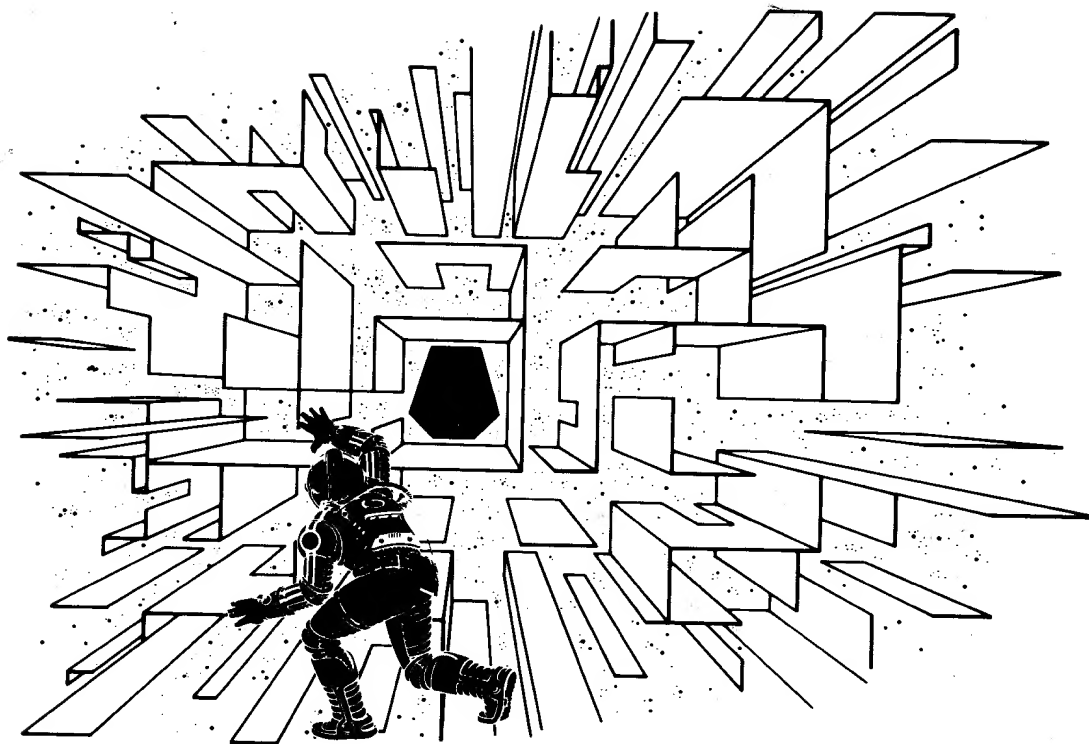


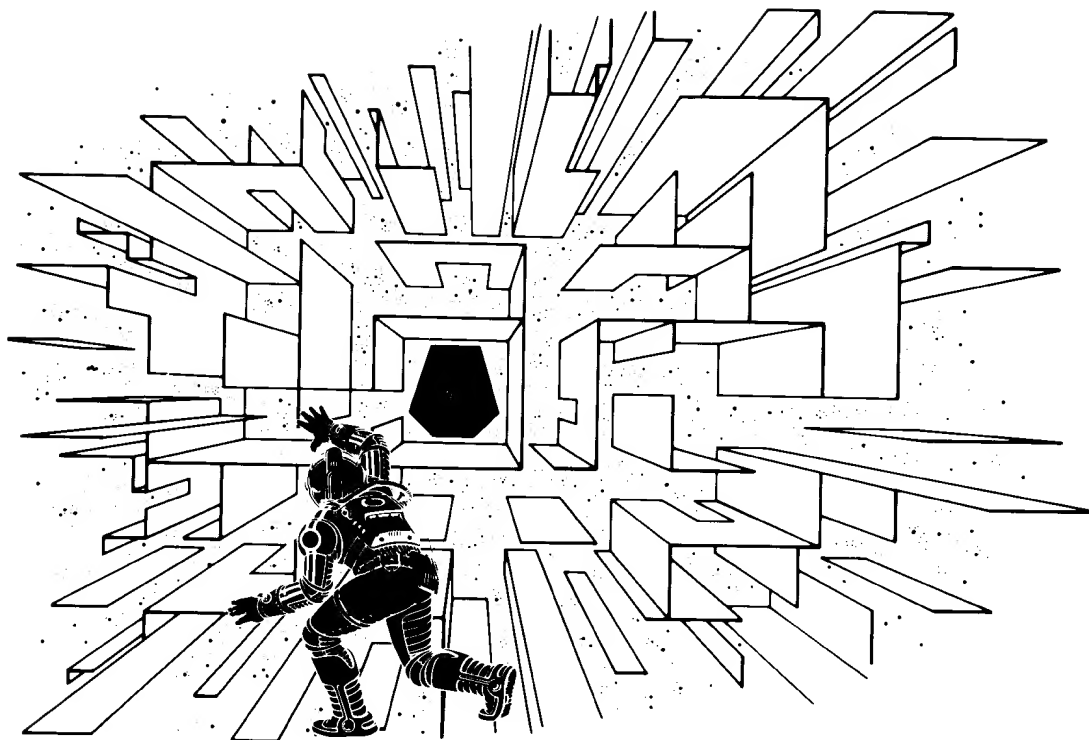


The Adventures of
MAJOR HAVOC™

**Conversion Instructions
for
Space Duel™, Black Widow™, and Gravitar™**



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MAJOR HAVOC™

Conversion Instructions for

Space Duel™, Black Widow™, and Gravitar™

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INTRODUCTION

This document includes the instructions necessary for changing your upright Space Duel, Gravitar, and Black Widow game into a Major Havoc game. The instructions include: (1) modifying the power supply, display, and rear access panel; (2) replacing the control panel and attraction panel; and (3) installing a fan, decals (optional), and Major Havoc game printed-circuit boards (PCBs). The procedures are organized to accomplish the change in the most efficient manner.

A Major Havoc instruction manual and schematic package is included with the kit. Keep your Space Duel, Gravitar, or Black Widow instruction manual and schematic package for information pertaining to those parts of the game that are not modified by this Major Havoc conversion.

NOTE

Do not discard this document after the conversion is completed. Keep this document as a supplement to the Major Havoc Operators Manual and display manual.

KIT PARTS INVENTORY

The parts listed in Table 1 are included (or are available as options) in the Major Havoc Conversion Kit.

Table 1 Kit Parts
A042425-01

Part No.	Quantity	Description
A038088-01	Optional	Input Protection Circuit PCB Assembly
A041347-21	1	Major Havoc PCB Assembly
A042427-01	1	Control Panel Assembly
A042441-01	1	Major Havoc Conversion PCB Assembly
A042445-01	1	X-Y Display Kit--includes
31-1N4002	4	Type-1N4002 Diode
32-1N756A	2	Type-1N756A, 8.2 V Zener Diode
110000-303	1	30 k Ω , $\pm 5\%$, 1/4 W, Resistor
131002-001	2	Type-1N754A, 6.8 V Zener Diode
A042448-01	1	Fan Harness Assembly
A042578-01	1	Control-Panel Harness Kit--includes
A042574-01	1	Harness Assembly
178065-100	5	Wire and Cable Tie (Miniature)
178068-002	2	Cable Tie Mount (Adhesive Back)
179002-001	4	Tap Splice Connector
A043629-01	1	AC Harness
72-HA4804S	1	#8-32 x 1/4-Inch, Cross-Recessed Pan-Head Screw
72-6636S	4	#6 x 2-1/4-Inch Cross Recessed, Self- Tapping Screw
75-99518	4	#8-32 Nut/Washer Assembly
78-24012	4	Beaded Nylon Tie
034536-02	1	1/2-Inch Foam Pad
034536-03	1	1-1/8-Inch Foam Pad
037410-01	1	Attraction-Panel Glass
042414-01	1	Label Kit--includes
038158-01	1	Conversion Kit Label (Non-UL)
039450-01	1	FCC Compliance Label
042421-01	Optional	Left Side-Panel Decal
042421-02	Optional	Right Side-Panel Decal
042424-01	1	Attraction-Panel Film
042450-01	1	PCB Mounting Bracket

** continued on next page **

Table 1 Kit Parts, continued
A042425-01

Part No.	Quantity	Description
042579-01	1	Control-Panel Wiring Diagram
171002-001	1	Exhaust Fan
176015-110	1	#10 x 5/8-Inch Cross-Recessed Deep-Thread Pan-Head Screw
178065-100	2	Tie Wrap
178093-001	1	Fan-Blade Guard
CO-252-03	1	Major Havoc Conversion PCB Supplement
CO-252-05	1	Major Havoc Encoder Wheel Supplement
SP-252	1	Major Havoc Schematic Package
ST-252-01	1	Major Havoc Label with Self-Test Procedure and Option Switch Settings
TM-252	1	Major Havoc Operators Manual
TM-268	1	Major Havoc Conversion Instructions for Space Duel, Gravitar, and Black Widow

TOOLS REQUIRED

The tools listed in Table 2 are required to perform a complete conversion.

Table 2 Tools Required

Description	Purpose
#2 Phillips Screwdriver	Removing the game PCB, power supply, and Amplifone Deflection PCB. Modifying the power supply. Installing the power supply and fan
1/8-Inch Allen Wrench	Removing the attraction panel
1/4-Inch Hex Driver	Removing the Wells-Gardner Deflection PCB
11/32-Inch Hex Driver	Removing the power supply. Modifying the power supply
7/16-Inch Hex Driver	Removing the control panel. Installing the control panel
15-27 W Soldering Iron	Modifying the Deflection PCB
1/4-Inch Drill Bit	Modifying the rear access panel
Pliers	Modifying the control-panel harness
#11 X-ACTO Knife (optional)	Installing the side panel decals

ASSEMBLY REMOVAL INSTRUCTIONS WARNING

To avoid electrical shock, unplug the game before performing the conversion procedures.

NOTE

These procedures must be performed by qualified service personnel. All interior and exterior surfaces of the cabinet and the working area should be clean and free of foreign material before starting the procedures.

The following procedures are arranged in the sequence recommended for performing the game conversion. The parts of your game that are affected by the conversion are removed, modified, and the new Major Havoc parts are installed.

A. REMOVE THE ATTRACTION PANEL

Perform the following procedure to remove the attraction panel from the game cabinet (see Figure 1).

1. Use a 1/8-inch Allen wrench to loosen the three screws securing the bottom retainer to the cabinet and to the bottom of the attraction-panel glass.
2. Use a 1/8-inch Allen wrench to remove the three screws securing the top retainer to the cabinet and to the top of the attraction-panel glass.
3. Remove the top retainer.
4. Remove the attraction-panel glass and film.

B. REMOVE THE CONTROL PANEL

Perform the following procedure to remove the control panel from the game cabinet (see Figure 2).

