test cassette TCD 815 NX12 however, is required; side "A" is used to check 1000Hz slide advance pulse sensitivity and side "B" to check cue-stop pulse sensitivity.

1000Hz Slide Advance Pulse Sensitivity Test — All Models. Turn the "Power" switch ON and move the accessories panel "Pulse" control switch to the ON position. Check the test cassette to see if the tape is rewound and insert the cassette into the loading slot to play side "A." Press the "Review" button to rewind the tape if necessary and then press the tape recorder "Play" button. The tray carrier should advance with each recorded pulse. Move the "Pulse" control switch to the OFF position and the carrier should stop cycling. Press the tape recorder "Stop" and "Review" buttons and remove the test cassette.

150Hz Cue-Stop Pulse Sensitivity Test — 840 and 850 Models Only. Return the "Pulse" control switch to the ON position and insert the test cassette into the loading slot to play side "B." Then referring to the appropriate instructions below test the projector for proper cue-stop operation.

840 Models Only. Press the tape recorder "Play" button and at the first recorded cue-stop pulse the tray carrier and tape should go into the PAUSE mode and the cue-stop red LED on the special features panel should be lit. Press the features panel "Restart" button; the cue-stop LED should go out and the tray carrier and tape should advance and "pause" again at the next recorded cue-stop pulse. If the projector failed the cue-stop test, refer to the "Trouble Shooting" section and check electronic frequencies as instructed; then re-test pulse sensitivity. When the tests have been completed, press the tape recorder "Stop" and "Review" buttons, remove the test cassette and turn the "Pulse" control switch OFF.

850 Models Only. Press the tape recorder "Play" button and at the first recorded cue-stop pulse the tray carrier and tape should go into the PAUSE mode and three dots (periods) should appear in the keyboard display. Press the keyboard PAUSE/RESTART key; the three periods should disappear from the display and the tray carrier and tape should advance and "pause" again at the next recorded cue-stop pulse. If the projector failed the cue-stop test, refer to the "Trouble Shooting" section and check electronic frequencies as instructed; then re-check pulse sensitivity. When the tests have been completed, press the tape recorder "Stop" and "Review" buttons, remove the test cassette and turn the "Pulse" control switch OFF.

64. AUDIO RECORDING TESTS.

To test the audio recording system, refer to paragraph 14 and perform steps (1) through (4) to set-up the projector for recording on a blank cassette tape. Then prepare the audio test tape as follows:

Repress the latched "Pause" button to start tape transport; wait approximately one second for the tape leader to pass and then voice record numbers (1) through (5) at approximately three second intervals (if an 840 or 850 model projector is being tested, voice record the words "cue-stop" after number 5). Check if the red "REC Level" indicator LED voice modulates (blinks) when speaking into the microphone. If the LED is not working properly, refer to the "Trouble Shooting" section electrical tests for a solution to the problem.

Press the "Stop" button, then the "Review" button to rewind the tape and unplug the microphone. Playback the tape to check if

audio was recorded; if not, refer to the "Trouble Shooting" section for probable causes.

65. PULSE RECORDING TESTS (830 AND 840 MODELS ONLY).

To record 1000Hz slide advance pulses on the control tracks of the audio test tape, press the "Review" button to rewind the tape. Insert the "Pulsing Control" plug into the REMOTE jack and switch the features panel "Pulse Record" control to the 1000Hz position. Press and lock-in the "Pause" button and then the "Play" button.

NOTE: The "Record" button is never used for pulse recording. If activated now, the audio recording will be erased from the test tape while the slide advance pulses are being recorded.

To add slide advance pulses to the test tape, release the latched "Pause" button and after each voice count press the "Pulsing Control" button to record the slide advance pulses. The pulse being recorded should be heard through the speaker and the tray carrier must advance at the same time the pulse was recorded.

To add a 150Hz cue-stop pulse to the 840 model test tape, after the fifth count is heard, press the "Pause" button and move the "Pulse Record" switch to the 150Hz position. Unlatch the "Pause" button and after hearing the words "cue-stop" press the "Pulsing Control" to record the cue-stop signal (pulse).

To check-out the 830 or 840 model projector pulse recording system(s) for proper operation and accuracy of the pulses just recorded; press the "Pause" button, turn the "Pulse Record" control OFF, unplug the "Pulsing Control" and press the "Review" button to rewind the tape. Turn the PULSE CONTROL switch on the side panel to "ON".

Release the "Pause" button and while the test tape is being played back, watch for the pulses to advance the tray as recorded (if an 840 model projector is being checked, make sure the tray pauses at the cue-stop pulse and lights the red cue-stop LED, then press the features panel "Restart" button to make sure the LED light extinguishes).

If problems exist in any of these areas or if the pulses did not record, check all switches used for pulse recording for proper positioning. If problems persist, refer to the appropriate wiring diagram and replace the option board. Then retest the audio, slide advance and cue-stop systems.

66. PULSE RECORDING TESTS (850 MODELS ONLY).

To test the microprocessors PULSE RECORD mode, refer to paragraph 17 and set-up the projector as explained in steps (1) through (4) and proceed as follows.

Press and lock-in the tape recorder "Pause" button. Enter command number 213 into the keyboard (the numbers should appear in the display). Press the keyboard GO TO EXECUTE key and then press the tape recorder "Play" button (the red "REC Level" light should glow). The projector is now ready to record slide advance and "cue-stop" pulses.

Press and release the "Pause" button and enter number 1 into the keyboard/display and press the REV 1/REC key. The projector should "beep" and advance the tray carrier to the No. 1 position. After hearing the voice recorded "2," enter number 2 into the keyboard/display and press the REV 1/REC key to record the pulse. Continue the pulse recording procedure (alternately entering the number and recording the pulse) for each remaining number and after entering and recording number 5, re-enter number 5 into the keyboard/display and press the REV 1/REC key. Then turn the "Pulse Control" switch ON and press the "Review" button to rewind the tape.

To check the just recorded pulses, playback the tape and the projector should automatically follow the recorded commands and during playback of number 5, the slide carrier should not advance to number 6 and the display should read "5."

If pulses were not recorded on the tape or if the red "REC Level" LED did not light, check all switches for proper positioning and re-test if necessary. If problems persist, check the microprocessor for self-analysis as follows.

Press the numbers 248 on the keyboard followed quickly by GO TO EXECUTE and five PAUSE/RESTARTS within five seconds. The display should read 888 and then go blank; if the test failed, refer to the appropriate wiring diagram and replace the option board. (Note: To restore the display, turn the "Power" switch OFF.)

67. TAPE ERASING TEST.

When the audio and pulse recording systems are in proper working order and the audio/pulse test tape is no longer needed, use the test tape to check the erasing systems. First erase the audio tracks and then refer to the appropriate paragraph below and erase the control tracks on the 830, 840 or 850 model test tapes.

Erasing the Audio Tracks — All Models. Press the "Review" button to rewind the tape if necessary. Press the tape recorder "Record" and "Play" buttons and let the tape run for approximately 15 seconds, then press the "Stop and "Review" buttons.

Erasing the Control Tracks — 830 and 840 Models Only. Plug the "Pulsing Control" into the the REMOTE jack, set the "Pulse Record" control in the 1000Hz position and press the "Play" button. Erase the tape up to the last narration (5 or cue-stop) and then press the "Stop" button. Press the "Review" button to rewind the tape, place the "Pulse Record" control in the OFF position and unplug the "Pulsing Control."

Erasing the Control Tracks — 850 Models Only. Enter command number 213 into the keyboard/display to place the projector in the PULSE RECORD mode. Press the GO TO EXECUTE key and press the PLAY button to erase the pulses. Then press the "Review" button to exit from the PULSE RECORD Mode and rewind the tape.

To complete the test, replay the tape to make sure both tracks have been erased (no audio, tray advance or cue-stop). If the tracks are not erased, check for an open oscillator coil on the tape recorder PC board.

68. INFRARED REMOTE CONTROL TEST (850 MODELS ONLY).

Test the infrared remote control system by entering command number 209 into the projector keyboard/display then EXECUTE to transfer control to the transmitter. Verify the transfer by attempting further commands on the projector keyboard; the projector should NOT respond.

To test the infrared transmitter, enter the number 1 into the transmitter keyboard then EXECUTE and the projector should respond and move to number 1. Repeat the test by entering and EXECUTING numbers 5 and 9. The projector should respond and move to the number entered; then press the transmitter keyboard TRAY HOME key and the tray carrier should return to "home base" ("O position).

Return control to the projector by entering command number 210 into the transmitter keyboard, then EXECUTE. Verify the transfer by attempting further commands on the transmitter keyboard; the projector should NOT respond.

If the projector or transmitter is not operating as just described, the projector is not grounded properly or, the option board, keyboard, or infrared transmitter may be at fault. Refer to the "Trouble Shooting" section to isolate the problem.

NOTE: When the infrared transmitter battery power is low, the transmitter range will decrease or no infrared signal will be sent. To alert the operator to this condition, when the transmitter's battery voltage decrease to 5 or 6 volts the green LED on the transmitter remains lit and the remaining power decreases rapidly.

TROUBLE SHOOTING

The trouble shooting charts have been broken down into the service areas listed below and, as a logical method of isolating electronic faults and repairing them, the charts in the electronic service area are presented in test sequence form.

Although the remedy procedures allow for servicing individual components, wherever possible modules should be removed and replaced with a new or repaired module and the defective module repaired at another time.

NOTE: The main (tape recorder) PC board comprises most of the projectors electronic systems and except for extensive board damage or multiple problems this PC board should be repaired rather than replaced.

When replacing modules and/or components, it is suggested that various colored tape be placed on wire connectors and plugs for use as locators during reassembly. Also, refer to the appropriate diagram in the Parts Catalog manual to aid in identifying the proper disconnects.

After the trouble has been isolated and resolved, perform the inspections and tests covered in the "Final Tests and Adjustments" section to assure proper operation of the projector.

Paragraph/Description — Page

69. SLIDE UNIT MECHANICAL SYSTEM PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
Slide mechanism noisy	Follower or setscrew not adjusted properly or needs replacement.	Refer to paragraph 34 and adjust or replace follower.
	Leveling screw gear out-of-mesh with elevate motor gear.	Loosen motor holding screws and move motor to accommodate gear mesh.
	Dry leveling screw and/or guide posts.	Lubricate leveling screw and/or guide posts with B&H grease (P/N 713280).
	Dry bearings.	Saturate upper bearing and oil wick with good quality machine oil.
Ratcheting noise	Slide tray not seated properly or not on "0" position.	Seat the tray so that its "0" position aligns with matched carrier/case arrows.
	Slide tray carrier not on "0" position (all except 850 models).	Remove the slide tray and use the "Slide Tray" switch to align the carrier arrow with the case arrow; then reseat the tray.
	Binding retractor.	Straighten retractor and free retractor by removing burrs.
	Missing retractor spring.	Add retractor spring.
Clank noise	Missing pad on mechanism base (figure 10-29 in parts catalog).	Add missing pad.
Slide tray does not return to "home base"	"Homing" switch improperly set (850 models only).	Reset "Homing" switch.
Lite pipe does not move	Missing or loose retractor springs.	Reassemble or replace retractor springs.
	Lite pipe binding.	Check for dirt, burrs or obstruction and clean or remove burrs/obstruction.
	Loose lite pipe assembly.	Check holding screws and reassemble module to top deck if necessary.

69. SLIDE UNIT MECHANICAL SYSTEM PROBLEMS (CONTINUED).

TROUBLE	PROBABLE CAUSE	REMEDY
No slide drop or double slide drop	Incomplete ring drive lock assembly.	Add missing part(s) or replace assembly; then adjust ring drive lock as described in paragraph 40.
	Ring drive lock out-of-adjustment.	Refer to paragraph 40 and adjust ring drive lock.
	Sticky or dirty lite pipe assembly.	Free-up assembly and clean lite pipe and phototransistor using tissue paper and soap and water.
	Slide lift switch assembly out-of-adjustment.	Adjust elevate switches as described in paragraph 36.
Partial slide drop	Bent or damaged slide.	Check slide and replace.
	Slide mechanism not aligned properly.	Realign mechanism; then refer to paragraph 57 and test and adjust if necessary.
	Gate does not open or opens partially.	Adjust gate tabs by bending.
	Defective gate cam surface.	Replace defective gate.
	Ring drive lock out-of-adjustment.	Refer to paragraph 40 and adjust ring drive lock.
	Side tension arm not retracting fully due to bent shaft or not perpendicular to the shaft.	Replace side tension arm.
Slide drop problems with 140-slide tray	Locking button and spring system not functional.	Replace defective parts and reassemble.
	Retractor on slide receiver jammed because of loose or missing studs.	Replace entire module. Then repair faulty module by replacing studs and seal with cement.

69. SLIDE UNIT MECHANICAL SYSTEM PROBLEMS (CONTINUED).

TROUBLE	PROBABLE CAUSE	REMEDY
Shutter stays open when no slide present	Missing side tension arm or spring.	Add side tension arm or spring.
	Side tension arm not seated due to binding condition.	Examine rectangular slot in mechanism housing and side tension arm for burrs or flashes and remove same.
	Side tension shaft bent.	Straighten or replace side tension shaft.
	Missing slider extension spring.	Add slider extension spring.
Shutter bounces	Missing shutter bounce pad.	Add shutter bounce pad.
	Slide lift switches out-of-adjustment.	Refer to paragraph 36 and adjust elevate switches.
	Damaged or worn leveling screw.	Refer to paragraph 34 and replace leveling screw.
Image not centered or tilted on rear screen	First mirror out-of-adjustment.	Refer to paragraph 59 and adjust first mirror.
	Loose second or third mirror.	Remove old adhesive, clean and recement.
Image out-of-focus	Slide bent or damaged.	Check and replace slide.
	Dirty screen, mirrors or lens.	Clean screen, mirrors and lens with lens cleaner and a soft cloth (be careful not to scratch surfaces).
	Binding focus knob.	Adjust for equal amount of clearance on either side of knob.
	Projection lens not set properly in lens carrier.	Refer to paragraph 38 and reset projection lens; then check framing as described in paragraph 59.

70. AUTOMATIC FOCUSING SYSTEM PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
No automatic focusing operation	Autofocus lamp circuit open or lamp burned out.	Correct open circuit or replace lamp (see paragraph 37).
	No DC power supply voltage to servo amplifier.	Correct power supply condition.
	Broken collector wire to phototransistor.	Replace purple phototransistor wire.
	Broken motor wire(s).	Replace motor wire(s).
	"E" ring missing from safety clutch shaft.	Replace missing "E" ring.
	Motor locked due to end of life (brush breakage).	Refer to paragraph 39 and replace motor.
	Binding foucs knob shaft.	Correct binding condition or replace knob.
Soft focus	Autofocus lamp and/or lens dirty.	Clean lamp and lens with soft cloth and cleaner.
	Autofocus lamp filament out-of-focus.	To refocus filament (see paragraph 37, steps (1) and (2).
	Mechanism binding.	Correct binding condition or replace mechanism.
Slow travel over entire range	Autofocus lamp and/or dirty.	Clean lamp and lens.
	Pressure fingers not holding slide firmly.	Adjust tension of pressure fingers.
	Autofocus gear train binding.	Clean and lubricate gear train with B&H grease P/N 713279.

70. AUTOMATIC FOCUSING SYSTEM PROBLEMS (CONTINUED).

TROUBLE	PROBABLE CAUSE	REMEDY
Continuous hunting for focus	Lens or lenses loose in mounts.	Secure lenses and adjust (see paragraph 38).
	Phototransistor loose in mount.	Secure phototransistor and check focusing (see paragraph 58).
	Excessive gear lash in autofocus gear train.	Correct condition or replace worn gears.
	Open feed back resistor (R7) in servo amplifier.	Replace resistor (R7).
Clutch ratchets continuously with slide in aperture	Slide surface out-of-range in autofocus system.	Adjust autofocus system (see paragraph 59).
	Faulty slide or mount.	Replace slide.
	Pressure fingers not holding slide firmly.	Adjust tension of pressure fingers.
Clutch ratchets continuously without slide in aperture	Half of DC power supply dead.	Check PCB connector and/or correct power supply condition.
	Shorted current pump transistor in servo amplifier.	Replace transistors Q1 and Q2.
	Broken emitter lead on phototransistor.	Repair or replace lead.

71. PROJECTION LAMP SYSTEM PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
No illumination	Defective projection lamp.	Refer to paragraph 20 and replace projection lamp.
	Poor lamp contact.	Clean terminals. Check in-line connector on red wire. Check wiring to lamp switch and the wire from the switch to the lamp socket.
	Defective transformer.	Check for 16VAC on red-to-yellow wires and 18VAC on red-to-gray wires near the transformer to determine proper transformer output. Replace transformer if necessary.
Low output	Improperly set voltage selector switch ("AX" models only).	Correct voltage selector setting.
	Decayed projection lamp filament.	Replace projection lamp (see paragraph 20).
	Low lamp terminal voltage.	Measure terminal voltage. If below 18 ±1VAC, check wiring and lamp socket for high voltage; if voltage okay and there is no arcing in the wiring or socket the transformer should be replaced.
Short lamp life or too bright rear screen	Improperly set voltage selector switch ("AX" models only).	Correct voltage selector setting.
	High lamp terminal voltage.	Measure terminal voltage. If above 18 ±1VAC replace the power transformer. If voltage okay, line voltage may be too high.

72. BLOWER SYSTEM PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
No operation	Obstruction in blower wheel.	Clear the obstruction.
	Improper voltage at motor terminals.	Measure for approximately 11.0VDC at motor terminals. Also refer to paragraph 81 in the "System Analysis" section for more information.
	Defective blower motor.	If above voltage check did not isolate problem; replace the blower motor.
	Blown fuse on power supply.	Replace power supply fuse.
Audible noise, squeal, rubbing, etc.	Blower wheel slipping.	Tighten wheel to motor shaft.
	Blower wheel rubbing on housing.	Check mounting at motor-to-mounting plate and blower assembly-to-lower housing.
	Worn blower motor bearings or brush noise.	Replace blower motor.
Electrically noisy	Defective motor capacitor.	Check bridge rectifier and C7 on power supply.
	Defective blower motor.	If noise persists after replacing capacitor (C7); blower motor is defective and must be replaced.
Runs slow or not enough air flow	Improperly set voltage switch ("AX" models only).	Correct voltage selector setting.
	Obstruction to rotation.	Check for obstructions in the housing, wheel slippage on motor shaft and loose mountings.
	Air flow blockage.	Check for dirt accumulation on fan blades; blocked intake opening, lamp cooling duct, lamphouse area and lamp change door.
	Improper voltage.	Measure for approximately 11.0VDC at motor terminals. If low, refer to paragraph 81 in the "System Analysis" section for more information.
	Defective blower motor.	Replace blower motor.
No air flow	Disconnected plug on power supply or loose blower fan.	Reconnect power supply plug or secure blower fan.
	Defective blower motor.	Replace blower motor.

73. POWER SUPPLY AND POWER SOURCE PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
All DC voltages low	Improper line voltage ("A," "AN" models only).	Check for low line voltage.
	Defective transformer.	Check for high resistance in power transformer primary; check for open thermal fuse.
	Defective or improperly set voltage selector ("AX" models only).	Reset voltage selector. Check tap voltages and compare with proper wiring diagram.
	Defective transformer.	Check for high impedance in primary.
All AC voltages high	Improper line voltage ("A," "AN" models only).	Check for high (over 130VAC line voltage.
	Defective transformer.	Check for shorts in primary.
	Defective or improperly set voltage selector ("AX" models only).	Reset voltage selector. Check tap voltages and compare with proper wiring diagram.
	Line current too high for voltage selector setting ("AX" models only).	Reset voltage selector.
	Defective transformer.	Check for short in primary causing excessive transformer heat.

NOTE: For additional power supply and power source trouble shooting, refer to paragraph 79 in the "System Analysis" section.

74. MASTER SOUND/PROJECTION CONTROL PANEL PROBLEMS.

TROUBLE	PROBABLE CAUSE	REMEDY
No sound	Open leads on volume control and/or tone control.	Check for continuity to wiper and top of volume and/or tone control.
Scratchy sound when sliding (moving) the volume and/or tone control	Defective resistors or capacitors.	Check resistor VR201 and VR202 and capacitor C214 and C218 for leakage.
Too loud	Open lead.	Check ground lead continuity.
"Power" switch control dead, shorted or intermittent	Defective wiring or "Power" switch.	Check for shorts and repair or replace "Power" switch with the exact same type.
"Power" switch will not shut-off	Defective "Power" switch.	Replace "Power" switch with exact same type.
"Slide Tray" switch dead, shorted or intermittent	Defective wiring or "Slide Tray" switch.	Check for shorts and repair or replace switch. If problems persist; check "System Analysis" and "Electrical Trouble Shooting" sections for remedies.
"Projection Lamp" switch dead, shorted or intermittent	Defective wiring or "Projection Lamp" switch.	Check for shorts and repair replace switch. If problems persist, isolate problem to switch and replace.
Tape recorder pushbutton controls or cassette insertion problems	Mechanical system not functioning properly.	See paragraph 49 in the "Tape Recorder Repair" section for mechanical operation of all push-button tape recorder controls and cassette guide (loading) slot.

75. ACCESSORIES PANEL CONTROLS AND JACK PROBLEMS.

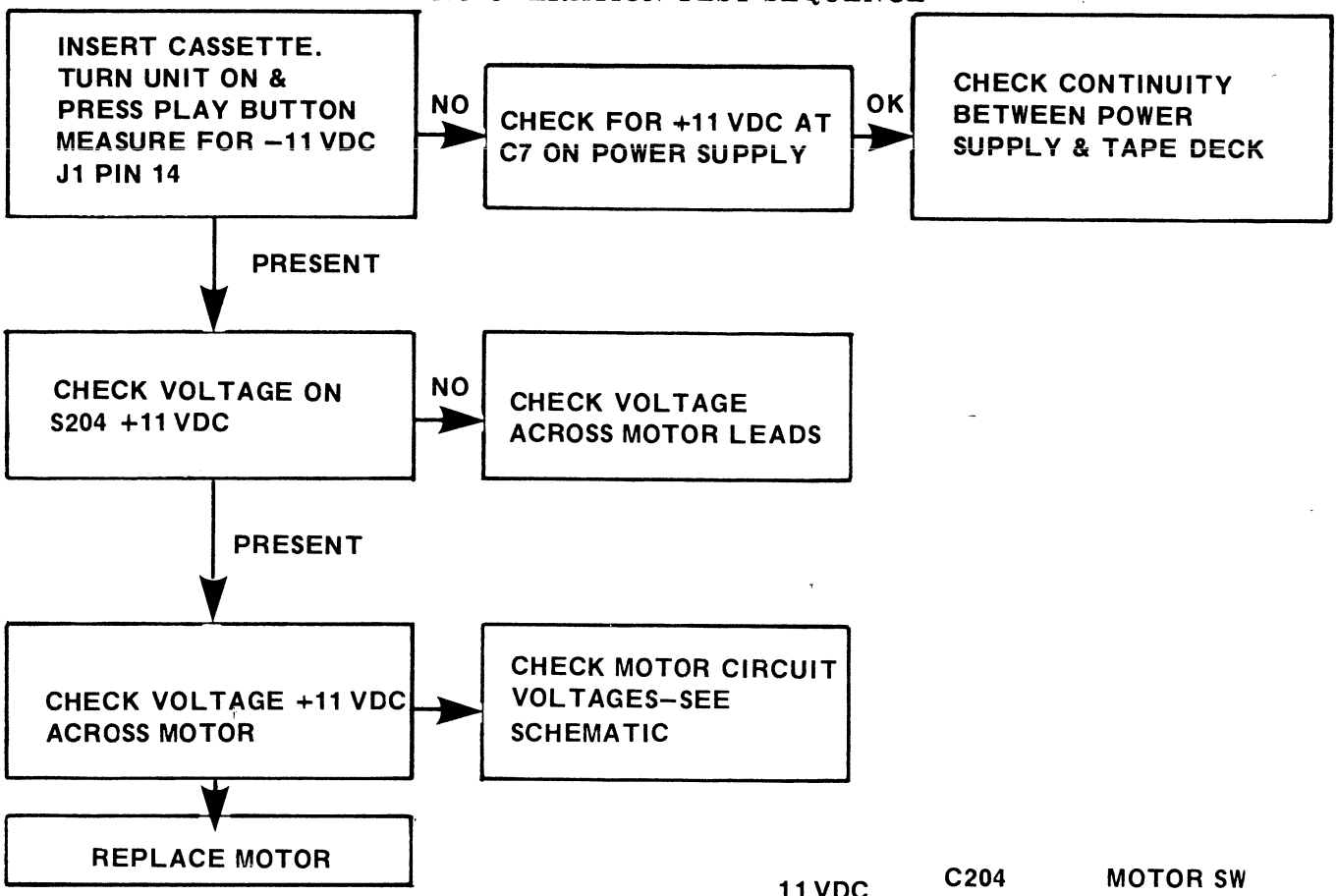
TROUBLE	PROBABLE CAUSE	REMEDY
Remote DIN plug does not work.	Defective plug (all except 850 models).	Check for shorts and replace if necessary.
Remote plug works intermittently	Poor connectors.	Check for loose contact and clean all contacts.
"Pulse Control" switch does not work or works intermittently	Poor contact or defective switch.	Isolate problem to switch. Clean and resolder contacts or replace switch.
PA switch does not work or works intermittently	Poor contact or defective switch.	Isolate problem to switch. Clean and resolder contacts or replace switch.
Microphone, external speaker or headphone jack does not work or works intermittently	Defective component or poor plug contact.	Replace defective jack.

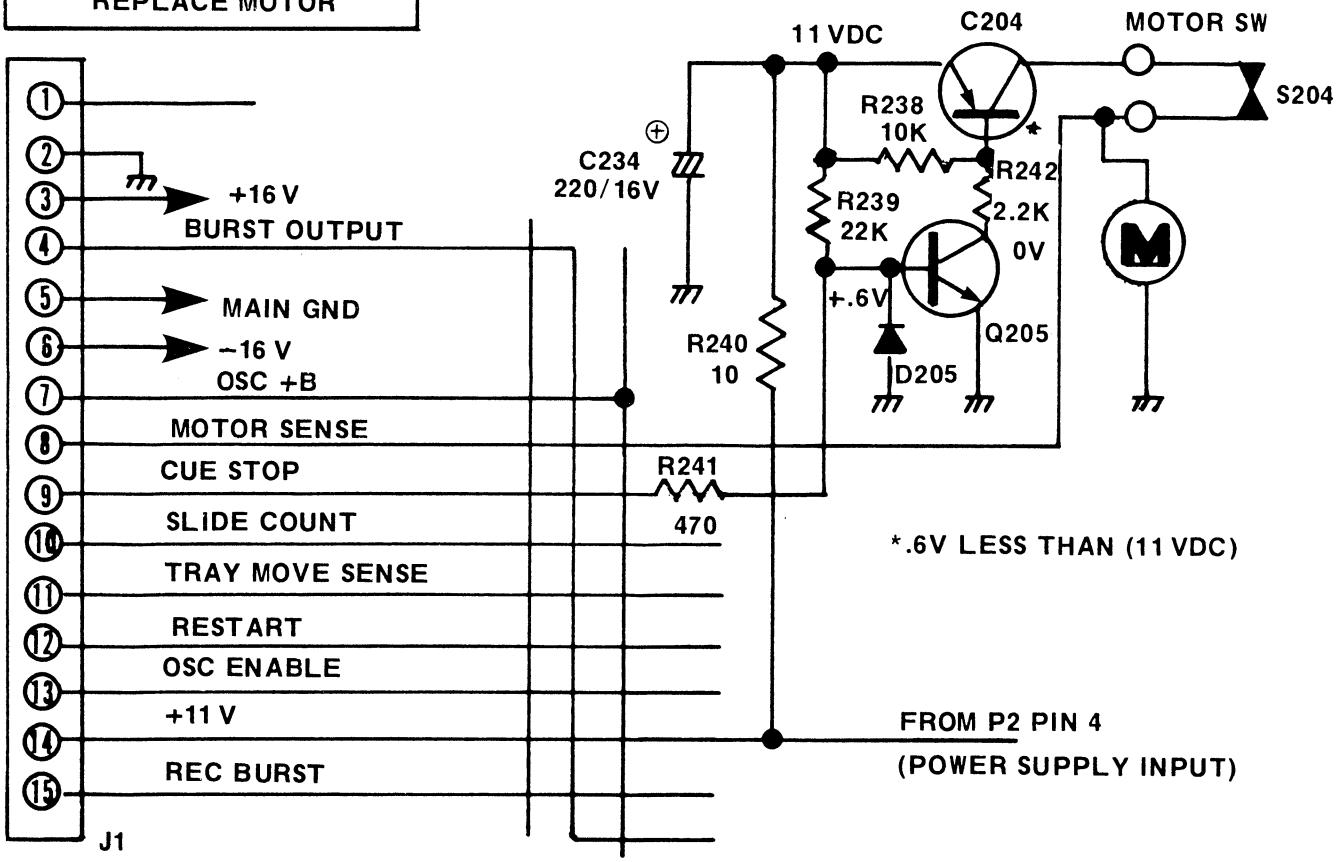
76. SPECIAL FEATURES CONTROL PANEL PROBLEMS.

"Pulse Record" switch sloppy movement	Defective switch (830, 840 models only).	Replace defective "Pulse Record" switch.
No pulse record	Defective switch (830, 840 models only).	Isolate problem to "Pulse Record" switch and replace.
LED indicator inoperative	Defective LED indicator (840 models only).	Refer to "System Analysis" section ("Miscellaneous, last system discussion) and repair or replace LED.
"Cue-Stop Restart" button does not function	Defective "Restart" switch (840 models only).	Refer to paragraph 83(F) in the "System Analysis" section and repair or replace faulty "Cue-Stop Restart" switch.
Microprocessor keyboard erratic	Keyboard not working properly (850 models only).	Refer to paragraph 83(H) in the "System Analysis" section to isolate problem to the keyboard and replace keyboard if necessary.
	Microprocessor not working properly (850 models only).	Refer to paragraph 66 and check the microprocessor for self-analysis as instructed in the last discussion.

77. TAPE RECORDER DRIVE SYSTEM PROBLEMS.

NO OPERATION TEST SEQUENCE





77. TAPE RECORDER DRIVE SYSTEM PROBLEMS (CONTINUED).

TROUBLE	PROBABLE CAUSE	REMEDY
Runs steadily off-speed	Low power supply voltage.	Check and repair or replace.
	Incorrect speed pot setting.	Reset or replace as needed.
Runs erratically	Motor defect.	If system is not ±11VDC, replace motor.
	Defective capacitor.	Check for open at C7 on the power supply and replace if necessary.
Thumps in speaker audio (one to three per second)	Flat spot on pressure roller.	Run continuously for one hour.
Audible mechanism noises	Flywheel bearing.	Lubricate or replace.
	Pressure roller bearing.	Lubricate or replace.
Wow or flutter	Worn pressure roller.	Replace pressure roller.
	Worn or dirty drive belt.	Clean or replace drive belt.
	Defective tape cassette.	Check with known "good" cassette.
	Speed control variable resistor defective.	Adjust or replace defective resistor.
Rewind too slow	Defective tape cassette.	Check with known "good" cassette.
	Worn drive belt.	Replace drive belt.

78. ELECTRONIC TROUBLE SHOOTING AND SEQUENCE TEST CHARTS.

The electronics for these projectors are contained on two to four printed circuit boards depending on model and features.

The mechanical tape deck and printed circuit board assembly contains the electronics for motor control logic, motor drive amplifiers, 1.0KHz pulse detect circuitry and audio record/play electronics. While this assembly is truly modular and readily replaceable, it comprises the bulk of the projectors electronics and should be repaired rather than replaced except in the case of extensive physical damage.

The power supply board contains all supplies including the autofocus electronics. Note that all models except the 815A model have the automatic focusing system.

The option board for the 830 models contains circuitry for recording 1KHz slide advance pulses.

The option board for the 840 models contains circuitry for recording both 1KHz slide advance and 150Hz cue-stop pulses as well as circuitry for detecting cue-stop pulses.

The option board for the 850 models contains the microprocessor electronics and a piggyback infrared receiver board assembly for detecting light pulses from an infrared remote control transmitter.

All option boards plug into a printed circuit edge connector at the front edge of the main (tape recorder) printed circuit board just below the tape deck pushbuttons. The front bezel must be removed in order to gain access to the option boards.

A. FIRST CHECKS.

Before attempting any electrical diagnosis a simple check of supply voltages may save much of the time and effort of back-tracking through circuits, connectors, etc

Extra care should be exercised in checking +16V or -16V on the main deck since accidental shorting to ground would immediately blow power supply fuses F3 and F4. Shorting to points other than ground might result in damage to semiconductors. Figure BG shows the location of some suitable points for checking these voltages on the main deck.

B. CONDITIONS FOR DIAGNOSTIC CHART TESTING.

(1) Make routine check of supply voltages at points indicated in Figure BG.

(2) No slide tray.

(3) Controls and switches set as specified in each chart.

C. BASIC PROBLEMS CHART LIST.

The following list does not include all possible problems but measurements involved in correcting these problems will usually uncover the cause of others.

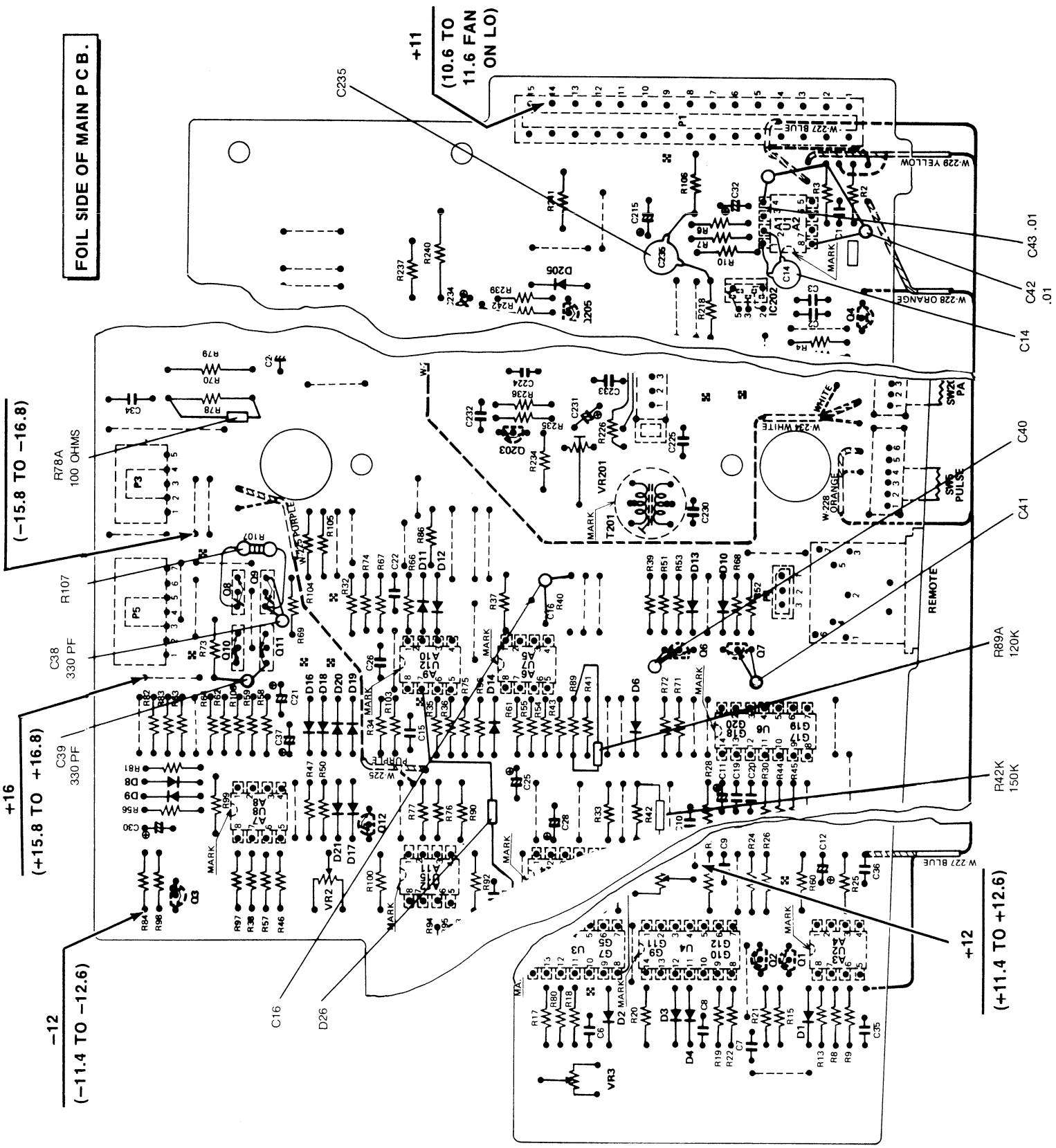


Figure BG. Supply Voltage Check Points on Foil Side of Main PC Board Assembly

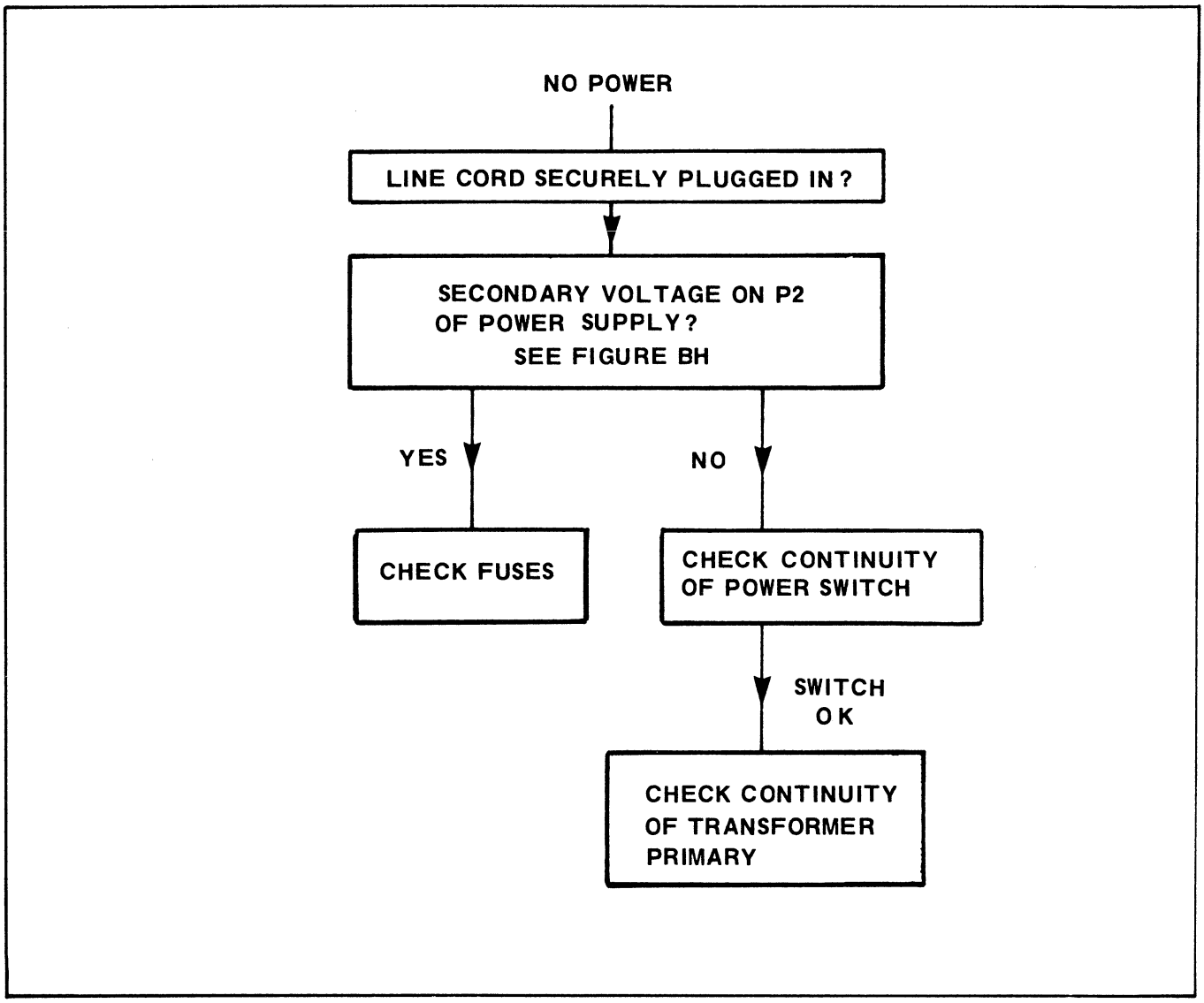


CHART 1 — DEAD UNIT - NO APPARENT POWER

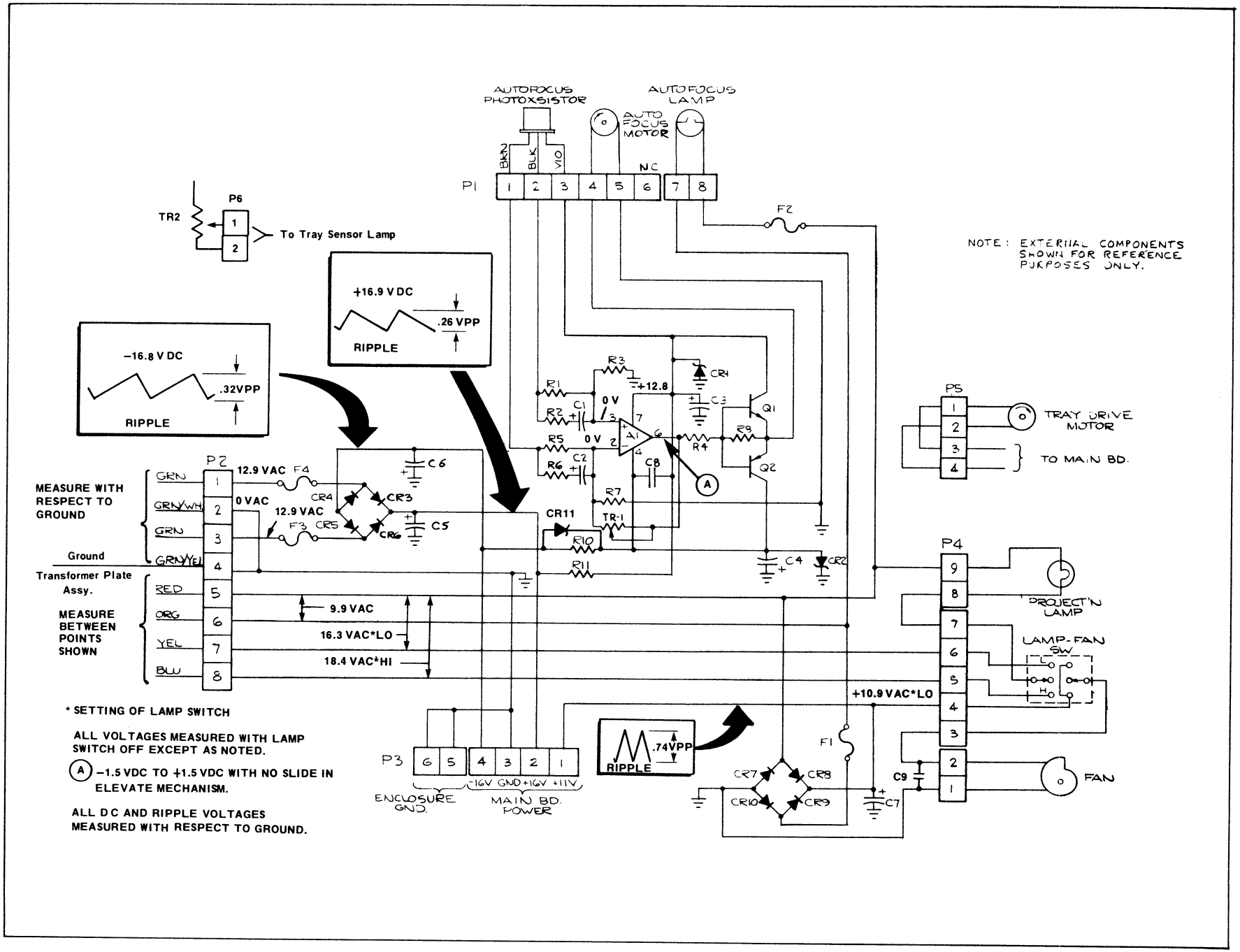


Figure BH. Power Supply PCB Assembly

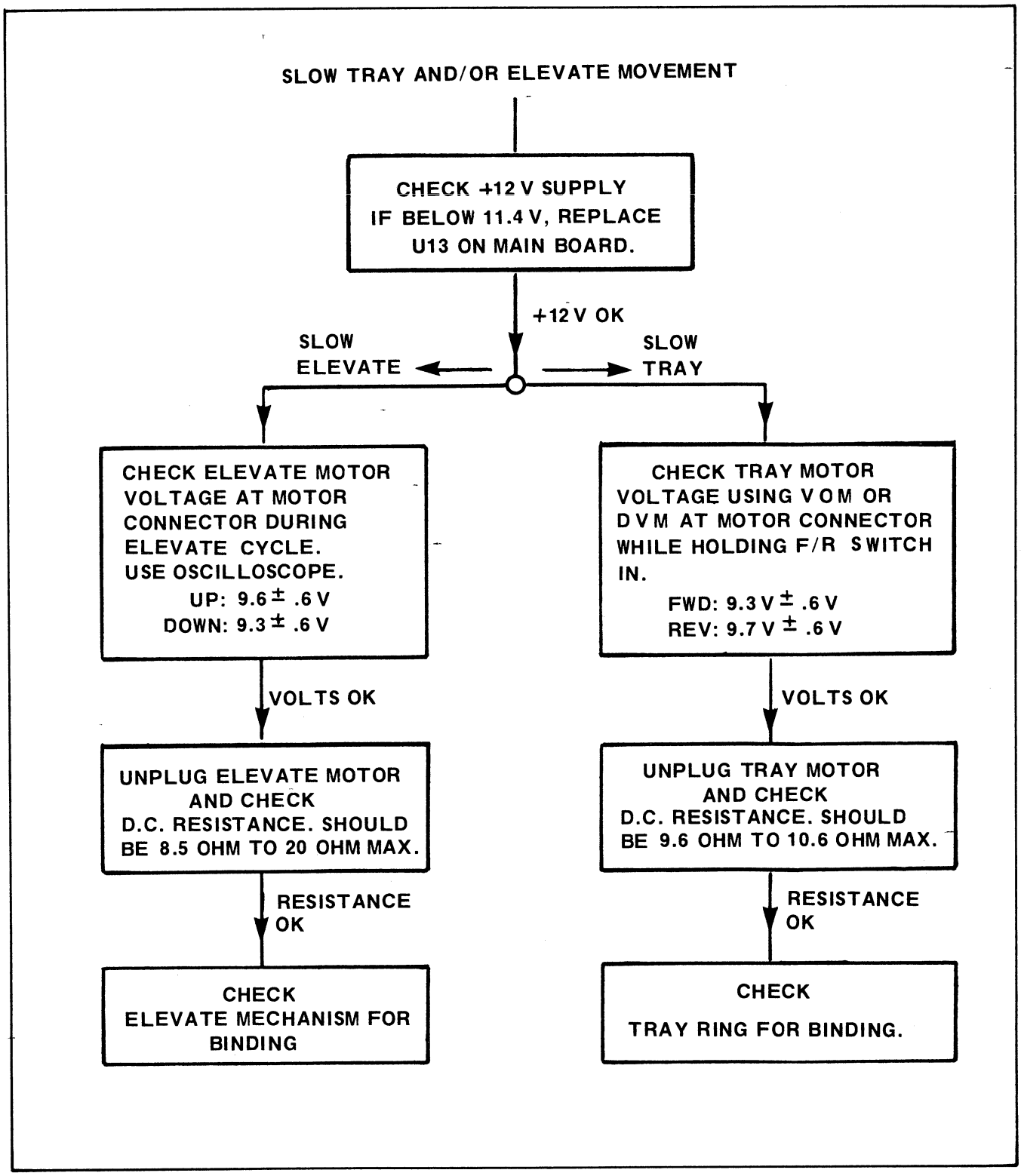


CHART 2 — SLOW TRAY AND/OR ELEVATE MOVEMENT

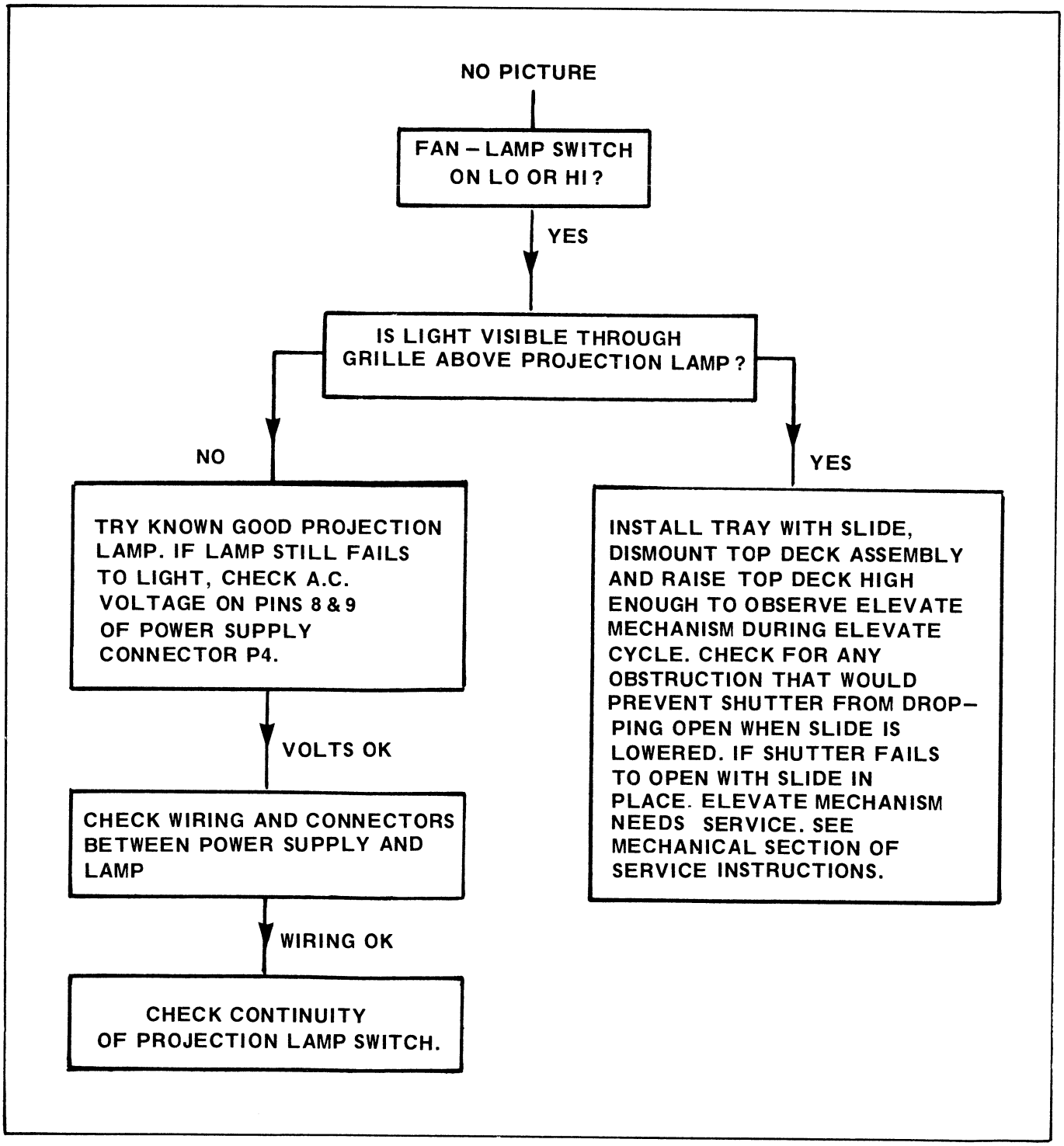


CHART 3 — NO PICTURE

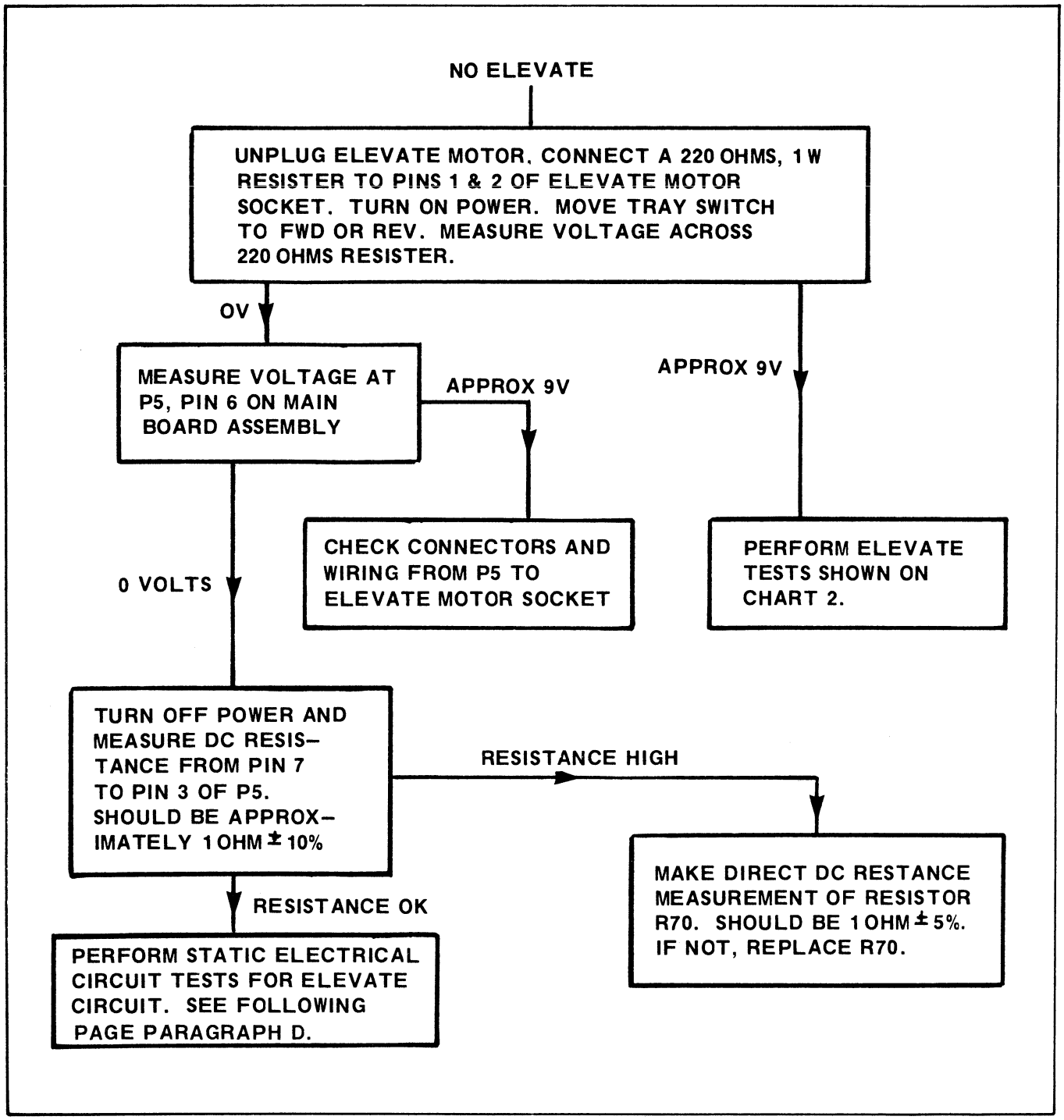


CHART 4 — NO ELEVATE

D. STATIC ELECTRIC CIRCUIT TEST PROCEDURE.

(1) Unplug elevate motor connector.

(2) Plug a 220 ohm, 1 watt resistor into pin 1 and pin 2 of connector socket.

(3) Turn the "Power" switch ON.

(4) Measure for the following voltages.

The "Slide Tray" switch must be held in the FWD position for the following voltages to remain. For REV position, the transistor voltages will be for Q6 instead of Q7.

Q7 base	<0.4V
Q7 collector	+12V
G29 pin 10	+12V

The following voltages will remain after the "Slide Tray" switch is released:

G26 pin 3	+12V
G13 pin 13	+12V
G13 pin 12	+12V
G13 pin 11	+12V

The following voltages will remain only as long as elevate is in upward motion:

A6 pin 5	+0.7V
A6 pin 7	+9.9V
Q13 collector	+0.7V
G17 pin 10	0V

(5) After measuring all of the above voltages, momentarily short pin 5 to pin 3 of the elevate motor connector. The tray motor should move to the next slide position of the tray.

The following voltages should then be read:

G17 pin 10	+12V
G13 collector	+9.5V
A6 pin 7	-9.4V

(6) Momentarily short pin 5 to pin 4 of the elevate motor connector. This should cause pin 7 of A6 to go to 0 volts thus completing the elevate and slide change cycle.

