PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

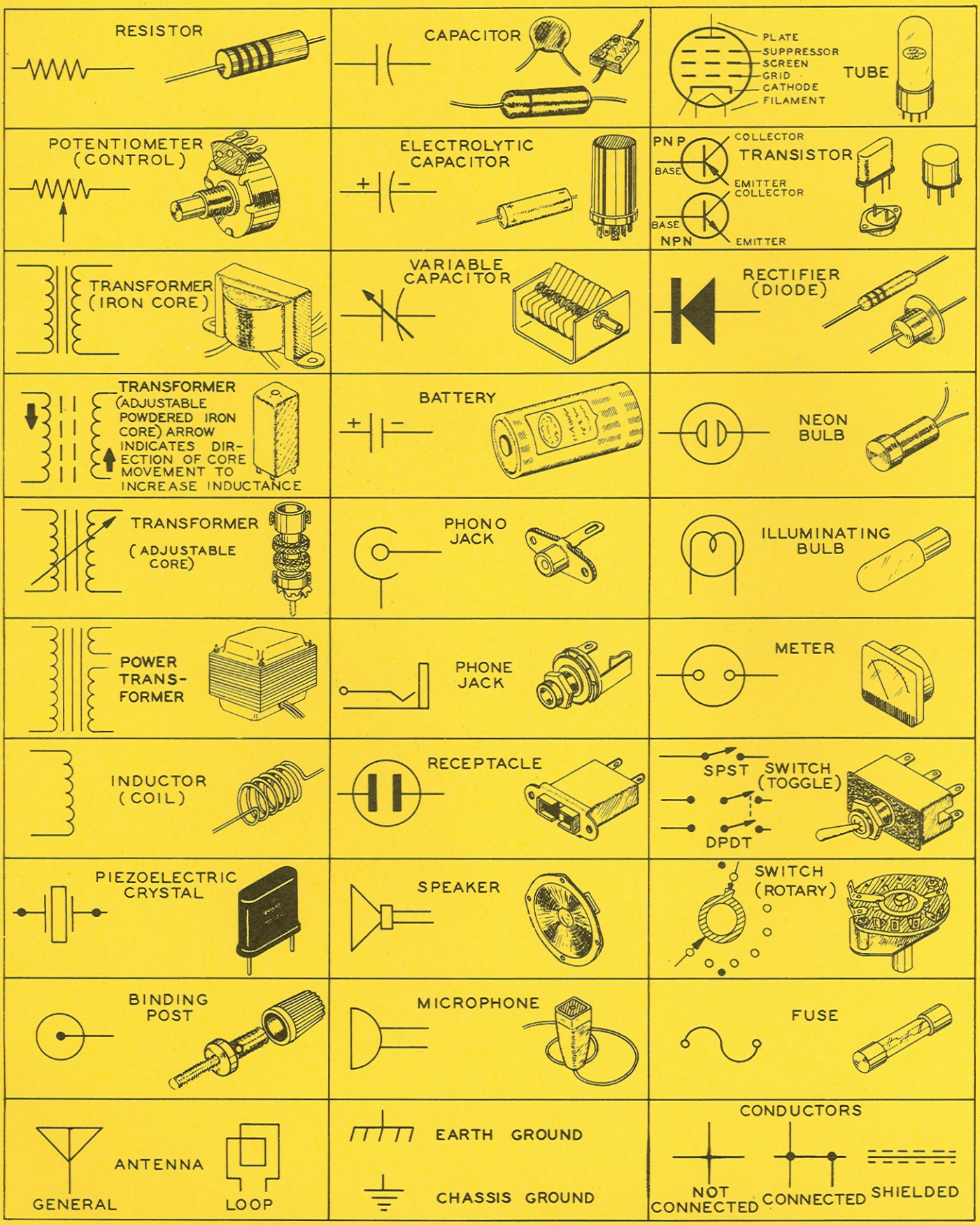
HEATHKIT®

12" PORTABLE TELEVISION SET

MODEL GR-104

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



Assembly
and
Operation
of the

HEATHKIT®

12" PORTABLE TELEVISION SET

Model GR-104

HEATH COMPANY

BENTON HARBOR, MICHIGAN

11/11/66

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INTRODUCTION

The Heathkit Model GR-104 Portable Television Set is a truly portable, assemble-it-yourself, quality TV receiver with a 74 square inch picture on a 12" (overall diagonal measure) cathode ray tube.

This TV Set will operate from 105-125 volt AC power, from a 12 volt automobile or boat battery, or from a Battery Pack Accessory, Model GRA-104-1, which is available from Heath Company.

Two printed circuit boards and two preassembled, prealigned tuners make the assembly of this TV Set quite easy. The hinged, swing-out chassis simplifies servicing, should the need arise.

Twenty-four transistors, thirteen diodes, and an integrated circuit that consists of twelve transistors, twelve diodes, and fifteen resistors, operate the TV Set with a minimum of heat dissipation and power consumption. This makes battery operation very economical.

A battery charging circuit is included with the Battery Pack Accessory. When this Battery is connected to the TV Set and the line cord is plugged into the AC power line, the battery automatically begins to recharge as soon as the Off-On switch is turned off.

Two thermal circuit breakers protect the set from overload and eliminate the need for fuses. The regulated low voltage power supply, which gives constant voltage under varying source and load conditions, helps produce a stable, clear picture on the screen.

Three video IF stages, gated AGC, VHF and UHF tuners for reception of channels 2 through 83, and many other features, make the Heathkit Model GR-104 one of the finest portable Television Sets available.

NOTE: This manual uses the new IEEE (Institute of Electrical and Electronic Engineers) and international standard term "hertz" as the basic unit of frequency. The terms are used as follows:

Hz (hertz) = cps (cycles per second).
kHz (kilohertz) = kc (kilocycles per second).
MHz (megahertz) = mc (megacycles per second).

UNPACKING

The Television Set packaging consists of the large shipping carton, which contains smaller packages and a number of loose parts. Some of the smaller packages have numbers 1 through 3 stamped on them. After these three numbered packages have been removed from the large carton, the remaining parts will be considered to be package #4.

You will be directed to open each of these packages as they are needed. Each of the three assembly sections of the Manual contains its own Parts List and Step-By-Step instructions. At the beginning of each Parts List you will be told which numbered package to open. You will also be directed to remove the parts from package #4 that are required to complete that assembly section.

To avoid intermixing parts, do not open any of the parts packs until directed to do so at the beginning of one of the Parts Lists. Any part that is packaged in an individual envelope with a part number on it, should be placed back in its envelope after it is identified, until that part is called for in a step.

Refer to the "Kit Builders Guide" for additional information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

AUDIO-VIDEO CIRCUIT BOARD

PARTS LIST

Unpack the package marked 1. Check each part against the following Parts List. The numbers in parentheses are keyed to the numbers on the Audio-Video Circuit Board Parts Pictorial (fold-out from Page 19).

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/2 Watt		
1-129	1	4.7 Ω (yellow-violet-gold)
1-41	4	10 Ω (brown-black-black)
1-1	2	47 Ω (yellow-violet-black)
1-3	2	100 Ω (brown-black-brown)
1-56	1	240 Ω (red-yellow-brown)
1-4	1	330 Ω (orange-orange-brown)
1-48	1	390 Ω (orange-white-brown)
1-6	1	470 Ω (yellow-violet-brown)
1-119	1	560 Ω (green-blue-brown)
1-7	1	680 Ω (blue-gray-brown)
1-79	1	820 Ω (gray-red-brown)
1-9	1	1000 Ω (brown-black-red)
1-80	1	1200 Ω (brown-red-red)
1-11	2	1500 Ω (brown-green-red)
1-93	1	1800 Ω (brown-gray-red)
1-44	2	2200 Ω (red-red-red)
1-13	1	2700 Ω (red-violet-red)
1-46	1	3900 Ω (orange-white-red)
1-16	2	4700 Ω (yellow-violet-red)
1-64	1	5100 Ω (green-brown-red)
1-51	2	6800 Ω (blue-gray-red)
1-20	1	10 KΩ (brown-black-orange)
1-21	1	15 KΩ (brown-green-orange)
1-22	1	22 KΩ (red-red-orange)
1/2 Watt (cont'd.)		
1-115	4	47 KΩ (yellow-violet-orange)
1-47	1	56 KΩ (green-blue-orange)
1-60	1	68 KΩ (blue-gray-orange)
1-102	1	82 KΩ (gray-red-orange)
1-126	1	180 KΩ (brown-gray-yellow)
2 watt		
(2) *3B-5	2	2.2 Ω (red-red-gold)
1B-17	1	6800 Ω (blue-gray-red)

*NOTE: Resistors that have a part number beginning with 3B- are 2 watt wire-wound resistors, but are the same size as 1 watt composition resistors.

PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS		
Disc		
(3) 21-33	2	3.3pf
21-78	2	5 pf
21-115	1	9 pf
21-14	1	.001 μfd
21-25	1	.0013 μfd (1300 pf)
21-27	7	.005 μfd
21-16	3	.01 μfd

PART No.	PARTS Per Kit	DESCRIPTION
Resin		
(4) 20-52	2	7.5 pf
20-130	2	12 pf
20-118	1	15 pf
20-100	1	30 pf
20-96	1	36 pf
20-119	2	90 pf
20-102	1	100 pf
20-114	1	270 pf
Mylar*		
NOTE: These capacitors may be color coded, or the value may be printed on them. If necessary, refer to the capacitor color code chart and example (fold-out from Page 19) to help you identify these capacitors.		
(5) 27-47	3	.1 μfd (brown-black-yellow)
27-60	2	.22 μfd (wide red band-yellow)
Electrolytic		
(6) 25-123	1	2 μfd
(7) 25-115	1	10 μfd
25-117	2	100 μfd
25-160	2	250 μfd
COILS-CHOKE-TRANSFORMERS		
Coils		
NOTE: Do not remove any coils from their envelopes until they are called for in the assembly steps.		
(8) 40-485	2	250 μh peaking coil (red-green, brown)
(9) 40-581	2	620 μh peaking coil (blue-red, brown)
(10) 40-794	1	4.5 MHz trap
40-751	1	47.25 MHz coil (red form)
40-752	1	39.75 MHz coil (brown form)
40-753	1	First video IF transformer (orange form)
40-754	1	Second video IF transformer (yellow form)
40-755	1	Third video IF transformer (green form)

* Du Pont Registered Trademark

PART No.	PARTS Per Kit	DESCRIPTION
Choke-Transformers		
(11) 45-57	1	10 μh filter choke (brown-black-orange)
(12) 52-93	1	Video detector transformer (clear form)
(13) 52-94	1	Sound take-off transformer
53-10	1	4.5 MHz ratio detector transformer
DIODES-TRANSISTORS		
(14) 56-20	1	1N295 crystal diode (red, white, green)
56-26	1	1N191 crystal diode (brown, white, brown)
(15) 417-119	1	CA3013 integrated circuit
(16) 417-105	1	SE5023 transistor
417-106	1	SE5024 transistor
NOTE: The following transistors may appear as any one of the three types of transistors illustrated in the chart on the Parts Pictorial. When identifying each transistor, look for the part number or type number printed on the case. EXAMPLE: Transistor number 417-107 may be marked 417-107, SE5025, or 417-107/SE5025 (or in this last case, where 417-107 is also on the transistor, another number may be used in place of SE5025).		
(17) 417-107	1	SE5025 transistor
(18) 417-115	1	2N3923 transistor
(19) 417-108	3	2N3692 transistor
(20) 417-109	1	2N3566 transistor
(21) 417-110	1	S2090 transistor
(22) 417-116	1	S2091 transistor
MISCELLANEOUS		
(23) 10-200	1	2000 Ω (2 K) control (AGC)
(24) 206-207	1	Small IF shield
206-205	1	Large IF shield
(25) 215-18	1	Heat sink
ITEMS FROM PACK #4		
85-150P322P349	1	Audio-video circuit board
344-58	1	Gray hookup wire
346-1	1	Black sleeving
331-6		Solder
597-308	1	Kit Builders Guide
595-828	1	Manual
597-186	1	Picture tube warranty card (inserted into this Manual)

STEP-BY-STEP ASSEMBLY

AUDIO-VIDEO CIRCUIT BOARD (#85-150P322P349)

Before you start the circuit board assembly be sure to read the Circuit Board Parts Mounting and Soldering sections (Pages 11, 12, and 13) of the Kit Builders Guide.

Position the audio-video circuit board on your work surface as shown in Pictorial 1-1. Then complete each step on the Pictorial. Resistors will be called out by only the resistance value (in Ω or KΩ) and color code. Use 1/2 watt resistors unless directed otherwise in a step. Capacitors will be called out by only the capacitance value (in pf or μfd) and type (disc, resin, Mylar, or electrolytic).

Use hookup wire of the color specified when wire is called for in a step. Cut the wires to the proper length and remove 1/4" of insulation from each end. Position each wire as shown.

START

( ) 47 Ω (yellow-violet-black).

( ) 47 KΩ (yellow-violet-orange).

( ) 22 KΩ (red-red-orange).

( ) 10 KΩ (brown-black-orange).

( ) 68 KΩ (blue-gray-orange).

( ) 2700 Ω (red-violet-red).

( ) 390 Ω (orange-white-brown).

( ) 100 Ω (brown-black-brown).

( ) 6800 Ω (blue-gray-red).

( ) 100 Ω (brown-black-brown).

( ) 560 Ω (green-blue-brown).

( ) 680 Ω (blue-gray-brown).

( ) 4" gray hookup wire.

( ) 250 μh peaking coil (red-green-brown).

( ) 620 μh peaking coil (blue-red-brown). Insert the longest leads into the circuit board.

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 2200 Ω (red-red-red).

( ) 1000 Ω (brown-black-red).

( ) 3900 Ω (orange-white-red).

( ) 1200 Ω (brown-red-red).

( ) 47 Ω (yellow-violet-black).

( ) 6800 Ω (blue-gray-red) 2 watt.

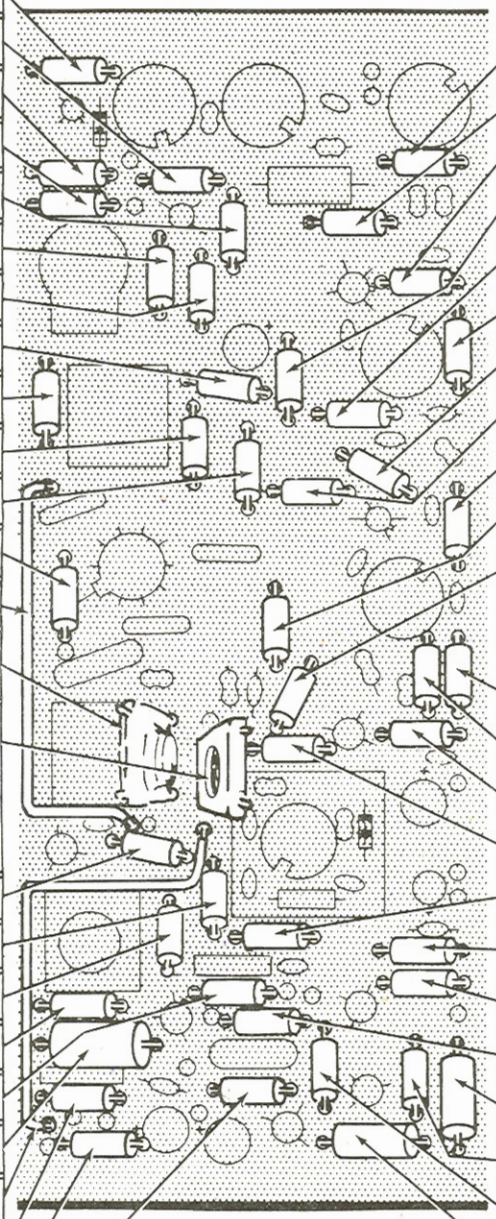
( ) 4" gray hookup wire.

( ) 180 KΩ (brown-gray-yellow).

( ) 10 Ω (brown-black-black).

( ) 820 Ω (gray-red-brown).

( ) Solder all leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) 15 KΩ (brown-green-orange).

( ) 2200 Ω (red-red-red).

( ) 1500 Ω (brown-green-red).

( ) 56 KΩ (green-blue-orange).

( ) 10 Ω (brown-black-black).

( ) 4700 Ω (yellow-violet-red).

( ) 4700 Ω (yellow-violet-red).

( ) 47 KΩ (yellow-violet-orange).

( ) 1500 Ω (brown-green-red).

( ) 10 Ω (brown-black-black).

( ) 10 Ω (brown-black-black).

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 1800 Ω (brown-gray-red).

( ) 5100 Ω (green-brown-red).

( ) 330 Ω (orange-orange-brown).

( ) 47 KΩ (yellow-violet-orange).

( ) 470 Ω (yellow-violet-brown).

( ) 6800 Ω (blue-gray-red).

( ) 4.7 Ω (yellow-violet-gold).

( ) 82 KΩ (gray-red-orange).

( ) 2.2 Ω (red-red-gold) 2 watt.

( ) 47 KΩ (yellow-violet-orange).

( ) 240 Ω (red-yellow-brown).

( ) 2.2 Ω (red-red-gold) 2 watt.

( ) Solder all leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 1-2.

PICTORIAL 1-1

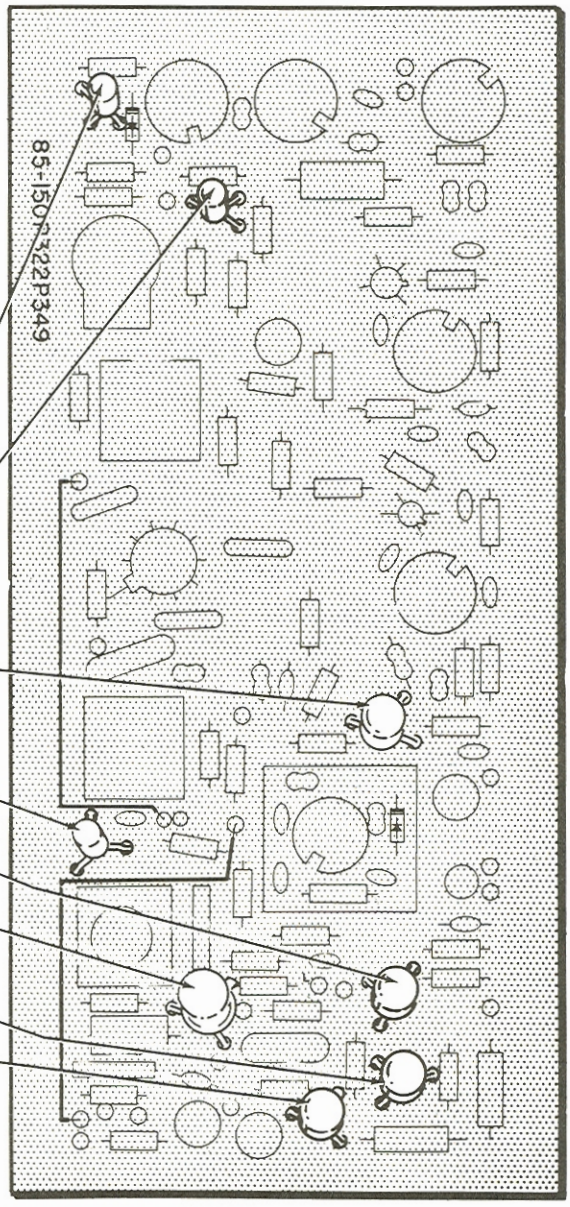
NOTE: When installing each transistor in the following steps, look for the part or type number printed on the case.

EXAMPLE: Transistor 417-108 may be marked 417-108, 2N3692, or 417-108/2N3692 (or in this last case, where 417-108 is also on the transistor, another number may be used in place of 2N3692).

Then refer to drawings A, B, or C (fold-out from Page 11). These drawings show how to install the transistors, in Pictorial 1-2. When you install a transistor, follow the instructions in the drawing (A, B, or C) that physically corresponds to that particular type of transistor.

START

- ( ) Install transistor Q107 (#417-108/2N3692).
- ( ) Install transistor Q106 (#417-108/2N3692).
- ( ) Install transistor Q103 (#417-107/SE5025).
- ( ) Install transistor Q104 (#417-108/2N3692).
- ( ) Install transistor Q109 (#417-109/2N3566).
- ( ) Install transistor Q105 (#417-115/2N3923).
- ( ) Install transistor Q111 (#417-116/S2091).
- ( ) Install transistor Q110 (#417-110/S2090).
- ( ) Make sure all connections are soldered.



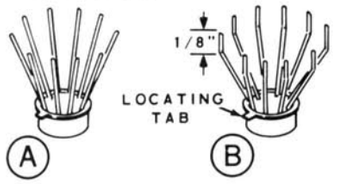
PICTORIAL 1-2

GR-102

START

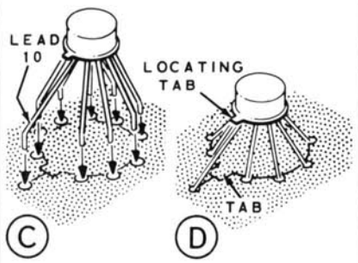
Install the integrated circuit at Q108 as follows:

(A) Bend all leads out to form a 3/4" circle.

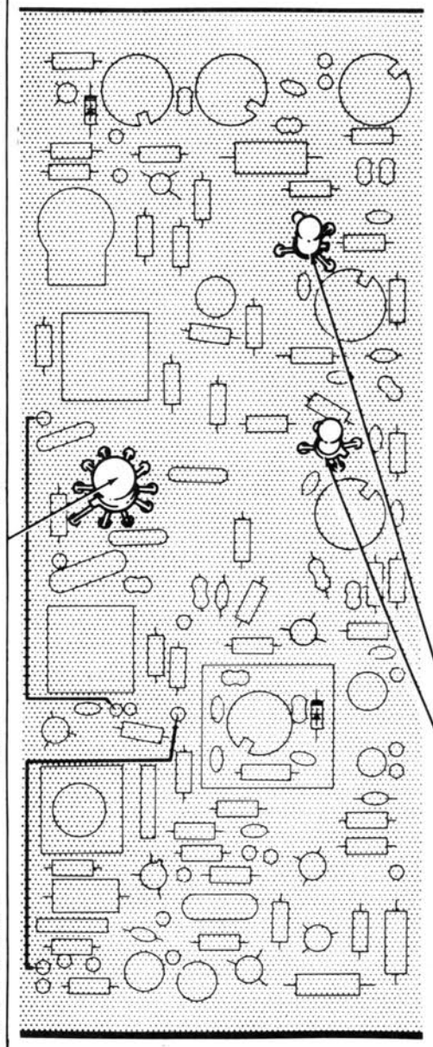


(B) Bend the end of each lead so that it points straight up as shown.

(C) Line up the locating tab of the integrated circuit with the outline of the tab on the circuit board. Insert lead 10 (the one nearest the locating tab) into the hole at the tab and then insert the remaining leads into their correct holes.



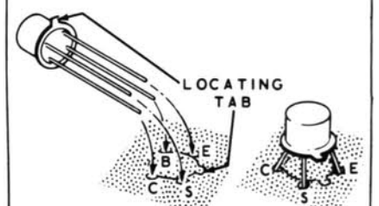
(D) Hold the integrated circuit in place and turn the circuit board over. First solder lead 10 to the foil, and then the remaining nine leads. Make sure lead 10 protrudes through the board far enough to make a good solder connection to the foil. NOTE: It is not necessary to bend the leads over or clip off the excess leads after soldering them.



PICTORIAL 1-3

CONTINUE

NOTE: Install the next two transistors in the following manner, as shown: First, line up the locating tab of the transistor with the outline of the tab on the circuit board. Then insert the transistor leads into their correct holes, which are indicated by S, C, B, and E. Position the transistors 1/4" away from the circuit board, and then solder the leads to the foil. Cut off the excess lead lengths after soldering them.

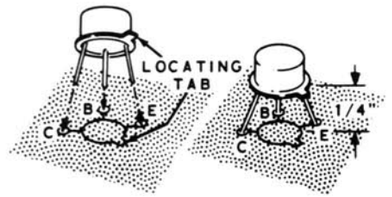


( ) Install transistor Q101 (#417-105/SE5023).

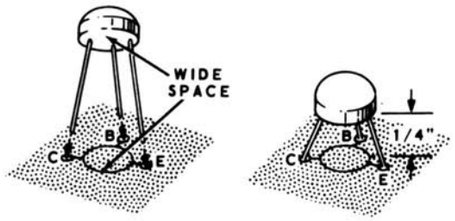
( ) Install transistor Q102 (#417-106/SE5024).

PROCEED TO PICTORIAL 1-4.

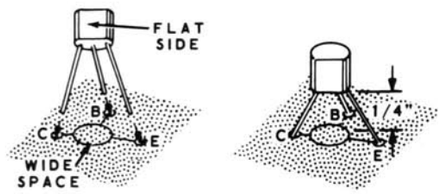
(A) Install the transistor in the following manner, as shown: First, line up the locating tab of the transistor with the outline of the tab on the circuit board. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



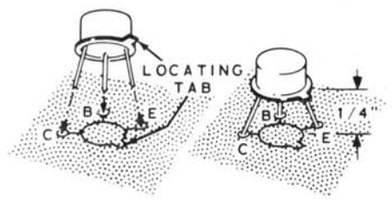
(B) Install the transistor in the following manner, as shown: First note the wide space on the circuit board between letters C and E. Line up the wide space between the transistor leads with the wide space on the circuit board. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



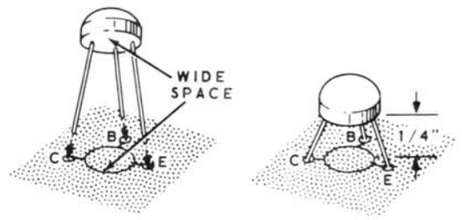
(C) Install the transistor in the following manner, as shown: First, note the wide space on the circuit board between letters C and E. Line up the flat side of the transistor with this wide space. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



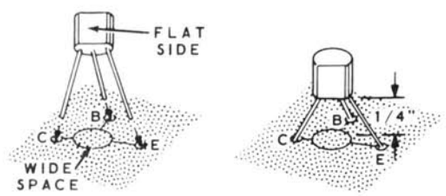
A Install the transistor in the following manner, as shown: First, line up the locating tab of the transistor with the outline of the tab on the circuit board. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



B Install the transistor in the following manner, as shown: First note the wide space on the circuit board between letters C and E. Line up the wide space between the transistor leads with the wide space on the circuit board. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.

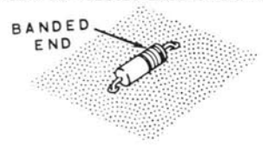


C Install the transistor in the following manner, as shown: First, note the wide space on the circuit board between letters C and E. Line up the flat side of the transistor with this wide space. Then insert the transistor leads into their correct holes, which are indicated by C, B, and E. Position the transistor 1/4" away from the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



START

( ) 1N191 crystal diode, #56-26, (brown-white-brown). Position the banded end as shown. NOTE: Do not confuse the banded end with the copper colored wire that is visible inside the diode.



( ) 36 pf resin.

( ) 2000 Ω control (#10-200). Push the control firmly against the circuit board and then solder the lugs to the foil.

NOTE: The Mylar capacitors may either be color coded or marked with a value.

( ) .1 µfd Mylar (brown-black-yellow).

( ) .1 µfd Mylar (brown-black-yellow).

( ) .1 µfd Mylar (brown-black-yellow).

( ) .22 µfd Mylar (wide red band-yellow).

( ) 270 pf resin.

( ) .0013 µfd (1300 pf) disc.

( ) .001 µfd disc.

( ) 30 pf resin.

( ) .005 µfd disc.

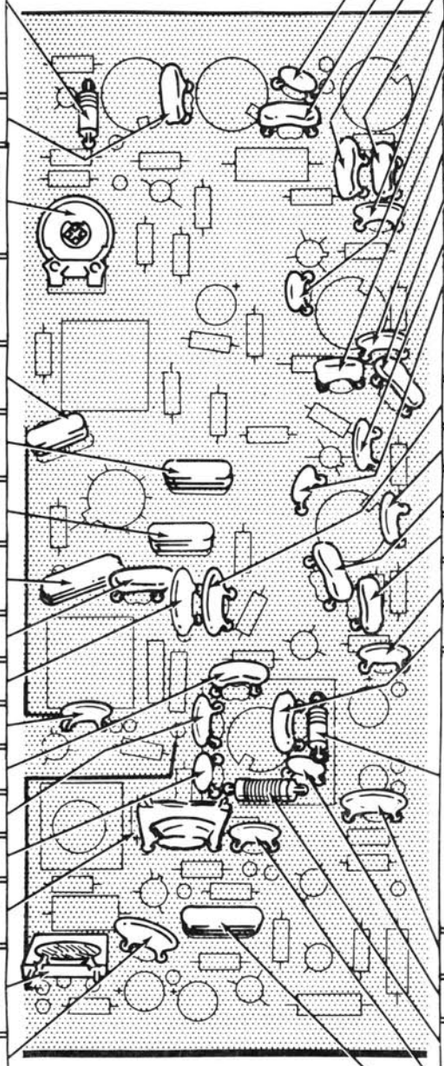
( ) 5 pf disc.

( ) 250 µh peaking coil (red-green-brown).

( ) 620 µh peaking coil (blue-red-brown). Insert the longest leads into the circuit board.

( ) .01 µfd disc.

( ) Solder all leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-4

CONTINUE

( ) 9 pf disc.

( ) 7.5 pf resin.

( ) 15 pf resin.

( ) 100 pf resin.

( ) .005 µfd disc.

( ) 3.3 pf disc.

( ) 12 pf resin.

( ) .005 µfd disc.

( ) 90 pf resin.

( ) .005 µfd disc.

( ) 3.3 pf disc.

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) .01 µfd disc.

( ) .005 µfd disc.

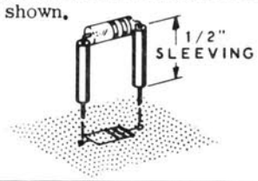
( ) 12 pf resin.

( ) 90 pf resin.

( ) .005 µfd disc.

( ) 7.5 pf resin.

( ) 1N295 crystal diode, #56-20, (red-white-green). Use 1/2" of small sleeving on each diode lead. Position the banded end as shown.



( ) .01 µfd disc.

( ) 5 pf disc.

( ) 10 µh filter choke (#45-57).

( ) .005 µfd disc.

( ) .22 µfd Mylar (wide red band-yellow).

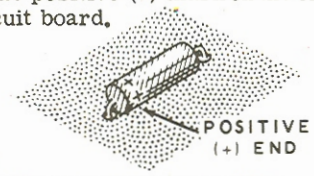
( ) Solder all leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 1-5.

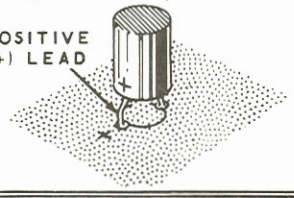
START

NOTE: After installing each of the following components, turn the circuit board over and solder each lead to the foil. Then cut off the excess lead lengths.

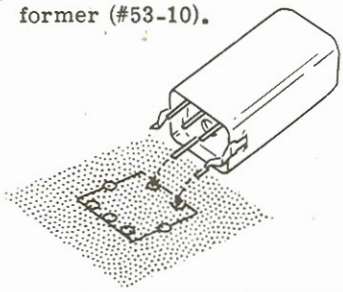
( ) 2 μfd electrolytic. NOTE: When mounting electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.



( ) 100 μfd electrolytic.



( ) 4.5 MHz ratio detector transformer (#53-10).

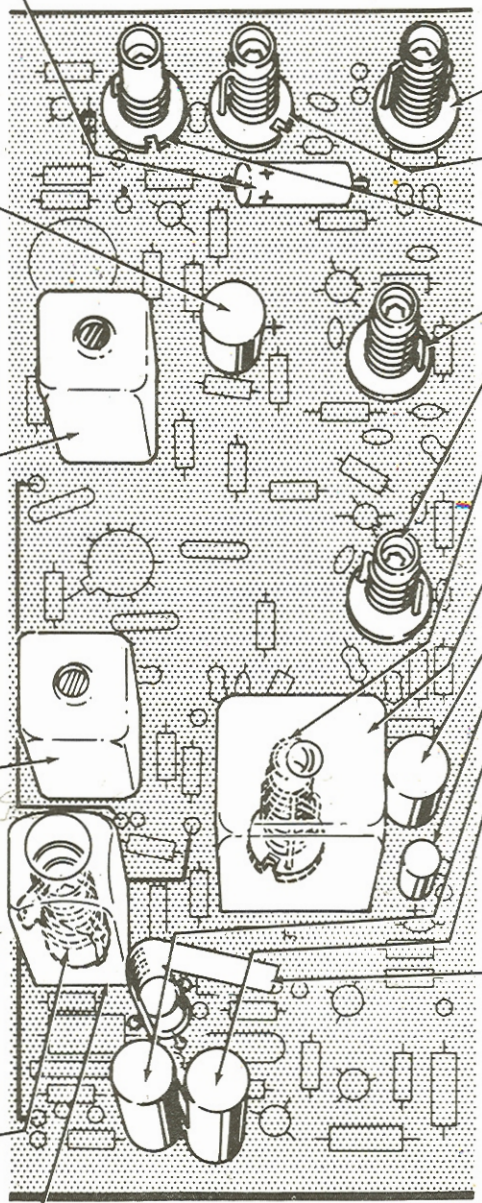


( ) Sound take-off transformer (#52-94). Match the wide-spaced transformer lugs with the wide spaced circuit board holes. Then install the transformer. Be careful not to pinch the hookup wire between the transformer and the circuit board.