1. Unlock and remove the rear access panel.

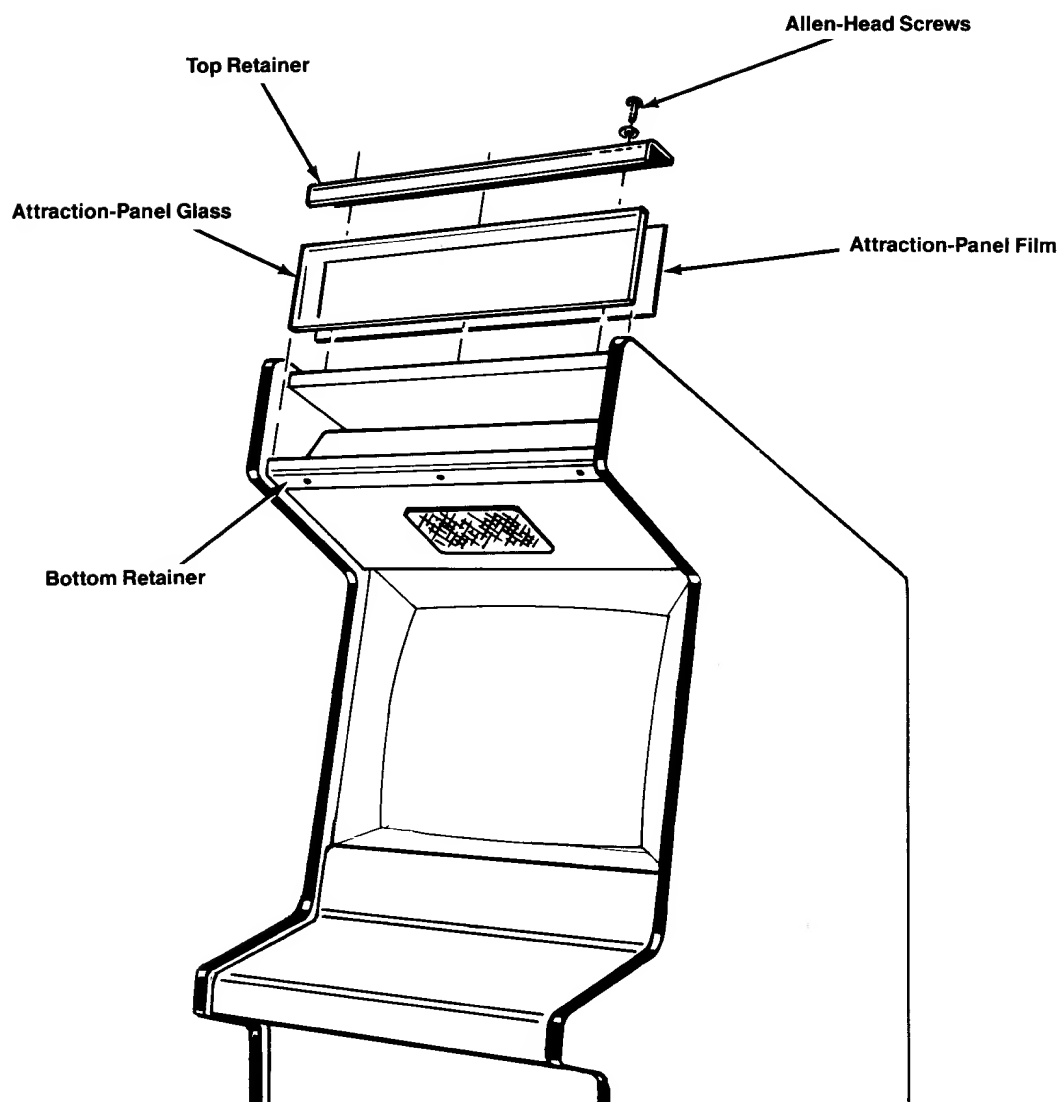


Figure 1 Removing and Installing the Attraction Panel

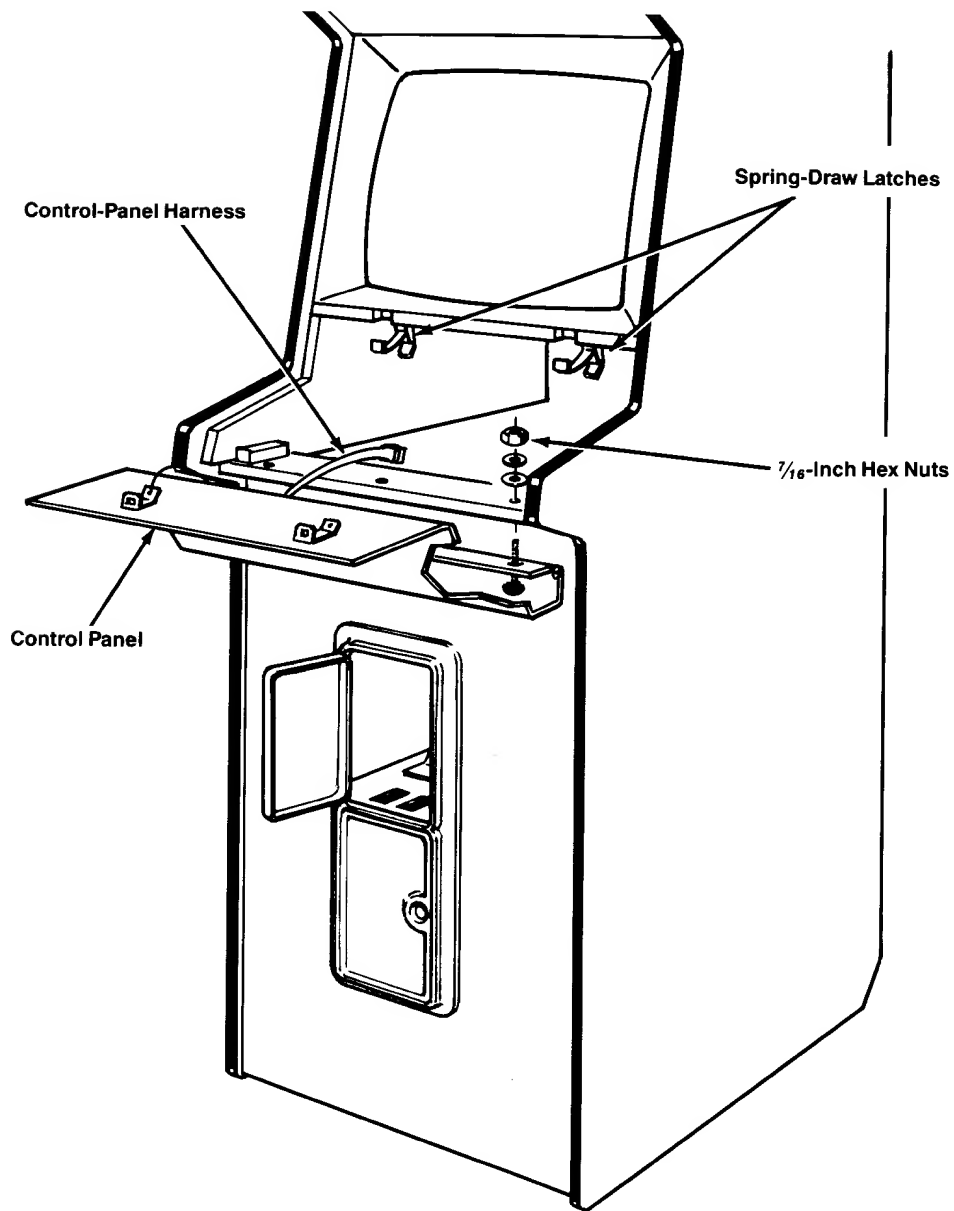


Figure 2 Removing and Installing the Control Panel

2. Reach through the rear of the cabinet and release the spring-draw latches on each end of the control panel.
3. Open the control panel and disconnect the control-panel harness connector from the game harness.
4. Use a 7/16-inch hex wrench to remove the three nuts and washers securing the control panel to the cabinet (save the mounting hardware for reassembly).
5. Disconnect and remove the control-panel harness from the control panel. Save the Space Duel, Gravitar, or Black Widow control-panel harness and green ground-wire securing hardware for reassembly.

C. REMOVE THE WELLS-GARDNER DEFLECTION PCB

NOTE

The following procedure applies to those Space Duel, Gravitar, and Black Widow games that use a Wells-Gardner display. If your game has an Amplifone display, proceed to procedure D. Remove the Amplifone Deflection PCB.

Perform the following procedure to remove the Wells-Gardner Deflection PCB from the display (see Figure 3).

WARNING

High voltages may exist in the display circuitry, even with power disconnected. Use extreme caution. Do not touch the display circuitry with your hands or with metal tools.

1. Discharge the high voltage from the cathode-ray tube (CRT) before proceeding:
 - a. Attach one end of a large, well-insulated, 18-gauge jumper wire to ground.

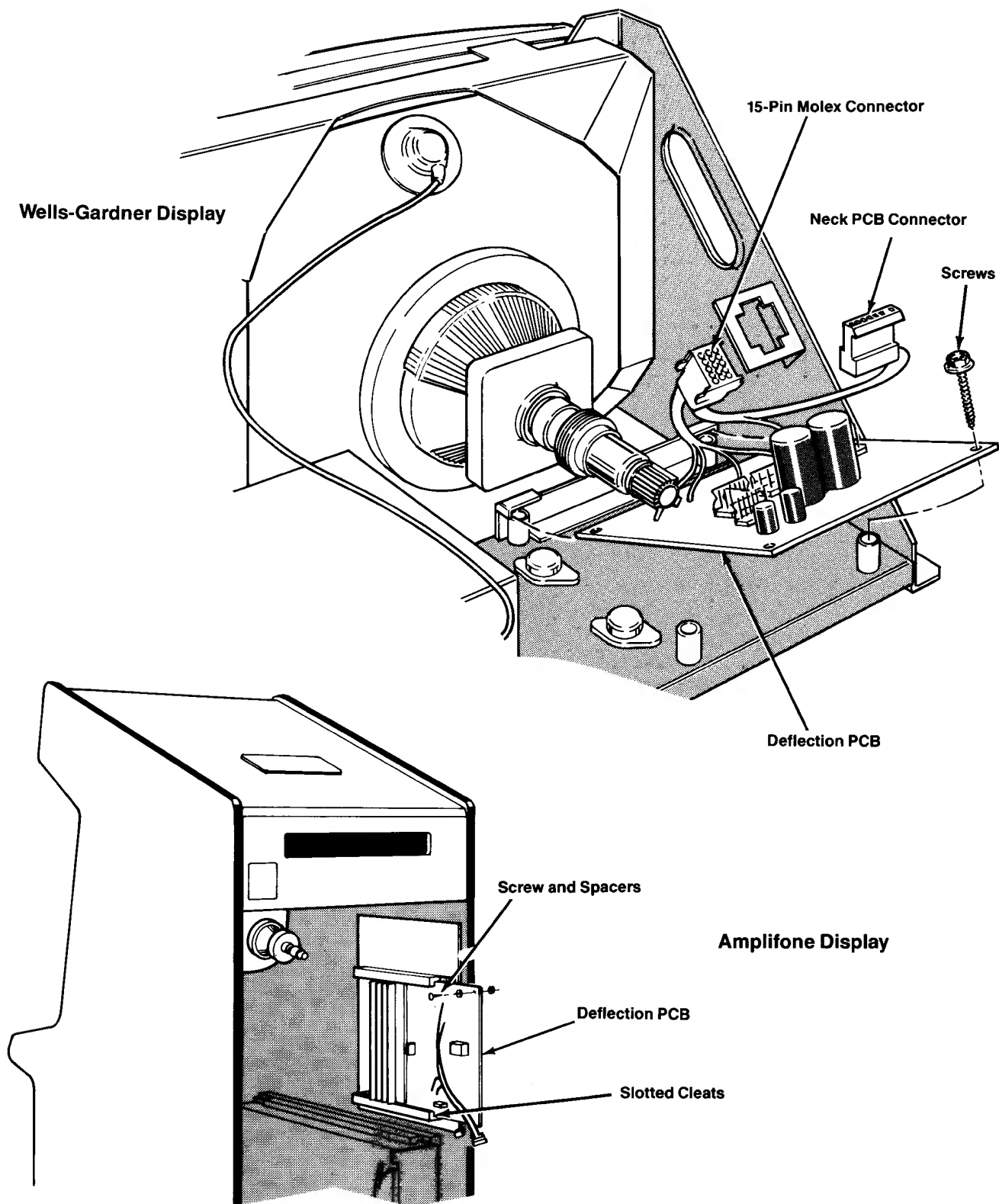


Figure 3 Removing and Installing the Display Deflection PCB

- b. Momentarily touch the free end of the grounded jumper to the CRT anode by carefully sliding the jumper under the anode cap.
 - c. Wait two minutes and repeat step 1b.
2. Disconnect the 15-pin Molex connector from the mounting bracket on the display chassis and the harness connectors from the Deflection PCB and the Neck PCB.
3. Use a 1/4-inch hex driver to remove the two screws securing the Deflection PCB to the display chassis.
4. Remove the Deflection PCB from the display.

D. REMOVE THE AMPLIFONE DEFLECTION PCB

NOTE

The following procedure applies to those Space Duel, Gravitar, and Black Widow games that use an Amplifone display. If your game has a Wells-Gardner display, perform procedure C. Remove the Wells-Gardner Deflection PCB.

Perform the following procedure to remove the Amplifone Deflection PCB from the game cabinet (see Figure 3).

1. Disconnect the harness connectors from the Deflection PCB.
2. Use a Phillips screwdriver to remove the screw and spacers securing the top right corner of the Deflection PCB to the cabinet.
3. Carefully slide the PCB straight out of the slotted cleats.

E. REMOVE THE GAME PCB

Perform the following procedure to remove the Space Duel, Gravitar, or Black Widow game PCB from the game cabinet (see Figure 4).

1. Disconnect the game harness edge connectors from the game PCB. If the edge connectors are secured with screws or tie wraps, remove the screws or tie wraps before disconnecting the edge connectors from the PCB.