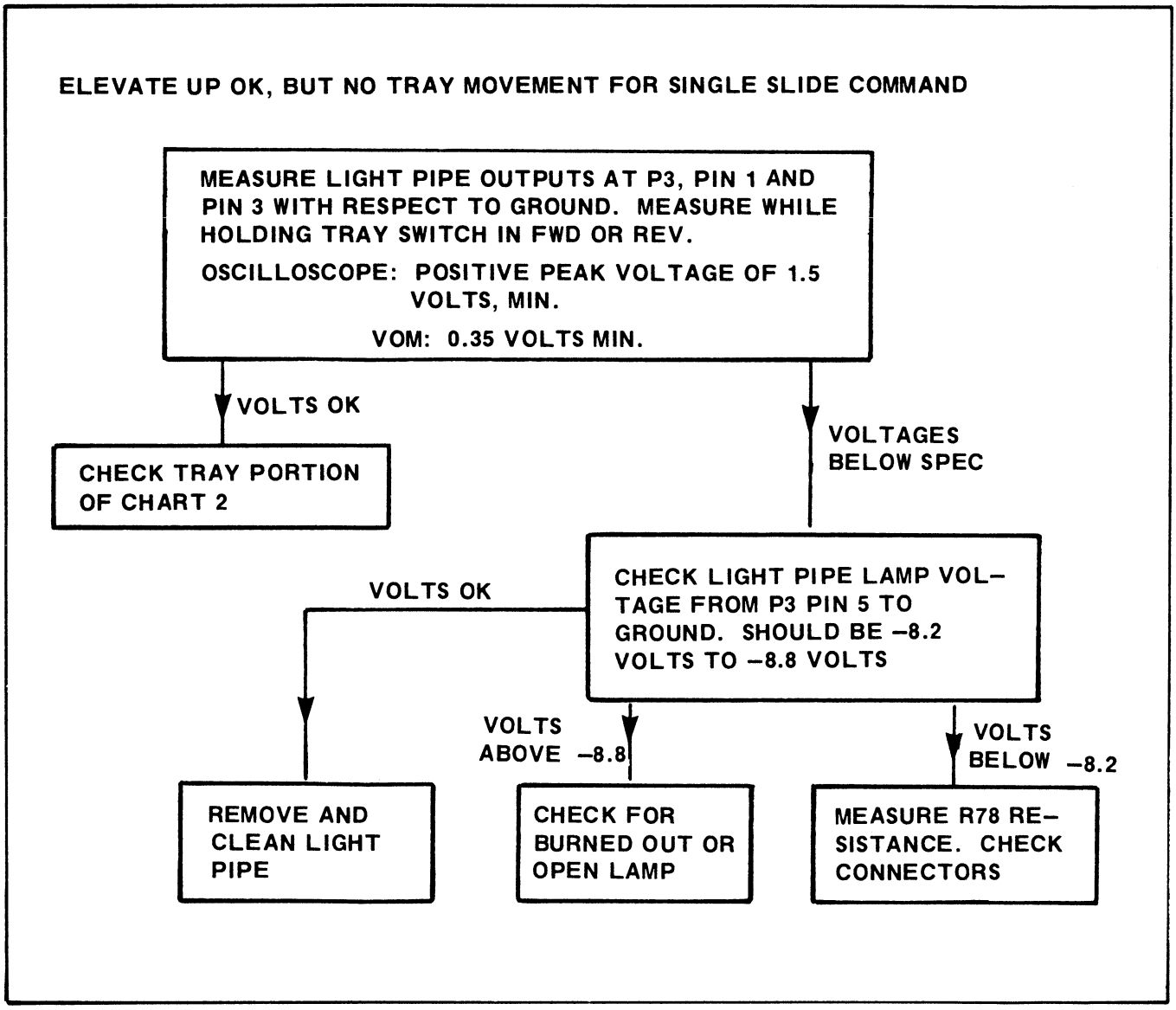


CHART 5 — ELEVATE UP OKAY BUT NO TRAY MOVEMENT FOR SINGLE SLIDE COMMAND

CHART 6 — PARTIAL ELEVATE (UP OR DOWN)

Before making detailed voltage measurements, check the elevate mechanism for binding by manually rotating the elevate motor gear clockwise (as viewed from the bottom of the top deck).

A slight loading can be sensed in the last seven or eight revolutions of the elevate motor. The last two revolutions may show still more loading. This is normal. The elevate motor overcurrent protection circuit automatically turns off the motor drive if the loading is too high. The wave form of normal elevate motor current flow is shown in Figure BJ below. This can be measured at pin 7 of connector P5 during the elevate drive.

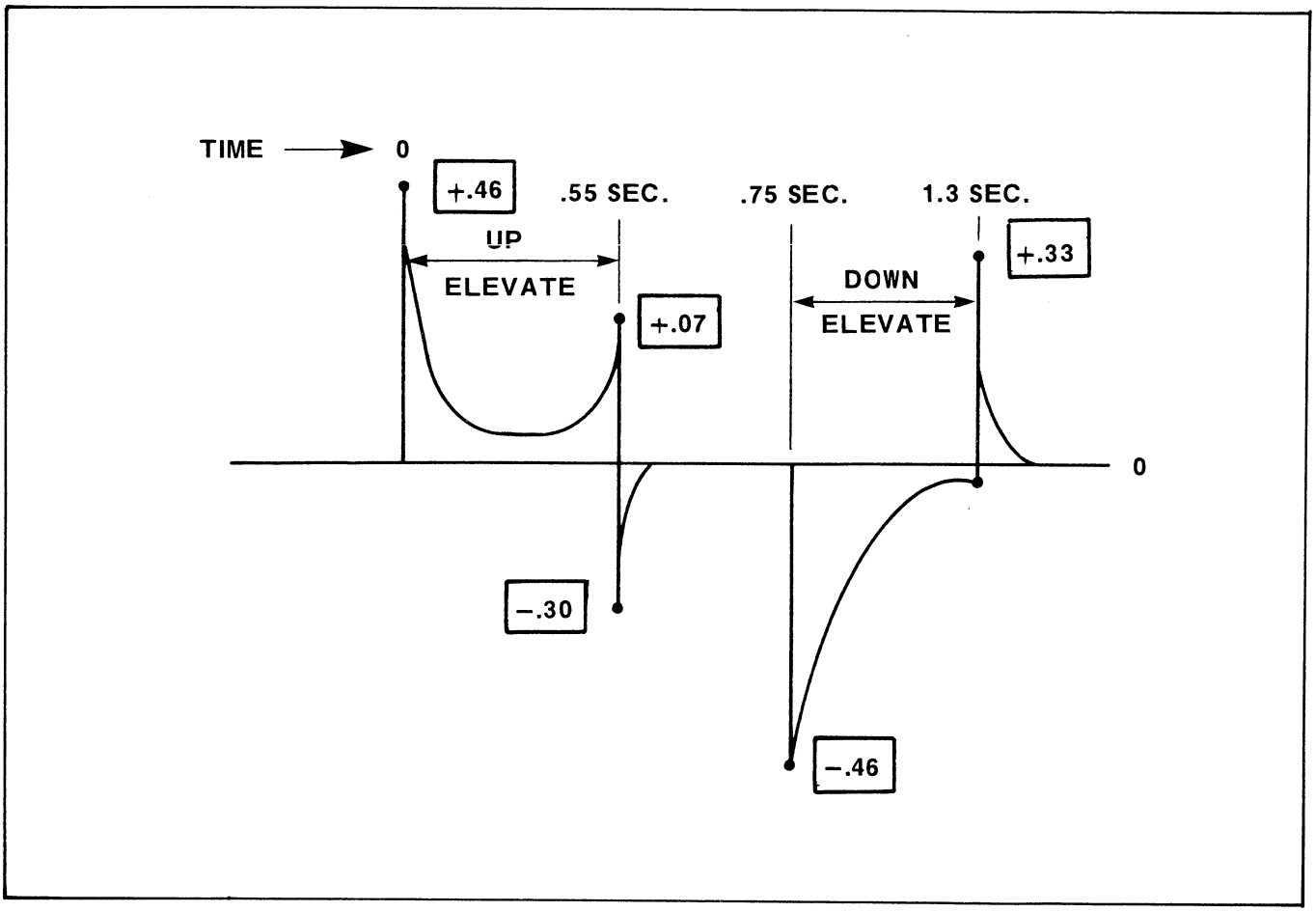


Figure BJ. Wave Form of Normal Elevate Motor Current Flow

Values shown in the boxes (Figure BJ) are the approximate DC voltages at each peak. Actual wave forms may not be quite as smooth as shown due to motor commutator effects.

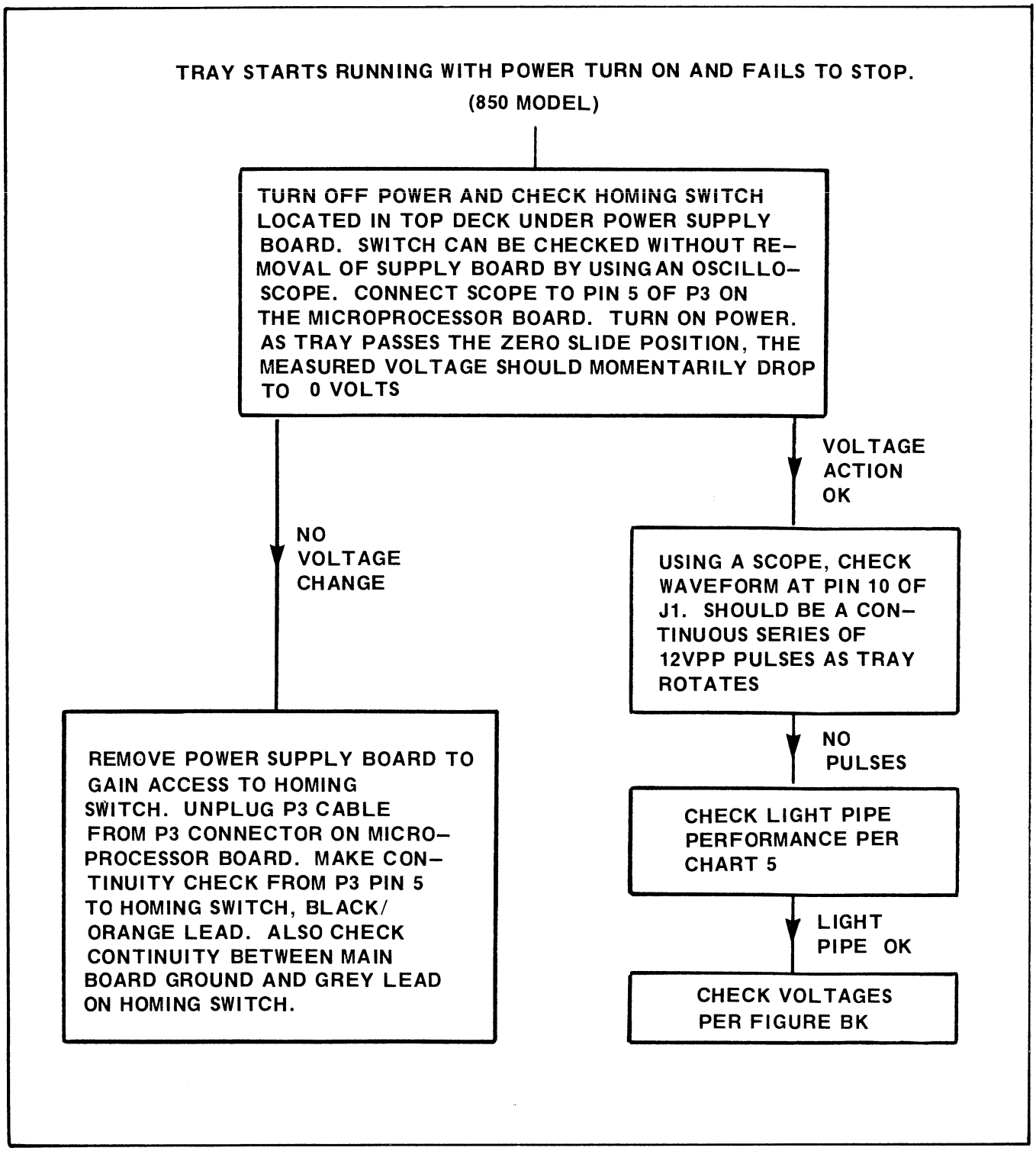


CHART 7 — SLIDE TRAY MOVES WITH POWER TURNED ON AND DOES NOT STOP (850 MODELS ONLY)

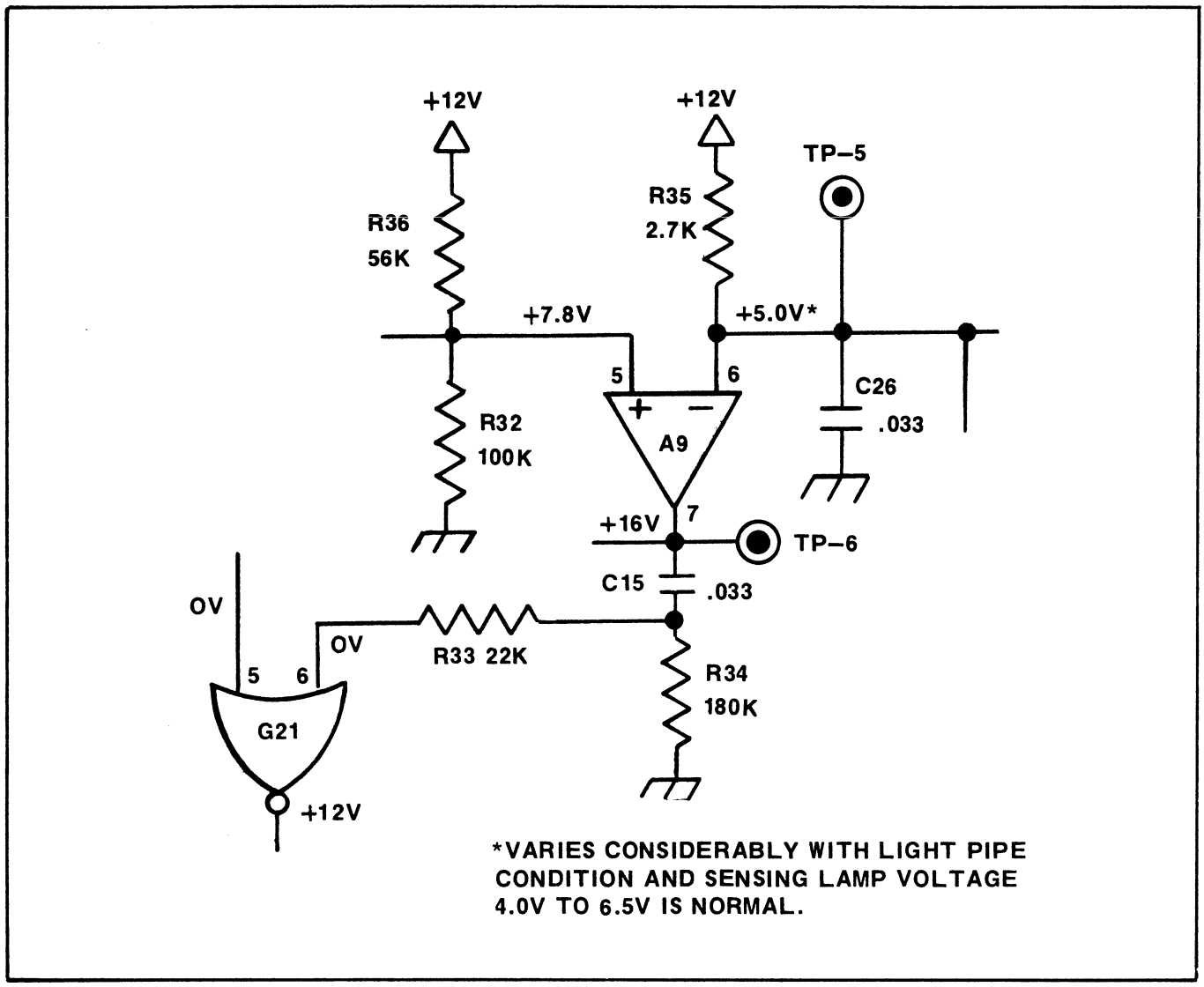


Figure BK. Tray Drive Threshold Sensing Amplifier

SYSTEM ANALYSIS

BLOCK DIAGRAMS ARE ON 11 X 17 FOLDOUTS AT THE END OF THIS SECTION FOR YOUR CONVENIENCE.

To adequately cover the operation of the projector electrical circuits, it has been necessary to separate the electrical systems into six major areas of discussion. The following lists in order, and by paragraph designations and description, the systems analyzed in this section.

79. Transformer and Power Supply Systems

80. Projection Lamp System

81. Blower System

82. Tape Recorder Audio System

A. Signal Flow in the Play Mode

B. Signal Flow in the Audio Record Mode

C. Nominal Voltages

83. Tape Recorder Digital Systems

A. Pre-Amplifier and 1.0KHz Digital Filter

B. Slide Elevate System

C. Tray Drive System

D. Overall Slide Change System Behavior

E. Miscellaneous Circuits

F. Option Board, 1.0KHz and 150Hz

G. Option Board, 1.0KHz

H. Option board, Microprocessor

J. Infrared Receiver PC Board

84. Automatic Focusing System

Miscellaneous

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79. TRANSFORMER AND POWER SUPPLY SYSTEMS.

All of these projectors incorporate line isolated DC power supplies for the electronics circuitry and line isolated low voltage AC taps for operation of the projection lamp. Major differences between the single-line voltage and multiple-line voltage "AX" models will be found in the mains connected circuitry on the primary of the transformer and the transformer itself.

All Except "AX" Models. The mains connected circuitry on the single-line voltage models consists of an attached three-wire grounded line cord, a strain relief and a 2-pole single-throw power line switch.

"AX" Models Only. The multiple-line voltage models are equipped with a line cord receptable (three-wire grounding type), a 2-pole single-throw power switch and a voltage selector switch for the selection of any one of six input voltages. The power transformer is equipped with an internal thermal protection device which opens the primary if the transformer becomes overheated. The power transformer primary windings, when properly arranged by the voltage selector switch, provide input voltages of 110, 130, 150, 220, 240 and 260VAC. The transformers are capable of 50/60 Hz operation. In global environments this transformer is considered a "safety isolating transformer."

There are two secondaries with taps at various voltages on both single-line (Figure CA) and multiple-line voltage (Figure CB) transformers. One secondary, with a nominal output voltage of 26VAC, total, is denoted with green, green/white and green wiring. The other

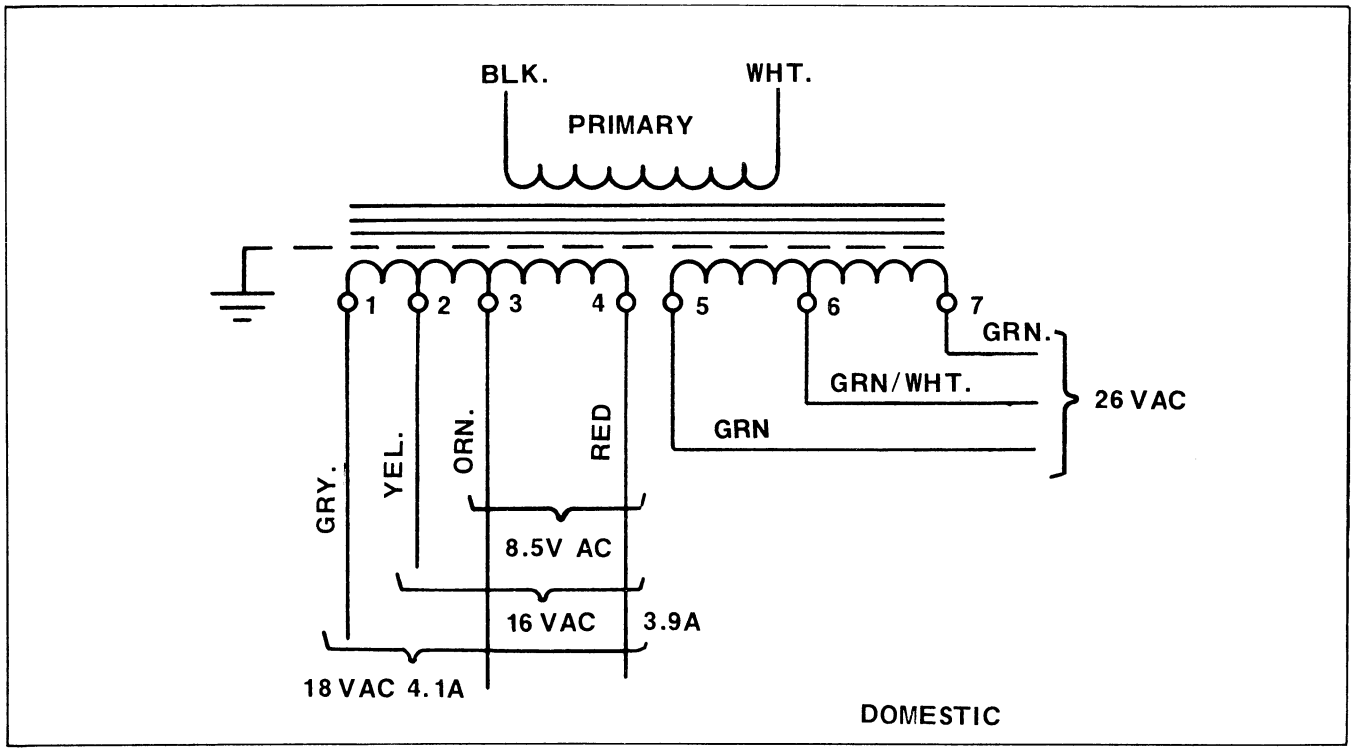


Figure CA. Transformer Wiring Diagram
("A" and "AN" Models Only)

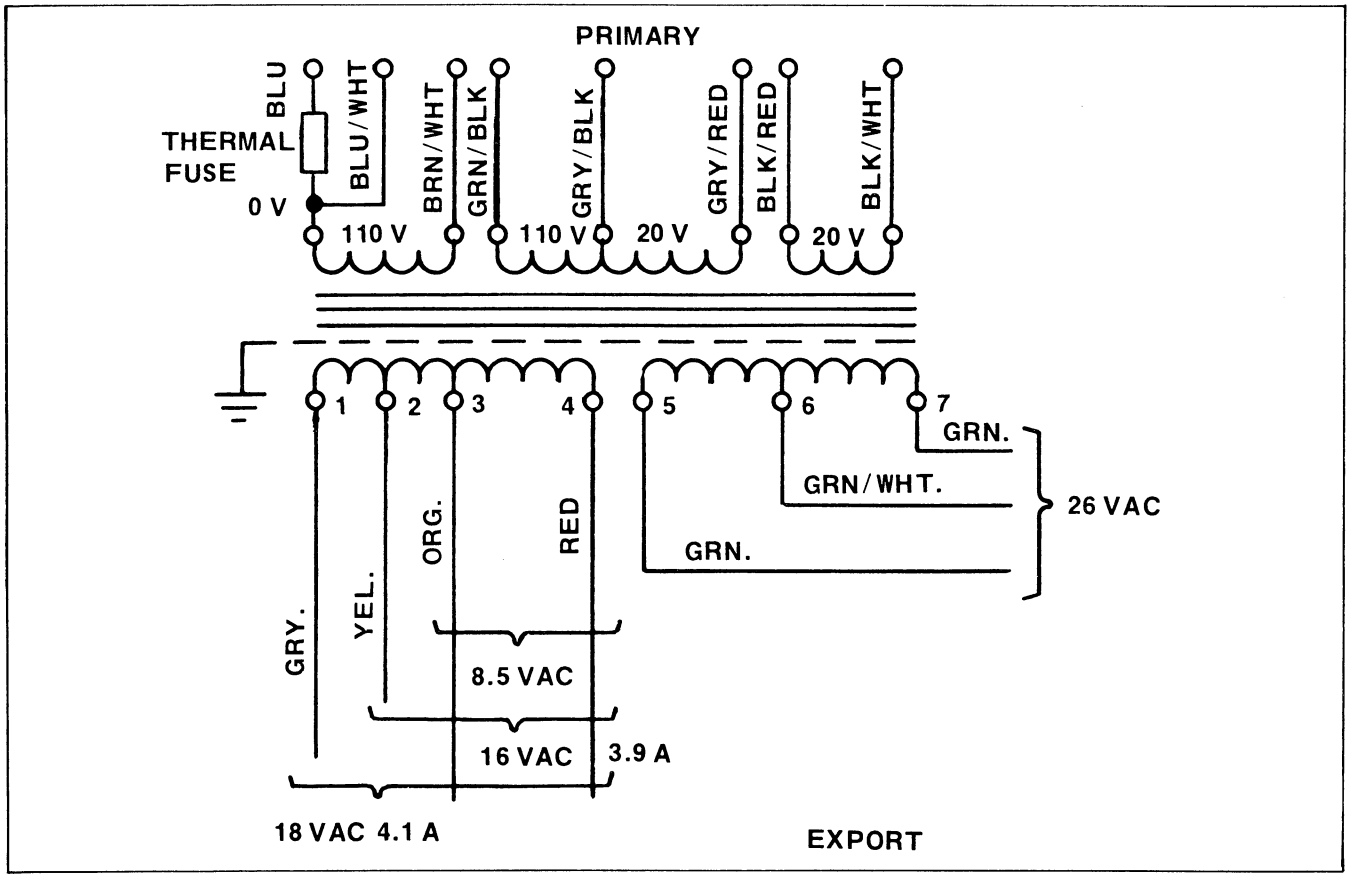


Figure CB. Transformer Wiring Diagram
("AX" Models Only)

secondary starts with a red wire. Succeeding taps on this secondary yield 8.5VAC (orange), 16VAC (3.9A) (yellow) and 18VAC (4.1A) (gray) all with respect to the red wire. The 16VAC and 18VAC taps are capable of driving the projection lamp at two brightness levels.

The AC voltages from the secondaries of the transformer are fed to a power supply PC board which converts most of these AC voltages to DC in order to power the electronic components and motor circuits of the projector.

Power Supply PC Board Description. On all projectors except the 815A manual focusing model, there are a total of five DC supply voltages present on the power supply PC board. DC voltages for the tape recorder, slide advance motor, blower motor and the automatic focusing system are derived from components on this power supply PC board.

The power supply PC board is designed with six separate pin connectors for all automatic focusing models and five separate pin connectors for the 815A manual focusing model. These connectors and their functions are as follows:

8-Pin Connector P2 — receives AC power from the transformer secondaries.

8-Pin Connector P1 — supplies power to the automatic focusing system; pins 7 and 8 to the autofocus lamp and pins 1 through 5 to the phototransistor and motor (see Figure 26 in the parts catalog manual).

6-Pin Connector P3 — supplies power to the tape recorder and also grounds various metal parts in the enclosure.

9-Pin Connector P4 — pins 1 and 2 supply power to the blower motor; pins 3 through 7 supply power to the lamp/fan switch and pins 8 and 9 supply power to the projection lamp.

4-Pin Connector P5 — does not receive power from the PC board but delivers power from the main PC board (tape recorder) to the ring drive motor.

2-Pin Connector P6 — does not receive power from the PC board but acts as a control channel between a variable resistor TR2 (on the PC board) and the tray sensor lamp.

Power Supply PC Board Operation. The power supply PC board contains three DC power supplies. A full wave bridge rectifier drives all audio and burst (pulse) system electronics. This supply consists of four diodes CR3, CR4, CR5 and CR6. In series with the AC legs of these diodes are two 2.5 amp fuses (F3 and F4) (one on each leg).

Diodes CR1 and CR2 involved with R10, R11, C3 and C4 act as supply filters. A 2.5 amp fuse (F2) is in series with one of the legs of the autofocus lamp.

Power Supply System Analysis. The power supply PC board feeds power to the main (tape recorder) PC board through the full wave rectifier made up of CR3, CR4, CR5 and CR6 with filtering capacitors C5 and C6 (3300 MFD) as part of the circuit with voltages at the pins of connector P3 as follows: pin 4 (-16V); in 3 (ground); in 2 (+16V); pin 1 (+11V); pins 5 and 6 are safety grounds.

The tape drive motor receives its 11VDC power from the power supply PC board through pin 4 of connector P2 on the tape recorder and a motor control circuit (see Figure CC).

The slide advance system drive motors receive power from the main PC board (tape recorder) through the tray and elevate control electronics. This circuitry is connected to a remote control socket that parallels the tray advance switch when in use.

NOTE: The 850 models do not have a tray advance switch or remote socket and control is exercised through the microprocessor option board.

The DC power supply activating the blower motor is supplied from the transformer primary (red, orange wires). 9.9VAC is applied to a full wave bridge rectifier consisting of diodes CR7, CR8, CR9 and CR10 with a filtering capacitor C7 (2200 MFD).

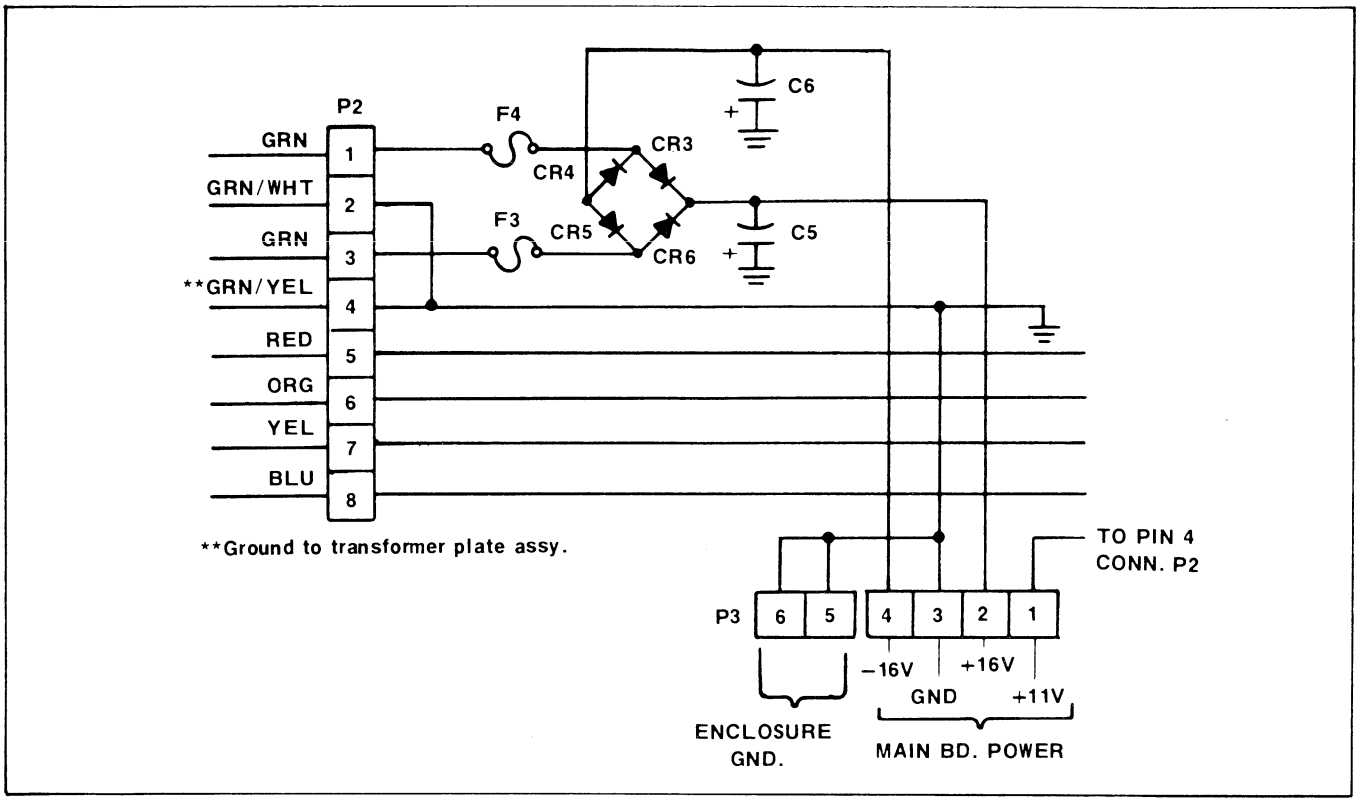


Figure CC. Power Supply PCB Circuit that
Feeds DC Power to Main PC Board

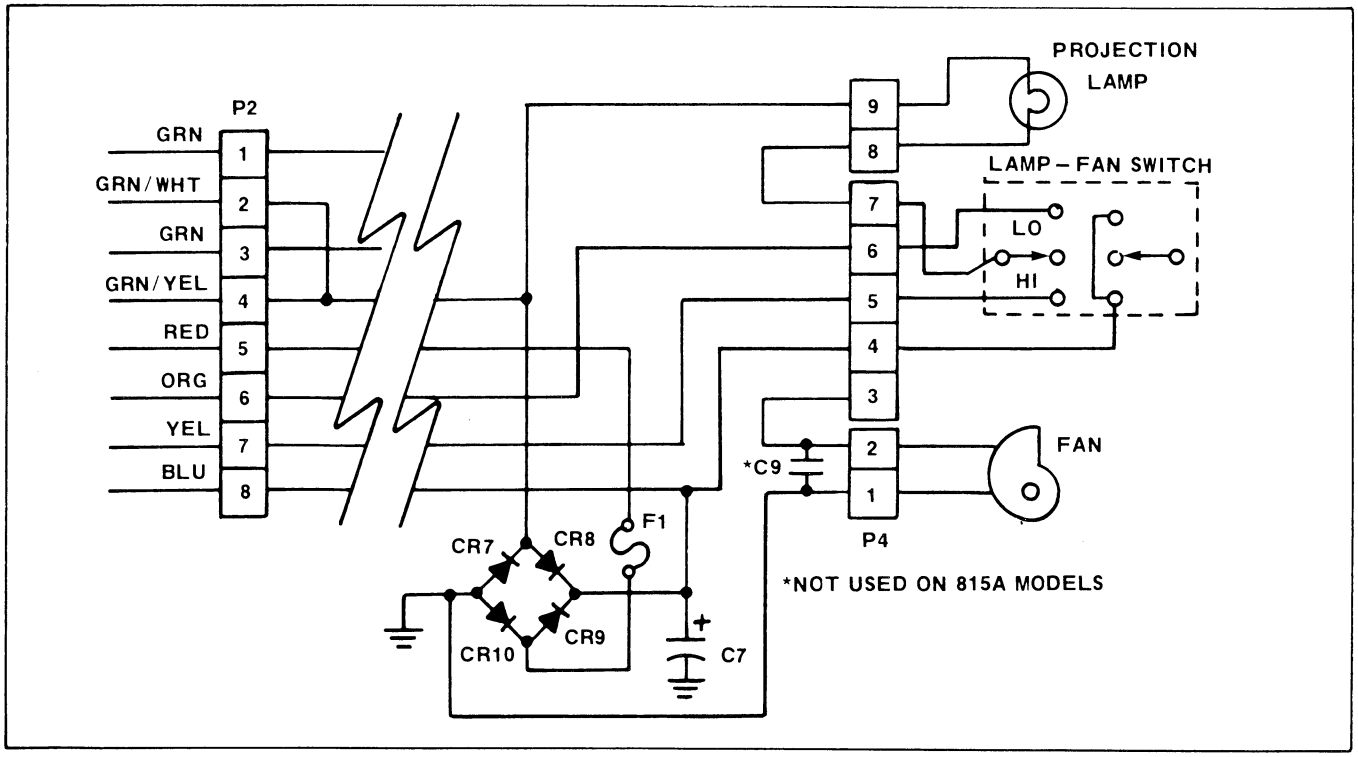


Figure CD. Projection Lamp and Blower
Motor System Wiring Diagram

850 Models Only. A 9.1MFD capacitor C9 is attached across pins 1 and 2 of connector P4 on the power supply PC board to filter out any electrical spiking from the motor brushes (See Figure CD).

80. PROJECTION LAMP SYSTEM (See Figure CD).

The projection lamp system on all projetor models consists of the power transformer secondary (red, yellow, gray (or blue wires) that supplies a nominal voltage of 16VAC for LO (red, yellow wires) or a nominal voltage of 18VAC for HI (red, gray (or blue) wires) to a lamp HI-LO selector switch and then to the projection socket and lamp.

81. BLOWER SYSTEM (See Figure CD).

The projector blower system is uncomplicated. The full-wave rectified DC supply described previously under "Power Supply PC Board Operation" feeds power directly to a permanent magnet DC brush type blower motor. Fitted to the shaft of the motor is a blower wheel which causes air movement. The brushes in the blower motor are not replaceable.

Blower motor voltage is approximately 11VDC and, if lower voltages are present on the motor, check the bridge rectifier that powers the blower motor and the 2200MFD filter capacitor C7. If the blower motor does not run, check fuse F1 (2.0 amp) on the power supply PC board and replace if necessary. Also, check for fuse failure (locked rotor, shorted leads, blower obstruction) and for a faulty transformer secondary or fan/lamp switch.

NOTE: The following paragraphs covering the operation of the tape recorder electrical circuits has been separated into two main areas of discussion; the audio system and digital system. The analysis of the audio system also covers the tape recorder motor circuits and the analog circuits of the control track channel. The remaining circuits in the system being 95 percent digital in nature will be covered in paragraph 83.

IMPORTANT

Included for use with the following tape recorder analytical discussions are illustrated block diagrams (flow charts). All number functional blocks shown on these diagrams will be referred to as "block 00" in the text. Also included with each discussion is a schematic wiring diagram for checking and/or testing the various circuits.

82. TAPE RECORDER AUDIO SYSTEM ANALYSIS.

The tape recorder electrical system is similar to a conventional mini-cassette tape recorder and is equipped with a playback system, record system, bias oscillator system, automatic level control (A.L.C.) for record and various outputs such as headphone and external speaker. Additional features included in the tape recorder are: an electronic muting system, a tone control and the capability of operating as a public address (PA) system.

The entire audio system, including the tape recorder motor control circuits, is described diagrammatically in Figure CE. All S201 switches in the system are part of a single 9-pole, 2-position record/play switch that is illustrated in the PLAY mode. Switch S202 is a 2-pole, 2-position public address (PA) switch and is shown in the OFF position.

The arrows shown on Figure CE indicate the direction of signal flow and all numbered blocks reference the following block descriptions.

(1) Input Switching. This circuit connects the playback head outpout to input of Q201 in the PLAY mode. When the PA switch is ON, the play had is disconnected and a microphone input from J201 is connected to the input of Q201. In the RECORD mode, S201-3 allows only the microphone input to be coupled into Q201.

(2) Low Noise Pre-Amplifier. Q201 is a low noise transistor operating at low collector voltage and current to result in a good signal-to-noise ratio.

(3) Equalized Amplifier. IC 201 is a high gain integrated circuit connected to the circuits in block 4 which provides a switchable feedback. In the PLAY mode, feedback components selected by S201-5 result in the conventional tape playback characteristics for 1.875 inches-per-second (4.76 cm) tape speed. When S202 is in the PA ON Position, the tape playback characteristic is switched out and a flat gain characteristic is switched in. In the RECORD mode, S201 switches out the playback feedback and switches in a flat record feedback circuit. Also, when the PA switch is ON, pin 1 of S202-2 connects R209 to the anode of D201. This reduces the DC voltage on the base of Q206 to a level that is too low to turn Q206 on. Thus, no muting action can be achieved with the PA switch ON and the PA feature can be used without the need for running the tape mechanism.

(4) Record/Play Equalization and Switching. This circuit automatically switches in the appropriate feedback circuit for IC201 to provide equalized gain for tape playback or flat gain for microphone use. Included in the circuit are C213 and L202 to reduce RF bias feed-through in the RECORD modes of operation.

(5) Output Gain Switching. S201-2 helps to compensate for required gain difference in IC201 during the RECORD and PLAY Modes so that the audio output level for headphone use will be reasonably constant.

(6) Muting Circuit. Q206 mutes audio output in all tape recorder modes except RECORD or PLAY and is disabled when the PA switch is ON. The muting circuit simply functions as a short circuit to the signal.

(7) Muting Switch. Switch S205 is automatically closed by the tape mechanism when the "Play" button is depressed.

(8) Volume and Tone Controls. The volume control circuit is connected in potentiometer fashion. The tone control functions as a treble attenuation shunt tone control in conjunction with C217.

(9) Audio Power Amplifier. IC202 is an integrated circuit type with gain determined by the ratio of resistors R220 and R219. Nominal voltage gain for IC202 is approximately 100.

(10) Headphone Output. Audio from the tape or microphone inputs is always available at output J202 and cannot be switched out.

(11) Speaker Switching. S201-1 automatically switches off speaker circuits in the AUDIO RECORD mode to prevent acoustical feedback.

(12) External Speaker Output. This output is active only in the PLAY or PA modes of operation and is automatically switched out by S201-1 in the AUDIO RECORD mode.

(13) A.L.C. Rectifier and Filter. Audio signals appearing at the output of IC201 (block 3) are rectified, filtered and used in the RECORD mode to control the gain of IC201. The level at which the signal output of IC201 will be held is determined by the ratio of R228 and R229. The action of this circuit is defeated in the PLAY mode by S201-4.

(14) A.L.C. Record Indicator Switch. In the PLAY mode, switch S201-4 shorts (defeats) the output of the A.L.C. circuit and opens the emitter circuit of the record indicator driver transistor, Q202.

(15) Record Indicator Driver. This circuit rectifies and partially filters the signal appearing at the output of IC201. The resulting signal is used to control current flow through transistor Q202 to cause LED201 to pulsate with the varying level of the audio record signal.

(16) Erase-Bias Oscillator. Q203 is an RF oscillator operating at approximately 50

KHz generating the erase and bias currents used in the RECORD mode. VR201 is used to adjust the RF bias for audio recordings.

⑰ Erase-Bias Oscillator Switching. In the RECORD mode, switch S201-7 powers the oscillator from the regulated +12 volt supply. When the 830, 840 and 850 model projectors are in the PLAY mode, this oscillator can be powered through an option board plugged into J1.

⑱ Audio Record/Play Head Switching. In the PLAY mode, switch S201-6 allows audio output from the record/play head to be fed into block 1. In the RECORD mode, S201-6 allows audio record current from block 21 and RF bias current from R224 to flow through the audio record/play head.

⑲ Erase Head Selector Switch. Switch S201-9 allows erase current to flow through either the audio or the control track erase head in their respective RECORD modes.

⑳ Tape Recorder Motor Control Switching. Q204 serves as a switch controlled by Q205. Q205 is controlled by input from an 840 or 850 model projector option board or by way of a switch plugged into J2. These inputs control the motor by turning off the forward bias on Q205. This stops current flow through Q205 which turns off Q204, thus opening the circuit between the +11V supply and S204 (the tape recorder motor switch).

㉑ Bias Trap and Audio Record Pre-Emphasis. In the AUDIO RECORD mode, the parallel resonant bias trap consisting of C223 and L201 prevents the audio record current source IC201 (block 3) from excessively loading the RF bias current source. Resistor R225 and capacitor C224 provide a record pre-emphasis for high frequency audio record currents.

A. SIGNAL FLOW IN THE PLAY MODE (See Figure CF).

Signal flow is from the playback head, through blocks 1, 2, 3, 4 and 5. In the PLAY mode, block 7 (S205) which is mounted inside the tape transport mechanism, is held closed. This removes forward DC bias from transistor Q206 (block 6), which would otherwise be ON and act as a short to ground for the signal coming from block 5. With the muting transistor thus disabled, the signal continues on to the tone and volume controls at block 8. Through the volume control, the operator selects a signal level which is fed to the power amplifier (block 9). The output of block 9 is coupled through capacitor C221 to the output circuits consisting of blocks 10, 11 and 12 where a choice can be made between the headphone output or speaker (internal or external) output.

B. SIGNAL FLOW IN THE AUDIO RECORD MODE (See Figures CG and CE).

Signal flow is from the microphone by way of J201 through blocks 1, 2, 3 and 4. As the signal enters block 4, it branches in four other directions:

(1) Through block 21 to provide audio record current to the record/play head:
(2) Through blocks 13 and 14 to provide automatic level control;
(3) Through block 15 to provide visual recording indication;
(4) Through block 5 where additional attenuation is introduced to compensate for the higher gain of block 3 in the RECORD mode.

After passing through block 5, an RF bias feed-through filter consisting of R215 and C216 helps reduce the level of stray RF signals that are picked up and amplified by the pre-amplifier (block 2). After passing through the filter, the audio signal is allowed to pass block 6 (because block 7 is closed as a result of the "Play" button being depressed) and continues on through blocks 8, 9 and 10. The signal does not go beyond block 10 in the RECORD mode because block 11 (S201-1) is open.

In the AUDIO RECORD mode, the pre-emphasized audio signal coming through block 21 is mixed with an RF bias current, which is provided by the erase oscillator secondary winding through R224 and C225.

R224 establishes the nominal level of RF bias current and C225 prevents the erase oscillator secondary winding, which is a low impedance to audio signal, from shunting the audio record current away from the record/play head. R224, C225 and the network in block 21 act to provide the optimum ratio of RF bias and audio currents to make the desired audio recording.

C. NOMINAL VOLTAGES. (SEE FIGURE CH)

Nominal DC voltages at various points in the audio system are shown for both the PLAY and AUDIO RECORD modes in Figure CH.

PLAY mode signal voltages appearing along the signal path are shown in Figure CF using a TEAC #MTT-112B test tape as a signal source. Actual voltages may differ from those shown by ±3dB due to head tolerances.

AUDIO RECORD mode signal voltages are shown in Figure CG using a 100 microvolt RMS, 1.0KHz signal into the microphone jack. The signal source should have an impedance of 50 ohms or less and be suitably isolated from ground to avoid ground loop problems. A shielded, transformer coupled signal is advisable.

83. TAPE RECORDER DIGITAL SYSTEM.

All digital systems share certain common characteristics. It is necessary for the technician to know the levels of the various logic signals in the system. For the remainder of this discussion on the logic system, we will assume that all gates operate with positive logic sense and the logic levels are as follows. The "1" level is equal to +12 volts, the "0" logic level is equal to 0 volt.

A. PRE-AMPLIFIER AND 1.0KHZ DIGITAL FILTER. (SEE FIGURE CJ)

IC amplifier stages A1 and A2 comprise the control track pre-amplifier. The function of this amplifier is to receive a signal from the control track record/play head and amplify it so it is usable by the 1KHz digital filter system and by circuits residing on an option board plugged into connector J1.

The signal from the control track record/play head is fed through an RF filter, R2 and C1 before entering amplifier A1. This filter reduces RF signals present on the head during the AUDIO RECORD mode. Feedback components are connected to amplifier A1 to produce a response that is typical of tape playback amplifiers. After being amplified by A1, the signal is coupled to A2. A2 circuitry has a flat response to audio signals and simply provides additional gain.

Transistor Q4 serves as a switch that disconnects the output of A2 from A3 input during control track recordings. This is necessary because the level of unwanted RF appearing at the output of A2 is great enough to upset the functioning of the circuitry following A3. When an option board plugged into J1 applies B+(16V) to pin 7, a portion of this positive voltage is applied to the gate of Q4 thus causing Q4 to behave like an open switch.

The control track pre-amplifier and the 1.0KHz digital filter circuits are shown in block diagram Figure CJ. Signal flow does not occur here in the usual sense. However, a sequence of events occurs when a signal is applied to the input, resulting in the appearance of wave forms as shown at the output side of each functional block. These numbered blocks reference the following block descriptions.

(1) Equalized Pre-Amplifier. This circuit was described in the preceding section. When playing back a 1.0KHz burst (pulse); the output, after passing through Q4, will be a severly clipped sine wave having an amplitude of appoximately 0.8V PP.

(2) Threshold Amplifier. Amplifier A3 is operated at maximum gain. This will yield a large signal output for very small signal inputs. To prevent A3 from producing unwanted output signals from noise and hum, a threshold bias is applied to one of A3 amplifiers inputs. This bias is developed at the junction of R8 and R9 and applied to pin 6 of A3 which causes the output at pin 7 of A3 to remain at approximately -11 volts when no signal is present.

(3) Squaring Circuit. Q1 is simply an over-driven common emitter amplifier. The output of Q1 will be a full 12V PP square wave, even for low signal levels out of the control track head.

(4) GO NO-GO Gating. The square wave output of Q1 is differentiated by C7 and R19. The negative going portion of the differentiated signal will be passed by G9 for in-passband signals or G10 for out of passband signals.

(5) Charge Pump. G11 and G12 are connected as a monostable oscillator having a period of approximately 5 milliseconds. Transistor Q2 interfaces the trigger input of the monostable to the output of G9. When the frequency of the signal from the control track head is within the passband, all of the differentiated pulses will pass through G9 and cause the charge pump to continue charging the charge filter (block 6). When the signal frequency is outside of the passband, the pulses will be applied to G12 at the "reset" input of the charge pump and cause it to discharge the filter (block 6) if any charge is present.

(6) Charge Filter. Accumulates charge for signals within the passband.

(7) Threshold Circuit. The output of this amplifier is normally near +12 volts because of the threshold bias voltage of approximately +8 volts applied to its non-inverting input. When the charge on the charge filter capacitor C12 exceeds the 8 volt bias voltage, the amplifier output abruptly drops to approximately -11 volts. This voltage is applied through R60 to Q7, the forward slide advance transistor.

(8) Delay Monostable. Every signal pulse triggers this monostable. The period of this circuit is adjusted by TR1 to be slightly greater than the period of the highest frequency in the passband and is approximately 860 microseconds.

(9) Window Monostable. The period of this monostable is proportional to the width of the passband and is adjusted by TR3 to approximately 460 microseconds. This window monostable is triggered by the trailing edge of the signal output of block 8 and both outputs of the window monostable are used to control the gating action of the GO NO-GO gates at block 4. The outputs from the window monostable are complimentary; when one output is high, the other will be low. Thus, gates G9 and G10 which are controlled by the window monostable outputs are only enabled one at a time.

Normal DC Voltages. In the absence of a signal, DC voltages will appear at various points in the system typical of any digital circuit (see Figure CL). That is, the voltage will either be high (12 volts) or 0 volts.

Signal Behavior (See Figure CK). The 1.0KHz signal output of the pre-amplifier is further amplified and squared by blocks 2 and 3. This results in a wave form that has steep slopes and can be differentiated by C7 and R19 to produce high, narrow pulses. It is the routing of these pulses that determine the digital filters response. All pulses occuring at a passband frequency rate are gated to the trigger input of the charge pump monostable. All out-of-passband rate pulses are gated to the reset, or discharge input of the charge pump. The routing of the pulses is determined by the timing of the window and delay monostables (blocks 8 and 9). In order for an incoming pulse to pass through gate G9 or G10, the gate's controlling input must be low. The controlling inputs for G9 and G10 are pins 13 and 8 respectively. When the timing relationship between the window monostable and the incoming pulses is correct, all pulses pass through G9. When the pulses have an out-of-passband frequency, they pass through G10. The first pulse of any tone burst, whether in passband or not, will always pass through G10. This is because the window monostable has not yet been triggered, and thus only the normal quiescent DC voltages as shown in Figure CL appear at its outputs. After the first pulse, the window monostable will by cycling and will automatically enable G9 to pass all in-passband pulses.

B. SLIDE ELEVATE SYSTEM.
(SEE FIGURE GM)

The speed at which the slide elevate system

signals follow one another is so great that they appear to be simultaneous when measured with all but the most sophisticated equipment. Therefore, with ordinary equipment, it is better to repeatedly operate the "Slide Tray" switch (not on 850 models) as the oscilloscope probe is used step-by-step down the signal path.

The signal flow arrows on functional block diagram Figure CM, show the direction in which the sequence of the slide elevate system operations proceeds. Wave forms in the diagram are shown as a guide to observe proper functioning of the system and all numbered blocks reference the following block descriptions.

(1) Interface Transistors. Q6 and Q7 are ordinary bipolar NPN transistors used here for two reasons: (1) to provide a means for controlling slide changes by grounding type switch circuits and (2) to provide greater immunity to the effects of electrostatic discharge occuring when the user plugs a remote control into J2. (Direct contact between a charged accessory cable and the CMOS integrated circuitry on which the slide elevate system is based could be destructive to these devices.) Grounding the input to either Q6 or Q7 causes the Q6 (or Q7) collector to go abruptly to +12 volts.

(2) Elevate Start Gating. These gates provide means for starting elevate motion from any one of three inputs. These are: (1) Forward tray command from Q7; (2) reverse tray command from Q6; (3) "tray motion completed" signal from G19.

(3) Elevate Drive Latch. G25 and G26 are interconnected to form the ordinary "flip-flop." This circuit therefore, has the ability to convert momentary signals from the gates at block 2 to a sustained elevate drive signal. This latch is automatically reset to its OFF state when the elevate mechanism closes either of its limit switches.

(4) Elevate/Tray Interlock Gate. This gate allows the elevate drive signal to be applied to the drive amplifier (A6) only if the tray drive is OFF. This prevents accidental simultaneous drive to both tray and elevate motors.

(5) Elevate Drive Interface Amplifier. Amplifier A6 provides the drive current necessary to drive power transistors Q8 and Q9. This level of drive current is not available from CMOS devices.

(6) Elevate Drive. These power transistors (Q8, Q9) are capable of directly driving the elevate motor.

(7) Elevate Limit Switch Latch. This flip-flop eliminates the effects of switch "bounce" to provide a clean output signal whenever an elevate limit switch is closed. This switch latch has two outputs, each of which provides a signal to the gates in block 8 to turn off the elevate motor and one of its outputs also enables the reversing circuit Q13 (block 9).

(8) Elevate Stop Gating. Gates G31, G32 provide a means for stopping elevate motion from any one of four sources as follows:

(1) Top elevate limit switch;

(2) Bottom elevate limit switch;

(3) Overcurrent circuit (block 10);

(4) Power-up reset circuit (C11, R28).

The power-up reset circuit assures that the elevate motor will be initially in an OFF state when system power is first turned on.

(9) Elevate Reversing Circuit. This circuit provides an input to the inverting terminal of amplifier A6 that is greater than the input appearing at the non-inverting terminal, thus causing A6 to produce a reversed polarity output signal. It is enabled only after the top elevate limit switch has been closed.

(10) Elevate Over-Current Sensing. This circuit amplifies the voltage appearing across R70 (the elevate current sensing resistor). This amplified voltage is used to

turn off the elevate drive motor when the motor current is excessive. This turn off voltage is applied to the gates at block 8 directly, for "positive" or "up" elevate drive and to gates G17, G18 (block 7) for "negative" or down elevate drive. Included in this circuit is a delay filter (R37 and C16). This delay filter prevents false turn off which would occur whenever the elevate motor is turned on and passes a normal high start up current for a brief period.

Normal Elevate System Action (See Figure CN). The user provides a forward or reverse tray command by moving the "Slide Tray" switch accordingly. This command is passed through blocks 1 and 2 to block 3 causing block 3 to become "set" or on. The ON condition of block 3 will provide an "up" elevate drive signal to block 5 if gate G13 (block 4) is enabled. Gate G13 is enabled when the tray mode latch is off, as indicated by a high output on G24, pin 3. The output of A6 (block 5) drives the power transistors Q8, Q9 (block 6) which in turn powers the elevate motor with a positive voltage causing the elevate mechanism to go up. When the elevate mechanism nears the top of its stroke, the top elevate limit switch closes, causing the gates in block 7 to change states. This change is coupled through C19 to block 8 which passes it to block 3 causing block 3 to become "reset" or off. Simultaneously, this change is coupled through C19 to the "set" input of the tray mode latch, pin 3 of G24. This starts the tray drive portion of the slide change cycle, which when completed, results in a positive voltage change at the output of G19 and G20, the tray motion sensing latch. The positive voltage change at the output of G19 is coupled through C10 into block 2 which again turns on the elevate latch (block 3). This time however, the elevate mechanism is in its uppermost position and requires a reversed motor drive to bring it down. Since the elevate reversing circuit was already enabled when the elevate mechanism reached the top of its motion earlier, a turn-on signal is all that is required. Thus, the output of the gates at block 3 passes through block 4 and the required elevate down drive is initiated. The elevate then proceeds downward until the bottom elevate switch closes, causing the gates at block 7 to change states. This change is coupled through C20 into the gates at block 8 which passes it to the gates at block 3 thus turning off elevate drive and completing the normal elevate system cycle.

C. TRAY DRIVE SYSTEM. (SEE FIGURE CP)

The tray drive system and over-current level adjust circuits are illustrated in Figure CP. The arrows on the diagram indicate the direction of signal flow and all numbered blocks reference the following block descriptons.

(1) Tray Mode Latch. This flip-flop establishes the tray drive system mode of operation in two states: the forced mode and the servo mode. The latch is triggered into the forced mode state when a voltage pulse from the elevate limit switch latch is applied to pin 1 of G24 and, into the servo mode state by the output of G22 in block 9.

(2) Phototransistor Signal Inhibit. Transistor Q12 when turned on by the tray latch (block 1), causes the diode logic circuit in block 5 to detour phototransistor emitter currents from the lite pipe assembly to ground. This prevents the phototransistor emitter currents from interfering with drive from gate G14 (block 3) or G15 (block 4) in the forced mode.

(3) Forward Gate. When gate G14 is enabled by the tray mode latch (block 1) it provides an input voltage to A8 (block 6) (see NOTE below).

(4) Reverse Gate. G15 is also enabled by the tray mode latch to provide input voltage to A8 (see NOTE below).

NOTE: Because gates G14 and G15 are connected to the complimentary outputs of gates G27, G28 (block 12), only one of them can produce an output at any given time when enabled.

(5) Diode Logic Circuit. These diodes together with Q12 in block 2 determine whether or not phototransistor emitter currents will be routed into block 6.

⑥ Logic Interface Amplifier. A8 converts logic type signals into signals having sufficient drive and correct polarity for driving transistors Q10, Q11 (block 7).

⑦ Tray Drive. Power transistors Q10, Q11 are capable of driving the load presented by the tray drive motor.

⑧ Threshold Sensing. This amplifier (A9) is used to detect the approach of each hole in the sensing ring as the tray rotates. The output of both phototransistors is sensed by this circuit to accommodate either direction of ring rotation. Passage of a hole causes the amplifier's output to generate a negative pulse of approximately 30V PP amplitude. This pulse serves to reset the tray mode latch from the forced mode to the servo mode.