NOTE: The coils and transformers which are mounted in the following steps are preset at the factory. Therefore, do not turn the adjustment slugs that are located inside the coils, move any parts connected to the coils, or move the coils of wire which are wrapped around the coil form.

( ) 4.5 MHz coil (#40-794).

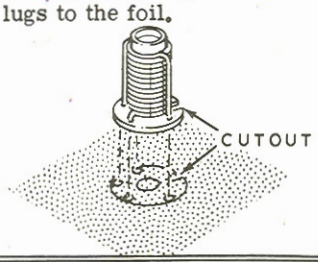
( ) Small IF shield. Be careful not to pinch the hookup wire between the shield and circuit board. Solder the lugs to the foil.



PICTORIAL 1-5

CONTINUE

Install the parts in the next six steps as follows: Line up the cutout on the part with the outline of the cutout on the circuit board. Then push the part against the circuit board and solder the lugs to the foil.



( ) First video IF transformer, #40-753, (orange form).

( ) 47.25 MHz coil, #40-751, (red form).

( ) 39.75 MHz coil, #40-752, (brown form).

( ) Second video IF transformer, #40-754, (yellow form).

( ) Third video IF transformer, #40-755, (green form).

( ) Video detector transformer (#52-93).

( ) Large IF shield. Solder the lugs to the foil. NOTE: Disregard the metal strap fastened to the shield.

( ) 100 μfd electrolytic.

( ) 10 μfd electrolytic.

( ) 250 μfd electrolytic.

( ) 250 μfd electrolytic.

( ) Push the heat sink over the transistor. If it fits loosely, remove the heat sink and squeeze it together slightly. Also, make sure it does not touch any metal parts on the circuit board. Then position it between the two upright capacitors as shown.

( ) Carefully inspect the foil side of the circuit board and solder any connections that might have been missed. Then set this circuit board aside temporarily.

FINISH

SYNC-SWEEP CIRCUIT BOARD

PARTS LIST

Unpack the package marked 2. Check each part against the following Parts List. The numbers in parentheses are keyed to the numbers on the Sync-Sweep Circuit Board Parts Pictorial (fold-out from Page 19).

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/2 Watt		
(1) 1-1	3	47 Ω (yellow-violet-black)
1-83	1	56 Ω (green-blue-black)
1-3	1	100 Ω (brown-black-brown)
1-111	1	150 Ω (brown-green-brown)
1-112	1	180 Ω (brown-gray-brown)
1-45	2	220 Ω (red-red-brown)
1-42	1	270 Ω (red-violet-brown)
1-94	1	390 Ω (orange-white-brown)
1-6	1	470 Ω (yellow-violet-brown)
1-119	2	560 Ω (green-blue-brown)
1-79	1	820 Ω (gray-red-brown)
1-9	4	1000 Ω (brown-black-red)
1-11	1	1500 Ω (brown-green-red)
1-44	1	2200 Ω (red-red-red)
1-14	1	3300 Ω (orange-orange-red)
1-16	3	4700 Ω (yellow-violet-red)
1-18	1	5600 Ω (green-blue-red)
1-51	1	6800 Ω (blue-gray-red)
1-73	1	8200 Ω (gray-red-red)
1-20	4	10 KΩ (brown-black-orange)
1-69	1	18 KΩ (brown-gray-orange)
1-26	2	100 KΩ (brown-black-yellow)
1-68	1	820 KΩ (gray-red-yellow)
2 Watt		
(2) 3B-7	1	1 Ω (brown-black-gold)
3B-5	1	2.2 Ω (red-red-gold)
CAPACITORS		
Disc		
(3) 21-14	3	.001 μfd
21-26	1	.003 μfd
21-27	2	.005 μfd
21-31	2	.02 μfd
21-48	2	.05 μfd
Mylar		

NOTE: These capacitors may be color coded, or the value may be printed on them. If necessary, refer to the color code chart and example on fold-out with Parts Pictorial to help identify these capacitors.

(4) 27-63	1	.022 μfd (wide red band-orange)
27-64	1	.033 μfd (wide orange band-orange)
27-39	1	.12 μfd (brown-red-yellow)
27-60	3	.22 μfd (wide red band-yellow)

PART No.	PARTS Per Kit	DESCRIPTION
Mylar (cont'd.)		
27-61	1	.47 μfd (yellow-violet-yellow)
27-62	1	.68 μfd (blue-gray-yellow)
Electrolytic		
(5) 25-115	2	10 μfd
25-117	1	100 μfd 15 V
25-160	2	250 μfd
25-148	2	1000 μfd
(6) 25-147	1	10 μfd 150 V
(7) 25-161	1	18 μfd, tantalum
25-162	1	33 μfd, tantalum
Other		
(8) 29-1	1	3900 pf polystyrene

CONTROLS-TRANSFORMERS

(9) 10-171	2	500 Ω control (vertical Linearity and Low Voltage)
10-201	1	10 KΩ control (vertical Height)
(10) 40-757	1	Horizontal blocking oscillator transformer
(11) 51-137	1	Horizontal driver transformer

DIODES-TRANSISTORS

(12) 56-16	1	Zener diode (may appear in one of three ways, as shown)
(13) 56-26	1	1N191 crystal diode (brown-white-brown)
(14) 56-35	1	Dual crystal diode (1N4951 marked on part)
(15) 57-27	1	750 milliampere silicon diode
57-46	1	Silicon diode (number marked on part)

NOTE: Each of the following transistors may look like any one of the transistors illustrated in the chart on the Parts Pictorial. When identifying each transistor, look for the number printed on the case. EXAMPLE: Transistor 417-108 may be marked 417-108, 2N3692, or 417-108/2N3692 (or in this last case, where 417-108 is also on the transistor, another number may be used in place of 2N3692).

(16) 417-108	1	2N3692 transistor
(17) 417-109	1	2N3566 transistor
(18) 417-114	2	2N3567 transistor
(19) 417-116	3	S2091 transistor

ITEMS FROM PACK #4

85-151P323P350	1	Sync-sweep circuit board
344-58	1	Gray hookup wire
331-6		Solder

STEP-BY-STEP ASSEMBLY

SYNC-SWEEP CIRCUIT BOARD (#85-151P323P350)

Position the sync-sweep circuit board on your work surface as shown in Pictorial 2-1. Then complete each step on the pictorial.

START

NOTE: In this Pictorial the circuit board is shown in two views, upper half and lower half.

( ) 5600 Ω (green-blue-red).

( ) 1000 Ω (brown-black-red).

( ) 4700 Ω (yellow-violet-red).

( ) 270 Ω (red-violet-brown).

( ) 100 Ω (brown-black-brown).

( ) 2.2 Ω (red-red-gold) 2 watt.

( ) 3300 Ω (orange-orange-red).

( ) 8200 Ω (gray-red-red).

( ) 820 KΩ (gray-red-yellow).

( ) 1500 Ω (brown-green-red).

( ) 10 KΩ (brown-black-orange).

( ) 3-1/2" gray hookup wire.

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 4700 Ω (yellow-violet-red).

( ) 560 Ω (green-blue-brown).

( ) 10 KΩ (brown-black-orange).

( ) 47 Ω (yellow-violet-black).

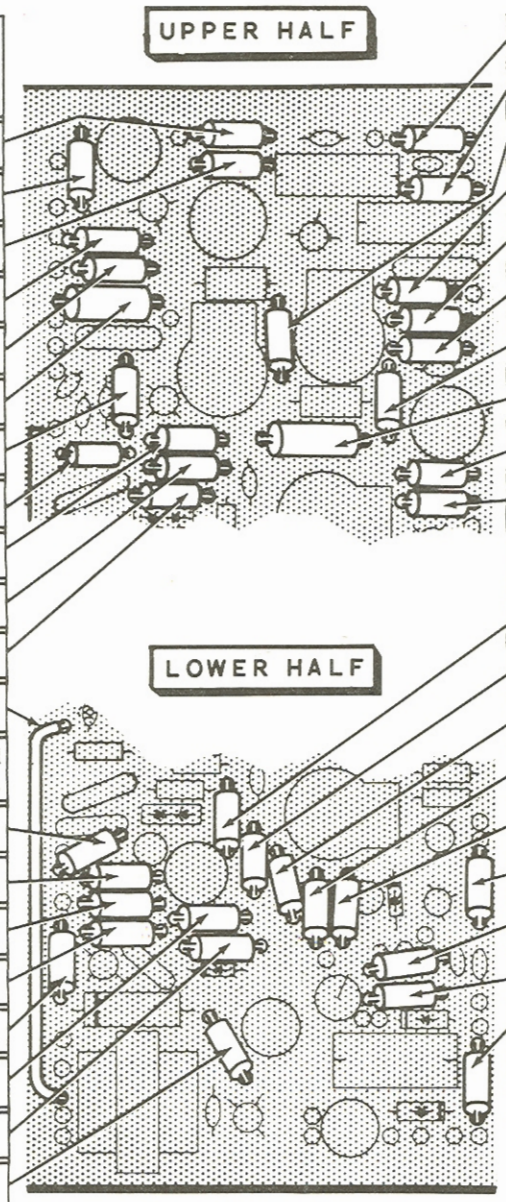
( ) 6800 Ω (blue-gray-red).

( ) 150 Ω (brown-green-brown).

( ) 180 Ω (brown-gray-brown).

( ) 560 Ω (green-blue-brown).

( ) Solder all leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) 100 KΩ (brown-black-yellow).

( ) 1000 Ω (brown-black-red).

( ) 56 Ω (green-blue-black).

( ) 1000 Ω (brown-black-red).

( ) 10 KΩ (brown-black-orange).

( ) 4700 Ω (yellow-violet-red).

( ) 18 KΩ (brown-gray-orange).

( ) 1 Ω (brown-black-gold) 2 watt.

( ) 820 Ω (gray-red-brown).

( ) 220 Ω (red-red-brown).

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 10 KΩ (brown-black-orange).

( ) 1000 Ω (brown-black-red).

( ) 47 Ω (yellow-violet-black).

( ) 470 Ω (yellow-violet-brown).

( ) 390 Ω (orange-white-brown).

( ) 2200 Ω (red-red-red).

( ) 220 Ω (red-red-brown).

( ) 100 KΩ (brown-black-yellow).

( ) 47 Ω (yellow-violet-black).

( ) Solder all leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 2-2.

PICTORIAL 2-1

NOTE: When installing each transistor in the following steps, look for the part or type number printed on the case.

EXAMPLE: Transistor 417-108 may be marked 417-108, 2N3692, or 417-108/2N3692 (or in this last case, where 417-108 is also on the transistor, another number may be used in place of 2N3692).

Then refer to drawings A, B, or C (fold-out from Page 12). These drawings show how to install the transistors, in Pictorial 2-2. When you install a transistor, follow the instructions in the drawing (A, B, or C) that physically corresponds to that particular type of transistor.

START

( ) Install transistor Q205 (#417-116/S2091).

( ) Install transistor Q204 (#417-116/S2091).

( ) Install transistor Q201 (#417-108/2N3692).

( ) Install transistor Q207 (#417-109/2N3566).

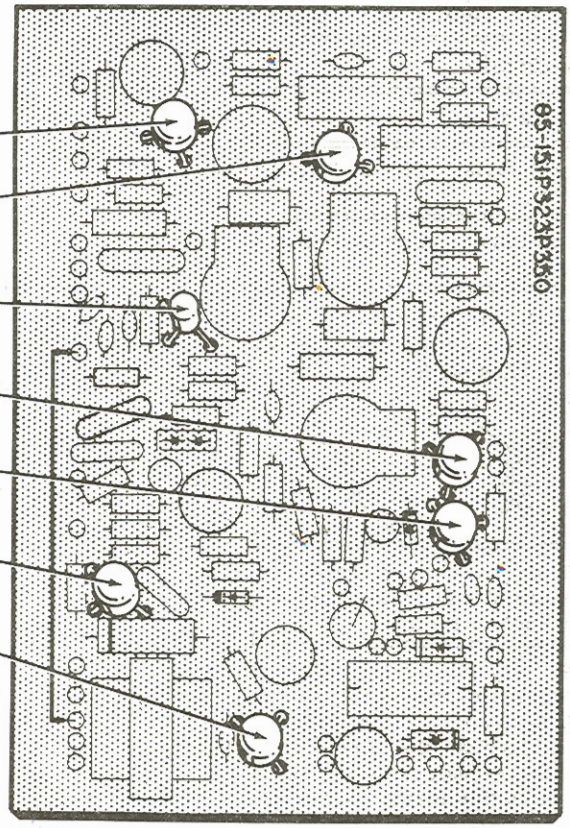
( ) Install transistor Q206 (#417-116/S2091).

( ) Install transistor Q202 (#417-114/2N3567).

( ) Install transistor Q203 (#417-114/2N3567).

( ) Make sure all connections are soldered.

PROCEED TO PICTORIAL 2-3.



PICTORIAL 2-2

START

( ) 18 µfd electrolytic. Position the positive (+) end as shown.

( ) .22 µfd Mylar (wide red band-yellow). NOTE: The Mylar capacitors may either be color coded or marked with a value.

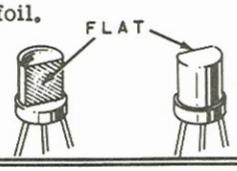
( ) .005 µfd disc.

( ) .001 µfd disc.

( ) .22 µfd Mylar (wide red band-yellow).

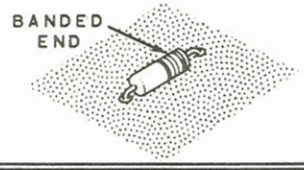
( ) .022 µfd Mylar (wide red band-orange).

( ) 1N4951 dual crystal diode. Mount the diode in either direction as shown. Then solder the leads to the foil.



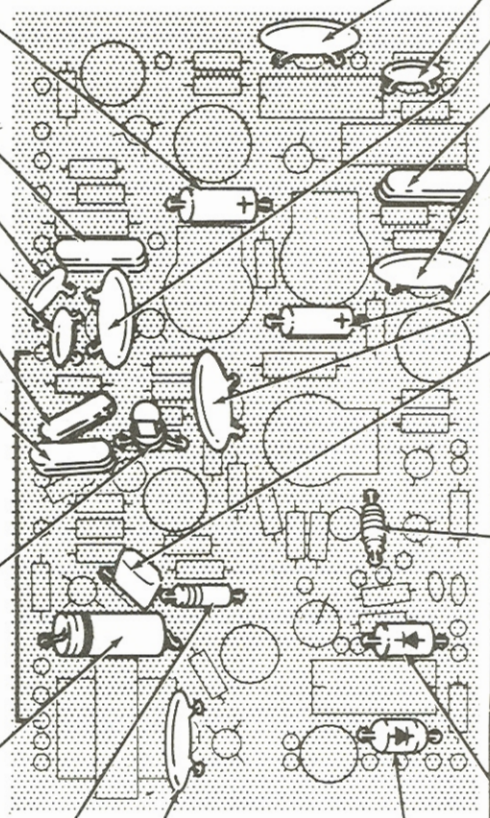
( ) 3900 pf polystyrene. Position the marked end (color band or color end) as shown.

( ) 1N191 crystal diode, #56-26, (brown-white-brown). Position the banded end as shown. NOTE: Do not confuse the banded end with the copper colored wire that is visible inside the diode.



( ) .02 µfd disc.

( ) Solder all leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) .02 µfd disc.

( ) .001 µfd disc.

( ) .05 µfd disc.

( ) .22 µfd Mylar (wide red band-yellow).

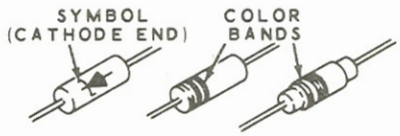
( ) .05 µfd disc.

( ) 33 µfd electrolytic. Position the positive (+) end as shown.

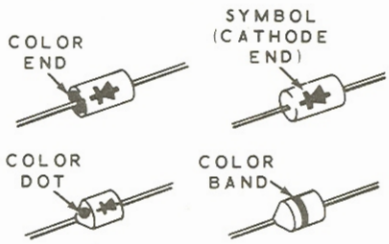
( ) .003 µfd disc.

( ) .033 µfd Mylar (wide orange band-orange).

( ) Zener diode. Be sure to position the cathode end of the diode as shown. NOTE: The cathode end is marked with either a symbol or color bands (violet-green-brown).



( ) Silicon diode (#57-27). Be sure to position the cathode end of the diode shown. NOTE: The cathode end is marked with either a symbol, a color dot, color end, or color band.



( ) Silicon diode (57-46 marked on part). Position the cathode end as shown.

( ) Solder all leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 2-4.

PICTORIAL 2-3

START

NOTE: After installing each of the following capacitors, turn the circuit board over and solder each lead to the foil. Then cut off the excess lead lengths.

( ) 250 µfd electrolytic. NOTE: When mounting the electrolytic capacitors, be sure to match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.

( ) 1000 µfd electrolytic.

( ) 500 Ω control (#10-171). NOTE: When mounting this type of control, push it firmly against the circuit board.

( ) 10 KΩ control (#10-201).

( ) 10 µfd 15 V electrolytic.

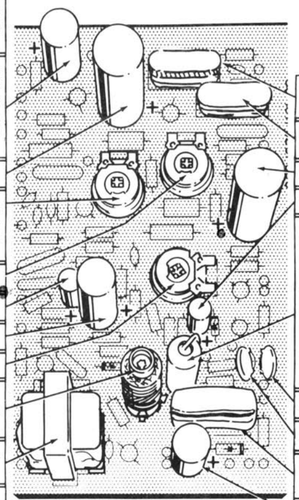
( ) 250 µfd electrolytic.

( ) 500 Ω control (#10-171).

( ) Horizontal blocking coil (#40-757). Observe the lug and hole spacing and then mount the coil.

( ) Horizontal driver transformer (#51-137).

( ) Make sure all connections are soldered.



CONTINUE

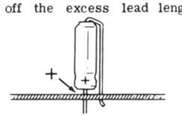
( ) .47 µfd Mylar (yellow-violet-yellow).

( ) .68 µfd Mylar (blue-gray-yellow).

( ) 1000 µfd electrolytic.

( ) 10 µfd 15 V electrolytic.

( ) 10 µfd 150 V electrolytic. Position the positive lead as shown. Then solder both leads and cut off the excess lead lengths.



( ) .001 µfd disc.

( ) .005 µfd disc.

( ) .12 µfd Mylar (brown-red-yellow).

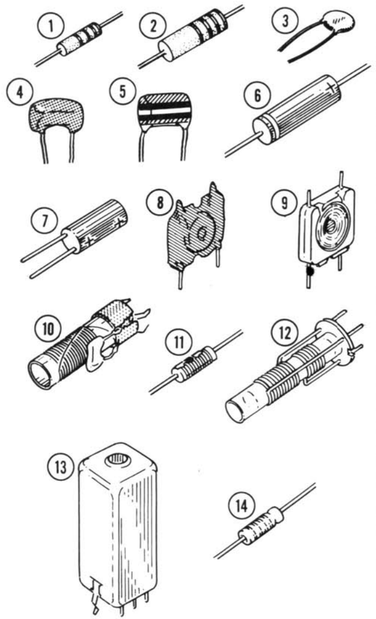
( ) 100 µfd electrolytic.

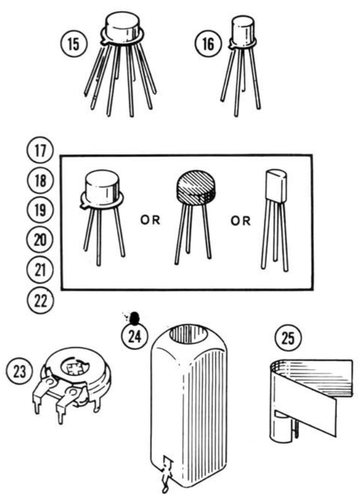
Carefully inspect the foil side of the circuit board and solder any connections that might have been missed. Then set this circuit board aside temporarily.

FINISH

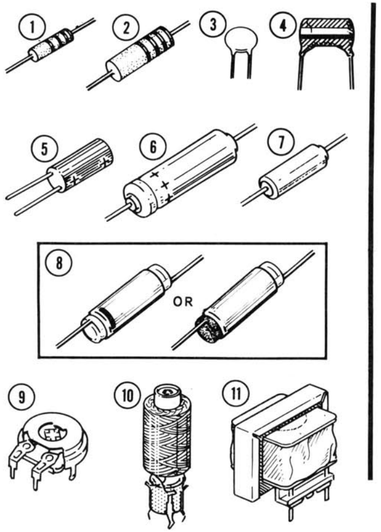
PICTORIAL 2-4

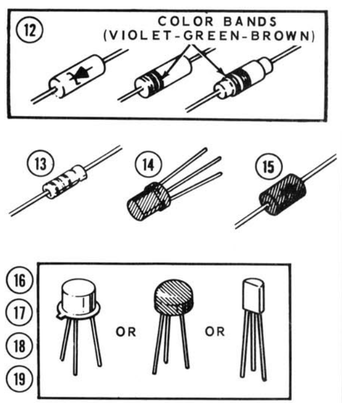
AUDIO-VIDEO PARTS PICTORIAL

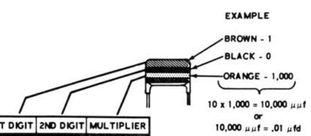




SYNC-SWEEP PARTS PICTORIAL

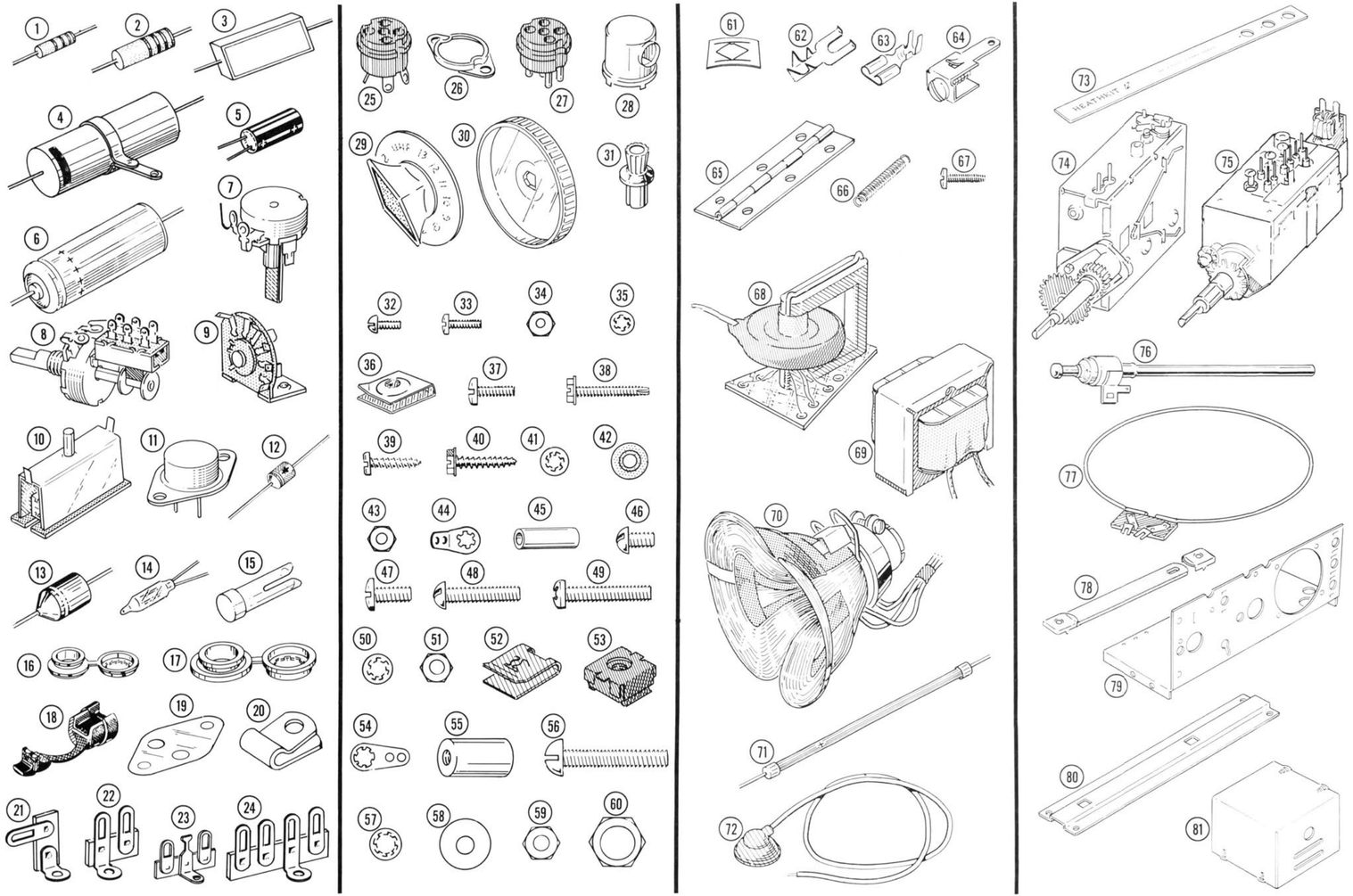






COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000

CHASSIS PARTS PICTORIAL



CHASSIS

PARTS LIST

Unpack the package marked 3. Check each part against the following Parts List. The numbers in parentheses are keyed to the numbers on the Chassis Parts Pictorial (fold-out from Page 20).

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
(1) 1-41	1	10 Ω 1/2 watt (brown-black-black)
1-6	1	470 Ω 1/2 watt (yellow-violet-brown)
1-9	1	1000 Ω 1/2 watt (brown-black-red)
1-47	2	56 KΩ 1/2 watt (green-blue-orange)
(2) 3B-2	1	.33 Ω 2 watt (orange-orange-silver)
(3) 3E-7	1	11 Ω 5 watt
3E-10	1	110 Ω 5 watt
CAPACITORS		
(4) 23-72	1	2 μfd 100 V tubular
(5) 25-115	2	10 μfd 15 V electrolytic
(6) 25-154	1	2500 μfd 30 V electrolytic
CONTROLS-SWITCH-CIRCUIT BREAKERS		
(7) 10-199	1	200 Ω control (Contrast)
10-198	1	5000 Ω (5 K) control (Horizontal Hold)
10-197	1	7500 Ω (7.5 K) control (Vertical Hold)
10-196	1	100 KΩ control (Brightness)
Controls-Switch-Circuit Breakers (cont'd.)		
(8) 19-102	1	5000 Ω (5 K) control with switch (Volume and OFF-ON)
(9) 63-419	1	Line cord switch
(10) 65-11	2	2.11 ampere circuit breaker
TRANSISTORS-DIODES-LAMPS		

NOTE: When identifying each transistor, look for the number printed on the case. EXAMPLE: Transistor #417-90 may be marked 417-90, 40050, or 417-90/40050 (or in this last case, where 417-90 is also on the transistor, another number may be used in place of 40050).

(11) 417-90	1	40050 transistor
417-112	1	2N3731 transistor
417-113	1	MP1613 transistor
(12) 57-27	1	750 milliampere silicon diode
(13) 57-42	2	3 ampere silicon diode
(14) 412-15	2	NE-2H neon lamp
(15) 413-11	2	Lamp lens
INSULATORS-TERMINAL STRIPS-SOCKET		
(16) 73-45	2	1/2" grommet
(17) 73-44	2	3/4" grommet
(18) 75-24	1	Line cord strain relief

PART No.	PARTS Per Kit	DESCRIPTION
Insulators-Terminal Strips-Socket (cont'd.)		
(19)75-44	2	Mica insulator (packed between two pieces of cardboard)
(20)207-3	1	1/8" cable clamp
207-18	3	3/8" cable clamp
(21)431-50	1	Short vertical terminal strip
431-25	1	Long vertical terminal strip
(22) 431-16	1	2-lug terminal strip
(23) 431-62	1	3-lug miniature terminal strip
(24) 431-40	1	4-lug terminal strip
431-45	1	6-lug terminal strip
(25)434-162	1	5-pin socket
(26)481-5	1	Plug mount
(27)438-37	1	5-pin plug
(28)440-9	1	Socket cap
434-163	1	7-pin socket with leads
KNOBS		
(29)462-233	1	VHF Channel Selector
(30)462-234	1	VHF Tuning
462-236	1	UHF Channel Selector
462-235	1	UHF Tuning
(31)462-237	5	Control knobs
HARDWARE		
#4 Hardware		
(32)250-3	2	4-40 x 3/16" screw
(33)250-213	29	4-40 x 5/16" screw
(34)252-2	16	4-40 nut
(35)254-9	19	#4 lockwasher
(36)252-89	14	#4 speednut
#6 Hardware		
(37)250-89	17	6-32 x 3/8" screw
(38)250-298	2	6-32 x 3/4" self-tapping screw
(39)250-284	4	#6 x 1/2" sheet metal screw
(40)250-252	1	#6 x 5/8" bronze screw
(41)254-1	23	#6 lockwasher
(42)253-2	4	#6 fiber shoulder washer
(43)252-3	17	6-32 nut
(44)259-1	4	#6 solder lug
(45)255-15	2	#6 x 1/2" spacer
#8 Hardware		
(46)250-17	1	8-32 x 1/4" screw
(47)250-137	19	8-32 x 3/8" screw
(48)250-72	2	8-32 x 3/4" screw
(49)250-297	4	8-32 x 7/8" phillips head screw
(50)254-2	17	#8 lockwasher

PART No.	PARTS Per Kit	DESCRIPTION
#8 Hardware (cont'd.)		
(51)252-4	2	8-32 nut
(52)252-68	7	#8 speednut
(53)252-92	4	8-32 self-retaining nut
(54)259-2	3	#8 solder lug
(55)255-68	2	9/16" long spacer
#10 Hardware		
(56)250-191	2	10-24 x 1-1/8" screw
(57)254-3	2	#10 lockwasher
(58)253-42	1	#10 flat washer
(59)252-30	2	10-24 nut
Other Hardware		
(60)252-7	1	Control nut
(61)252-32	2	Speednut
(62)259-22	1	Spade lug
(63)432-66	5	Connector
(64)432-68	4	Antenna terminal
(65)265-7	2	Hinge
(66)258-1	1	Coil spring
(67)250-295	1	5-40 x 3/8" self-tapping screw
MISCELLANEOUS		
345-1	1	Wire braid
134-37	1	UHF-VHF shielded cable
ITEMS FROM PACK #4		
92-37	1	Cabinet
92-38	1	Front panel
(68) 51-138	1	Horizontal output transformer
(69) 46-40	1	Vertical output choke
54-171	1	Power transformer
(70)58-8	1	Deflection yoke
(71)57-45	1	15.5 kilovolt selenium diode
340-2	1	Bare wire
344-16	1	Red stranded wire
344-50	1	Black hookup wire
344-58	1	Gray hookup wire
347-2	1	Twin lead
343-9	1	Large coaxial cable
343-7	1	Small coaxial cable
134-133	1	Wire harness
89-26	1	Line cord
346-1	1	Black sleeving
346-23	1	Large clear sleeving
346-7	1	Small clear sleeving
(72)432-49	1	High voltage lead with connector
(73)205-530	1	Front panel trim strip
(74)110-35	1	UHF tuner
(75)110-36	1	VHF tuner
(76)142-111	1	VHF whip antenna

PART No.	PARTS Per Kit	DESCRIPTION
Items From Pack #4 (cont'd.)		
(77)142-112	1	UHF loop antenna
(78)211-31	1	Plastic handle
401-109	1	3" speaker
411-224	1	12CEP4 picture tube
200-M472	1	Chassis
(79)204-M730	1	Control bracket
(80)204-M731	1	Handle bracket

PART No.	PARTS Per Kit	DESCRIPTION
Items From Pack #4 (cont'd.)		
(81)206-M307	1	High voltage shield
490-1	1	Plastic alignment tool
490-5	1	Nut starter
390-135	1	FCC label
390-170	1	Transistor location label
391-34	1	Blue and white label
597-260	1	Parts order form

STEP-BY-STEP ASSEMBLY

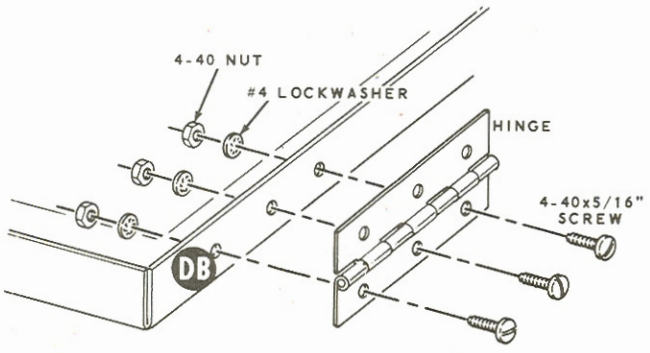
CHASSIS PARTS MOUNTING

Refer to Pictorial 3-1 (fold-out from Page 27) for the following steps.

( ) Locate the chassis and position it on your work surface as shown.

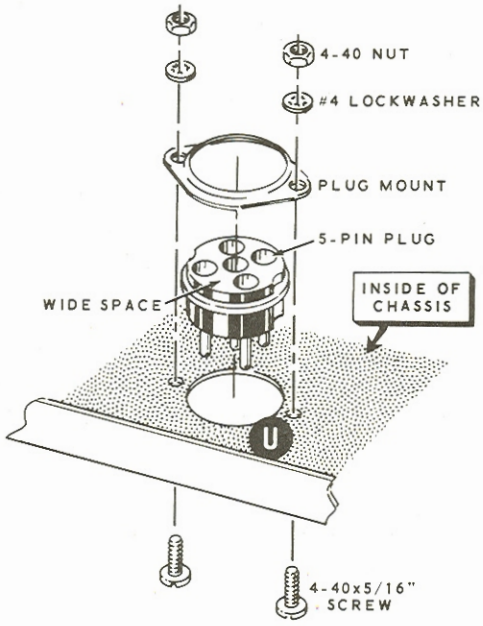
NOTE: The Heath Company has provided a plastic nut starter with this kit. Use this nut starter to hold and start 6-32 and 4-40 nuts on screws. Refer to Page 3 of the Kit Builders Guide for further information.