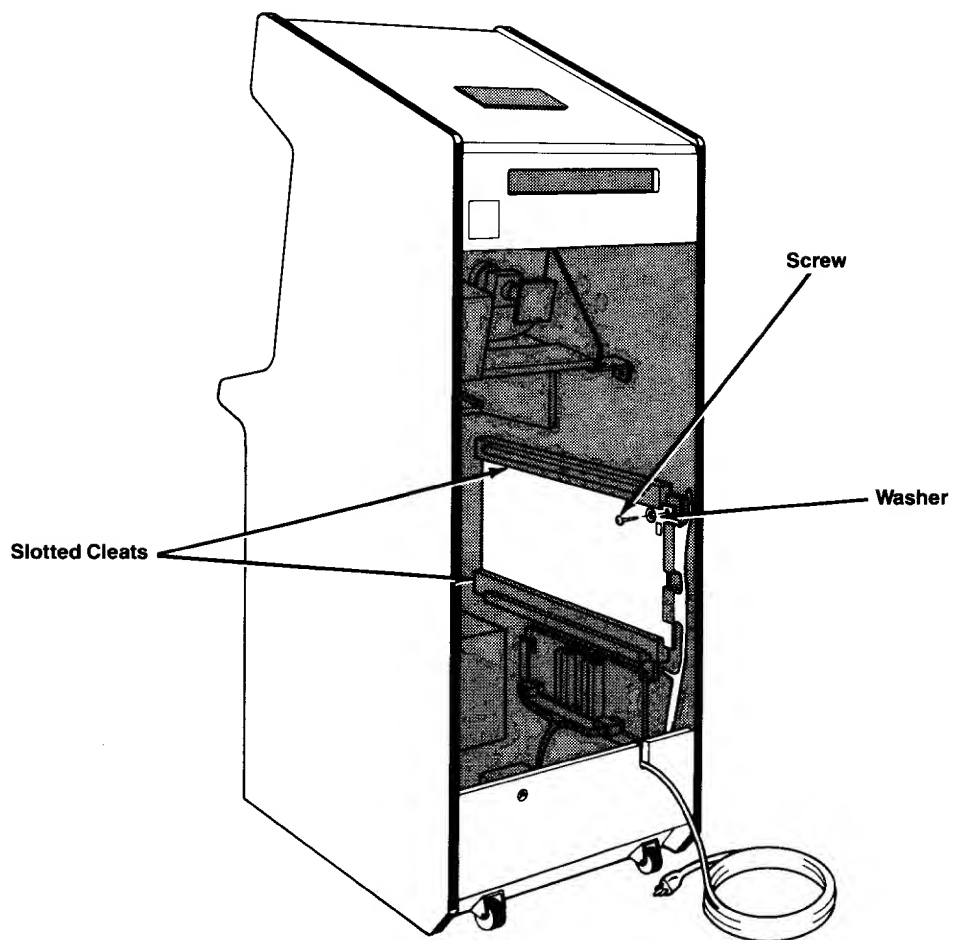


Figure 4 Removing the Game Printed-Circuit Board

2. Use a Phillips screwdriver to remove the screw, washer, and two spacers securing the top right corner of the PCB to the cabinet wall.
3. Carefully slide the PCB straight out of the slotted cleats.

F. REMOVE THE POWER SUPPLY

Perform the following procedure to remove the power supply from the game cabinet.

1. Disconnect the four harness connectors (J1, J2, J4A, and J5).
2. Disconnect the power cord from the power supply.
3. Use a 11/32-inch hex driver to remove the nut and star washer from the ground screw attaching the green grounding wires to the power supply.
4. If applicable, cut the cable tie located on the rear right corner of the power supply chassis.
5. Use a Phillips screwdriver to remove the four screws securing the power supply to the cabinet.
6. Remove the power supply from the cabinet.

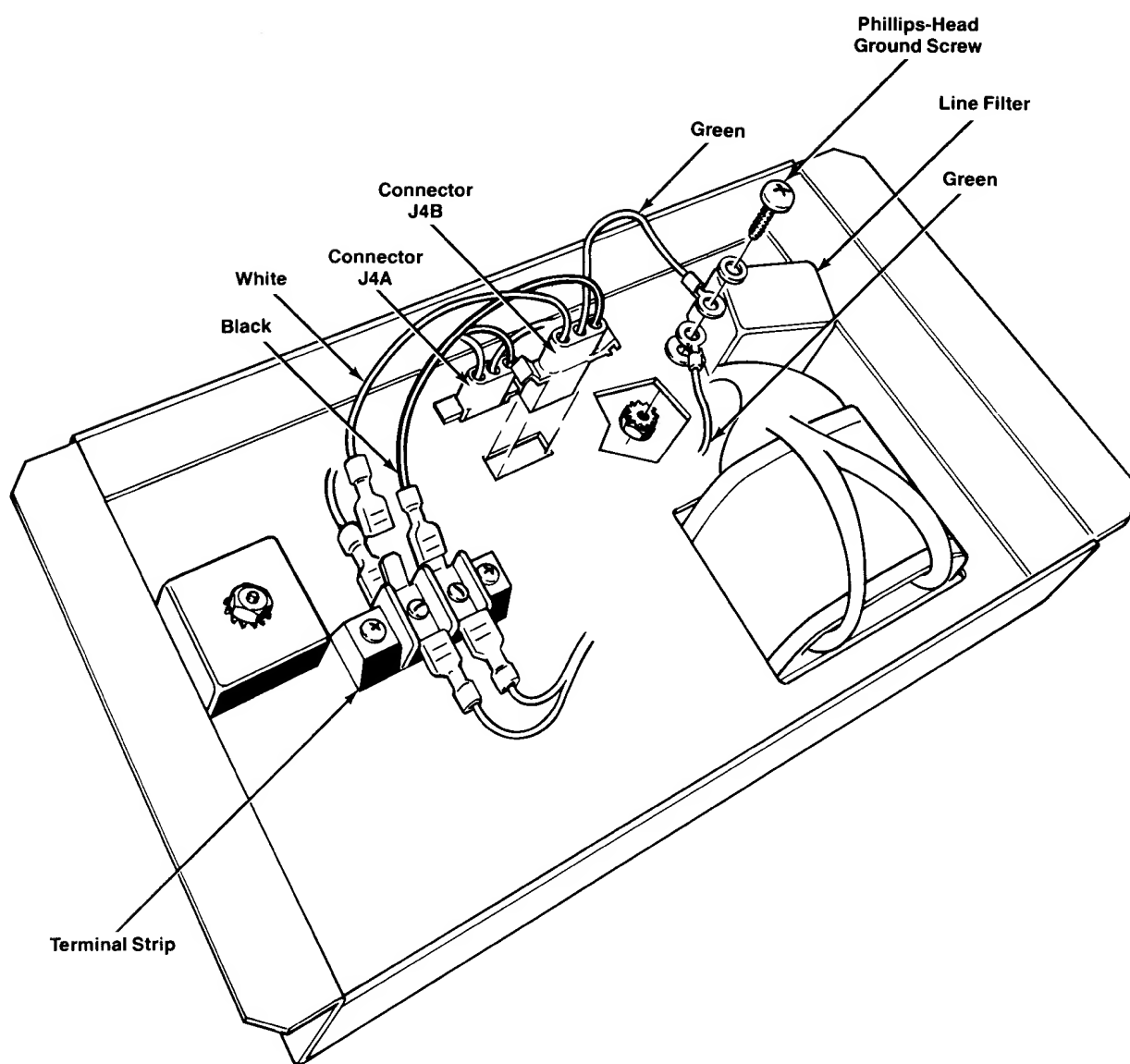
ASSEMBLY MODIFICATION INSTRUCTIONS

The following procedures describe the modifications required for this conversion. Provide a clean work surface on which to perform the modifications to the assemblies removed from the game cabinet.

G. MODIFY THE POWER SUPPLY

Perform the following procedure to modify the power supply (see Figure 5).

1. Set the power supply upside down on a clean work surface.
2. Install the three-pin AC harness connector with the white wire on the left end of the connector.
3. Connect the white wire from AC harness connector J4B to the terminal lug adjacent to the white wire from connector J4A.
4. Connect the black wire from AC harness connector J4B to the terminal lug adjacent to the black wire from connector J4A.
5. Use a 11/32-inch hex driver to remove the nut and star washer from the ground screw securing the green wires and the line filter to the power supply. Remove the ground screw.
6. Attach the green wire from connectors J4A and J4B, and the green wire from connector J2, to the ground screw.
7. Insert the ground screw, with the green wires attached, through the line filter bracket and power-supply chassis.
8. Use a 11/32-inch hex driver and a Phillips screwdriver to secure the nut and star washer (removed in step 5) to the power supply.
9. Check that the power supply fuses match the ratings given on the labels located near the fuse block and the cartridge fuse holder.

**Figure 5 Modifying the Power Supply**

H. MODIFY THE WELLS-GARDNER DEFLECTION PCB

NOTE

The following procedure applies to those Space Duel, Gravitar, and Black Widow games that use a Wells-Gardner display. If your game has an Amplifone display, proceed to I. Modify the Amplifone Deflection PCB.

Four versions of the Wells-Gardner display were used in the Space Duel, Gravitar, and Black Widow games. Perform the preliminary procedure for all versions of the Wells-Gardner display, then refer to Table 3 to determine which version of the four displays was installed in your game. Perform the additional procedure for that version.

CAUTION

When soldering components to the display circuitry, apply just enough heat to provide a proper electrical connection. Excessive heat can damage the semiconductor material.

Preliminary Procedure

Perform the following procedure to modify the Wells-Gardner Deflection PCB (see Figures 6 and 7).

1. Set the Deflection PCB on a clean work surface.
2. Connect two type-1N754A Zener diodes together, anode to anode, as shown in Figure 6. Use a soldering iron to solder the two anode leads together.

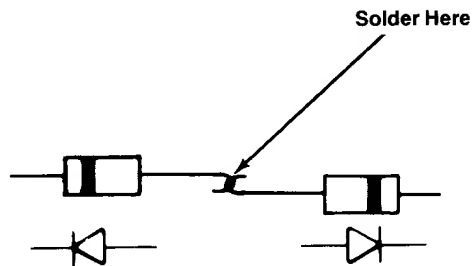


Figure 6 Type-1N754A and 1N756A Zener-Diode Connections

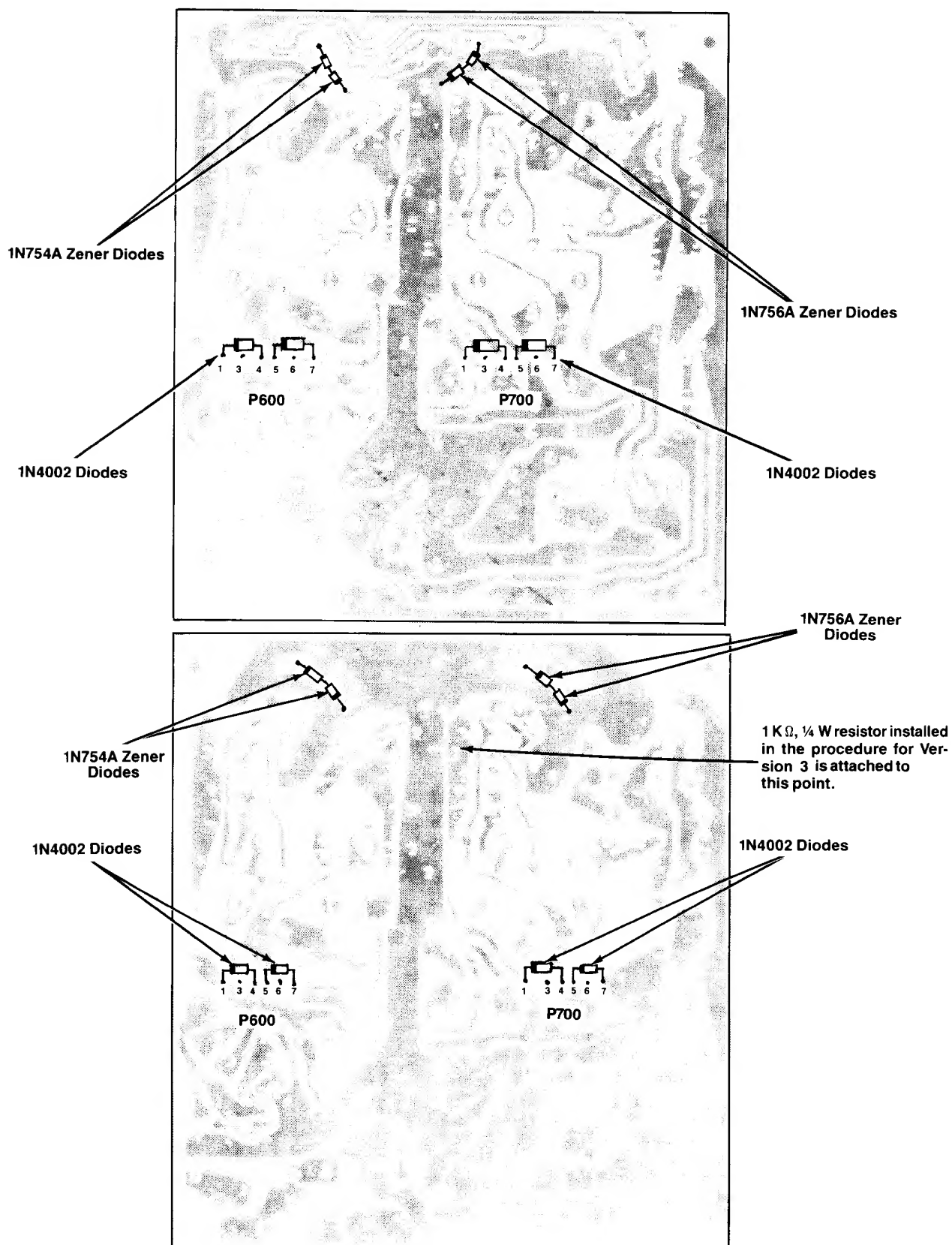


Figure 7 Modifying the Wells-Gardner Deflection PCB

3. Connect two type-1N756A Zener diodes together and solder as described in step 2.
4. Examine the soldered side of the Deflection PCB removed from the display and determine which of the two PCBs shown in Figure 7 matches your PCB.
5. On the component side of the Deflection PCB, locate the yellow wire (top right side of the PCB).
6. Solder one cathode lead of the two type-1N754A Zener diodes (soldered together in step 2) to the yellow lead on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.
7. Solder the other cathode lead of the two type-1N754A Zener diodes to ground as shown on the appropriate illustration in Figure 7.
8. On the component side of the Deflection PCB, locate the orange wire (near top center of the PCB).
9. Solder one cathode lead of the two type-1N756A Zener diodes (soldered together in step 3) to the orange lead on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.
10. Solder the other cathode lead of the two type-1N756A Zener diodes to ground as shown on the appropriate illustration in Figure 7.
11. On the component side of the Deflection PCB, locate connector P600 (right center of the PCB).
12. Solder the cathode lead of a type-1N4002 diode to pin 1 and the anode lead to pin 4 of connector P600 on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.
13. Solder the cathode lead of a type-1N4002 diode to pin 5 and the anode lead to pin 7 of connector P600 on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.
14. On the component side of the Deflection PCB, locate connector P700 on the soldered side of the PCB (left center of the PCB).
15. Solder the cathode lead of a type-1N4002 diode to pin 1 and the anode lead to pin 4 of connector P700 on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.