⑨ Forced Mode/Servo Mode Gating. The pulse generated by A9 (block 8) is differentiated by C15 and R34 and then fed through G21 and G22 to reset the tray mode latch (block 1). However, this resetting will occur only after the operator releases the "Slide Tray" switch. If the "Slide Tray" switch is held in either the forward or reverse position, G22 will be disabled by a high input from G29 and resetting will not occur and the tray will continue to rotate in the forced mode.

⑩ Tray Motion Sensing. To complete a slide change cycle, the elevate mechanism must lower the next slide into viewing position. This final action should not occur until the tray has completed its motion. Amplifier A10 senses tray motion by monitoring the voltage applied to the tray motor. This voltage is amplified and after being delayed by filter components R66 and C22, is used to trigger gates G19, G20 in block 11. The delay filter helps to assure that tray motion has "settled down" before the elevate down cycle is triggered.

⑪ Tray Motion Latch. The voltage changes appearing at the output of the filter in amplifier A10 are too slow to properly trigger the elevate system. Gates G19 and G20 are connected to a flip-flop or latch to convert the filter's slow voltage to an abrupt change. This abrupt change in voltage is coupled through C10 into the elevate system.

⑫ FWD/REV Latch. In any slide change cycle, the elevate up action takes place first. This requires about one-half second of time. For a single slide change, the operator may move the "Slide Tray" switch with a short pulse motion. If the "Slide Tray" switch is held for less time than required for the elevate up action, the tray drive system will not "know" which way to rotate. The FWD/REV latch serves as a tray direction memory and is set to the forward or reverse state by output from Q7 or Q6 respectively. Since it is a latching circuit, it retains its last state until it is given a new input.

⑬ Variable Threshold Interface. The exact moment when the forced (or rapid search) mode of tray drive should switch over to the servo mode in preparation for stopping is dependent on the load represented by the tray. A good tray with few slides represents a much lighter load than a binding tray with a full load of slides. To help compensate for these differences, the loading is monitored by sensing the tray motor current through resistor R79. This information is amplified by A7 and introduced into A9 (block 8) by Q3. It is fed into the same input of A9 that receives phototransistor outputs. The combined effect causes the phototransistor output to effectively be delayed when heavy tray loading is present. Since A9 (block 8) establishes the exact moment when the tray drive switches from forced to servo mode, the interface circuit keeps the system in the forced mode a little longer for heavy tray loads.

⑭ Septum Center Detect. This circuit generates a single narrow output pulse when the center of a slide septum arrives. This pulse is fed into A9 (block 8) to serve as a fail safe mode trigger in the event that a severely binding tray should, through the interface and current sensing circuits, bias A9 into an in-operative condition. However, the tray over-current sensing will usually act before this condition occurs.

⑮ Interface Gate and Over-Current Level Adjust. The output of gate G16 goes high when the tray motor current exceeds a pre-determined level. The output of G16 varies with the tray motor current and this output is applied to TR2. The level of tray motor current at which tray drive is automatically turned off is set by adjusting TR2. Tray motor start-up current is normally much higher than this level and would automatically shut itself off except for the delay filter R100 and C29. The voltage across C29 follows the level of tray motor current but does not change as rapidly. Therefore, the high peak current at start-up which is very brief is ignored. The action of the delay filter would be severly loaded down if it were connected directly to the tray mode latch. Gate G16 interfaces these circuits without loading the delay filter.

⑯ Tray Current Sensing Amplifier. This amplifier provides an amplified, positive polarity output signal that is proportional to tray motor current for either direction of motor current. The input signal for A7 is provided by the voltage drop across the tray motor current sensing resistor R79.

D. OVERALL SLIDE CHANGE SYSTEM BEHAVIOR.

All slide change action can be broken down into three basic steps: (1) elevate goes up to tray level and stops; (2) tray moves one or more slides and stops at the selected slide; (3) elevate lowers the selected slide and mechanically opens the dark shutter when the slide has fully descended into viewing position.

Refer to Figure 45 in the parts catalog manual to trace the complete slide change sequence of events through the electronics system as follows:

(1) Operator moves the "Slide Tray" switch to forward or reverse position, thus turning off transistor Q7 or Q6, respectively.

(2) Collector voltage of Q7 (or Q6) rises abruptly to +12V.

(3) The choice of forward or reverse tray movement is "memorized" by the tray motion latch while at the same time the +12 volt signal in step (2) above is also applied through the elevate start gates G29 and G30 to G25.

(4) The pulse applied to G25 turns the elevate drive latch ON.

(5) Since the tray is not yet being driven, gate G13 is enabled and thus passes the output of G26 to A6 causing A6 to deliver a positive voltage to transistor Q8, Q9.

(6) The positive output voltage from Q8 and Q9 causes the elevate motor to drive the elevate mechanism upward.

(7) When the elevate nears its upper limit, the upper limit switch closes, causing one of the imputs to G17 to be grounded. This causes G17 output to go to +12 volts and a pulse to be coupled through C19, G32, G31 and into the reset input of the elevate drive latch, thus turning off elevate drive.

(8) The pulse that passed through C19 also is fed to pin 1 of G24 causing the tray drive latch to switch to the forced mode. In this mode, pin 11 of G23 is high and this turns on G12 while enabling G14 and G15. G14 or G15 will then provide a drive voltage according to whether the operator selected forward or reverse tray drive. This information is stored in the tray motion latch as mentioned in preceding step (3). If forward was chosen, pin 11 of G27 will be high and a positive voltage will be applied by G14 to the (+) input of A8. If reverse was chosen, pin 10 of G28 will be high and a positive voltage will be applied to the (-) input of A8. A positive voltage into the (-) input of A8 will result in a negative output voltage from A8 causing reverse tray drive.

(9) The output voltage from A8 is applied to Q10 and Q11 and causes the tray motor to be driven.

(10) As the tray rotates, holes in the sensing ring causes one pulse of output from the

phototransistors for each slide or septum. If the operator's command was just for a single slide change, the next hole sensed by the phototransistor will cause the tray drive to switch from forced mode drive to servo mode drive. In the forced mode, tray drive is dictated by a fixed output from G14 or G15 with phototransistor output being blocked out by the combined action of Q12 and the diode logic circuit. In the servo mode, G14 and G15 are disabled, Q12 is off and the diode logic allows phototransistor output to control tray positioning.

(11) When the "Slide Tray" switch is held for rapid search operation, the output of G29 remains high. This in turn disables G22 thus preventing the pulses from the threshold sensing circuit from resetting the tray mode latch.

(12) When the "Slide Tray" switch is released, G22 allows the next pulse to reset the tray mode latch, thus switching the tray drive to the servo mode.

(13) In the servo mode, outputs from the two phototransistor emitters are applied to the opposing inputs of A8. A8 amplifies the difference between its inputs and thus will produce no output when a hole is centered on the light path to the phototransistors, resulting in equal outputs. This is the locked-in condition that assures adequate centering of the slide septum over the elevate mechanism. Any slight rotation of the tray from this centered position causes the phototransistor outputs to become unequal, resulting in an appropriate direction of tray drive to restore centering.

(14) Once tray centering is established, the tray motor voltage drops to zero or very near zero. The tray motion sensing and motion latch respond by issuing a pulse to pin 13 of G30. This initiates elevate drive as before, however, the elevate mechanism is at the top of its stroke and should be driven down by applying a reverse drive to the elevate motor. When gate G17 output switched high (preceding step 7) pin 11 of G18 switched to 0 volts. This enabled reverse drive transistor Q13. When the second elevate drive occurs, a voltage will be applied to the (-) input of A6. This input is greater than the input that will be applied to the (+) input of A6. The net result will be a negative output from A6. This will drive the elevate motor backwards causing the elevate mechanism to go down.

(15) The downward motion of the elevate mechanism continues until the lower elevate limit switch is closed. This switch grounds pin 13 of G18 causing the output of G18, pin 11, to go to +12 volts. This +12 volts change is coupled through C20, G32 and G31 into the reset input of the elevate drive latch thus turning off elevate drive. Also, when +12 volts appeared at the output of G18, reverse drive transistor Q13 became disabled. Thus no elevate drive remains at all. With this, the slide change cycle is completed.

E. MISCELLANEOUS CIRCUITS.

The lamp used for a light source in the ring sensing assembly (lite pipe) is powered from the negative 12 volt regulated supply. The light output of this lamp changes considerably for a small change in lamp current, and thus the need for a regulated source. If the negative regulator should be replaced, the lamp current may need to be re-adjusted. This can be done by monitoring the wave form at pin 1 or pin 3 of the P3 connector on the main (tape recorder) PC board while holding the "Slide Tray" switch in the forward or reverse position. The peak voltage of the wave form should be set between 1.8 and 2.5 volts by adjusting TR2 on the power supply PC board. If tray instability or oscillation should occur near the 2.5 volt setting, check the ring bearings for excessive play or looseness.

If a power failure should occur while the tray is being driven, there is a possibility that the tray may stop between slide positions. The result may seem to indicate an inoperative tray drive when power is restored. This can be corrected by holding the "Slide Tray" switch in the forward (or reverse) position long enough to cause tray motion. Usually it will be

necessary to operate the "Slide Tray" switch twice; once, briefly, to bring the elevate mechanism back down, and a second time for about one second. Once the tray rotates, normal operation has been restored.

DC supply circuitry is conventional and is not explained or presented in functional block diagram form.

F. OPTION BOARD, 1.0KHZ/150HZ (840 MODELS ONLY (SEE FIGURE CQ)

The 1.0Khz/150Hz option PC board circuits are illustrated in Figure CQ. The arrows on the diagram indicate the direction of signal flow and wave forms are shown for various points in the circuitry. Notice that the wave forms are shown for both the 150Hz filter and the sine wave oscillator however, in normal use these wave forms will not be present at the same time.

The descriptive explanations for numbered functional blocks (1 through 8) are essentially the same as those previously covered in paragraph 83(C) blocks (2 through 9) and will not be included in the following block descriptions. Component values do differ however, primarily in the "Delay Monostable" and "Window Monostable" circuits because of the lower frequency of operation. Also note blocks 9, 10 and 18 (Figure CQ). These blocks serve to sustain the cue-stop condition once it has occured and also provide for more positive means of restarting. The following block descriptions will describe the remaining system circuits and will proceed at block 9.

(9) Enable Gating. This gating circuit blocks the passage of signal pulses from block 2 to block 3 once the output of the 150Hz filter system has locked itself in the CUE-STOP mode.

(10) Enable Delay Filter. If the system is in the CUE-STOP mode, the operator presses the restart button in block 12 and this filter will maintain the enable gating in block 9 in the blocked condition for a short period of time. This prevents the system from re-stopping on the remainder of the cue-stop signal burst that had just caused a cue-stop.

(11) Cue-Stop Indicator Drive. This circuit provides adequate drive current to properly illuminate the LED stop indicator DS1.

(12) Restart Control and Logic. This circuit provides means for cancelling the CUE-STOP mode from a pushbutton on the option PC board assembly or from an externally connected switch plugged into J2 on the main PC board (tape recorder).

(13) Sine Wave Oscillator. This oscillator circuit (A1B) generates a low distortion, constant amplitude sine wave for use in recording 1KHz or 150Hz bursts on the control tracks. A1B's frequency is determined by C3, C5, R13 and R14 for 150Hz operation or C4, C6, R15 and R16 for 1KHz operation.

(14) Automatic Amplitude Control. By using Q2 as an automatically controlled variable resistor in the negative feedback loop of A1B, oscillator output is maintained at low distortion and constant amplitude.

(15) Output Gating. Q4 and Q8 are FET transistors that act as switches to gate the output of the oscillator to the control track head via board pin 1 and via board pin 4 to the input of the 1KHz digital filter, respectively.

(16) Burst Timing. This circuit generates a single 450 millisecond pulse to control the transistors in block 15. The output of U2 is also used to block passage of the sine wave oscillator's signals into the 150Hz filter. This would automatically occur since Q8 in block 15 feeds these signals to pin 4 which also happens to be the input to the threshold amplifier (block 1). The 1KHz signal would simply be ignored by the 150Hz filter, while the 150Hz signal would cause a cue-stop. This, in turn, would stop the tape drive motor while a control track recording is being made. Signal block is achieved by using the positive signal output of U2 (block 16) to bias Q6 into saturation, thus preventing Q6 from responding to any input signals.

⑰ Power-Up Oscillator Inhibit. This circuit uses the rising of supply voltages during projector turn-on to prevent A1B (block 13) from generating any oscillations during this period of time. This assures that no signals will be gated to the control track head while the gating in block 15 stabilizes into its turned-off state, since block 15 depends on the -12 volt supply for its OFF bias control voltage.

⑱ Erase Bias Oscillator Supply Interface. This circuit provides supply voltage for the erase-bias oscillator when the accessory burst record switch is plugged into J2 and S1 is in one of its frequency select positions.

Signal Behavior (See Figure CR). The behavior of the 150Hz filter is the same as previously described for the 1KHz digital filter in paragraph 83-A. The only significant difference is the added indicator and reset circuits shown in blocks 9 through 12. Block 9 contains a logic gate, U5A, that is normally enabled and thus permits passage of incoming signals. U5A is normally held in the enabled state by +12 volts applied to pin 2 through R54 and R55. Detection of a 150Hz cue-stop tone burst causes the output of the threshold circuit (block 6) to become locked-up in the negative state. This negative voltage is applied through R53 and CR16 to the enabling input of U5A, thus disabling it and preventing passage of any further signals. The locked-up state of the threshold circuit is accomplished by using the negative output voltage from its output to override the normal positive bias on its (+) input. This condition will hold indefinitely or until someone chooses to restart the system by closing S2 or an external restart switch via pin 12. This action will short the negative voltage coming from A6 output and allow approximately +.6 volts to be applied to A6 (+) input from R49, R50 and CR15. Meanwhile, the charge that had been stored in C23 while A6 output was negative, will slowly discharge and hold the enable gating in block 9 in a disabled state for enough time to allow the remainder of the cue-stop burst to run out without causing a nuisance re-stop. The output of A6 is also used to control (U5D, Q7) block 11. A6 output has the wrong polarity to directly drive indicator drive transistor Q7. This would cause the indicator to turn off rather than on when a cue-stop occurs. Gate U5D is used as an inverter to satisfy this requirement. The operation of the sine wave oscillator, A1B, is based on balancing its variable resistive negative feedback against its fixed reactive feedback. In the OFF state, there is only negative feedback and this is applied through R11, R8, R5 and Q2, resulting in 0 volts signal output. When the operator switches S1 to 150Hz or 1KHz the positive feedback loop is closed and strong oscillations start immediately. The oscillations are initially strong because the negative feedback is much lower than the positive feedback. The circuitry of block 14 then rapidly develops a bias voltage for Q2 that causes Q2 resistance to increase and this in turn results in increased negative feedback. This process continues until the negative feedback stabilizes at a value that is slightly less than the positive feedback. This results in low distortion stable oscillations. This sine wave oscillation is applied to FET switches Q4 and Q8 in block 15 which are in the OFF state.

The output of A1B (block 13) is allowed to pass through the output gating at block 15 when the operator applies a command pulse to U2 (block 16) via input pin 15. By shorting pin 15 momentarily to ground, a negative trigger pulse results at pin 2 of U2 causing U2 to produce a 450 millisecond positive voltage across R23. This positive voltage causes Q3 to remove the negative bias that has been applied to Q4 and Q8 through CR8, CR21, R27 and CR7. Thus, Q4 and Q8 become turned on and oscillator signals flow as explained in the description of block 15.

One final bit of circuitry to consider on this board is the interlock connection between S1B, block 16 (U2) and block 18 (Q9, Q5). This is a form of record safety interlock where the zero voltage being maintained at the output of A1B (block 13) in its OFF state is applied via S1B to blocks 16 and 18. In block 16, pin 4 of U2 is held at this zero voltage, thus positively preventing U2 from generating an output. In block 18 this zero voltage is used to forward bias Q9 thus causing Q9 to act as a short circuit to the input of Q5, preventing Q5 from turning on the erase bias oscillator. In the other positions of S1B, this zero voltage is

disconnected from blocks 16 and 18 allowing them to function normally.

G. OPTION BOARD, 1.0KHZ (830 MODELS ONLY). (SEE FIGURE CS)

The functions of the 1.0KHz option board circuits are identical to the ones found on Figure CR. Therefore, the descriptions given in paragraph 83(F) for functional blocks 13 through 18 will not be repeated here but are to be used as reference to Figure CS.

H. OPTION BOARD, MICROPROCESSOR (850 MODELS ONLY). (SEE FIGURE CT)

To explain the operation of the microprocessor option board, Figure CT has been sectioned into blocks and numbered for reference to the following descriptions. The wave forms shown at various points in the diagram will be present only in the appropriate mode of operation, not simultaneously.

(1) Display. Each of the three displays (D1, D2 and D3) is a seven segment plus period, display. When in use, these displays are pulsed sequentially such that only one display is being powered at any moment. The pulsing is rapid enough so that all three displays can seem to be on, however, only one is powered at any instant. The microprocessor selects the display to be driven and activates that display through one of the three interface circuits in block 3. Simultaneously, the decoding logic (block 2) powers the appropriate segments of the selected display according to information being delivered by microprocessor pins 8, 9, 10 and 11.

(2) Value Decoding Logic. Integrated circuit U4 will, through its output terminals, power the appropriate segments of a seven segment display to form a digit. The value of this digit (0 through 9) is presented in binary coded form to U4 by pins 8, 9, 10 and 11 of the microprocessor.

(3) Display Select Interface Circuit. The microprocessor does not have the current drive capability needed for directly driving the readout segments. This requirement is satisfied by transistors Q5, Q6 and Q7.

(4) Slide Change Control Interface. Transistors Q8 and Q9 simulate grounding switches to initiate forward or reverse slide change action U2 and U3 translate information from pin 16 and pin 17 into slide change commands.

(5) Tray Drive Monitor. This microprocessor input monitors tray drive activity by sensing the output of the tray mode latch on the main PC board. When the latch is in the forced mode, this input to the microprocessor will be high causing the microprocessor to direct its attention to tray location and disregard keyboard activity. Thus, the system will ignore any input from the keyboard while the tray is in motion.

(6) Slide Count Input. This microprocessor input receives one pulse for each slide position passed (forward or reverse). The pulse is produced at the output of gate G21 on the main PC board and used by the microprocessor to compute tray position.

(7) Command Lock-Out Logic. This microprocessor input monitors the state of the tape record motor and mute switch. If the tape recorder is in the PLAY mode, encoded signal bursts on the control track will direct the control of the tray position. There must be only one active source of commands to the system at any time otherwise erroneous functioning could occur. Whenever the tape recorder motor is running or the mute switch is closed, the microprocessor will ignore all inputs from the keyboard. The microprocessor however, will respond to the keybaord if the tape recorder motor is off and the mute switch is open.

(8) Control Track Signal Input. This microprocessor input receives an amplified signal from the output of the control track amplifier on the main PC board. A1 further amplifies this signal to a level where

it becomes a square wave. The signal is then fed through gate U3 to the microprocessor.

(9) Pause Output. When a pause command is read off the control track or keyboard, the microprocessor causes pin 9 of P1 (P1-9) to go low. This is connected to the tape recorder motor control circuit on the main PC board and causes power to the tape motor to be turned off. In the PAUSE mode, three decimal points appear (light up) on the display. This circuit is also activated if the slide tray is not in the home ("0") position during projector power-up.

(10) Erase Bias Oscillator Control. This output turns on the erase bias oscillator in the burst record mode of operation.

Other inputs and outputs on the microprocessor option board shown in Figure CT are:

P1-1 Data Output. Through this output the microprocessor delivers the encoded signal burst to the control track head in the RECORD mode.

P3-6 Beep Output. During the recording of a burst and when the microprocessor senses an erroneous input or condition, a tone beep is fed to the audio amplifier on the main PC board.

P3-5 Slide "0" Input. A switch on the projector's top deck closes when the tray ring drive is in the slide zero position. This input initializes the microprocessor's starting point for computing subsequent tray positioning.

P3-3 80/140 Switch Input. A switch located on the lite pipe assembly (top deck) closes when a 140-slide tray is installed. This establishes a basis on which the microprocessor can compute the shortest drive direction between any two points on a tray.

Connector P2. A piggy-back PC board containing the keyboard connector and an infrared receiver plugs into connector P2.

J. INFRARED REMOTE RECEIVER PC BOARD (850 MODELS ONLY). (SEE FIGURE CU)

To discuss the operation of the infrared remote receiver PC board, Figure CU has been sectioned into numbered blocks for reference to the following descriptions.

(1) Current-To-Voltage Amplifier. This amplifier minimizes the effects of circuit and cable capacitances by presenting a low impedance to the current output of the receiver diode. Some differentiation of the signal pulses occurs through C2.

(2) Voltage Amplifier. Second amplifier stage to provide additional AC gain and further differentiate signal pulses.

(3) Third Amplifier Stage and Detector.

(4) Decoder. Converts the signal pulse train into a binary coded signal on pins 5 through 8 of U1. Adjustment VR1 is used to adjust the oscillator in U1 to correctly decode the transmitted light pulses.

(5) Signal Gating. Binary coded signal appearing at the output of the decoder (block 4) is gated into the microprocessor input when an enabling voltage delivered by the microprocessor appears on pin 4 of connector P2.

(6) Static Discharge Interface. The microprocessor is a CMOS device and as such is susceptible to the effects of electrostatic discharge. U3 is a TTL device that serves simply as a buffer between the microprocessor keyboard and the keyboard's input pins. In normal use, the keyboard is a likely target for electrostatic discharge.

Signal Behavior. Each light pulse, upon striking the photodiode, results in a pulse of signal voltage across R3, the photodiode load resistor. This pulse is coupled through C2 into the first stage amplifier (block 1) and is partially differentiated because of the low effective input resistance of this amplifier. After being amplified in the first stage (block 1), the differentiated pulses are further

amplified and differentiated by the second stage amplifier (block 2). After the third stage of amplification (block 3), the pulses are applied to a negative signal inverter consisting of C8 and CR1. Here, the negative going portion of each pulse charges C8 and this charge is then added to the positive going portion of the pulse to effectively yield twice the signal amplitude. This doubled signal is then fed into the decoder (block 4). The transmitter automatically sends each complete pulse train twice and must be sensed twice by the decoder for proper decoding. This redundancy helps guard against erroneous decoding of noise pulses.

84. AUTOMATIC FOCUSING SYSTEM.

The automatic focusing system is found on all projectors except the 815A model. The components of this system are shown diagrammatically in Figure CV and following is an explanation of their operation.

The 12-volt autofocus lamp (9.9 volts applied) has a relatively straight filament and an image of this filament is projected through the autofocus system for use as a reference.

The primary lens element is a single plastic condenser lens that gathers the autofocus lamp's light and focuses the filament image on the slide. The slide, which can be virtually any type, reflects the filament image onto the secondary lens element.

The secondary lens element, which is identical to the primary element, gathers the reflected light from the slide surface and re-focuses it to form an image of the autofocus lamp filament on the surfaces of the two phototransistors.

The high-gain phototransistors provide an output current of approximately one milliamp when illuminated. They are mounted behind a filter which passes infrared light and blocks out almost all visible light (see Figure CW). As the image of the autofocus lamp filament illuminates the phototransistors, each outputs a current equivalent to the amount of illumination. The output of each phototransistor is fed into the servo amplifier for processing.

The servo amplifier (Figure CX) amplifies the output currents of the phototransistors to drive the focusing motor in a direction (clockwise or counterclockwise) which will move the image of the lamp filament into a centered position between the two phototransistors. When the image is in this centered position, each phototransistor outputs the same amount of current to keep the image centered. The servo amplifier consists of an integrated circuit (IC) amplifier operating in a differential mode and driving two current amplifying transistors. As its inputs, the servo amplifier has two differentiator networks and two voltage dividing, gain-scaling networks. R1 and R3, plus R5 and R7 shown in Figure CX form the voltage dividers (gain-scaling) networks. These resistors set the servo loop gain when the autofocus system is in a steady state (non-operating) condition. The differentiator network (R2, R6, C1 and C2) increases the overall loop gain acting on changing AC signals and allows the autofocus system to start quickly from "stop" and to recover quickly from overshoot. R10, R11, C3, C4, CR1 and CR2 act as supply filters to the system. TR1 is used to adjust the gain in the amplifier to compensate for variables in the photocells and a physical light filter in front of the autofocus lamp.

As the shutter opens and a slide is exposed, the image of the autofocus lamp filament falls on one of the phototransistors (in this example, the one on the left). Current instantaneously flows from emitter 1. No current flows from emitter 2 at this time because the image of the filament is offset on the left phototransistor, indicating a need for focus correction. Current from emitter 1 flows through R1 and establishes a voltage across R3 at the input of the OP-AMP. Because this was an instantaneous change, C1 conducts and increases the current through R3, thus increasing its voltage drop. As a result, the OP-AMP (+) input experiences a large input voltage and produces a large positive output. Q1 conducts and the focusing motor begins to operate.

The current output of emitter 1 continues as long as the filament image is offset (on the left phototransistor). As the image crosses the

"dead band" area (between the two phototransistors), an instantaneous current from emitter 2 results. This current is coupled through R5 and C2 to the inverting (or negative) input of the OP-AMP. The resulting negative output causes Q2 to conduct, thus reversing drive to the focusing motor. Thus Q1 and Q2 will conduct alternately to bring the focusing motor to a complete stop with the image of the lamp filament centered on the "dead band" with small amounts of light one each phototransistor. Each phototransistor puts out a small amount of current which will balance out in the OP-AMP so the focusing motor remains stopped in the focused position.

The focusing motor is a three-pole, permanent magnet-type DC motor which draws about 45 milliamps under no-load conditions. The motor runs from 0 to 6000 RPM in either direction (forward or reverse) and is equipped with ring resistors to reduce electrical noise output. During automatic focusing, it requires up to 150 milliamps (approximately) for starting and reversing the focusing motor.

The lens moving mechanism is a multi-pass gear train terminating in a rack-and-pinion system used to move the lens carrier and photocell holder. The gear train is equipped with a clutch to prevent the motor from drawing excessive current in case of lens carrier over-travel.

MISCELLANEOUS.

To complete the analysis of the projector's electrical systems the two red LED indicators ("Power On" and "REC Level") located on the tape recorder control panel will be discussed.

The "Power On" indicator receives about 15 milliamps of current from a voltage dropping resistor (R237) located on the main (tape recorder) PC board and should light when the main "Power" switch is turned ON.

The "REC Level" indicator should light when the tape recorder "Play" and "Record" buttons are activated simultaneously. This red LED should also light when recording pulses on the control track of a tape. In this mode, previously recorded audio will not be erased.

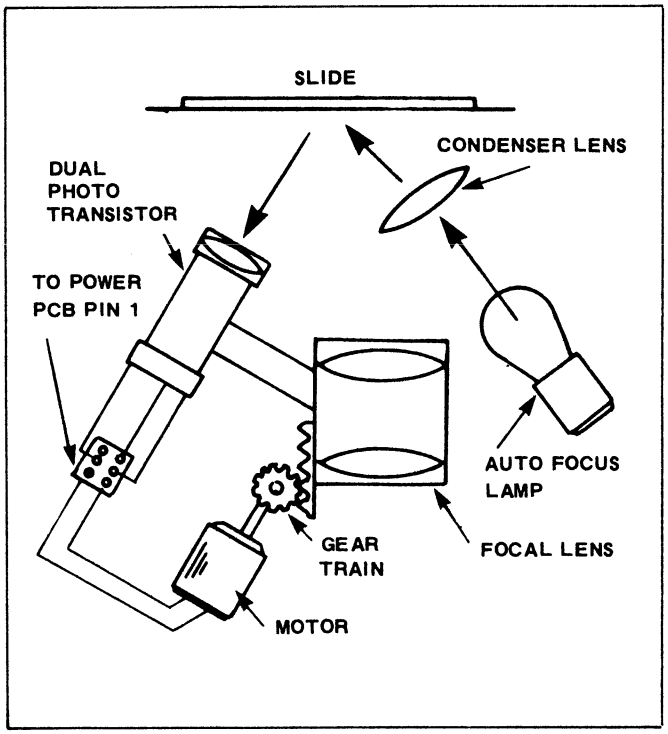


Figure CV. Diagrammatical Layout of the Automatic Focusing System

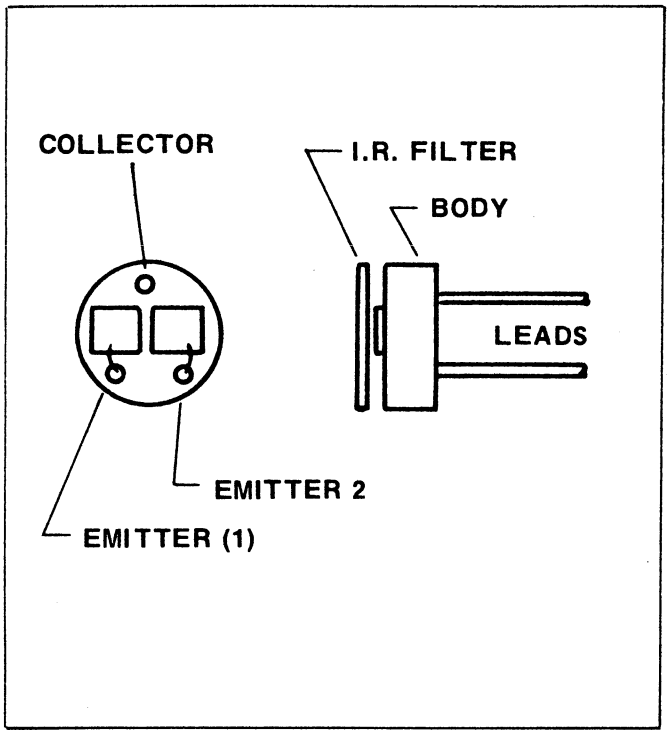


Figure CW. Dual Phototransistor

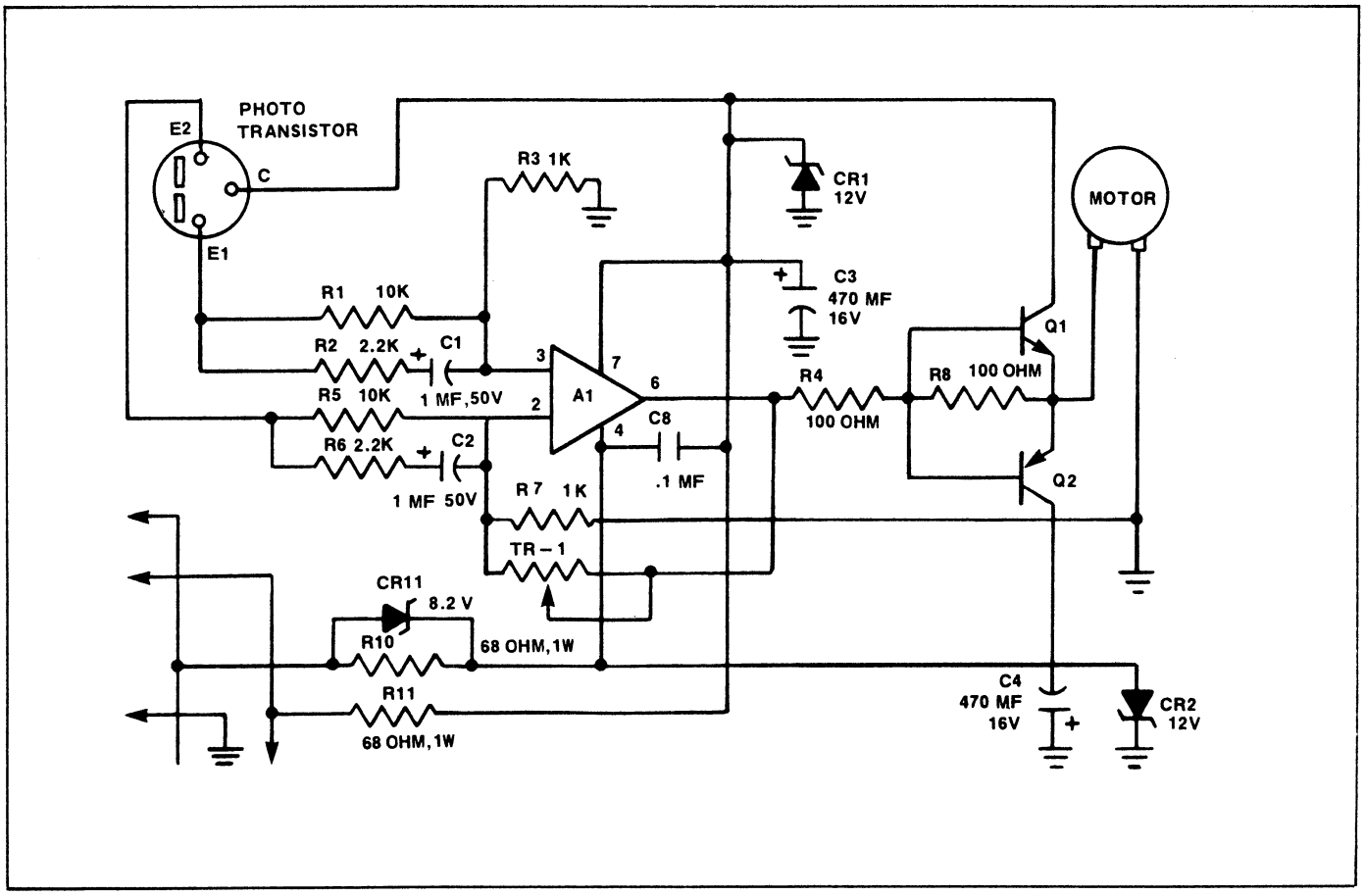
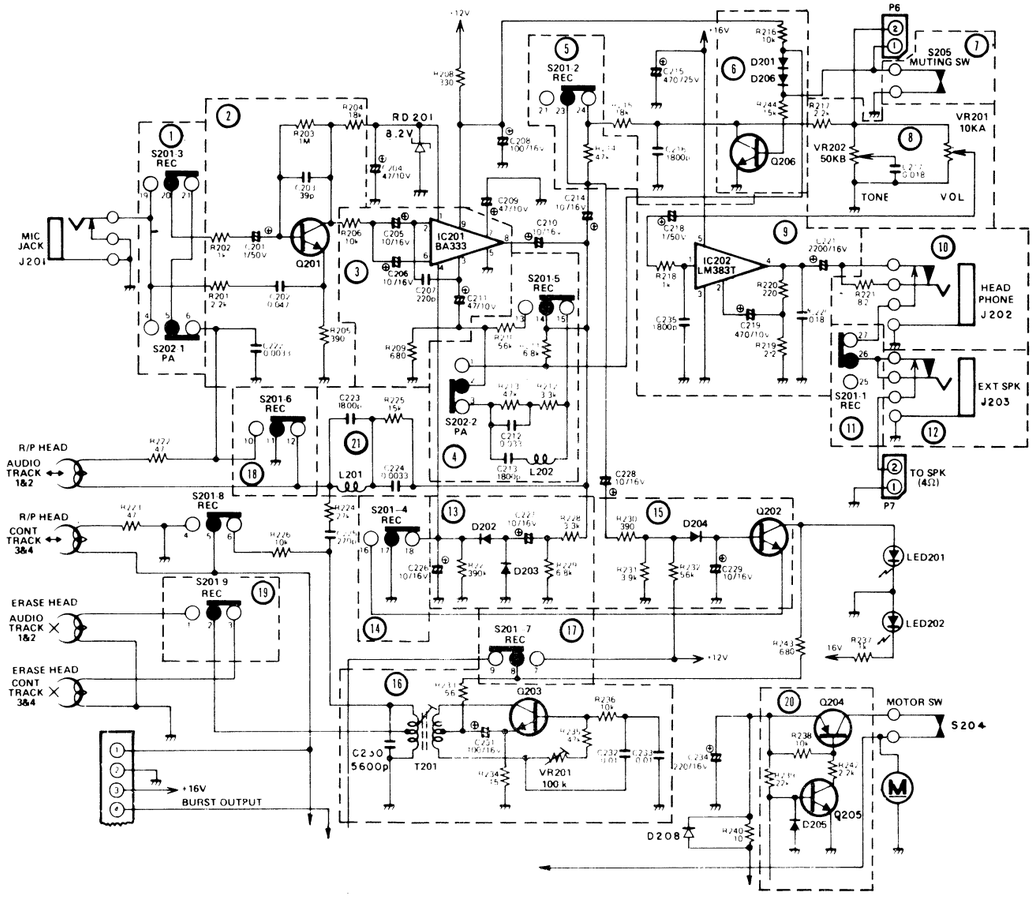


Figure CX. Servo Amplifier Schematic Diagram



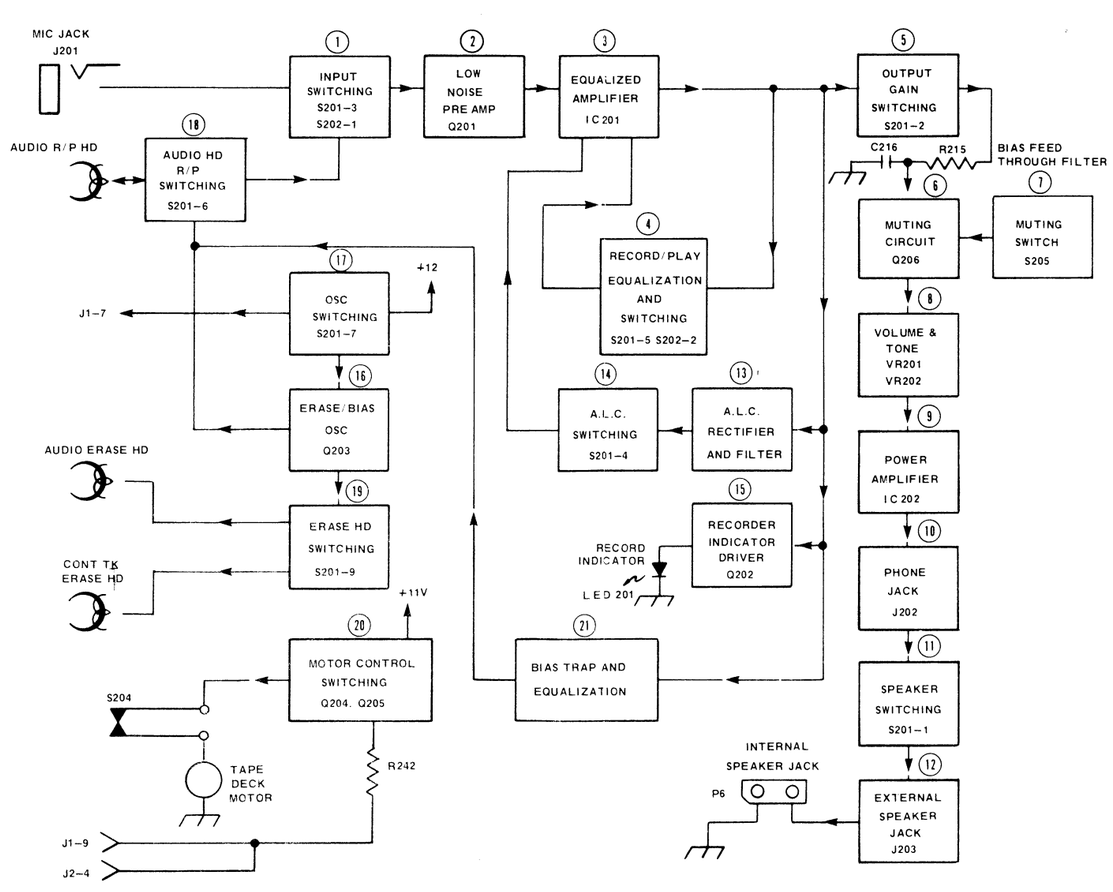


Figure CE. Audio System Functional Block Diagram

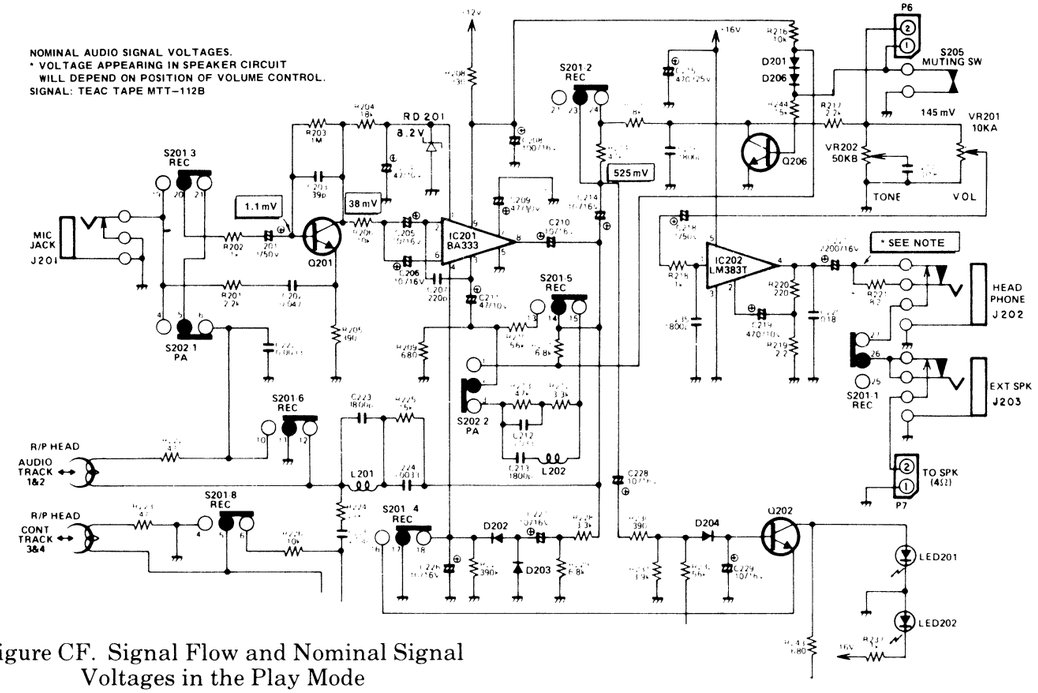


Figure CF. Signal Flow and Nominal Signal Voltages in the Play Mode

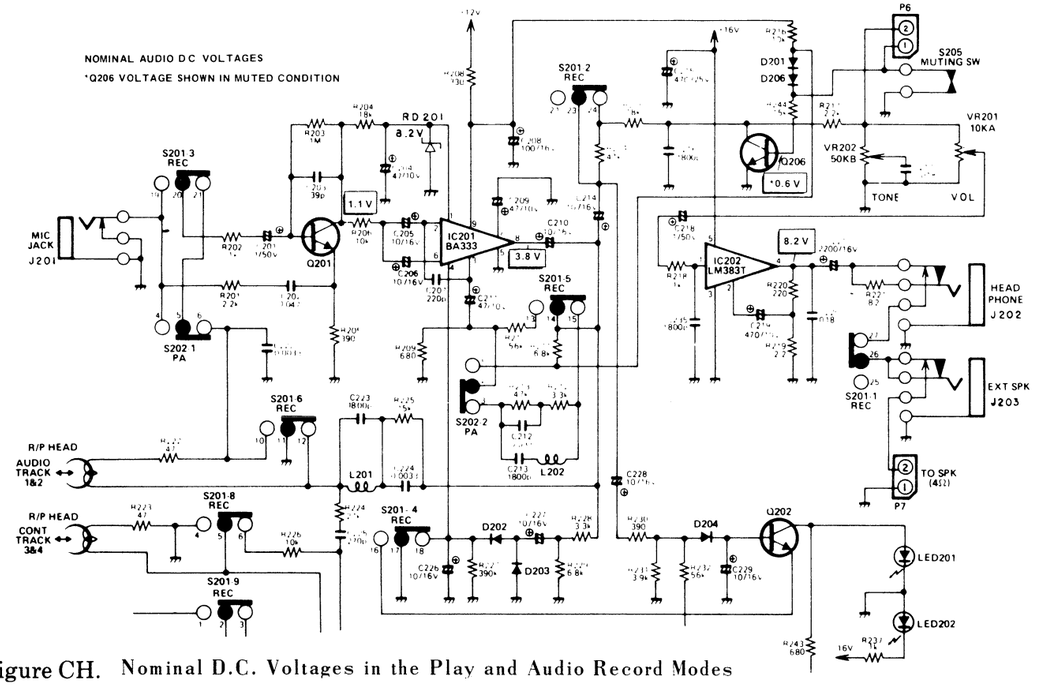


Figure CH. Nominal D.C. Voltages in the Play and Audio Record Modes

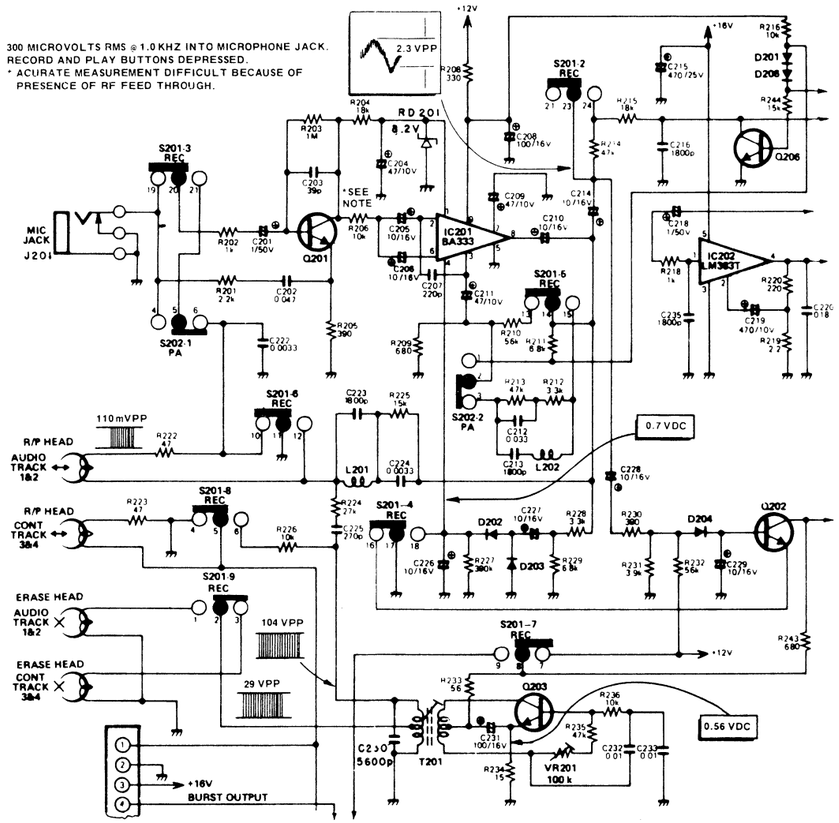


Figure CG. Signal Flow and Nominal Signal Voltages in the Audio Record Mode

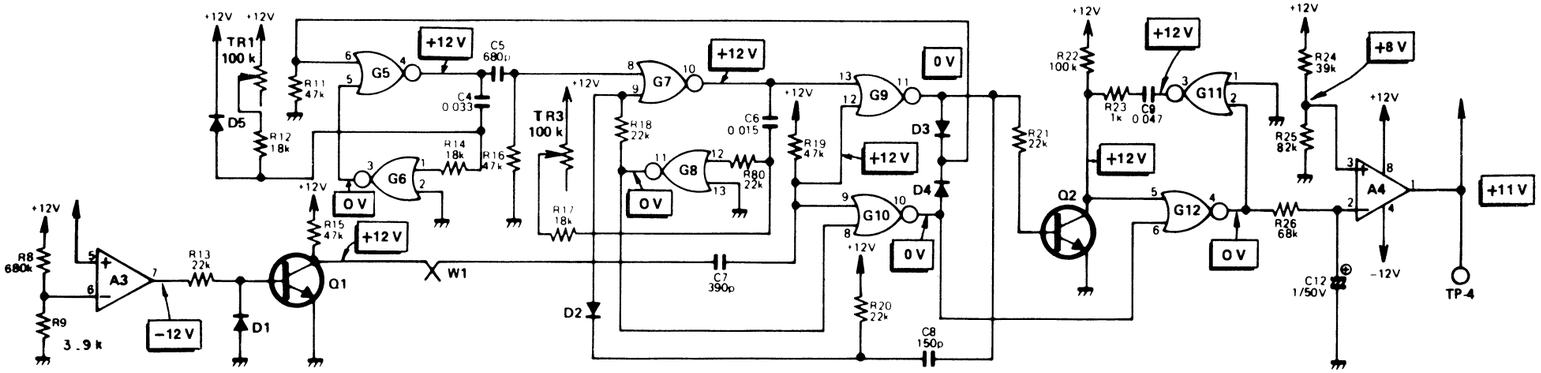


Figure CL. Normal DC Voltages for the Pre-Amplifier and 1.0KHz Digital Filter

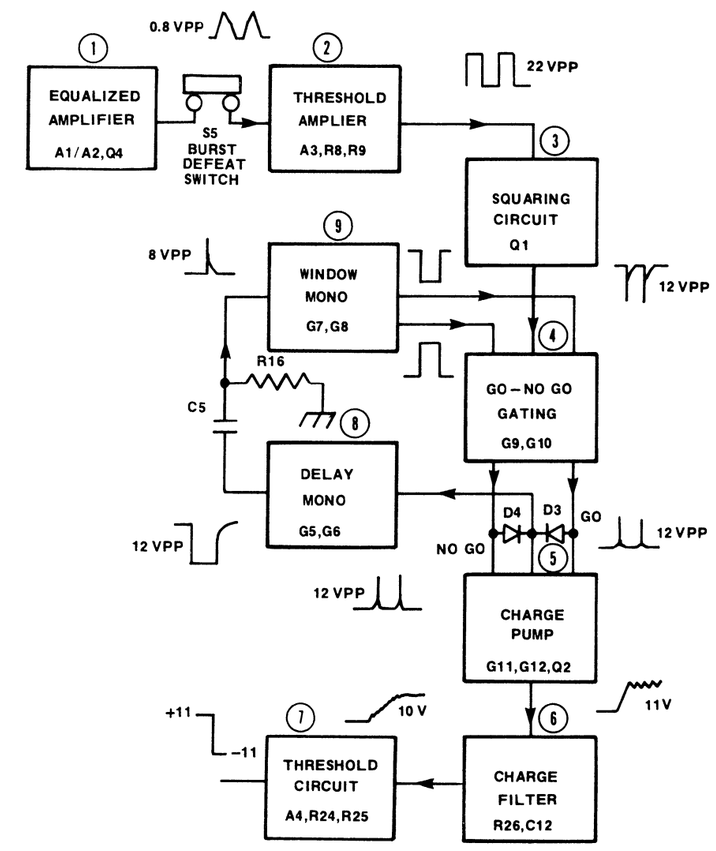


Figure CJ. Pre-Amplifier and 1.0KHz Digital Filter Functional Block Diagram

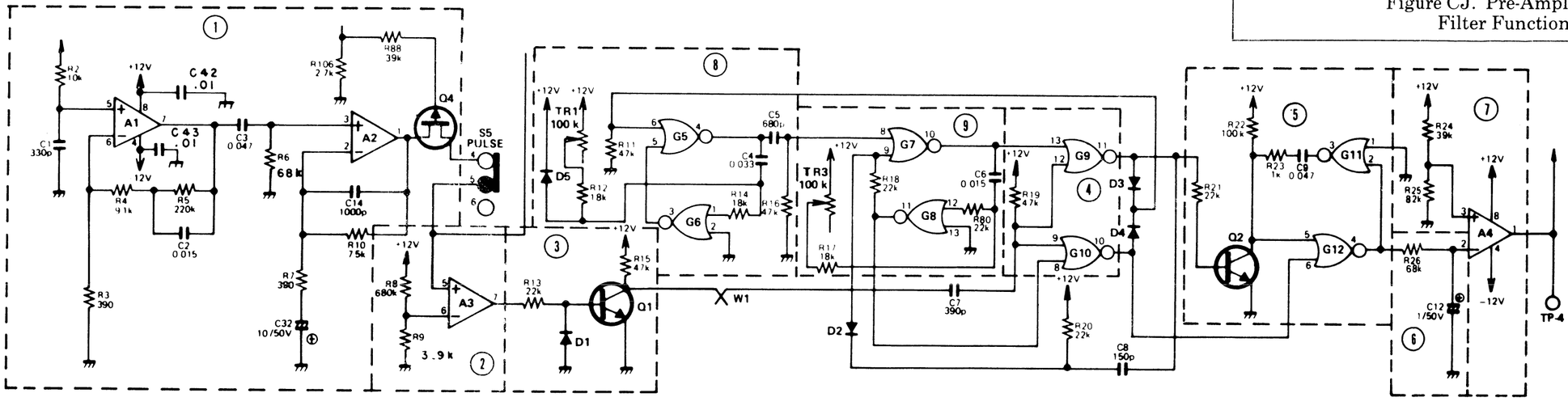
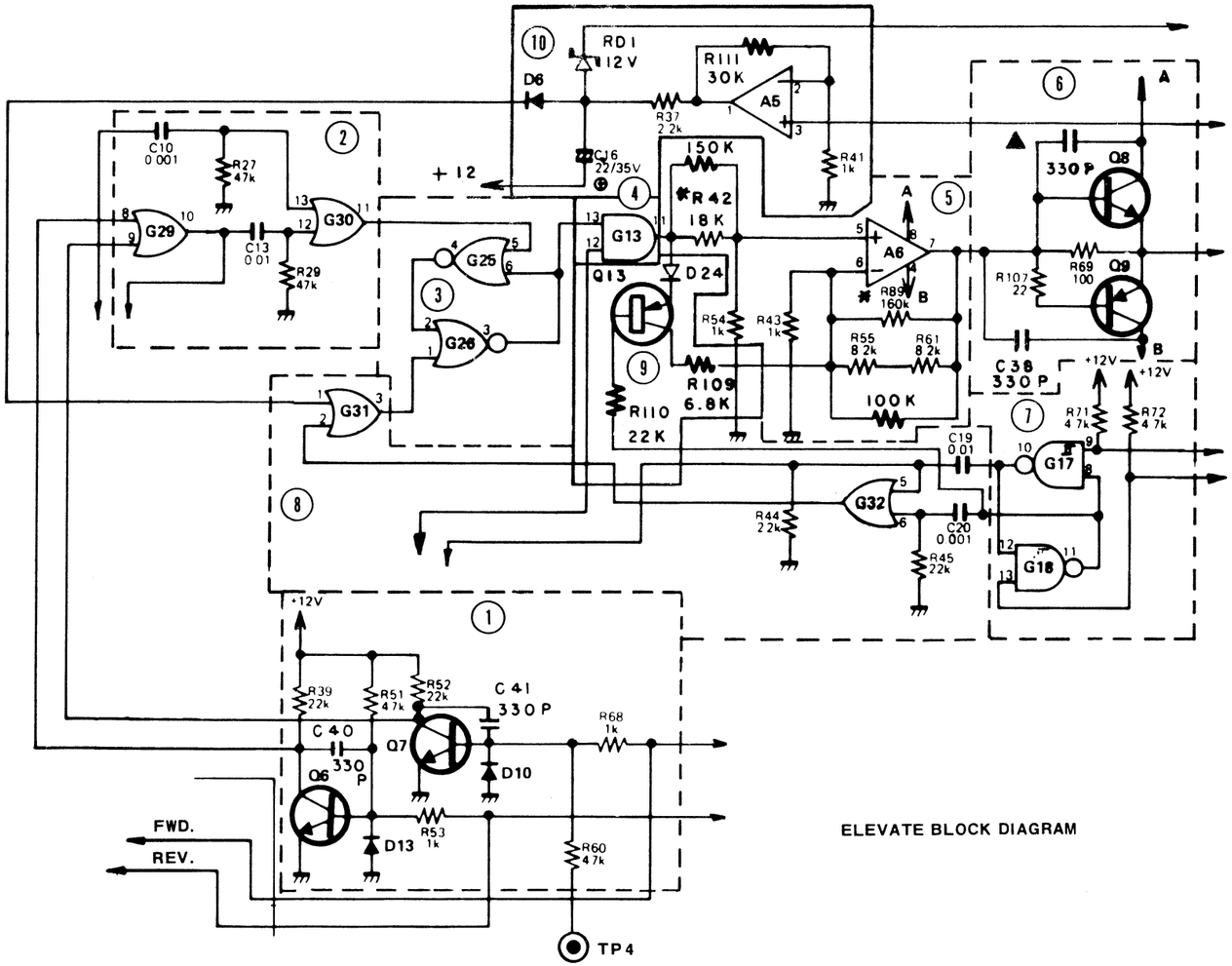