( ) Mount hinges at locations DA and DB. Use 4-40 x 5/16" screws, #4 lockwashers, and 4-40 nuts as shown in Detail 3-1A.



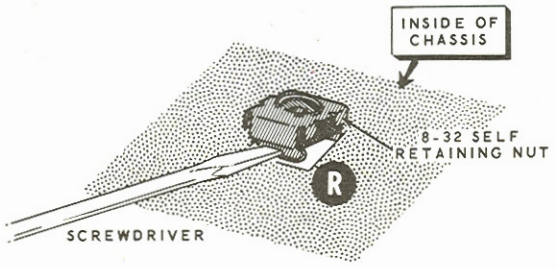
Detail 3-1A

( ) Place the plug mount on the 5-pin plug as shown in Detail 3-1B. Position the plug with the wide space toward the chassis flange as shown at U in the Pictorial. Then mount it with 4-40 x 5/16" screws, #4 lockwashers, and 4-40 nuts.

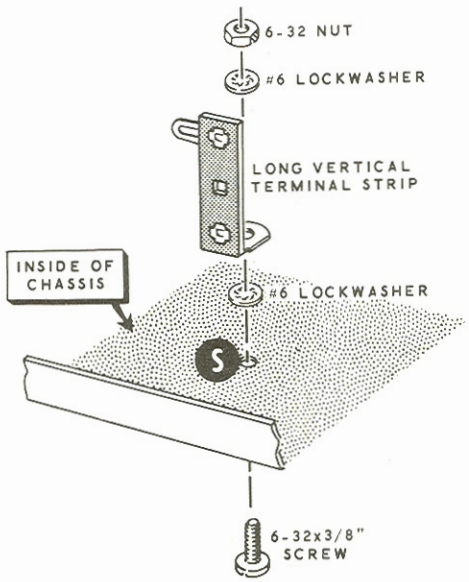


Detail 3-1B

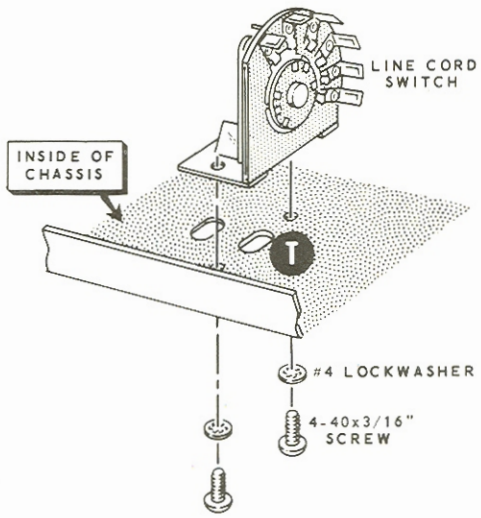
( ) Install 8-32 self-retaining nuts at R and X as shown in Detail 3-1C.



Detail 3-1C



Detail 3-1D



Detail 3-1E

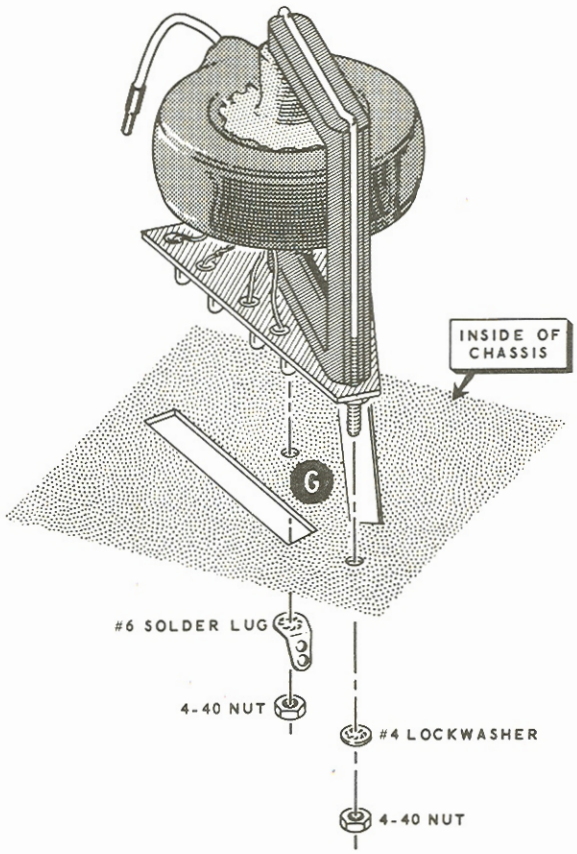
( ) Mount the long vertical terminal strip at S. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut. Refer to Detail 3-1D.

( ) Similarly mount the 2-lug terminal strip at Y. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut. Position the terminal strip as shown.

( ) Mount the line cord switch at T. Use 4-40 x 3/16" screws and #4 lockwashers. Refer to Detail 3-1E.

NOTE: In the following step, handle the high voltage transformer carefully to avoid breaking the thin wires.

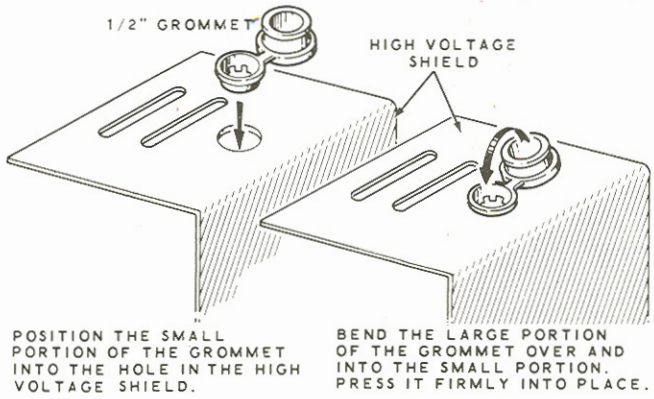
( ) Mount the horizontal output transformer at G. Use one #4 lockwasher, one #6 solder lug, and two 4-40 nuts. Position the solder lug as shown in Detail 3-1F. Before tightening the mounting nuts, center the transformer lugs in the chassis slots.



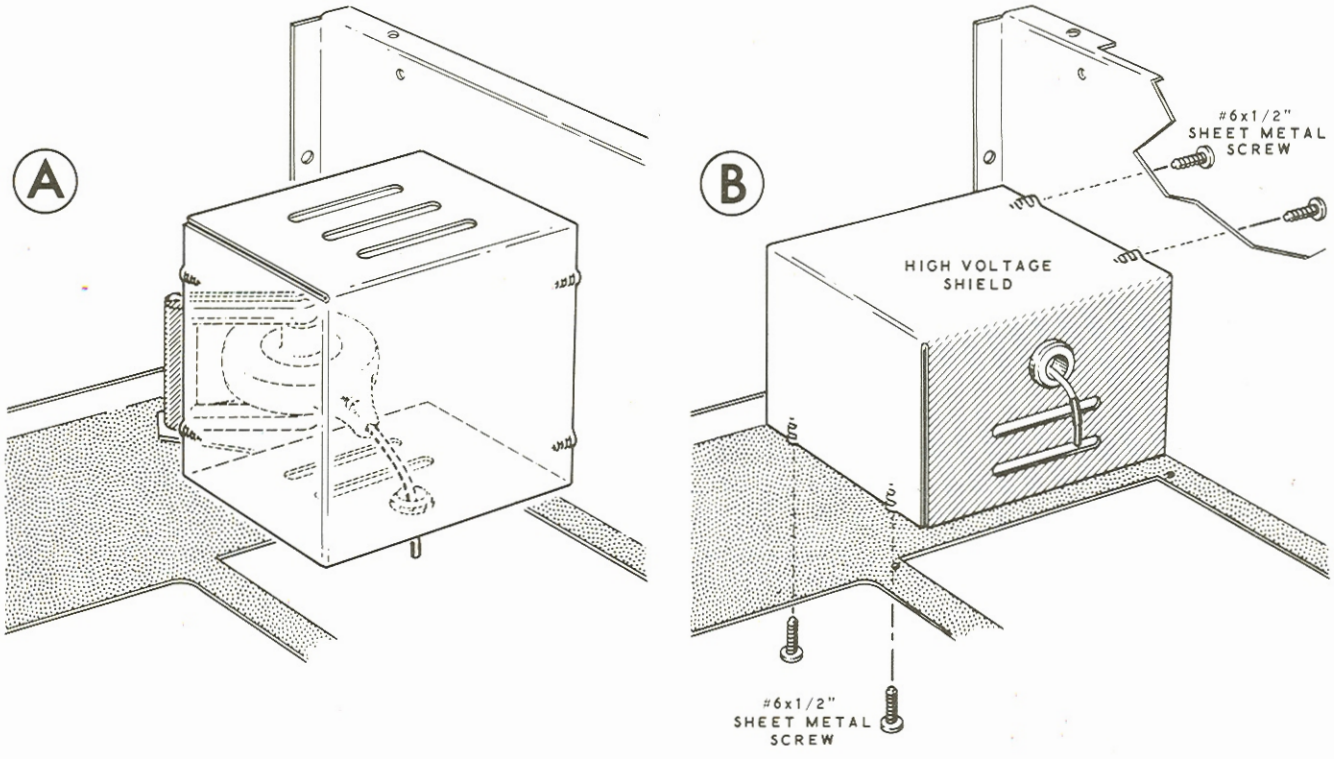
Detail 3-1F

( ) Locate the high voltage shield. Install a 1/2" grommet in the hole as shown in Detail 3-1G.

( ) Position the high voltage shield as shown in Part A of Detail 3-1H. Then insert the transformer lead through the grommet, place the shield over the transformer, and fasten the shield with four #6 x 1/2" sheet metal screws. Refer to Part B of Detail 3-1H.



Detail 3-1G



Detail 3-1H

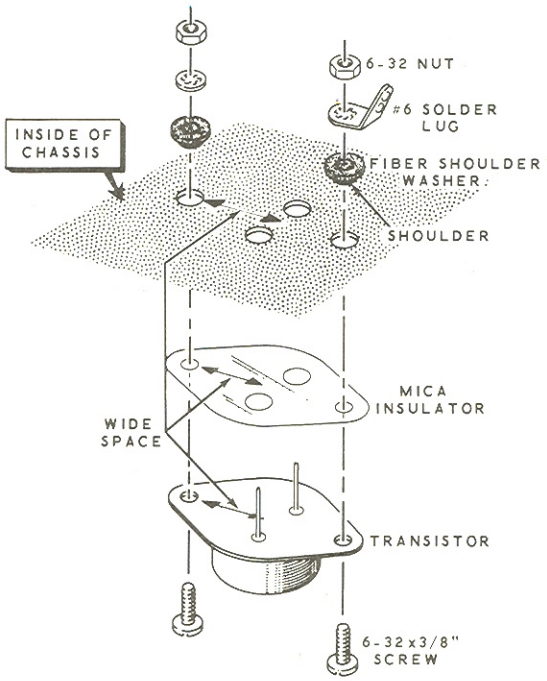
Refer to Detail 3-1J for the following steps.

( ) Locate the 417-90/40050 transistor, 417-113/MP1613 transistor, and two mica insulators.

NOTE: In the following two steps, observe the spacing on the transistors, mica insulators, and chassis as shown in Detail 3-1J.

( ) Mount the 417-90/40050 transistor and mica insulator at K. Use two 6-32 x 3/8" screws, two fiber shoulder washers, one #6 lockwasher, one #6 solder lug, and two 6-32 nuts. Make sure the shoulder of each fiber washer seats properly in its chassis hole.

( ) Similarly mount the 417-113/MP1613 transistor at A.

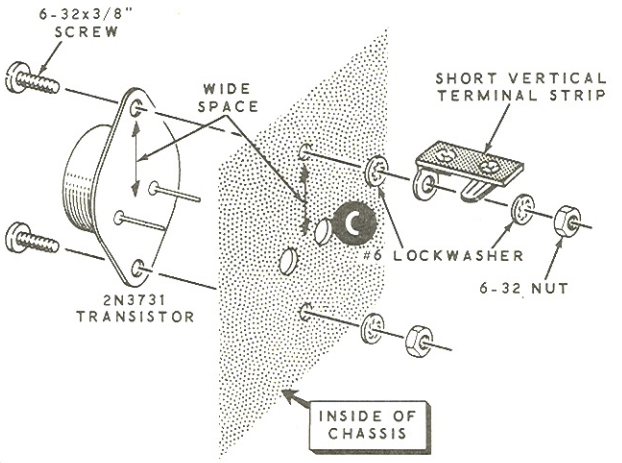


Detail 3-1J

Refer to Detail 3-1K for the following steps.

( ) Locate the 417-112/2N3731 transistor and short vertical terminal strip.

( ) Observe the spacing on the transistor and chassis. Then mount the transistor at C. Use two 6-32 x 3/8" screws, three #6 lockwashers, two 6-32 nuts, and a short vertical terminal strip. Use two lockwashers at the terminal strip as shown.



Detail 3-1K

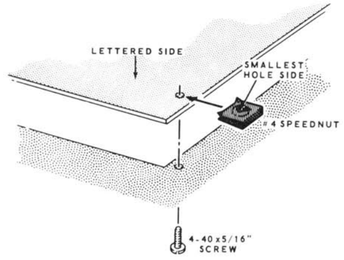
(✓) Locate three #8 speednuts. Pinch the indicated ends together slightly with a pair of long-nose pliers. See the inset drawing on Pictorial 3-1 (fold-out from this Page).

(✓) Position the speed nuts with the round hole side as shown. Then mount them at AA, AB, and AC.

(✓) Locate both circuit boards and fourteen #4 speednuts.

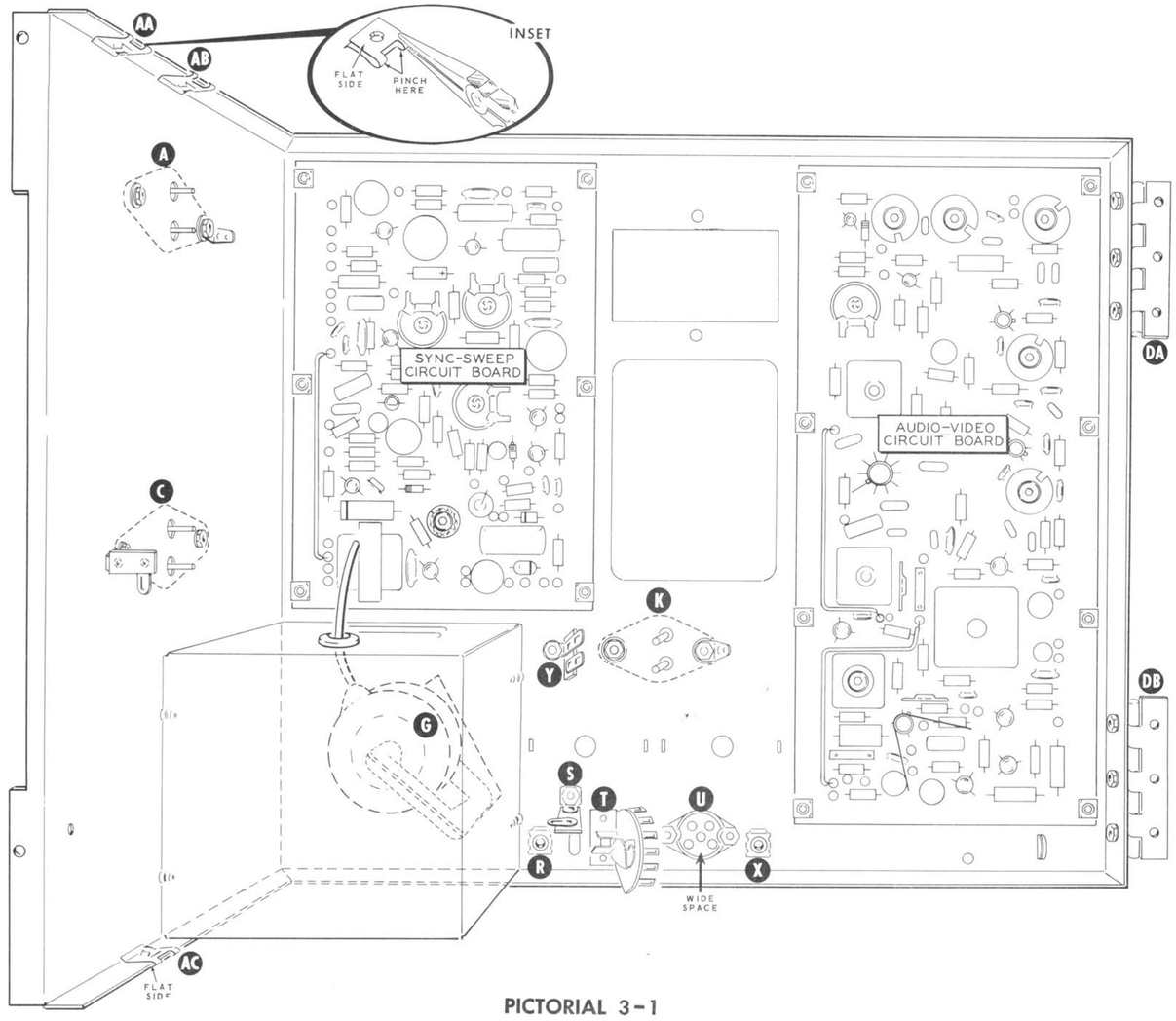
(✓) Position the circuit boards with the lettered side up as shown in Detail 3-1L. Position the speednuts with the flat side as shown, and then push them in place over the holes in the circuit boards.

(✓) Position the sync-sweep circuit board as shown in Pictorial 3-1. Then install it on the chassis with six 4-40 x 5/16" screws. Refer to Detail 3-1L. Be careful not to overtighten the screws, to avoid stripping the threads.

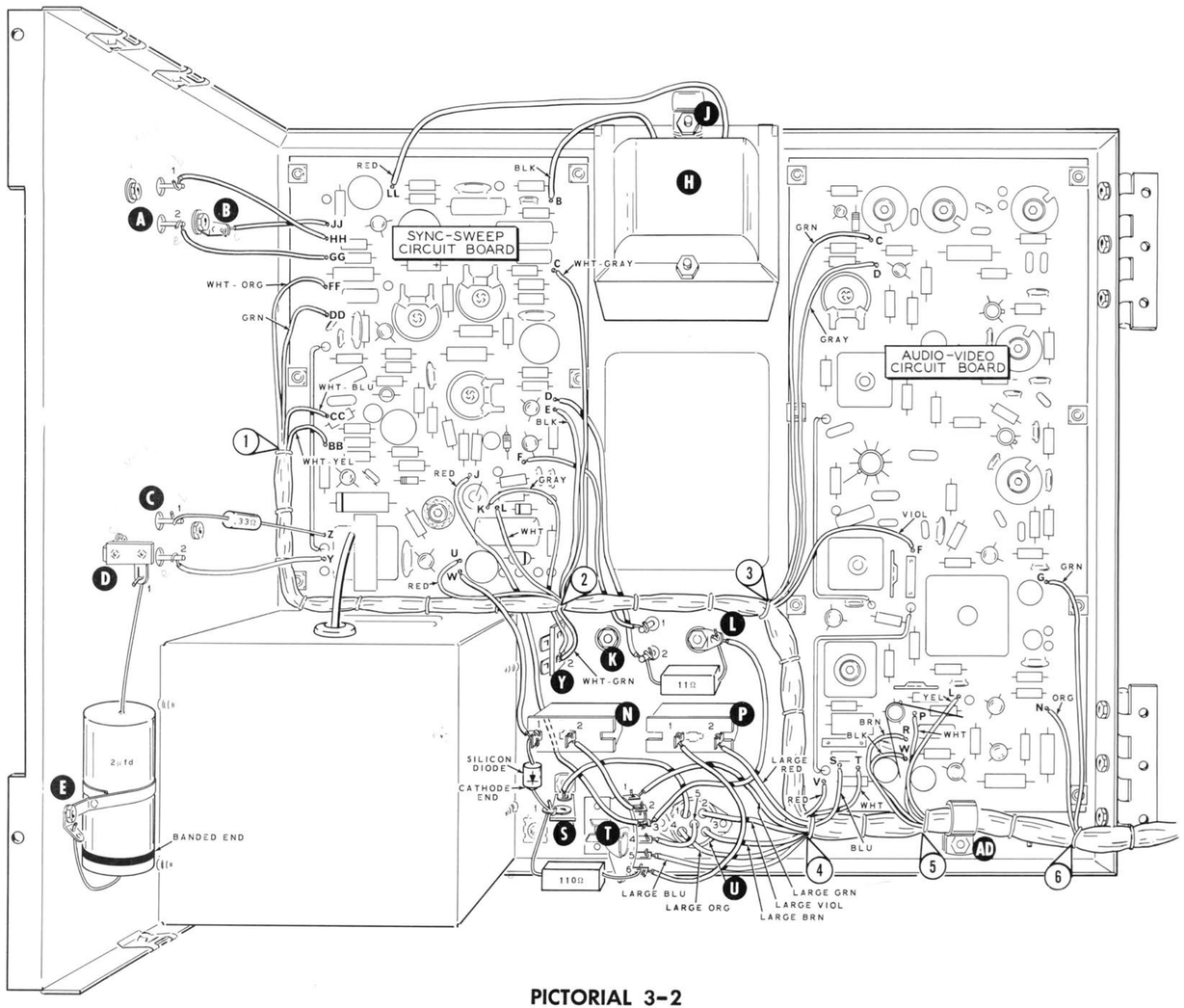


Detail 3-1L

(✓) Position the audio-video circuit board as shown in Pictorial 3-1. Then install it on the chassis with eight 4-40 x 5/16" screws. Be sure to position the circuit board under the hinge screws at locations DA and DB.



PICTORIAL 3-1



PICTORIAL 3-2

HEATHKIT

CHASSIS WIRING

Refer to Pictorial 3-2 for the following steps.

NOTE: When wiring this kit you may find it easier to prepare the lengths of hookup wire ahead of time as in the following step. To prepare a wire, cut it to the indicated length and strip 1/4" of insulation from each end. The wires are listed in the order in which they will be used.

( ) Prepare the following lengths of hookup wire:

4-1/2" gray	4" gray
5" red stranded	1-3/4" red stranded
5" red stranded	2" gray
8-1/2" red stranded	3" black
	3" gray

NOTE: When you connect wires to the transistor lugs, wrap the wire around near the end of the lug.

( ) Connect a 4-1/2" gray wire from F on the sync-sweep circuit board (S-1) to lug 1 of transistor K (S-1).

( ) Connect a 5" red stranded wire from D on the sync-sweep circuit board (S-1) to lug 2 of transistor K (NS).

( ) Connect an 11 Ω 5 watt resistor from lug 2 of transistor K (S-2) to solder lug L (NS).

( ) Connect a 5" red stranded wire from solder lug L (S-2) to lug 3 of switch T (NS).

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

( ) Remove an additional 1/2" of insulation from one end of an 8-1/2" red stranded wire. Connect this end through lug 3 (S-3) to lug 2 (NS) of switch T.

( ) Connect the other end of this wire to J on the sync-sweep circuit board (S-1). Route the wire as shown.

( ) Connect a 4" gray wire from K on the sync-sweep circuit board (S-1) to the eyelet (bottom hole) in lug 2 of terminal strip Y (NS).

( ) Connect a 1-3/4" red stranded wire to lug 2 of switch T (S-2). The other end of this wire will be connected later.

( ) Connect a 2" gray hookup wire from solder lug B (S-1) to JJ on the circuit board (S-1).

( ) Connect a 3" black hookup wire from lug 1 of transistor A (S-1) to HH on the circuit board (S-1).

( ) Connect a 3" gray hookup wire from lug 2 of transistor A (S-1) to GG on the circuit board (S-1).

( ) Locate the wire harness. Position it on your work surface so the wires at breakouts 1 through 9 are placed as shown in Detail 3-2A.

( ) Place the harness on the chassis with breakouts 1, 2, 3, 4, 5, and 6 positioned as shown in Pictorial 3-2.

( ) Place a 3/8" cable clamp around the harness wires at AD. Fasten the clamp to the chassis with a 6-32 x 3/8" screw, #6 lockwasher, and 6-32 nut.

Connect the wires from breakout 1 to the sync-sweep circuit board as follows:

( ) White-yellow to BB (S-1).

( ) White-blue to CC (S-1).

( ) Green to DD (S-1).

( ) White-orange to FF (S-1).

Connect the wires from breakout 2 to the sync-sweep circuit board as follows:

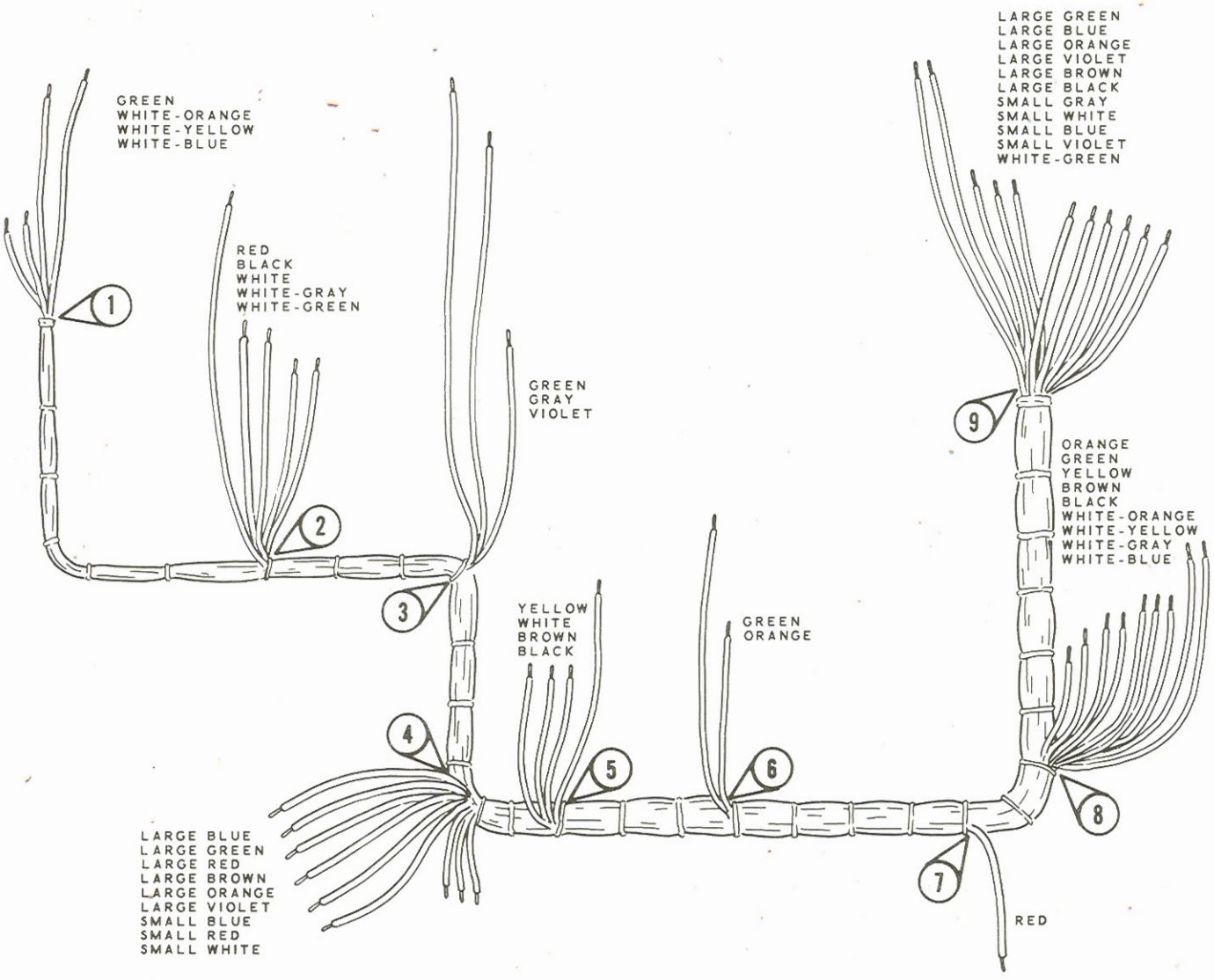
( ) Red to U (S-1).

( ) White to L (S-1).

( ) Black to E (S-1).

( ) White-gray to C (S-1).

( ) White-green to the eyelet in lug 2 of terminal strip Y (S-2).



Detail 3-2A

Connect the wires from breakouts 3 and 4 to the audio-video circuit board as follows:

( ) Green from breakout 3 to C (S-1).

( ) Gray from breakout 3 to D (S-1).

( ) Violet from breakout 3 to F (S-1).

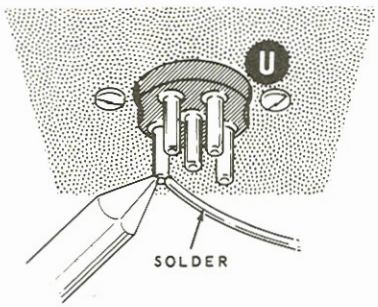
( ) Small red from breakout 4 to V (S-1).

( ) Small white from breakout 4 to T (S-1).

( ) Small blue from breakout 4 to S (S-1).

( ) Large green wire from breakout 4 to lug 1 of switch T (S-1).

( ) Large blue wire from breakout 4 to lug 5 of switch T (S-1).



Detail 3-2B

NOTE: Wire plug U in the next five steps as shown in Detail 3-2B. Push each wire all the way into the correct pin. Brace the chassis so the plug is at an angle and then solder the pin as shown. With the plug in this position the solder is drawn inside the pin by "capillary" action. Use a small amount of solder to avoid getting a small ball at the end of the pin. After the solder has had time to harden, pull on the wire slightly to make sure it has been soldered.

( ) Large violet wire from breakout 4 to pin 2 (S-1).

( ) Large brown wire from breakout 4 to pin 3 (S-1).

( ) Large orange wire from breakout 4 to pin 4 (S-1).

( ) Connect a 3" red stranded wire from pin 1 of plug U (S-1) to the hole in the mounting foot of terminal strip S (S-1).

( ) Connect a 2" red stranded wire from pin 5 of plug U (S-1) to lug 4 of switch T (S-1).

NOTE: The remaining red wire from breakout 4 will be connected later.

Connect the wires from breakouts 5 and 6 to the audio-video circuit board as follows:

( ) Black from breakout 5 to W (S-1).

( ) Brown from breakout 5 to R (S-1).

( ) White from breakout 5 to P (S-1).

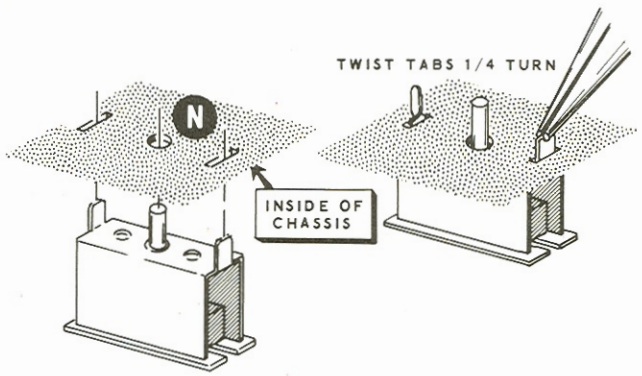
( ) Yellow from breakout 5 to L (S-1).

( ) Orange from breakout 6 to N (S-1).

( ) Green from breakout 6 to G (S-1).

NOTE: The wires from breakouts 7, 8, and 9 will be connected later.

( ) Mount circuit breakers at N and P as shown in Detail 3-2C. Position lugs 1 and 2 of each circuit breaker as shown in the Pictorial.



Detail 3-2C

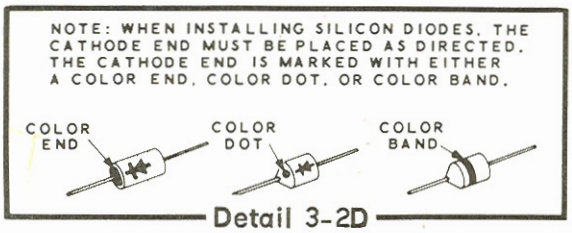
( ) Connect the large red wire from breakout 4 to lug 2 of circuit breaker P (S-1).

( ) Connect a 3" red stranded wire from lug 1 of circuit breaker P (S-1) to lug 6 of switch T (NS).

( ) Connect the free end of the red wire coming from lug 2 of switch T, to lug 2 of circuit breaker N (S-1).

( ) Connect a 4" red stranded wire from lug 1 of circuit breaker N (NS) to W on the sync-sweep circuit board (S-1).

NOTE: When installing silicon diodes, be sure to place the cathode end as directed. The cathode end is marked with either a color end, color dot, or color band. See Detail 3-2D.



Detail 3-2D

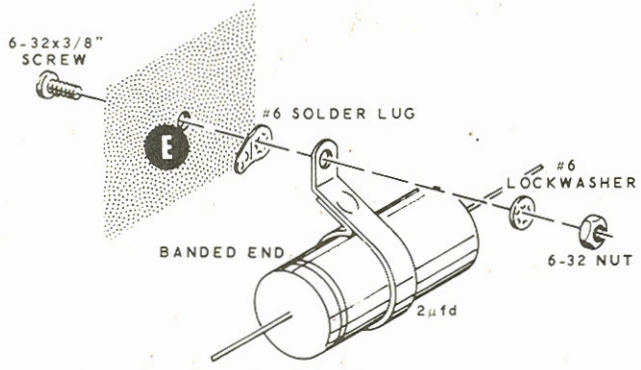
( ) Connect the cathode end of a 750 milliampere silicon diode (the small diode) to lug 1 of terminal strip S (NS). Connect the other end to lug 1 of circuit breaker N (S-2).