16. Solder the cathode lead of a type-1N4002 diode to pin 5 and the anode lead to pin 7 of connector P700 on the soldered side of the PCB as shown on the appropriate illustration in Figure 7.
17. Refer to Table 3 to determine which of the four versions of the Wells-Gardner display has been installed in your game.

Table 3 Display Versions

Determine	Procedure
Deflection PCB has two large, black, tubular capacitors, C804 and C805, installed below top center of PCB.	Version 1
Input Protection Circuit PCB is installed (piggyback) <u>with a 1 kΩ, $\pm$5%, 1/4 W resistor connected between the Input Protection Circuit PCB and the Deflection PCB.</u>	Version 2
Input Protection Circuit PCB is installed (piggyback) <u>but does not have a resistor between the Input Protection Circuit PCB and the Deflection PCB.</u>	Version 3
Deflection PCB <u>does not have capacitors C804 and C805 (below top center of PCB) or an Input Protection Circuit PCB installed.</u>	Version 4

18. Perform the appropriate procedure for the version of Wells-Gardner display determined from Table 3. (Refer to the Wells-Gardner display manual, TM-183, for component and connector locations.)

NOTE

The 30 k Ω , 1/4 W resistor supplied in the kit is used only for Version 1 of the Wells-Gardner display.

Version 1

Perform the following procedure for Version 1 of the Wells-Gardner display.

1. Verify that the Preliminary Procedure has been performed.
2. Use a soldering iron to remove resistor R811 and replace it with the 30 k Ω , 1/4 W resistor supplied in the kit.

Version 2

Perform only the Preliminary Procedure for Version 2 of the Wells-Gardner display.

Version 3

Perform the following procedure for Version 3 of the Wells-Gardner display.

1. Verify that the Preliminary Procedure has been performed.
2. Locate the wire connected to resistor R1 (22 k Ω) and the collectors of transistors Q1 and Q3 (type 2N3904) on the Input Protection Circuit PCB and the point shown in Figure 7 on the Deflection PCB.
3. Use a wire cutter to cut the wire, located in step 2, midway between the two PCBs.
4. Use a soldering iron to solder a 1 k Ω , $\pm 5\%$, 1/4 W resistor (not included in the kit) between the two ends of the wire cut in step 3.

Version 4

Perform the following procedure for Version 4 of the Wells-Gardner display.

NOTE

This version of the display requires that an Input Protection Circuit PCB assembly be installed on the Deflection PCB as part of the display modification procedure. This PCB assembly is not included in the kit. However, to obtain the Input Protection Circuit PCB assembly, use the order form at the back of this document.

1. Verify that the Preliminary Procedure has been performed.
2. Install the Input Protection Circuit PCB to the Deflection PCB as described in the instructions supplied with the Input Protection Circuit PCB assembly.

I. MODIFY THE AMPLIFONE DEFLECTION PCB

NOTE

The following procedure applies to those Space Duel, Gravitar, and Black Widow games that use an Amplifone display. If your game has a Wells-Gardner display, perform "H. Modify the Wells-Gardner Deflection PCB".

Perform the following procedure to modify the Amplifone Deflection PCB (see Figure 8).

1. Set the Deflection PCB on a clean work surface.
2. Connect two type-1N754A Zener diodes together, anode to anode, as shown in Figure 6. Use a soldering iron to solder the two anode leads together.
3. Connect two type-1N756A Zener diodes together and solder as described in step 2.
4. On the component side of the Deflection PCB, locate the yellow wire connected to resistor R1 (left center of the PCB).
5. Solder one cathode lead of the two type-1N754A Zener diodes (soldered together in step 2) to the yellow wire on the soldered side of the Deflection PCB as shown in Figure 8.
6. Solder the other cathode lead of the two type-1N754A Zener diodes to the nearest ground on the PCB as shown in Figure 8.
7. On the component side of the Deflection PCB, locate the orange wire connected to resistor R24 (right center of the PCB).

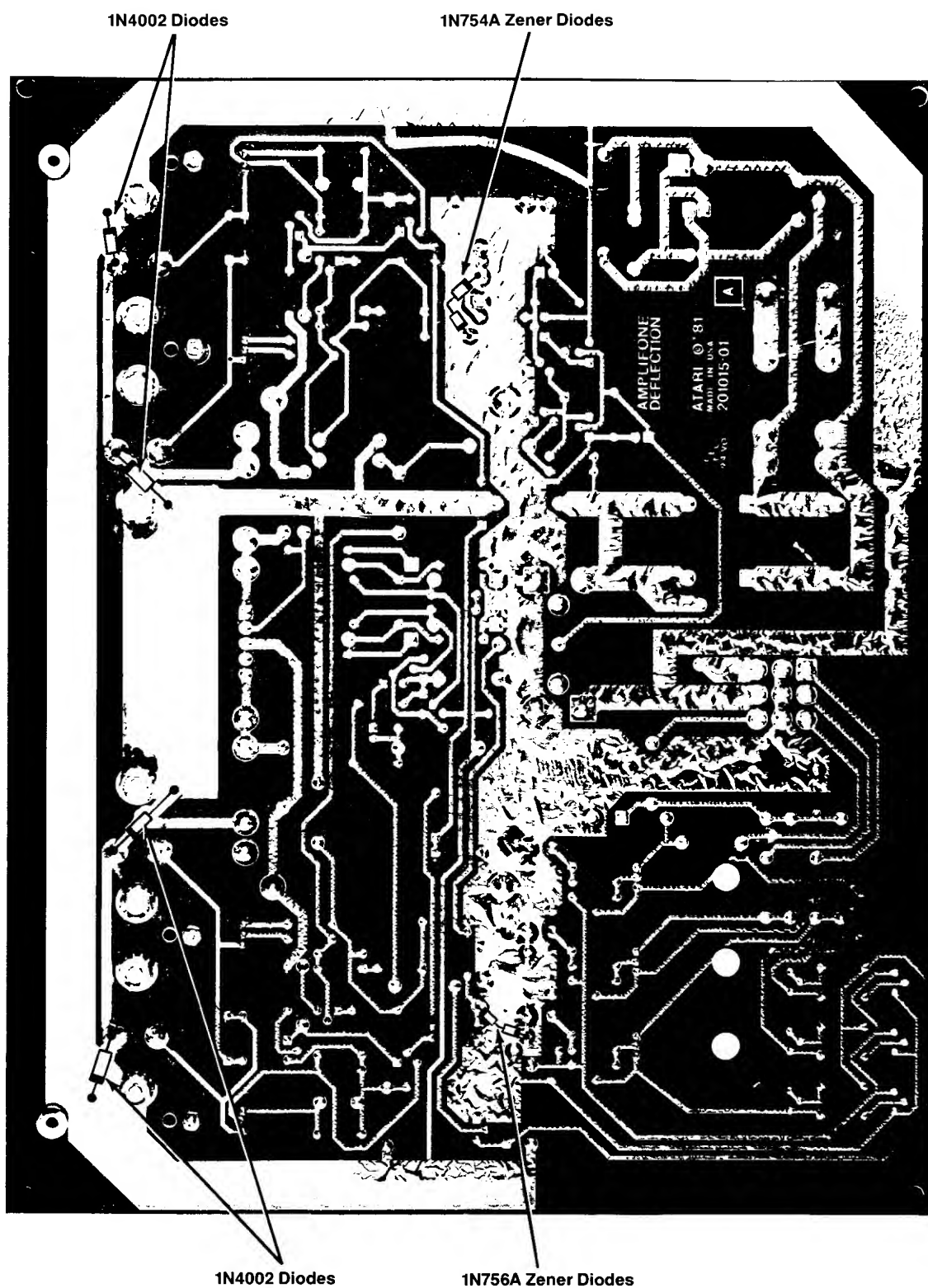
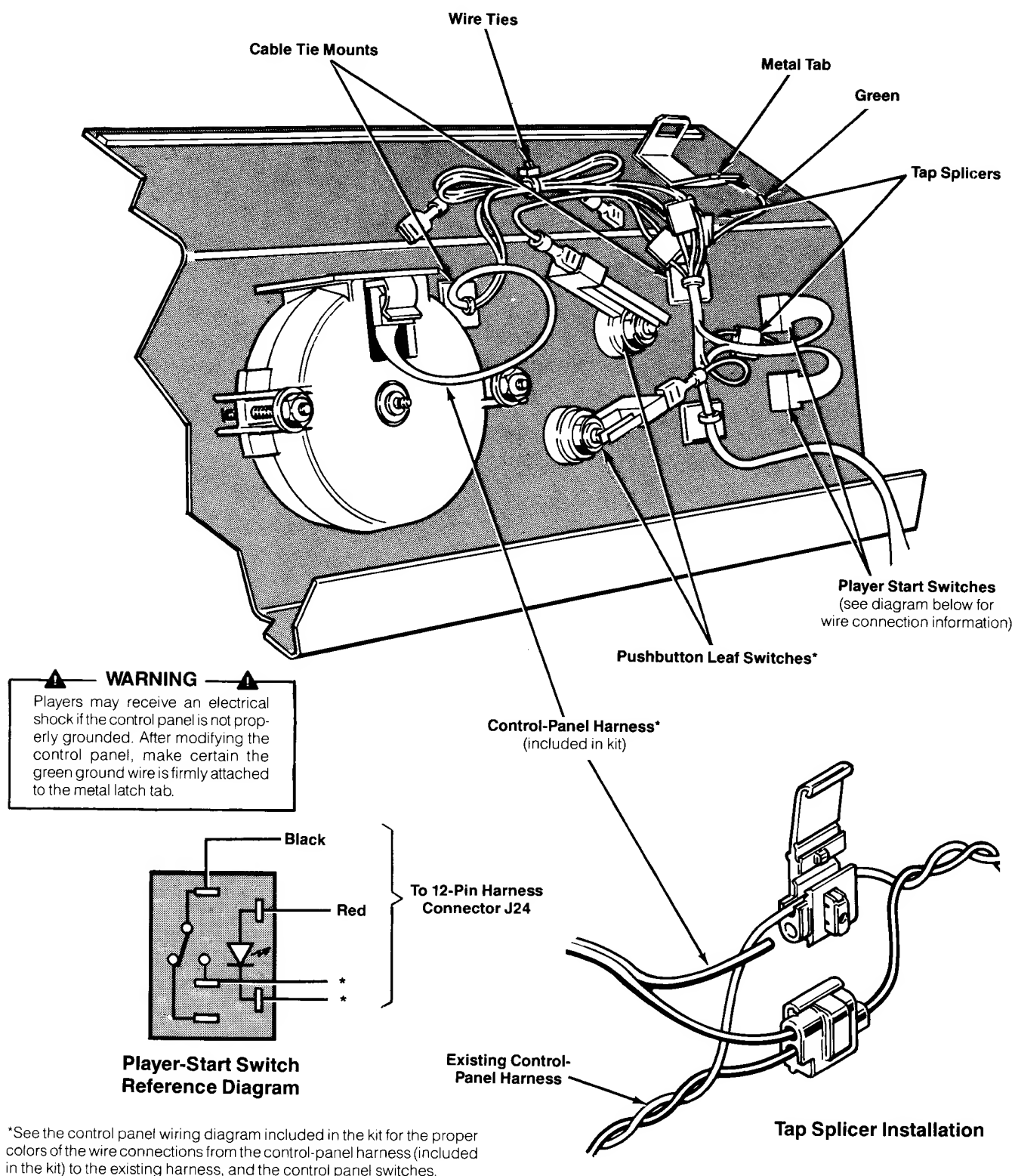


Figure 8 Modifying the Amplifone Deflection PCB

8. Solder one cathode lead of the two type-1N756A Zener diodes (soldered together in step 3) to the orange wire on the soldered side of the Deflection PCB as shown in Figure 8.
9. Solder the other cathode lead of the two type-1N756A Zener diodes to the nearest ground on the PCB as shown in Figure 8.
10. On the soldered side of the Deflection PCB, solder the cathode lead of a type-1N4002 diode to the emitter of transistor Q17 as shown in Figure 8.
11. Scrape away the green protective coating at a convenient point on the PCB, and solder the anode lead of the type-1N4002 diode to the collector of transistor Q17 as shown in Figure 8.
12. On the soldered side of the Deflection PCB, solder the anode lead of a type-1N4002 diode to the emitter of transistor Q16 as shown in Figure 8.
13. Scrape away the green protective coating at a convenient point on the PCB and solder the cathode lead of the type-1N4002 diode to the collector of transistor Q16 as shown in Figure 8.
14. On the soldered side of the Deflection PCB, solder the cathode lead of a type-1N4002 diode to the emitter of transistor Q7 as shown in Figure 8.
15. Scrape away the green protective coating at a convenient point on the PCB and solder the anode lead of the type-1N4002 diode to the collector of transistor Q7 as shown in Figure 8.
16. On the soldered side of the Deflection PCB, solder the anode lead of a type-1N4002 diode to the emitter of transistor Q6 as shown in Figure 8.
17. Scrape away the green protective coating at a convenient point on the PCB and solder the cathode lead of the type-1N4002 diode to the collector of transistor Q6 as shown in Figure 8.