Figure CK. Pre-Amplifier and 1.0KHz Digital Filter Schematic Block Diagram

Figure CJ. Pre-Amplifier and 1.0KHz Digital Filter Functional Block Diagram



ELEVATE BLOCK DIAGRAM

Figure CN. Slide Elevate System Schematic Block Diagram

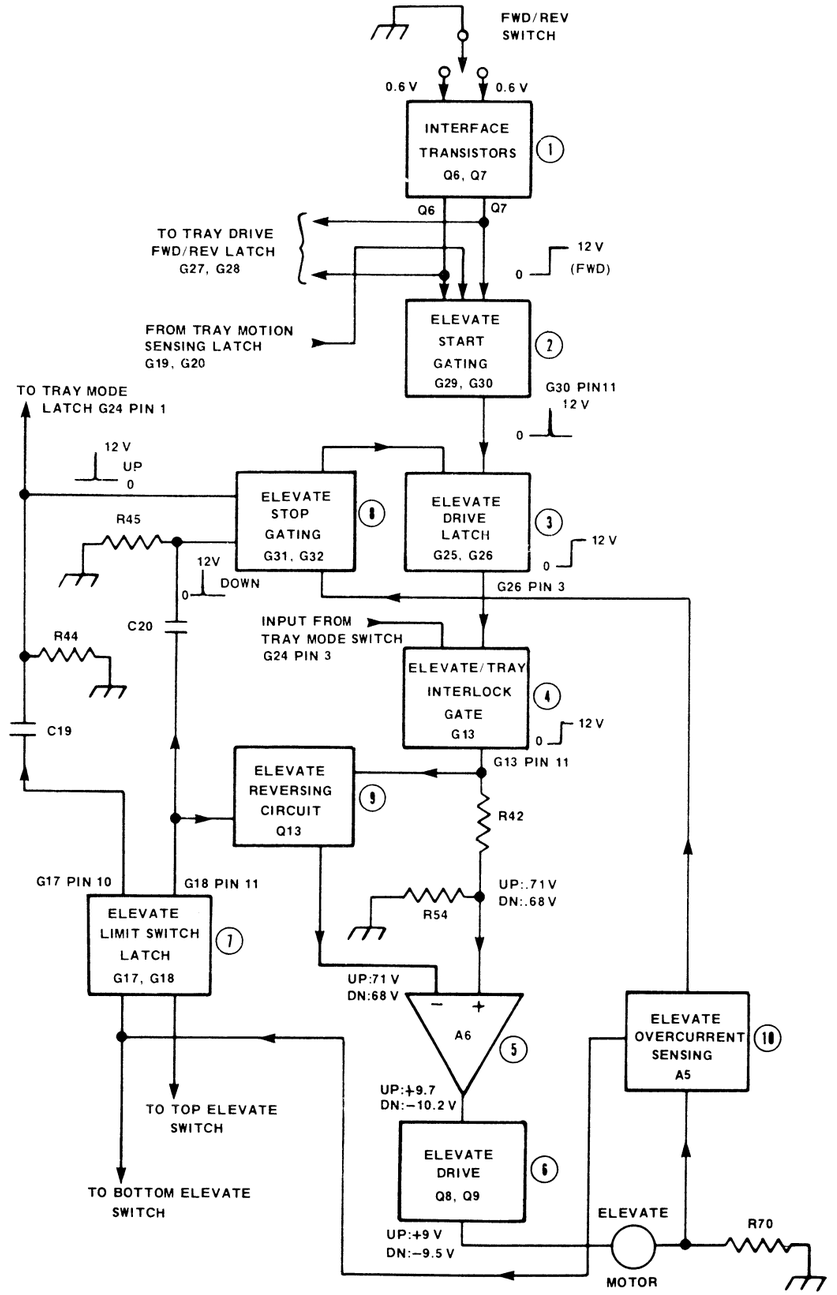
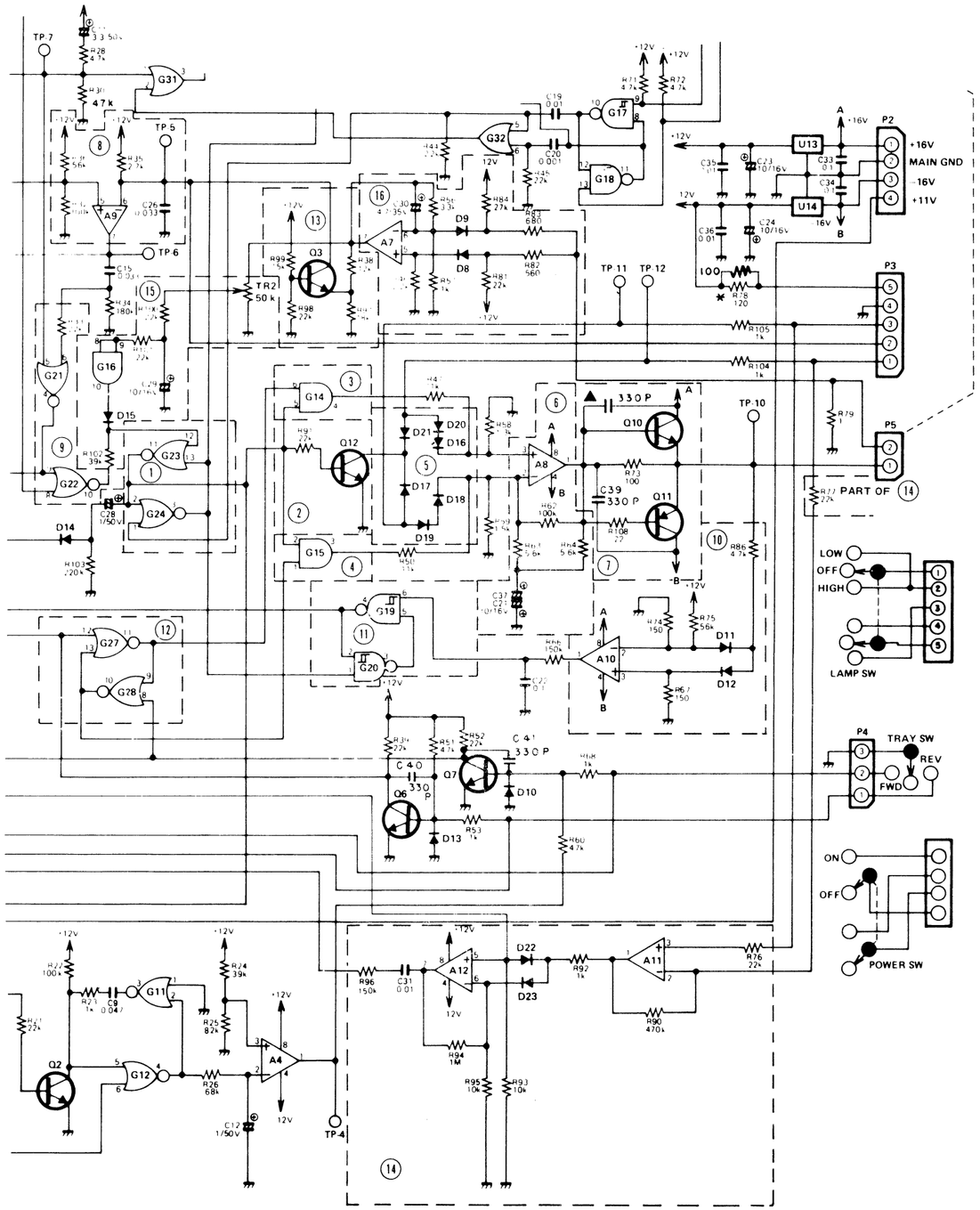
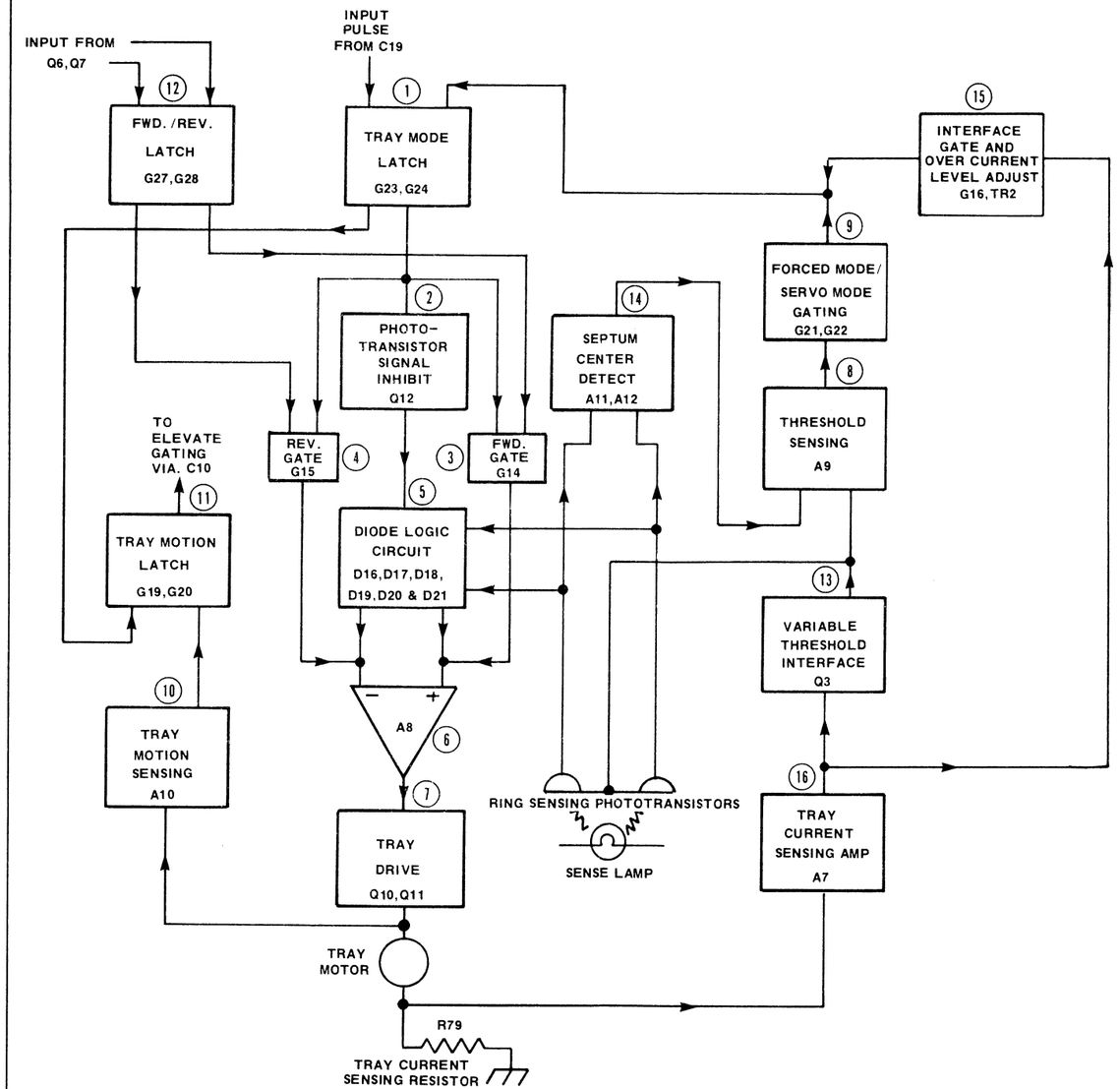


Figure CM. Slide Elevate System Functional Block Diagram





(Includes Over-Current Adjust Circuits)

Figure CP. Tray Drive System Functional Block Diagram and Schematic

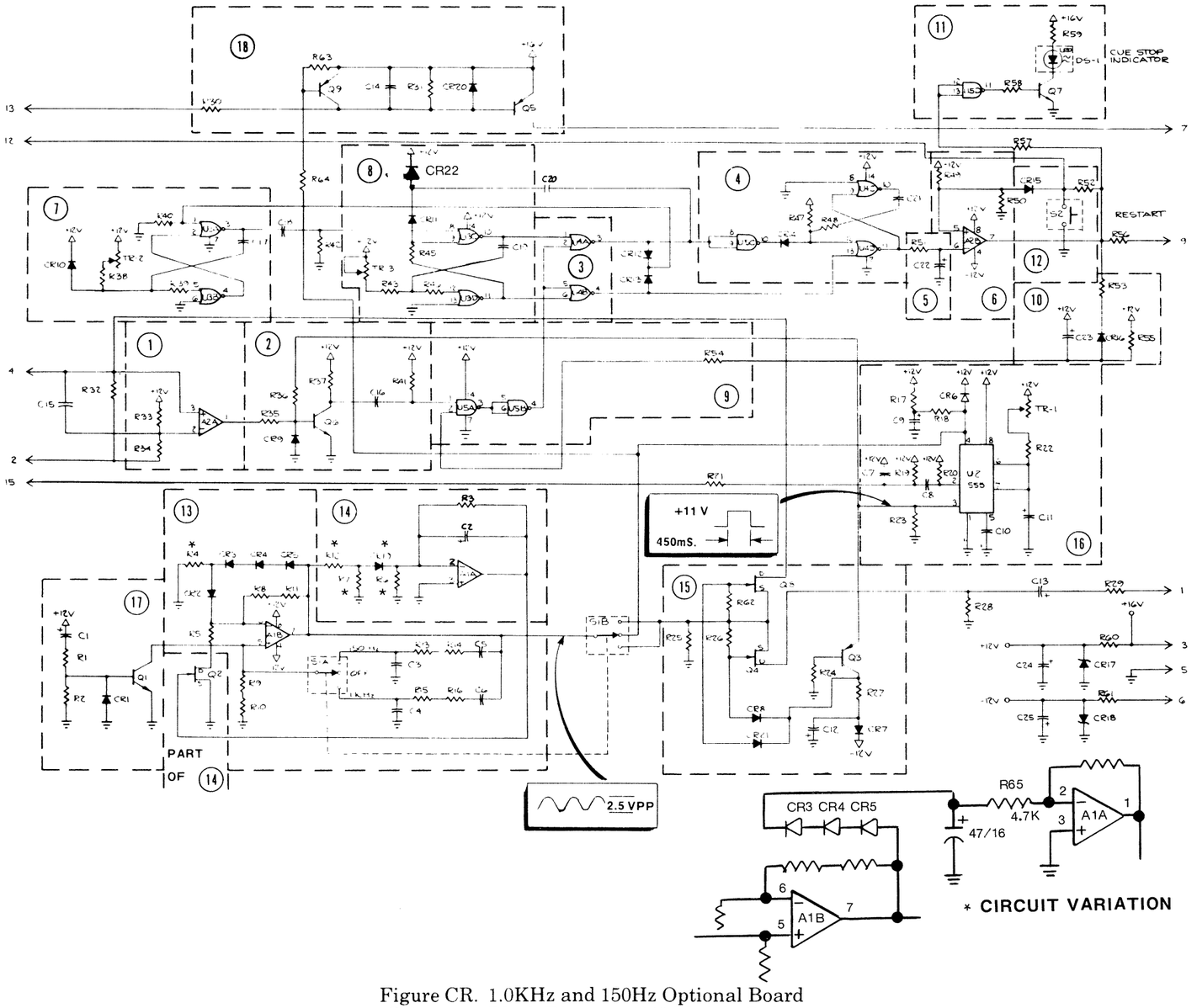


Figure CR. 1.0KHz and 150Hz Optional Board Schematic Block Diagram (840 Models Only)

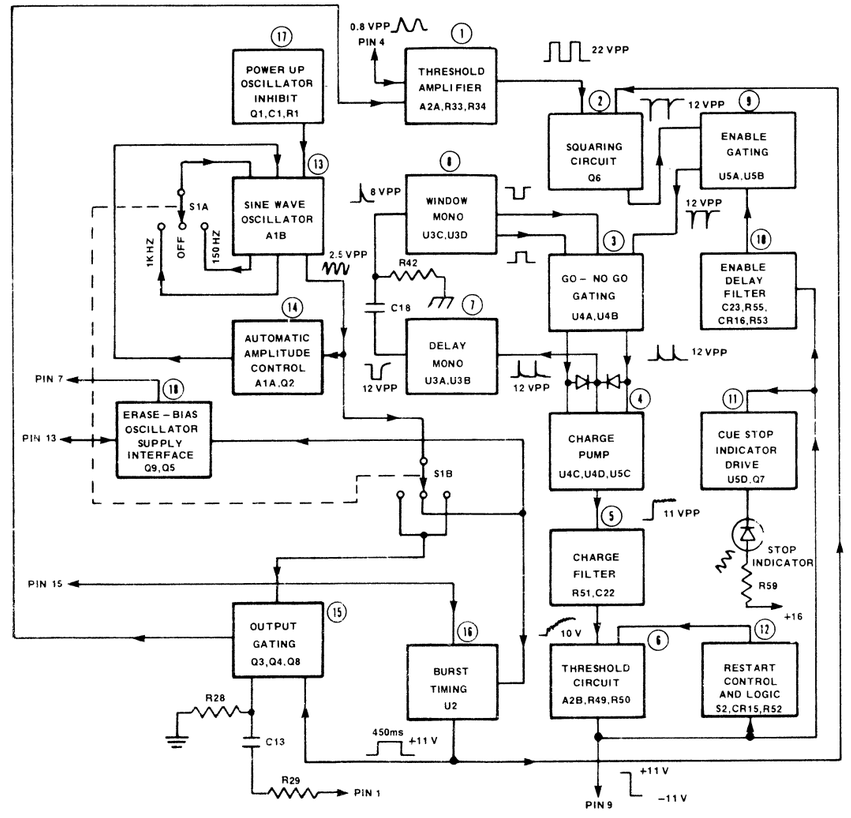
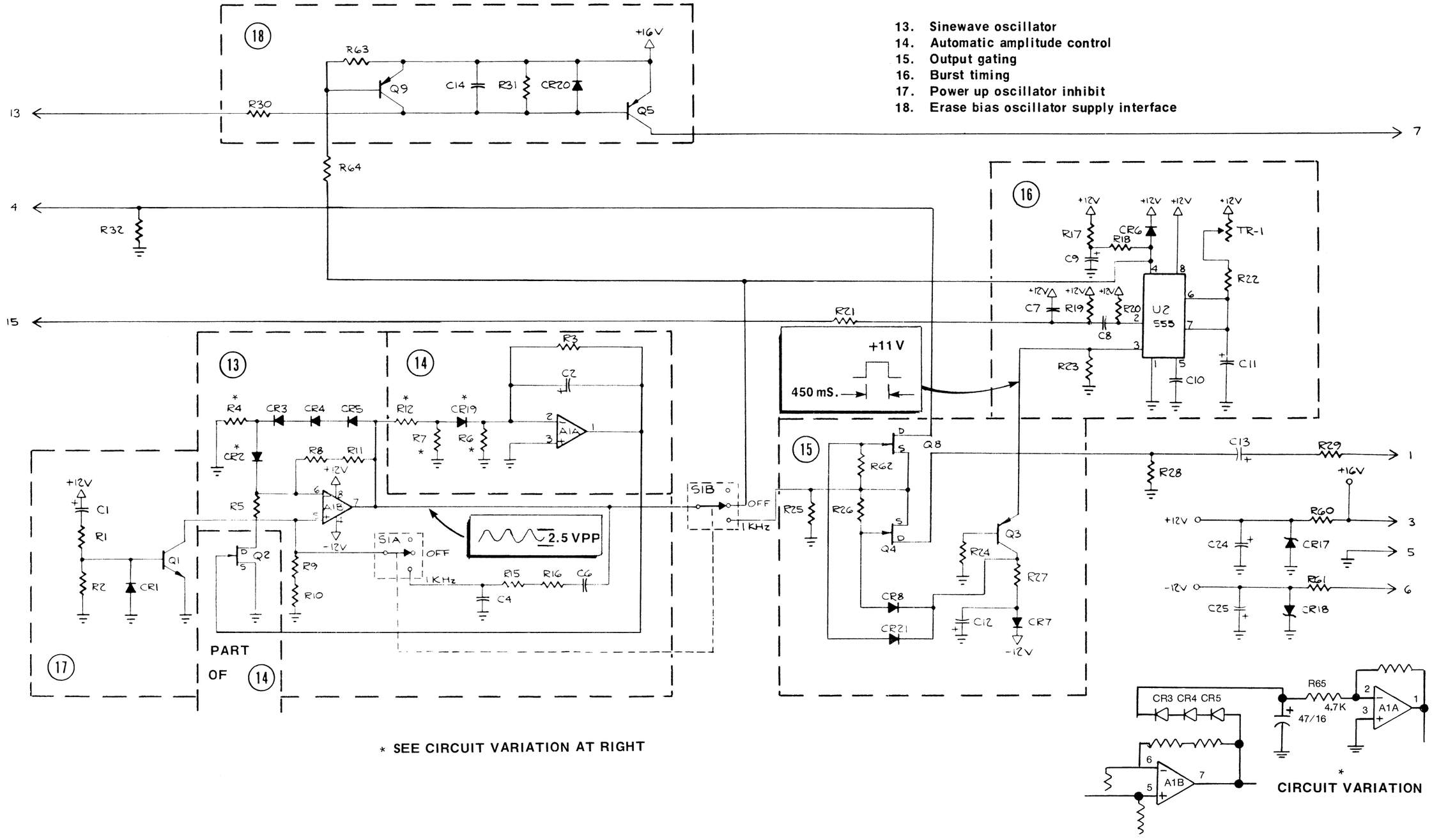


Figure CQ. 1.0KHz and 150Hz Option Board Functional Block Diagram (840 Models Only)

13. Sinewave oscillator
14. Automatic amplitude control
15. Output gating
16. Burst timing
17. Power up oscillator inhibit
18. Erase bias oscillator supply interface



* SEE CIRCUIT VARIATION AT RIGHT

Figure CS. 1.0KHz Option Board Schematic Block Diagram (830 Models Only)

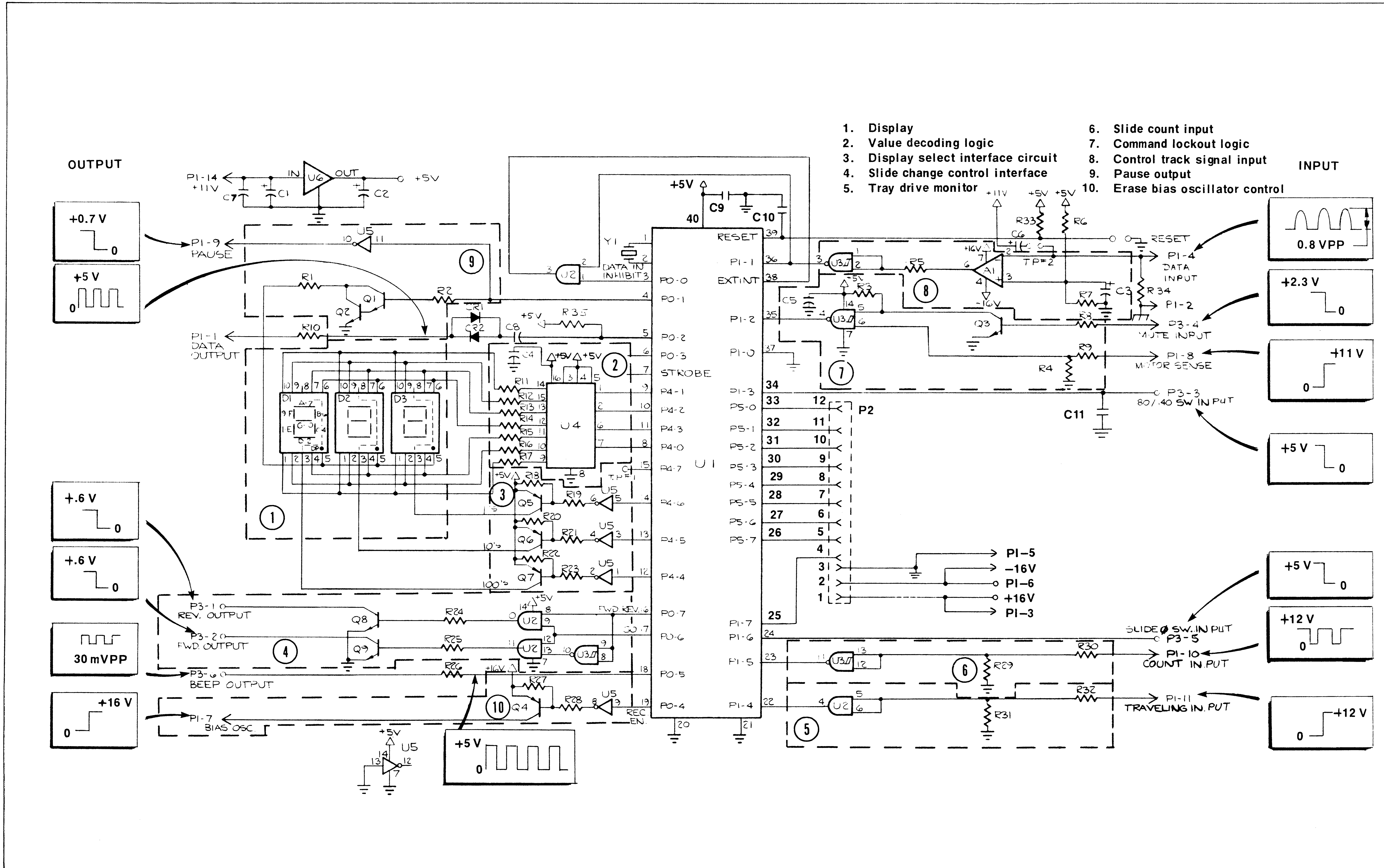

1. Display
2. Value decoding logic
3. Display select interface circuit
4. Slide change control interface
5. Tray drive monitor
6. Slide count input
7. Command lockout logic
8. Control track signal input
9. Pause output
10. Erase bias oscillator control
OUTPUT
INPUT
+0.7 V
+5 V
+.6 V
+.6 V
30 mVPP
+16 V
0.8 VPP
+2.3 V
+11 V
+5 V
+5 V
+12 V
+12 V
P1-9 PAUSE
P1-1 DATA OUTPUT
P3-1 REV. OUTPUT
P3-2 FWD. OUTPUT
P3-6 BEEP OUTPUT
P1-7 BIAS OSC
P1-4 DATA INPUT
P3-4 MUTE INPUT
P1-8 MOTOR SENSE
P3-3 80/140 SW INPUT
SLIDE Ø SW. IN PUT P3-5
P1-10 COUNT IN PUT
P1-11 TRAVELING IN PUT
RESET
U1
U4
P2

Figure CT. Microprocessor Option Board Schematic Block Diagram (850 Models Only)

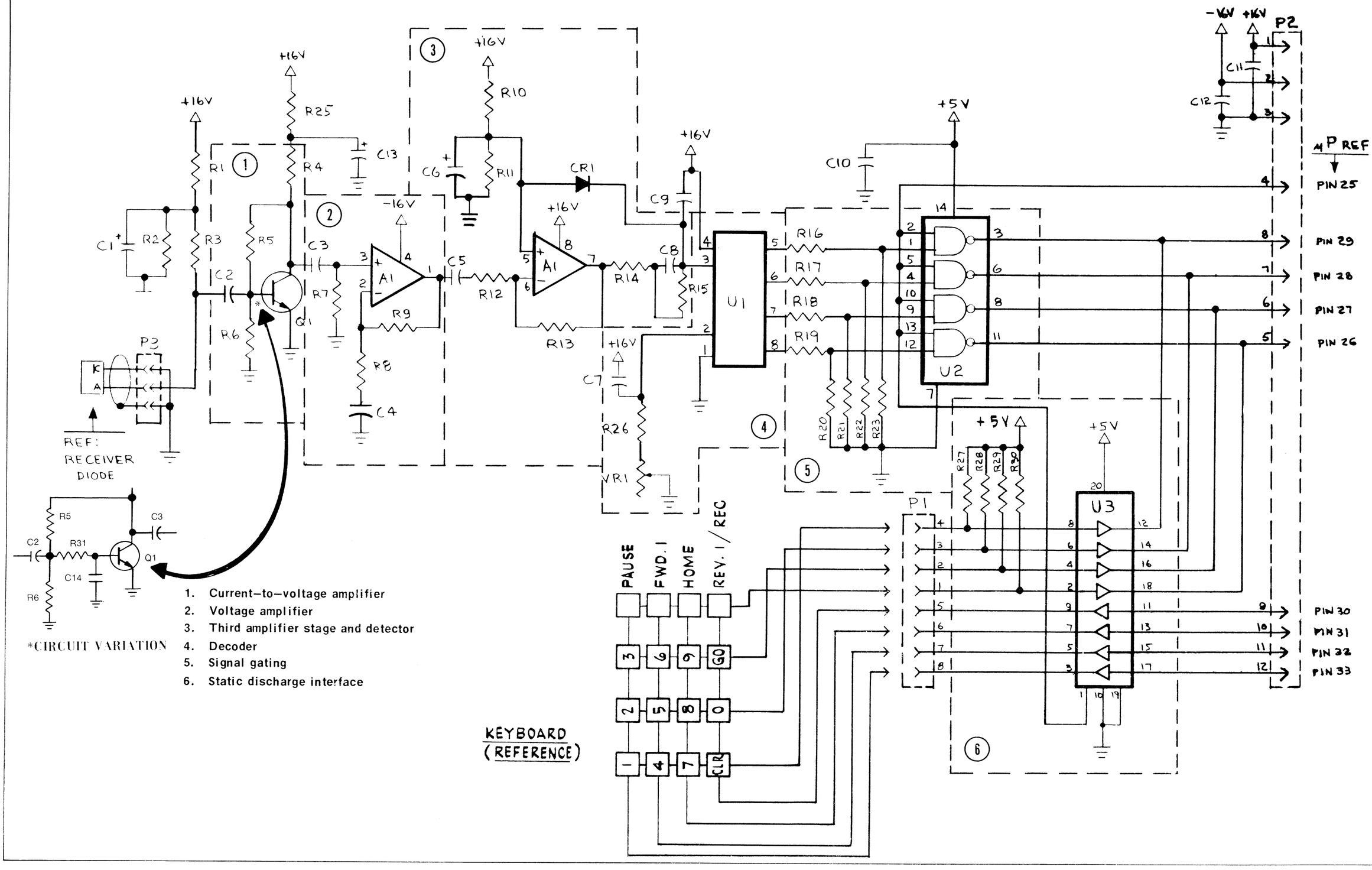


Figure CU. Infrared Remote Receiver PC Board Schematic Block Diagram

PARTS CATALOG

RINGMASTER® II SOUND SLIDE PROJECTOR

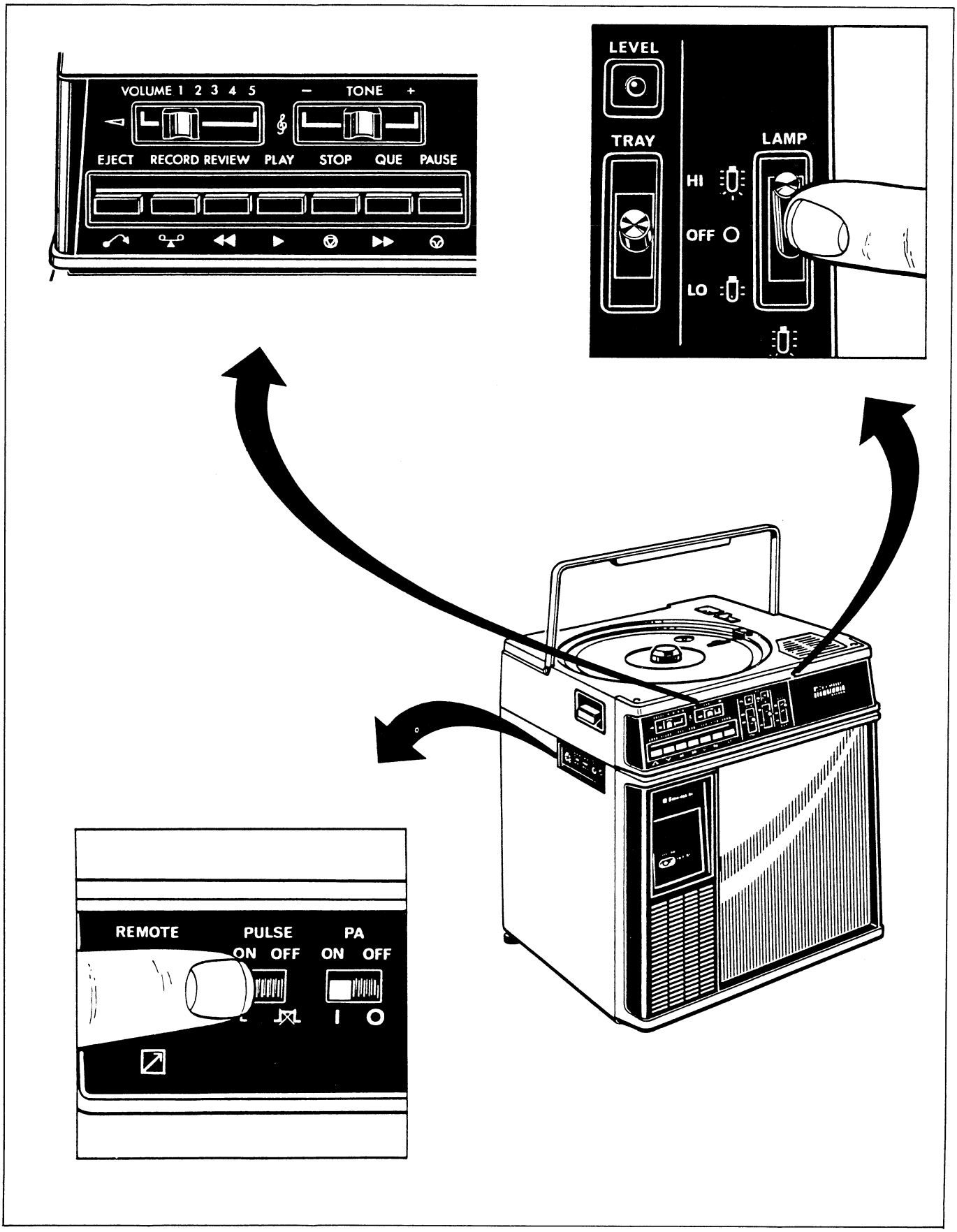
MODELS
815A, 820A, 825A, 830A, 840A, 850A,
820AN, 830AN, 840AN, 850AN,
EXPORT MODELS
820AX, 830AX, 840AX, 850AX

BELL+HOWELL

VISUAL COMMUNICATIONS DIVISION

GENERAL SERVICE DEPT.
7100 McCORMICK ROAD
CHICAGO, ILLINOIS 60645

PART NO. 74427 PRINTED IN U.S.A. JANUARY 1986



Model 840 Sound/Slide Projector

TABLE OF CONTENTS

NOTE: Use 850A Service Manual On 860A and 860AK Models.

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

*All tape recorders manufactured through 12-31-82 have a generically modified printed circuit board. Tape recorders manufactured after 12-31-82 will be equipped with the printed circuit board shown in Figures 45,46 and 47.

FOR PARTS, ORDERS AND SERVICE INFORMATION

Bell & Howell
General Service Department
Visual Communication Divisions
7100 No. McCormick Road
Chicago, IL 60645
(312)262-1600

RECOMMENDED SPARE PARTS AND MODULE LIST

In accordance with the Bell & Howell Company Modular Exchange Program the following modules used in these sound/slide projectors are affected.

PART NO.	MODULE DESCRIPTION	USED ON
079000	Tape Recorder Deck Assembly	All Models*
	***CAUTION:** See "Product Modification" for use on all 850 microprocessor models.	
079002	Lamp Bracket and Mirror Assembly	All Models
079006	Ring Drive Motor and Bracket Assembly	All Models
079008	Lite Pipe and PC Board Assembly	All Except 850
079036	Focus Assembly	All Except 815A
079052	Slide Lift Mechanism and Lead Assembly	All Models
079058	100Hz Option Board	830 Models Only
079082	Transformer and Wiring Plate Assembly (Domestic)	'A' Models Only
079098	1000Hz and 150Hz Option Board	840 Models Only
079120	Lite Pipe and PC Board Assembly	850 Models Only
079158	Transformer and Wiring Plate Assembly (Export)	AX Models Only
079164	Focus Assembly	815 Model
079173	Transformer and Wiring Plate Assembly (Japanese)	AN Models Only
079500	Power Supply PC Board Assembly (Automatic Focusing)	All Except 815A
079146	Power Supply PC Board Assembly (Basic)	815 Model
079530	Microprocessor Option Board	850 Models Only

In many cases the serviceman will be able to repair and/or replace certain components without modular replacement. The following spare parts are recommended for inventory mostly because of possible wear or damage.

PART NO.	DESCRIPTION	USED ON
078622	Tilt Foot Assembly	All Models
079010	Lamp Door Assembly	All Models
079088	Autofocus Lamp Assembly	All Except 815A
079195	2-Pin Connector and Cable Assembly	850 Modification
44532	Rubber Foot	All Models
708065	Projection Lamp - Type DDM	All Models
709298	Autofocus Condenser	All Except 815A
709667	Connector Lug	850 Modification
710329	Plastic Condenser	All Models
711211	Mirror - Part of Lamp Bracket	All Models
711229	Second Mirror	All Models
711230	Third Mirror	All Models
711262	Screen	All Models

FEATURE DESCRIPTION LIST

General .....Console type sound/slide projector with front throw, rear projection capability and built-in viewing screen

Screen Size ..10" x 10" (25.4cm x 25.4cm)

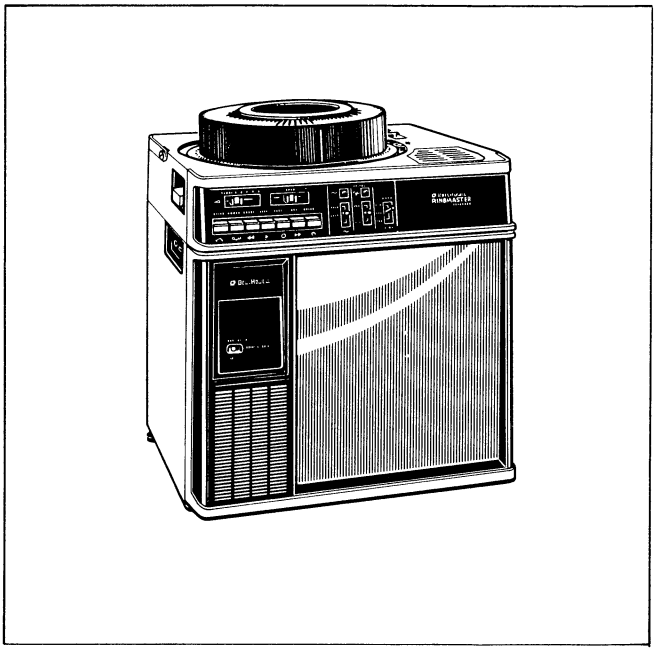
Optics .....f/3.5 80mm lens

Loading .....2" x 2" 35mm or 126mm slides loaded in an 80 or 140 position rotary tray

Slide Advance .....Manual integral, automatic 1KHz advance pulse cycling, microprocessor control or optional remote control

Overall Dimensions .....15-3/8" (39.1cm) high by 14-7/8" (37.8cm) wide by 13-1/2" (34.4cm) deep

Weight..... 26 pounds (11.8KG) (approx.)



Sound/Slide Projector

Electrical Requirements

All "A" Models .....Single Input - 117VAC, 60 Hz, 3-wire line cord

All "AN" Models ....Single Input - 100 Vac, 50/60Hz, 3-wire line cord

All "AX" Models .....Multiple Input - Voltage Selector 110, 130, 150, 220, 240, 260VAC, 50/60Hz, 3-wire line cord

Audio .....1.2 watt amplifier, 3" x 5" builtin speaker, two 1/4" jacks for an 8 to 600 ohm headset and a 4 ohm (minum) 5 watt external speaker

Type DDM Lamp ...19V, 80W projection lamp rated at 100 hours on high and 500 hours on low (P/N 708065)

USABLE ON CODE	A	B	C	D	E	F	G	H	J	K	L	M	N	O
MODEL / FEATURE	815A	820A	820AX	830A	830AX	840A	840AX	850A	850AX	820AN	830AN	840AN	850AN	825A
Tap Play/Record	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Automatic Focusing		X	X	X	X	X	X	X	X	X	X	X	X	X
Manual Forward/Reverse Control Switch	X	X	X	X	X	X	X	*	*	X	X	X	*	X
1000Hz Advance Pulse				X	X	X	X	*	*		X	X	*	X
150Hz Cue Stop						X	X	*	*			X	*	
*Microprocessor Control								X	X				X	

NOTE: Tapes with micropressor signals for cue-stop can only be used on 850 units. If used on other units the signal is recognized as a pulse and will not stop on cue.

INTRODUCTION

The following pages illustrate and list, by part number and description, all replacement parts for the Bell & Howell Company Sound/Slide Projectors Models 815, 820, 825A, 830, 840 and 850.

All models covered are similar in design, using a module replacement approach for servicing wherein a module can be replaced immediately putting the projector back into service quickly and repairing the module at another time.

Basic and electrical differences between models are given in the Feature Description List and Chart on the preceding page. Electrical differences also are noted on the pictorial and schematic diagrams found at the rear of this parts catalog manual.

In addition to the listed features, these units have built-in capacity to accommodate the optional remote control accessory . All models except the 850 series are equipped with a "remote" jack which accepts a remote control assembly. The 850 models however, have an infrared receiver that is activated by an infrared remote control transmitter assembly.

Each model number has an assigned suffix letter which denotes usability. For example, suffix letter "A" has been assigned to all models made for domestic use, "AN" models are made for Japan and "AX" designates all other export (global) models.

When ordering replacement parts, check the "Usable on Code" column to make certain that the part in question is applicable to the projector being repaired. Whenever this column is blank, the listed parts apply to all models. The following letter code system is used to identify those parts which are applicable only to specific models.

CODE	MODEL	CODE	MODEL
A	815A	H	850A
B	820A	J	850AX
C	820AX	K	820AN
D	830A	L	830AN
E	830AX	M	840AN
F	840A	N	850AN
G	840AX	O	825A

OPTIONAL ACCESSORY ITEMS

Pulse Switch, Cue Record ..... P/N 711389
Rotary Tray (80 Slides) ..... P/N 708602
126 Format Copy Stand..... P/N 708665
Headphones ..... P/N 715735
Projection Lamp (type DDM) ..... P/N 078065
Microphone..... P/N 707808
Plug, 7-Pin..... P/N 712115
Transportation Case..... P/N 712076
Protective Soft Side
Storage Cover ..... P/N 712075
Remote Control for
815/820/825/830 Models ..... P/N 079181
Remote Control for
840 Models..... P/N 079182
Infrared Remote Control
for 850 Models ..... P/N 713450

Endless Cassettes:

30 Seconds - One - N710051; 10 pack N077511
1 Minute - One - N710052; 10 pack N077512
3 Minutes - One - N710093; 10 pack N077513
6 Minutes - One - N710094; 10 pack N077514
12 Minutes - One - N710095; 10 pack N077515

The above items are available from:

Bell & Howell Company
Visual Communications Division
7100 North McCormick Road
Chicago, IL 60645

For additional Optional Accessories see current Audio-Visual Products Catalogs.

PRODUCT MODIFICATION

CAUTION

Replacement tape recorder deck modules (P/N 079000) must be modified for use on **all** 850 microprocessor models. Before assembling the replacement tape recorder deck to the slide projector, refer to the modification diagrams and follow the instructions outlined below.

The following parts and special tools are needed to perform the modification:

Part No.	Part/Tool
079195	2-Pin Connector/Cable Assy (1)
709667	Connector Lugs (2)
S-709926-1-FX1 or AMP Inc. 457445	Lead Extractor Tool
S-709667-2-F1 or AMP Inc. 90062	Crimping Tool

1 Remove the center switch (fwd/rev) from the right-hand side on the front of the tape recorder deck.

2 Clip the red, yellow and blue leads at the switch and unravel from the twisted harness crossing below the pushbuttons to termination at 3-pin plug P4. Secure the remaining leads.

3 Clip the blue lead at P4 and discard. Trim the yellow and red leads to 13 inches from P4. Strip the wire ends and lug with connectors (P/N 709667) securely crimping the lugs with a crimping tool.

4 Insert the 2-pin connector and cable assembly (P/N 079195) into P6 noting lead orientation (blue lead to pin 1).

5 Dress all four leads (yellow, red, blue and brown) from P4 and P6 toward cable harness near the front corner of the tape recorder deck and wire tie to the harness.

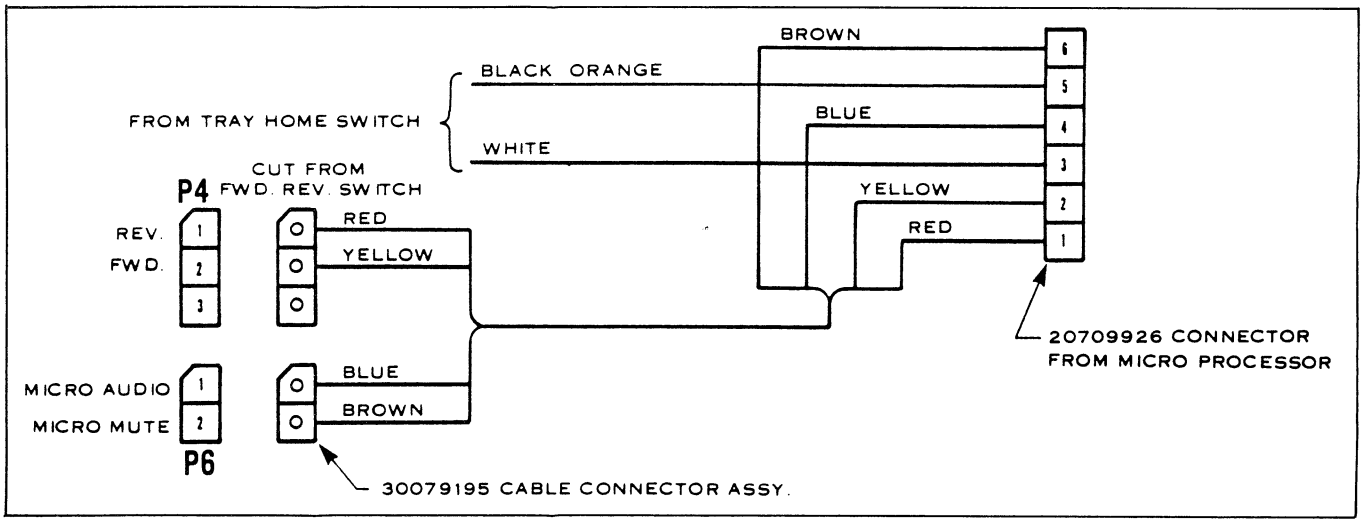
6 Cut jumper W-1 from the printed circuit board and discard. The modified tape recorder deck is now ready for placement into the projector.

7 Before removing the defective tape deck, refer to the disassembly/reasembly procedures and note the precautionary instructions and lead orientations for the 850 models. Then carefully remove the defective tape deck from the projector.

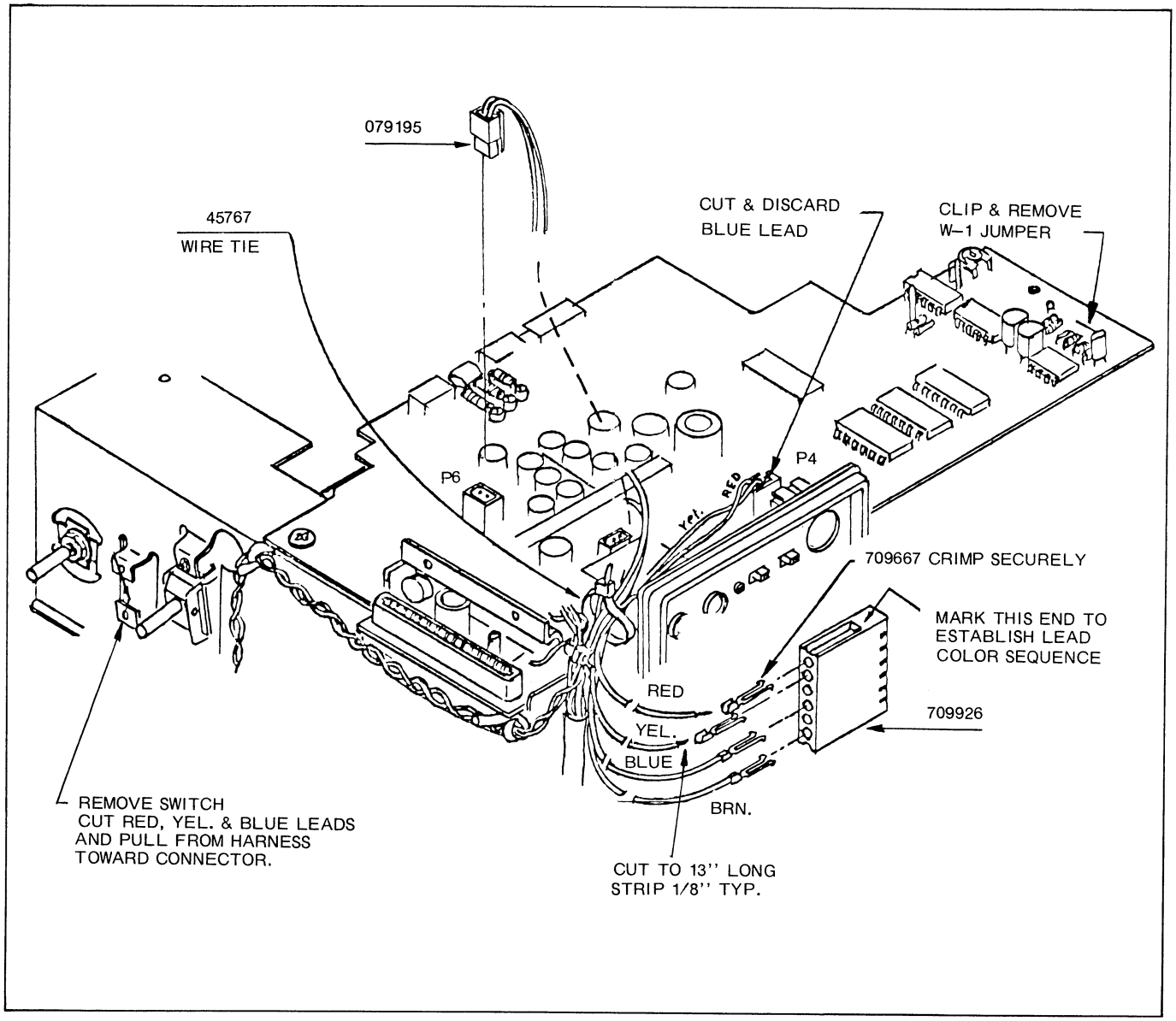
8 Mark the end of the microprocessor housing connector (P/N 709926) with a piece of red tape to establish lead color sequencce (see Product Modification - Pictorial Diagram). Then use the lead extractor tool to remove the existing red, yellow, blue and brown leads from the connector.

9 Now refer to the schematic diagram below and insert the modified tape deck leads into the microprocessor connector.

10 Assemble the modified tape deck to the projector and complete the reassembly procedures as instructed torquing all screws fastening modules to 5 in-lbs. minimum.