( ) Connect a 110 Ω 5 watt resistor from lug 1 of terminal strip S (NS) to lug 6 of switch T (S-2).

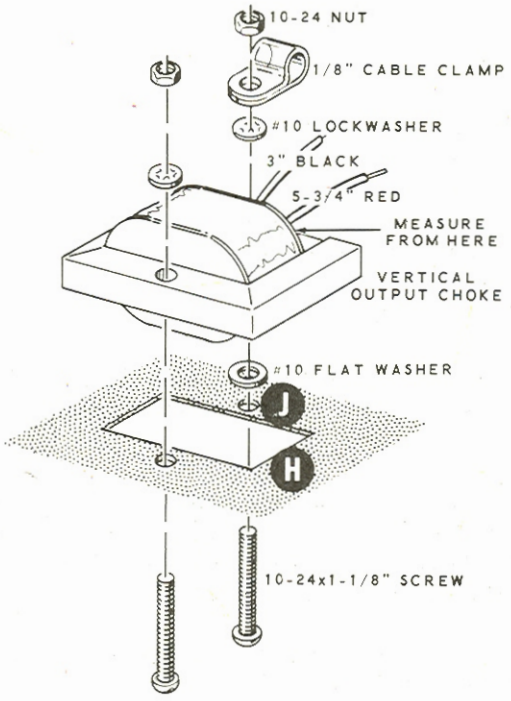
( ) Connect a .33 Ω (orange-orange-silver) 2 watt resistor from Z on the sync-sweep circuit board (S-1) to lug 1 of transistor C (S-1).

( ) Connect a 3" gray hookup wire from Y on the sync-sweep circuit board (S-1) to lug 2 of transistor C (NS).

( ) Mount a 2 μfd tubular capacitor at E. Use a 6-32 x 3/8" screw, #6 solder lug, #6 lockwasher, and 6-32 nut as shown in Detail 3-2E. Position the banded end of the capacitor as shown.



Detail 3-2E



Detail 3-2F

( ) Connect the lead at the banded end of the capacitor to solder lug E (S-1). Connect the other lead to lug 1 of terminal strip D (NS).

Refer to Detail 3-2F for the following steps.

( ) Locate the vertical output choke (#46-40). Cut the leads to the dimensions shown in Detail 3-2F (measure the leads from where they come out of the transformer). Then remove 1/4" of insulation from the ends of the leads.

( ) Position the choke with the leads as shown and mount it at H. Use a 10-24 x 1-1/8" screw, #10 flat washer, #10 lockwasher, 1/8" cable clamp, and 10-24 nut at hole J. Use a 10-24 x 1-1/8" screw, #10 lockwasher, and 10-24 nut at the other mounting hole.

( ) Connect the red choke lead to LL on the sync-sweep circuit board (S-1). Connect the black lead to B (S-1).

( ) Set the chassis aside temporarily.

CONTROL PANEL PARTS MOUNTING

Refer to Pictorial 3-3 for the following steps.

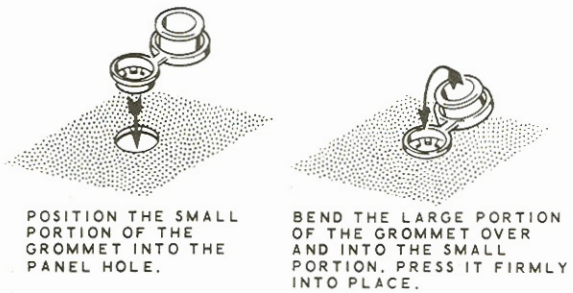
( ) Locate the control panel and position it as shown.

( ) Locate three #8 speednuts. Pinch the indicated ends together slightly with a pair of long-nose pliers. See inset drawing #2 on Pictorial 3-3.

( ) Position the speednuts with the flat side as shown. Then mount them at BJ, BK, and BL.

( ) Mount the control panel to the chassis hinges. Use 4-40 x 5/16" screws, #4 lockwashers, and 4-40 nuts as shown in the inset drawing #1 on Pictorial 3-3.

( ) Install 3/4" grommets at AD and AK as shown in Detail 3-3A.



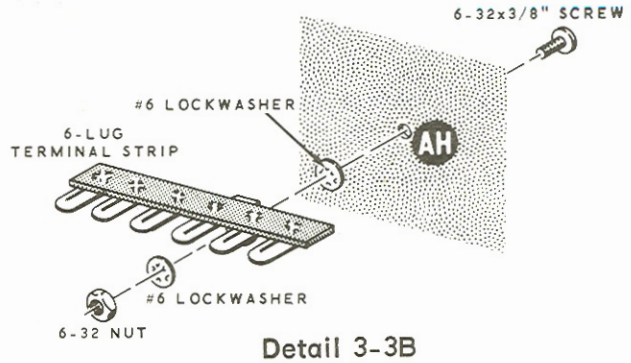
Detail 3-3A

( ) Similarly install a 1/2" grommet at AG.

( ) Mount a 6-lug terminal strip at AH with a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut. Refer to Detail 3-3B.

( ) Insert the free end of the harness through grommet AK as shown.

( ) Place a 3/8" cable clamp around the harness at breakout 7. Fasten the clamp with a 6-32 x 3/8" screw, #6 lockwasher, and 6-32 nut.



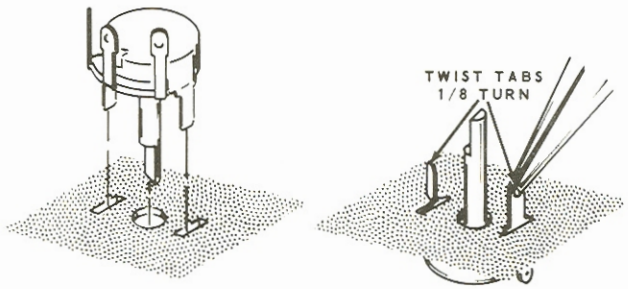
Detail 3-3B

Refer to Pictorial 3-4 (fold-out from Page 37) for the following steps.

( ) Turn the chassis and control panel around and position them as shown.

( ) Route the harness along the bend in the control panel. Place a 3/8" cable clamp around the cable and fasten the clamp at AF. Use a 6-32 x 3/8" screw, #6 lockwasher, and 6-32 nut.

NOTE: To mount the following controls, insert both tabs in the control panel slots. Then twist the tabs 1/8 turn with a pair of long-nose pliers. Refer to Detail 3-4A.



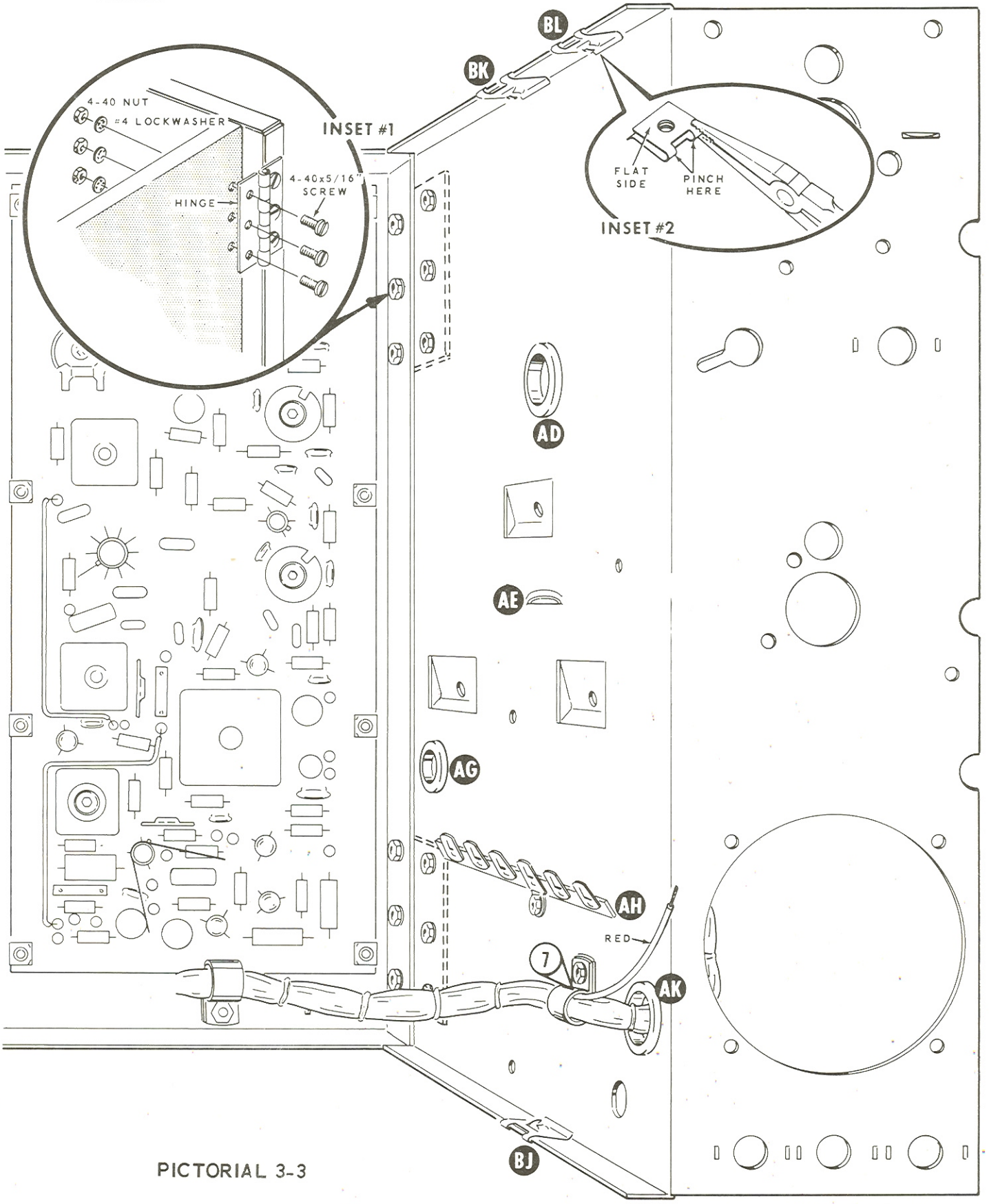
Detail 3-4A

( ) Mount a 200 Ω control (#10-199) at AX.

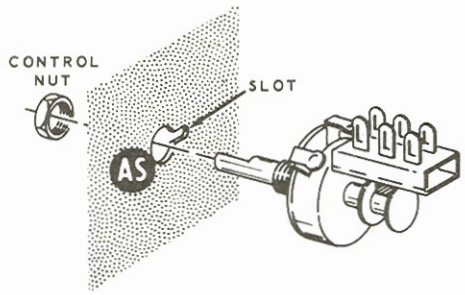
( ) Mount a 7500 Ω control (#10-197) at AY.

( ) Mount a 5000 Ω control (#10-198) at AZ.

( ) Mount a 100 KΩ control (#10-196) at AR.



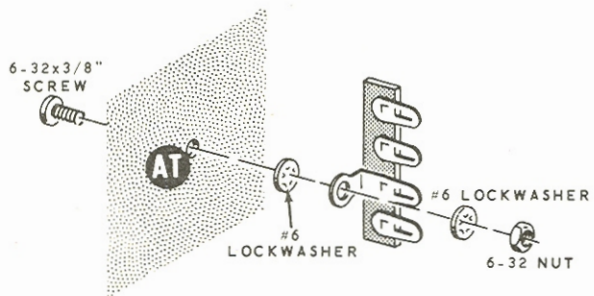
PICTORIAL 3-3



Detail 3-4B

( ) Mount a 5000 Ω control with switch (#19-102) at AS. Position the locating tab in the slot, and then fasten the control with a control nut. Refer to Detail 3-4B.

( ) Mount a 4-lug terminal strip at AT. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut. Refer to Detail 3-4C.



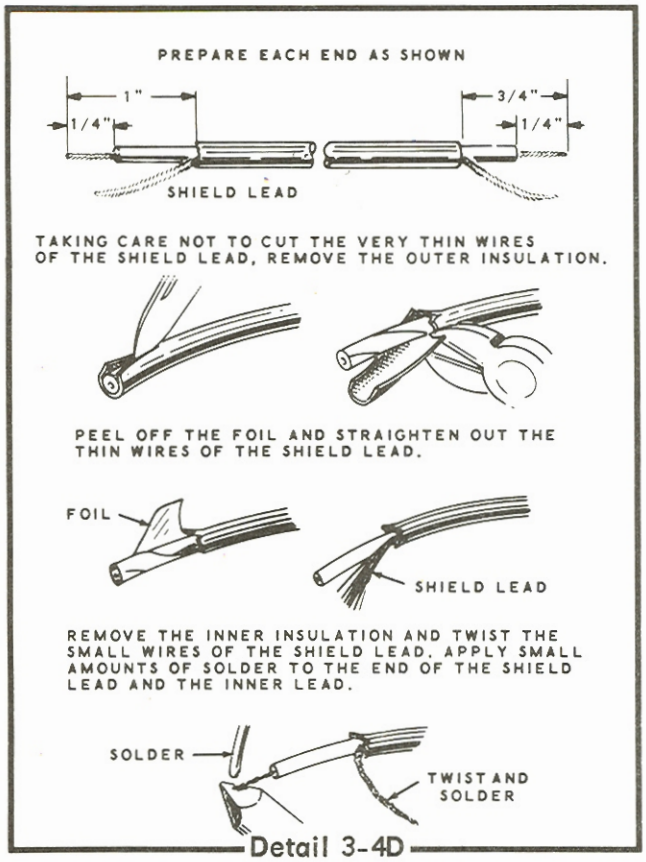
Detail 3-4C

CONTROL PANEL WIRING

( ) Refer to Detail 3-4D, and prepare two 11" coaxial cables. Use the small cable.

Refer to Part A of Detail 3-4E for the following steps.

( ) Place a 1/2" length of black sleeving on the shield lead at the 3/4" stripped end of the 11" cable. Connect this shield lead to lug 1 (NS) and the center lead to lug 2 (S-1) of control AS. Insert the other end of the cable through grommet AD to be connected later.



Detail 3-4D

( ) Cut off the shield lead from the short end of the remaining cable.

( ) Place a 1/2" length of black sleeving on the remaining shield lead of the cable. Connect this shield lead to lug 1 (S-2) and the center lead to lug 3 (S-1) of control AS. Insert the other end of the cable through grommet AD to be connected later.

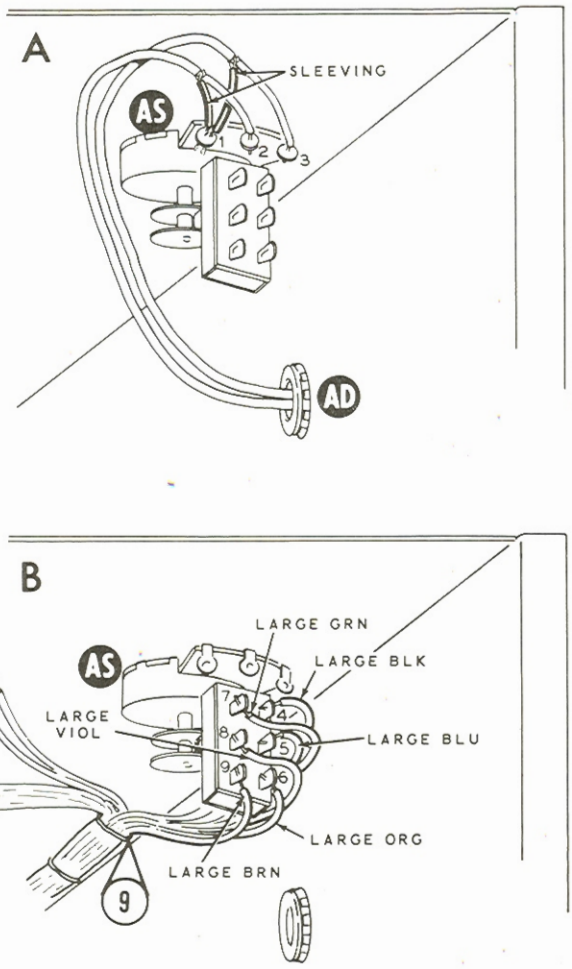
Refer to Part B of Detail 3-4E for the following steps.

NOTE: When you connect the harness wires in the following steps, insert each wire into the correct lug. It is not necessary to bend the wire around the lug. Before soldering, make sure the end of the wire does not touch other lugs.

Connect the wires from breakout 9 to switch AS as follows:

( ) Large black to lug 4 (S-1).

( ) Large blue to lug 5 (S-1).



Detail 3-4E

( ) Large orange to lug 6 (S-1).

( ) Large green to lug 7 (S-1).

( ) Large violet to lug 8 (S-1).

( ) Large brown to lug 9 (S-1).

Refer to Pictorial 3-4 for the following steps.

( ) Small blue to lug 3 of control AR (S-1).

( ) Small white to lug 2 of control AR (S-1).

( ) White-green to lug 4 of terminal strip AT (NS).

NOTE: The gray and the violet wires from breakout 9 will be connected later.

Connect the wires from breakout 8 as follows:

( ) White-blue to lug 2 of control AZ (S-1).

( ) White-yellow to lug 1 of control AZ (S-1).

( ) White-gray to lug 3 of control AY (S-1).

( ) White-orange to lug 2 of control AY (S-1).

( ) Yellow to lug 3 of control AX (S-1).

( ) Green to lug 2 of control AX (S-1).

( ) Orange to lug 1 of control AX (S-1).

NOTE: The brown and the black wires from breakout 8 will be connected later.

( ) Connect a 56 KΩ (green-blue-orange) resistor between lugs 1 (NS) and 4 (NS) of terminal strip AT.

( ) Connect a 56 KΩ (green-blue-orange) resistor between lugs 2 (NS) and 4 (S-3) of terminal strip AT.

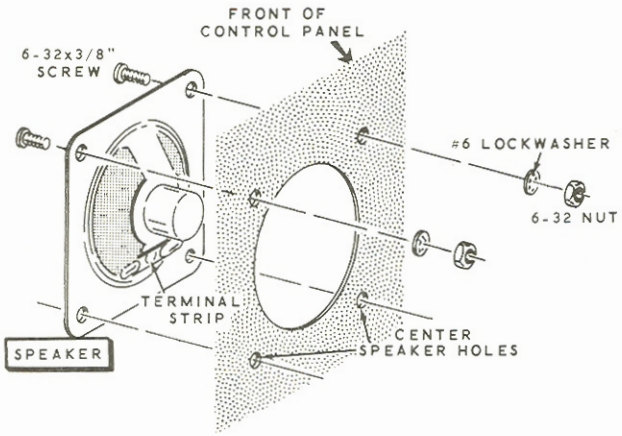
( ) Connect a 2-1/4" black hookup wire from lug 1 of control AR (NS) to lug 3 of terminal strip AT (S-1).

( ) Locate both neon lamps. Place a 1-3/4" length of sleeving over each lead of one of the lamps.

( ) Connect one lead of this lamp to lug 1 of control AR (S-2). Connect the other lead to lug 2 of terminal strip AT (S-2). Then insert the lamp through hole AU.

( ) Connect a 3-1/2" gray hookup wire on one lead of the remaining lamp as shown in the inset drawing on Pictorial 3-4. Then place a 3" length of sleeving over this lead.

( ) Connect the gray wire to lug 1 of terminal strip AT (S-2). Connect the other lead to ground lug AP (S-1). Then insert the lamp through hole AN.



Detail 3-4F

NOTE: In the following step, handle the speaker carefully to avoid damaging the paper cone.

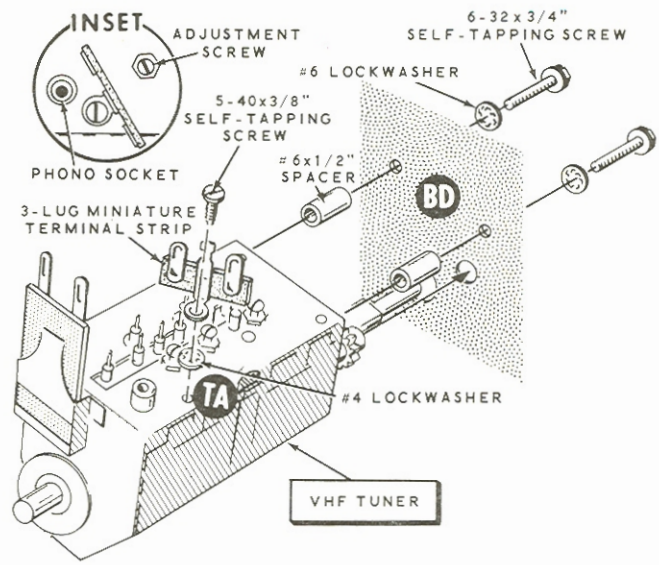
( ) Position the speaker with the terminal strip pointing down as shown in Detail 3-4F. Then mount it to the control panel with two 6-32 x 3/8" screws, two #6 lockwashers, and two 6-32 nuts. Before you tighten the screws, make sure the bottom speaker holes are centered with the control panel holes.

( ) Connect the black harness wire coming from breakout 8 to lug 2 of the speaker (S-1).

( ) Connect the brown harness wire coming from breakout 8 to lug 1 of the speaker (S-1).

( ) Connect a 3" length of braid between ground lugs BA (S-1) and BB (S-1). Make sure the end of the braid at BA is flush with the ground lug, and the end at BB is inserted into slot BB. This is to allow room for a transformer which will be mounted later, and to allow enough slack in the braid for the chassis to close.

( ) Turn the chassis over so the control panel is positioned as shown in Pictorial 3-5.



Detail 3-5A

Refer to Detail 3-5A for the following steps.

NOTE: When mounting the terminal strip in the following step, be careful not to turn the three adjustment screws on the tuner.

( ) Mount the 3-lug terminal strip at TA. Use a 5-40 x 3/8" self-tapping screw and a #4 lockwasher. Before tightening the screw, position the terminal strip between the phono socket and the adjustment screw as shown in the inset drawing.

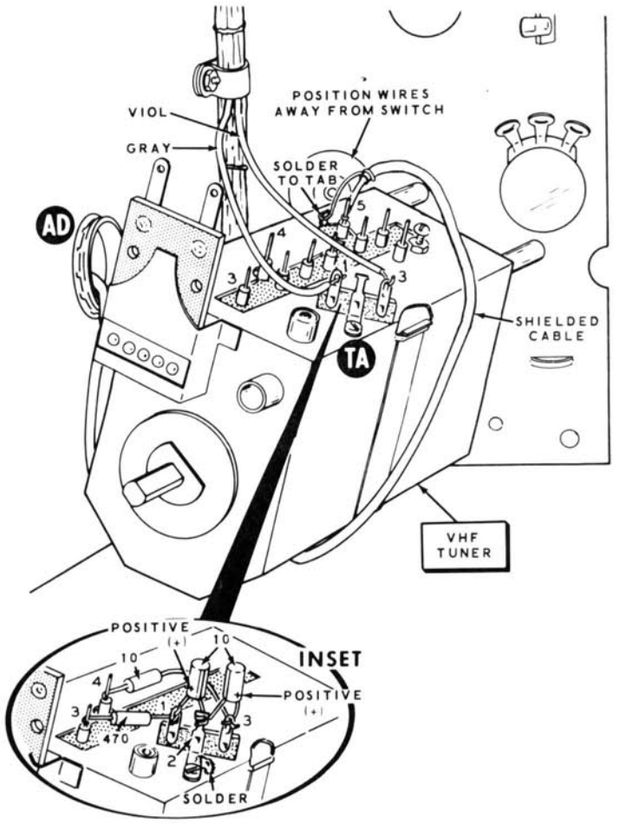
( ) Mount the VHF tuner at BD. Use two 6-32 x 3/4" self-tapping screws, two #6 lockwashers, and two #6 x 1/2" spacers.

Refer to Pictorial 3-5 for the following steps.

NOTE: After connecting the following two wires, position them away from the On-Off switch.

( ) Connect the gray harness wire to lug 1 of terminal strip TA (NS).

( ) Connect the violet harness wire to lug 3 of terminal strip TA (NS).



PICTORIAL 3-5

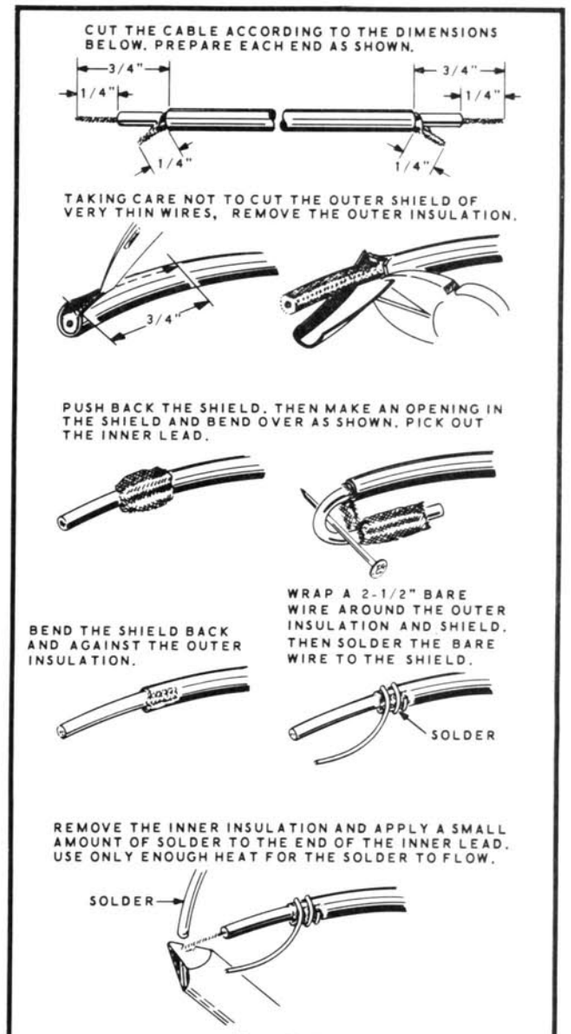
Refer to the inset drawing on Pictorial 3-5 to install the resistors and the capacitors in the following steps. Be sure to keep the leads of these parts as short as possible when making the connections.

(✓) Connect a 10 Ω (brown-black-black) resistor from lug 3 of terminal strip TA (NS) to lug 4 (B+) of the tuner (S-1).

(✓) Connect the 470 Ω (yellow-violet-brown) resistor from lug 1 of terminal strip TA (NS) to lug 3 (AGC) of the tuner (S-1).

(✓) Connect the positive (+) marked lead of a 10 μfd electrolytic capacitor to lug 1 (S-3) and the other lead to lug 2 (NS) of terminal strip TA.

(✓) Connect the positive (+) marked lead of a 10 μfd electrolytic capacitor to lug 3 (S-3) and the other lead to lug 2 (S-2) of terminal strip TA.



Detail 3-5B

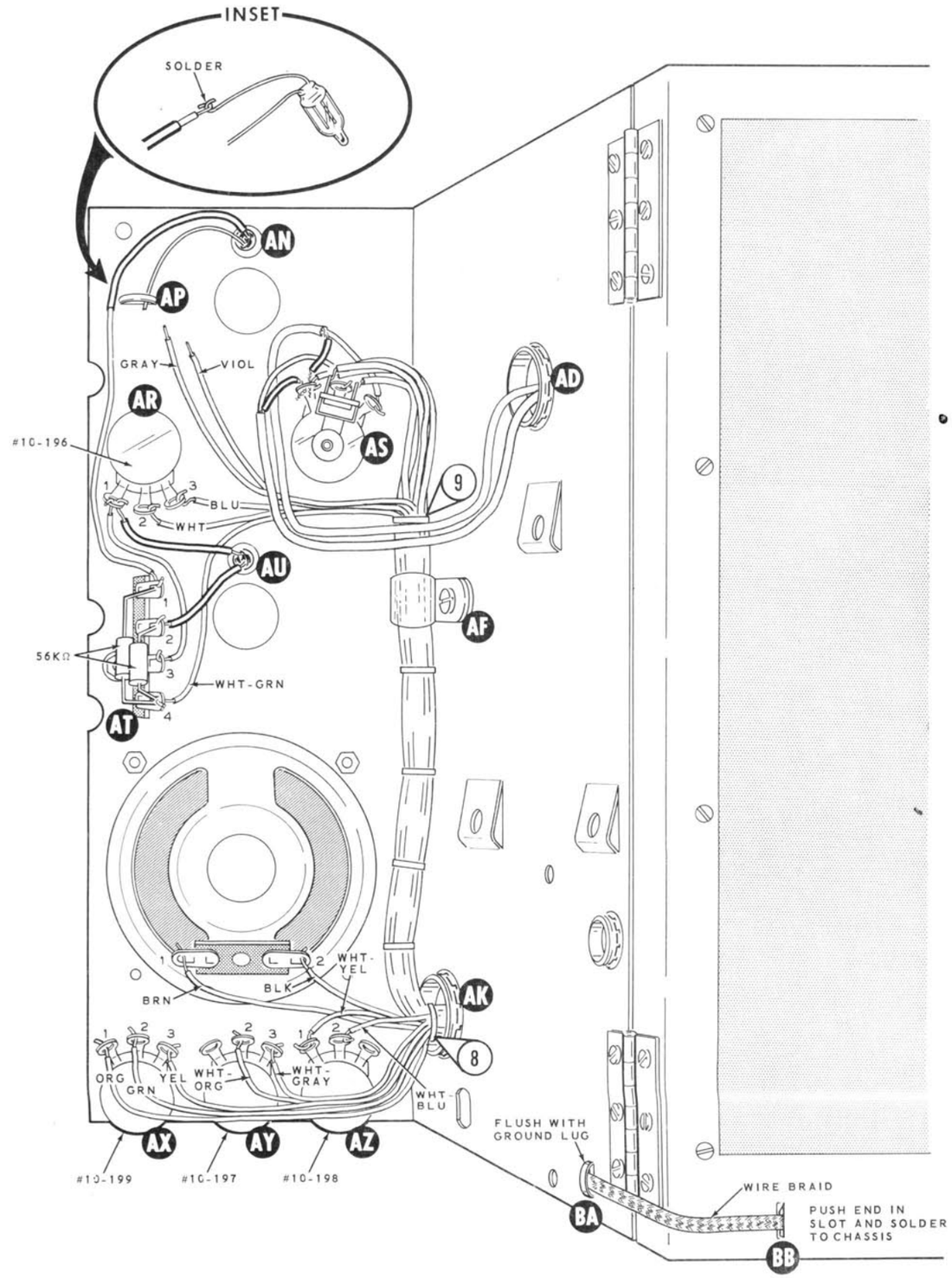
(✓) Solder the mounting foot of terminal strip TA to the top of the tuner.

(✓) Prepare a 13-1/2" length of large coaxial cable as shown in Detail 3-5B. Avoid using excessive heat when soldering.

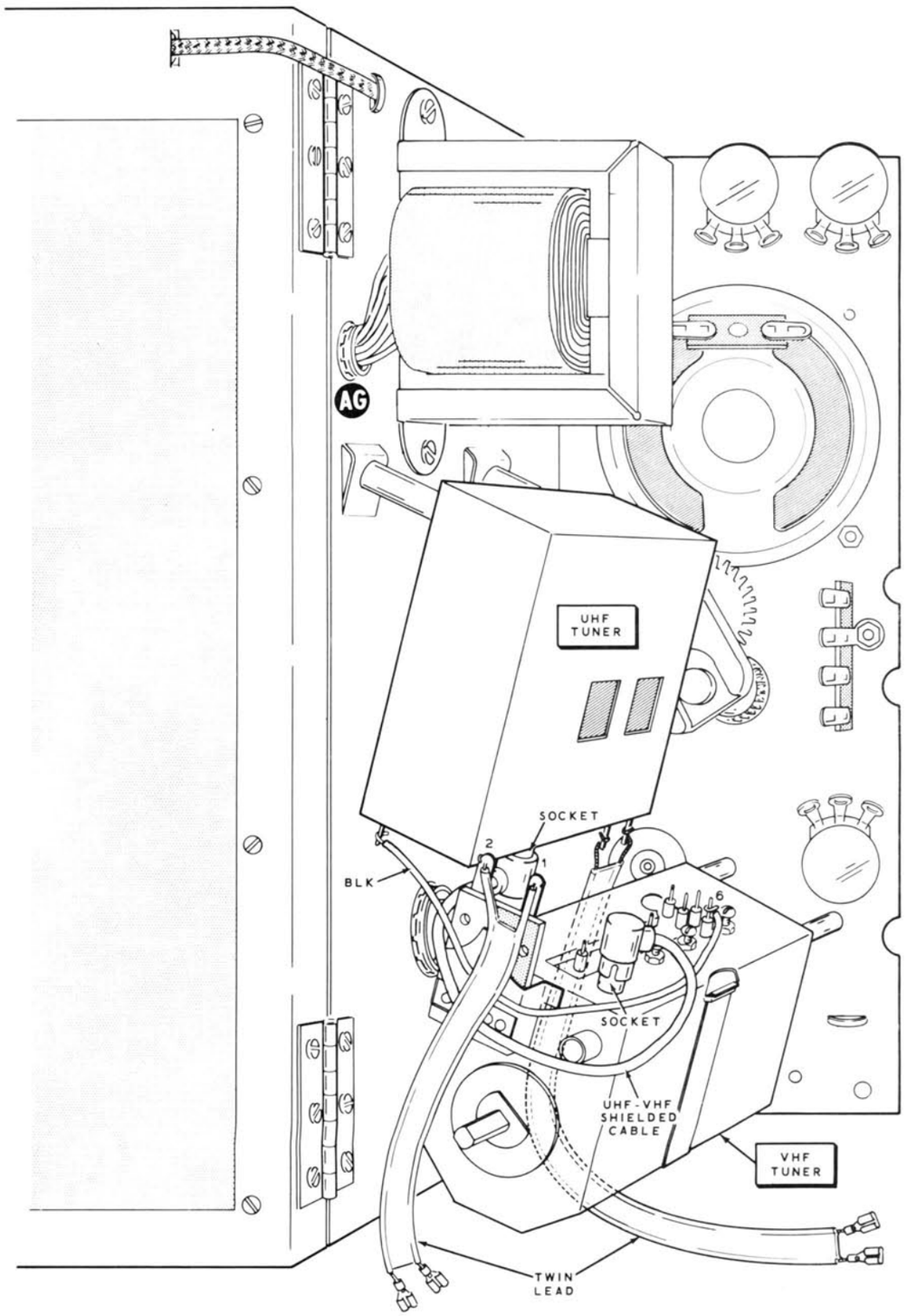
(✓) Connect the center lead at one end of the cable to lug 5 (IF) of the VHF tuner (S-1). Solder the shield lead to the tuner tab as shown. Then bend the tab away from lug 5.