*See the control panel wiring diagram included in the kit for the proper colors of the wire connections from the control-panel harness (included in the kit) to the existing harness, and the control panel switches.

Figure 9 Modifying and Installing the Control-Panel Harness

J. MODIFY THE CONTROL-PANEL HARNESS

Perform the following procedure to modify and install the Space Duel, Gravitar, or Black Widow control-panel harness (see Figure 9).

1. Use pliers to attach the tap splicers and connect the violet, black, red, and blue wires from connector P52 (included in the kit) to the appropriate wires of the existing control-panel harness. Refer to the control-panel wiring diagram (included in the kit) and Figure 9 for the proper harness-wire connections to connector P52 and to the control-panel switches.
2. Black Widow Only. Remove the white/gray wire from pin 9 of connector J24A and reconnect it to pin 5 of the 12-pin connector J24A. (If available, use an extraction tool, AMP part no. 458994-1).
3. Connect the modified control-panel harness to the Major Havoc control panel as shown in Figure 9. Make certain that: (1) the green ground wire is securely attached to the metal tab on the control panel; (2) the wire ties and cable tie mounts (included in the kit) are installed; and (3) the excess wire is securely and neatly tied to prevent the excess and unused wires from contact with the control-panel switches when the control panel is closed.

K. MODIFY THE REAR ACCESS PANEL

Perform the following procedure to modify the rear access panel to provide a fan intake opening (see Figure 10).

1. Measure and mark the rear access panel for locating the fan intake opening as shown in Figure 10.
2. Use an electric hand drill with a 1/4-inch bit to drill holes in the rear access panel at each corner of the marked fan intake opening.
3. Use a sabre saw to cut the wood from the fan intake opening.

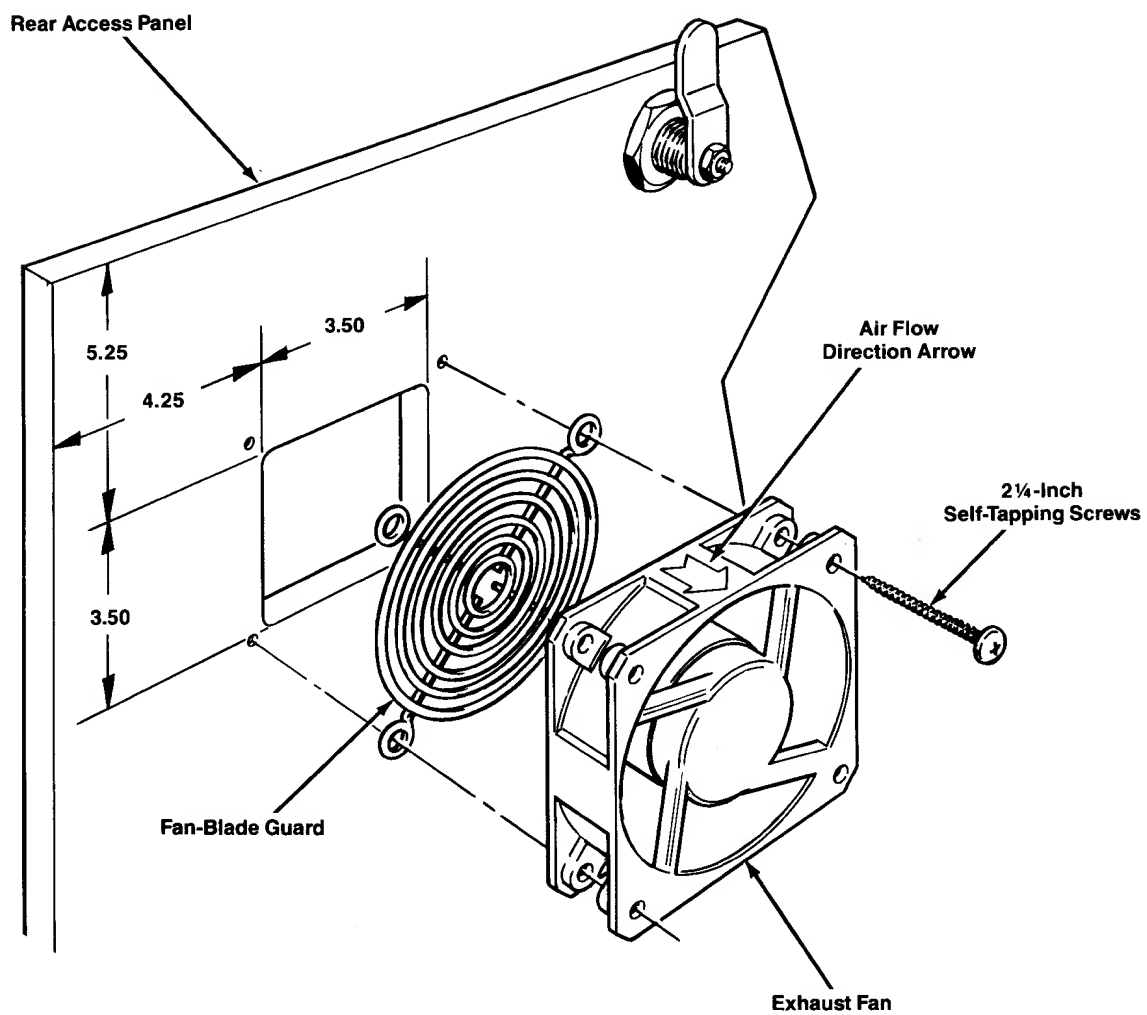


Figure 10 Modifying the Rear Access Panel and Installing the Fan

ASSEMBLY INSTALLATION INSTRUCTIONS

The following procedures describe the installation of the Major Havoc assemblies.

L. INSTALL THE SIDE-PANEL DECALS (OPTIONAL)

NOTE

The Major Havoc side-panel decals are not included in the kit. However, if you wish to purchase these decals, use the order form provided at the back of this document.

Perform the following procedure to install the Major Havoc side-panel decals on the game cabinet (see Figure 11).

1. Mix a normal solution of any liquid dishwashing detergent and approximately three quarts of water in a bucket.
2. Clean all oil, film and dust from the sides of the cabinet. Fill any dents or gouges with a filler material.

NOTE

We recommend that the following procedure be performed by two persons. One person may have difficulty handling the cabinet and the large decals.

3. Tip the game cabinet and gently lay one side on a blanket.
4. Use a sponge to liberally apply the water and detergent solution over the entire side of the cabinet.
5. Grasp the top edge of the appropriate decal for the side of the cabinet. Hold the decal up and off of the floor and peel away the protective backing.

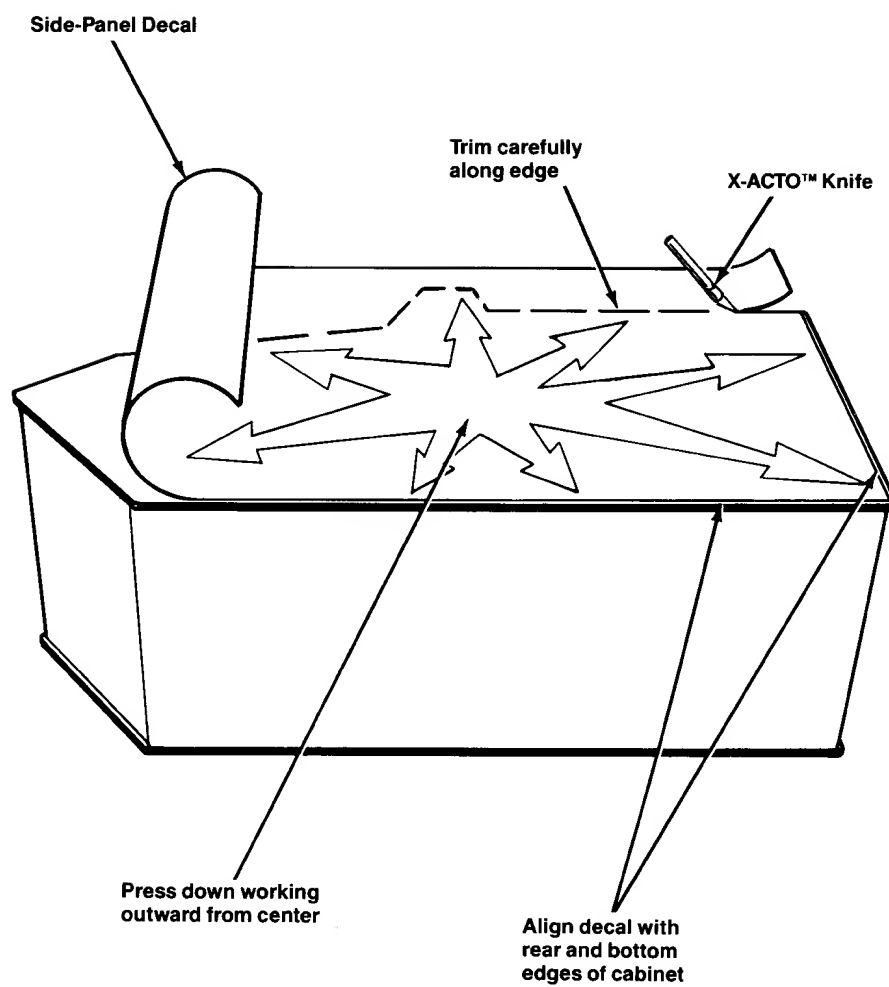


Figure 11 Installing the Side-Panel Decals

6. Align the decal with the rear and bottom edges of the cabinet as shown in Figure 11.
7. After the decal is in position, use the squeegee to remove all the excess water and detergent from beneath the decal by quickly working from the center to the outside edges. HINT: If any air bubbles form, puncture them with a pin or the tip of an X-ACTO™ blade. Rub gently with a soft cloth to disperse the trapped air.
8. Carefully insert a #11 X-ACTO™ blade (or suitable substitute) between the T-molding and cabinet wall and, following the contour of the cabinet, cut off the excess decal. Rub the cut edges with a cloth to smooth down any rough edges.
9. When the wrinkles are removed and the decal is free of all excess water and detergent, gently turn the game cabinet over to the opposite side. Be careful to avoid damaging the freshly applied decal.
10. Repeat steps 2 through 8 for the remaining decal.
11. Carefully raise the cabinet to the upright position.
12. Use a lint-free cloth to wipe off any excess water and detergent from inside and outside of the cabinet. Allow time to dry before proceeding.

M. INSTALL THE ATTRACTION PANEL

Perform the following procedure to install the Major Havoc attraction panel in the game cabinet (see Figure 1).

1. From the front of the cabinet, install the Major Havoc attraction-panel film and glass into the bottom retainer.
2. Use a 1/8-inch Allen wrench to secure the top retainer to the game cabinet.
3. Press the bottom retainer tight against the attraction-panel glass.
4. Use a 1/8-inch Allen wrench to tighten the three screws securing the bottom retainer to the game cabinet.

N. INSTALL THE WELLS-GARDNER DEFLECTION PCB

Perform the following procedure to install the modified Wells-Gardner Deflection PCB on the display chassis (see Figure 3).

1. From the rear of the game cabinet, slide the Deflection PCB into the front retaining bracket on the chassis.
2. Use a 1/4-inch hex driver to install the two screws and washers securing the modified Deflection PCB to the display chassis.

CAUTION

Make certain that the harness from Q705 and Q706 is connected to P700 and NOT to P100.

3. Attach the 15-pin Molex connector to the chassis bracket and connect the 15-pin mating connector.
4. Connect the Neck PCB connector to the Neck PCB (P500).
5. Connect the remaining nine connectors to the appropriate plugs on the Deflection PCB. The single wire connectors have the wire color labeled beside the mating pin on the PCB.