Product Modification - Schematic Diagram (850 Models Only)



Product Modification - Pictorial Diagram (850 Models Only)

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

PROJECTOR ASSEMBLY (FRONT VIEW)

1-1	711243	SCREW, Shoulder	2	
-2	079083	HANDLE AND INSERT ASSEMBLY	1	
-3	712037	SCREW, Type AB, '6-20 x 5/8 inch	2	
-4	712036	SCREW, Hi-Riser, '8 x 3 inches	2	
-5	079044	TOP DECK ASSEMBLY (See Figures 6, 7, 8)	1	BCDEFGKLMO
-5	079165	TOP DECK ASSEMBLY (See Figures 6, 7, 8)	1	A
-5	079166	TOP DECK ASSEMBLY (See Figures 6, 7, 8, 9)	1	HJ
-5	079558	TOP DECK ASSEMBLY (See Figures 6, 7, 8, 9)	1	N
-6	712086	KNOB, Volume and Tone Control	2	
-7	712034	SCREW, Hi-Riser, #6 x 1/2 inch	2	
-8	712035	SCREW, Hi-Riser, #6 x 1-1/4 inches	2	
-9	702933	BEZEL ASSEMBLY (See Figure 4 For Parts)	NP	
-10	711350	TRIMPLATE, Upper Control (See Figure 21)	1	A
-10	712056	TRIMPLATE, Upper Control (See Figure 21)	1	BDFKLM
-10	712057	TRIMPLATE, Upper Control (See Figure 22)	1	C
-10	712117	TRIMPLATE, Upper Control (See Figure 22)	1	E
-10	712118	TRIMPLATE, Upper Control (See Figure 22)	1	G
-10	711351	TRIMPLATE, Upper Control (See Figure 21)	1	HN
-10	712058	TRIMPLATE, Upper Control (See Figure 22)	1	J
-10	715302	TRIMPLATE, Upper Control (See Figure 22)	1	O
-11	711352	TRIMPLATE (See Figure 19)	1	ABCK
-11	711353	TRIMPLATE, Option Board (See Figure 19)	1	DEL
-11	711354	TRIMPLATE, Option Board (See Figure 19)	1	FGM
-11	713428	KEYBOARD, Microprocessor (See Figure 19)	1	HJN
-12	711384	DISC, Bat Switch	3	ABCK
-12	711384	DISC, Bat Switch	4	DEGFLMO
-12	711384	DISC, Bat Switch	2	HJN
-13	709050	SCREW, Hi-Riser, Hex Washer Head, #4 x 1/4 inch	2	ABCK
-13	712033	SCREW, Hi-Riser, #4-10 x 1-1/2 inches	2	DEFGHJLMNO
-14	711297	SPACER	2	DEFGHJLMNO
-15	016522	WIRE TIE	1	ABCK
-16	079058	OPTION BOARD, 1KHz Record (See Figure 28)	1	DELO
-16	079098	OPTION BOARD, 150Hz Pulse, 1KHz Record (See Figure 30)	1	FGM
-16	079570	OPTION BOARD	1	HNJ
-16	079530	MICROPROCESSOR (See Figure 32)	1	HJN
-17	713407	SHIELD	1	
-18	712032	PAD	1	
-19	712196	SCREW, Hex Washer Head, M3, 150 x 5mm	2	
-20	712195	HEAT SINK	1	
-21	711349	TRIMPLATE, Jack Panel (See Figure 20)	1	ABCDEFGKLM
-21	711369	TRIMPLATE, Jack Panel (See Figure 20)	1	HJN
-21	715301	TRIMPLATE, Jack Panel (See Figure 20)	1	O
-22	709049	SCREW, Hi-Riser, #6-10 x 5/16 inch	6	
-23	712127	PAD, Light Seal	2	
-24	14175	WASHER, External Lock	1	
-25	079187	LEAD ASSEMBLY, Electrostatic Ground (Connected to Speaker Tab)	1	DEFGHJLMNO
-26	709926	CONNECTOR HOUSING, Microprocessor	1	HJN
-27	079195	CABLE, Microprocessor Interface	1	HJN
-28	079000	TAPE RECORDER ASSY (See Figures 40-48)	1	
-29	709049	SCREW, Hi-Riser, Hex Washer Head, #6-10 x 5/16 inch	2	
-30	016522	WIRE TIE	2	
-31	711296	COVER, Channel	1	
-32	079144	CABLE, Speaker	1	
-33	712094	GROMMET, Continuous	1	DEFGLMO

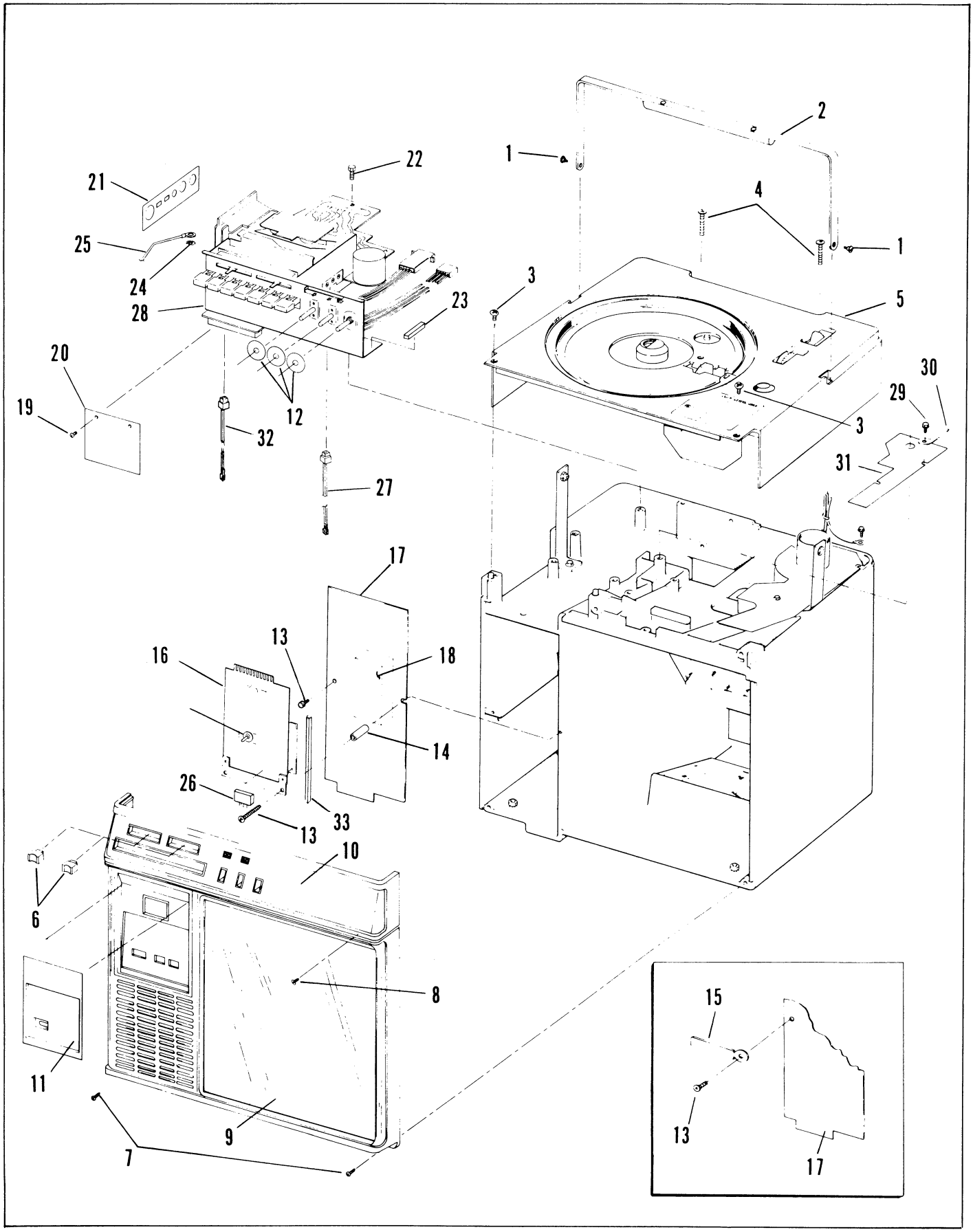


Figure 1. Projector Assembly - Front View

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

PROJECTOR ASSEMBLY (REAR VIEW)

2-1	709049	SCREW, Hi-Riser, Hex Washer Head #4 x 1/4 inch	1	
-2	712052	SCREW, Hex Washer Head, Type AB, #8-18 x 5/8 inch	1	
-3	711246	PLATE, Hinge	2	
-4	711239	DOOR, Tray Access	1	
-5	712032	PAD	1	
-6	709049	SCREW, Hi-Riser, Hex Washer Head, #4 x 1/4 inch	4	
-7	711295	KEEPER, Cord Storage	1	
-8	709049	SCREW, Hi-Riser, Hex Washer Head, #6-10 x 5/16 inch	4	
-9	715304	DATA PLATE	1	O
-9	713408	DATA PLATE	1	ABDFH
-9	713409	DATA PLATE	1	CEGJ
-9	712082	DATA PLATE	1	KLMN
-10	712129	LABEL, FCC Compliance	1	H
-11	766221	SCREW, Hex Washer Head, Swage Form '6-32 x 3/8 inch	1	
-12	712052	SCREW, Hex Washer Head, Type AB, '8-18 x 5/8 inch	1	
-13	709049	SCREW, Hi-Riser, Hex Washer Head, '6-10 x 5/16 inch	2	
-14	079082	TRANSFORMER AND WIRING PLATE ASSEMBLY (Domestic Models - See Figure 17 For Detail Parts)	1	ABDFH
-14	079158	TRANSFORMER AND WIRING PLATE ASSEMBLY (Export Models - See Figure 18 For Detail Parts)	1	CEGJ
-14	079173	TRANSFORMER AND WIRING PLATE ASSEMBLY (Japanese Models - See Figure 17 For Detail Parts)	1	KLMN
-15	No Number	HOUSING ASSEMBLY, (Domestic Models - See Figure 17 For Detail Parts)	1	ABDFH
-14	079533	TRANSFORMER AND WIRING PLATE ASSEMBLY (Domestic Models - See Figure 17 For Detail Parts)	1	O
-16	14175	WASHER, External Lock	1	

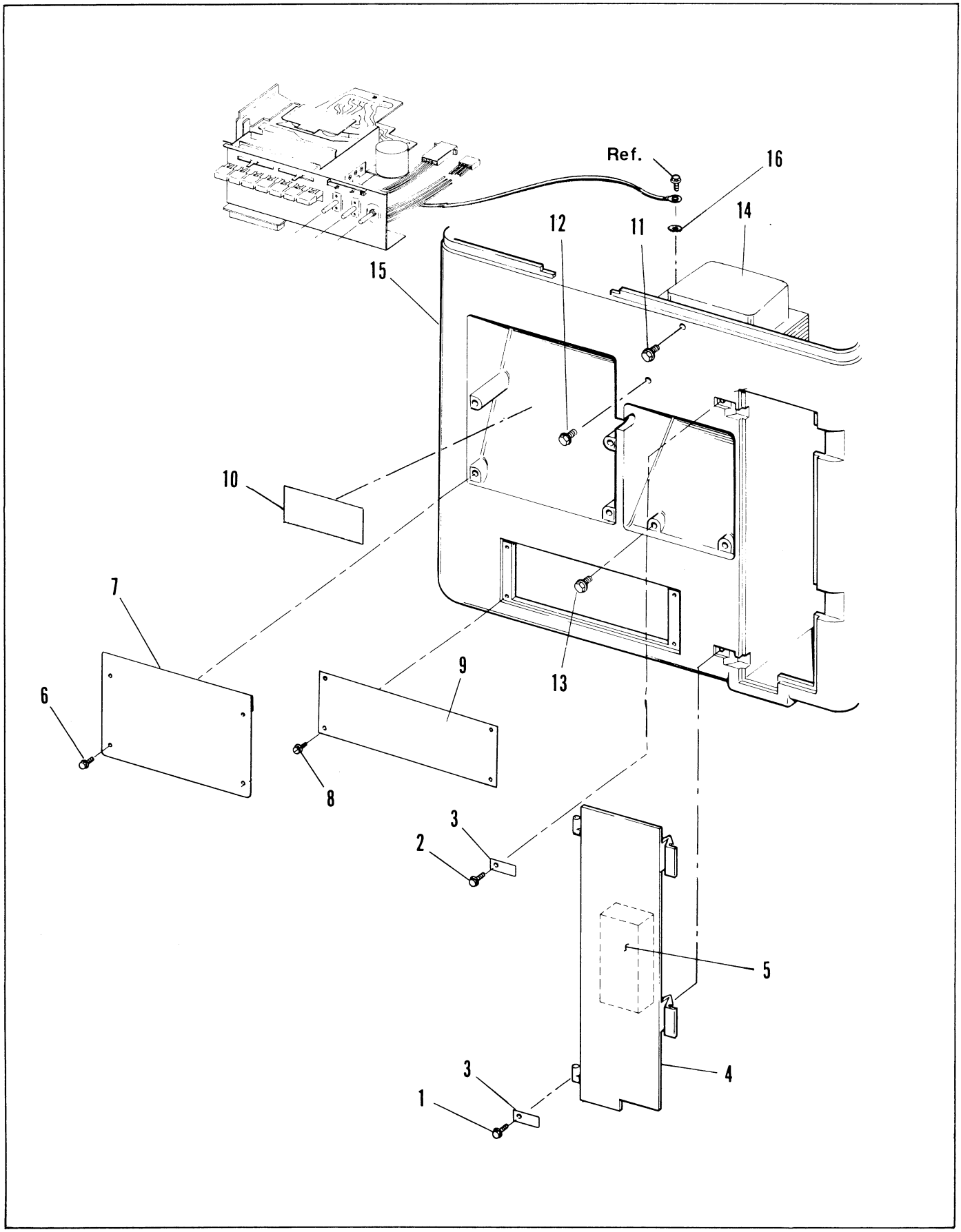


Figure 2. Projector Assembly - Rear View

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

LOWER HOUSING ASSEMBLY

3-0	No Number	LOWER HOUSING ASSEMBLY, Complete	NP	
-1	709050	• SCREW, Hi-Riser, Hex Washer Head, #4 x 1/4 inch	3	
-2	079004	• MOTOR AND BLOWER ASSEMBLY (See Figure 5 For Detail Parts)	1	
-3	712108	• PAD, Shutter Bounce	1	
-4	30824	• SCREW, Machine, Hex Washer Head, #10-21 x 1 inch	2	
-5	712045	• NUT, Keps, #10-32	2	
-6	079133	• BRACKET ASSEMBLY, Handle	2	
-7	36844	• SCREW, Machine, #6-32 x 5/8 inch	2	
-8	44532	• FOOT, Rubber	2	
-9	309923	• NUT, Hex, Sems, #6-32	2	
-10	42430	• NUT, Cap	2	
-11	078622	• TILT FOOT ASSEMBLY	2	
-12	710952	• RIVET NUT	2	
-13	712029	• TAPE, Two-sided Adhesive	3	
-14	711230	• MIRROR, Third	1	
-15	711301	• TAPE, Two-sided Adhesive	2	
-16	711229	• MIRROR, Second	1	
-17	No Number	• HOUSING, Lower	NP	

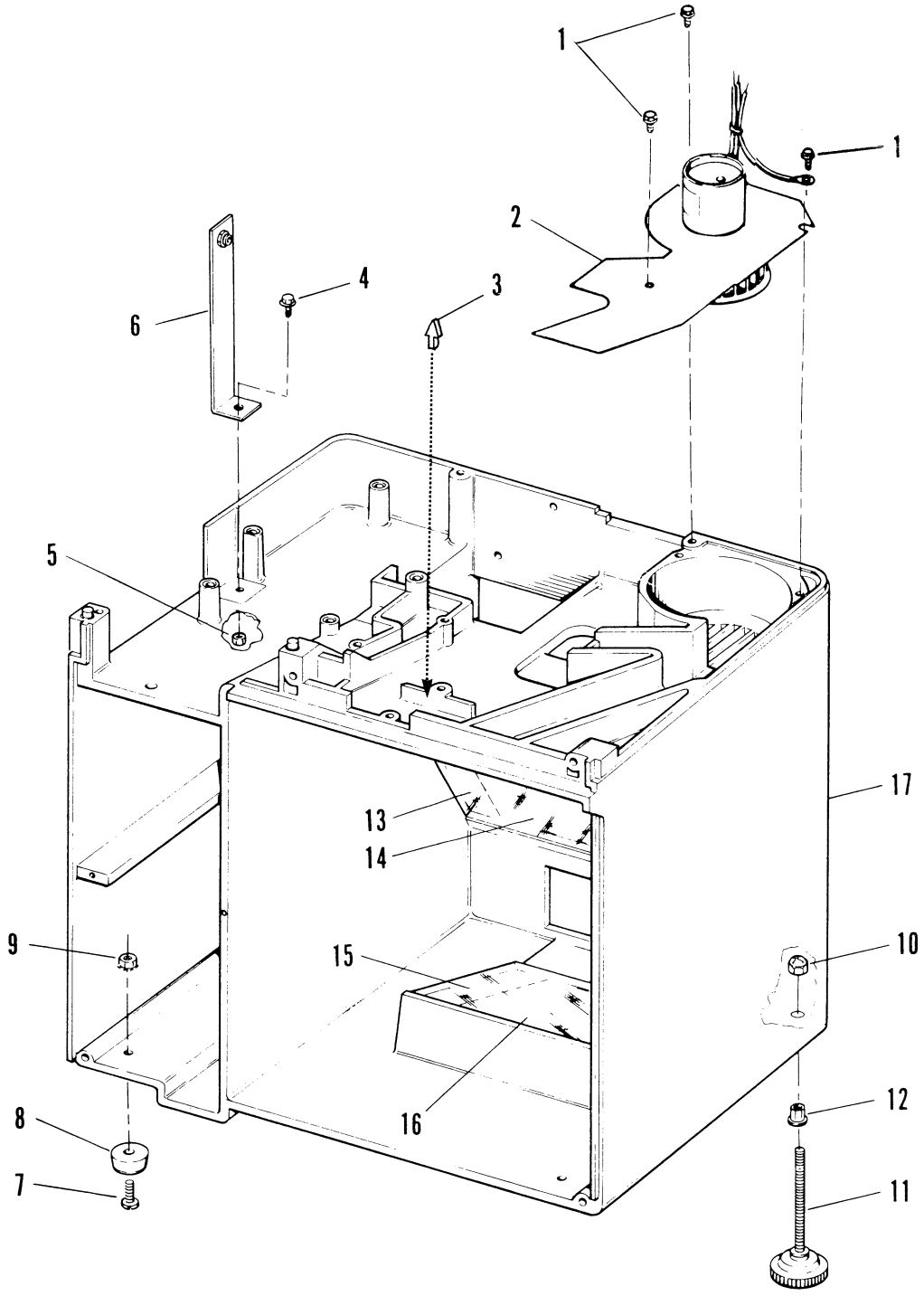


Figure 3. Lower Housing Assembly

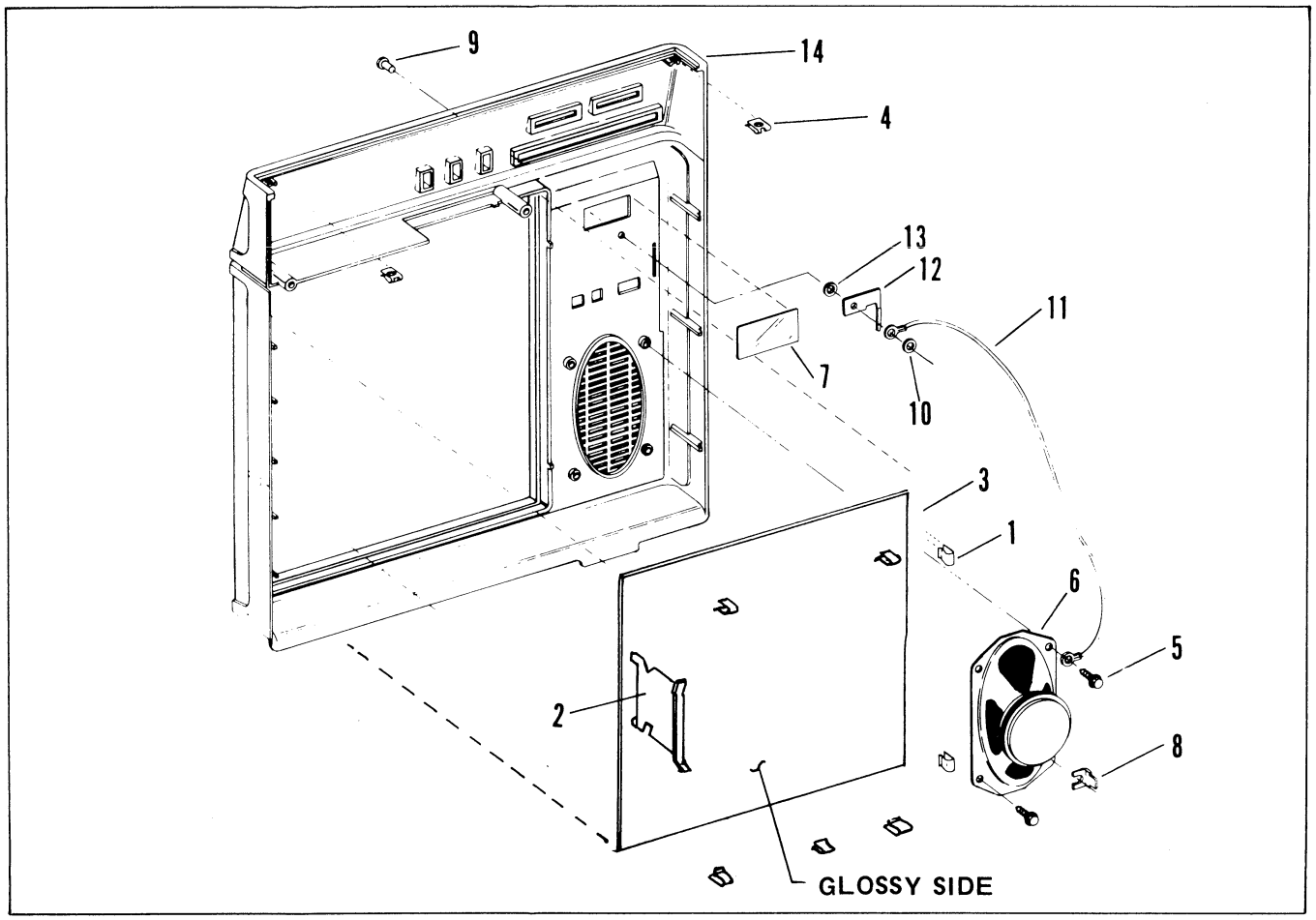


Figure 4. Bezel Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

BEZEL ASSEMBLY

4-	No Number	BEZEL ASSEMBLY, Complete	NP	
-1	711298	• CLIP, Screen	7	
-2	713467	• NICKERMAN CLIP	1	
-3	711262	• SCREEN	1	
-4	709218	• NUT, Tinnerman	2	
-5	709045	• SCREW, Hi-Rinser, Hex Head, #9-10 x 1.312 inch	4	
-6	711255	• SPEAKER (Alternate Part #20712005)	1	
-7	713425	• WINDOW	1	HJN
-8	712106	• TAB, Quick/Disconnect	1	D thru O
-9	712122	• RIVET, S.T., 0.123 x 3/16 inch	1	D thru O
-10	31020	• WASHER, Flat	1	D thru O
-11	079186	• LEAD ASSEMBLY, Ground	1	D thru O
-12	712105	• SPRING, Grounding	1	D thru O
-13	709012	• WASHER	1	D thru O
-14	711237	• BEZEL	1	

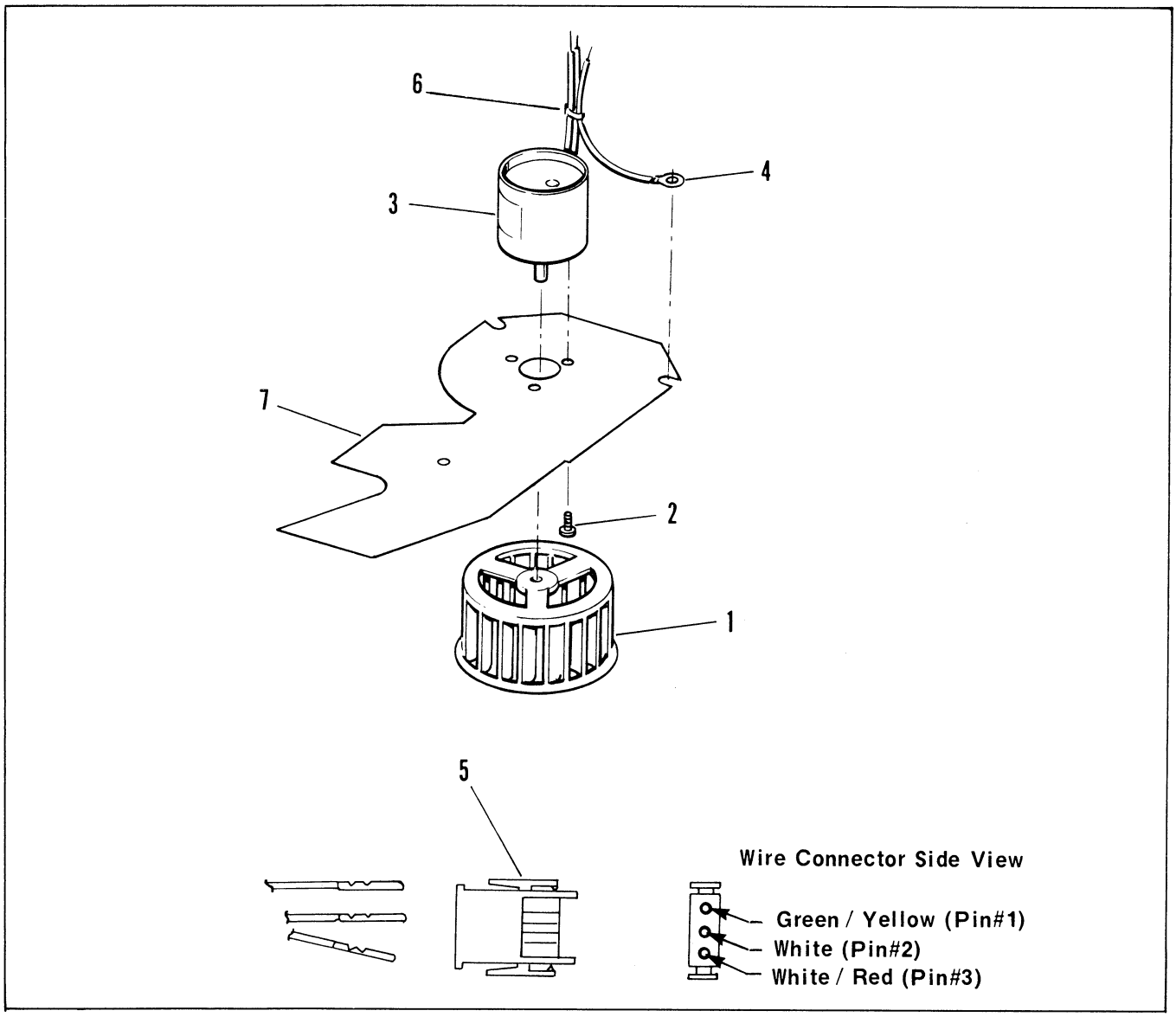


Figure 5. Motor and Blower Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

MOTOR AND BLOWER ASSEMBLY

5-	079004	MOTOR AND BLOWER ASSEMBLY, Complete	1
-1	711293	• BLOWER	1
-2	708031	• SCREW, Pan Head, 2.56mm x 3.5mm	3
-3	079087	• MOTOR AND LUG ASSEMBLY, Blower	1
-4	079128	• • CABLE ASSEMBLY, Ground	1
-5	711359	• • CONNECTOR, 3 Pin	1
-6	45767	• WIRE TIE (3 Inches From Motor)	1
-7	712088	• PLATE, Mounting	1

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

PROJECTOR ASSEMBLY (FRONT VIEW)

6-	079165	TOP DECK ASSEMBLY, Complete	NP	A
6-	079044	TOP DECK ASSEMBLY, Complete	NP	BCDEFGKLMO
6-	079166	TOP DECK ASSEMBLY, Complete	NP	HJ
6-	079558	TOP DECK ASSEMBLY, Complete	NP	N
-1	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	4	
-2	079501 (See Note)	PRINTED CIRCUIT BOARD, Power Supply (See Figure 23)	1	A
-2	079500 (See Note)	PRINTED CIRCUIT BOARD, Power Supply (See Figure 25)	1	B thru O
-3	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch	4	
-4	079002	LAMP BRACKET AND MIRROR ASSEMBLY (See Figure 14 For Detail Parts)	1	
-5	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch	1	B thru O
-6	712007	SHIELD, Lamp	1	B thru O
-7	713416	MASK, Scan Lamp	1	B thru O
-8	711370	SPRING, Wire Retractor	1	
-9	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch	4	
-10	079164	FOCUS ASSEMBLY, Complete (See Figure 11 For Detail Parts)	1	A
-10	079036	FOCUS ASSEMBLY, Complete (See Figure 11 For Detail Parts)	1	B thru O
-11	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch	3	
-12	079052	SLIDE LIFT MECHANISM AND LEAD ASSEMBLY (See Figure 10 For Detail Parts)	1	
-13	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch	3	
-14	079554	LITE PIPE AND PHOTOCELL ASSEMBLY (See Figure 13 For Detail Parts	1	ABCDEFGKLMO
-14	079555	LITE PIPE AND PHOTOCELL ASSEMBLY (See Figure 13 For Detail Parts)	1	HJN
-15	712074	SCREW, Hex Washer Head, Type BT #4 x 1/4 inch (See item 7-1)	1	
-16	079010	LAMP DOOR ASSEMBLY (See Item 7-2)	1	
-17	079006	RING DRIVE MOTOR AND BRACKET ASSEMBLY (See Figure 15 For Detail Parts)	1	
-18	712025	Shroud (See Item 7-23)	1	
-19	711357	SHIELD CABLE (See Item 7-24)	1	
-20	No Number	WIRING HARNESS (See Figure 37)	NP	A
-20	No Number	WIRING HARNESS (See Figure 37)	NP	B thru O
-21	713493	CLAMP, Plastic	1	

NOTE: Initial production of the 815A Models will use Power Supply PCB P/N 079501 until 11-6-82 and P/N 079146 after that date.

Initial production of all models except the 815A will use Power Supply PCB P/N 079500 until 11-6-82 and P/N 079011 after that date.

A potentiometer and 2-pin connector (P6) have been added on the 079500 and 079501 printed circuit boards to control the tray sensor lamp.

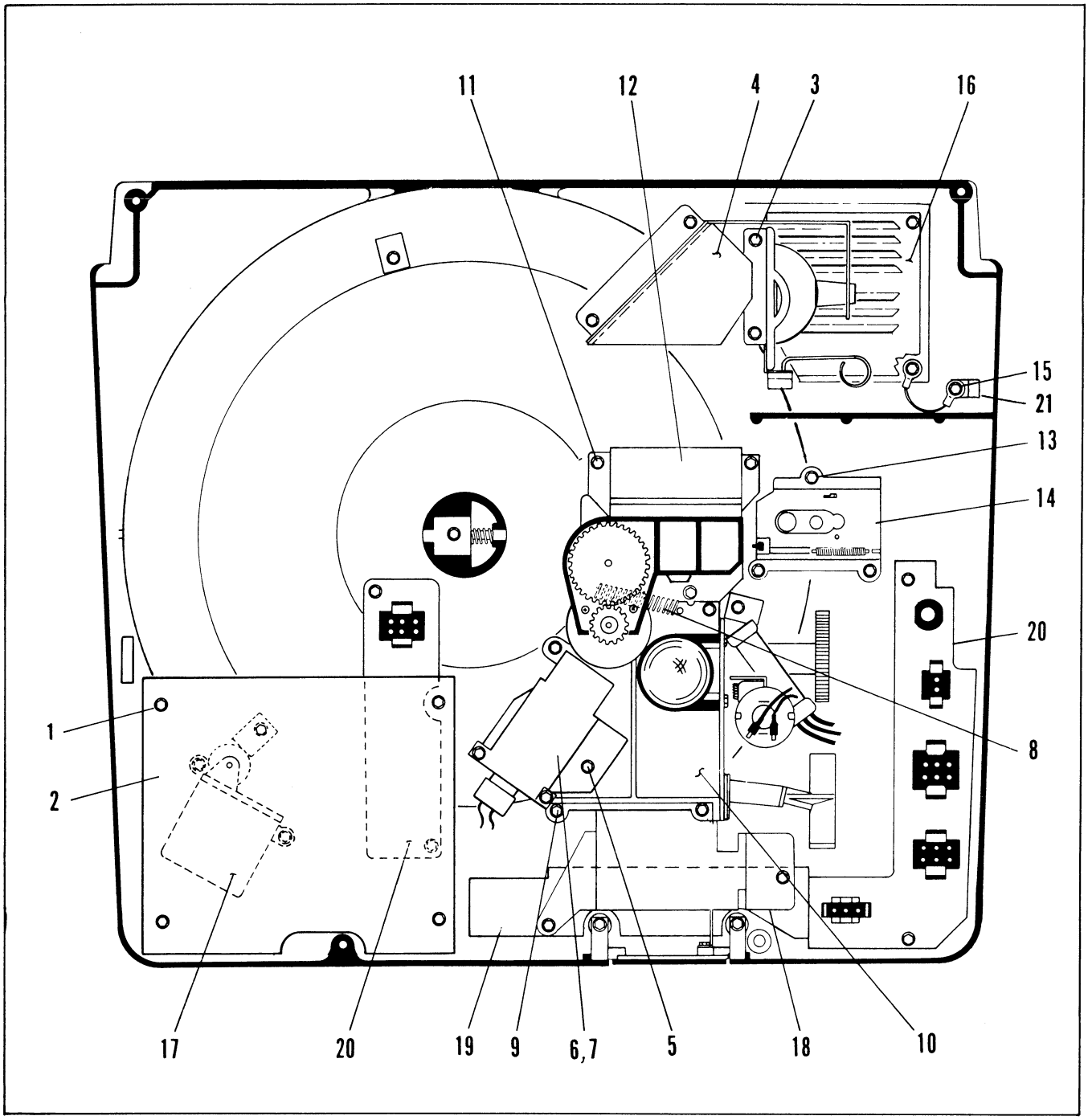


Figure 6. Top Deck Assembly - Locating View

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

TOP DECK ASSEMBLY (EXPLODED VIEW)

7-1	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	1	
-2	079010	LAMP DOOR ASSEMBLY	1	
-2A	712074	• SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	3	
-2B	711304	• BAFFLE	1	
-2C	710258	• SCREW	1	
-2D	710941	• WASHER	1	
-2E	711305	• DOOR, Lamp	1	
-2F	766895	• TIE, Door	1	
-3	711393	NUT, Tinnerman	1	
-4	708065	LAMP, Projection, Type DDM	1	
-5	712153	LABEL, Lamp	1	
-6	711276	STUD, Tray Positioning	1	
-7	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	1	
-8	711280	KNOB, Tray Release	1	
-9	711274	LOCK, Tray	1	
-10	712038	WASHER, Flat Plain	1	
-11	712011	SPRING, Tray Lock	1	
-12	712171	SCREW, Hex Washer Head, Type BF, #4-24 x 5/16 inch	5	
-13	712124	PAD, Bearing	5	
-14	079149	RING DRIVE ASSEMBLY	1	
-15	711363	SCREW, Hex Washer Head, Swage Form, #2-56 x 1/4 inch	2	
-16	711346	LOCK, Ring Drive	1	
-17	711347	EXPANDER	1	
-18	711348	SPRING, Compression	1	
-19	712053	TRIMPLATE, Ring Drive	1	
-20	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	2	
-21	079006	MOTOR AND BRACKET ASSEMBLY, Ring Drive (See Figure 15 for Detail Parts)	1	
-22	712074	SCREW, Hex Washer Head, Type BT, N4 x 1/4 inch	2	
-23	712025	SHROUD	1	
-24	711357	SHIELD, Cable	1	
-25	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	4	
-26	079544	WIRING HARNESS ASSEMBLY (See Figure 37)	NP	A
-27	079555	WIRING HARNESS ASSEMBLY (See Figure 37)	NP	B thru O
-28	45767	WIRE TIE, Plastic	1	
-29	709487	MOUNT, Wire Tie	1	
-30	712173	SETSCREW, Hex Socket Half Dog Point, #4-40 NC-3A x 1/2 inch (Mirror Adjusting)	1	
-31	712192	CONNECTOR, Housing, 3 Pin	1	HJN
-32	713486	#8 PAL NUT	2	HJN
-33	713485	SCREW, Phillips Trust Head, #8-32 x 1/2 inch	2	HJN
-34	079559	I.R. RECEIVER AND LENS ASSEMBLY	1	HJN
-35	713484	RETAINER, Filter	1	HJN
-36	713482	FILTER, Static	1	HJN
-37	079526	TOP DECK & FRONT THROW DOOR	1	ABCDEFGKLMO
-37	079575	TOP DECK & FRONT THROW DOOR	1	HJN

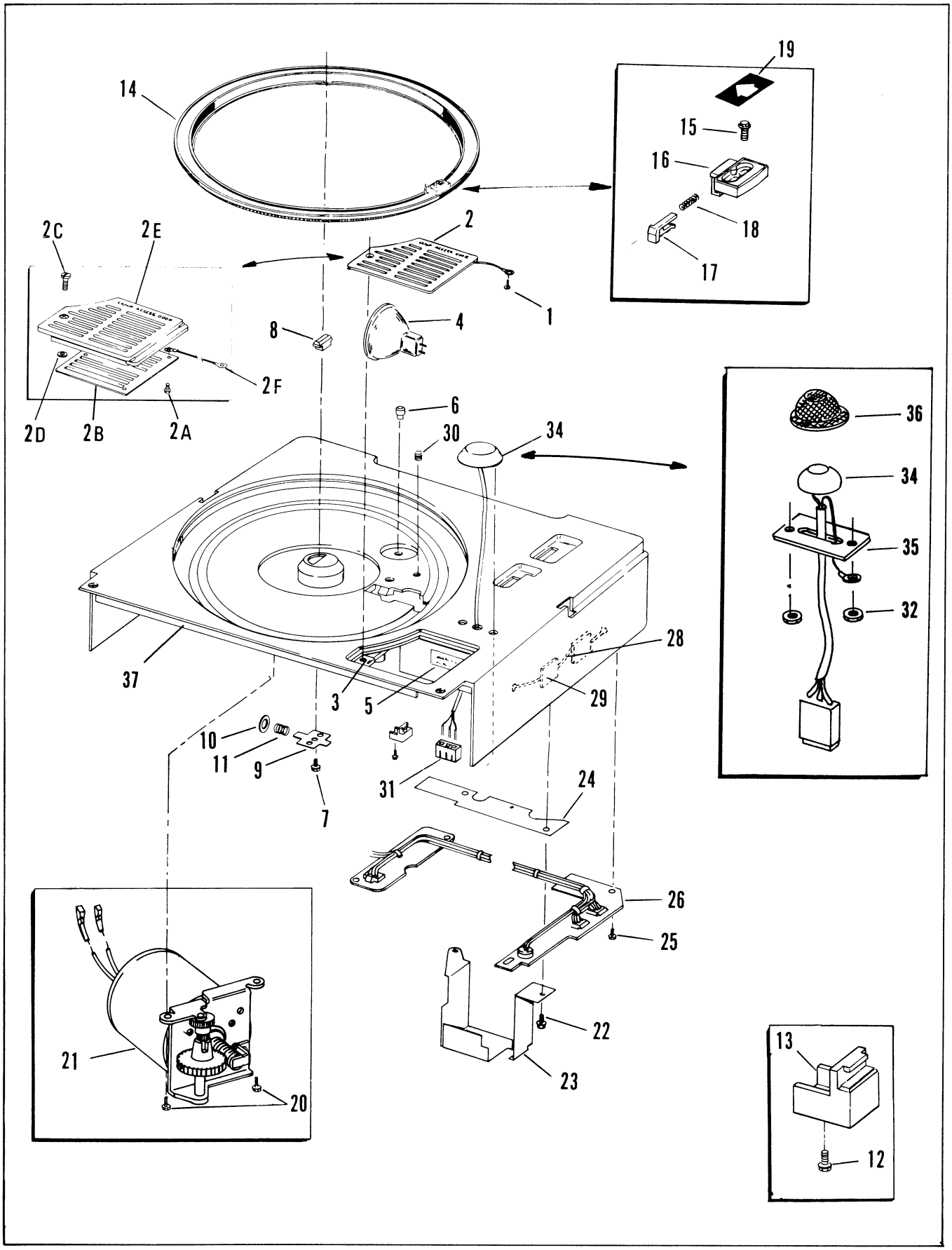


Figure 7. Top Deck Assembly - Exploded View

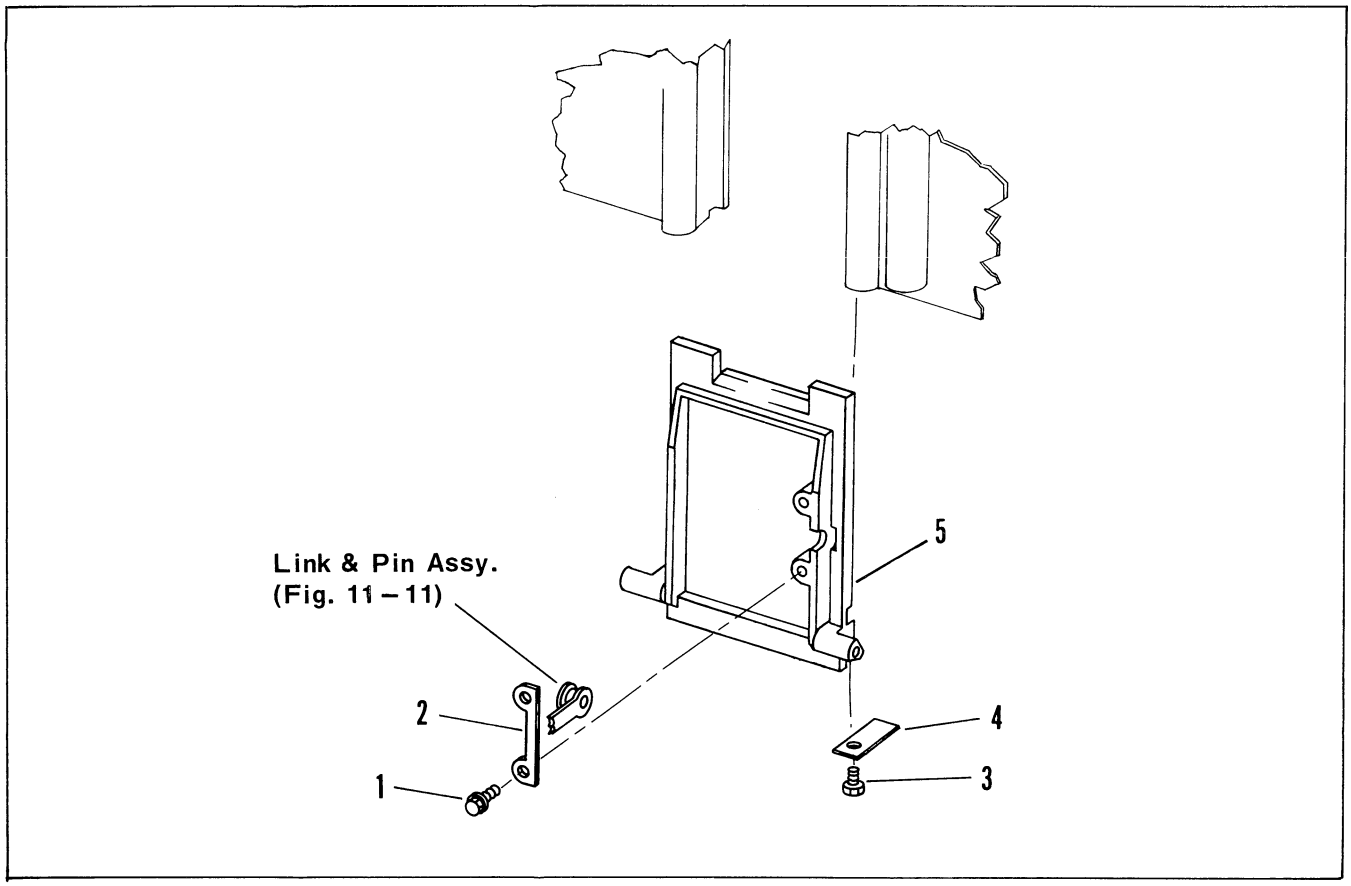


Figure 8. Top Deck Assembly - Front Throw Door View

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

TOP DECK ASSEMBLY (FRONT THROW DOOR VIEW)

8-1	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	2	
-2	711381	STRAP, Front Throw Door	1	
-3	712074	SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	2	
-4	711367	SPRING, Strap, Front Throw Door	2	
-5	713817	DOOR, Front Throw	1	

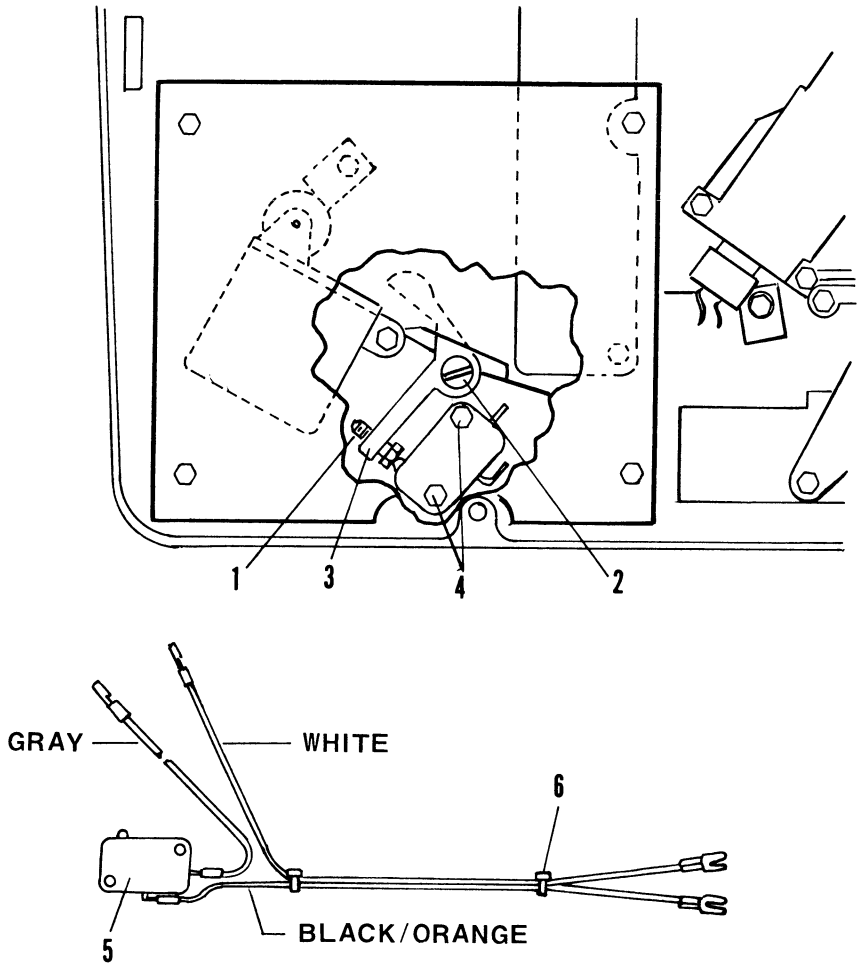


Figure 9. Top Deck Assembly - Homing Switch Components and Connector Wiring (850 Models Only)

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

TOP DECK ASSEMBLY — HOMING SWITCH COMPONENTS

9-1	713468	TRIMMED HEX HEAD, #4-24 x 5/16 inch	1	HJN
-2	711283	SCREW, Shoulder	1	HJN
-3	713464	ACTUATOR, Switch	1	HJN
-4	713469	SCREW, Hex Washer Head, Type BT, #4 x 9/16 inch	2	HJN
-5	073564	SWITCH ASSEMBLY, Homing	1	HJN
-6	45767	WIRE TIE	2	HJN
-7	713470	MICRO SWITCH	1	HJN

NOTE: Initial Production, prior to June 1984, of Models HJN will use 712068 Spring Actuator, 712286 Actuator Switch, 712074 Hex Screw, No. 4 x 1/4 inch, Type BT & 079121 Homing Switch Assembly.

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

SLIDE LIFT MECHANISM AND LEAD ASSEMBLY

10-	079052	SLIDE LIFT MECHANISM AND LEAD ASSEMBLY	1	
-1	711307	• CONNECTOR, Housing, 6 Pin	1	
-2	45767	• WIRE TIE, Plastic	2	
-3	712113	• SCREW, Hex Washer Pan Head, #2-56 NC 2 x 5/16 inch	3	
-4	079505	• SLIDE LIFT SWITCH AND WIRE ASSEMBLY	1	
-4A	712113	• • SCREW, Hex Washer Pan Head, #2-56 NC 2 x 5/16 inch	4	
-4B	712112	• • PLATE, Adjusting	2	
-4C	712062	• • SWITCH, Elevate	2	
-4D	713480	• • BRACKET, Switch	1	
-5	079031	• MECHANISM ASSEMBLY, Slide Lift (Not Shown Assembled)	1	
-6	711206	• • • SPRING, Slider	1	
-7	41226	• • • E-RING	1	
-8	41244	• • • WASHER	1	
-9	711205	• • • SPRING, Side Tension	1	
-10	079135	• • • ARM AND ROD ASSEMBLY, Tension	1	
-11	30802	• • • SCREW, Hex Washer Head, Swage Form, #4-40 x 7/16 inch	4	
-12	710329	• • • CONDENSER, Plastic	1	
-13	712074	• • • SCREW, Hex Washer Head, Type BT, #4-24 x 1/4 inch	1	
-14	710561	• • • ROD, Pivot	1	
-15	079035	• • • SHUTTER AND BRACKET ASSEMBLY	1	
-16	711204	• • • SPRING, Gate	1	
-17	710559	• • • GATE	1	
-18	712081	• • SETSCREW, Cup Point, #10-32 x 3/16 inch	1	
-19	713442	• • • FOLLOWER	1	
-23	711203	• • • RETAINER	1	
-24	079545	• • • LEVELING SCREW AND GEAR ASSEMBLY	1	
-25	708031	• • • SCREW, Pan Head, 2.56mm x 3.5mm	2	
-26	079086	• • • MOTOR ASSEMBLY, Elevate	1	
-28	712197	• • • WICK, Oil Impregnated	1	
-29	712107	• • • PAD	1	

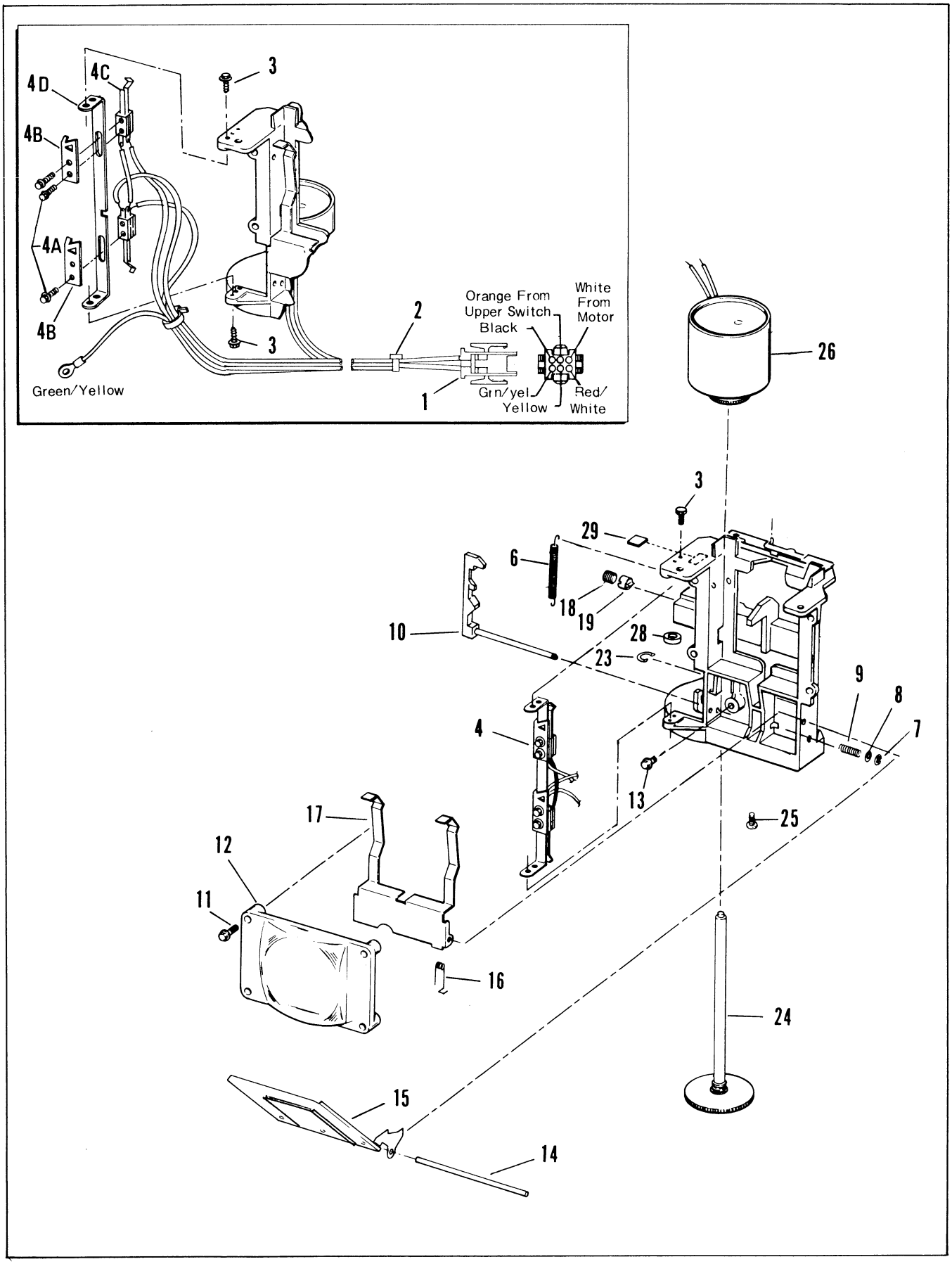


Figure 10. Slide Lift Mechanism and Leaf Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

COMPLETE FOCUS ASSEMBLY

11-	079164	FOCUS ASSEMBLY, Complete	1	A
11-	079036	FOCUS ASSEMBLY, Complete	1	B thru O
-1	17676	• E-RING	1	
-2	711221	• CONTROL, Expander	1	
-3	711277	• SPRING, Expander	1	
-4	710281	• SETSCREW, Hex Socket Flat Pt., #4-40 NC-3A	1	
-5	711213	• KNOB, Focus	1	
-6	766174	• SCREW, Slotted Hex Head, Type AB, #4-24 x 5/8 inch	2	
-7	079137	• LINK AND PIN ASSEMBLY, Expander	1	
-8	078268	• LENS ASSEMBLY, Expander	1	
-9	17676	• E-RING	2	
-10	711225	• SPRING, Pivot Arm	1	
-11	079139	• LINK AND PIN ASSEMBLY, Door	1	
-12	712074	• SCREW, Hex Washer Head, Swage Form, #4-40 x 1/4 inch	4	
-13	710763	• OPTICS HOLDER (Without Optics)	1	A
-13	079041	• OPTICS HOLDER ASSEMBLY	1	B thru O
-14	712074	• • SCREW, Hex Washer Head, Type BT, #4 x 1/4 inch	1	B thru O
-15	079088	• • LAMP ASSEMBLY, Autofocus	1	B thru O
-16	48493	• • SCREW, Phillips Pan Head, #4-14 x 5/16 inch	2	B thru O
-17	700639	• • WASHER, Flat, Plain, 0.156 inch ID	2	B thru O
-18	709401	• • CLAMP	1	B thru O
-19	709298	• • CONDENSER, Autofocus	1	B thru O
-20	710763	• • OPTICS HOLDER (Without Optics)	1	B thru O
-21	079163	• LENS CARRIER AND OPTICS PLATE ASSEMBLY (See Figure 12 for Detail Parts)	1	A
-22	079138	• LENS CARRIER AND OPTICS PLATE ASSEMBLY (See Figure 12 for Detail Parts)	1	B thru O
-23	079037	• MIRROR ASSEMBLY, First	1	
-23A	712081	• • SETSCREW, Hex 500, Flat Point, #4-40 x 1/4 inch	1	
-23B	713459	• • MIRROR, First	1	
-23C	710861	• • HOUSING, First Mirror	1	
-24	713463	• SPRING, First Mirror	1	
-25	079096	• CABLE ASSEMBLY	1	B thru O
-26	711307	• CONNECTOR, Housing, 6 Pin	1	B thru O

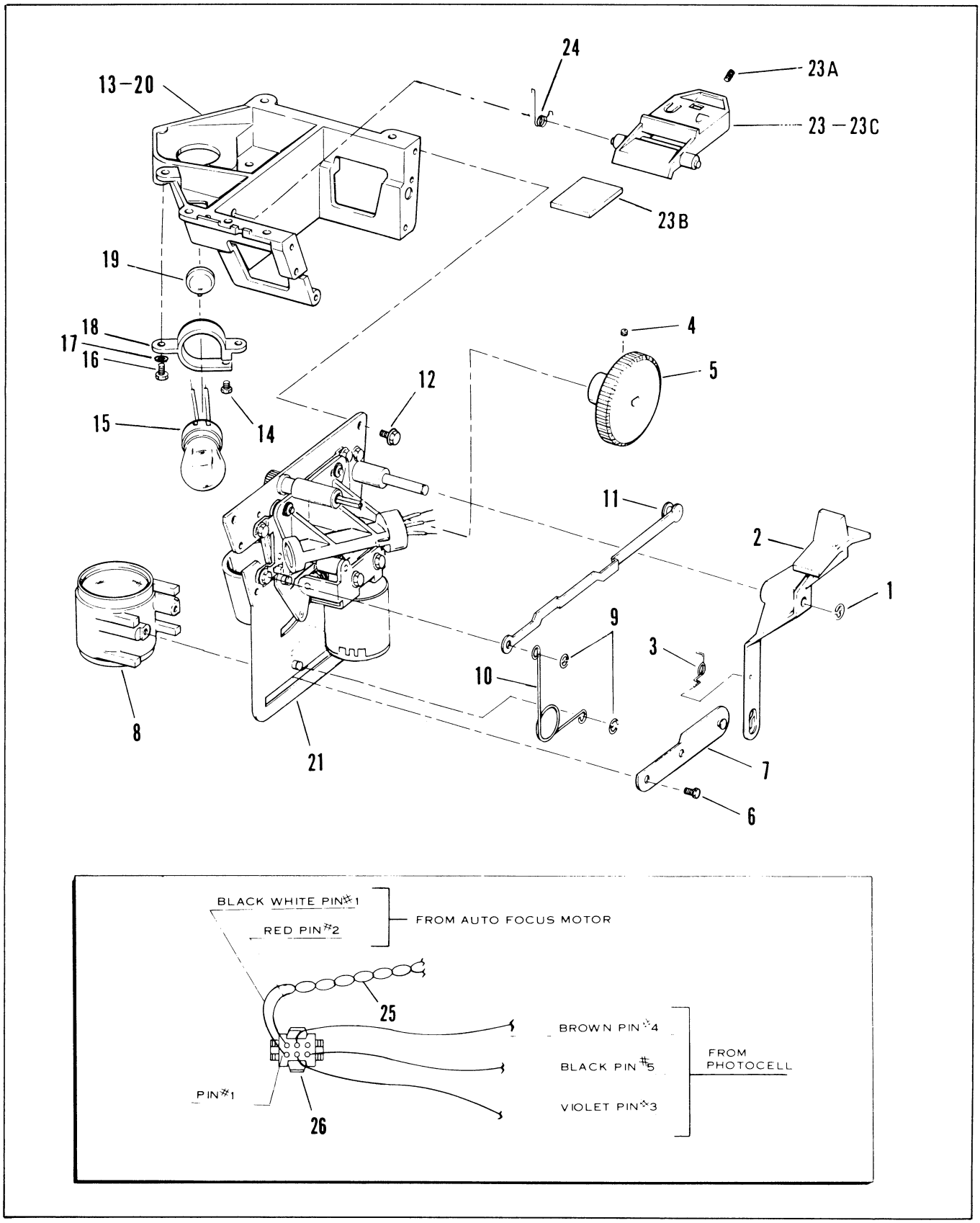


Figure 11. Complete Focus Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

LENS CARRIERS AND OPTICS PLATE ASSEMBLY

12-	079163	LENS CARRIER AND OPTICS PLATE ASSEMBLY	1	A
12-	079138	LENS CARRIER AND OPTICS PLATE ASSEMBLY	1	B thru O
-1	712074	• SCREW HEX WASHER HEAD, Type BT, #4 x 1/4 inch	1	
-2	710555	• LENS, Projection, 79.2mm, f/3.8	1	
-3	712026	• SETSCREW, Cup Point, #3-48 x 1/8 inch	1	
-4	710858	• COLLAR	1	
-5	308145	• E-RING	1	
-6	709730	• WASHER	AR	
-7	713461	• CARRIER, Lens	1	
-8	711207	• GEAR, Focus	1	
-9	712205	• GEAR, Clutch	1	A
-9	079516	• CLUTCH ASSEMBLY	1	B thru O
-10	709730	• WASHER	1	
-11	308145	• E-RING	1	B thru O
-12	710053	• GEAR, Pinion (Clutch)	1	B thru O
-13	30803	• SCREW, hex Washer Head, Swage Form, #4-40 x 3/16 inch	3	
-14	700639	• WASHER	1	
-15	079162	• BRACKET ASSEMBLY	1	A
-15	079046	• CARRIER AND BRACKET ASSEMBLY, Photocell (See Figure 16 for Detail Parts)	1	B thru O
-16	079038	• ARM ASSEMBLY, Pivot	1	
-17	30803	• SCREW, Hex Washer Head, Swage Form, #4-40 x 3/16 inch		
-18	077397	• MOTOR AND BRACKET ASSEMBLY, Focus	1	B thru O
-18	708031	• • SCREW, Pan Head, 2.6mm x 3.5mm	2	B thru O
-18B	709666	• • MOTOR AND GEAR	1	B thru O
-18C	079148	• • BRACKET AND GEAR ASSEMBLY	1	B thru O
-19	710054	• GEAR, Clutch Friction	1	B thru O
-20	17676	• E-RING	1	
-21	709898	• GEAR, Focus	1	
-22	079040	• BRACKET ASSEMBLY, Focus	1	
-23	713418	BOWED WASHER	1	A
-24	713462	LENS CLAMP	1	

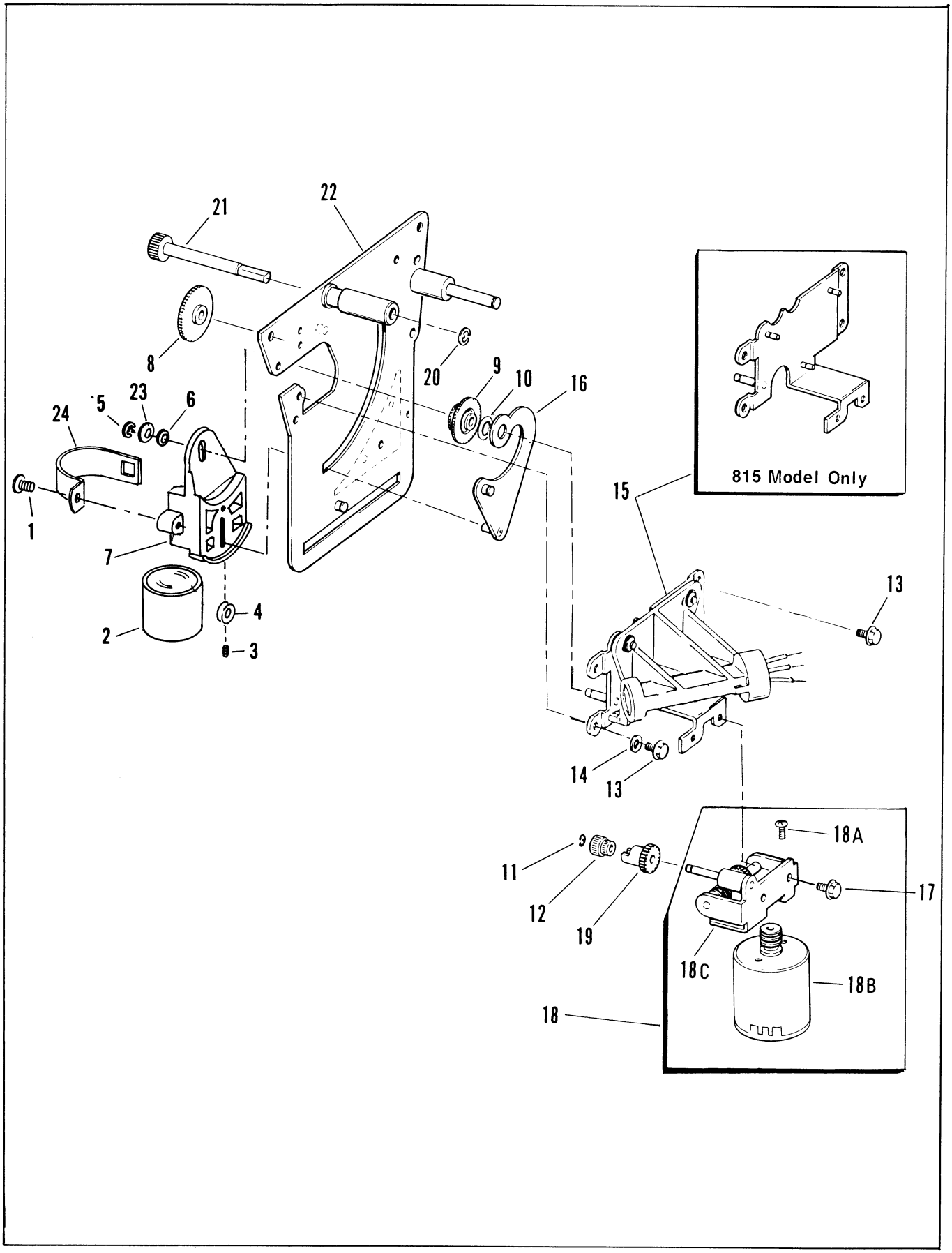


Figure 12. Lens Carrier and Optics Plate Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