(✓) Route the other end of the shielded cable around the tuner and through grommet AD; it will be connected later. Make sure the shield lead does not touch any of the tuner lugs.

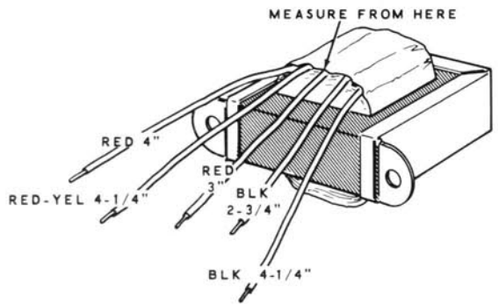
GR-104



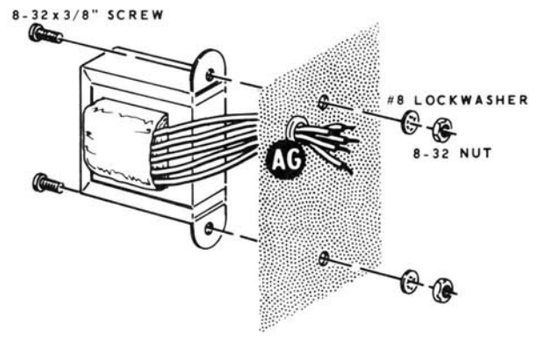
PICTORIAL 3-4



PICTORIAL 3-6



Detail 3-6A



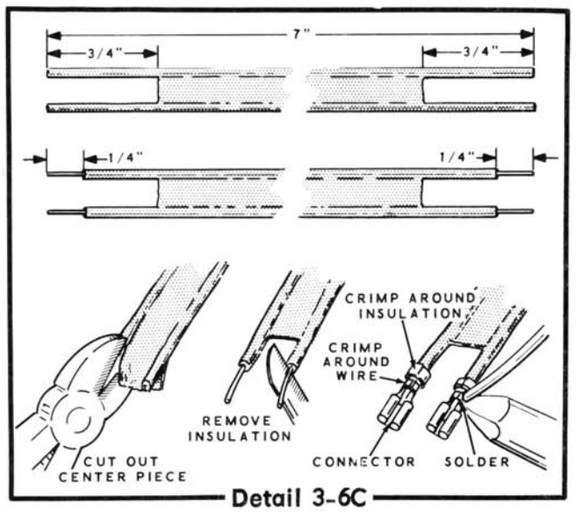
Detail 3-6B

Refer to Pictorial 3-6 (fold-out from Page 38) for the following steps.

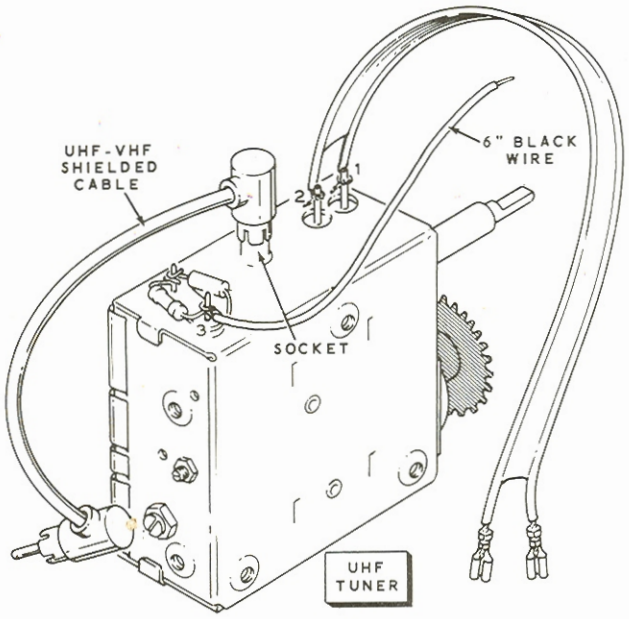
(√) Locate the power transformer. Cut the leads to the dimensions shown in Detail 3-6A (measure the leads from where they come out of the transformer). Remove 1/4" of insulation from the end of each lead and apply a small amount of solder to hold the strands of wire together.

(√) Insert the transformer leads through grommet AG as shown in Detail 3-6B. Mount the transformer on the control panel with 8-32 x 3/8" screws, #8 lockwashers, and 8-32 nuts.

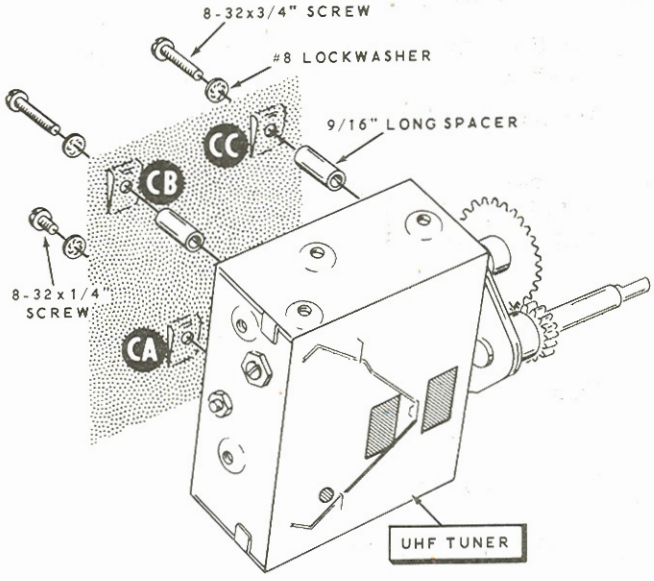
(√) Prepare a 7" and a 10" length of twin lead as shown in Detail 3-6C. Attach connectors to one end only of each twin lead.



Detail 3-6C



Detail 3-6D



Detail 3-6E

Refer to Detail 3-6D for the following steps.

( ) Locate the UHF tuner.

( ) Connect the end of a 10" twin lead (the end without the connectors) to lugs 1 (S-1) and 2 (S-1) of the UHF tuner.

( ) Connect a 6" black hookup wire to lug 3 of the tuner (S-2). The other end will be connected later. NOTE: This lug already has one lead soldered to it.

( ) Install one end of the UHF-VHF shielded cable into the socket of the tuner. The other end will be connected later.

( ) Refer to Detail 3-6E, and mount the tuner on the control panel by inserting the tuner shaft through the hole in the front panel. Route the twin lead behind the VHF tuner as shown in Pictorial 3-6. Then fasten the tuner with one 8-32 x 1/4" screw and #8 lockwasher at CA. Use two 8-32 x 3/4" screws, two #8 lockwashers, and two 9/16" long spacers at CB and CC. Before you tighten the screws, center the tuner shaft in the front panel hole.

( ) Install the free end of the UHF-VHF shielded cable into the socket on the VHF tuner.

( ) Connect the black hookup wire coming from the UHF tuner to lug 6 of the VHF tuner (S-1).

( ) Connect the end of a 7" twin lead (the end without connectors) to lugs 1 (S-1) and 2 (S-1) of the VHF tuner.

Refer to Pictorial 3-7 for the following steps.

( ) Position the chassis on your work surface as shown.

( ) Prepare the following lengths of hookup wire:

5" gray	3-1/2" red stranded
5-1/2" gray	4" gray
5-3/4" gray	

Connect each of the following wires from the high voltage transformer to the sync-sweep circuit board as follows: Route the wires as shown in the Pictorial. NOTE: The letter designations (T, R, etc.) are not on the foil side of the circuit board. Therefore, as you install each wire, observe the foil pattern carefully.

WIRE	FROM TRANSFORMER	TO CIRCUIT BOARD LOCATION
( ) 5" gray hookup	lug 1 (S-1)	T (S-1).
( ) 5-1/2" gray hookup	lug 2 (S-1)	R (S-1).
( ) 5-3/4" gray hookup	lug 3 (NS)	P (S-1).
( ) 3-1/2" red stranded	lug 3 (S-2)	X (S-1).
( ) 4" gray hookup	lug 5 (S-1)	H (S-1). (NOTE: The indicated hole near H will not be soldered.)

( ) Connect a 2-1/2" bare wire from lug A (S-1) through solder lug G (S-2) to lug 4 (S-1) of the high voltage transformer.

( ) Connect a 12-1/2" black hookup wire from K of the audio-video circuit board (S-1) to EE of the sync-sweep circuit board (S-1). Route the wire as shown.

( ) Solder the foils of both circuit boards to the chassis at the indicated locations.

FINAL WIRING

Refer to Pictorial 3-8 (fold-out from Page 57) for the following steps.

Connect the cable and wires coming through grommet AD to the audio-video circuit board as follows:

( ) Center lead of the large shielded cable to B (S-1). Shield lead to A (S-1).

( ) Center lead of the small shielded cable (the one with the shield lead cut off) to E (S-1).

( ) Center lead of the remaining shielded cable to H (S-1) and the shield lead to J (S-1).

Connect the transformer leads coming through grommet AG to terminal strip AH as follows:

( ) Short black to lug 1 (NS).

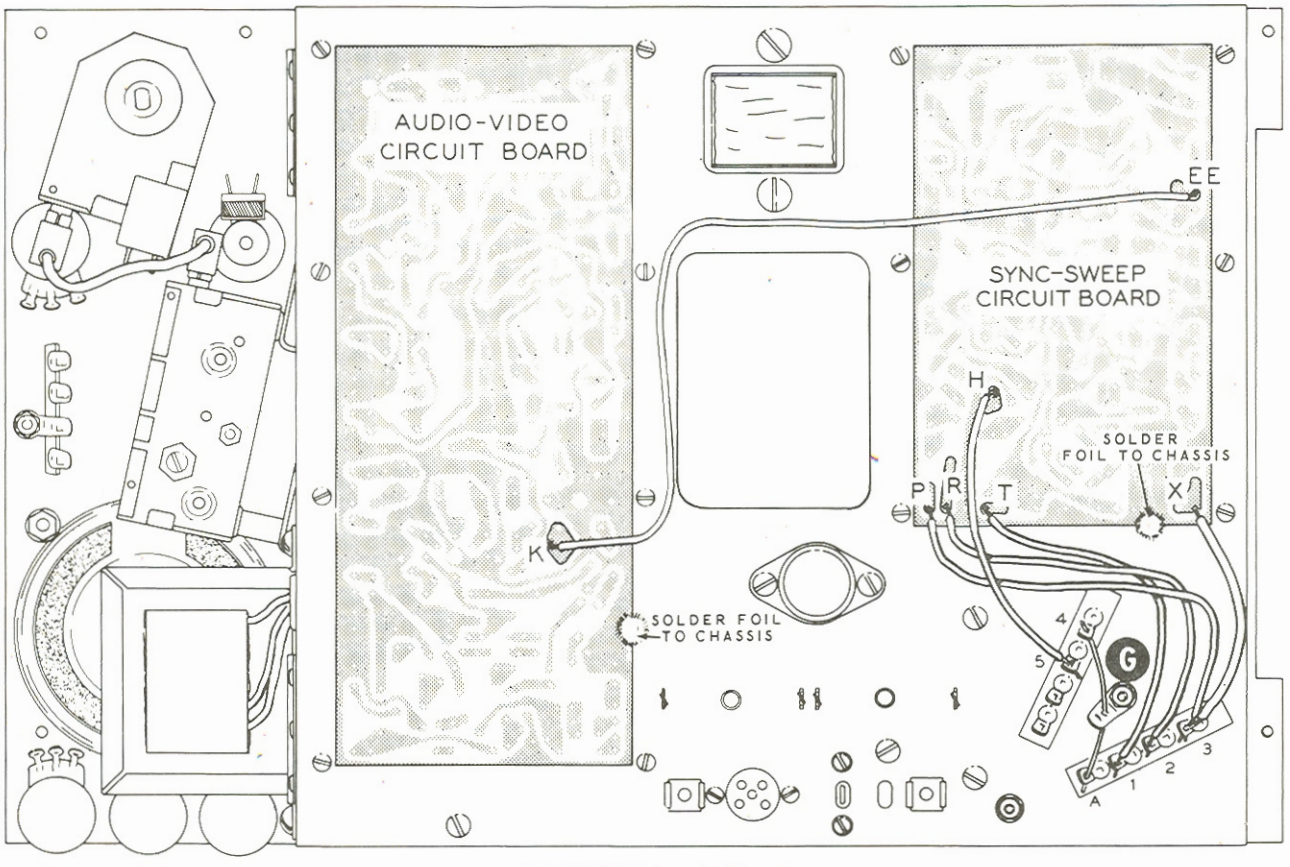
( ) Short red to lug 2 (NS).

( ) Long red to lug 3 (NS).

( ) Red-yellow to lug 5 (NS).

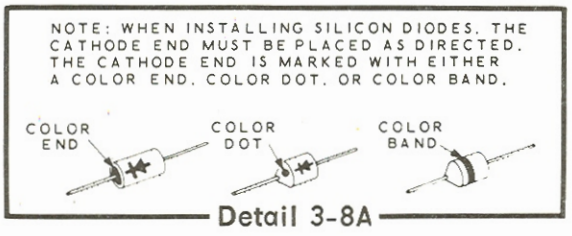
( ) Long black to lug 6 (NS).

( ) Connect the red harness wire coming from breakout 7 to lug 5 of terminal strip AH (NS).



PICTORIAL 3-7

NOTE: When installing silicon diodes, be sure to place the cathode end as directed. The cathode end is marked with either a color end, color dot, or color band. See Detail 3-8A.



Detail 3-8A

( ) Connect the lead at the cathode end of a silicon diode to lug 3 of terminal strip AH (S-2). Connect the other lead to lug 4 (NS).

( ) Connect the lead at the cathode end of a silicon diode to lug 2 of terminal strip AH (S-2). Connect the other lead to lug 4 (S-2).

( ) Connect the lead at the positive (+) end of a 2500 μfd electrolytic capacitor to lug 5 of terminal strip AH (S-3). Connect the other lead to ground lug AE (NS).

Refer to Detail 3-8B for the following steps.

( ) Locate the selenium diode, the high voltage lead, and the length of large clear sleeving.

( ) Prepare the high voltage lead as shown.

( ) Slide the sleeving over the high voltage lead.

( ) Cut both leads of the selenium diode to 1/2" as shown in inset drawing #1 on Detail 3-8B.

( ) Form a small hook at the positive (+) end of the diode and at the end of the high voltage lead. Then solder the leads together. This solder connection should be as smooth as possible to prevent high voltage arcing when the television set is operating.

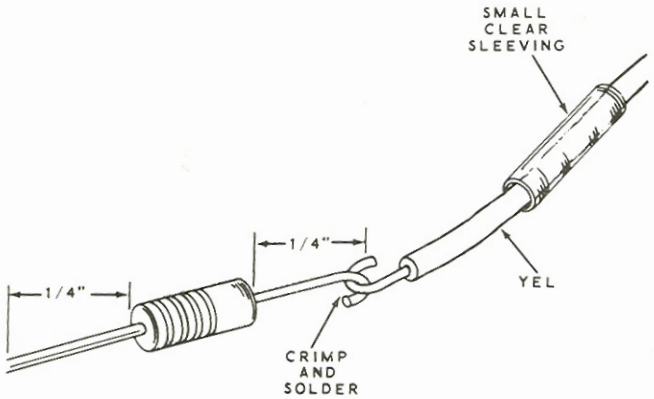
( ) Insert the other end of the diode into the connector at the end of the high voltage transformer lead as shown in inset drawing #2 on Detail 3-8B. Then slide the clear sleeving over the diode and into the grommet. Make sure the diode lead does not pull out of the transformer lead.

( ) Remove the cable clamp at J, as shown in Pictorial 3-8. Place the clamp around the high voltage lead, and then reinstall the clamp at J.

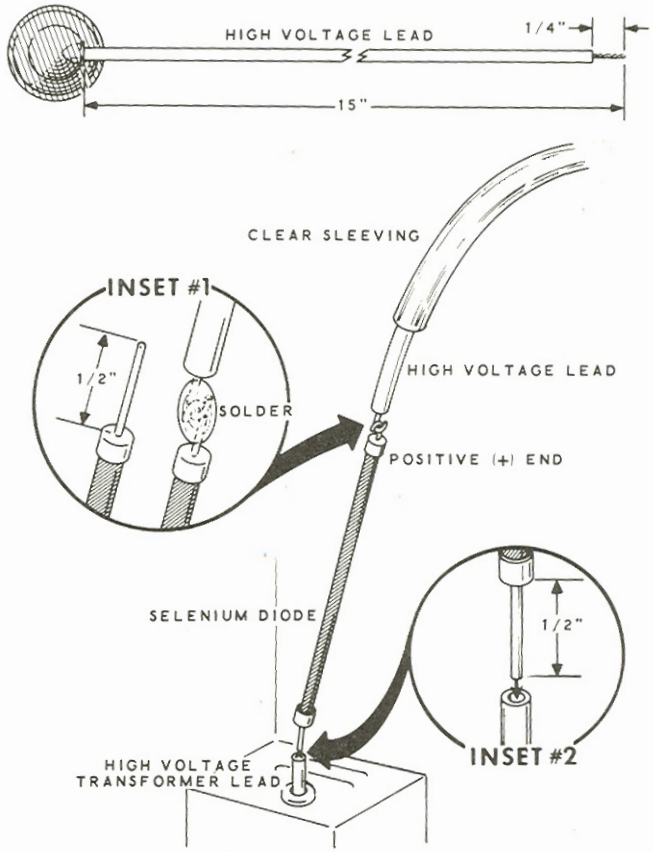
( ) Locate the 7-pin socket with the leads attached.

( ) Cut a 1-1/4" length of small clear sleeving and slide it over the yellow lead of the 7-pin socket.

( ) Refer to Detail 3-8C and cut both leads of a 1000 Ω (brown-black-red) resistor to 1/4". Then form a hook in one lead.



Detail 3-8C



Detail 3-8B

( ) Place the yellow lead of the 7-pin socket through the hooked resistor lead and crimp the leads together. Then solder the connection.

( ) Insert the other lead of the prepared resistor into hole X on the audio-video circuit board (S-1). Position the yellow lead, on the other end of the resistor, between L105, T105, and T104 as shown.

( ) Connect the brown lead to lug 1 of terminal strip S (S-3).

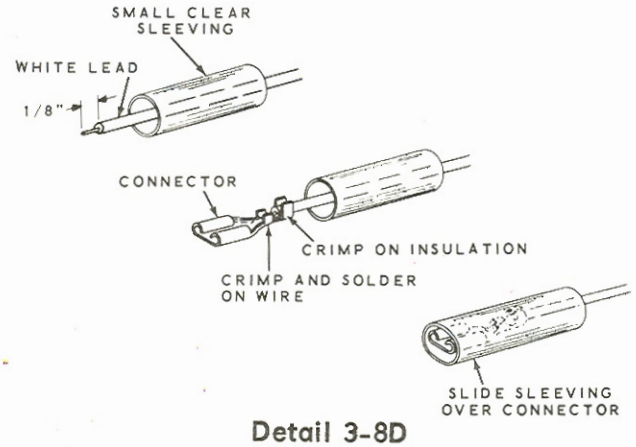
Connect the remaining socket leads to the sync-sweep circuit board as follows:

( ) Orange to S (S-1).

( ) Red to M (S-1).

( ) Green to A (S-1).

( ) Slide the remaining length of small clear sleeving over the white lead of the 7-pin socket. Cut the stripped end of this lead, leaving 1/8" of bare wire. Then crimp and solder a connector on the end of this wire, and slide the sleeving on the connector. Refer to Detail 3-8D.



Detail 3-8D

( ) Push the connector over lug 2 of terminal strip Y as shown in the Pictorial.

( ) Locate the deflection yoke (#58-8) and clamp. Place the yoke on your work surface as shown.

Connect the deflection yoke leads as follows:

( ) Brown lead to lug 1 of terminal strip D (S-2).

( ) Red lead to lug 2 of transistor C (S-2).

( ) Green lead to MM on the sync-sweep circuit board (S-1).

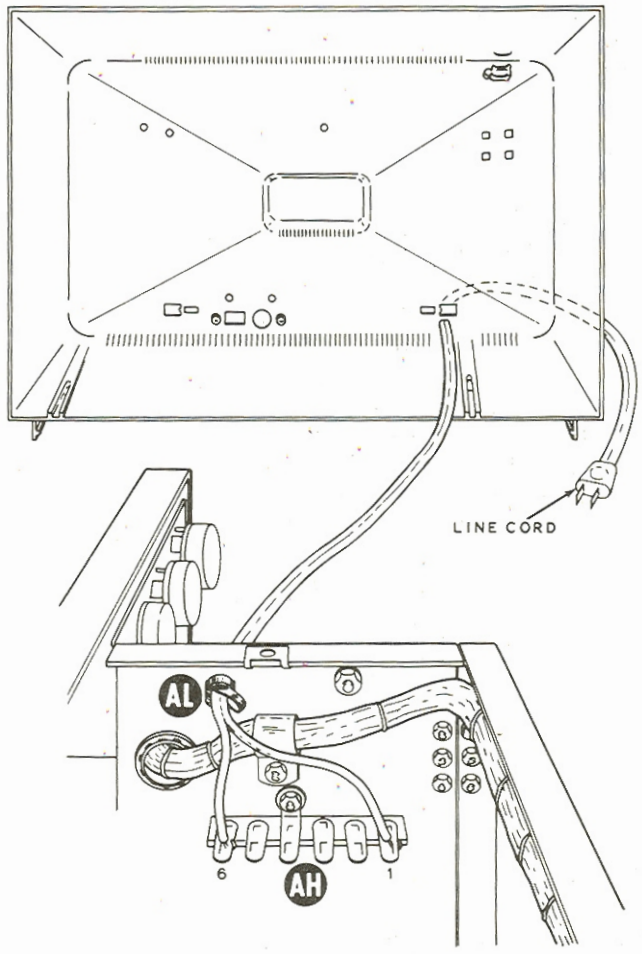
( ) Orange lead to KK on the sync-sweep circuit board (S-1).

Refer to Pictorial 3-9 for the following steps.

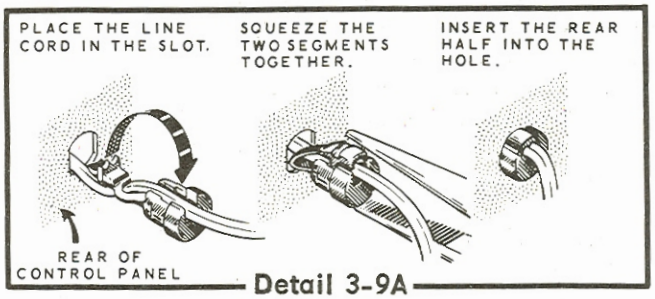
( ) Position the chassis as shown in the Pictorial.

( ) Position the cabinet so the open side is toward the chassis.

( ) Insert the bare lead end of the line cord through the oval shaped hole near the bottom of the cabinet. Then insert the line cord through hole AL in the chassis.



PICTORIAL 3-9

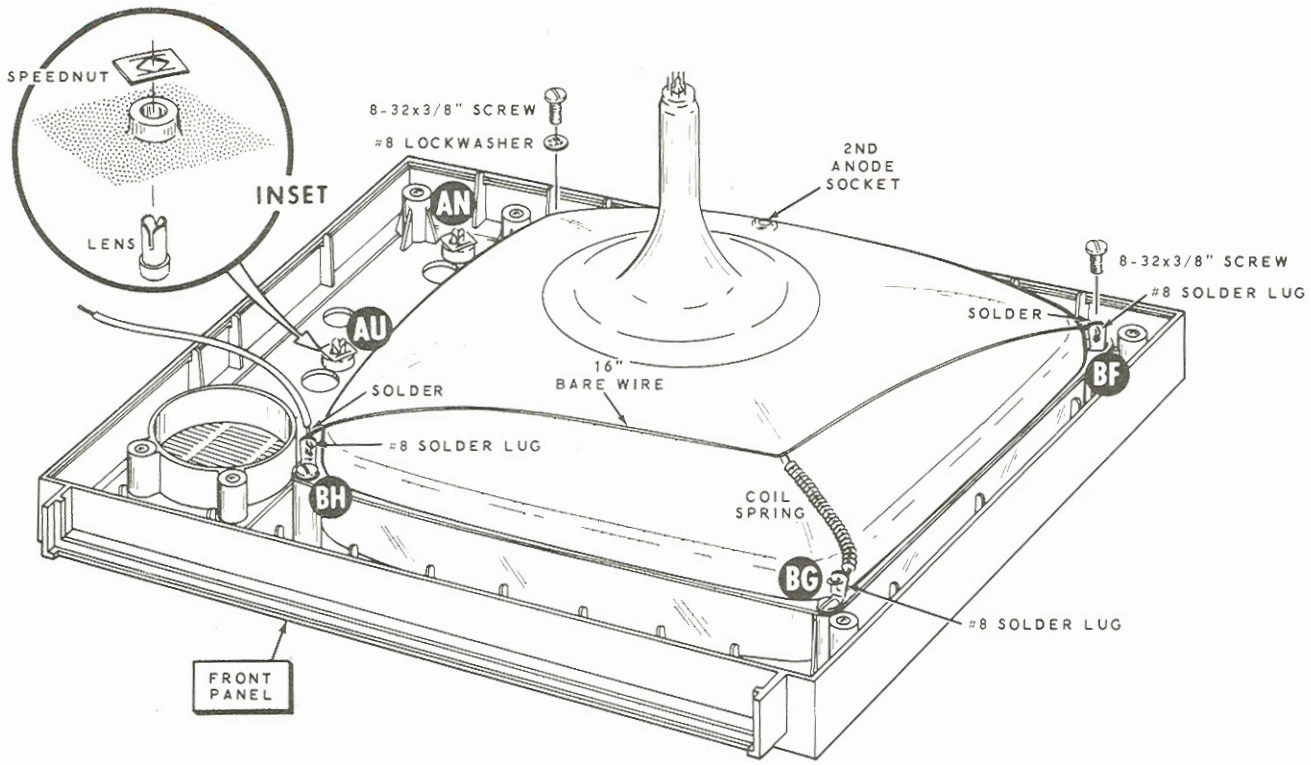


Detail 3-9A

( ) Connect one line cord lead to lug 1 (S-2) and the other lead to lug 6 (S-2) of terminal strip AH.

( ) Place the line cord strain relief around the cord and insert it in hole AL. Refer to Detail 3-9A.

( ) Set the chassis and cabinet aside temporarily.



PICTORIAL 3-10

INSTALLING THE PICTURE TUBE

Refer to Pictorial 3-10 for the following steps.

CAUTION: Be extremely careful when handling the picture tube. Do not strike, scratch, or subject it to more than moderate pressure at any time. Never lift the picture tube by its neck. A fracture of the glass could result in an implosion of considerable violence due to the high vacuum inside the tube. Such an implosion would be capable of damaging both property and person.

IMPORTANT: Do not set the picture tube down so any part of its weight rests on the neck of the tube. Place a soft cloth over any surface on which the tube will be placed; then place the tube face down on the cloth.

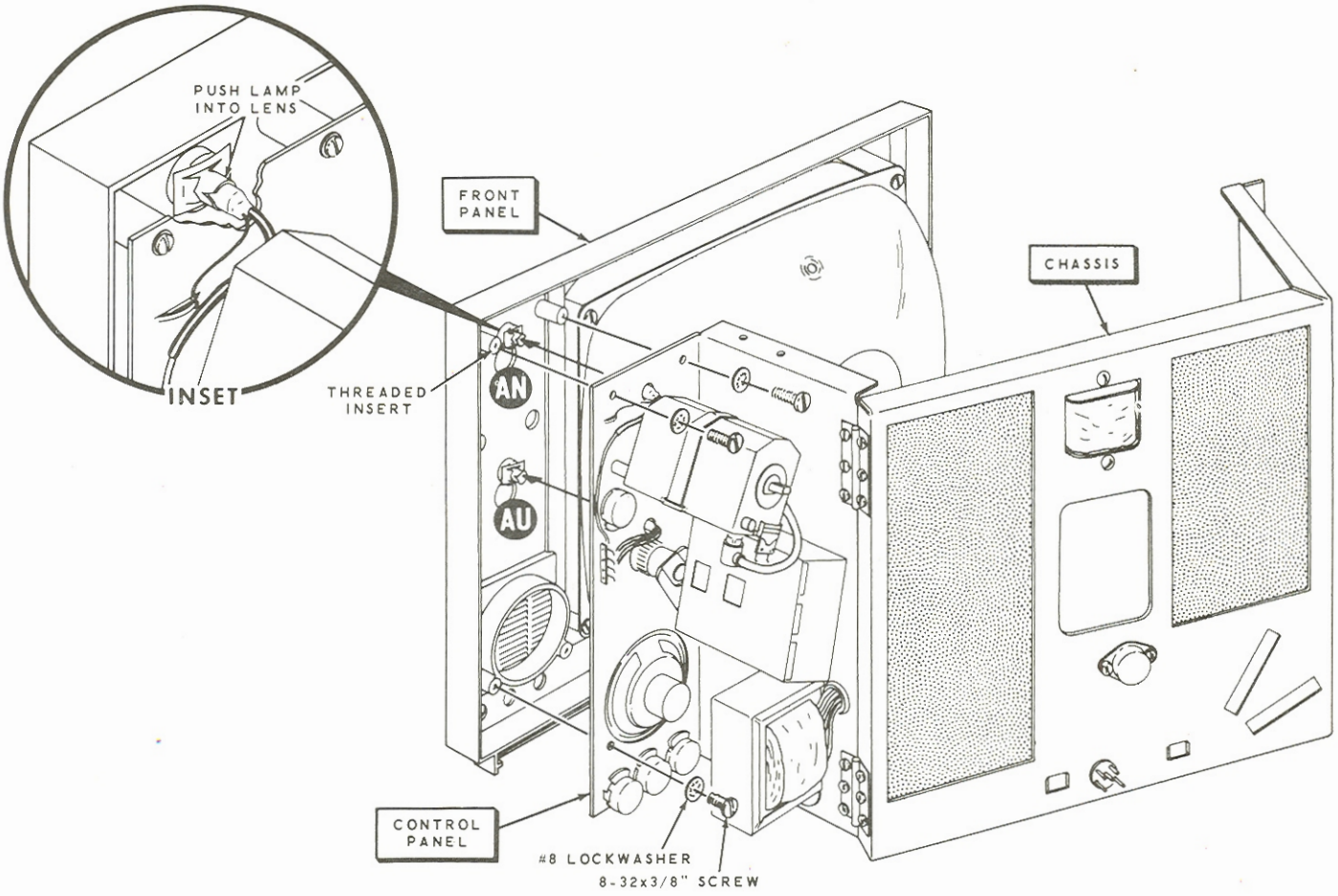
( ) Place a soft cloth on your work surface. Then place the front panel on the cloth as shown in the Pictorial.

( ) Mount one lamp lens at AN and another one at AU. Use speednuts as shown in the inset drawing on Pictorial 3-10.

NOTE: Be sure to fill out the picture tube warranty card and mail it to the Heath Company after you remove the picture tube from its carton.

( ) Place the carton containing the picture tube on the floor beside your workbench, then open it carefully; be sure to open the correct end of the carton.

( ) Carefully lift the tube from the carton by placing both hands on the bell (or larger section) of the tube. Never, under any circumstances, lift a picture tube by holding the neck of the tube. Place the picture tube face down on the front panel as shown in Pictorial 3-10. Be sure the 2nd anode socket is in the position shown.



PICTORIAL 3-11

( ) Fasten the picture tube to the front panel. Use four 8-32 x 3/8" screws, one #8 lockwasher, and three #8 solder lugs. Position the solder lugs so they are near but do not touch the picture tube.

( ) Connect a 6" black hookup wire to solder lug BH (NS). The other end will be connected later.

( ) Connect a 16" bare wire between solder lugs BH (S-2) and BF (S-1).

( ) Hook the coil spring between the remaining solder lug and bare wire as shown.

Refer to Pictorial 3-11 for the following steps.