O. INSTALL THE AMPLIFONE DEFLECTION PCB

Perform the following procedure to install the Amplifone Deflection PCB in the game cabinet (see Figure 3).

1. From the rear of the cabinet gently slide the modified Deflection PCB into the slotted cleats. Make certain that the components soldered to the back of the board clear the cabinet wall.
2. Use a Phillips screwdriver to secure the PCB to the cabinet with the screw and spacers removed previously.
3. Connect the four harness connectors to the Deflection PCB.

P. INSTALL THE CONTROL PANEL

Perform the following procedure to install the Major Havoc control panel in the game cabinet (see Figure 2).

1. Use a 7/16-inch hex driver to secure the control panel to the cabinet with the three bolts, washers, and nuts removed previously.
2. Connect the control-panel harness connector to the game harness. Do not close the control panel.

Q. INSTALL THE MAJOR HAVOC PCBs

Perform the following procedure to install the Major Havoc PCBs in the game cabinet (see Figure 12).

1. Peel the protective backing from the 1-1/8-inch thick foam pad supplied in the kit.
2. From the front of the cabinet, reach in through the control-panel opening and attach the foam pad to the front wall of the cabinet approximately midway between the upper and lower slotted PCB guides.
3. Connect the Conversion PCB to the Major Havoc game PCB edge connectors.

CAUTION

Do not over-tighten the tie wraps to the printed-circuit boards. If the tie wraps are too tight, the Conversion PCB could bow and cause a faulty contact at the edge connectors.

4. Use tie wraps at each end of the PCBs to secure the Conversion PCB to the Major Havoc PCB.

NOTE

Before installing the Major Havoc printed-circuit boards in the cabinet, be sure the option switches are set for the desired game options. See Chapter 1 in the Major Havoc operators manual (TM-252).

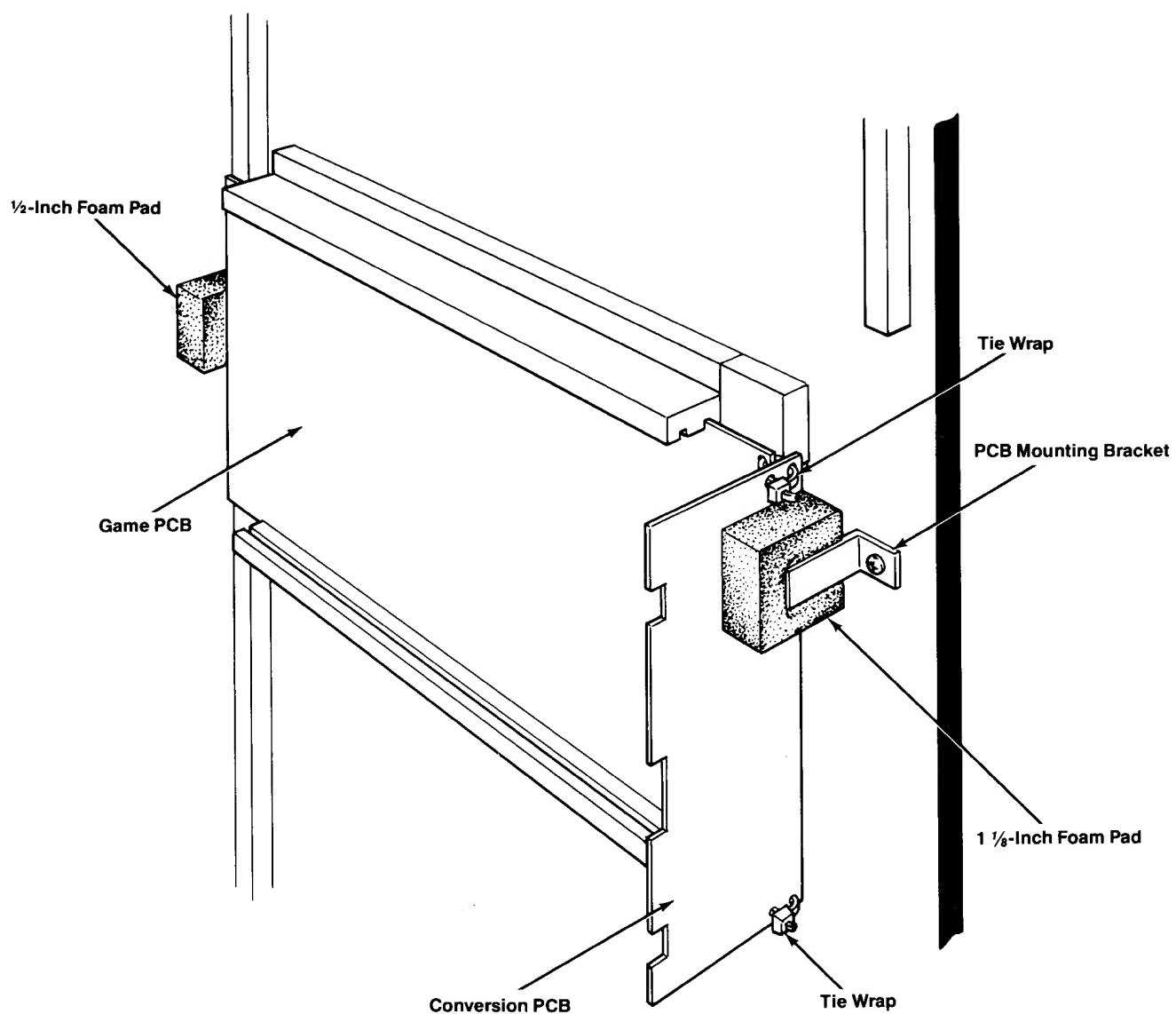


Figure 12 Installing the Major Havoc PCBs

5. Slide the Major Havoc PCB (with the Conversion PCB attached) into the slotted cleat.
6. Attach the 1/2-inch thick foam pad approximately 1-inch from the top of the Conversion PCB.
7. Position the PCB mounting bracket in the center of the 1/2-inch thick foam pad and press firmly against the pad.
8. Check that the back edge of the Major Havoc PCB is pressed firmly against the 1-1/8-inch foam pad installed in step 2. Use a Phillips screwdriver to secure the PCB mounting bracket to the cabinet with the pan-head screw.
9. Connect the top and bottom connectors on the main harness to the Conversion PCB.
10. Use beaded tie wraps at each end to secure the two edge connectors to the Conversion PCB.

R. INSTALL THE POWER SUPPLY

Perform the following procedure to install the modified power supply into the game cabinet.

1. Use a Phillips screwdriver to secure the power-supply base plate and power supply to the cabinet floor with the four screws removed previously.
2. Connect the game harness to connectors J2, J4A, and J5 on the top of the power supply.
3. Connect the power cord to connector J1 on the right side of the power supply.
4. Use a 11/32-inch hex driver to secure the green ground wires to the grounding screw on the power supply with the washer and nut removed previously.

S. INSTALL THE FAN

Perform the following procedure to install the fan in the game cabinet (see Figure 10).

1. On the inside of the rear access panel, position the fan-blade guard over the fan opening.

2. Place the exhaust fan on the fan-blade guard with the arrow on the fan housing pointing toward the inside of the cabinet.
3. Use a Phillips screwdriver to install the four self-tapping screws which will secure the exhaust fan and guard to the rear access panel.
4. Connect the black and white wires on the fan harness to the two fan power-input terminals.
5. Use a Phillips screwdriver to secure the green wire to the fan frame with the self-tapping screw.
6. Connect the fan harness to connector J4B on the power supply.

T. INSTALL THE SELF-TEST CHART

Staple or tape the Major Havoc self-test chart to the inside of the rear access panel.

U. INSTALL THE LABELS

NOTE

Do not remove or mark any of the existing labels on the game cabinet.

Perform the following procedure to install the conversion kit and FCC compliance labels on the game cabinet (see Figure 13).

1. Remove the protective backing from the conversion kit and the FCC compliance labels.
2. Attach the conversion kit label to the back of the game cabinet directly above the rear access panel.
3. If your game has an FCC label, attach the FCC compliance label included in the kit directly OVER the existing FCC label. If not, attach the FCC compliance label included in the kit next to the conversion kit label directly above the rear access panel.

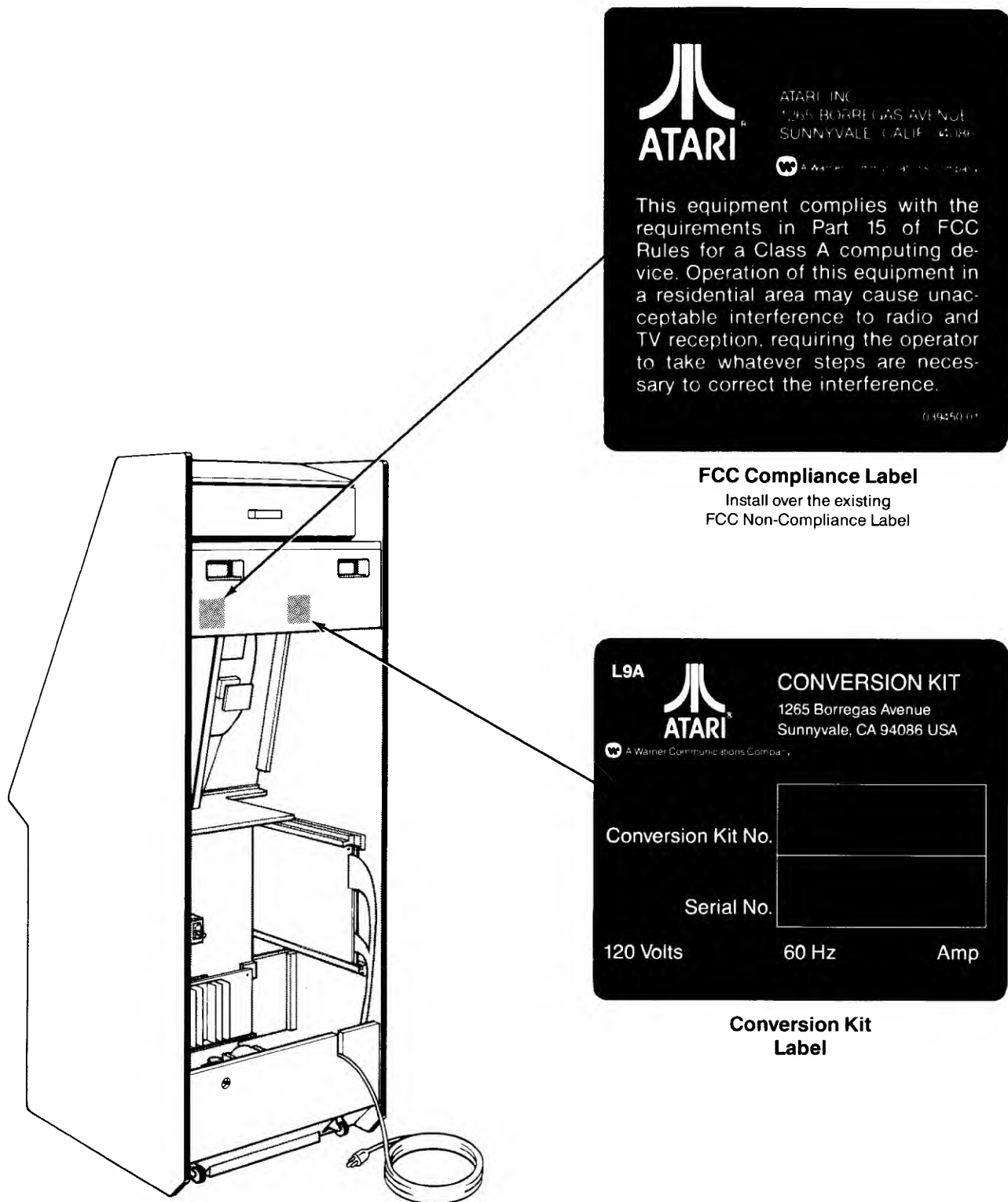


Figure 13 Installing the Labels

V. INSPECT THE MAJOR HAVOC GAME

Before applying power, perform the following procedure to ensure that the game is modified correctly.

1. Carefully check that the conversion has been properly performed.
2. When you are confident that all instructions were properly followed, close and lock the rear access panel.
3. Reach up through the coin-door opening and latch the two spring-draw latches to the control panel.
4. Plug in the game power cord and turn the game on.
5. Set the game self-test switch to the on position and perform the self-test procedure in the Major Havoc operators manual (TM-252).

W. ADJUST THE DISPLAY

Perform the following procedures to adjust the display size, centering, linearity, brightness, and color tracking.

X/Y Center, Size, and Linearity

1. Set the game self-test switch to the on position and obtain Screen 5, Diagonal Crosshatch display.

NOTE

The horizontal (X) adjustments are located on the Conversion PCB (see Figure 14) and the vertical (Y) adjustments are located on the Major Havoc game PCB (see Major Havoc operators manual). The X adjustments on the Major Havoc game PCB are bypassed through the Conversion PCB and are not functional when the Conversion PCB is connected.

2. Adjust the X and Y SIZE and CENTER controls so that the white rectangle fills the screen with the corners visible while the red rectangle corners are off the screen.