LITE SENSOR ASSEMBLIES

13-	079554	LITE SENSOR ASSEMBLY	1	ABCDEFGKLMO
13-	079555	LITE SENSOR ASSEMBLY	1	HJN
-1	711363	• SCREW, Hex Head, Swage Form, #2-56 x 1/4 inch	3	
-2	713452	• REFECTOR, Led	1	
-3	713454	• PHOTOTRANSISTOR	2	
-4	713453	• INFRARED — EMITTING DIDDE	1	
-5	713451	• HOLDER, Phototransistor	1	ABCDEFGKLMO
-5	079553	• HOLDER AND CONTACT ASSEMBLY, Phototransistor	1	HJN
-6	711271	• SPRING, Extension, Shifter	1	
-7	710716	• SHIFTER	1	
-8	710720	• HOUSING	1	ABCDEFGKLMO
-8	079150	• HOUSING AND CONTACT ASSEMBLY	1	HJN
-9	711270	• SPRING, Extension, Photocell	1	
-10	711360	• TAB, Commoning	1	ABCDEFGKLMO
-10	711360	• TAB, Commoning	2	HJN
-11	711319	• HOUSING, Connector (9 Pin)	1	
-12	079100	• LEAD AND LUG ASSEMBLY (White)	1	HJN
-13	079104	• LEAD AND LUG ASSEMBLY (Gray)	1	HJN
-14	079128	• LEAD AND LUG ASSEMBLY, Ground (Green/Yellow)	2	
-15	079577	• SENSOR, P.C. Board Assembly	1	
-16	45767	• WIRE TIE	1	

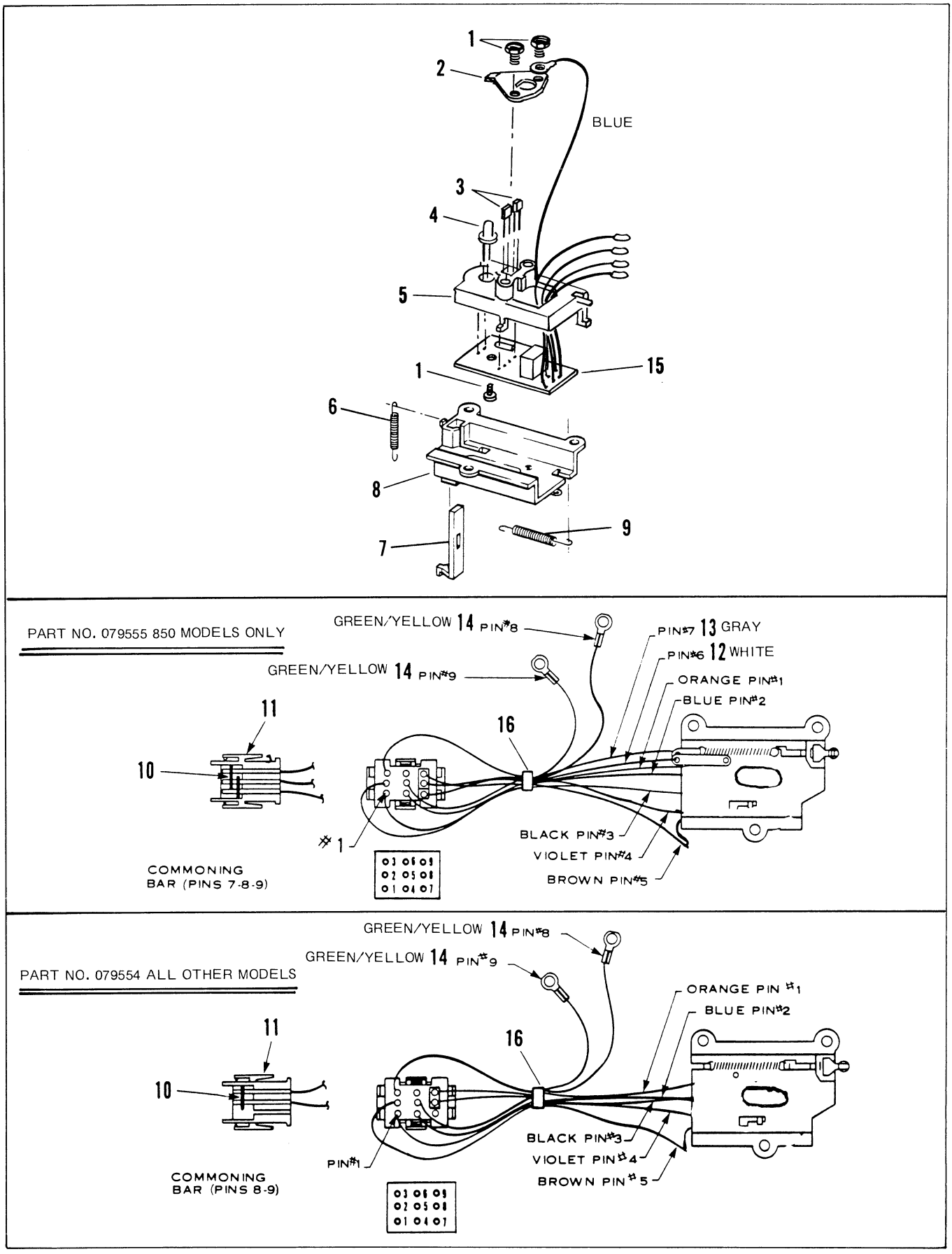


Figure 13. Lite Pipe and Photocell Assemblies

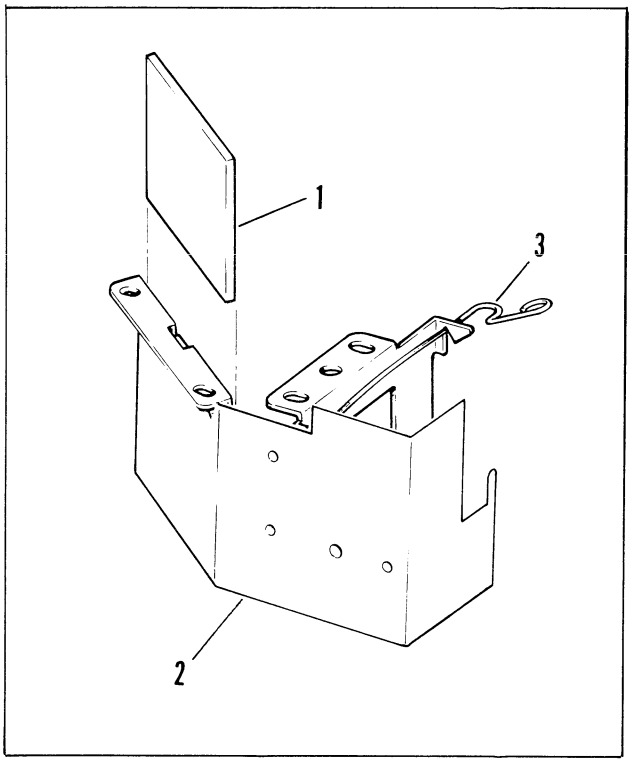


Figure 14. Lamp Bracket and Mirror Assembly

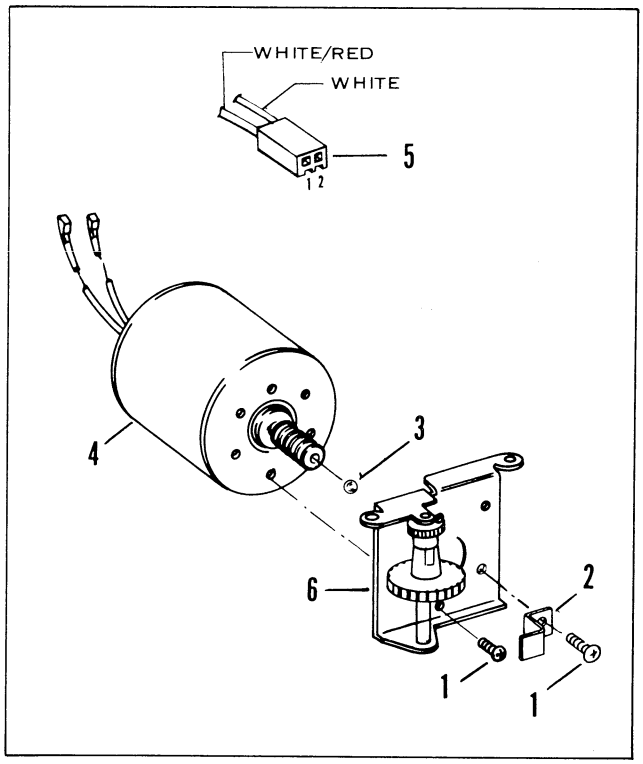


Figure 15. Ring Drive Motor and Bracket Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

LAMP BRACKET AND MIRROR ASSEMBLY

14-	079002	LAMP BRACKET AND MIRROR ASSEMBLY	1	
-1	711211	• MIRROR	1	
-2	079179	• SUPPORT AND SHIELD ASSEMBLY, Lamp	1	
-3	711361	• • WIRE, Lamp Support	1	

RING DRIVE MOTOR AND BRACKET ASSEMBLY

15-	079006	MOTOR AND BRACKET ASSEMBLY, Ring Drive	1	
-1	708031	• SCREW, Pan Head, 2.56mm x 3.5mm	3	
-2	712125	• BRACKET, End Play Adjusting	1	
-3	712126	• BALL, Steel, 3/32 inch Diameter	1	
-4	079085	• MOTOR ASSEMBLY, Ring Drive	1	
-5	710358	• • CONNECTOR, Wire (2 Pin)	1	
-6	079167	• BRACKET AND GEAR ASSEMBLY, Ring Drive (Service Assembly)	1	

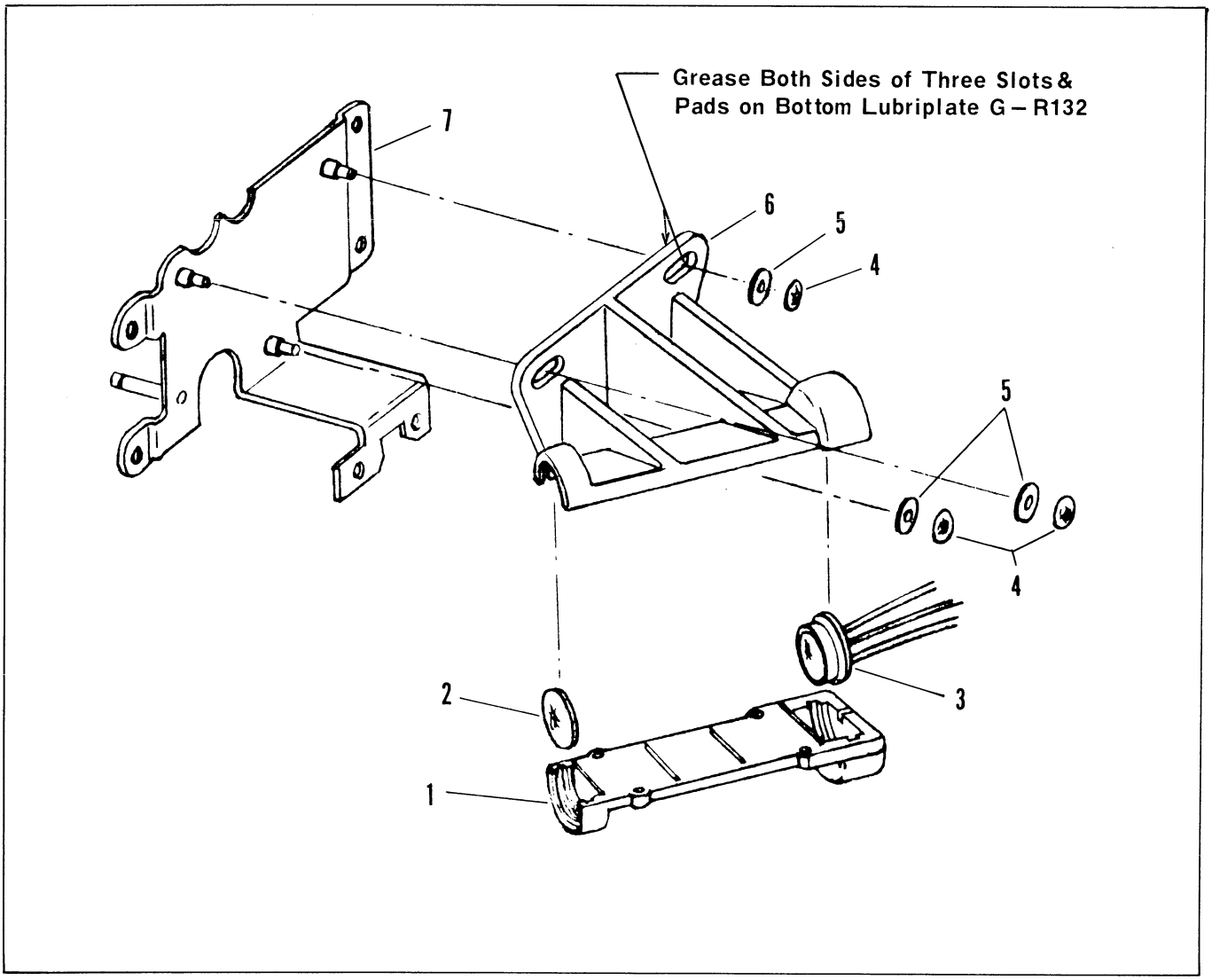


Figure 16. Autofocus Photocell Carrier and Bracket Assembly

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

AUTOFOCUS PHOTOCELL CARRIER AND BRACKET ASSEMBLY

16-	079046	AUTOFOCUS PHOTOCELL CARRIER AND BRACKET ASSEMBLY	1	B thru O
-1	709400	• COVER, Autofocus Photocell	1	B thru O
-2	709298	• ELEMENT, Condenser	1	B thru O
-3	079118	• PHOTOCELL AND LEAD ASSEMBLY, Autofocus	1	B thru O
-4	709857	• PALNUT, Push-On	3	B thru O
-5	709546	• WASHER, Flat	3	B thru O
-6	709299	• HOUSING, Autofocus Photocell	1	B thru O
-7	079039	• BRACKET ASSEMBLY, Autofocus	1	B thru O

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

TRANSFORMER AND WIRING PLATE ASSEMBLY (DOMESTIC AND JAPANESE MODELS ONLY)

17-	079533	TRANSFORMER AND WIRING PLATE ASSEMBLY	1	O
17-	079082	TRANSFORMER AND WIRING PLATE ASSEMBLY (Domestic Models Only)	1	ABDFH
17-	079173	TRANSFORMER AND WIRING PLATE ASSEMBLY (Japanese Models Only)	1	KLMN
-1	45767	• WIRE TIE, Plastic	5	ABDFH KLMNO
-2	712010	• CONNECTOR, 8 Pin, Post	1	ABDFH KLMNO
-3	49102	• SOCKET, 4 Pin	1	ABDFH KLMNO
-4	26906	• NUT	2	ABDFH
-4	26906	• NUT	1	KLMNO
-4	14175	• WASHER	1	O
-5	079075	• LEAD, Ground	1	ABDFHKLMN
-6	079185	• LEAD, Ground	1	ABDFHKL MNO
-7	14175	• WASHER	2	ABDFHKLMN
-8	26906	• NUT	1	KLMN
-9	43410	• WASHER	1	KLMN
-10	712079	• STRIP, Terminal	1	KLMN
-11	700735	• WASHER	1	KLMN
-12	33268	• CAPACITOR, Fixed Ceramic Disc, 4700PF 1400WVDC	2	KLMN
-13	079191	• LEAD AND LUG ASSEMBLY (White)	1	KLMN
-14	079192	• LEAD AND LUG ASSEMBLY (Black)	1	KLMN
-15	712109	• SLEEVE	1	KLMN
-16	712051	• SCREW, Phillips Flat Head, Type F, #8-32 x 3/8 inch	2	ABDFH KLMNO
-17	079048	• TRANSFORMER ASSEMBLY (Domestic)	1	ABDFHO
-17	079172	• TRANSFORMER ASSEMBLY (Japanese)	1	KLMN
-18	711300	• BUSHING, Strain Relief	1	ABDFH
-18	712085	• BUSHING, Strain Relief	1	KLMNO
-19	016783	• LINE CORD ASSEMBLY	1	ABDFHO
-19	079174	• LINE CORD ASSEMBLY	1	KLMN
-19	079532	• LINE CORD	1	O
-20	711250	• PLATE, Transformer Mounting	1	ABDFH KLMNO
-21	711383	• STUD, Self-Clinching	2	ABDFH KLMNO

NOTE: All wire ties are not shown. Make a note of positioning if disassembly is necessary.

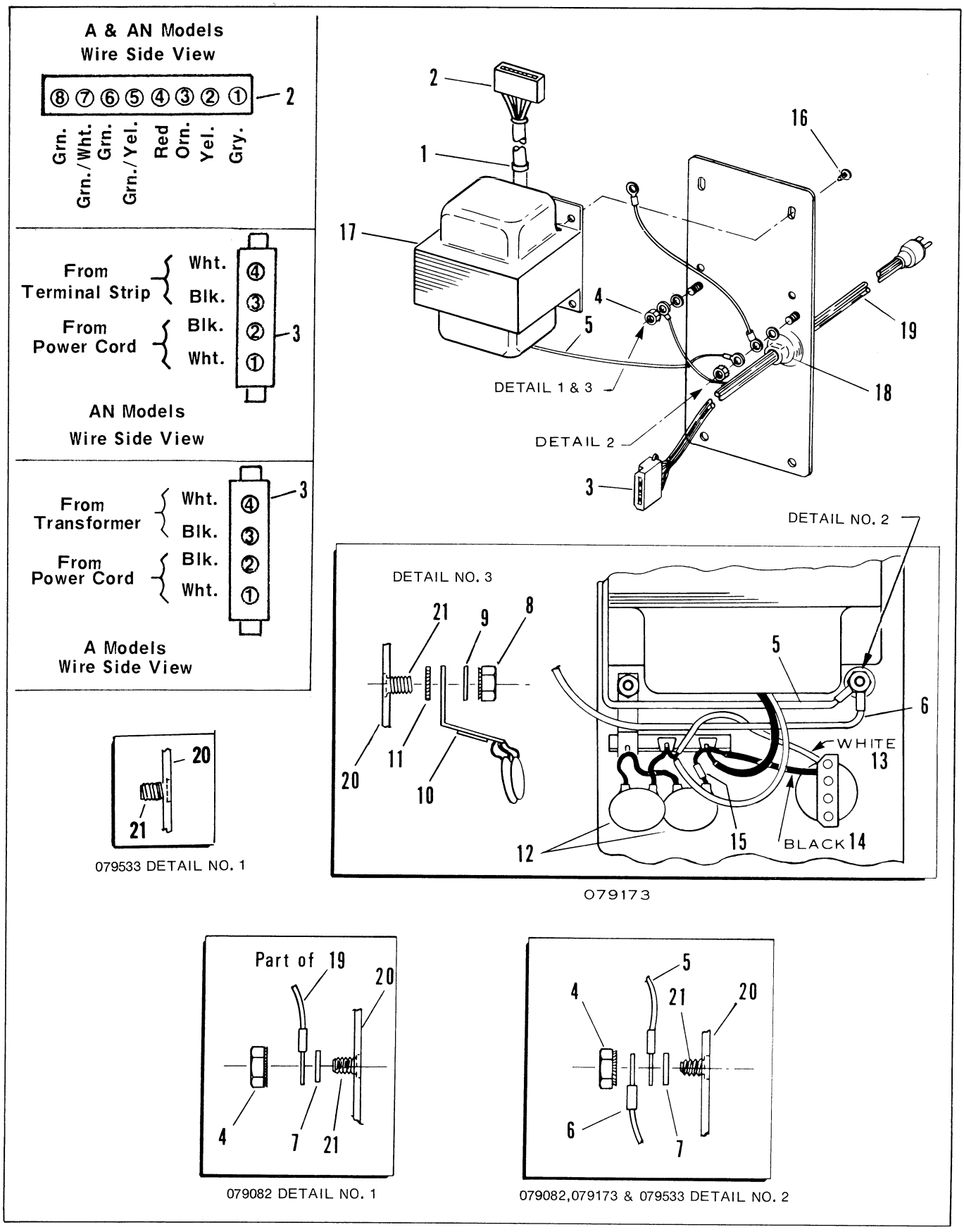


Figure 17. Transformer and Wiring Plate Assembly ("A"and "AN" Models Only)

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

TRANSFORMER AND WIRING PLATE ASSEMBLY (EXPORT MODELS ONLY)

18-	079158	TRANSFORMER AND WIRING PLATE ASSEMBLY (Export Models Only)	1	CEGJ
-1	45767	• WIRE TIE, Plastic	8	CEGJ
-2	712010	• CONNECTOR, 8 Pin, Post	1	CEGJ
-3	49102	• SOCKET, 4 Pin	1	CEGJ
-4	26906	• NUT	2	CEGJ
-5	079185	• LEAD ASSEMBLY, Ground (Green/Yellow)	1	CEGJ
-6	079075	• LEAD ASSEMBLY, Ground (Green/Yellow)	1	CEGJ
-7	016963	• LEAD ASSEMBLY, Ground (Green/Yellow)	1	CEGJ
-8	17168	• WASHER	2	CEGJ
-9	079171	• TWISTED LEAD ASSEMBLY	1	CEGJ
-10	712071	• TUBING, PVC., 12 inches Long	1	CEGJ
-11	708619	• FUSE, Type T, Slo-Blo, 1.6 amp	1	CEGJ
-12	712051	• SCREW, Phillips Flat Head, Type F, #8-32 x 3/8 inch	2	CEGJ
-13	079136	• TRANSFORMER ASSEMBLY (Export)	1	CEGJ
-14	079157	• PLATE ASSEMBLY, Transformer (Export)	1	CEGJ
-15	711390	• • CARRIER, Fuse, 5 x 20mm	1	CEGJ
-16	710876	• • HOLDER, Fuse (With Nut)	1	CEGJ
-17	712091	• • RIVET, Oval Head, 0.123 x 9/32 inch	2	CEGJ
-18	712090	• • WASHER	2	CEGJ
-19	434684	• • SOCKET, External Speaker	1	CEGJ
-20	712092	• • RIVET, Oval Head, 0.123 x 1/4 inch	4	CEGJ
-21	709737	• • HOUSING, Receptacle	1	CEGJ
-22	712050	• • VOLTAGE SELECTOR	1	CEGJ
-23	711383	• • STD, Self Clinching	2	CEGJ
-24	711302	• • PLATE, Transformer	1	CEGJ
-25	48266	• LABEL, Ground	1	CEGJ
-26	079161	LEAD ASSEMBLY	1	CEGJ
-27	079159	LEAD ASSEMBLY (Brown)	1	CEGJ
-28	079160	LEAD ASSEMBLY (Brown)	1	CEGJ
-29	079189	LEAD ASSEMBLY (Blue)	1	CEGJ

NOTE: All wire ties are not shown. Make a note of positioning if disassembly is necessary.

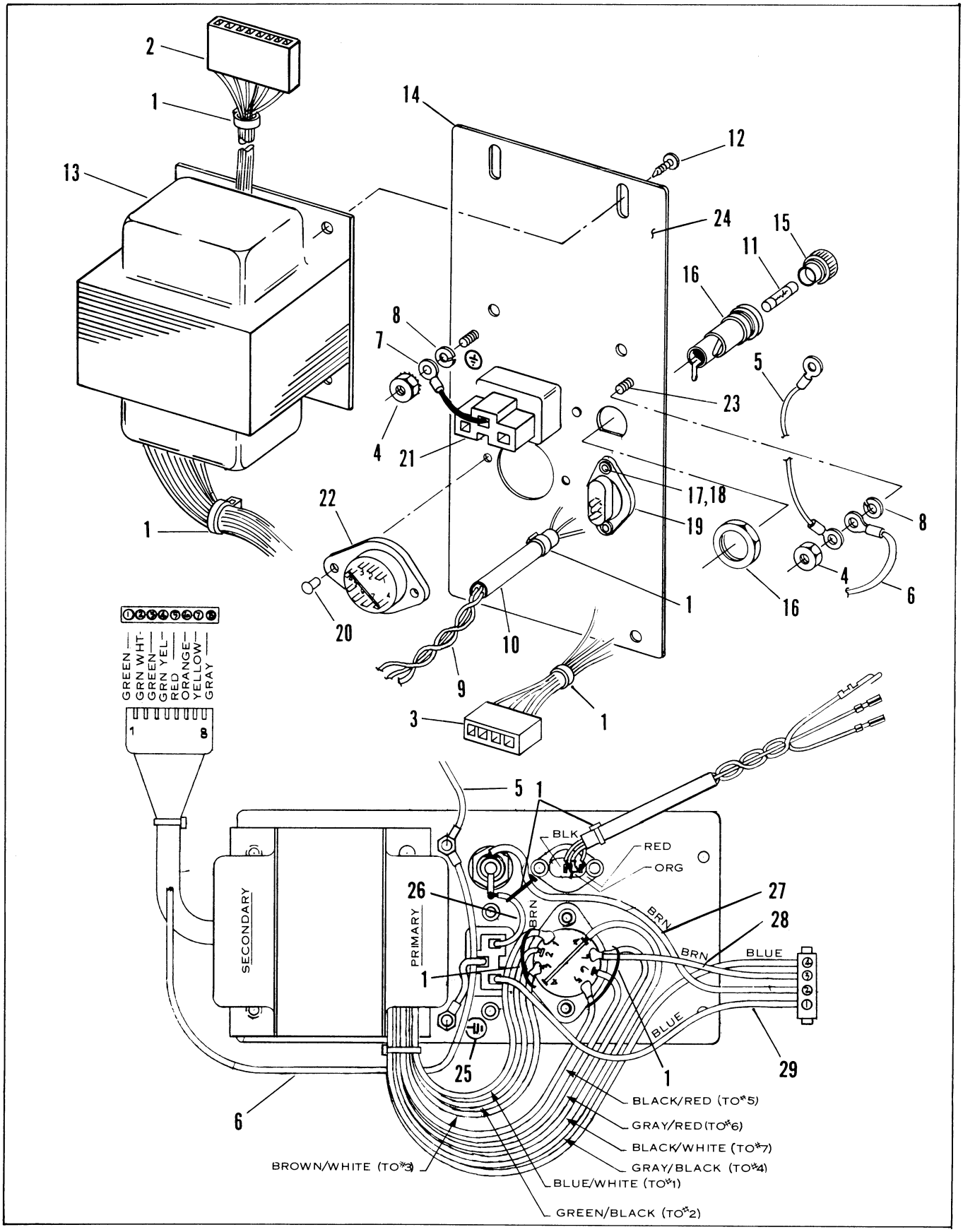
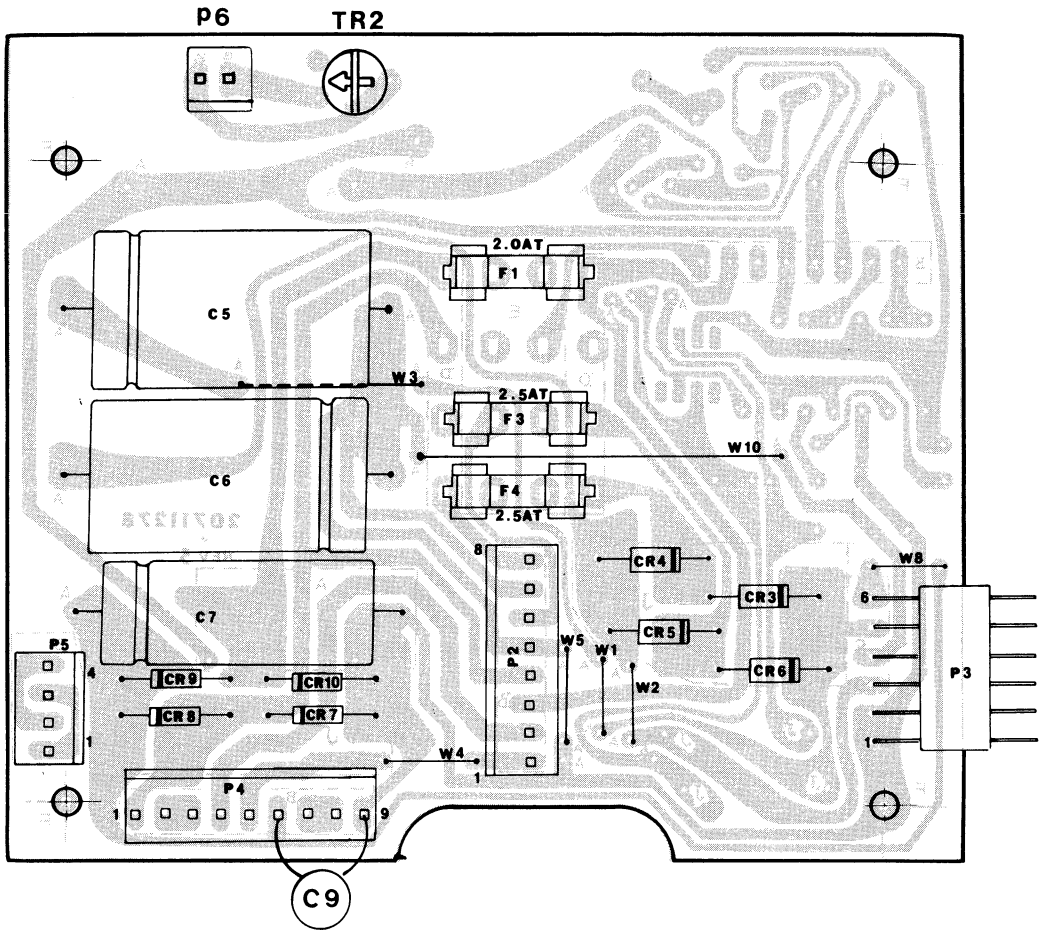


Figure 18. Transformer and Wiring Plate Assembly ("AX" Models Only)



Most electrical components are available from local sources by MFR'S part number.

CODE	B & H P/N	DESCRIPTION	MFR'S P/N
	079501	Power Supply PCB Assy. (Basic)	
C5,C6	671022	Axial Electrolytic, 3300MF −10%+50% 25V	25ELA3300
C7	671025	Electrolytic, 2200MF −10%+50% 16V	16ELA2200
C9	49708	Creamic Disc 0.1MFD 25V	
CR3–CR10	671013	Rectifier, Silicon	30S2
F1	713413	Fuse, Cartridge SD6 SloBlo	
F3,F4	713414	Fuse, Cartridge SD6 SloBlo	
TR2	712008	Potentiometer, 100 ohms	
P2	711378	Connector, 8 Pin	
P3	711379	Connector, 6 Pin	
P4	711377	Connector, 9 Pin	
P5	712028	Connector, 4 Pin	
P6	712099	Connector, 2 Pin	

Figure 19. Power Supply PCB Assembly - Basic (815A Model Only)

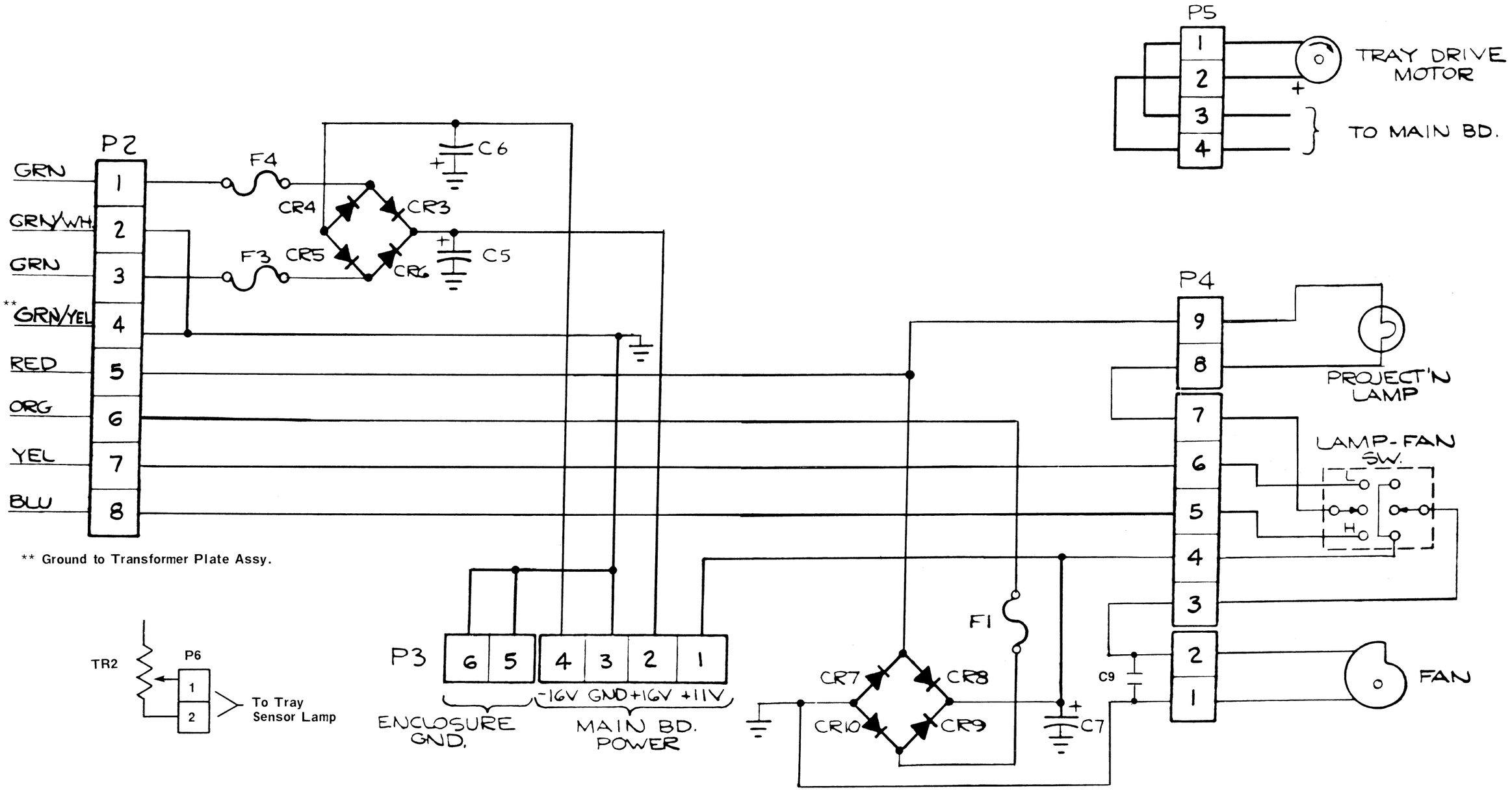


Figure 20. Power Supply PCB Schematic - Basic (815A Model Only)

Most electrical components are available from local sources by MFR'S part number.

	CODE	B&H P/N	DESCRIPTION	MFR'S P/N
		079500	Power Supply PCB Assy. (Autofocus Models)	
	A1	709468	Operational Amplifier	MC741CP
CAPACITORS	C1,C2	671024	Electrolytic, 1UF ±20% 50V	50ELA1M
	C3,C4	671023	Axial Electrolytic, 470UF −10%+50% 16V	16ELA470
	C5,C6	671022	Axial Electrolytic, 3300UF −10%+50% 25V	25ELA3300
	C7	671025	Electroytic, 2200UF −10%+50% 16V	16ELA2200
	C8	671189	Polyester mylar, 0.1UF ±10% 100V	TDYS2A104K
	C9	49708	Ceramic Disc 0.1MFD 25V	
	CR1,CR2	671006	Diode, Zener, 12V	IN4742A
	CR3−CR10	671013	Rectifier, Silicon	30S2
	CR11	671018	Diode, Zener 8.2V	IN4738A
EXPORT	F2 (3)	712030	Fuse, Type T, SloBlo 2.5 amp CODE CEGJ	
EXPORT	F1 (1)	711388	Fuse, Type T, SloBlo 2.0 amp CODE CEGJ	
DOMESTIC	F2 (3)	713414	Fuse Partridge SloBlo SD6 2.5 amp CODE BDFHKLMN	
DOMESTIC	F1 (1)	713413	Fuse Partridge SloBlo SD6 2.0 amp CODE BDFHKLMN	
	P1,P2	711378	Connector, 8 Pin	
	P3	711379	Connector,6 Pin	
	P4	711377	Connector, 9 Pin	
	P5	712028	Connector, 4 Pin	
	P6	712099	Connector, 2 Pin	
	Q1	671216	Transistor, Audio amp, NPN Silicon	MPS6531
	Q2	671217	Transistor, Audio amp, PNP Silicon	MPS6534
	R1	100804	10K ohm ±5%	
	R2	100780	2.2K ohm ±5%	
	R3	100768	1K ohm ±5%	
	R4	100732	100 ohm ±5%	
	R5	100804	10K ohm ±5%	
	R6	100780	2.2K ohm ±5%	
	R7	100768	1K ohm ±5%	
	R8	100732	100 ohm ±5%	
	R10,R11	671026	Fixed Composition, 68 ohm ±10% 1 Watt	
	TR1	712097	Potentiometer, 250K ohms	
	TR2	712008	Potentiometer, 100 ohms	
		708210	Spacer	

NOTE: All resistors are carbon film ¼ Watt unless otherwise specified.
NOTE: Fuses not supplied with power supply−order seperately.

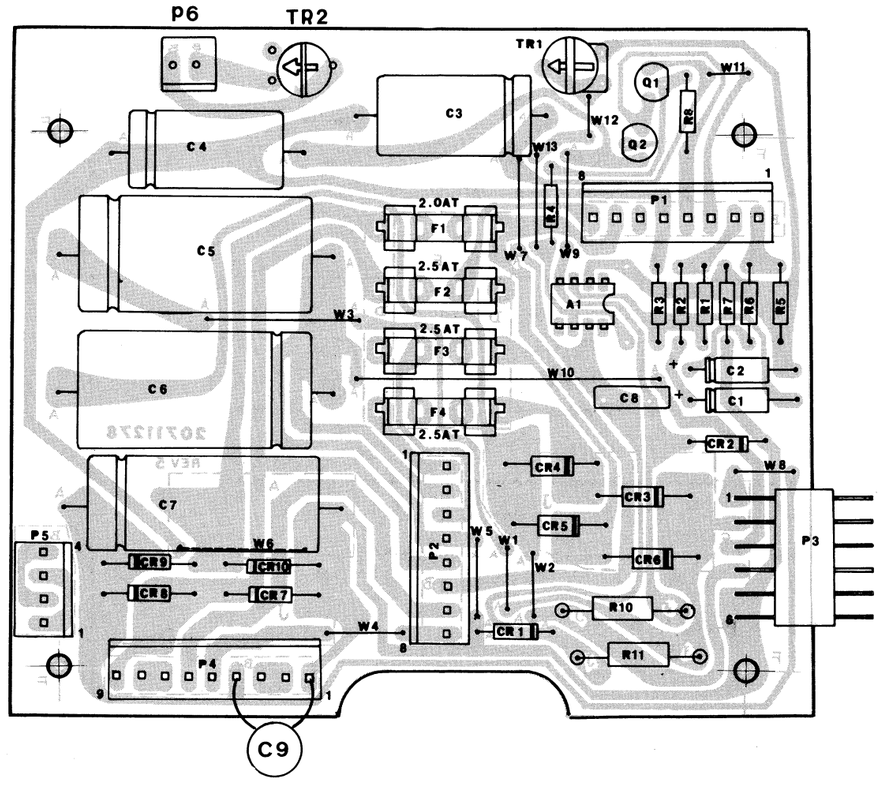


Figure 21. Power Supply PCB Assembly (Autofocus Models Only)

AUTOFOCUS PHOTOXSISTOR

AUTOFOCUS LAMP

AUTO FOCUS MOTOR

BRN BLK VIO

N.C.

P1 1 2 3 4 5 6 7 8

F2

P6

TR2

1

2

To Tray Sensor Lamp

NOTE: EXTERNAL COMPONENTS SHOWN FOR REFERENCE PURPOSES ONLY.

P5

1 2 3 4

TRAY DRIVE MOTOR

TO MAIN BD.

R3 CR1 R1 C3 Q1 C1 R2 A1 R8 R5 R4 C2 R6 C8 Q2 R7 TR-1 CR11 R10 R11 C4 CR2

P2

GRN 1

GRN/WH 2

GRN 3

GRN/YEL 4

RED 5

ORG 6

YEL 7

BLU 8

F4 CR4 CR3 C6 F3 CR5 CR6 C5

Ground

Transformer Plate Assy.

P4

9 8 7 6 5 4 3 2 1

PROJECT'N LAMP

LAMP-FAN SW.

L H

FAN

F1 CR7 CR8 CR10 CR9 C9 C7

P3 6 5 4 3 2 1

-16V GND +16V +11V

ENCLOSURE GND.

MAIN BD. POWER

Figure 22. Power Supply PCB Schematic (Autofocus Models Only)

Most electrical components are available by MFR'S part number.

CODE	B & H P/N	DESCRIPTION	MFR'S P/N
	079058	1K Option Board PCB Assy.	
A1	049700	Operational Amplifier	MC1458CP
C1	671029	Electrolytic, 2.2UF −10%+50% 50V	50ELA2R2
C2	671030	Electrolytic, 4.7UF ±20% 50V	50ELA4R7M
C4	671032	Poly Film, .0068UF ±5% 400V	.0068−400−5%−60−C
C6	671034	Ceramic Disc, 680PF ±5% 50V	DB201Z5E681J
C7,8,10,14	671035	Ceramic Disc, 0.01UF ±10% 50V	DB205Z5P103K
C9	671039	Electrolytic, 47UF −10%+30% 16V	R1−A10E47
C11	671040	Electrolytic, 4.7UF −10%+50% 16V	16ELA4R7
C12	671036	Electrolytic, 100UF −10%+50% 16V	16ELA100
C13	671041	Electrolytic, 1UF −10%+50% 50V	50ELA1
C24,C25	671042	Electrolytic, 10UF −10%+50% 16V	16ELA10
CR1−CR8 CR19,20, CR21	671002	Diode	IN914
CR17,CR18	671006	Diode, Zener, 1 watt, 12V	IN4742A
Q1	671216	Transistor, NPN	MPS6531
Q2,Q4,Q8	671028	Transistor, FET	2N5639
Q3,Q5,Q9	671217	Transistor, PNP	MPS6534
S1	711326	Switch, Toggle, DPDT P.C. (SLE6230A)	
	712031	Screw, Pan Head, No. 3−48 x ¼ inch.	
TR1	711328	Trim−Pot, 100K ohm 10% 1 watt	
U2	729914	Integrated Circuit, Timer	LM555CN

NOTE: All resistors are carbon film ¼ watt unless otherwise specified.

CODE	B & H P/N	DESCRIPTION
R1,R2	100840	100K ohm ±5%
R3,R26,R62	100864	470K ohm ±5%
R4	100792	4.7K ohm ±5%
R5,R6,R10,R11,R21	100768	1K ohm ±5%
R7	100777	1.8K ohm ±5%
R8,R9	100816	22K ohm ±5%
R12,R30	100786	3.3K ohm ±5%
R15	100852	220K ohm ±5%
R16,R17,R19,R23, R24,R25,R31	100804	10K ohm ±5%

CODE	B & H P/N	DESCRIPTION
R18	100780	2.2K ohm ±5%
R20,R22,R27,R32,R64	100828	47K ohm ±5%
R28	100801	8.2K ohm ±5%
R29	100813	18K ohm ±5%
R60	671027	82 ohm ±5% Fixed Comp ½ w
R61	100480	100 ohm ±5% ½ watt
R63	100790	3.9K ohm ±5%

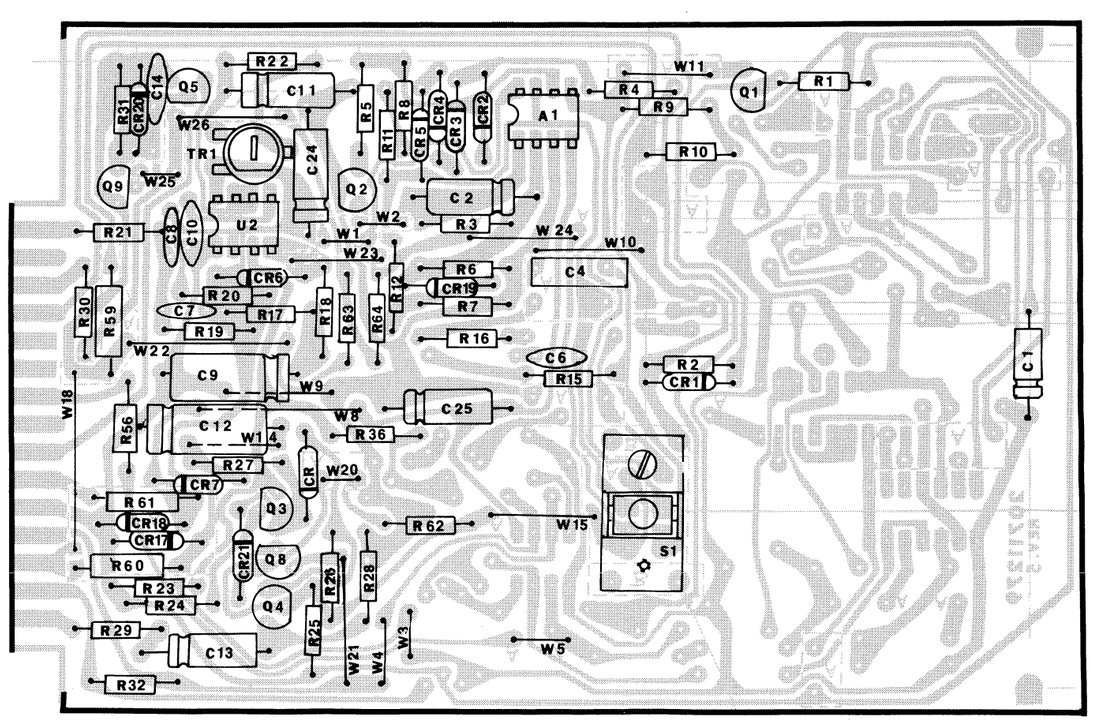


Figure 23. 1000Hz Option Board PCB Assembly (825A & 830 Models Only)

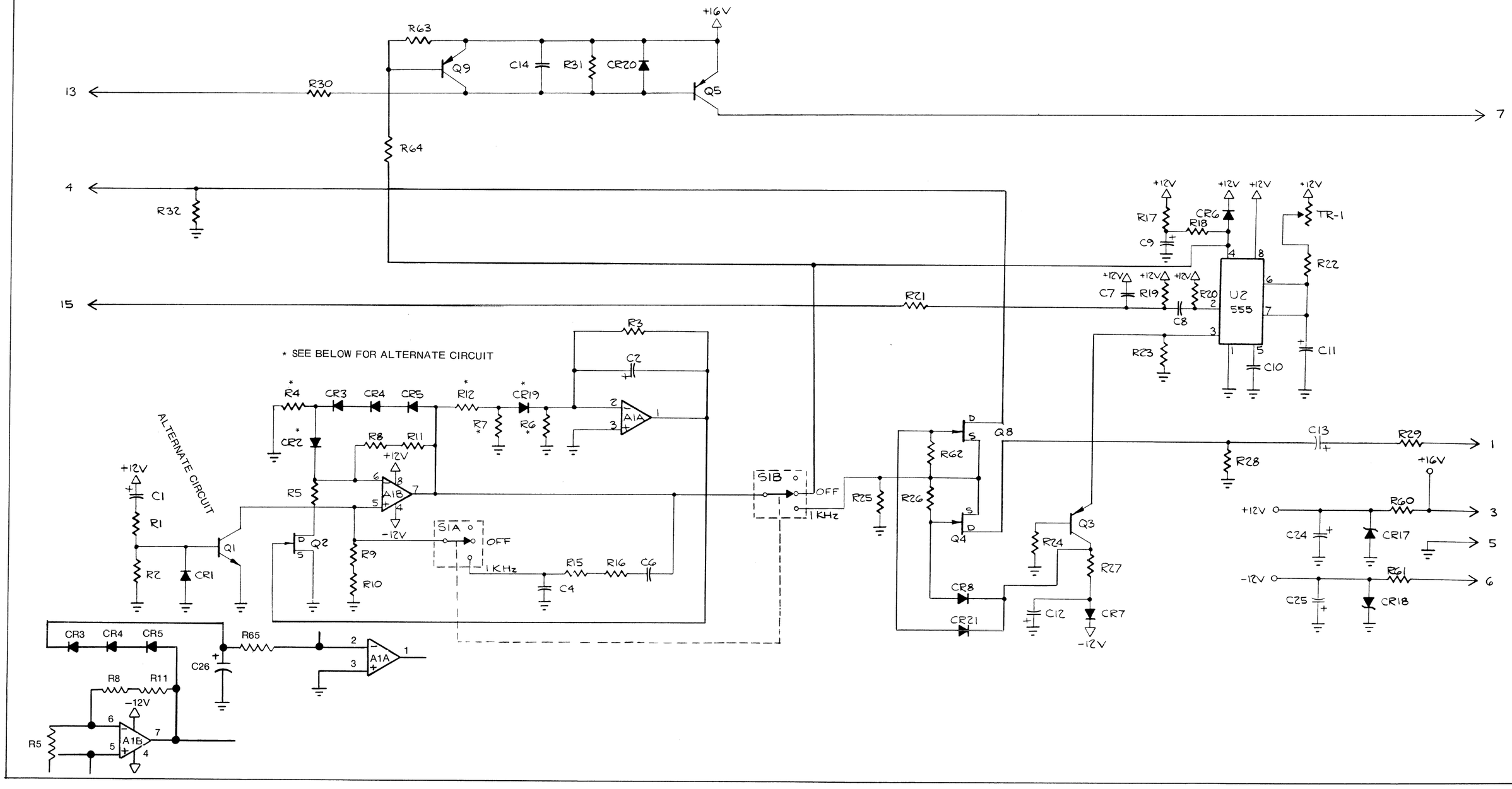


Figure 24. 1000Hz Option Board PCB Schemanatic (825A & 830 Models Only)

CODE	B & H P/N	DESCRIPTION	MFR'S P/N
PCB Assy.	079098	1K and 150Hz Option Board PCB Assy.	
A1,A2	49700	Operational Amplifier MC1458CP	LM1458N
C1	671029	Electrolytic 2.2UF –10%+50% 50V	50ELA2R2
C2	671030	Electrolytic 4.7UF ±20% 50V	50ELA4R7M
C3	671031	Poly Film 0.047UF ±5% 250V	.047–250–5%–60–C
C4	671032	Poly Film 0.0068UF ±5% 400V	.0068–400–5%–60–C
C5	671033	Poly Film 0.0047UF ±5% 400V	.0047–400–5%–60–C
C6	671034	Ceramic Disc 680PF ±5% 50V	DB201Z5E681J
C7,C8,C10	671035	Ceramic Disc 0.01UF ±10% 50V	DB205Z5P103K
C9,C26	671039	Electrolytic 47UF–10%+50% 16V	R1–A10E47
C11	671040	Electrolytic 4.7UF–10%+50% 16V	16ELA4R7
C12	671036	Electrolytic 100UF–10%+50% 16V	16ELA100
C13	671041	Electrolytic 1UF–10%+50% 50V	50ELA1
C14,C15	671035	Ceramic Disc, 0.01UF ± 10% 50V	DB205Z5P103K
C16	671043	Ceramic Disc 150PF ±10% 50V	DT203CO151K
C17	671037	Poly Film 0.15UF ±10% 100V	.15–100–10%–60–C
C18	671033	Poly Film 0.0047UF ±5% 400V	.0047–400–5%–60–C
C19	671038	Poly Film 0.1UF ±10% 100V	.1–100–10%–60–C
C20	671043	Ceramic Disc 150PF ±10% 50V	DT203CO151K
C21	671037	Poly Film 0.15UF ±10% 100V	.15–100–10%–60–C
C22	671024	Electrolytic 1UF ±20% 50V	50ELA1M
C23,24,25	671042	Electrolytic 10UF–10%+50% 16V	16ELA10
CR1–16	671002	Diode	IN914
CR19– 22	671002	Diode	IN914
CR17,18	671006	Diode Zener 1 Watt 12V	IN4742A
DS1	671044	Indicator Cue–Stop (Red LED)	MV5752
Q1,Q6,Q7	671216	Transistor NPN	MPS6531
Q2,Q4,Q8	671028	Transistor FET	2N5639
Q3,Q5,Q9	671217	Transistor PNP	MPS6534
S1	711326	Switch, Toggle DPDT P.C. (SLEC2302A)	
S2	711327	Switch, Pushbutton, SPST P.C. (JPD11CG–PCO)	
SP1	711373	Spacer (For DS1 LED)	
TR1,TR3	711328	Trim–Pot 100K ohm ±10% 1 watt	
TR2	711329	Trim–Pot 150K ohm ±10% 1 watt	
U2	709914	Integrated Circuit Timer	NE 555V
U3,U4	457001	Integrated Circuit MO'S 4–2 Input NOR–Gate 2	CD4001BE
U5	709915	Integrated Circuit MO'S 4–2 Input NAND–Gate 1	CD4011BE

Most electrical components are available from local sources by MFR'S part number.

NOTE: All resistors are carbon film ¼ Watt unless otherwise specified.