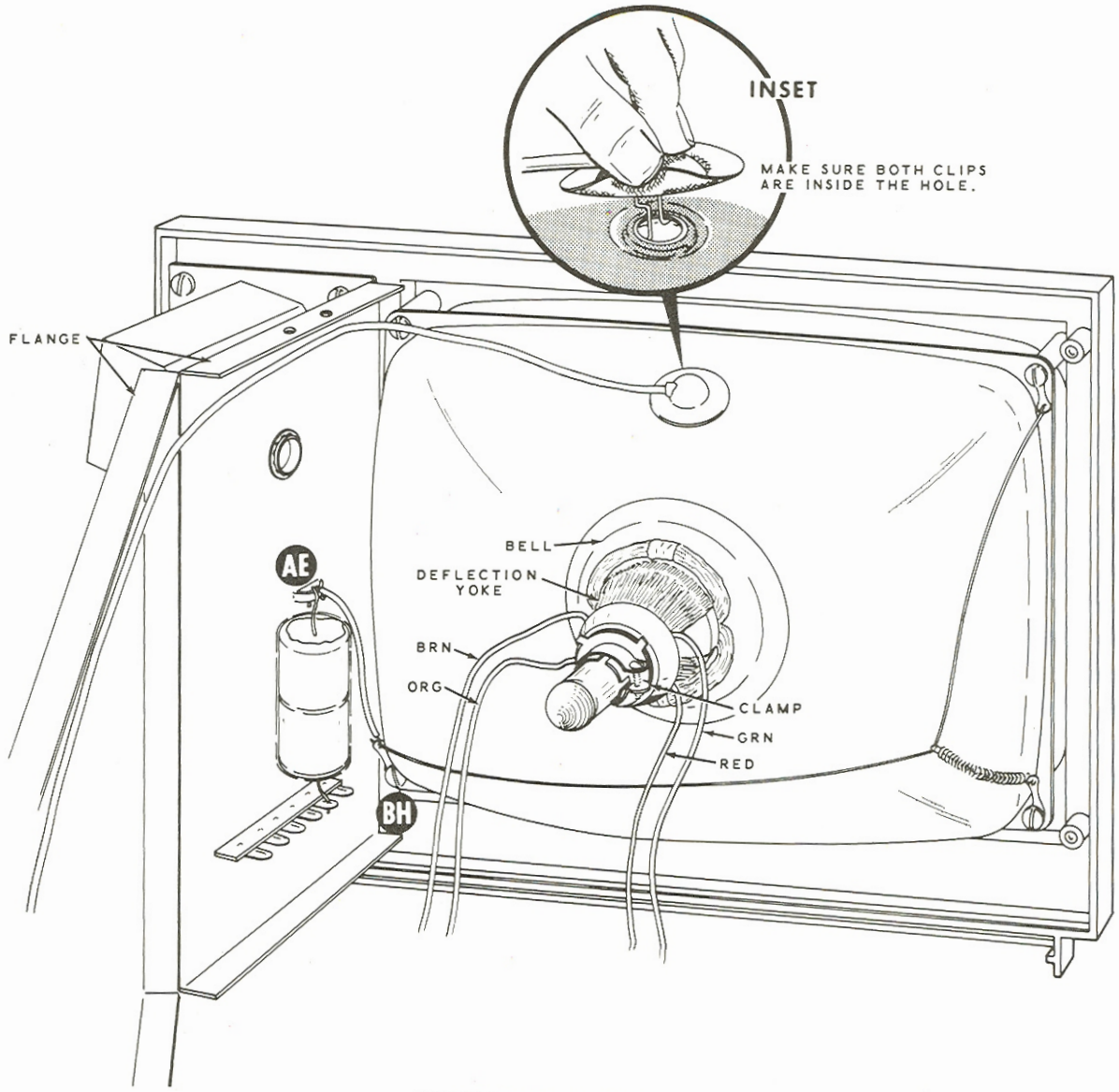
( ) Locate three 8-32 x 3/8" screws and three #8 lockwashers. Place the lockwashers on the screws; then put the screws near the control panel so they can be easily reached for the next step.

( ) Position the chassis and control panel as shown in the Pictorial. Make sure no wires are pinched between the chassis and control panel.

( ) Carefully place the front panel against the control panel and start each screw in the threaded insert.

( ) Carefully push the neon lamps into the lamp lenses at AN and AU as shown in the inset drawing on Pictorial 3-11.

( ) Now tighten the three front panel screws.



PICTORIAL 3-12

Refer to Pictorial 3-12 for the following steps.

( ) Position the Television Set on your work surface as shown in the Pictorial.

( ) Connect the free end of the black hookup wire coming from solder lug BH, to ground lug AE (S-2).

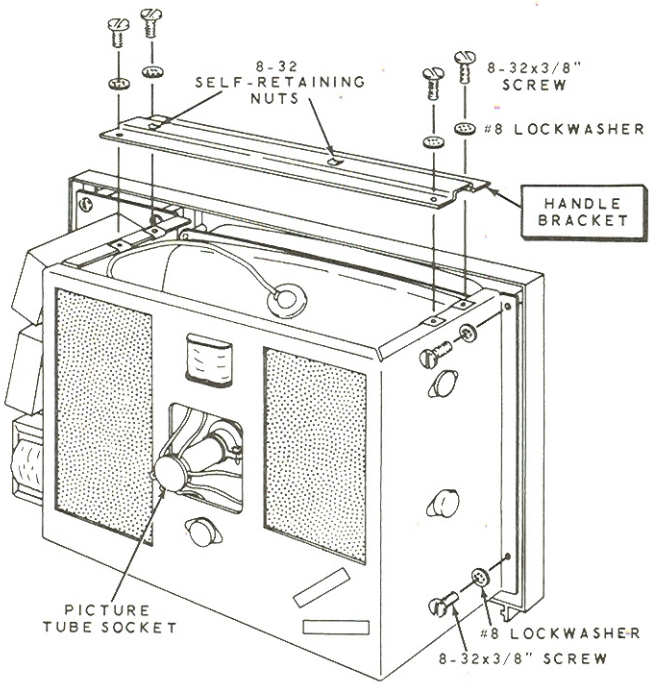
( ) Route the anode lead under the flange of the chassis and control panel as shown. Then insert both clips of the connector in the picture tube anode socket as shown in the inset drawing on Pictorial 3-12.

( ) Install the deflection yoke on the neck and against the bell of the picture tube. Then turn the yoke so the green wire comes out the right side as shown. Do not tighten the screw in the clamp at this time.

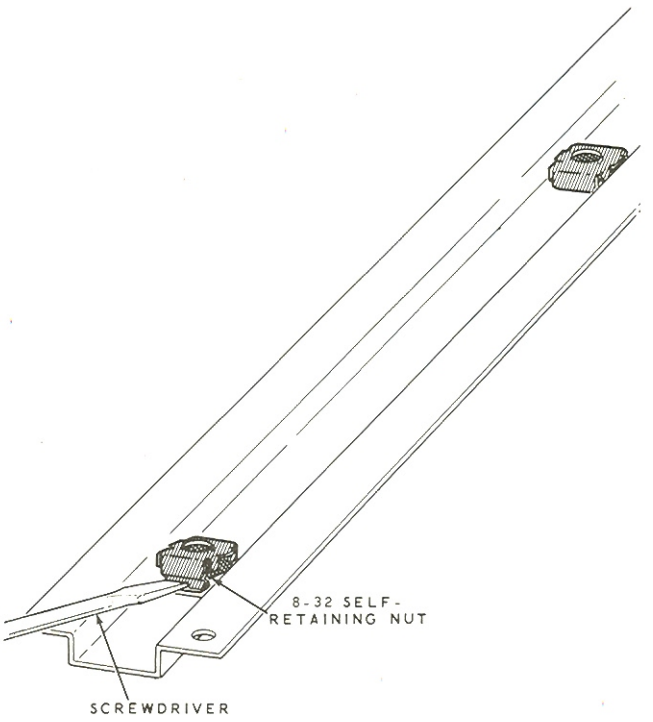
Refer to Pictorial 3-13 for the following steps.

( ) Position the tube socket through the large opening in the chassis.

( ) Carefully close the chassis against the front panel. Make sure the wires from the tube socket do not get caught on the picture tube.



PICTORIAL 3-13



Detail 3-13A

( ) Fasten the chassis to the front panel with two 8-32 x 3/8" screws and two #8 lockwashers.

( ) Carefully remove the protective cap from the lugs of the picture tube. Then match the wide space on the socket with the wide space between the pins of the tube, and carefully install the socket.

( ) Locate the handle bracket and position it as shown. Then install two 8-32 self-retaining nuts in the square holes. Refer to Detail 3-13A.

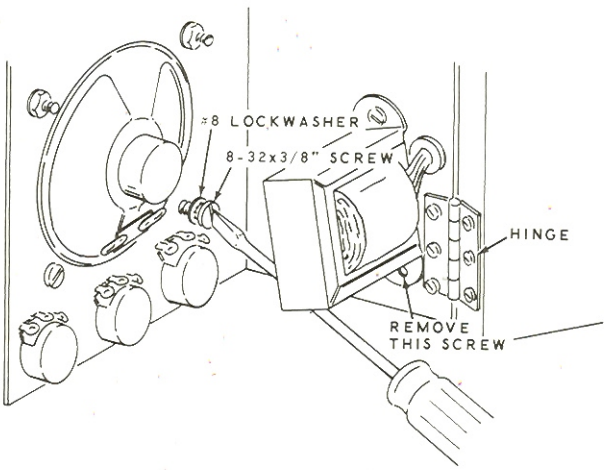
( ) Refer to Pictorial 3-13, and position the bracket with the 8-32 self-retaining nuts as shown. Then mount the bracket with 8-32 x 3/8" screws and #8 lockwashers.

( ) Refer to Pictorial 3-14 for the following steps.

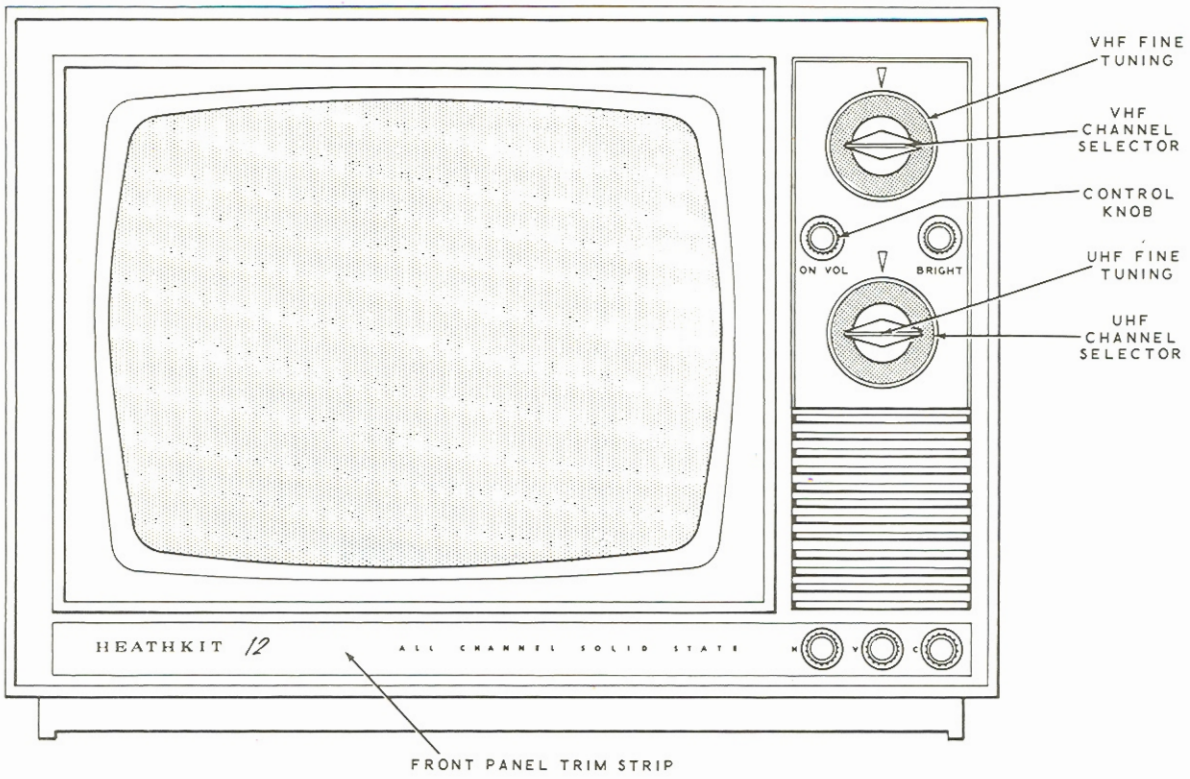
( ) Remove the bottom screw, lockwasher, and nut from the power transformer. Then swing the transformer toward the hinge as far as it will go.

( ) Place a #8 lockwasher on an 8-32 x 3/8" screw. Then start the screw in the threaded stud on the front panel. Tighten the screw carefully with a screwdriver as shown.

( ) Replace the screw, lockwasher, and nut that were previously removed from the transformer.



PICTORIAL 3-14



PICTORIAL 3-15

Refer to Pictorial 3-15 for the following steps.

NOTE: Before you install the knob in each of the following steps, line up the flat inside the knob with the flat on the control or tuner shaft. Then push the knob in place.

( ) Carefully peel away the backing paper from the front panel trim strip. Then press the trim strip in place on the front panel.

( ) Install the UHF channel selector knob.

( ) Install the UHF tuning knob.

( ) Install the VHF tuning knob.

( ) Install the VHF channel selector knob.

( ) Install the five control knobs on the remaining shafts.

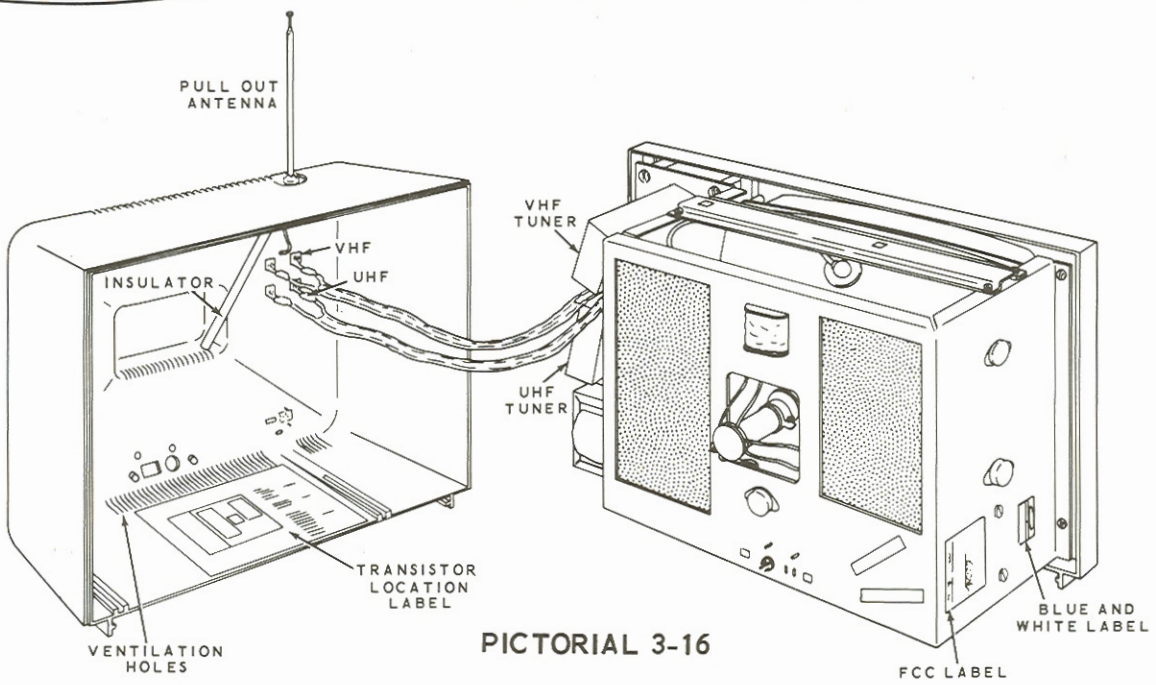
Refer to Pictorial 3-16 for the following steps.

NOTE: The blue and white identification label that is installed in the next step shows the Model number and Production Series number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the side of the chassis.

( ) Similarly, install the Transistor Location label on the inside bottom of the cabinet. Position the label so it can be read as you view the cabinet from the inside. Also, make sure the label does not cover any ventilation holes.

( ) Read, sign, and date the FCC certification label. Remove the protective backing and press the label into position on the picture tube shield.



PICTORIAL 3-16

( ) Insert the whip antenna through the hole in the cabinet. Then fasten it with a #6 x 5/8" bronze screw.

( ) Remove 1/4" of insulation from both ends of a 6" red stranded wire. Then install a spade lug on one end as shown in the inset drawing on Detail 3-16A.

( ) Insert this wire through the hole in the back of the cabinet and connect it to the lug on the VHF antenna (S-1).

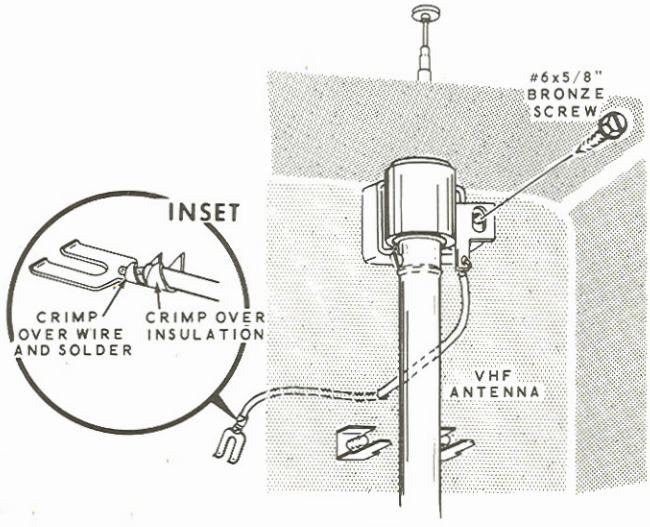
Refer to Detail 3-16B for the following steps.

( ) Position the antenna terminals with the tab as shown. Then install a terminal in each of the four holes in the cabinet. Push the terminal until the tab catches on the inside of the cabinet.

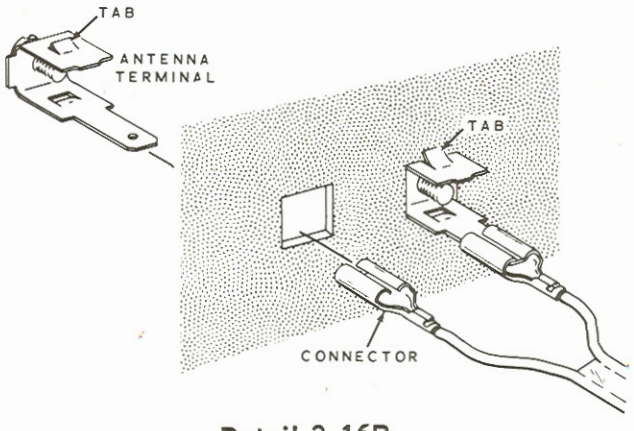
( ) Pull the VHF antenna out of the insulator. Then push the insulator aside to the left as shown in Pictorial 3-16. Install the VHF twin lead connectors onto the VHF antenna terminals and the UHF connectors onto the UHF antenna terminals. Make sure both twin leads are on the right side of the antenna insulator.

( ) Push the VHF antenna into the insulator.

This completes the chassis wiring. Carefully inspect the wiring for any unsoldered connections, loose or broken leads, or accidental solder bridges between foils of the circuit boards.



Detail 3-16A



Detail 3-16B

ADJUSTMENTS

PRELIMINARY CONTROL SETTINGS

If any difficulty is encountered in the following adjustments, refer to the In Case Of Difficulty section of the Manual.

WARNING: Read the following paragraph in case you should have to remove the high voltage anode connector at any future date.

The capacitance between the inner and outer conductive coatings of the picture tube allows a high voltage charge to be stored at the high voltage anode. Be sure to discharge the picture tube as shown in Figure 1 before the high voltage anode is removed. NOTE: TO DISCHARGE THE HIGH VOLTAGE ANODE, WRAP ONE END OF A BARE WIRE AROUND THE HANDLE BRACKET. WRAP THE OTHER END OF THE BARE WIRE AROUND THE METAL PART OF A SCREWDRIVER. HOLD THE SCREWDRIVER BY THE INSULATED HANDLE AND TOUCH THE BLADE TO THE WIRES UNDER THE RUBBER CAP OF THE HIGH VOLTAGE ANODE CONNECTOR.

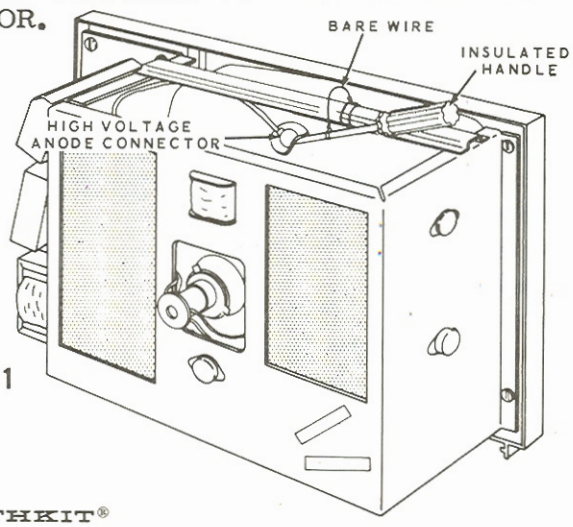


Figure 1

WARNING: Extremely high voltage (12,000 volts) is present in the vicinity of the horizontal output transformer and on the second anode of the picture tube. Extreme care should be taken to make sure that you do not touch any of these parts when the Set is in operation. After the Set is turned off, discharge the capacitors in the circuit by connecting a screwdriver blade between the terminal that will be touched and the chassis ground. A safe rule to remember when you work around any high voltage is to use only one hand to work on the circuit and keep the other hand behind you. This helps prevent your body from becoming part of an electrical circuit by being connected from the high voltage to ground.

Refer to Figure 2 (fold-out from Page 59) for the following steps.

( ) Connect the VHF and UHF antennas to their respective terminals as indicated on the back of the cabinet. NOTE: If the VHF whip antenna and UHF loop antenna are used (this depends on your locality) refer to Figure 7D (fold-out from Page 60) for installation instructions.

NOTE: The following controls can be reached from the foil side of the board. Use a screwdriver (phillips or regular type) for these adjustments.

Place the following controls in the center of their range:

AGC (Automatic Gain Control).
LO V (Low Voltage).
LIN (Vertical Linearity).
HGT (Height).

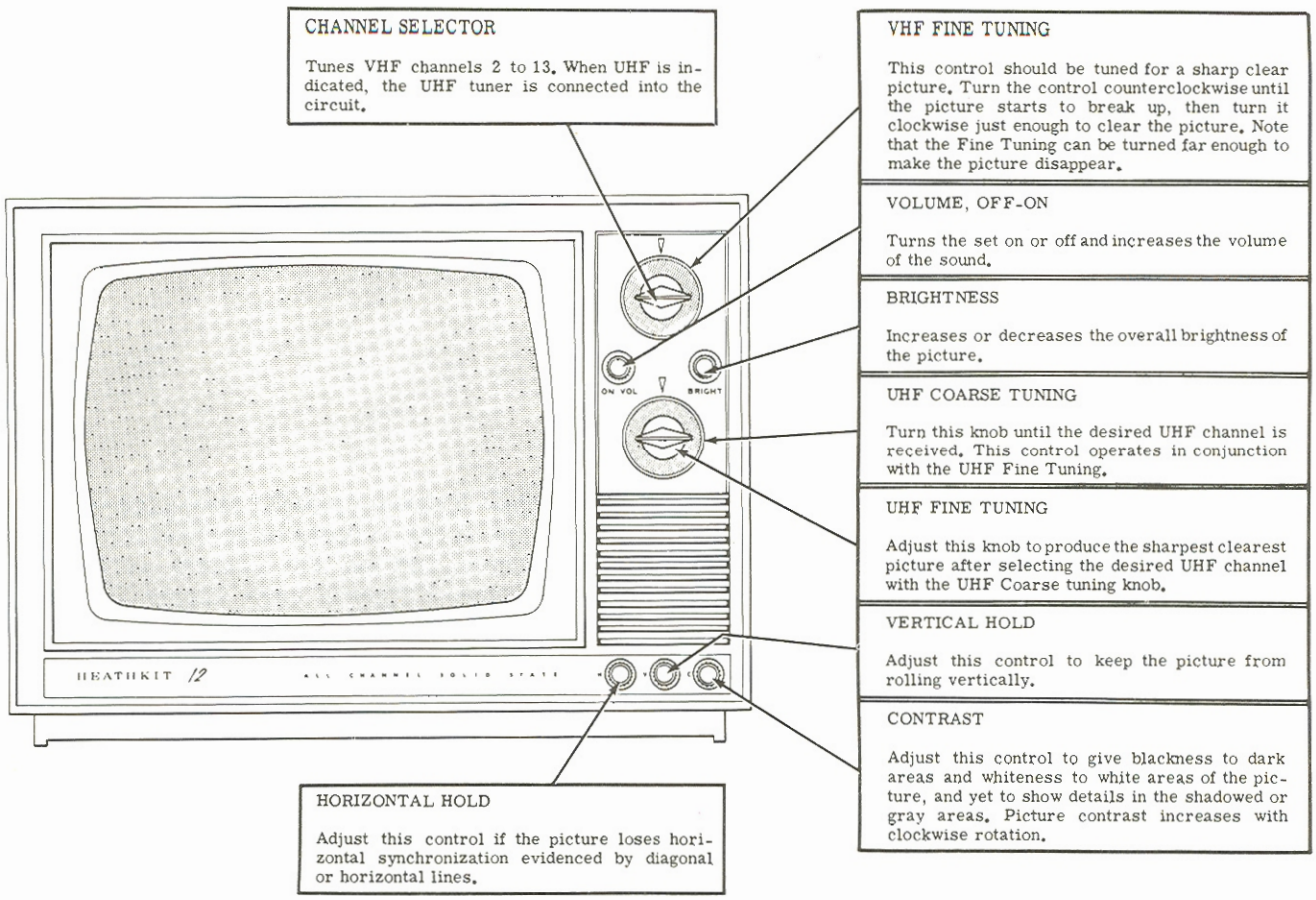


Figure 3

Refer to Figure 3 for the following steps.

Place the front panel controls in the following positions:

ON-VOL - Fully counterclockwise and pushed in (Off).
Brightness - Fully clockwise.
Contrast - 1/4 turn clockwise.
H (Horizontal Hold) - Center of its range.
V (Vertical Hold) - Center of its range.
Channel Selector - To a strong station (VHF or UHF).

( ) Plug the line cord into a 105-125 volt 50/60 Hz AC outlet.

( ) Observe the neck of the picture tube near the socket. After a few seconds the filament should glow. NOTE: The filament will remain on, using approximately 1/2 of the normal operating voltage, as long as the line cord is plugged into an AC outlet. This allows the picture tube screen to light up as soon as the Television Set is turned On.

( ) Pull the ON-VOL switch out. A high whistling sound will be heard momentarily; and then the picture tube should light. Both neon lamps should also light.

( ) Turn the ON-VOL clockwise; sound should be heard from the speaker.

LOW VOLTAGE (LO V) ADJUSTMENT

This adjustment can be made with or without a VTVM (vacuum tube voltmeter). If a VTVM is used, refer to the steps entitled "With VTVM". If a VTVM is not used, refer to the step entitled "Without VTVM".

With VTVM

( ) Set the VTVM to the 15 volt scale. Connect the ground lead of the VTVM to the chassis and the positive lead to the collector of transistor Q303. NOTE: The collector of Q303 is connected to the outside of the transistor case.

( ) Turn the LO V control until you obtain a 12 volt meter reading. Then disconnect the VTVM leads from the Television Set.

Without VTVM

( ) Turn the LO V control slowly counterclockwise until a black space can be seen on one side of the screen.

( ) Center the light area of the picture tube by rotating the centering magnets, first one, then the other. See Figure 6A on Page 55.

( ) Turn the LO V control clockwise until the dark space disappears. Then turn the control an additional 1/4 turn clockwise.

AGC ADJUSTMENT

( ) Turn the AGC control slowly counterclockwise until the contrast appears dark enough for normal viewing. NOTE: During this adjustment, the picture may be out of vertical and horizontal synchronization. If necessary, adjust the front panel Horizontal and Vertical controls. Also, adjust the Fine Tuning for the best picture.

HORIZONTAL ADJUSTMENTS

( ) Turn the front panel Horizontal control to the center of its range.

NOTE: Perform the following step only if the picture loses horizontal synchronization (diagonal or horizontal lines on the screen).

( ) Refer to Figure 2 and adjust the horizontal blocking oscillator transformer T201. Use the alignment tool and turn the adjustment slowly until the picture synchronizes.

SOUND DETECTOR AND SOUND TAKE-OFF

NOTE: Transformers T105 and T106, which will be adjusted next, each have two internal adjustments, one near the top and one near the bottom. To reach the top adjustment, push the alignment tool through the hole in the bottom adjustment as shown in the inset drawing on Figure 2. Do not turn these adjustments more than 1/2 turn in either direction.

( ) Turn the ON-VOL control for a normal listening level.

( ) Turn the Fine Tuning knob clockwise until the sound begins to decrease and background noise is noticeable.

( ) Adjust the bottom slug of transformer T106 clockwise or counterclockwise for the clearest and loudest sound. Repeat the same procedure with the top slug.

( ) Adjust the bottom slug of T105 clockwise or counterclockwise for clearest sound. Repeat the same procedure with the top slug.

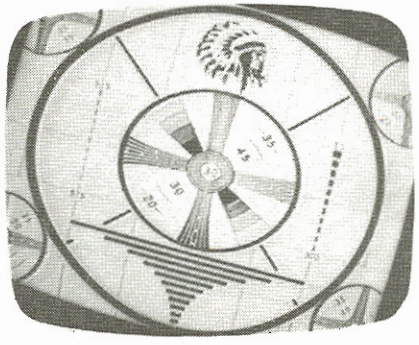
PICTURE ADJUSTMENTS

NOTE: It is easier to make the following adjustments if a test pattern is used. Generally, test patterns are available for a short while in the morning when the station first comes on the air.

The following photographs show how the picture may appear on your television screen if the deflection yoke and various controls are not properly adjusted. Follow the instructions that go with the photographs to make the following adjustments.

Picture Tilted

( ) Be sure the yoke rests up tight against the flared out portion of the picture tube. If the picture is tilted as shown in Figure 4, it can be straightened out by turning the yoke. Be sure that you touch only the plastic part of the yoke. After straightening the yoke, tighten the clamp screw.



PICTURE TILTED
Figure 4

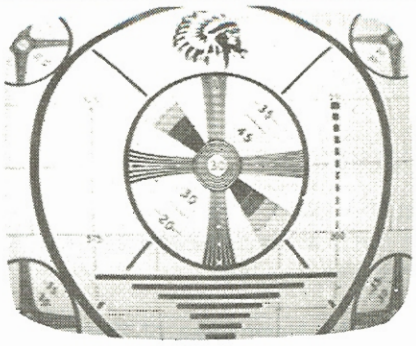
Picture Stretched, Or Too Small

NOTE: Keep the picture locked in with the VERTical HOLD control while making the following adjustments for the correct height and linearity of the picture.

( ) Adjust the Height and the Vertical Linearity controls so there is approximately 1/2" of black space at the top and bottom of the picture. This size can only be obtained by compromising between the two adjustments; first adjust one control a small amount, then adjust the other. The Height adjustment primarily adjusts the overall height of the picture; the Vertical Linearity adjusts the top and bottom of the picture. See Figures 5A, 5B, and 5C.

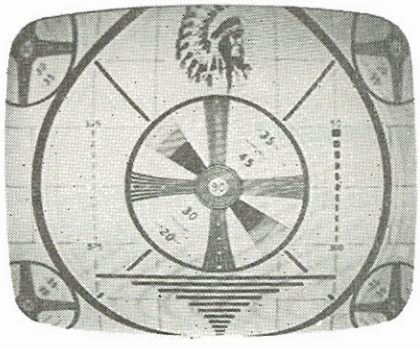
( ) Now adjust the Height control until the picture fills the screen and extends approximately 1/2" beyond the top and bottom of the picture tube. A normal test pattern is shown in Figure 5D.

In another method that can be used to adjust Height and Vertical Linearity, the Vertical Hold is adjusted so that the picture rolls slowly downward. The controls are then adjusted so that the black bar that moves down the screen stays the same height (or thickness) all the way down the screen.



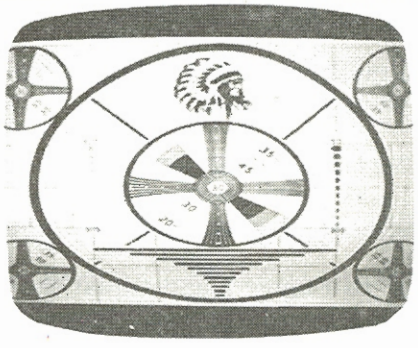
BOTTOM OF PICTURE STRETCHED

Figure 5A



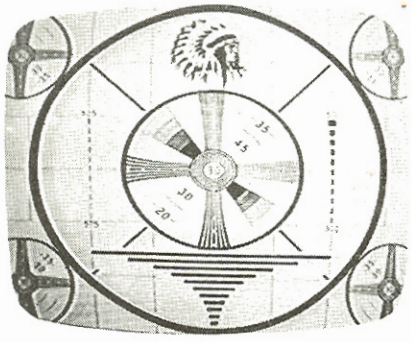
TOP OF PICTURE STRETCHED

Figure 5B



PICTURE TOO SMALL

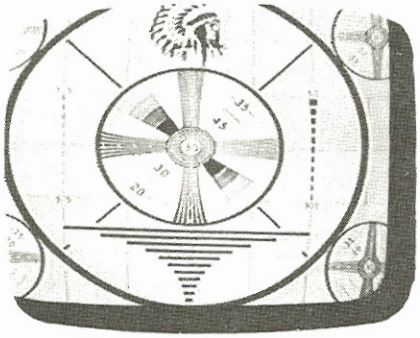
Figure 5C



NORMAL PICTURE
Figure 5D

Picture Off Center

( ) Center the picture on the picture tube by rotating the centering magnets, first one, then the other. See Figure 6A. Note that a black spot or "neck shadow" appears at the corners of the picture tube as shown in Figure 6B when the picture is not centered properly, or the yoke is not pushed up against the bell portion of the picture tube.