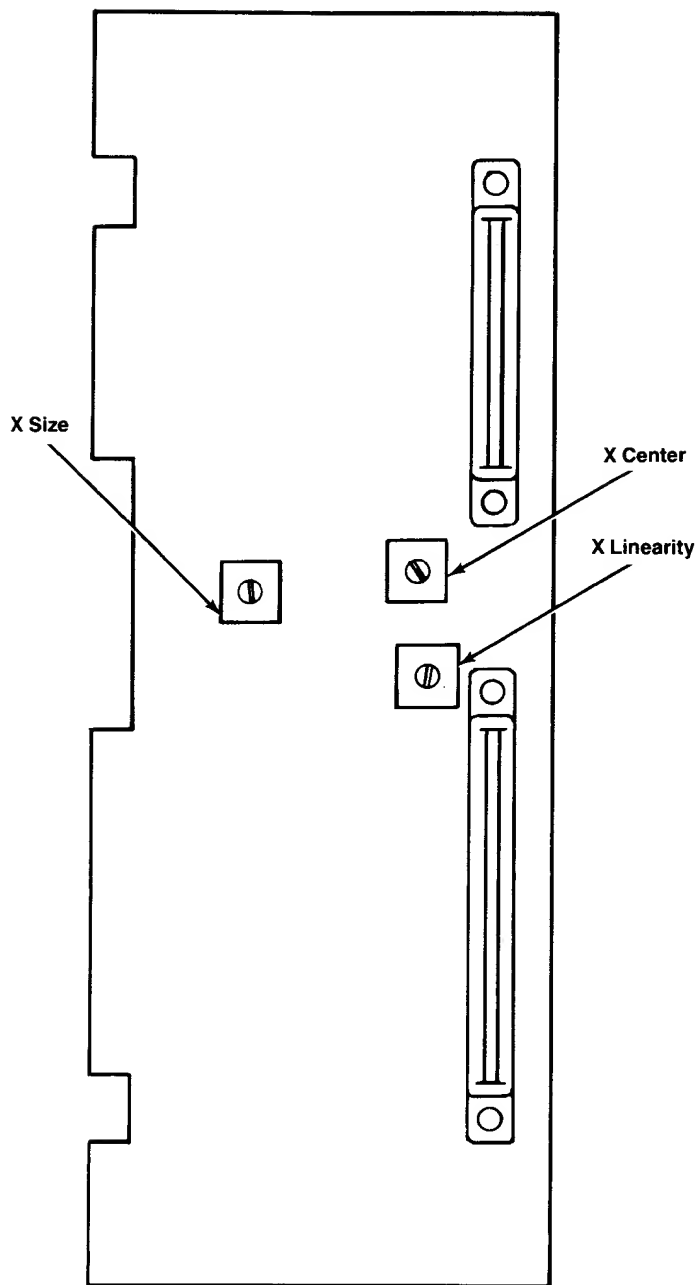


Figure 14 Adjusting the Display

3. Adjust the X and Y LINEARITY controls for the straightest possible diagonal lines in the Diagonal Crosshatch display.
4. Repeat step 2 and 3 until the straightest possible diagonal lines are obtained (the linearity and size adjustments are interactive).

Brightness

Perform the following procedure to adjust the display brightness.

1. Set the game to the Self-Test Mode and obtain Screen 6, Color Intensity Test display. See the Major Havoc operators manual for a description of self-test operation.
2. Adjust the SCREEN BRIGHTNESS control to make the longest white line visible and the white line above the longest line not visible. See the display manual for the location of the SCREEN BRIGHTNESS control.

Tracking

Perform the following procedure to evaluate and adjust the white tracking.

1. Set the game to the Self-Test Mode and obtain Screen 6, Color Intensity Test display. See the Major Havoc operators manual for a description of the self-test operation.
2. Verify that the middle five or six lines are white and remain white as the intensity progresses from dim to bright (top line compared to bottom line). If not, perform the tracking adjustment procedure in the display manual.

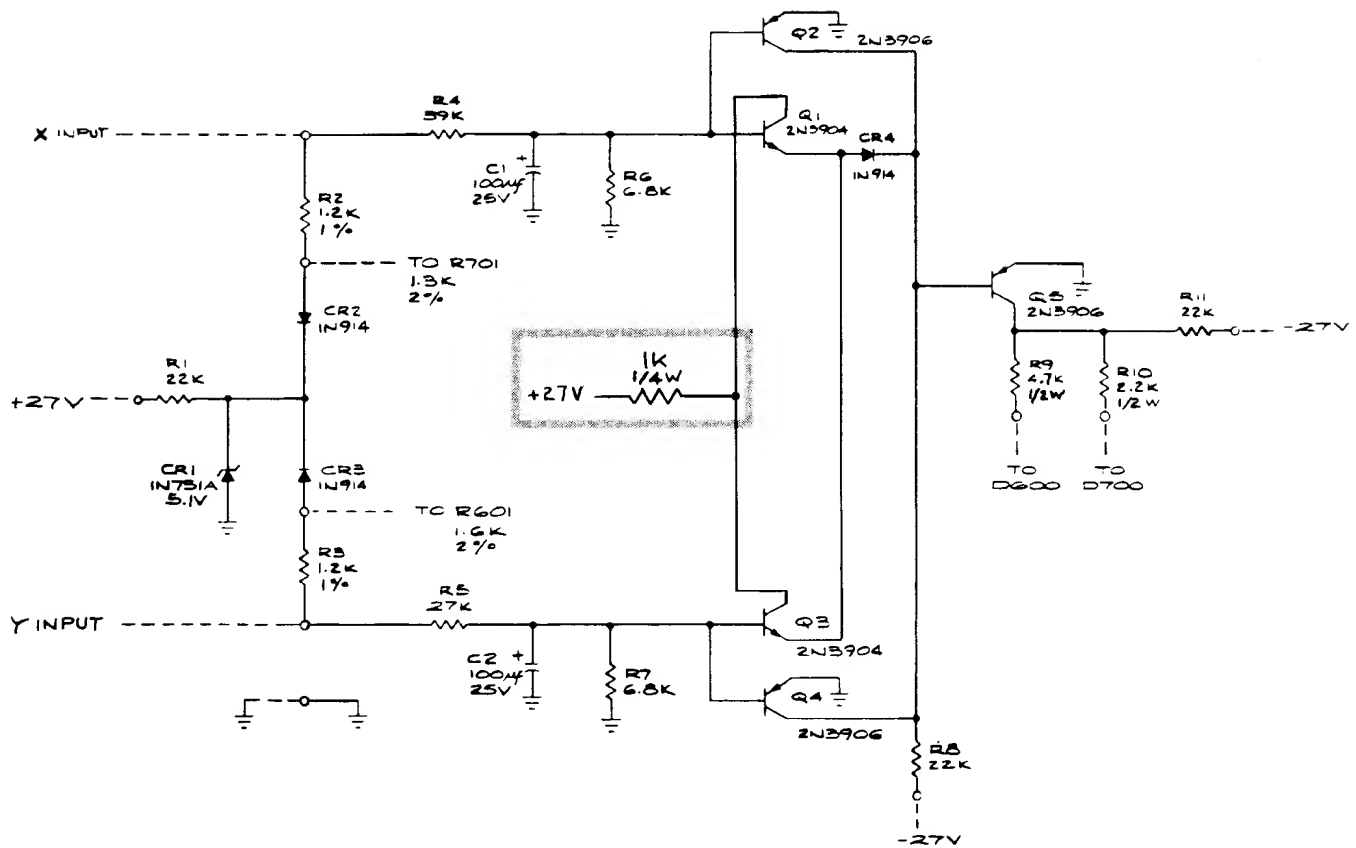
X. SET THE OPTION SWITCHES

Verify that the option switches are set to the desired play options for your location. The recommended play options are 2 coins for 5 starting lives, medium difficulty, and bonus life for 100,000 points. Refer to the Major Havoc operators manual for option switch location and setting information.

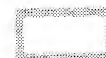
Y. UPDATE THE GAME DOCUMENTATION

We suggest that you keep this document and CO-252-03 for conversion kit parts information. Keep the control-panel wiring diagram (included in the kit) as part of the Major Havoc schematic package (SP-252).

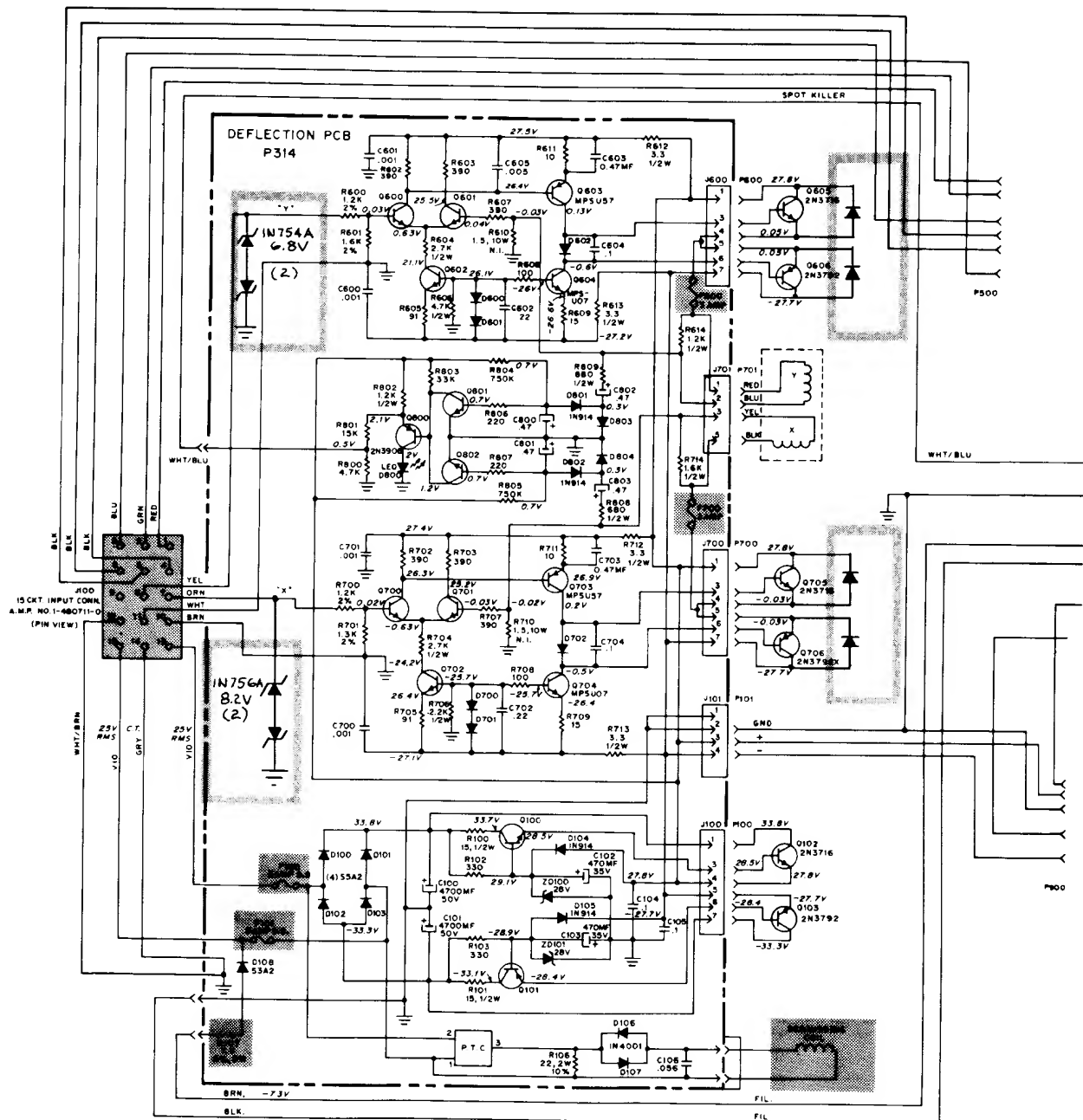
Change your Wells-Gardner display manual (TM-183) schematics as shown in Figure 15 (for Versions 2, 3, and 4), Figure 16 (for Versions 2, 3, and 4), or Figure 17 (for Version 1). Change your Amplifone display manual schematics as shown in Figure 18 for TM-194 or as shown in Figure 19 for TM-239.



Components outlined by shaded frame have been added per TM-268.



**Figure 15 Input Protection Circuit Schematic
(Versions 2, 3, and 4)**



GENERAL NOTES

1. Resistance values in ohms, $\frac{1}{4}$ watt, $\pm 5\%$, unless otherwise noted. K = 1,000, M = 1,000,000
2. Capacitance value of 1 or less is in microFarads, above 1 in picoFarads, unless otherwise noted.
3. * Q900 and Q906 are not in High-Voltage PCB.
4. All D.C. voltages are $\pm 10\%$ measured from point indicated to ground, using a high-impedance meter. Voltages are measured with no signal input and controls are in a normal operating position.
5. Circled numbers indicate location of waveform reading.
6. ZD100-101 uses (66X0040-007) zener diode in series with (340X2331-934) 330-ohm resistor in early production models.
7. Use a 1,000:1 probe when measuring G2 (screen) or focus voltage.