CODE	B & H P/N	DESCRIPTION
R1,R2	100840	100K ohm ±5%
R3,R26,R62	100864	470K ohm ±5%
R4,R35,R48,R65	100792	4.7K ohm ±5%
R5,R6,R10,R11, R21,R52,R53	100768	1K ohm ±5%
R7	100777	1.8 ohm ±5%
R8,R9,R37,R39, R45,R46,R54,R57,R58	100816	22K ohm ±5%
R12,R30,R36,R56	100786	3.3K ohm ±5%
R13,R15,R47	100852	220K ohm ±5%
R14,R16,R17,R19, R23,R24,R25,R31	100804	10K ohm ±5%
R18	100780	2.2K ohm ±5%

CODE	B & H P/N	DESCRIPTION
R20,R22,R27,,R32, R40,R41,R42,R55,R64	100828	47K ohm ±5%
R28,R34	100801	8.2K ohm ±5%
R29,R43	100813	18K ohm ±5%
R33	100879	1.2M ohm ±5%
R38	100819	27K ohm ±5%
R49	100824	36K ohm ±5%
R50	100837	82K ohm ±5%
R51	100834	68K ohm ±5%
R59	100508	680 ohm, ½W ±5%
R60	671027	82 ohm ½W ±5%
R61	100480	100 ohm ½W ± 5%
R63	100790	3.9 K ohm ±5%

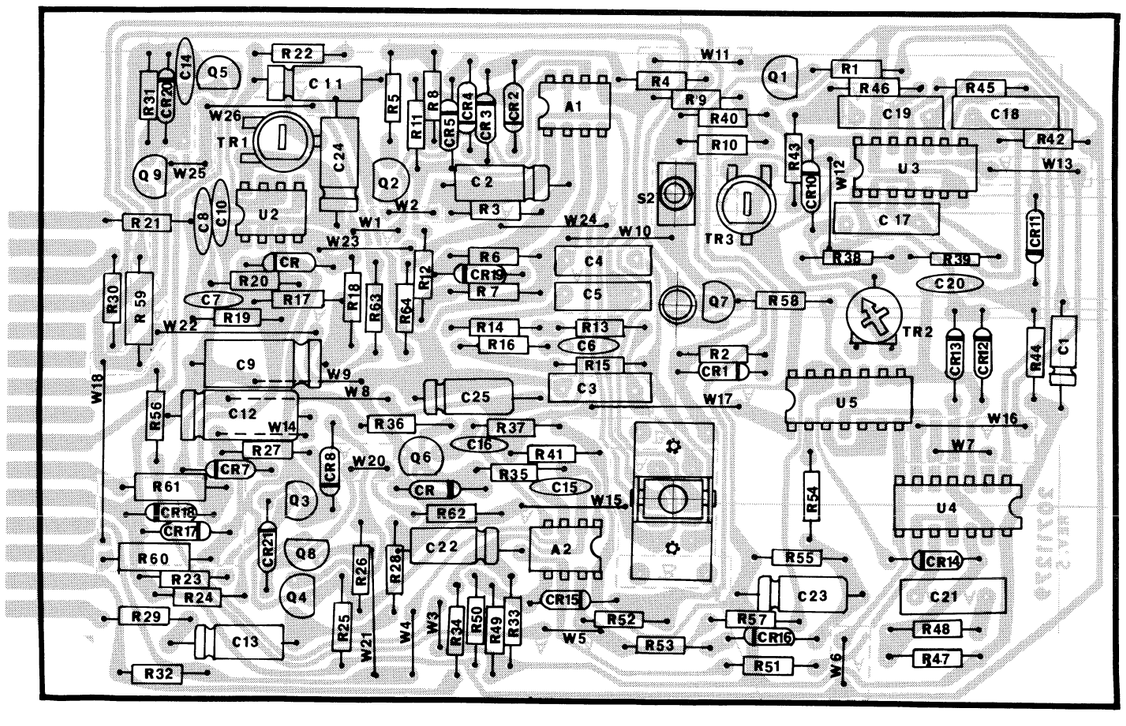


Figure 25. 1000Hz and 150Hz Option Board PCB Assembly (840 Models Only)

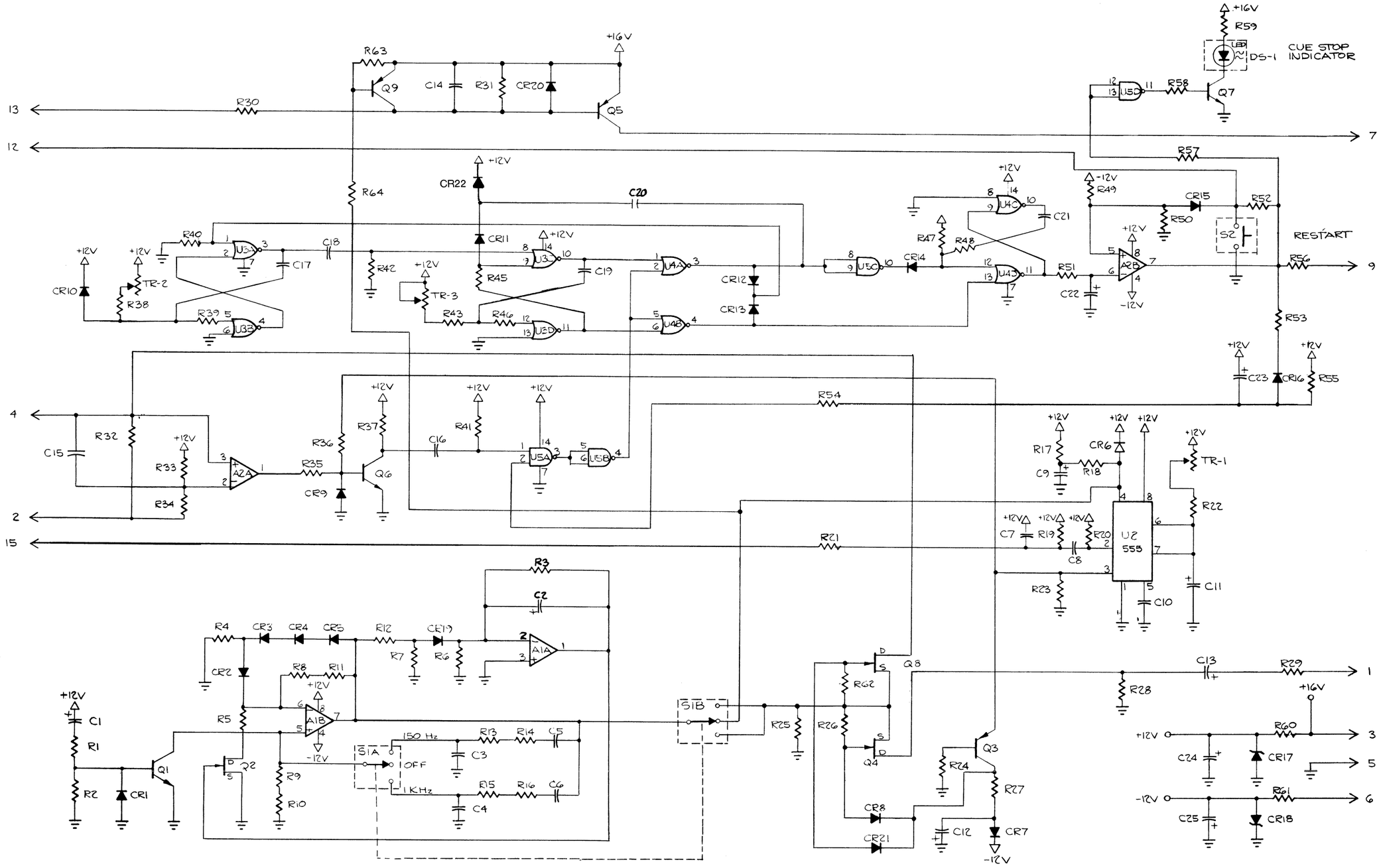


Figure 26. 1000Hz and 150Hz Option Board PCB Schematic (840 Models Only)

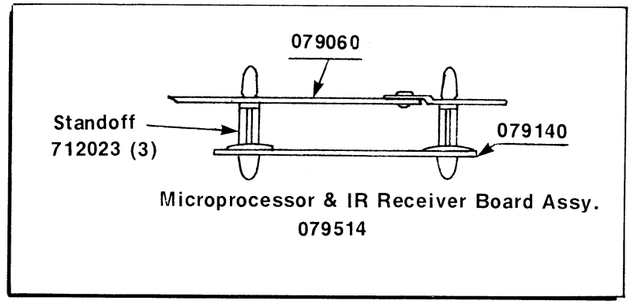
Most electrical components are available from local sources by MFR'S part number.

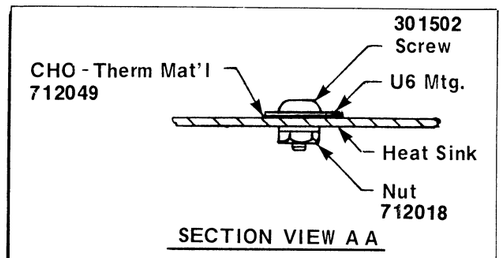
CODE	B & H P/N	DESCRIPTION	MFR'S P/N
	079060	Microprocessor Option Board PCB Assy.	
A1	709468	Integrated Circuit, Operational Amplifier	MC741CP
C1,C2	671041	Electrolytic, 1MF −10%+50% 50V	50ELA1
C3	671042	Electrolytic, 10MF −10%+50% 16V	16ELA10
C4,5,7,8	671045	Poly Film, 0.1MF ±20% 50V	CZ20C104M
C6	671047	Radial Electrolytic, 2.2MF −10%+50% 50V	50ULA2.2
C9,10,11	671184	Disc Ceramic, .01MF ±10%	
CR1,CR2	671002	Diode	FD600
D1,D2,D3	711397	G.I.MAN6660F LED Display	
P2	712160	Connector, 12 Pin	
P3	711395	Connector, 6 Pin	
Q1,2,3,8,9	671230	Transistor, NPN	MPS6531
Q4,5,6,7	671231	Transistor, PNP	MPS6534
(U2,U3)	712309	Socket, 14 Pin	
U1	711398	Integrated Circuit, Microprocessor	
U2	457081	Integrated Circuit	MC14081BCP−T
U3	709920	Integrated Circuit	MC14093BCP−TORD
U4	455047	Integrated Circuit	SN447AN
U5	455006	Integrated Circuit	SN7406N
U6	671046	Voltage Regulator	UA78MO5C
Y1	711399	Crystal, 4MHZ	EDC779; CY3A
	712018	Nut, Hex No. 6−32 (KEPS)	
	301502	Screw, No. 6−32 x ¼ inch	
	712049	Transistor, Thermal Material (CO−THERMAL)	
PCB/ H'SNK	079147	PCB & Heat Sink Assy.	

Note: All resistors are carbon film ¼ watt unless otherwise specified.

CODE	B & H P/N	DESCRIPTION
R1,R11,R12,R13, R14,R15,R16,R17	100729	82 ohm ±5%
R2	100831	56 K ohm ±5%
R3,R8,R24,R25	100804	10K ohm ±5%
R4,R5,R9,R10, R29,R30,R31,R32	100816	22K ohm ±5%

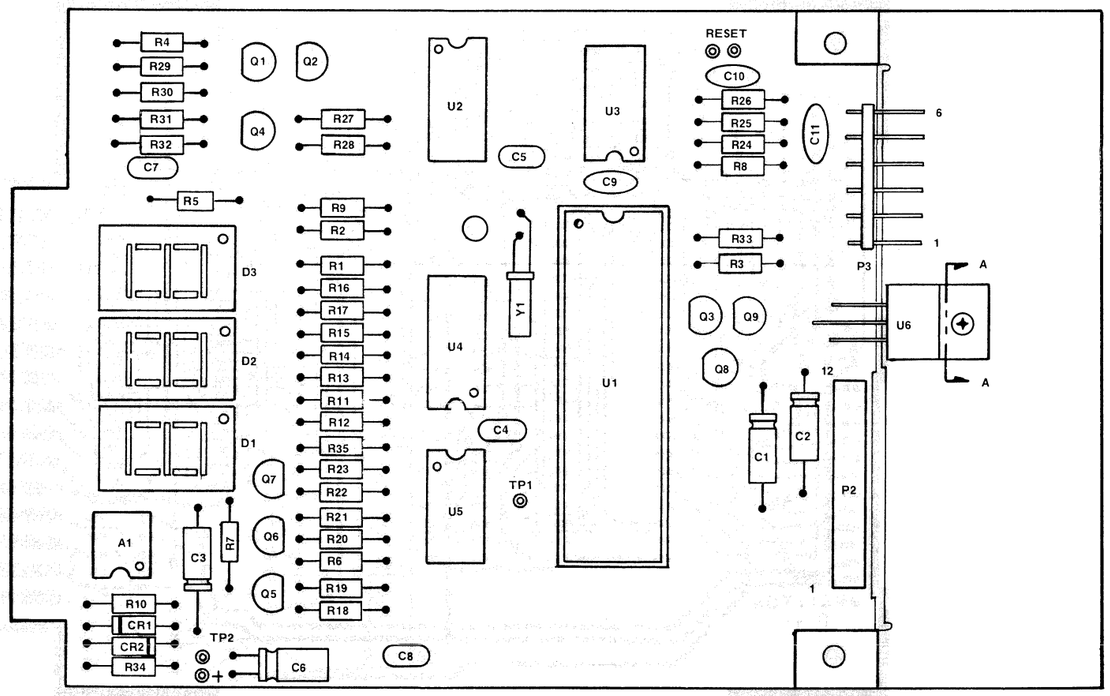
CODE	B & H P/N	DESCRIPTION
R6,R34	100828	47K ohm ±5%
R7,R19,R21,R23,R33	100768	1K ohm ±5%
R18,R20,R22,R27	100786	3.3K ohm ±5%
R26	100858	330K ohm ±5%
R28	100780	2.2K ohm ± 5%
R35	100783	2.7K ohm ±5%





Microprocessor Subassembly P/N 079514 Consists Of:

(1) 079140 Infrared Remote Receiver PCB Assembly (see Figures 32A and 32B)
(1) 079060 Microprocessor Option Board PCB Assembly
(3) 712023 Standoffs



(See Figures 32A and 32B for electrical parts listing and wiring diagrams for the piggyback Infrared Remote Receiver PCB Assembly P/N 079140).

Figure 27. Microprocessor Option Board PCB Assembly (850 Models Only)

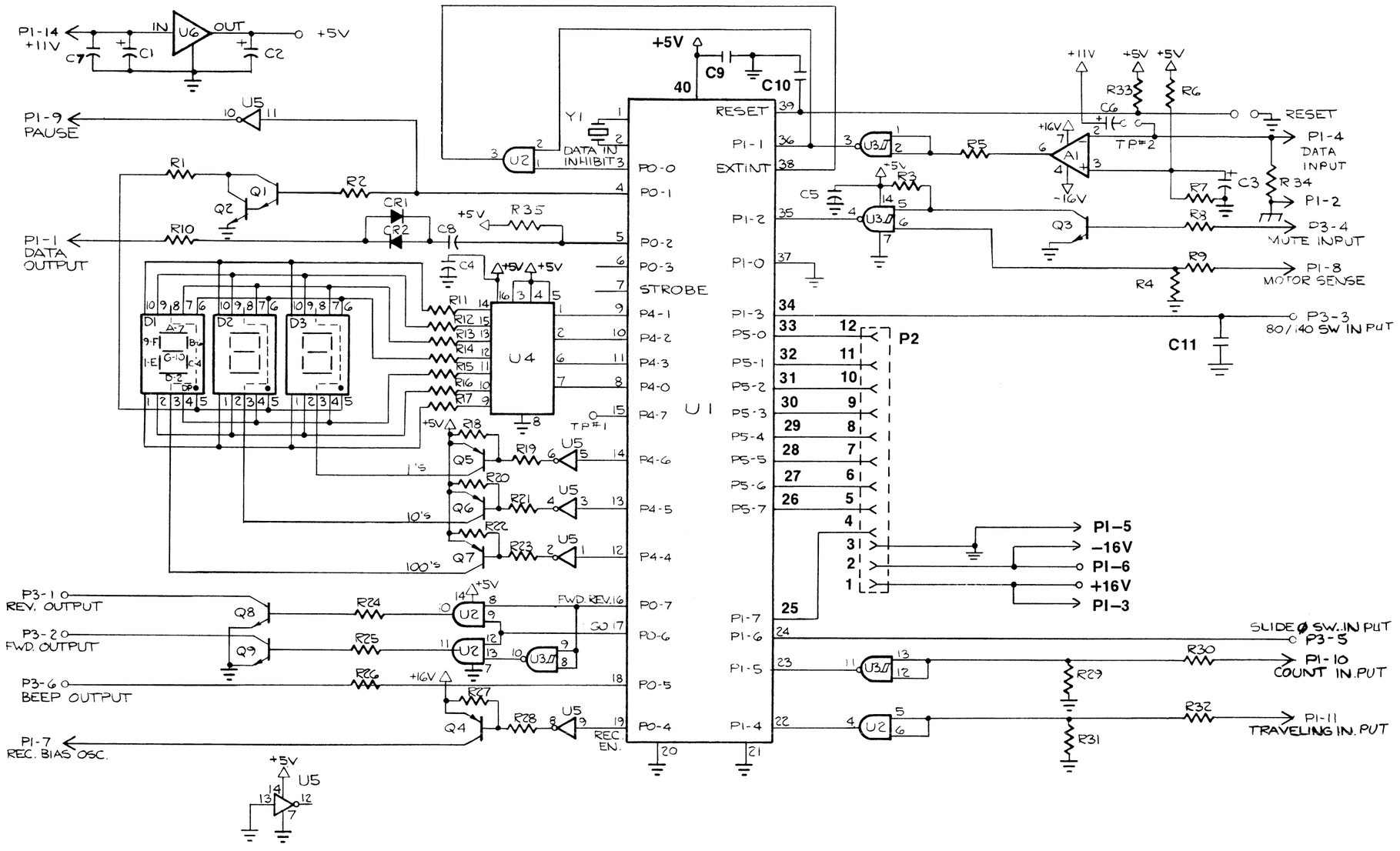


Figure 28. Microprocessor Option Board PCB Schematic (850 Models Only)

Most electrical components are available from local sources by MFR'S part number.

CODE	B & H P/N	DESCRIPTIONS	MFR'S P/N
	079140	Infrared Remote Receiver PCB Assembly	
A1	712162	Operational Amplifier, Dual Bifet	UAF772LTC
C1	671036	Electrolytic, 100MFD –10%+50% 16V	16ELA100
C2	671193	Mylar, 0.0022MFD ±10% 100V	TDY2A222K
C3,C8	671194	Ceramic Disc, 0.001MFD ±10% 50V	DB201–Z5P–102K
C4,C5	671035	Ceramic Disc, 0.01MFD ±10% 50V	DB205–Z5P–103K
C6,C13	671270	Electrolytic, 10MFD –10%+15% 35V	35ULA10
C7	671291	Mylar, 0.033MFD ±10% 50–100V	TDY2A333K
C9,C14	044496	Ceramic Disc, 100PF ±10% 500V	DB201–Z5P–101M
C10,11,12	671038	Poly Film, 0.1MFD ±10% 100V	.1–100–10%–60–C
CR1	671002	Diode, Forward Reference	IN914
CR2	671021	Case J Diode, Zener, 5.1 volt ±5% 1 watt	IN4733A
P1	712009	Ribbon, 8 Pin	HBLBBR–5
P2	712159	Header, 12 Pin	22–03–2121
P3	710264	Header, Post, right–angle	640097–8
Q1	671210	Transistor, NPN silicon	2N5089; SE4020
U1	712158	Infrared Receiver, Remote (with momentary outputs)	ML926
U2	456038	Quad, 2–Input NAND Buffer	SN74LS38N
U3	456244	Buffer, Octal, 3–State	74LS244N
VR1	712024	Potentiometer, 100K ohm ±20%, 1 watt at 40°C	
Socket	712311	I.C. Socket, 20 Pin	

NOTE: All resistors are carbon film ¼ watt unless otherwise specified.

CODE	B & H P/N	DESCRIPTION
R1,R10,R26	100816	22K ohm ±5%
R2,R3	100804	10K ohm ±5%
R4	100801	8.2K ohm ±5%
R5,R7,R9,R13	100834	68K ohm ±5%
R6,R11,R27,R28, R29,R30	100819	27K ohm ±5%

CODE	B & H P/N	DESCRIPTION
R8,R12,R24	100762	680 ohm ±5%
R14	100768	1K ohm ±5%
R15	100852	220K ohm ±5%
R16,R17,R18,R19	100765	820 ohm ±5%
R20,R21,R22,R23	100750	330 ohm ±5%
R25	100780	2.2K ohm ±5%

Figure 29. Infrared Remote Receiver PCB Assembly (850 Models Only)

Microprocessor Subassembly P/N 079514 Consists Of:

(1) 079140 Infrared Remote Receiver PCB Assembly (Figures 32A and 32B)
(1) 079060 Microprocessor Option Board PCB Assembly (Figures 31 and 32)
(3) 712023 Standoffs

Figure 30. Infrared Remote Receiver PCB Schematic (850 Models Only)

710358 ORG. ORG.

POWER SUPPLY 079501

P6

SLIDE ELEVATION ASY ③ 079052

TOP DECK

PROJECTOR LAMP ASY ①

GRN/YEL ③

LAMP SOCKET 079074

711307 ③

CONNECTOR PLATE 711308 ②

HEYCO ②

WH WH/BLK

GRN/YEL ④

COMMONING BAR 711360 (1)

711309 ②

711319 ④

PHOTO CELL LAMP

TRAY SENSING ASY ④ 079008

SPLICES

MAIN CHASSIS

TRAY MTR 079085 ①

P5 P4 P2 P3

711312 ②

710358 ②

(BLK) (RED/WH)

⑨ GRN/YEL

079082 ⑨

TRANSFORMER ⑨

HEYCO

LINE CORD 016783 ⑨

711308 ② CONNECTOR PLATE ②

711358

TOP DECK

711359

FAN ASY

GRN/YEL

⑦

LAMP/FAN SWITCH ⑦

TRAY SW ⑦

POWER SWITCH ⑦

P5 P3 P2

P4

RECORDER 079000 ⑦

P7 AUDIO OUTPUT

079144 SPEAKER CABLE

SPEAKER

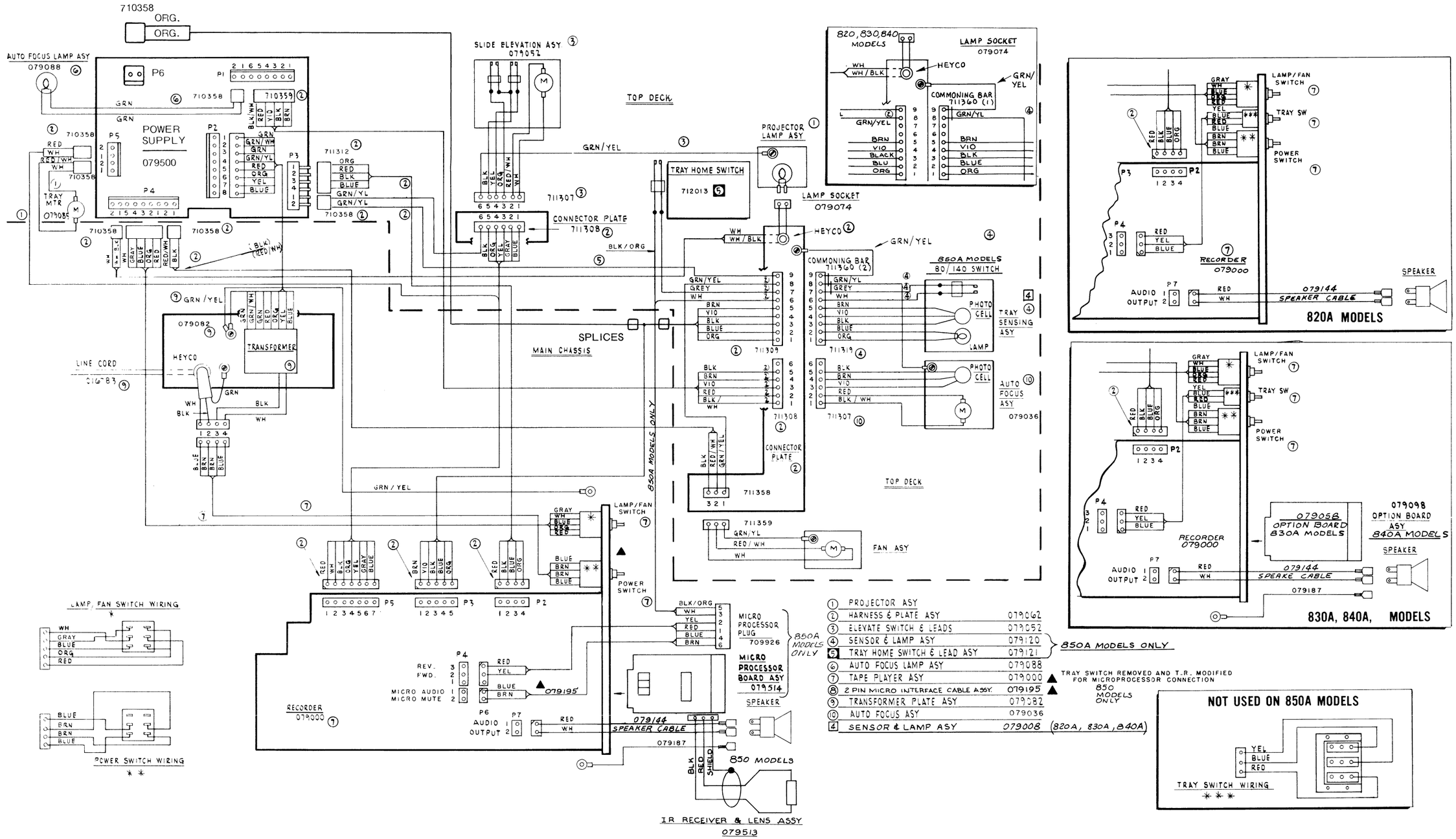
TRAY SWITCH WIRING ✳✳✳

LAMP/FAN SWITCH WIRING ✳

POWER SWITCH WIRING ✳✳

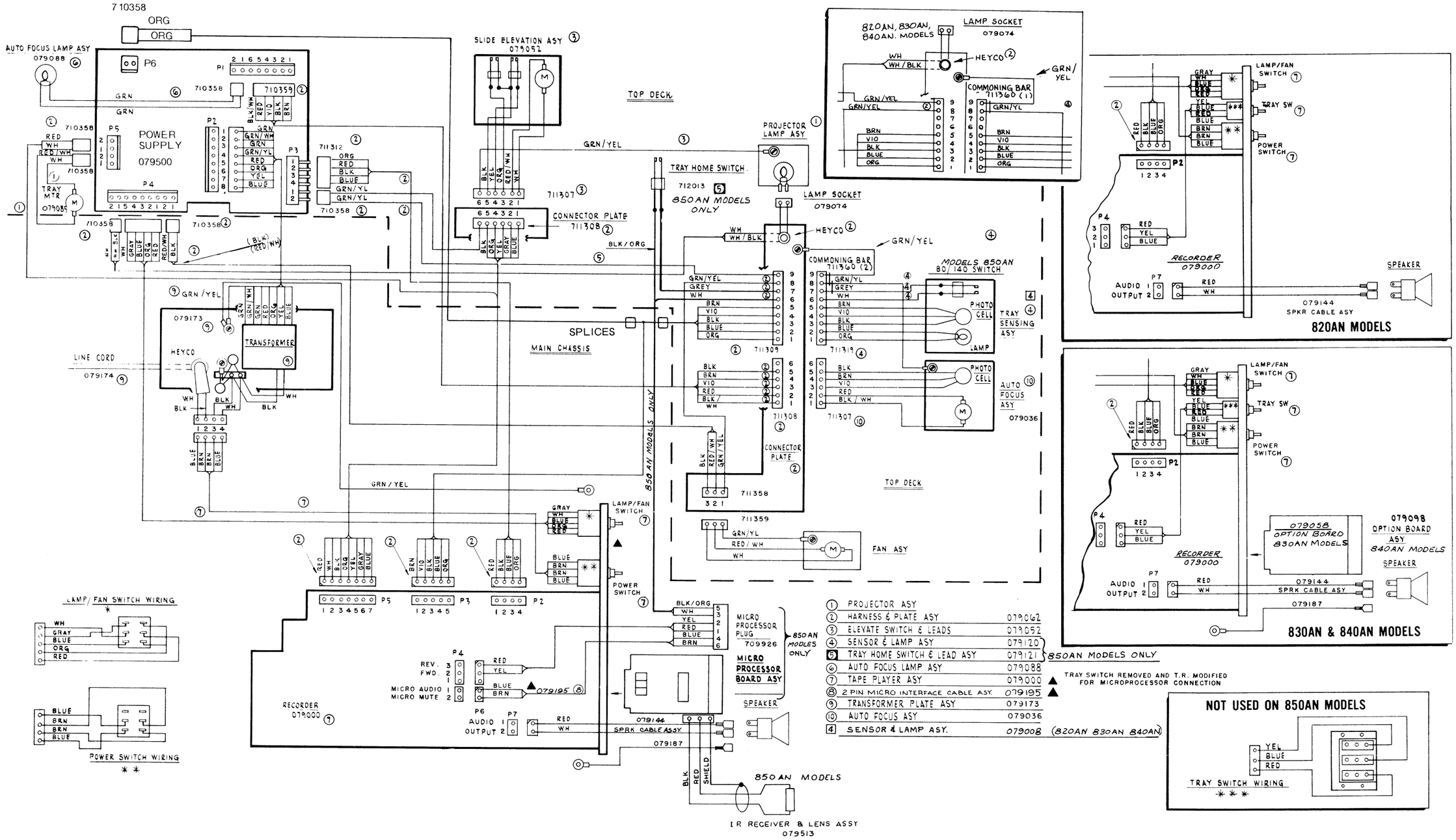
①	PROJECTOR ASY	
②	HARNESS & PLATE ASY	079153
③	ELEVATE SWITCH & LEADS	079052
④	SENSOR & LAMP ASY	079008
⑦	TAPE PLAYER ASY	079000
⑨	TRANSFORMER PLATE ASY	079082

Figure 31. Interconnect Wiring Diagram (815A Model Only)



1	PROJECTOR ASY	079062	
2	HARNESS & PLATE ASY	079052	
3	ELEVATE SWITCH & LEADS	079120	850A MODELS ONLY
4	SENSOR & LAMP ASY	079121	
5	TRAY HOME SWITCH & LEAD ASY	079088	
6	AUTO FOCUS LAMP ASY	079000	
7	TAPE PLAYER ASY	079195	TRAY SWITCH REMOVED AND T.R. MODIFIED FOR MICROPROCESSOR CONNECTION
8	2 PIN MICRO INTERFACE CABLE ASSY.	079082	850 MODELS ONLY
9	TRANSFORMER PLATE ASY	079036	
10	AUTO FOCUS ASY	079008	(820A, 830A, 840A)
4	SENSOR & LAMP ASY		

Figure 32. Interconnect Wiring Diagram (All "A" Models Except 815A)



1	PROJECTOR ASY	
2	HARNESS & PLATE ASY	079062
3	ELEVATE SWITCH & LEADS	079052
4	SENSOR & LAMP ASY	079120
5	TRAY HOME SWITCH & LEAD ASY	079121 (850AN MODELS ONLY)
6	AUTO FOCUS LAMP ASY	079088
7	TAPE PLAYER ASY	079000
8	2 PIN MICRO INTERFACE CABLE ASY.	079195
9	TRANSFORMER PLATE ASY	079173
10	AUTO FOCUS ASY	079036
4	SENSOR & LAMP ASY.	079008 (820AN 830AN 840AN)

Figure 32A. Interconnect Wiring Diagram (All "AN" Models)

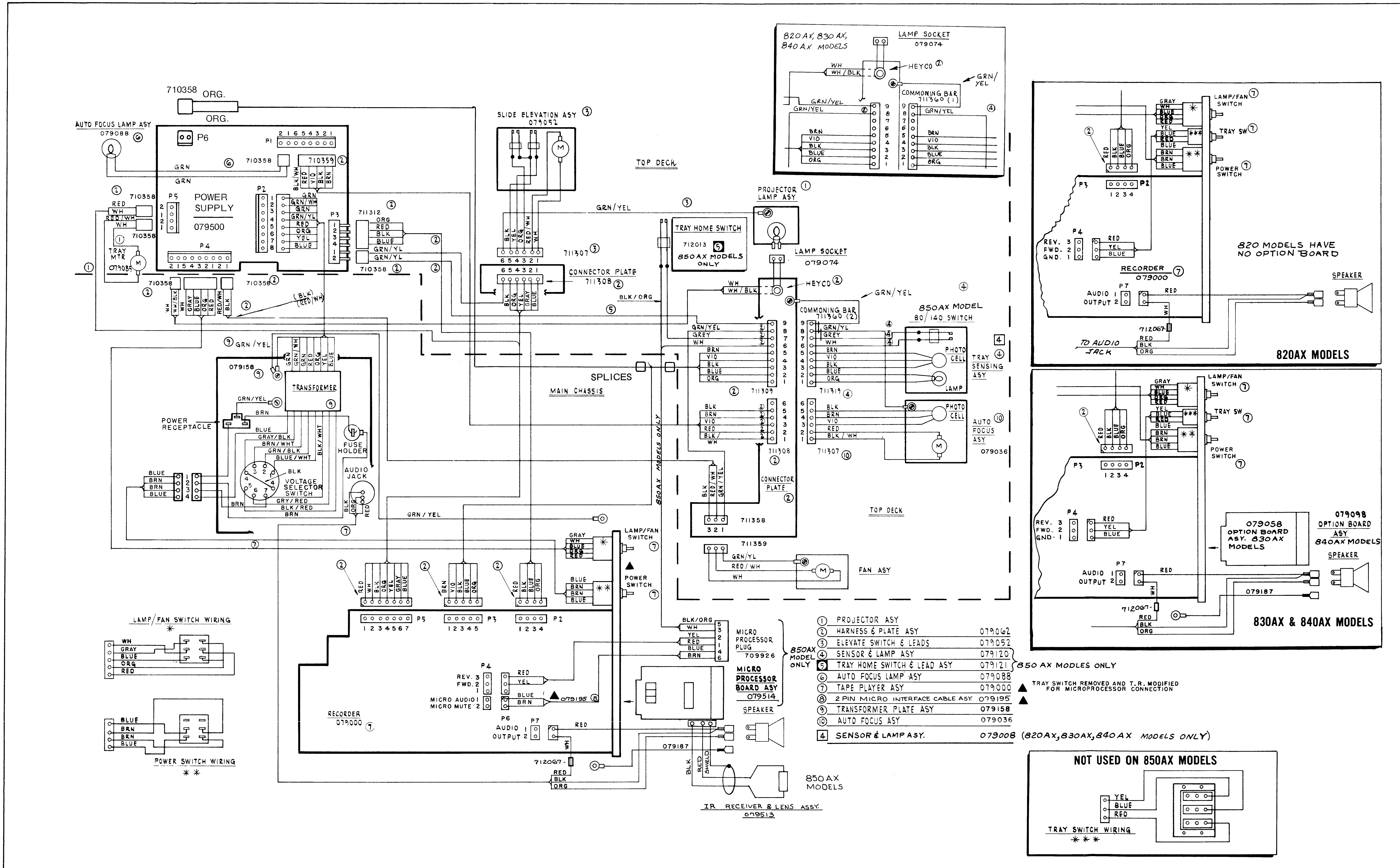

820AX MODELS
830AX & 840AX MODELS
NOT USED ON 850AX MODELS
TRAY SWITCH WIRING
LAMP/FAN SWITCH WIRING
POWER SWITCH WIRING
POWER SUPPLY
079500
TRANSFORMER
VOLTAGE SELECTOR SWITCH
POWER RECEPTACLE
FUSE HOLDER
AUDIO JACK
AUTO FOCUS LAMP ASY
079088
SLIDE ELEVATION ASY
079052
CONNECTOR PLATE
TOP DECK
MAIN CHASSIS
SPLICES
PROJECTOR LAMP ASY
TRAY HOME SWITCH
850AX MODELS ONLY
LAMP SOCKET
079074
COMMONING BAR
850AX MODEL 80/140 SWITCH
TRAY SENSING ASY
AUTO FOCUS ASY
079036
FAN ASY
RECORDER
079000
MICRO PROCESSOR PLUG
709926
MICRO PROCESSOR BOARD ASY
079514
SPEAKER
IR RECEIVER & LENS ASSY.
079513
820 MODELS HAVE NO OPTION BOARD
079058 OPTION BOARD ASY. 830AX MODELS
079098 OPTION BOARD ASY 840AX MODELS
① PROJECTOR ASY
② HARNESS & PLATE ASY 079062
③ ELEVATE SWITCH & LEADS 079052
④ SENSOR & LAMP ASY 079120
⑤ TRAY HOME SWITCH & LEAD ASY 079121 850 AX MODLES ONLY
⑥ AUTO FOCUS LAMP ASY 079088
⑦ TAPE PLAYER ASY 079000
⑧ 2 PIN MICRO INTERFACE CABLE ASY 079195
⑨ TRANSFORMER PLATE ASY 079158
⑩ AUTO FOCUS ASY 079036
④ SENSOR & LAMP ASY. 079008 (820AX, 830AX, 840AX MODELS ONLY)
▲ TRAY SWITCH REMOVED AND T.R. MODIFIED FOR MICROPROCESSOR CONNECTION

Figure 32B. Interconnect Wiring Diagram (All "AX" Models)

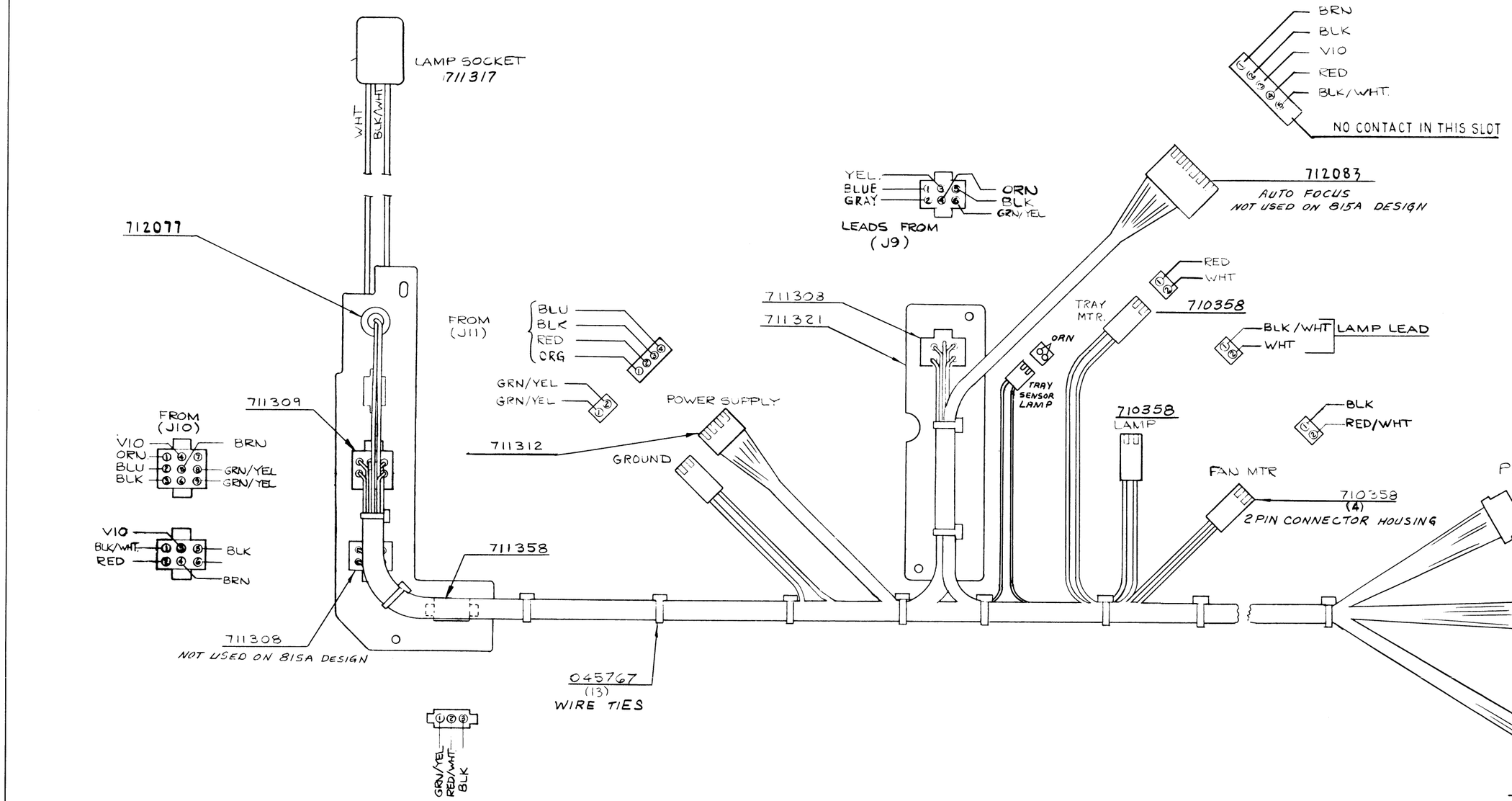


Figure 33. Wiring Harness Pictorial Diagram (All Models)

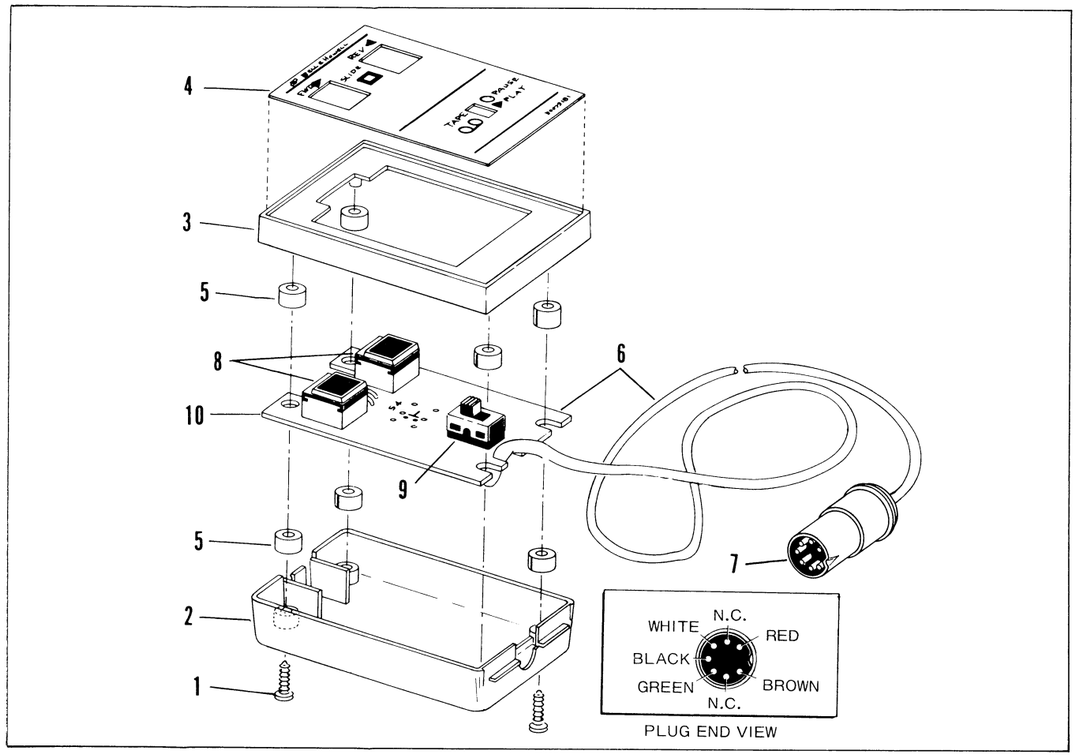


Figure 34. Optional Remote Control Accessory - Exploded View (All Except 850)

Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code
		REMOTE CONTROL ASSEMBLY — ALL MODELS EXCEPT 850		
34-	079181	REMOTE CONTROL ASSEMBLY, Complete (Forward/Reverse, Tape Pause/Play)	1	A thru E,KLO
34-	079182	REMOTE CONTROL ASSEMBLY, Complete (Forward/Reverse, Tape Pause/Play, Cue-Stop and Restart)	1	FGM
-1	766196	SREW, Phillips Hd, Type B, #4-24 x 3/8 inch	4	A thru G, KLMO
-2	44840	• CASE, Bottom	1	A thru G, KLMO
-3	709767	• CASE, Top	1	A thru G, KLMO
-4	712100	• NAMEPLATE	1	A thru E, KLO
-4	712101	• NAMEPLATE	1	FGM
-5	709782	• SPACER	8	A thru G, KLM
-6	079183	• PCB AND CORD ASSEMBLY, Remote Control	1	A thru E, KL
-6	079184	• PCB AND CORD ASSEMBLY, Remote Control	1	FGM
-7	712102	• • CORD, Remote Control, 5-Conductor w/Plug	1	A thru G, KLMO
-8	709719	• • SWITCH, Pushbutton (S1, S2)	2	A thru G, KLMO
-8	709719	• • SWITCH, Pushbutton (S4)	1	FGM
-9	712104	• • SWITCH, Slide (S3)	1	A thru G, KLMO
-10	712103	• • PC BOARD, Remote Control	1	A thru G, KLMO

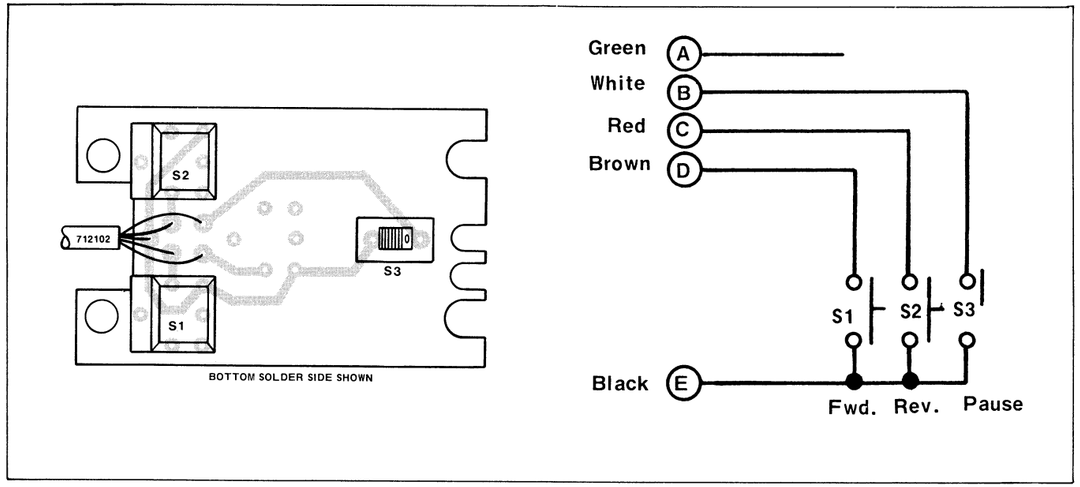


Figure 35. Remote Control Printed Circuit Board (Models 815, 820, 825A and 830 Only)

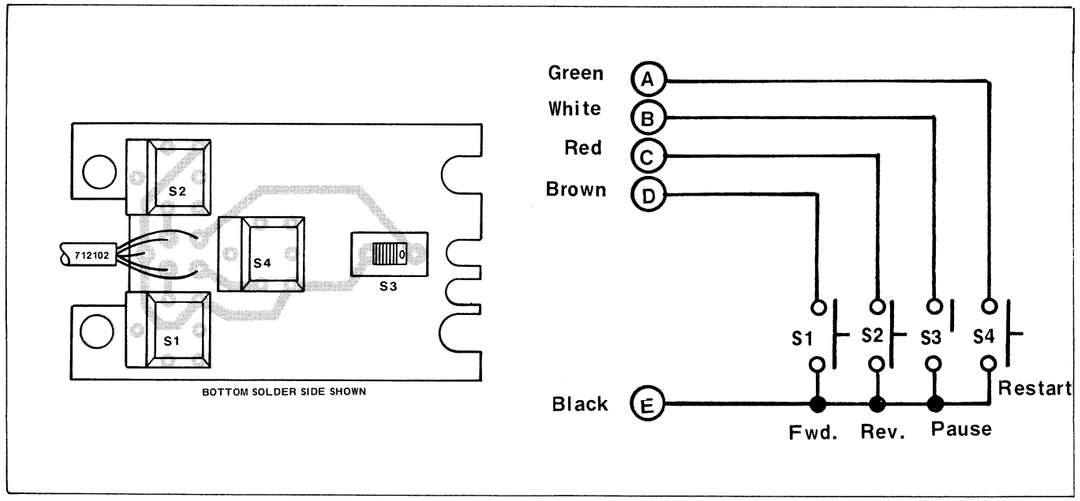


Figure 36. Remote Control Printed Circuit Board (Model 840 Only)

CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

CODE	PART NO.	DESCRIPTION	USABLE CODE
	712103	Printed Circuit Board, Remote control	A thru G, KLM O
S1, S2	709719	Switch, Pushbutton	A thru G, KLM O
S3	712104	Switch, Slide	A thru G, KLM O
S4	709719	Switch, Pushbutton	FGM

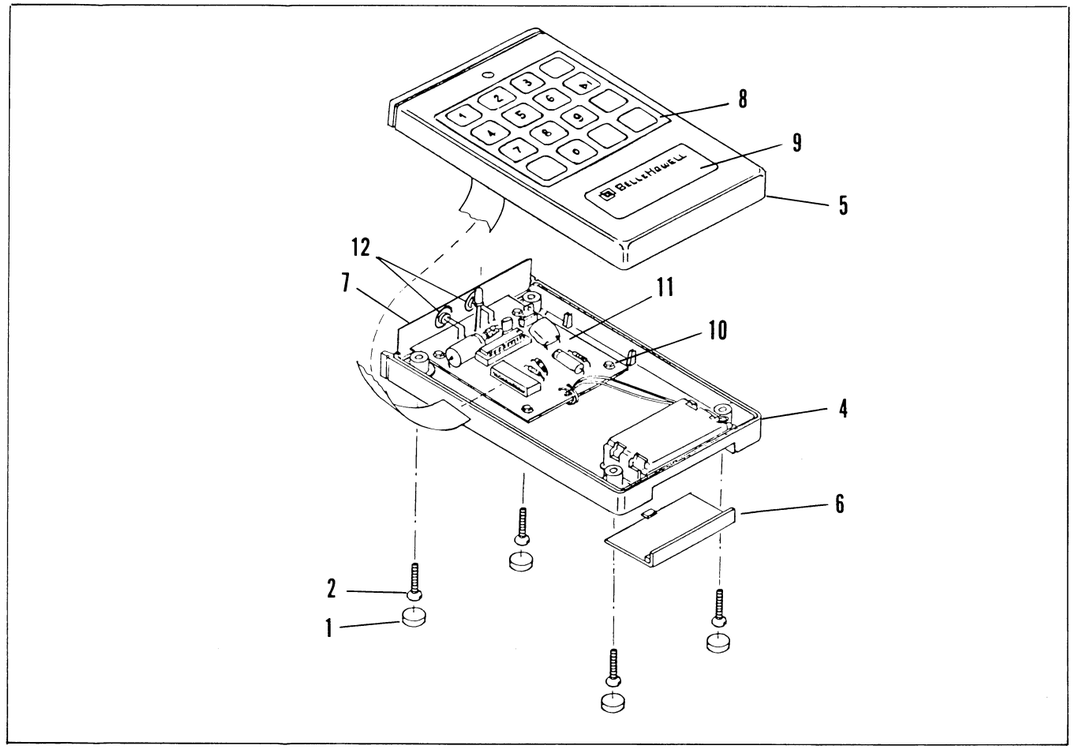


Figure 37. Infrared Remote Control Assembly 850 Models Only

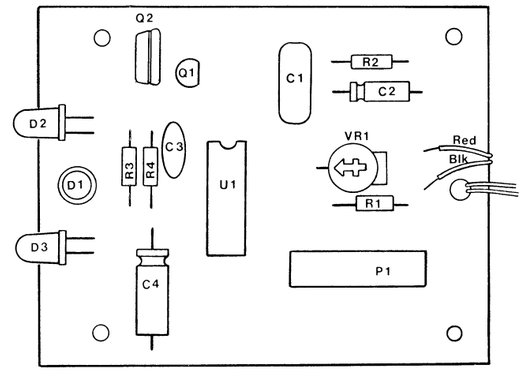
CODE MODEL	A 815A	B 820A	C 820AX	D 830A	E 830AX	F 840A	G 840AX	H 850A	J 850AX	K 820AN	L 830AN	M 840AN	N 850AN	O 825A

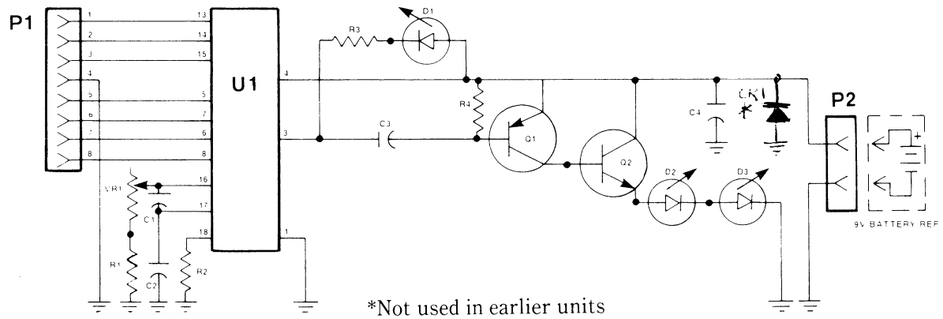
Fig. & Index No.	Part No.	Description	Units Per Assy	Usable On Code

INFRARED REMOTE CONTROL ASSEMBLY — 850 MODELS ONLY

37-	079529	INFRARED TRANSMITTER ASSEMBLY	1	HJN
-1	712174	BUMPER, Foot	4	HJN
-2	712187	SCREW, Flat Head Machine, M3 x 20mm	4	HJN
-3	079528	CASE ASSEMBLY (consists of item 4, 5 & 6)	1	HJN
-4	712189	• HOUSING, Lower	1	HJN
-5	712188	• HOUSING, Upper	1	HJN
-6	712190	• COVER, Battery	1	HJN
-7	713420	WINDOW	1	HJN
-8	713428	KEYBOARD	1	HJN
-9	712156	LABEL, Infrared Remote Control	1	HJN
-10	712074	SCREW, Hex Washer Head, Type BT, #4-24 x 1/4 inch	4	HJN
-11	079529	PCB ASSEMBLY, Infrared Transmitter	1	HJN
-12	713419	REFLECTOR	2	HJN

Infrared Transmitter PCB Assembly - P/N **079529** (850 Models Only)





*Not used in earlier units

Figure 38. Infrared Transmitter PCB Assembly Schematic Diagram (850 Models Only)

Most electrical components are available from local sources by MFR'S part number.

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
	079529	Infrared Transmitter PCB Assy.	
C1	671187	Mylar, 22MF ±10% 100V	TDY2A224K
C2	671040	Electrolytic, 4.7MF −10%+50% 16V	16ELA4R7
C3	671195	Mylar, 0.015MF ±10% 100V	TDYS−2A153K
C4	671300	Electrolytic, 220MF 10V	10ELA220
D1	671208	Diode, Light Emitting (Green)	521−9175
D2,D3	671207	Diode, Light Emitting (Infrared)	CQW13
P1	713429	Connector, 8 Pin ribbon	520314-8
P2	712142	Connector, 9V Battery	MSA−7470
Q1	671217	Transistor, PNP silicon	MPS6534
Q2	671219	Transistor, NPN silicon	MPSU01
U1	712169	Integrated Circuit	SL490
VR1	712172	Trimpot, 25K, 1 watt	CTS375E

CR1	671000	DIODE 1.5 AMP.	NONE
Spacer	708210	4 Required.	NONE

NOTE: All resistors are carbon film ¼ watt.

CODE	B&H P/N	DESCRIPTION
R1	100813	18K ohm ±5%
R2	100780	2.2K ohm ±5%

CODE	B&H P/N	DESCRIPTION
R3	100768	1K ohm ±5%
R4	100732	100 ohm ±5%

TAPE RECORDER PARTS CATALOG

This section contains replacement parts lists and exploded view illustrations, printed circuit board assembly diagrams and a schematic wiring diagram for the sound/slide projector tape recorder.

All of the projector models covered in this manual are equipped with tape recorder deck (P/N 079000). However, modification of this tape deck module is required for use on the 850 microprocessor models (see Product Modification for instructions).

Note also that instructions have been given at the beginning of this manual for removal and replacement of the tape recorder module as well as an analysis of its audio and digital systems.

Separate slide unit and tape recorder numerical indexes will be found at the end of this section.

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
		TAPE RECORDER DECK (VIEW I)		
39-1	713011	SCREW, Phillips binding head	3	
-2	713000	PANEL, Side	1	
-3	713004	STOP, Cassette eject	1	
-4	713021	SCREW, Phillips binding head	2	
-5	713022	SCREW, Phillips binding head	2	
-6	713047	PRINTED CIRCUIT BOARD ASSEMBLY (With Components)	1	
-7	713002	KNOB, Switch	2	
-8	713003	KNOB, Switch	1	
-9	713044	SWITCH, Fan/Lamp (Includes Fasteners)	1	
-10	713042	CONNECTOR, 5 Pin	1	
-11	713023	SCREW, Phillips binding head	2	
-12	713039	SWITCH, Forward/Reverse	1	
-12A	713040	CONNECTOR, 3 Pin (To PCB)	1	
-13	713020	SCREW, Phillips binding head	2	
-14	713043	SWITCH, Power	1	
-15	713041	CONNECTOR, 4 Pin	1	
-16	713017	WIRE TIE	2	
-17	713022	SCREW, Phillips binding head	1	
-18	713038	PRINTED CIRCUIT BOARD, LED, Record/Power Indicator	1	
-19	998030	SCREW, Phillips binding head	4	
-20	713010	WIRE TIE	2	
-21	713008	PANEL, Front support	1	
-22	713023	SCREW, Phillips binding head	4	
-23	713037	PRINTED CIRCUIT BOARD, Volume/Tone controls	1	
-24	713016	HOOK, Slider	1	
-25	713028	SPRING, Extension	1	
-26	713029	SPRING, Extension	1	
-27	713032	SLIDER	1	
-28	713005	GROMMET	1	
-29	713001	PLATE, Baffle	1	
-30	998030	SCREW, Phillips binding head	1	
-31	713009	SHIELD	1	
-32	713015	SUPPORT, Front panel	1	
-33	713007	GUIDE, Cable	1	
-34	713035	SCREW, Phillips binding head	7	
-35	713034	WASHER, Spring	7	
-36	713036	NUT, Hex	7	
-37	713033	BUTTON, Cassette control	7	
-38	998030	SCREW, Phillips binding head, self-tapping	4	
-39	713012	GUIDE, Cassette	1	
-40	713006	BUMPER, Cassette	1	
-41	998030	SCREW, Phillips binding head, self-tapping	4	
-42	713010	WIRE TIE	1	
-43	713025	E-RING	2	
-44	713014	BRACKET, Support, cassette holder (R.H.)	1	
-45	713013	BRACKET, Support, cassette holder (L.H.)	1	
-46	713030	SPRING, Torsion	1	
-47	713018	HOLDER, Cassette	1	
-48	713026	E-RING	1	
-49	713031	LEVER, Eject	1	
-50	713024	WASHER, Non-Metal	1	
-51	713017	WIRE TIE, Plastic	2	
-52	713019	SCREW, Special (for IC202) (see NOTE)	1	
-53	713045	INTEGRATED CIRCUIT (IC202) (see NOTE)	1	
-54	713022	SCREW, Phillips head binding, self-tapping (see NOTE)	1	
-55	713046	HEAT SINK (see NOTE)	1	

NOTE. MOUNTED TO PCB ASSEMBLY (ITEM 39–6).