PICTURE NOT CENTERED
Figure 6B

This completes the Adjustments. Proceed to the Final Assembly section.

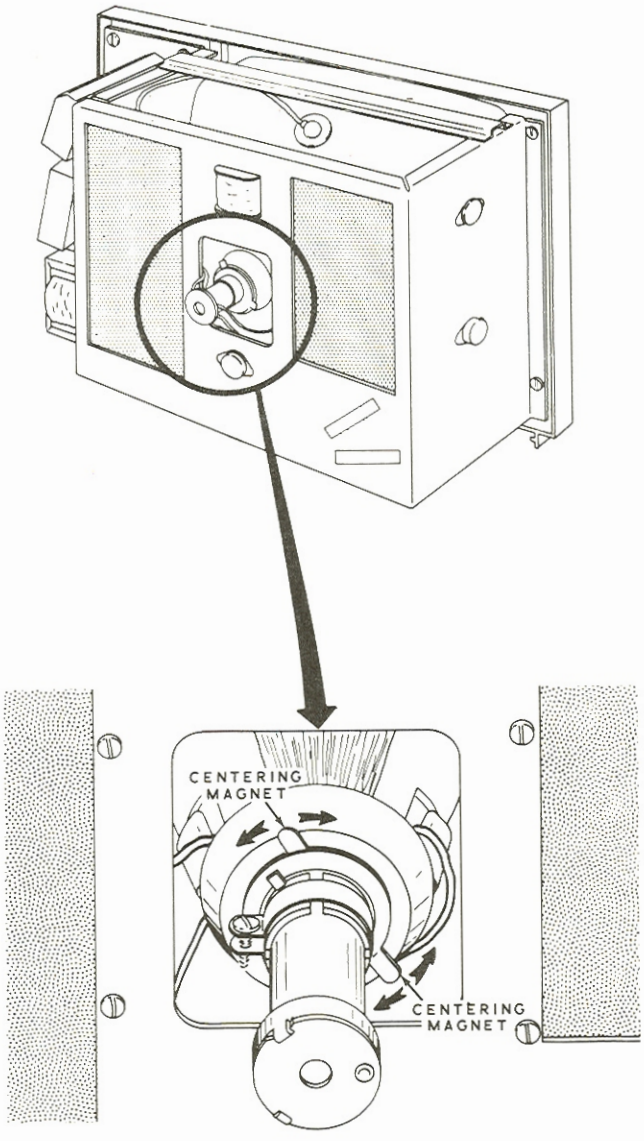


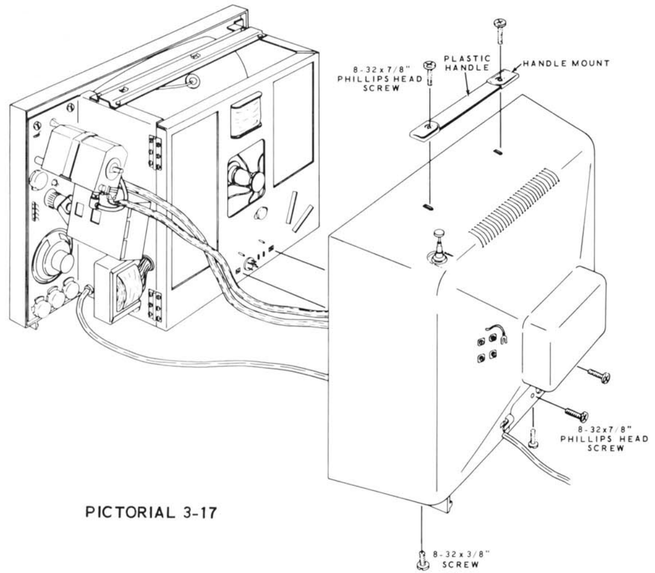
Figure 6A

FINAL ASSEMBLY

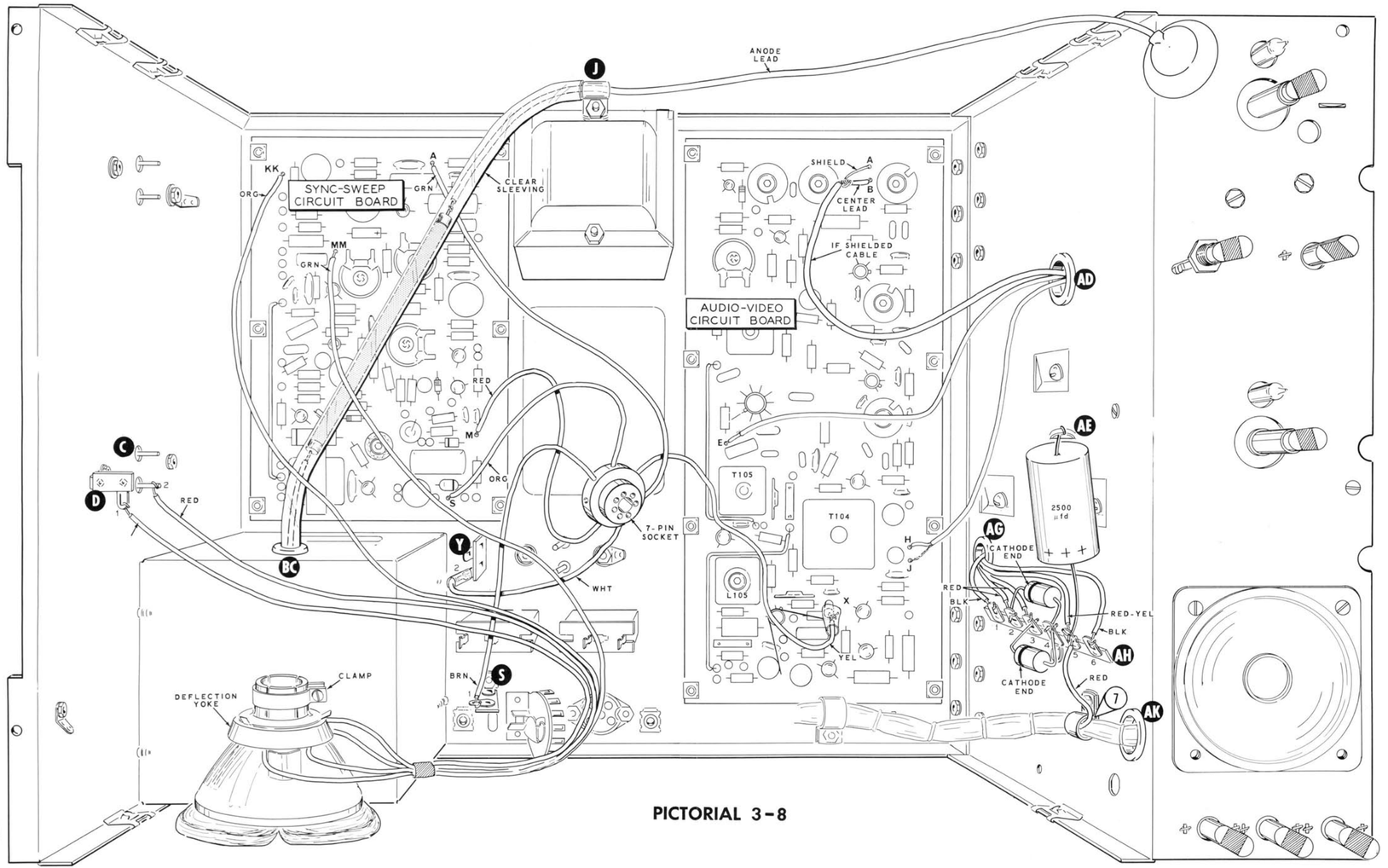
Refer to Pictorial 3-17 for the following steps.

( ) Place the Television Set inside the cabinet. Fasten the cabinet to the chassis with two 8-32 x 3/8" screws from the bottom of the cabinet and two 8-32 x 7/8" phillips head screws from the back.

( ) Place the handle mounts over the ends of the plastic handle. Then fasten the handle to the top of the cabinet with 8-32 x 7/8" phillips head screws.



PICTORIAL 3-17



PICTORIAL 3-8

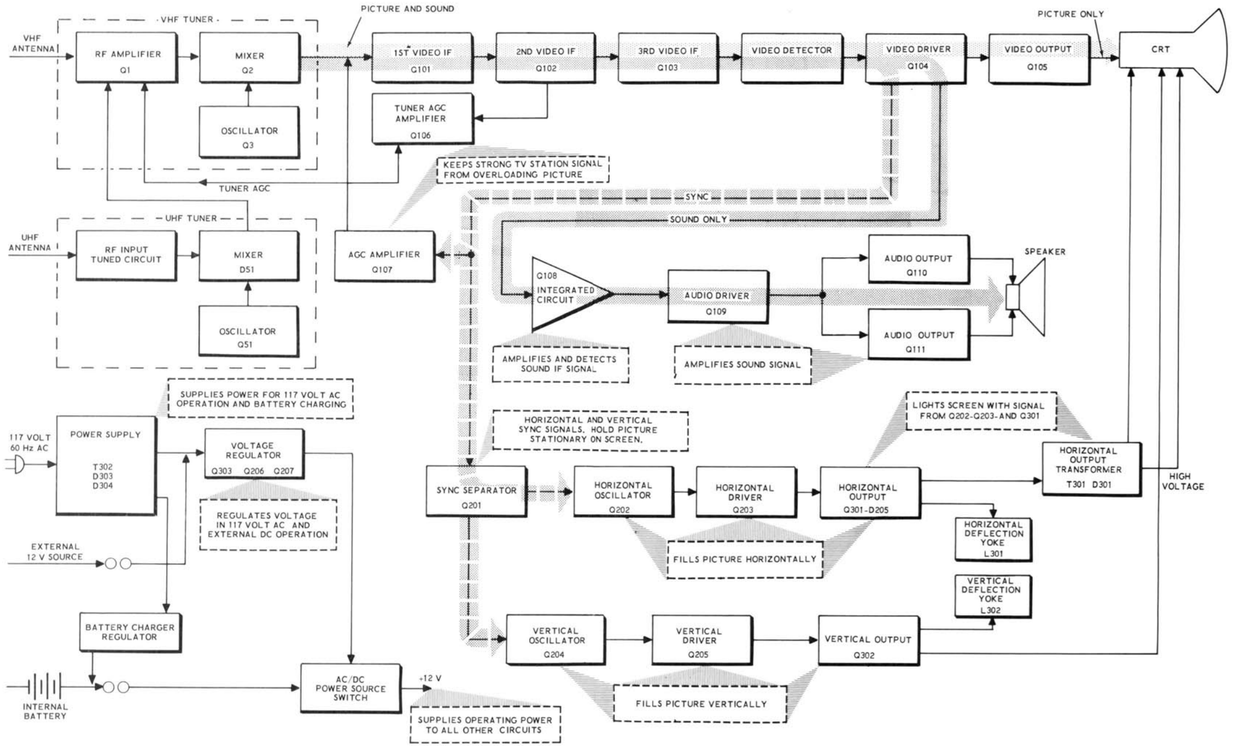


FIGURE 8

OPERATION

Refer to Figure 7A for a brief description of how to operate each of the controls.

To operate this TV Set on 105-125 volts, 60 Hz AC, insert the line cord plug into any standard 105-125 volt AC outlet and turn the Off-On switch to ON. Adjust the controls shown in Figure 7A to tune in the desired channel and produce a clear and stable picture with the desired sound level.

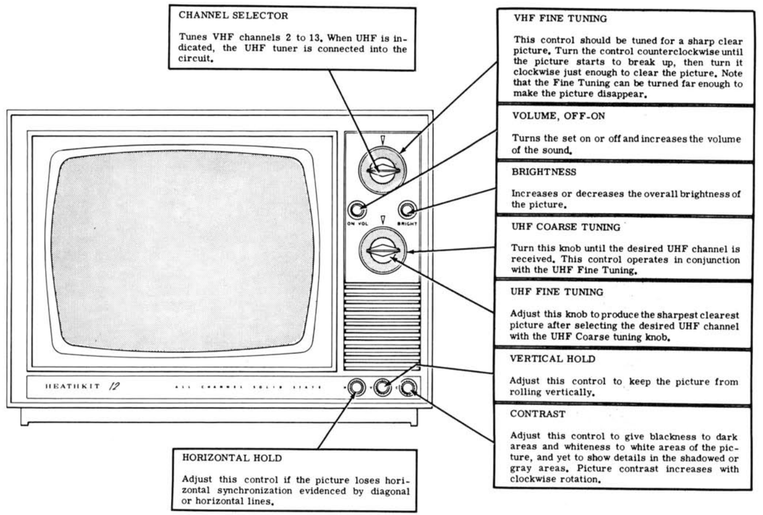


Figure 7A

When the TV Set is connected to an AC outlet with the switch in the Off position, the picture tube filament receives about half of its normal voltage. This avoids warm-up time and provides an "instant on" feature. This feature does not decrease the life of the picture tube.

When the Model GRA-104-1 Accessory Portable Battery pack and charger is installed, the battery is recharged automatically from the power line with the Off-On switch in the Off position.

To operate the TV Set from the Accessory Portable Battery pack, plug the Battery pack cable onto the TV Set accessory plug. Then insert the line cord plug into the receptacle on the rear of the cabinet and operate the controls as directed for 105-125 volt AC operation.

The TV Set can also be used with an external 12 volt DC supply, such as a boat or automobile battery. To do this, the 5-pin socket must be prepared as shown in Figure 7B, using #18 gauge stranded wire of any two colors (red and black are shown here). Then refer to Figure 7C and install the socket on the 5-pin plug at the rear of the chassis. Connect the black and red leads to the correct negative and positive terminals of the external 12 volt source. Insert the line cord plug into the receptacle on the rear of the cabinet and operate the controls as directed for 105-125 volt AC operation.

NOTE: The "instant on" feature will apply only to the sound when this TV Set is used with either the Accessory Portable Battery pack or with an external 12 volt supply. The picture tube will not reach normal brightness for approximately fifteen seconds after the power is turned on. This will conserve battery life as no power is drawn when the switch is in the Off position.

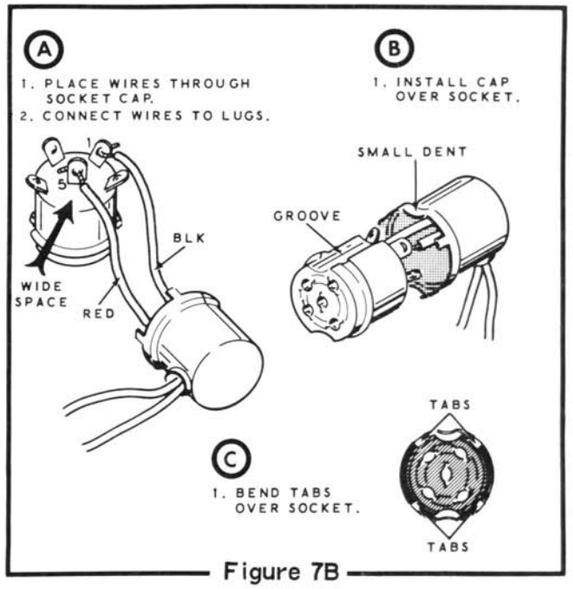


Figure 7B

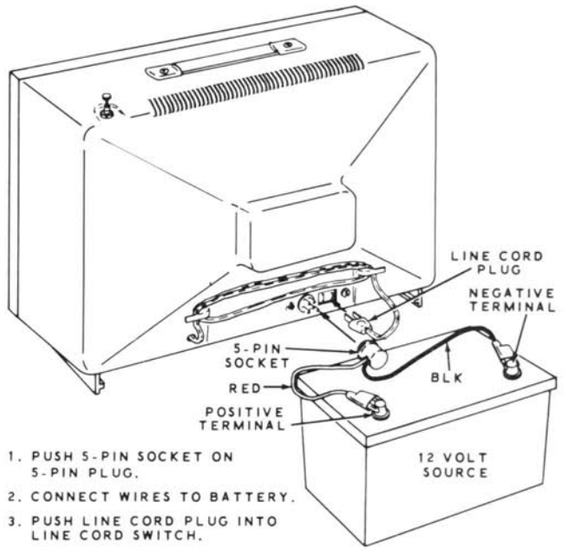


Figure 7C

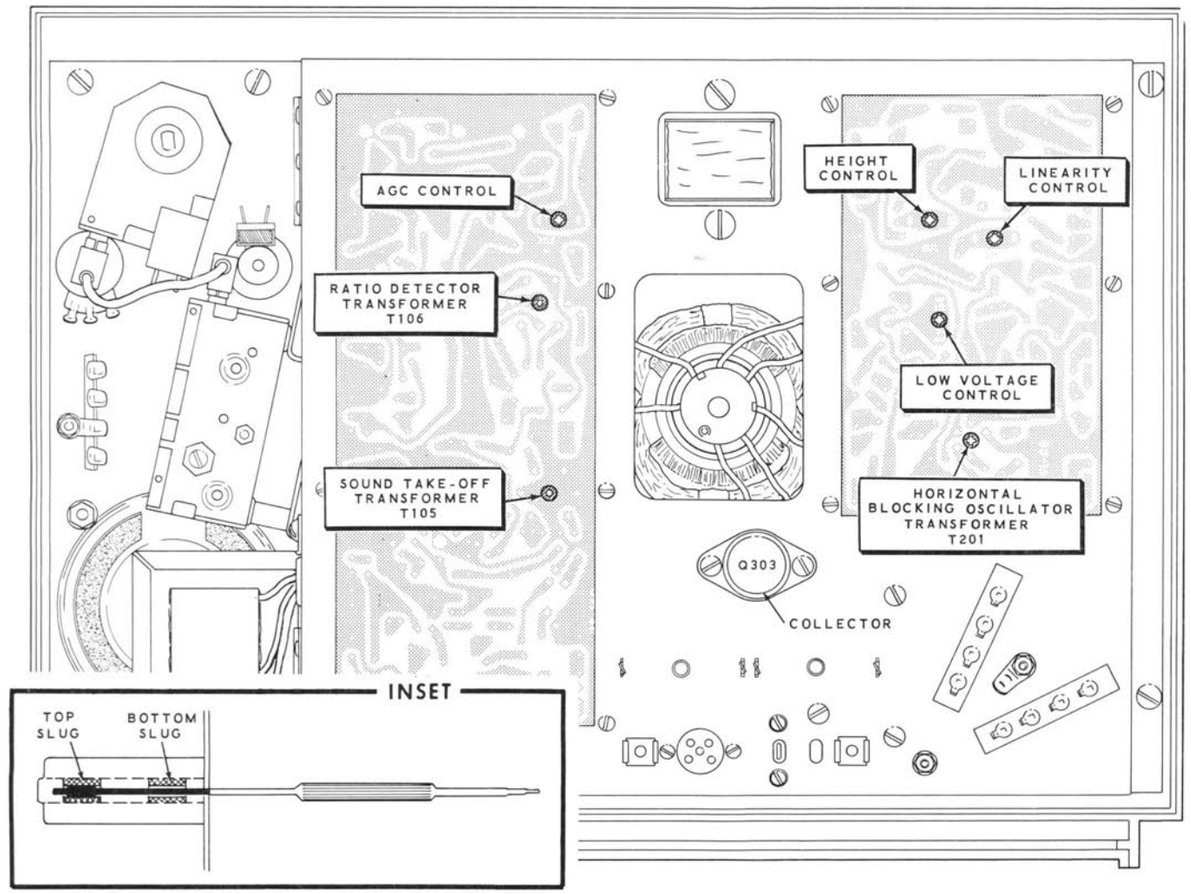


FIGURE 2

LR-104

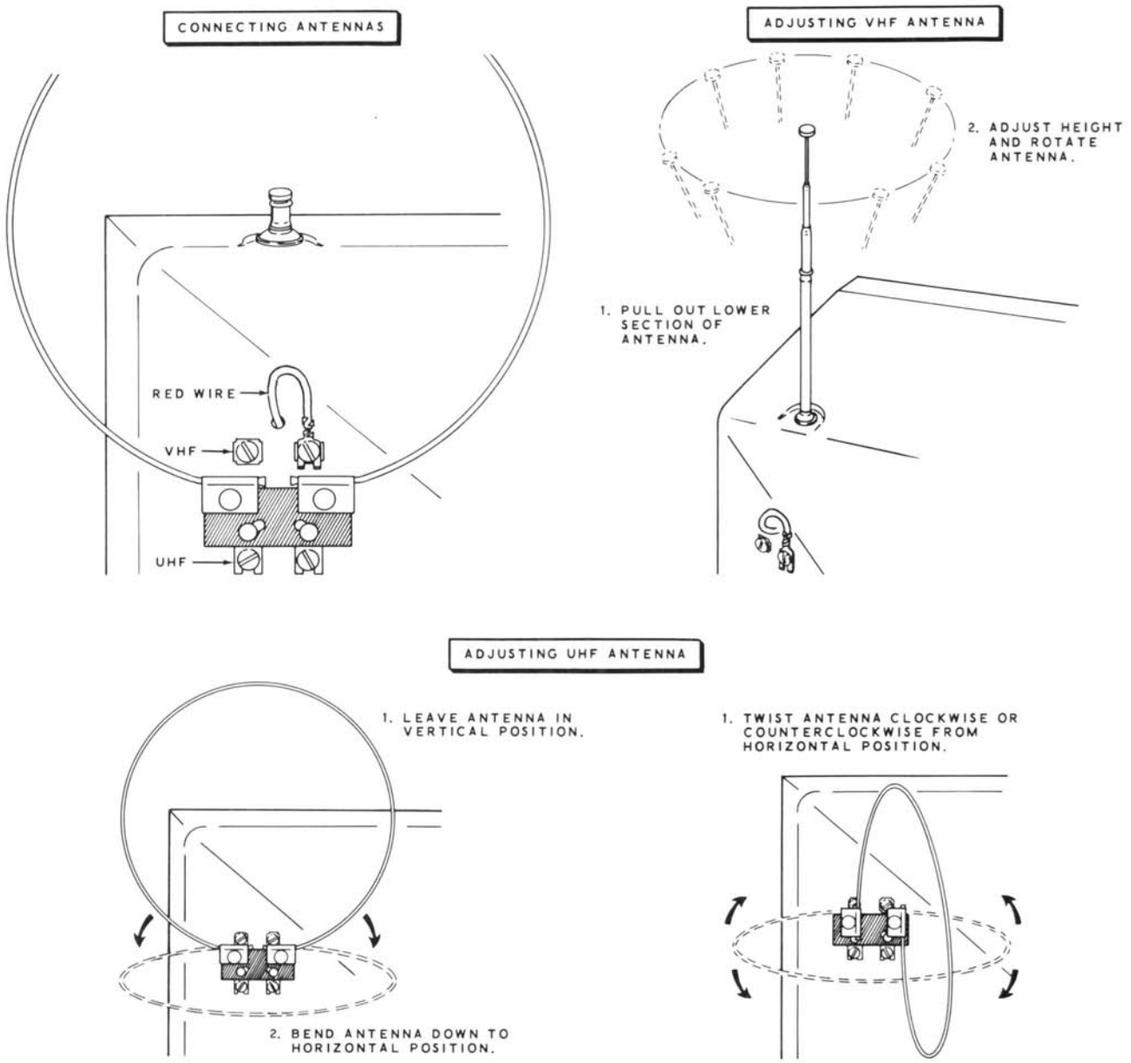


Figure 7D

VHF AND UHF PORTABLE ANTENNAS

The following steps tell you how to connect and position the portable antennas which were received with this kit. NOTE: For best reception, always disconnect these antennas when external VHF and UHF antennas are being used in place of them.

Refer to Figure 7D (fold-out from this page) for the following steps.

( ) Connect the red wire, coming through the back of the cabinet, to either of the VHF antenna terminals; then tighten the screw.

( ) Install the loop antenna between the UHF antenna terminals. Then tighten both screws.

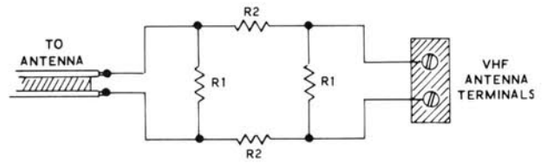
The whip antenna is used for VHF operation. To use this antenna, pull the lower section all the way out of the cabinet. Then rotate the antenna and adjust its height for best reception.

The UHF loop antenna can be turned to various positions to receive the best signal. Figure 7D shows how the antenna can be adjusted.

ATTENUATOR PAD FOR VHF OUTDOOR ANTENNAS

A distorted picture can sometimes be caused by too large a signal, especially in metropolitan areas, where the transmitting antenna is quite close to the receiving antenna.

The distortion will appear as a tearing or bending condition, as shown in Figure 22 on Page 68. In this case, the signal from the antenna can be reduced by using an attenuator pad, like the one shown in Figure 7E. Connect this pad between the antenna and the TV Set, as shown. Resistors for making these pads can be obtained locally.



FOR A SMALL AMOUNT OF ATTENUATION (6 DB)
R1 = 910 Ω
R2 = 110 Ω

FOR A MEDIUM AMOUNT OF ATTENUATION (12 DB)
R1 = 510 Ω
R2 = 270 Ω

FOR A LARGE AMOUNT OF ATTENUATION (18 DB)
R1 = 390 Ω
R2 = 560 Ω

Figure 7E

IN CASE OF DIFFICULTY

NOTE: Refer to the Kit Builders Guide for Service and Warranty information.

This section of the Manual is divided into two parts. The first part, titled General, describes what to do about any difficulties that might occur right after the TV Set is assembled. The second part, titled Troubleshooting, tells how to find out why a television set is not working properly.

A Troubleshooting Chart is also provided. This Chart lists a number of possible difficulties that could arise. It also shows how the picture would look with these difficulties, and lists several possible causes.

Figure 8 (fold-out from Page 58) shows the signal paths and the principal functions of various stages in the TV Set. This will help you localize difficulties to particular stages.

The Circuit Board X-Ray Views (Page 94) and the Chassis Photographs (Page 95) show the locations of components on the circuit boards and chassis. The Block Diagram (fold-out from Page 82), and the Schematic Diagram (fold-out from Page 97), are aids for locating causes of difficulties.

Before you try to locate the cause of difficulty, recheck the operation of the controls on your TV Set. Be sure the controls that are mounted on the circuit boards have been adjusted as outlined in the Adjustment section of this Manual.

WARNING High voltages are present at some points in this TV Set. Use caution to avoid shock.

GENERAL

The following general checks should be made if the TV Set fails to respond properly after the kit is assembled, during the Adjustments.

1. The first step in locating your difficulty is to make a visual inspection of the whole TV Set to make sure there are no obvious faults or errors. Look for faulty or unsoldered connections, burned or overheated parts, bare wires touching each other, solder bridges between circuit board foils, etc. Make sure there are not bits of solder, wire ends, or other foreign matter, lodged in the wiring. Check any terminals that have more than one or two wires attached to make sure all wires are soldered.

2. Recheck the wiring against the Pictorials. Make sure the correct resistors and capacitors have been installed at each location. It is not difficult, for example, to mistake the orange band of a 10 KΩ (brown-black-orange) resistor for the yellow band of a 100 KΩ (brown-black-yellow) resistor, or vice versa. Check to see that all transistors are properly connected.

3. It is often helpful to have a friend check your work. Someone who is not so familiar with the unit may notice something that you have consistently overlooked.

TROUBLESHOOTING

The following information will most often be used to deal with difficulties that might occur after the TV Set has been in operation for some time. This type of difficulty is usually caused by transistor failure or parts breakdown.

Troubleshooting your TV Set means to search through it to find out why it is not operating properly. First, you must determine the general area the trouble is in; then you must find the cause of the trouble and correct it.

FINDING THE AREA

Use some detective work to locate a trouble in your TV Set. A detective examines clues, questions suspects, and eliminates the innocent, to solve a case. In a similar manner, you should analyze the clues or symptoms that are presented by your TV Set. The number of suspected causes can be reduced through a process of elimination. Study the Block Diagram in Figure 8 to understand the function of the various circuits. Then determine which sections are operating properly and could NOT cause the trouble. A review of the Circuit Description may also be helpful.

Suppose, for an example of this type of analysis, that the sound in your TV Set is good and the face of the picture tube is lit up, but no picture appears on the screen. Refer to Figure 8 and note that these clues (sound ok, bright picture tube, no picture) eliminate all circuits except the video output stage, Q105. (The picture is probably ok from the antenna to video detector Q104 because the sound is ok, and the sound and picture travel together through these stages. The lit-up picture tube indicates that all other circuits except Q105 are probably ok.) The next step is to find the trouble itself by using the suggestions given in the next section: "Finding The Trouble."

In another example, the picture rolls vertically very rapidly and cannot be made to stop. In this case, the trouble might be in the sync separator stage (Q201), which supplies control signals, or in the circuits of vertical oscillator and output transistors Q204, Q205, and Q302.

NOTE: In the event of audio trouble, integrated circuit Q108 should be the least suspected. Check the components and circuits that connect to Q108 first. The Troubleshooting Chart will help you locate the trouble. See "Tests For Integrated Circuit Q108," Page 73.

FINDING THE TROUBLE

When you have localized the trouble to a general area, search that area carefully to find the exact cause of the trouble. Start by making a more complete visual inspection of the area, as listed below.

A. About 90% of the kits that are returned for repair do not function properly because of poor solder connections. Search through all the connections in the trouble area to make sure they are properly soldered. Troubles can often be eliminated by reheating all connections to be sure they are properly soldered.

B. Check the values of the parts to make sure the proper part is wired into the circuit at each location.

C. Check the transistors to be sure the correct transistor is wired properly into each circuit.

If the above checks do not reveal the trouble, and a voltmeter is available, check the voltage readings against those on the Schematic Diagram (fold-out from Page 97). NOTE: All voltage measurements were made with an 11 megohm input vacuum tube voltmeter. Voltages may vary as much as ±15%.

REPAIRING THE TV SET

When you repair your TV Set, make sure you eliminate both the cause and the effect of your trouble. For example, suppose you found a burned resistor in the Set. This would indicate that another faulty component, or a wiring error, or a short circuit, had caused the resistor to burn. You must eliminate the cause before you replace the resistor, or the new resistor will also burn.

Since a television set is an extremely complex device, a case may sometimes arise where the trouble is not found, even after making the checks listed above. If this condition should occur, you may avail yourself of the help provided by the Heath Technical Consultation Department or Service Department as described in the Kit Builders Guide.

NOTE: When writing to the Heath Company, be sure to include the following information: kit Model Number, Series Number, purchase date, and date of the kit assembly Manual (date at bottom of Page 1).

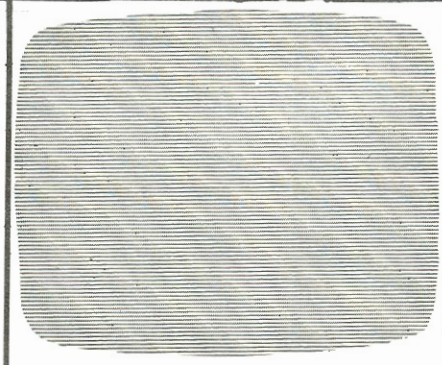
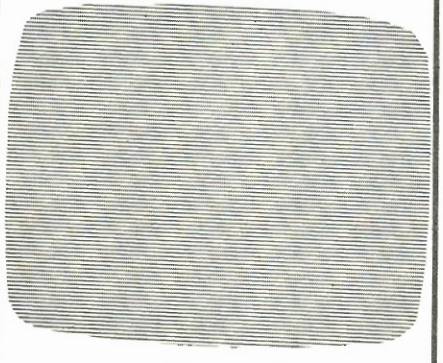
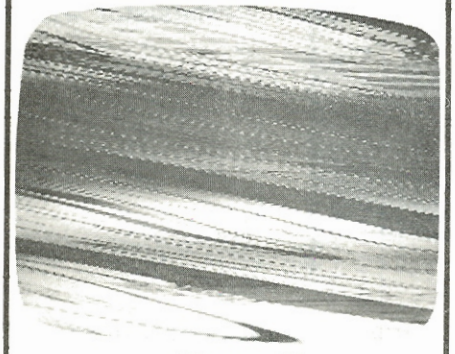
TROUBLESHOOTING CHART

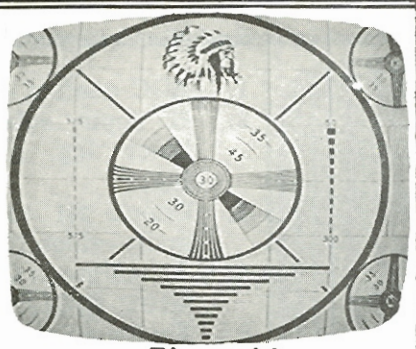
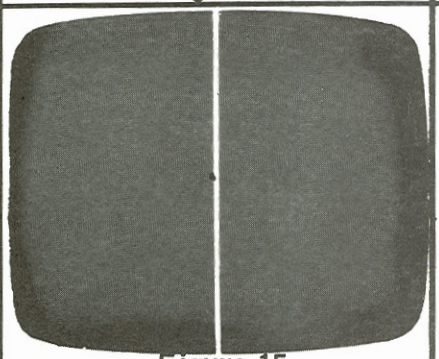
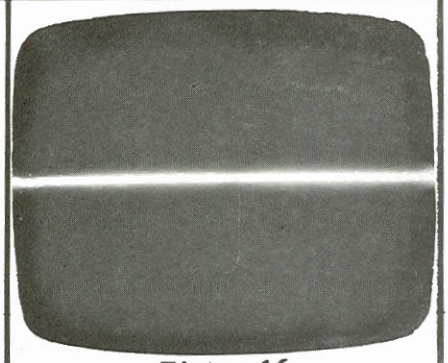
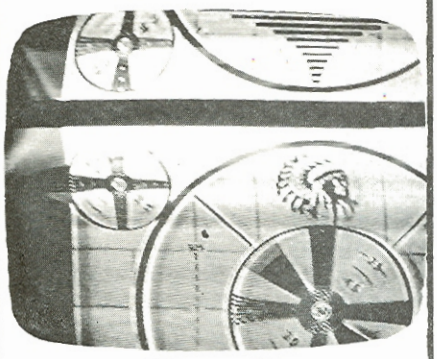
The Troubleshooting Chart that follows lists some possible difficulties that might arise in the operaton of your Television Set. The suggested possible causes are given primarily to direct your attention to the areas most likely to be faulty; they do not rule out other possibilities.