Components identified by shading have special characteristics important to safety and should be replaced only with identical types.



Components outlined by shaded frame have been added per TM-268.

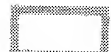
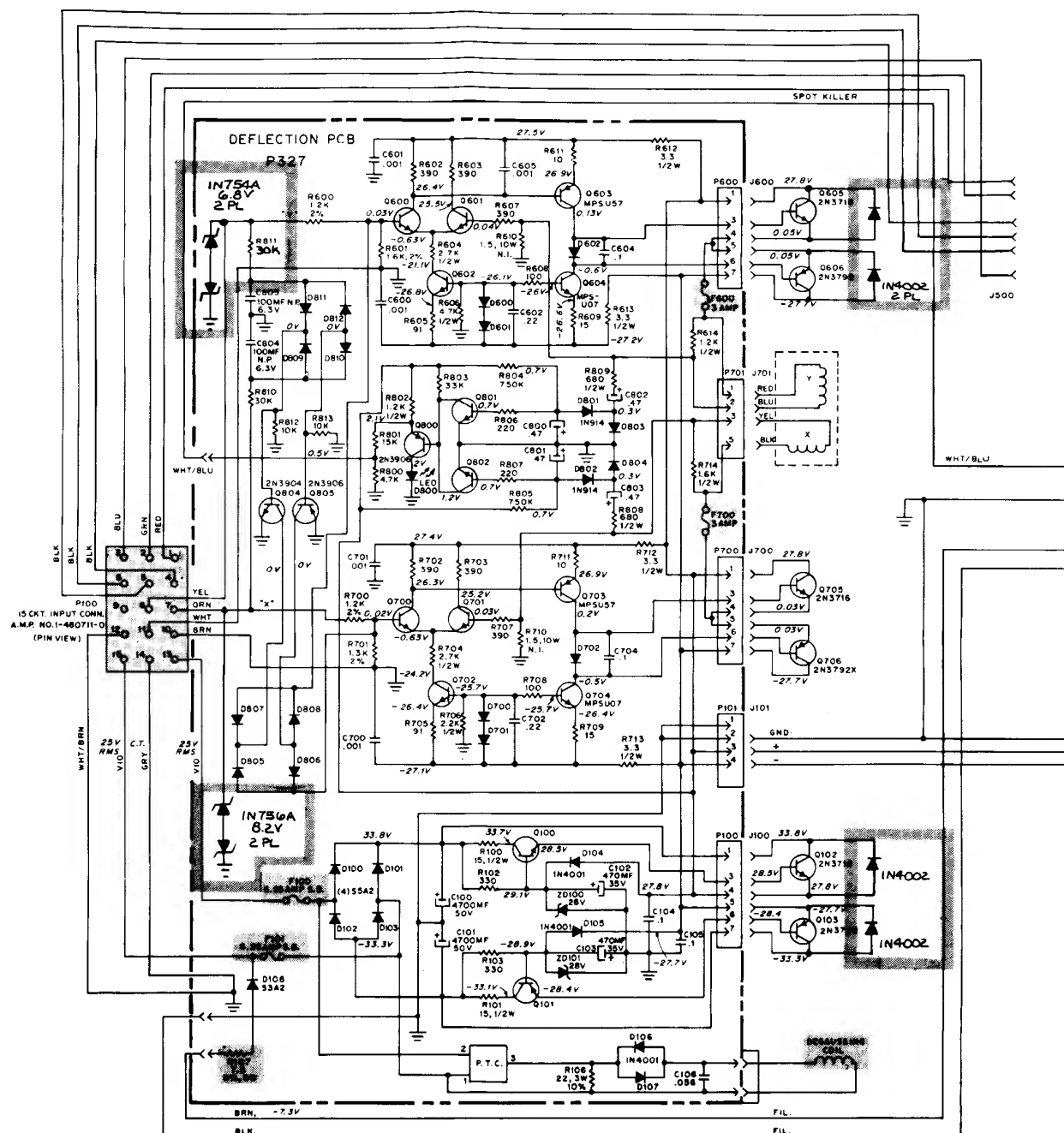


Figure 16 Wells-Gardner Deflection PCB Schematic (Versions 2, 3, & 4)



GENERAL NOTES

1. Resistance values in ohms, ¼ watt, $\pm 5\%$, unless otherwise noted. K = 1,000, M = 1,000,000
2. Capacitance value of 1 or less is in microFarads, above 1 in picoFarads, unless otherwise noted.
3. * Q900 and Q906 are not in High-Voltage PCB.
4. All D.C. voltages are $\pm 10\%$ measured from point indicated to ground, using a high-impedance meter. Voltages are measured with no signal input and controls are in a normal operating position.
5. Circled numbers indicate location of waveform reading.
6. ZD100-101 uses (66X0040-007) zener diode in series with (340X2331-934) 330-ohm resistor in early production models.
7. Use a 1,000:1 probe when measuring G2 (screen) or focus voltage.

Components identified by shading have special characteristics important to safety and should be replaced only with identical types.

Components outlined by shaded frame have been added per TM-268.

Figure 17 Wells-Gardner Deflection PCB Schematic (Version 1)

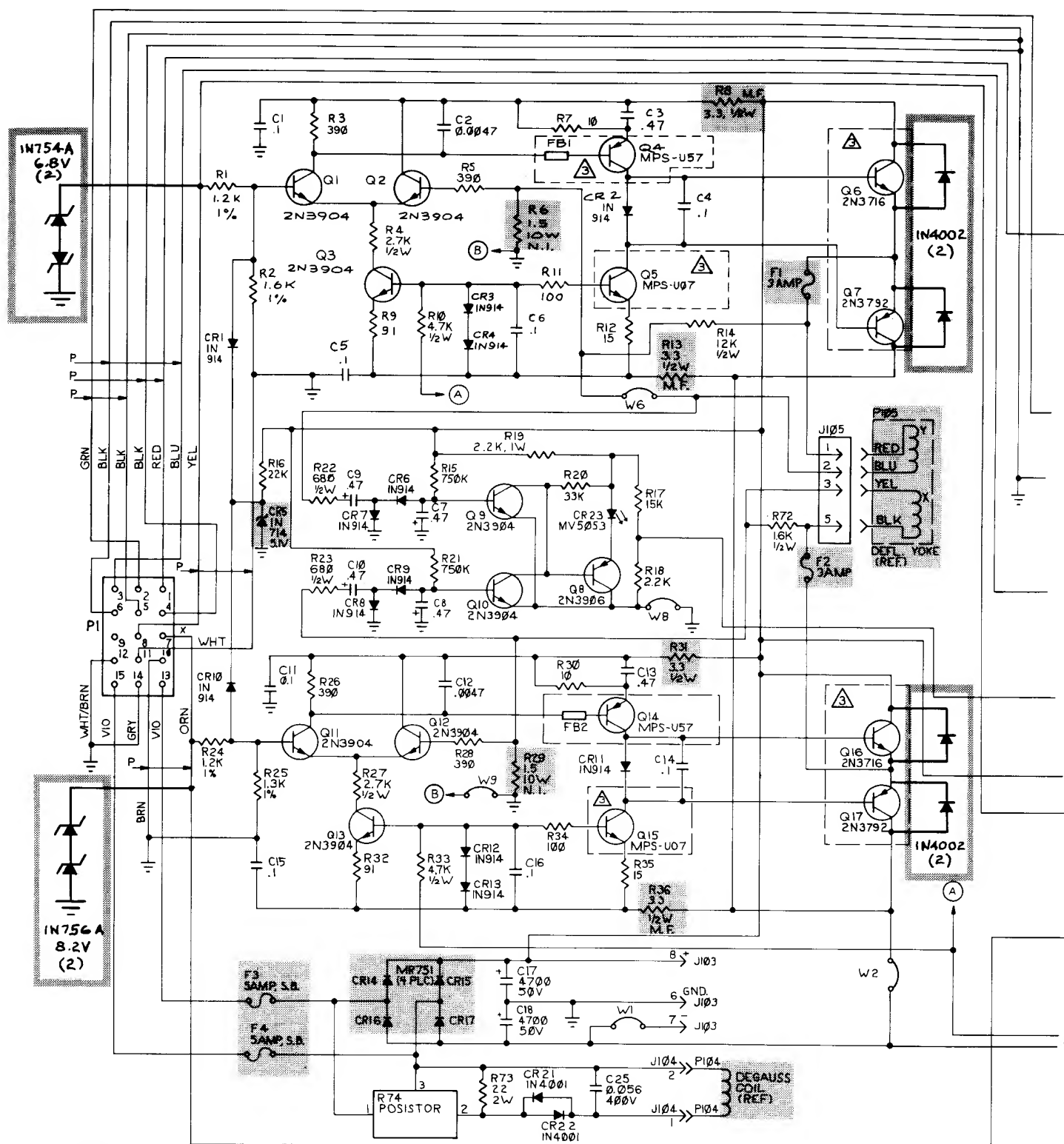


Figure 18 Amplifone Deflection PCB Schematic for TM-194

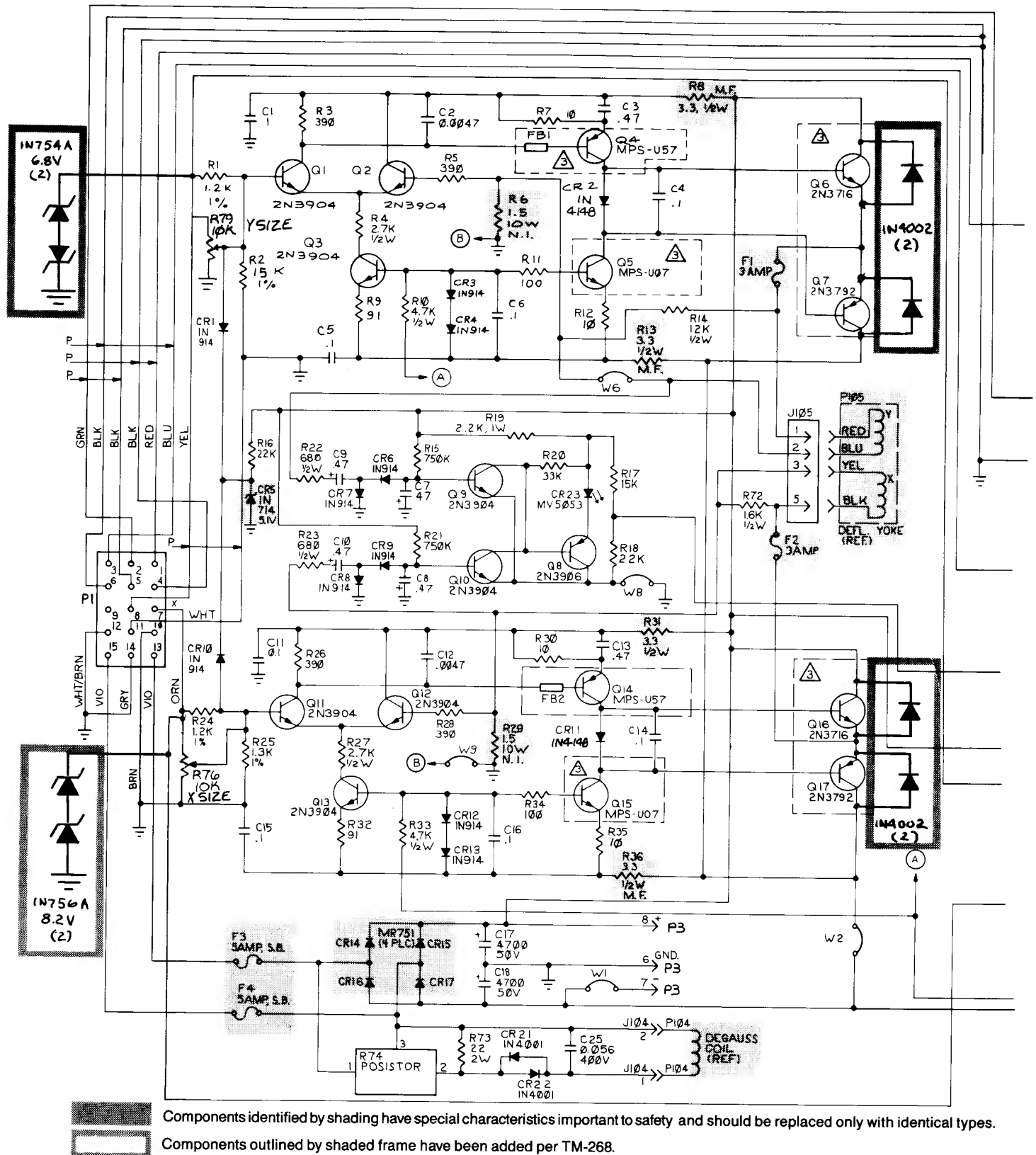


Figure 19 Amplifone Deflection PCB Schematic for TM-239