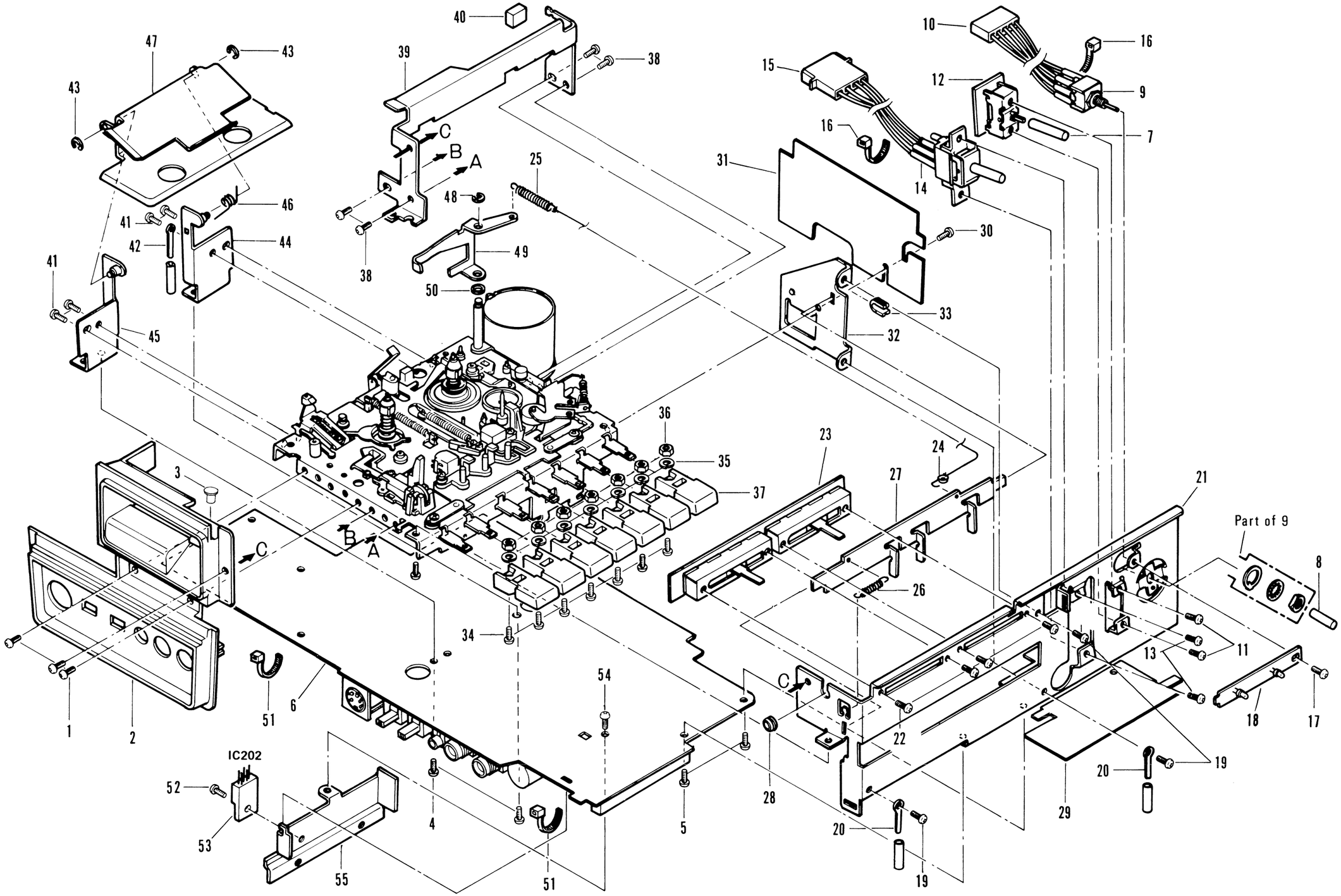


Figure 39. Tape Recorder Deck - View I

FIG. & INDEX NO.	PART NO.	1 2 3 4 5 6 7 DESCRIPTION	UNITS PER ASSY	USABLE ON CODE
		TAPE RECORDER DECK (VIEW II)		
40-1	713077	SCREW, Phillips head, 2.6 x 8 mm	3	
-2	713054	WASHER, Metal, 2.8 x 8	3	
-3	713053	SPACER, 2.65 x 3.65	3	
-4	713049	BUSHING, Grommet	3	
-5	713082	MOTOR, D.C. (Includes Pulley)	1	
-6	998030	SCREW, Phillips binding head, self-tapping 3 x 6 mm	1	
-7	713051	BRACKET AND POST, Motor	1	
-8	713052	BRACKET, Flywheel	1	
-9	713065	BEARING, Flywheel, nylon	1	
-10	713068	BELT, Drive	1	
-11	713048	BUSHING, Rubber	1	
-12	713064	WASHER, Mylar, 2.3 x 5.5 OD	1	
-13	713067	FLYWHEEL	1	
-14	713063	WASHER, Mylar, 2.6 x 4.7 OD	1	
-15	713062	WASHER, Mylar, 2.6 x 4.7 OD	1	
-16	713066	SPRING, Leaf, switch actuating	1	
-17	713074	SCREW, Special	3	
-18	713058	WASHER, Flat, 2.3 x 5 OD	2	
-19	713081	ERASE HEAD	1	
-20	713078	LUG	1	
-21	713057	WASHER, Metal, 2.3 x 5 OD	1	
-22	713075	SCREW, Special	1	
-23	713080	PLAY/RECORD HEAD (see NOTE)	1	
-24	713056	WASHER, Metal, 2.3 x 6 OD	1	
-25	713069	SPRING, Coil	1	
-26	713055	WASHER, Metal, 3.8 x 6.5 OD	1	
-27	713050	BRACKET, Head carrying	1	
-28	713073	LEVER	1	
-29	713072	SPRING, Extension	1	
-30	713071	HOLDER	1	
-31	713070	LEVER	1	

NOTE: The following special washers are used for head height adjustment and are not shown:

713059	WASHER, Special	AR	
713060	WASHER, Special	AR	
713061	WASHER, Special	AR	

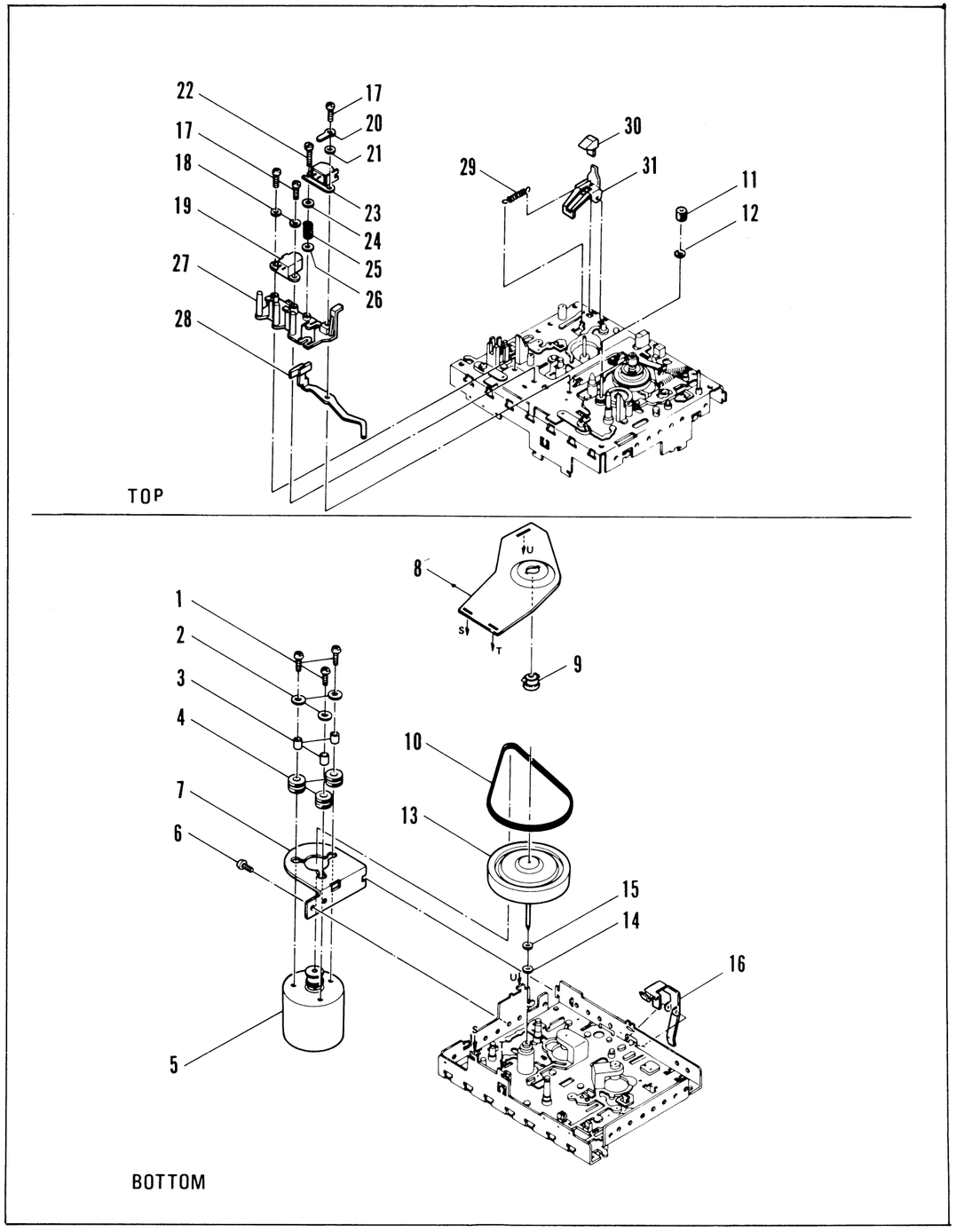


Figure 40. Tape Recorder Deck - View II

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
		TAPE RECORDER DECK (VIEW III)		
41-1	713091	WASHER, Grip	1	
-2	713110	SPRING, Pinch roller tension	1	
-3	713095	ROLLER, Pinch	1	
-4	713093	WASHER, Flat, nylon	1	
-5	713115	LEVER, Pinch roller activating	1	
-6	713133	SCREW, Self-tapping	2	
-7	713113	SPRING, Pressure, play lever	2	
-8	713109	SPRING, Tension, play lever	1	
-9	713134	E-RING, Stop	1	
-10	713092	WASHER, Flat	1	
-11	713121	SLIDER, Play/Record lever	1	
-12	713120	SPRING, Eject lever	1	
-13	713086	LEVER, Eject	1	
-14	713076	SCREW, 2 x 6 mm	1	
-15	713079	SWITCH, Leaf, record muting (S205)	1	
-16	(Deleted)			
-17	713135	BALL, Steel	3	
-18	713105	SPRING, Idler retractor	2	
-19	713116	LEVER, Idler control	1	
-20	713097	IDLER	1	
-21	713098	IDLER	1	
-22	713104	SPRING, Idler tension	1	
-23	713087	BUSHING, Locking	3	
-24	713137	SPRING, Torsion, pause lock lever	1	
-25	713138	LEVER, Pause lock	1	
-26	713108	SPRING, Play slide retracting	1	
-27	713090	WASHER, Grip, nylon	2	
-28	713101	REEL, Supply	1	
-29	713100	REEL, Take-Up	1	
-30	713131	SCREW, 2 x 5 mm	3	
-31	713139	BRACKET, Record spring	1	
-32	713107	SPRING, Extension, record slider	1	
-33	713111	SPRING, Extension, rewind idler/slider	1	
-34	713112	SPRING, Extension, slider stop	1	
-35	713103	SPRING, Extension	1	
-36	713106	SPRING, Extension, pause/slider	1	
-37	713117	LEVER, Slide bar stop	1	
-38	713096	IDLER	1	
-39	713094	WASHER, Flat, nylon	1	
-40	713099	BELT	1	
-41	713114	SPRING, Extension, slider lock lever	1	
-42	713127	SLIDE, Locking lever, upper	1	
-43	713128	SLIDE, Locking lever, lower	1	
-44	713085	SLIDER, Pause	1	
-45	713132	SCREW, 2 x 6 mm	1	
-46	713136	SWITCH, Leaf, play motor (S204)	1	
-47	713130	SCREW, Special, play slider	1	
-48	713084	SLIDER, Play	1	
-49	713102	SPRING, Wire brake	1	
-50	713089	LEVER, Brake	1	
-51	713088	SHOE, Brake	2	
-52	713122	SLIDER, Cue (Fast Forward)	1	
-53	713123	SLIDER, Stop	1	
-54	713124	SLIDER, Review (Rewind)	1	
-55	713125	SLIDER, Record	1	
-56	713126	SLIDER, Eject	1	
-57	713129	SLIDER, Locking	1	
-58	713118	LEVER, Caming, L.H.	1	
-59	713119	LEVER, Caming, R.H.	1	
-60	713083	CHASSIS	1	

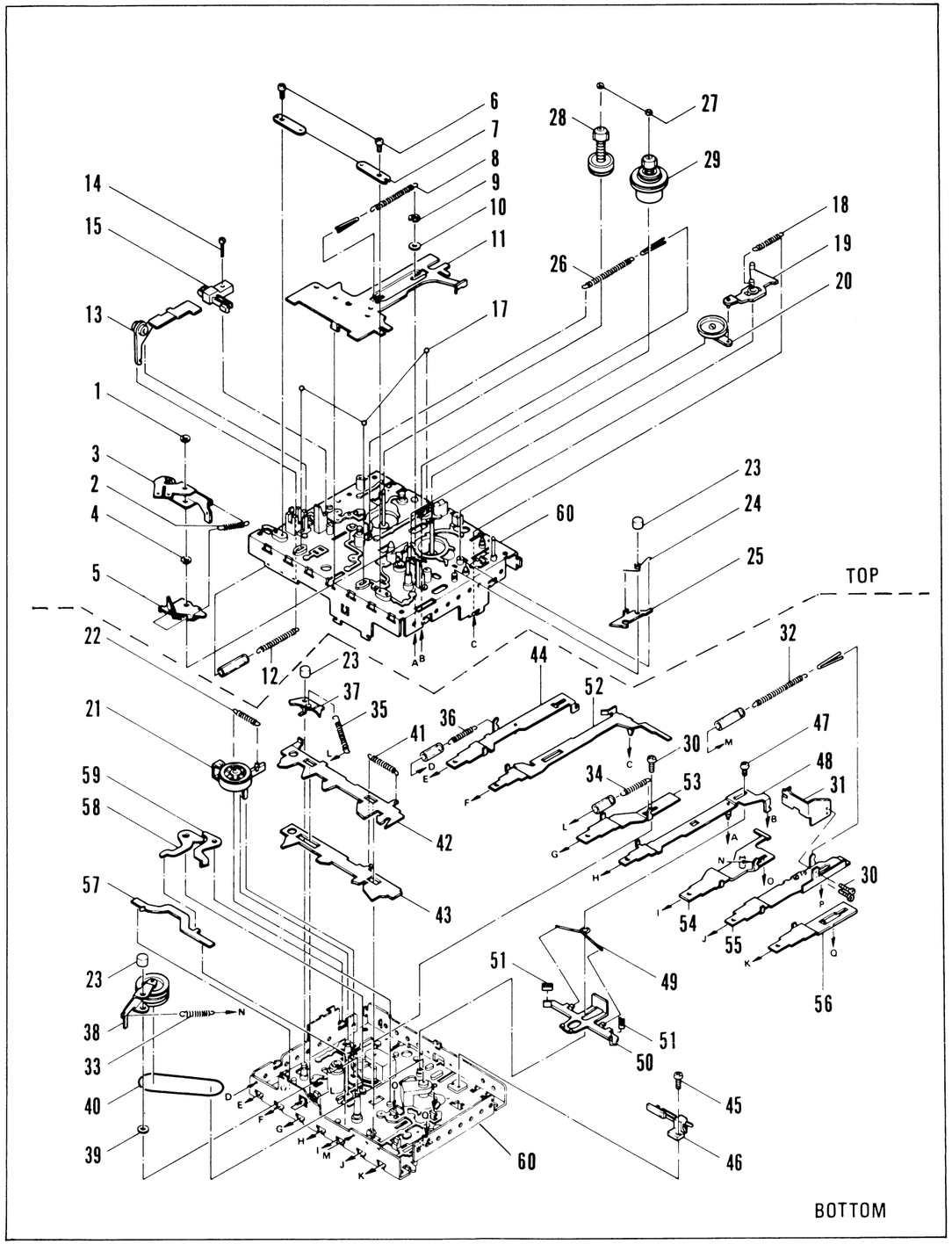


Figure 41. Tape Recorder Deck - View III

NOTE: All resistors are carbon film ¼ watt unless otherwise specified.

CODE	B & H P/N	DESCRIPTION	MFR'S P/N
C14	713164	Capacitor, Ceramic Disc 1000PF ±20% 100V	
C16	713160	Capacitor, Electrolytic 22MFD −10%+50% 35V	
C38,39, 40,41	712130	Capacitor, Ceramic Disc 330PF	
C42,43	711340	Capacitor, Ceramic Disc 0.01 MFD	
C203	713165	Capacitor, Ceramic Disc 39PF ±20% 100V	
C207	713166	Capacitor, Ceramic Disc 270PF ±20% 100V	
C235	713167	Capacitor, Ceramic Disc 1800PF ± 10% 100V	
D26	41173	Diode	IN914
R42A	100846	Resistor, C.F. 150K ±5% (In parallel with R42 /18K ohms/)	
R78A	100480	Resistor, C.F. 100 ohms ±5% (In parallel with R78 /120 ohms/)	
R89A	712179	Resistor, C.F. 120K± 5% (In parallel with R89 /160K ohms/)	
R107	100708	Resistor, 22 ohms ±5%	

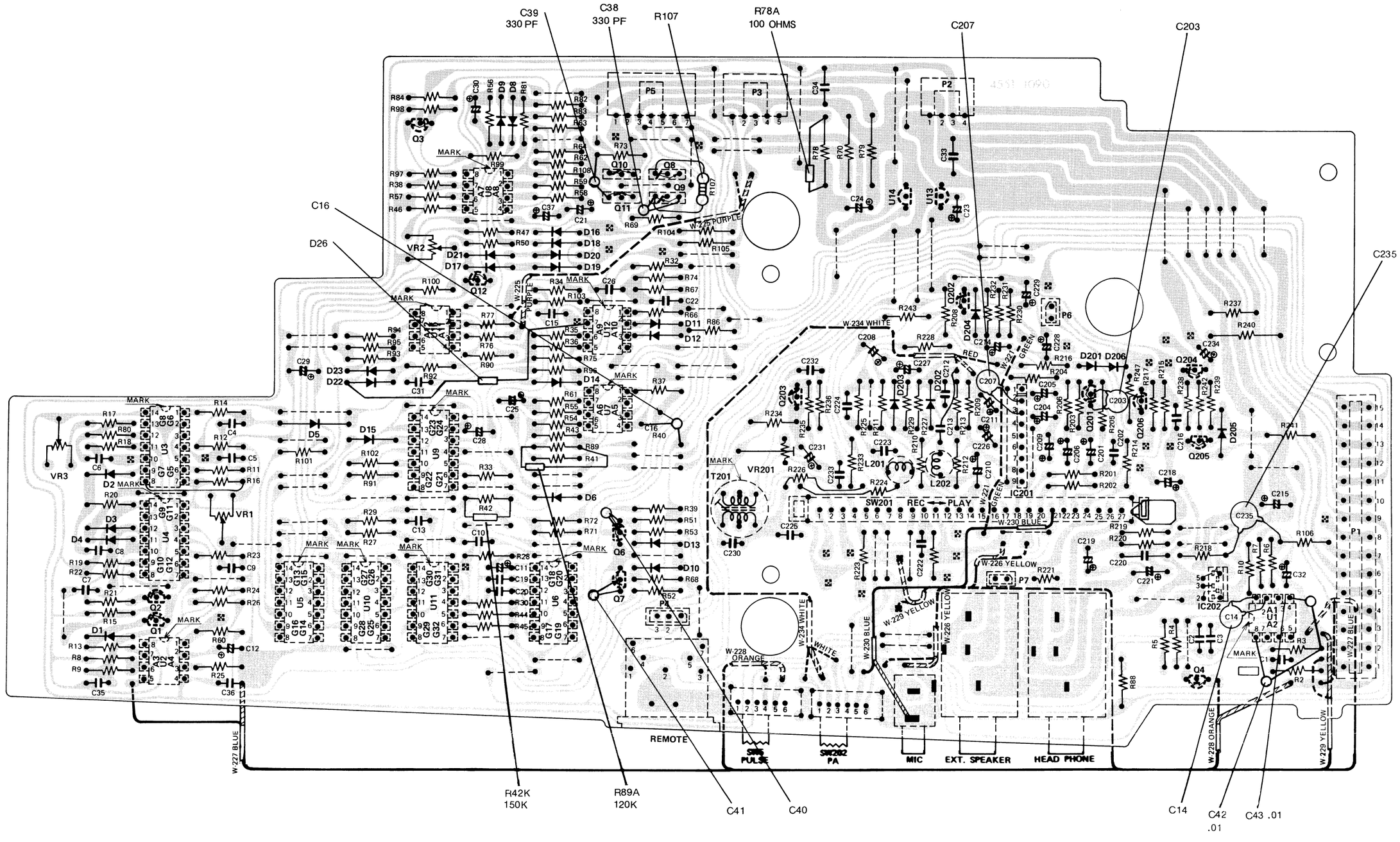


Figure 42. Tape Recorder PCB Assembly - Top View (*Generic Modification)

CODE	B&H P/N	DESCRIPTION
C1	713168	Ceramic 330MF ±10% 100V
C2,C6	709480	Mylar 0.015MF ±10% 100V
C3,9,202	713169	Mylar 0.047MF ±10% 100V
C4,15,26,212	454068	Mylar 0.033MF ±10% 100V
C5	998158	Ceramic 680PF ±10% 100V
C7	713170	Ceramic 390PF ±10% 100V
C8	713171	Ceramic 150PF ±10% 100V
C10,C20	19716	Mylar 0.001MF ±10% 100V
C11	713172	Electrolytic 3.3MF −10% +50% 50V
C12,28,201,218	708963	Electrolytic 1MF −10%+50% 50V

CODE	B&H P/N	DESCRIPTION
C13,19,31,35,36, 232	713173	Mylar 0.01MF ±10% 100V
C21,23,24,29,32,37, 205,206,210,214,226, 227,228,229	998162	Electrolytic 10MF ±20% 16V
C22,33,34	713174	Mylar 0.1MF ±10% 100V
C25,C30	713175	Electrolytic 4.7MF ±20% 10V
C204,C209,C211	998160	Electrolytic 47MF −10%+50% 10V
C208,C231	713176	Electrolytic 100MF −10%+50% 16V
C215	713177	Electrolytic 470MF −10%+50% 25V

CODE	B&H P/N	DESCRIPTION
C213,C223	713178	Stylor 1800PF ±10% 100V
C216	713167	Ceramic 1800PF ±10% 100V
C217	713179	Mylar 0.018MF ±10% 100V
C219	713180	Electrolytic 470MF −10%+50% 10V
C220	713181	Mylar 0.18MF ±10% 100V
C221	713182	Electrolytic 2200MF −10%+50%16V
C222,C224	713183	Mylar .0033MF ±10% 100V
C225	713184	Ceramic Disc 270PF ±10% 100V
C230	713185	Stylor 5600PF ±10% 100V
C234	713186	Electrolytic 220MF −10%+50% 16V
C233	713188	Mylar .0022MF ±10% 100V

RESISTORS– All of the following resistors are carbon film ¼ watt ±5% unless otherwise noted.

CODE	B&H P/N	DESC.
R2,93,95,206,216, 226,236,238	100804	10K ohm
R3,7,205,230	100753	390 ohm
R4	100803	9.1K ohm
R5,R103	100853	220K ohm
R6,R26,R245	100834	68K ohm
R8	100870	680K ohm
R9	100801	8.2K ohm
R10	100800	7.5K ohm
R11,15,16,19,27,29, 30,51,60,213,214,235	100828	47K ohm
R12,14,17, 97,204,215	100813	18K ohm
R13,18,20,21,33,39,	100816	22K ohm
R42	100812	16K ohm

CODE	B&H P/N	DESC.
R44,45,52,76,77,80, 81,91,98,100,101,239	100816	22K ohm
R22,R32,R62	100840	100K ohm
R23,41,43,53,54,57, 68,92,104,105,202, 237,218	100768	1K ohm
R24,R88,R102	100825	39K ohm
R25	100837	82K ohm
R34	100849	180K ohm
R35,R106	100783	2.7K ohm
R36,75,210,232	100831	56K ohm
R37,46,201,217,242	100780	2.2K ohm
R38	100807	12K ohm
R47,R50	100806	11K ohm

CODE	B&H P/N	DESC.
R55,R61	100801	8.2K ohm
R56	100822	33K ohm
R58	100773	1.3K ohm
R59	100774	1.5K ohm
R63,R64	100795	5.6K ohm
R66,R96	100846	150K ohm
R67,R74	100738	150 ohm
R69,R73	100732	100 ohm
R70,R79	100675	1.0 ohm ½ watt ±5%
R71,72,86,28	100792	4.7K ohm
R78	713162	Resistor Metal Comp. 120 ohm 1 watt ±5%
R82	100759	560 ohm
R83,R209,R243	100762	680 ohm

CODE	B&H P/N	DESC.
R84	100819	27K ohm
R89	100848	160K ohm
R90	100864	470K ohm
R94,R203	100876	1M ohm
R99,R225,R244	100810	15K ohm
R107,R108	100708	22 ohm
R109	712180	6.8K ohm
R110	100816	22K ohm
R111	712178	30K ohm
R208	100750	330 ohm
R211,R229	100798	6.8K ohm
R212,R228	100786	3.3K ohm
R216	100804	10K ohm
R219	100780	2.2K ohm

CODE	B&H P/N	DESC.
R220	100744	220 ohm
R221	100477	Resistor Carbon 82 ohm ½ watt ±5%
R222,R223	100719	42 ohm
R224	100819	27K ohm
R227	100861	390K ohm
R231	100789	3.9K ohm
R233	100723	56 ohm
R234	100702	15 ohm
R240	301288	Carbon Comp. 10 ohm 1 watt ±5%
R241	100756	470 ohm
R244	100810	15K ohm

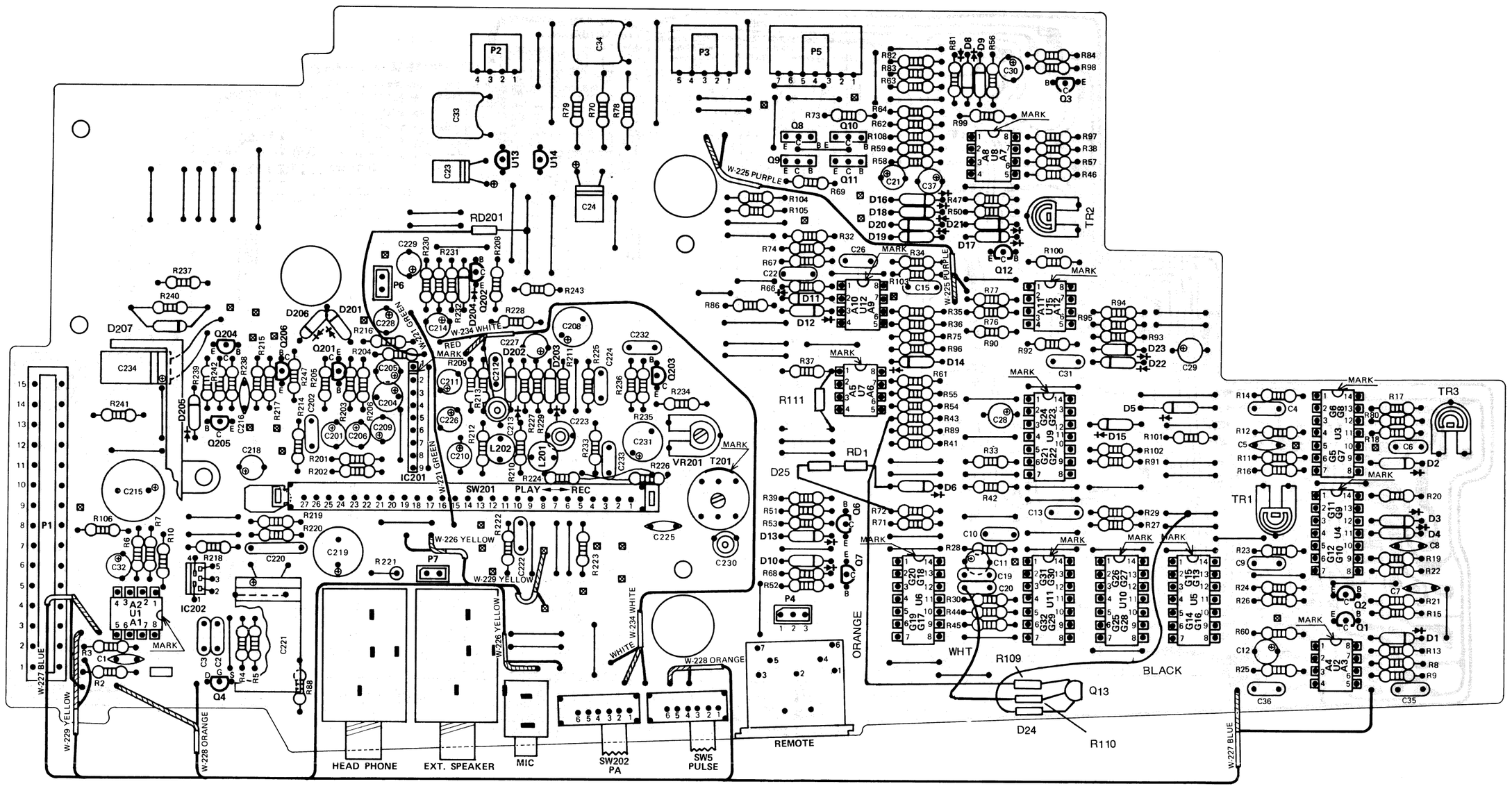
Most components are available from local sources by MFR'S part number.

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
J1	713150	Connector, 15 Pin PCB	
J2	713149	Connector, 7 Pin DIN (for remote control)	
J201	713147	Jack, Microphone	
J202	713148	Jack, Headphone	
J203	713148	Jack, Ext. speaker	
L201,202	X62762	Inductor Coil, Bias Trap, 5.6mm	
T201	713144	Coil, Bias oscillator	
IC201	713143	IC, Audio preamp	
IC202	713045	IC, Audio power amp (Ntl. LM383)	
U1	709269	IC, Dual Op–Amp	MC4558C
U2	713156	IC, Dual Op–Amp	MC14001B
U3,4,9,10	713156	IC, Quad 21 NOR	MC14001B
U5	457081	IC, Quad 21 AND	MC14081B
U6	709920	IC, Quad 21 NAND schmidt	MC14093B
TR1,3,201	713145	Resistor, Variable trim, 100K ohm ±30% linear carbon	

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
U7,8,12,15	49700	IC, Dual Op–Amp	MC1458CPI
U11	713156	IC, Quad 21 NOR	MC14001B
U13	708956	IC, Voltage regulator 12V ±5%	MC78L12AC
U14	713157	IC, Voltage regulator 12V ±5%	MC79L12AC
P2	713151	Connector, Male, 4 Pin PCB mounting	
P3	713152	Connector, Male, 5 Pin PCB mounting	
P4	713153	Connector, Male,3 Pin PCB mounting	
P5	713154	Connector, Male, 7 Pin PCB mounting	
P6,P7	713155	Connector, Male, 2 Pin	
Q1,2,3,6, 7,12,202, 205,206	713161	Transistor, NPN	A7T5172
Q4	713163	Transistor, Field Effect	2N5462
Q8,Q10	713141	Transistor, NPN (J)	
Q9,Q11	713140	Transistor, PNP (J)	
TR2	X62763	Resistor, Variable trim, 50K ohm ±30% linear carbon	

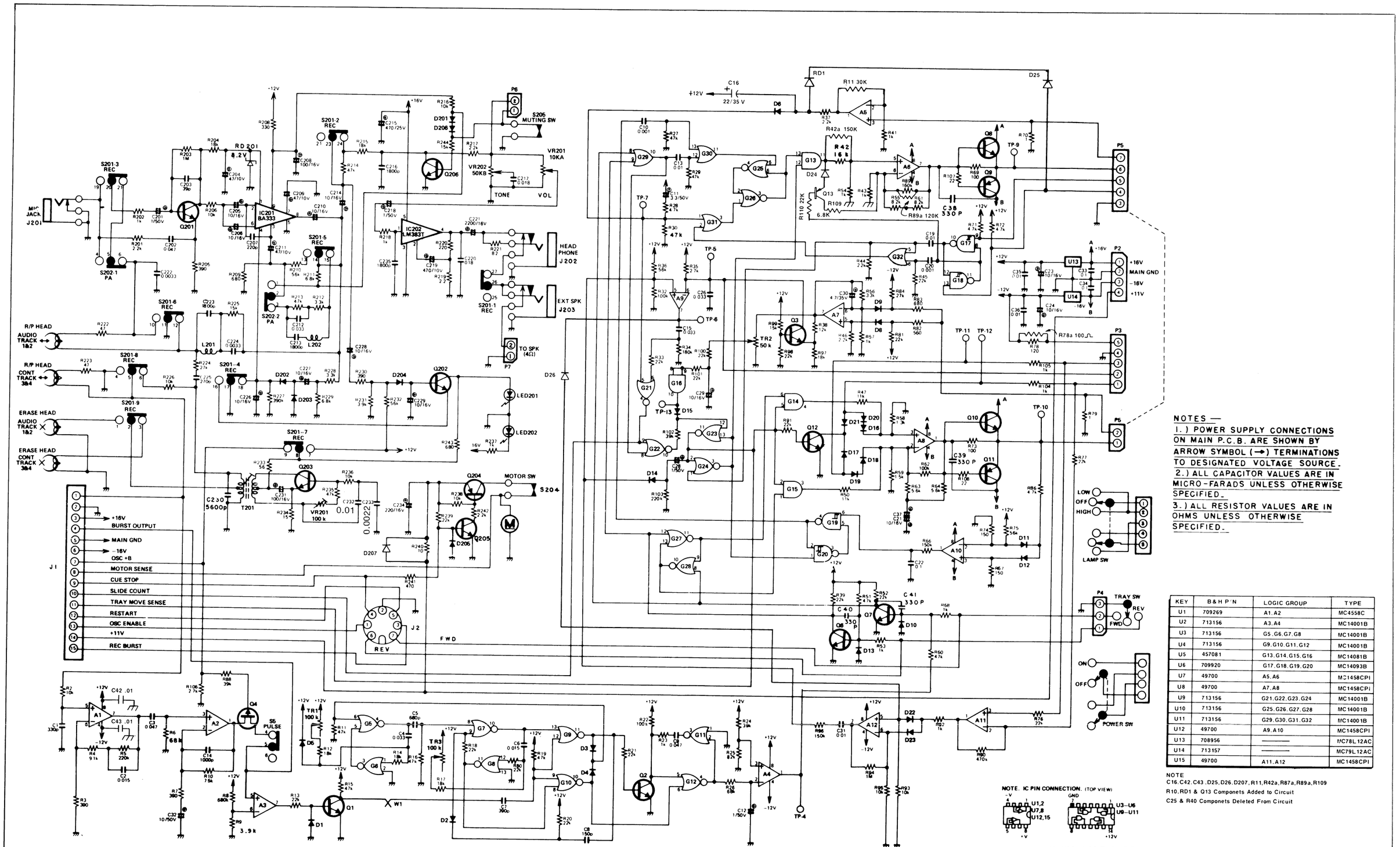
CODE	B&H P/N	DESCRIPTION	MFR'S P/N
Q13	45594	Transistor, NPN	MPS6531
Q201	713158	Transistor, NPN	2N3707
Q203	713159	Transistor, NPN	T.I.S.95
Q204	713142	Transistor	
S5	713146	Switch, DPDT, PCB mtg. burst defeat	
S201	998177	Switch, Slide (record)	
S202	713146	Switch, DPDT, PCB mtg. P/A On–Off	
S204	713136	Switch, Motor	
S205	713079	Switch, Muting	
D1–D23	41173	Signal Diode	IN914
D24,25, D202–206	41173	Signal Diode	IN914
D207	41174	Rectifier Diode	IN4002
RD1	671006	Zener Diode 12V	IN4738A
RD201	712131	Zener Diode 8.2V	
VR201,VR202	713037	Volume & Tone Control Assy.	

SN 2000000 to 2312150.



GENERIC MODIFICATION S.N. 2000000 – 2312150

Figure 43. Tape Recorder PCB Assembly - Bottom View (*Generic Modification)



NOTES —

1.) POWER SUPPLY CONNECTIONS ON MAIN P.C.B. ARE SHOWN BY ARROW SYMBOL (→) TERMINATIONS TO DESIGNATED VOLTAGE SOURCE.

2.) ALL CAPACITOR VALUES ARE IN MICRO-FARADS UNLESS OTHERWISE SPECIFIED.

3.) ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE SPECIFIED.

KEY	B&H P/N	LOGIC GROUP	TYPE
U1	709269	A1, A2	MC4558C
U2	713156	A3, A4	MC14001B
U3	713156	G5, G6, G7, G8	MC14001B
U4	713156	G9, G10, G11, G12	MC14001B
U5	457081	G13, G14, G15, G16	MC14081B
U6	709920	G17, G18, G19, G20	MC14093B
U7	49700	A5, A6	MC1458CPI
U8	49700	A7, A8	MC1458CPI
U9	713156	G21, G22, G23, G24	MC14001B
U10	713156	G25, G26, G27, G28	MC14001B
U11	713156	G29, G30, G31, G32	MC14001B
U12	49700	A9, A10	MC1458CPI
U13	708956	———	MC78L12AC
U14	713157	———	MC79L12AC
U15	49700	A11, A12	MC1458CPI

NOTE
C16, C42, C43, D25, D26, D207, R11, R42a, R87a, R89a, R109
R10, RD1 & Q13 Components Added to Circuit
C25 & R40 Components Deleted From Circuit

NOTE: IC PIN CONNECTION (TOP VIEW)

-V U1,2 U7,8 U12,15 +V

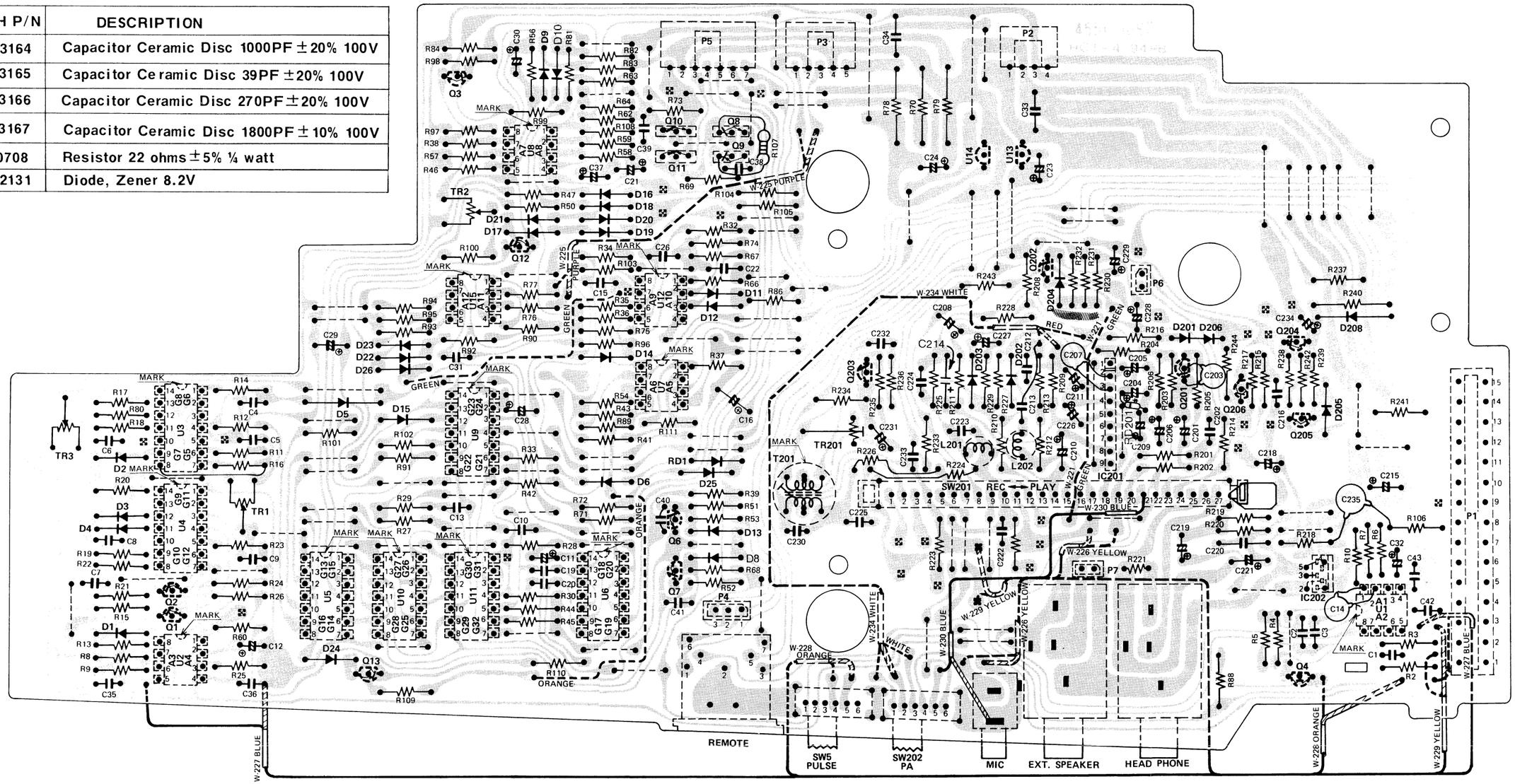
GND U3–U6 U9–U11 +12V

GENERIC MODIFICATION S/N. 2000000 – 2312150

Figure 44. Tape Recorder Schematic Wiring Diagram (*Generic Modification)

BEGIN WITH S.N. 2312151

CODE	B & H P/N	DESCRIPTION
C14	713164	Capacitor Ceramic Disc 1000PF ±20% 100V
C203	713165	Capacitor Ceramic Disc 39PF ±20% 100V
C207	713166	Capacitor Ceramic Disc 270PF ±20% 100V
C235	713167	Capacitor Ceramic Disc 1800PF ±10% 100V
R107	100708	Resistor 22 ohms ±5% ¼ watt
RD201	712131	Diode, Zener 8.2V



BEGIN WITH S.N 2312151

Figure 45. Tape Recorder PCB Assembly - Top View (*After 12-31-82)

CAPACITORS

CODE	B&H P/N	DESCRIPTION
C1,38,39,40,41	713168	Ceramic 330PF ±10% 100V
C2,C6	709480	Mylar 0.015MF ±10% 100V
C3,9,202	713169	Mylar 0.047MF ±10% 100V
C4,15,26,212	454068	Mylar 0.033MF ±10% 100V
C5	998158	Ceramic 680PF ±10% 100V
C7	713170	Ceramic 390PF ±10% 100V
C8	713171	Ceramic 150PF ±10% 100V
C10,C20	19716	Mylar 0.001MF ±10% 100V
C11	713172	Electrolytic 3.3MF −10% +50% 50V
C12,28,201,218	708963	Electrolytic 1MF −10%+50% 50V

CODE	B&H P/N	DESCRIPTION
C13,19,31,35,36, 232	713173	Mylar 0.01MF ±10% 100V
C16	713160	Electrolytic 22MF −10%+50% 35V
C21,23,24,29,32,37, 205,206,210,214,226, 227,228,229	998162	Electrolytic 10MF ±20% 16V
C22,33,34	713174	Mylar 0.1MF ±10% 100V
C30	713175	Electrolytic 4.7MF ±20% 10V
C204,C209,C211	998160	Electrolytic 47MF −10%+50% 10V
C208,C231	713176	Electrolytic 100MF −10%+50% 16V
C215	713177	Electrolytic 470MF −10%+50% 25V

CODE	B&H P/N	DESCRIPTION
C213,C223	713178	Stylor 1800PF ±10% 100V
C216	713167	Ceramic 1800PF ±10% 100V
C217	713179	Mylar 0.018MF ±10% 100V
C219	713180	Electrolytic 470MF −10%+50% 10V
C220	713181	Mylar 0.18MF ±10% 100V
C221	713182	Electrolytic 2200MF −10%+50%16V
C222,C224	713183	Mylar .0033MF ±10% 100V
C225	713184	Ceramic Disc 270PF ±10% 100V
C230	713185	Stylor 5600PF ±10% 100V
C234	713186	Electrolytic 220MF −10%+50% 16V
C233	713188	Mylar .0022MF ±10% 100V

RESISTORS– All of the following resistors are carbon film ¼ watt ±5% unless otherwise noted.

CODE	B&H P/N	DESC.
R2,93,95,206,216, 226,236,238	100804	10K ohm
R3,7,205,230	100753	390 ohm
R4	100803	9.1K ohm
R5,R103	100853	220K ohm
R6,R26,R245	100834	68K ohm
R8	100870	680K ohm
R9	100801	8.2K ohm
R10	100800	7.5K ohm
R11,15,16,19,27,29, 30,51,60,213,214,235	100828	47K ohm
R12,14,17, 97,204,215	100813	18K ohm
R13,18,20,21,33,39,	100816	22K ohm
R42	100812	16K ohm

CODE	B&H P/N	DESC.
R44,45,52,76,77,80, 81,91,98,100,101,239	100816	22K ohm
R22,R32,R62	100840	100K ohm
R23,41,43,53,54,57, 68,92,104,105,202, 237,218	100768	1K ohm
R24,R88,R102	100825	39K ohm
R25	100837	82K ohm
R34	100849	180K ohm
R35,R106	100783	2.7K ohm
R36,75,210,232	100831	56K ohm
R37,46,201,217,242	100780	2.2K ohm
R38	100807	12K ohm
R47,R50	100806	11K ohm

CODE	B&H P/N	DESC.
R56	100822	33K ohm
R58	100773	1.3K ohm
R59	100774	1.5K ohm
R63,R64	100795	5.6K ohm
R66,R96	100846	150K ohm
R67,R74	100738	150 ohm
R69,R73	100732	100 ohm
R70,R79	100675	1.0 ohm ½ watt ±5%
R71,72,86,28	100792	4.7K ohm
R78	713187	Resistor Metal Comp. 56 ohm 1 watt ±5%
R82	100759	560 ohm
R83,R209,R243	100762	680 ohm

CODE	B&H P/N	DESC.
R84	100819	27K ohm
R89	100809	13K ohm
R90	100864	470K ohm
R94,R203	100876	1M ohm
R99,R225,R244	100810	15K ohm
R108	100708	22 ohm
R109	712180	6.8K ohm
R110	100816	22K ohm
R111	712178	30K ohm
R208	100750	330 ohm
R211,R229	100798	6.8K ohm
R212,R228	100786	3.3K ohm
R216	100804	10K ohm
R219	100780	2.2K ohm

CODE	B&H P/N	DESC.
R220	100744	220 ohm
R221	100477	Resistor Carbon 82 ohm ½ watt ±5%
R222,R223	100719	42 ohm
R224	100819	27K ohm
R227	100861	390K ohm
R231	100789	3.9K ohm
R233	100723	56 ohm
R234	100702	15 ohm
R240	301288	Carbon Comp. 10 ohm 1 watt ±5%
R241	100756	470 ohm
R244	100810	15K ohm

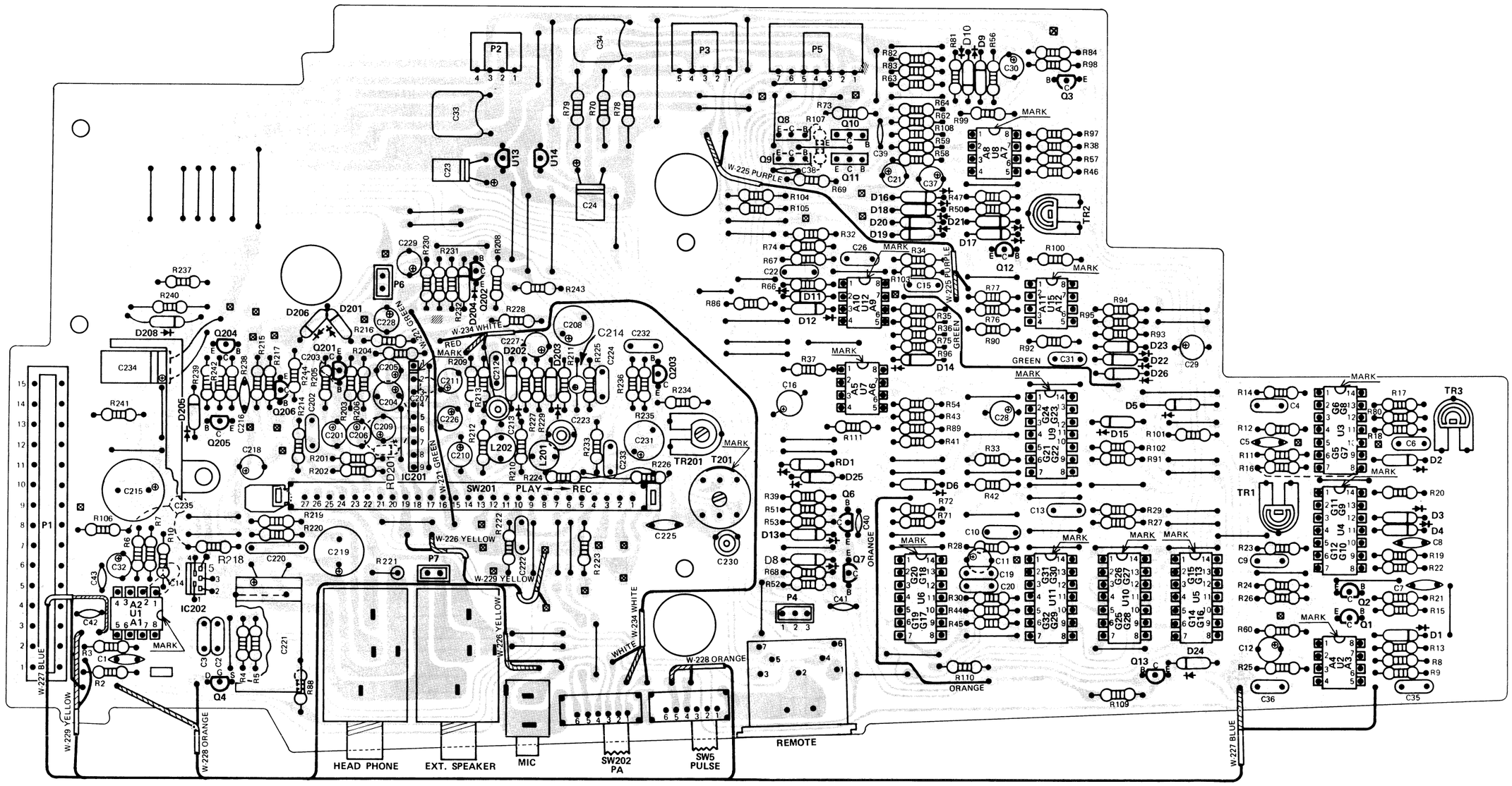
Most components are available from local sources by MFR'S part number.

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
J1	713150	Connector, 15 Pin PCB	
J2	713149	Connector, 7 Pin DIN (for remote control)	
J201	713147	Jack, Microphone	
J202	713148	Jack, Headphone	
J203	713148	Jack, Ext. speaker	
L201,202	X62762	Inductor Coil, Bias Trap, 5.6mm	
T201	713144	Coil, Bias oscillator	
IC201	713143	IC, Audio preamp	
IC202	713045	IC, Audio power amp (Ntl. LM383)	
U1	709269	IC, Dual Op–Amp	MC4558C
U2	713156	IC, Dual Op–Amp	MC14001B
U3,4,9,10	713156	IC, Quad 21 NOR	MC14001B
U5	457081	IC, Quad 21 AND	MC14081B
U6	709920	IC, Quad 21 NAND schmidt	MC14093B
TR1,3,201	713145	Resistor, Variable trim, 100K ohm ±30% linear carbon	

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
U7,8,12,15	49700	IC, Dual Op–Amp	MC1458CPI
U11	713156	IC, Quad 21 NOR	MC14001B
U13	708956	IC, Voltage regulator 12V ±5%	MC78L12AC
U14	713157	IC, Voltage regulator 12V ±5%	MC79L12AC
P2	713151	Connector, Male, 4 Pin PCB mounting	
P3	713152	Connector, Male, 5 Pin PCB mounting	
P4	713153	Connector, Male,3 Pin PCB mounting	
P5	713154	Connector, Male, 7 Pin PCB mounting	
P6,P7	713155	Connector, Male, 2 Pin	
Q1,2,3,6, 7,12,202, 205,206	713161	Transistor, NPN	A7T5172
Q4	713163	Transistor, Field Effect	2N5462
Q8,Q10	709418	Transistor, NPN	TIP41A
Q9,Q11	709419	Transistor, PNP	TIP42A
TR2	X62763	Resistor, Variable trim, 50K ohm ±30% linear carbon	

CODE	B&H P/N	DESCRIPTION	MFR'S P/N
Q13	45594	Transistor, NPN	MPS6531
Q201	713158	Transistor, NPN	2N3707
Q203	713159	Transistor, NPN	T.I.S.95
Q204	713142	Transistor	
S5	713146	Switch, DPDT, PCB mtg. burst defeat	
S201	998177	Switch, Slide (record)	
S202	713146	Switch, DPDT, PCB mtg. P/A On–Off	
S204	713136	Switch, Motor	
S205	713079	Switch, Muting	
D1–D23	41173	Signal Diode	MZ2360
D24,25,26, D202–206	41173	Signal Diode	MZ2360
D208	41174	Rectifier Diode	IN4002
RD1	671006	Zener Diode 12V	IN4738A
VR201,VR202	713037	Volume & Tone Control Assy.	

SN 2312151 and up.



BEGIN WITH S.N. 2312151

Figure 46. Tape Recorder PCB Assembly - Bottom View (*After 12-31-82)

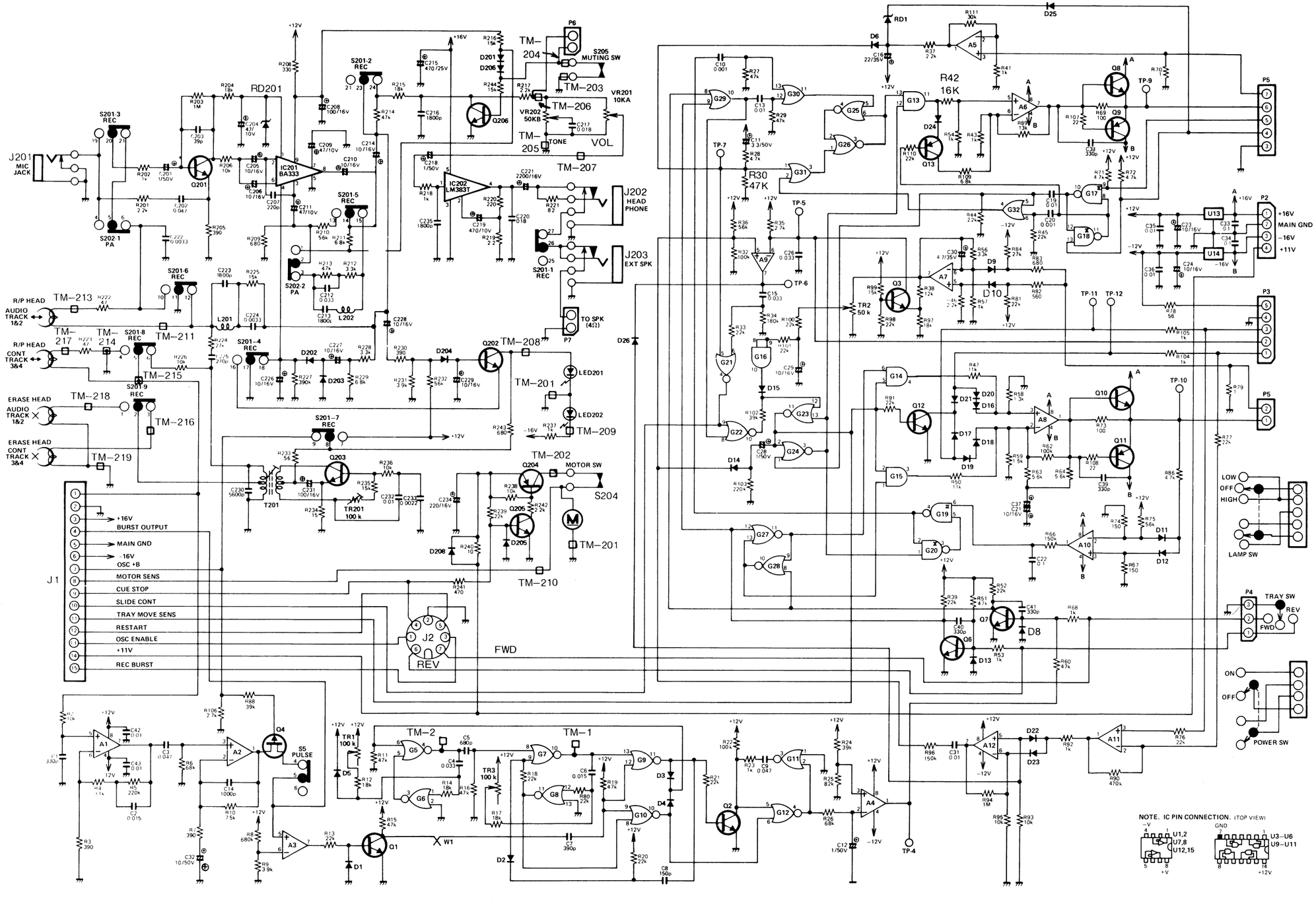


Figure 47. Tape Recorder Schematic Wiring Diagram (*After 12-31-82

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