TROUBLESHOOTING CHART

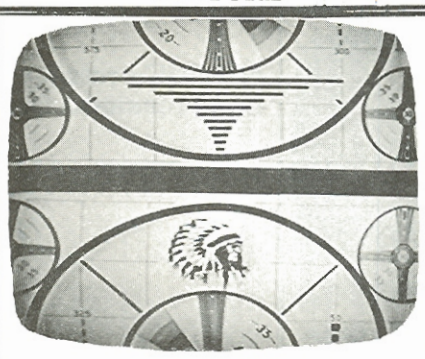
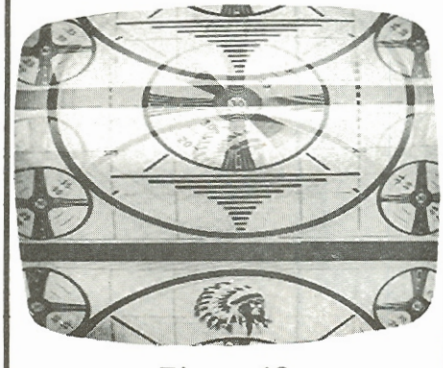
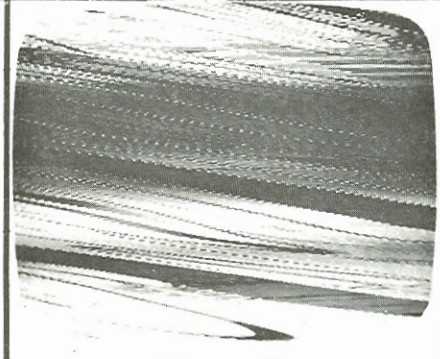
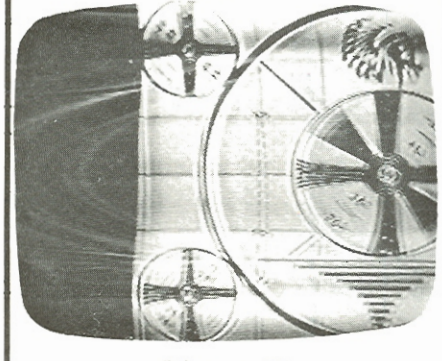
TROUBLE	PICTURE	POSSIBLE CAUSE
TV Set completely dead.	 Figure 9	1. Circuit breaker open.* 2. Line cord unplugged, unsoldered, or broken. 3. Incorrect wiring of Off-On switch, line cord switch, or red leads of harness to circuit boards. 4. Connections to power supply terminal strips. 5. Faulty diode D303 or D304. 6. Faulty transistor Q206, Q207, or Q303.
No light on screen, sound OK, pilot lamps lit.	 Figure 10	1. Faulty picture tube filament connections (at circuit board and pins 3 and 4 of CRT socket) or faulty picture tube. 2. High voltage anode not connected. 3. Brightness control not clockwise. 4. Yoke leads open. 5. Check voltages at picture tube base. 6. Faulty diode D301 or picture tube.
No light on screen, sound OK, pilot lamps not lit.		1. Faulty transistor Q202, Q203, Q301. 2. Faulty components in these circuits. 3. Open transformer T201. 4. Open transformer T301. 5. Open transformer T202.

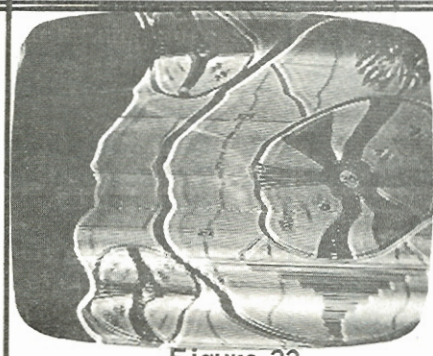
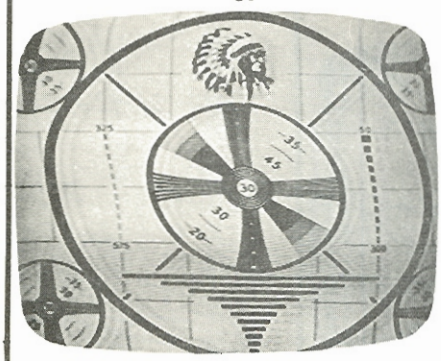
*Push button to reset. If the power transformer circuit breaker will not stay closed, there is a short circuit in the power supply. If the B+ circuit breaker will not stay closed, there is a short circuit in other sections of the TV Set.

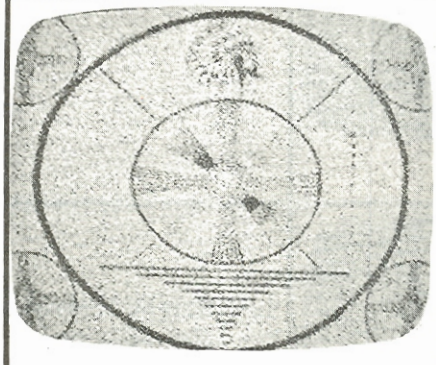
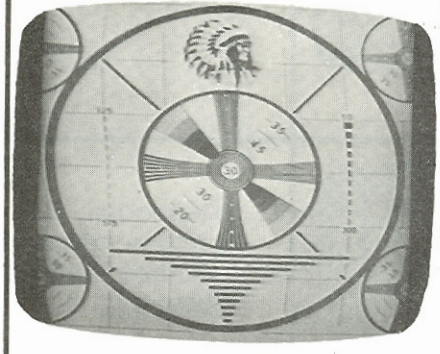
TROUBLE	PICTURE	POSSIBLE CAUSE
Light on screen, no picture, no snow, no sound, no noise.	 Figure 11	1. AGC control misadjusted. 2. IF input cable connected to wrong tuner lug, or shield lead touching lug. 3. Check all connections to tuner and audio-video circuit board. 4. Transistors Q101, Q102, Q103, Q104, Q106, Q107. 5. Faulty components in one of the transistor circuits listed in step 4. 6. Make sure the violet and gray harness wires are connected to the proper lugs on the VHF tuner. 7. Faulty VHF tuner.
No UHF reception, VHF reception OK.		1. No UHF antenna or faulty UHF antenna connections. 2. Faulty UHF-to-VHF connector cable. 3. Check all wiring to both tuners. 4. Check voltage at lug 3 of UHF tuner. 5. Faulty UHF tuner.
Light on screen, sound OK, but no picture or jumbled picture.	 Figure 12 or  Figure 13	1. Fine Tuning misadjusted. 2. Horizontal Hold misadjusted. 3. Vertical Hold misadjusted. 4. AGC misadjusted. 5. Transistor Q105 and associated parts. 6. Transistor Q107 and associated parts.

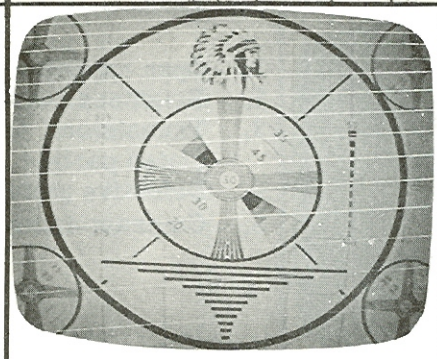
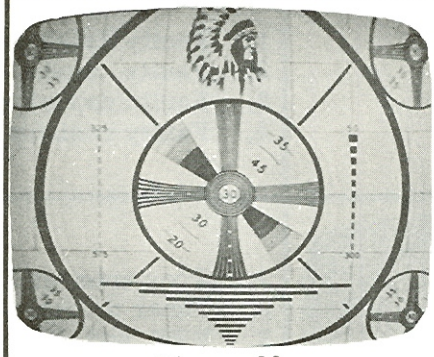
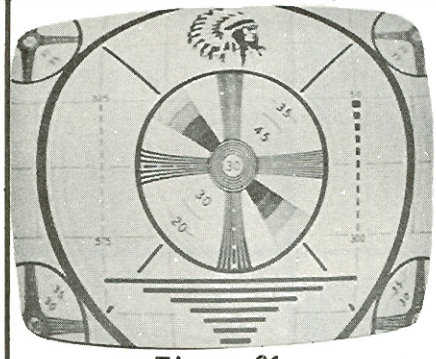
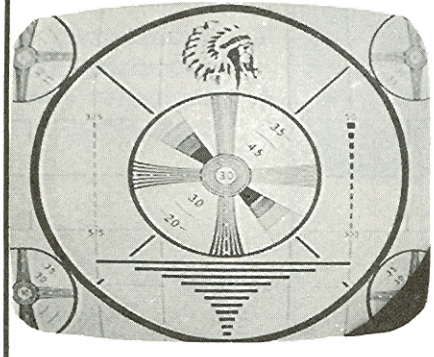
TROUBLE	PICTURE	POSSIBLE CAUSE
Picture OK, no sound, or distorted sound.	 Figure 14	1. Fine tuning misadjusted. 2. Transistors Q104, Q109, Q110, Q111, or associated circuits. 3. Defective speaker or wiring to circuit board. 4. Leads to Volume control shorted or connected wrong. 5. Misadjusted transformers T105 or T106. 6. Integrated circuit Q108 defective.*
No horizontal deflection (white line down center of screen).	 Figure 15	1. Yoke wiring to circuit board. 2. Open horizontal deflection coils in yoke. 3. Open capacitor C302.
No vertical deflection (white line across center of screen.	 Figure 16	1. Vertical output choke L303. 2. Vertical deflection coils in yoke. 3. Transistors Q204, Q205, or Q302 and associated parts.
Picture not stationary on screen (no horizontal or vertical sync).	 Figure 17	1. AGC control misadjusted. 2. Transistor Q201 and associated parts. 3. Transistor Q107 and associated parts.

*NOTE: Integrated circuit Q108 is a rugged unit and does not damage easily. Check all other audio circuit components before suspecting Q108. Refer to Page 73 to test integrated circuit Q108.

TROUBLE	PICTURE	POSSIBLE CAUSE
Picture rolls (no vertical sync).	 Figure 18 or  Figure 19	1. Vertical Hold control misadjusted. 2. Height or Linearity control misadjusted. 3. AGC control misadjusted. 4. Transistors Q204, Q205, and associated parts. 5. Resistors R223, R224, capacitors C221, C218.
No horizontal hold.	 Figure 20 or  Figure 21	1. Horizontal Hold control misadjusted. 2. AGC control misadjusted. 3. Faulty dual diode D201-D202 and associated parts. 4. Transistor Q202 and associated parts. 5. Wiring of transformer T301.

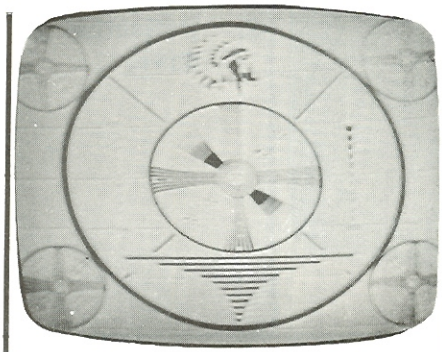
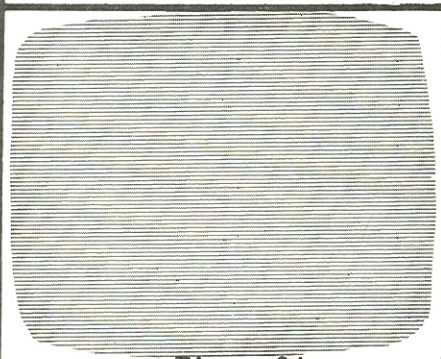
TROUBLE	PICTURE	POSSIBLE CAUSE
Picture tears or bends.	 Figure 22 or  Figure 23	1. AGC control misadjusted. 2. Transistor Q107 and associated parts.
Herringbone interference in picture.	 Figure 24	1. Fine Tuning misadjusted. 2. Local RF interference. 3. 4.5 MHz trap (L105) misadjusted.
Picture smeared (not clear).	 Figure 25	1. Fine Tuning misadjusted. 2. Poor video IF alignment. 3. Shorted capacitor C134.

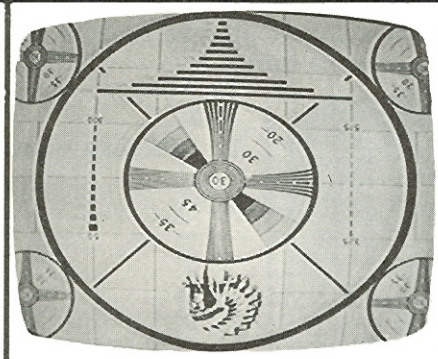
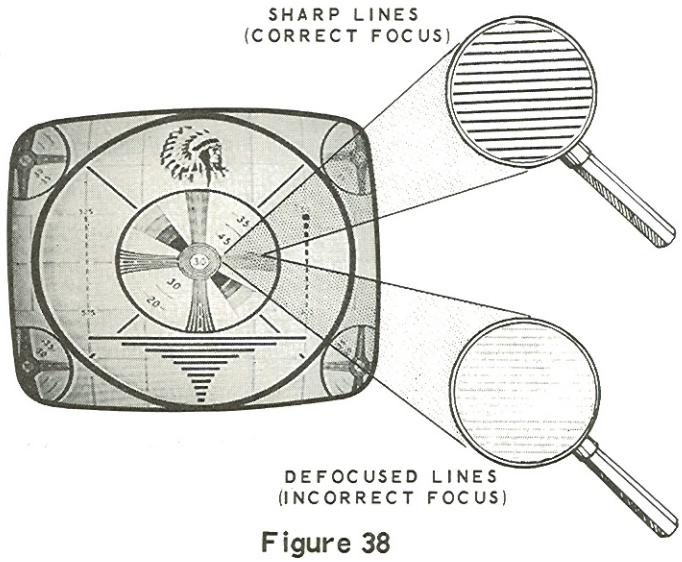
TROUBLE	PICTURE	POSSIBLE CAUSE
No contrast (picture washed out), no brightness, no snow.	 Figure 26	1. Open capacitor C134. 2. Brightness control misadjusted. 3. Transistors Q104, Q105, and associated parts. 4. Defective picture tube. 5. Contrast control misadjusted.
Brightness control does not have enough range.		1. Faulty Brightness control. 2. Faulty diode D301 or D104. 3. Faulty capacitor C135. 4. Faulty resistor R129.
Snowy picture.	 Figure 27	1. Poor antenna. 2. Tuner or tuners. 3. VHF and UHF antenna leads interchanged.
Picture slow coming on, does not fill screen horizontally.	 Figure 28	1. Low battery voltage. 2. Diodes D303, D304, D306. 3. Transistors Q206, Q207, Q303 and associated parts. 4. Improper low voltage (LO V) Adjustment (Page 52).

TROUBLE	PICTURE	POSSIBLE CAUSE
Retrace lines diagonally across picture.	 Figure 29	1. No vertical retrace blanking. 2. Resistors R237, R239, capacitors C225, C227.
Top of picture stretched (people's heads too long).	 Figure 30	1. Vertical Linearity control misadjusted. 2. Resistor R234.
Bottom of picture stretched (people's leg too long).	 Figure 31	1. Height control misadjusted. 2. Resistor R227.
Neck shadow (corner of picture black).	 Figure 32	1. Deflection yoke out of position on picture tube neck. 2. Picture centering magnets misadjusted.

TROUBLE	PICTURE	POSSIBLE CAUSE

NOTE: The following symptoms may indicate a faulty picture tube. It is suggested that you obtain a professional opinion before you replace the picture tube.

Picture slow to come on, has a dim milky look.	 Figure 33	1. Picture tube.
Light on screen, no picture, Brightness control has no effect.	 Figure 34	1. Picture tube.
Highlights (bright objects) look silvery or artificial as Brightness control is turned up.	 Figure 35	1. Picture tube.
As Brightness control is turned up, picture tends to go negative.	 Figure 36	1. Picture tube.

TROUBLE	PICTURE	POSSIBLE CAUSE
Picture upside down.	 Figure 37	1. Green and orange deflection yoke wires reversed. 2. Deflection yoke installed upside down.
Trace lines out of focus.	 Figure 38	1. Focus voltage. Perform the adjustment listed below.

FOCUS ADJUSTMENT

Refer to Pictorial 3-8 (fold-out from Page 57) and to Figure 38 above.

CAUTION: Do not touch lug 2 of terminal strip Y with your fingers during the following adjustment. This terminal is connected to +135 volts DC.

Study Figure 38 carefully; it is sometimes difficult to distinguish between properly focused and defocused lines. Then unplug the white picture tube socket lead from lug 2 of terminal strip Y. Alternately plug this lead into lug 1 and lug 2 of terminal strip Y while studying the focusing on the screen. Leave the lead plugged onto the lug that produces the best focusing.

TESTS FOR INTEGRATED CIRCUIT Q108

If a normal picture is present on the screen but there is no sound (or distorted sound), from the loudspeaker, the trouble will be found within the audio section of the TV Set.

NOTE: Integrated circuit Q108 is a rugged unit, not easily damaged. It should be the last circuit to be suspected in the event of audio trouble. Check all components and circuits that connect to Q108 before suspecting the integrated circuit.

Carefully re-examine all the circuits and components in the audio section. Be sure the correct transistors have been properly wired into the circuit. Be sure the correct resistors and capacitors are in the proper locations, and that there are no unsoldered, or poorly soldered connections.

If careful inspection does not reveal the cause of trouble, refer to the Schematic Diagram (fold-out from Page 97) and make voltage tests in the audio circuit. Measure the integrated circuit voltages last, as directed in the following paragraphs.

The following chart lists the normal voltages that should be found at the pins of integrated circuit Q108, and the components to check if these voltages vary more than ±15%. The chart assumes that the picture on the CRT screen is normal. Voltages are measured with an 11 megohm input VTVM from chassis ground to the point indicated.

Q108 Lead #	Normal Voltage	Possible cause, if voltage is not correct.
1	2.1	C131, C132
2	2.1	C131, C132
3	2.1	C136
4	2.1	C137, T106
5	7.5	R143, T106
6	2.1	C138, T106
7	2.1	C138, T106
8	0	Open ground connection
9	0.7	R145, R146, C141
10	7.5	R113, R144, C139

If the correct voltages are measured at each lead of integrated circuit Q108, and still no sound is heard from the speaker, repeat the Sound Detector and Sound Take-Off adjustments on Page 53. Only if this fails should you suspect Q108.

ALIGNMENT

Instrument alignment of this TV Set is not normally required because all tuners, coils and traps have been carefully preset at the factory. The following information is given in case alignment should be needed at some future time.

WARNING! Do not attempt to align this TV Set unless you have previous TV alignment experience, a thorough knowledge of the theory involved, and the necessary equipment.

EQUIPMENT NEEDED

1. VHF-TV Sweep and Marker Generator, such as the Heath TV Alignment Generator.
2. An RF Generator, of crystal-controlled accuracy, with a frequency range of 4 MHz through 50 MHz, and AM modulated.
3. An Oscilloscope, such as the Heath Laboratory Oscilloscope, and an oscilloscope demodulator probe.
4. A Bias Supply capable of furnishing from 0 to 2.5 volts. (Two flashlight batteries and an adjustable control can be used.)

SOUND IF AND DETECTOR ALIGNMENT (Figure 39)

1. Connect the oscilloscope and generator ground leads to chassis ground as close as possible to their respective test points throughout the alignment procedure.
2. Connect one lead of a .001 μfd capacitor at TP1 (Base of Q104).
3. Connect the properly terminated sweep and marker generator to the free end of the .001 μfd capacitor. Set the sweep generator to a center frequency of 4.5 MHz, with an approximate sweep width of ±500 kHz. Set the marker generator to 4.5 MHz.

NOTE: The 4.5 MHz marker frequency should be of crystal controlled accuracy.

4. Connect the vertical input of the oscilloscope to TP2 (the junction of resistor R145 and the shielded lead from the Volume control).
5. Turn the AGC control fully clockwise as viewed from the foil side of the audio-video circuit board.
6. Increase the output of the sweep and marker generator until an S-curve similar to Waveform A appears on the oscilloscope screen (disregard the 4.5 MHz marker). NOTE: The S-curve can have an opposite polarity from that shown in Waveform A due to the particular oscilloscope and sweep generator being used. If an extreme amount of "grass" from the horizontal oscillator appears on the curve, shunt the input of the oscilloscope to ground with a .001 μfd capacitor.

NOTE: Keep the output of the generator as low as possible in the following steps while still maintaining the correct waveform. These waveforms are shown disregarding the center line reference on the oscilloscope.

SOUND ALIGNMENT

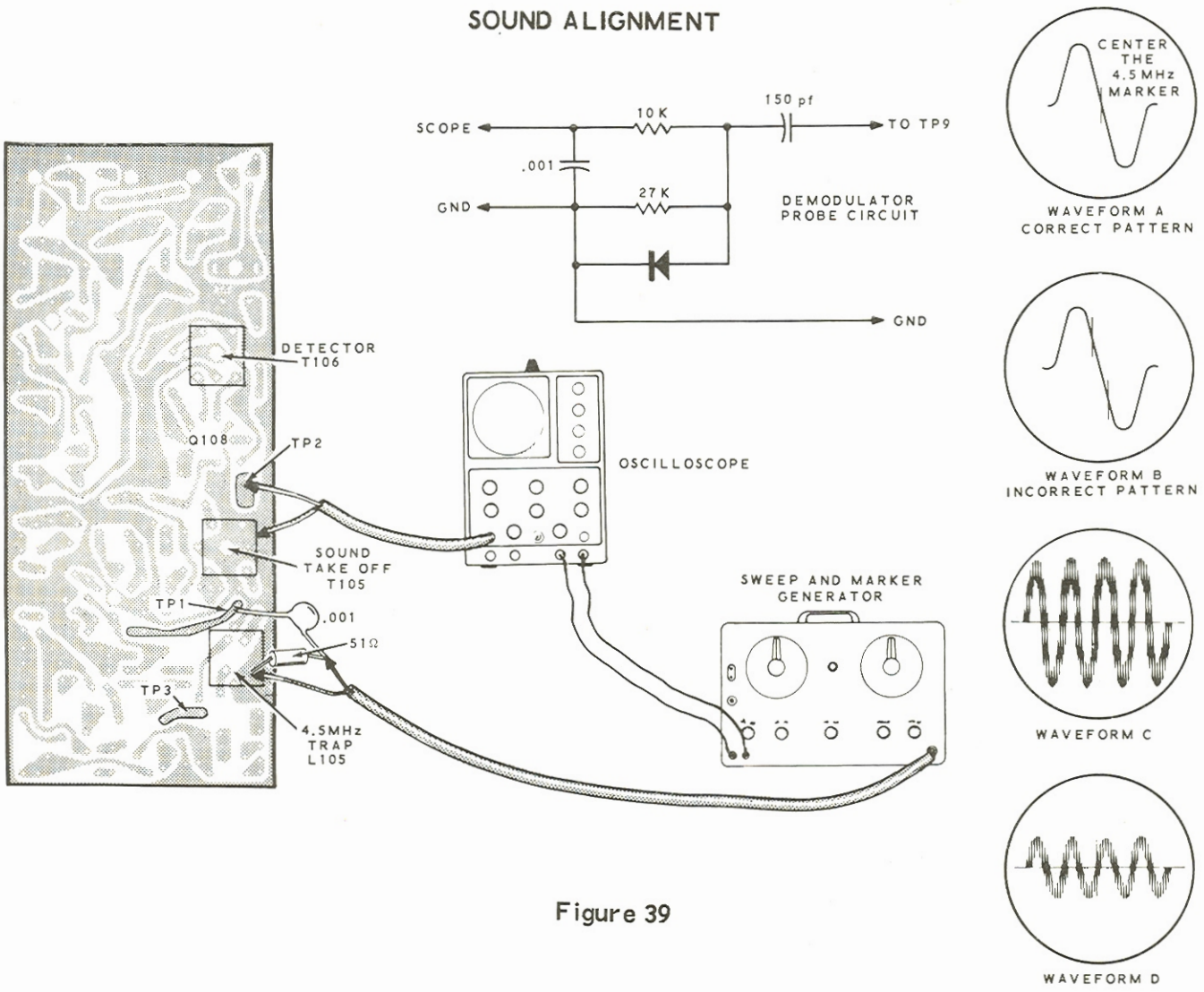


Figure 39

( ) Adjust the bottom slug in T106, and the top and bottom slugs in T105 for maximum amplitude and symmetry of the S-curve. It may be necessary to make these adjustments several times to obtain Waveform A.

( ) Adjust the top slug in T106 to position the 4.5 MHz marker in the center of the linear portion of the waveform, as shown in waveform A of Figure 39. Waveform B shows the incorrect positions of the 4.5 MHz marker.

( ) Remove the oscilloscope and sweep and marker generator connections from the circuit board.

( ) Repeat the Sound Detector And Sound Take-off Adjustments on Page 53.

4.5 MHz TRAP ADJUSTMENTS

( ) Use a demodulator probe to connect the oscilloscope at TP3 (collector of Q105).

( ) Connect the RF generator through a .001 μfd capacitor to TP1 (base of Q104). Set the generator for a 4.5 MHz signal that is audio modulated at 400 Hz.

NOTE: The oscilloscope screen should show a pattern similar to Waveform C.

( ) Adjust the slug in L105 until the pattern is reduced to minimum. See Waveform D.

( ) Remove all connections from the circuit board.

VIDEO IF ALIGNMENT (Figure 40)

1. Turn the VHF tuner to the channel 10 position.

2. Turn the AGC control fully clockwise as viewed from the foil side of the audio-video circuit board.

3. Connect one end of a 22 KΩ resistor at TP1 (Base of Q104).

4. Connect the oscilloscope vertical input to the free end of the 22 KΩ resistor.

5. Shunt T102 and T103 with a 100 Ω resistor as shown.

6. Connect the properly terminated sweep and marker generator through a .001 μfd capacitor as directed in the first step in the Video Alignment Chart.

7. Connect the positive lead of the bias supply to TP4 (junction of C106 and R102). Connect the negative lead to the chassis. Adjust the bias supply to 1.5 volts DC.

Perform the steps in order as shown in the following Video Alignment Chart.

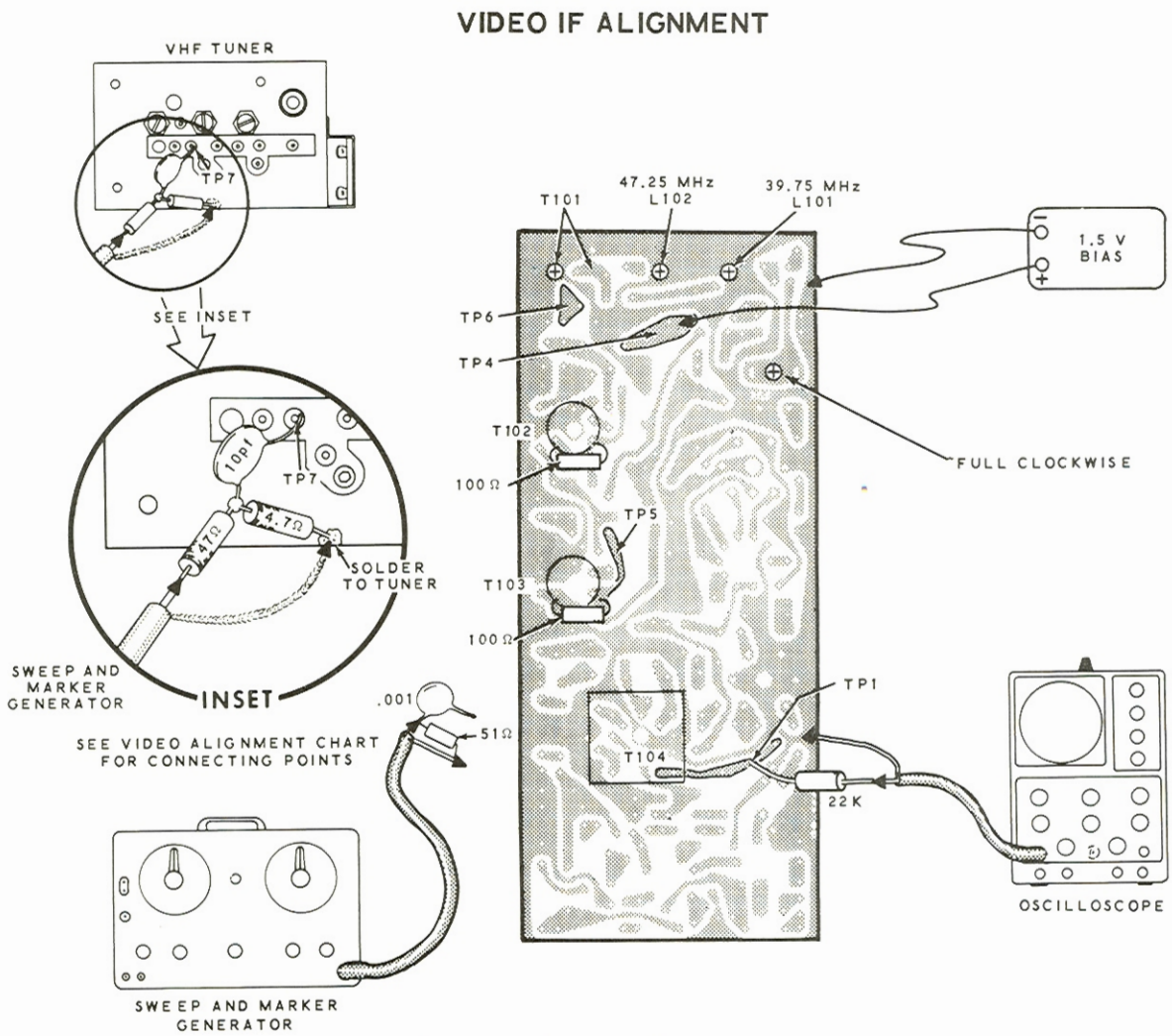
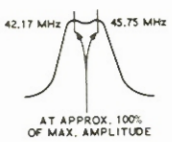
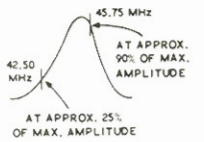
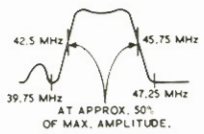


Figure 40

VIDEO ALIGNMENT CHART

	STAGE	Connect the sweep and marker generator through a .001 μfd capacitor to:	Sweep generator center frequency approximately 43.5 MHz. Sweep width approximately 8 MHz.	Marker generator frequency	Adjust for maximum gain and bandwidth, except as indicated (*)	REMARKS Set bias to 1.5 volts.
1	3rd IF Video Detector T104	TP5 collector of Q102		42.17 MHz 45.75 MHz (both CW)	Top and bottom slugs of T104	Use full vertical gain of oscilloscope. Adjust output of sweep generator to produce approximately 2" of vertical deflection. Keep marker output low enough so that it does not distort the waveform.
2	2nd IF(T103) 1st IF (T102) (See Remarks)	TP6 Secondary of T101		42.5 MHz 45.75 MHz (both CW)	Adjust BOTH T103 and T102 to produce waveform as shown.	Remove both 100 Ω shunt resistors. Reduce output of sweep and marker generators.
3	L101 (Adjacent channel picture trap) L102 (Adjacent channel sound trap)	VHF TUNER TP7 (Base of Q2) through a 10 pf capacitor (See insets of Figure 2)		39.75 MHz 47.25 MHz (both CW)	(*)Adjust L101 for MINIMUM at 39.75 MHz. (*)Adjust L102 for MINIMUM at 47.25 MHz.	Reduce sweep width and increase generator output to observe marker locations more clearly.
4	T101 (Circuit board input IF) and T1 (Mixer output IF) Overall IF response	VHF TUNER TP7 (Base of Q2) through a 10 pf capacitor		42.5 MHz 45.75 MHz (both CW)	T1 Tuner IF output coil T101 IF input coil NOTE: Retouch adjustments in steps 1 and 2 to obtain the correct overall response curve.	Reduce output of sweep and marker generator.

( ) Disconnect the test leads and bias supply. Disconnect the 22 KΩ resistor from TP1 and the matching pad from the VHF tuner.

TUNER ALIGNMENT

VHF TUNER ALIGNMENT

Refer to Figure 41 for the following steps.

( ) Connect the oscilloscope, sweep and marker generator, and bias supply (set to +2 volts) to the VHF tuner as shown in the Figure.

( ) Turn the Channel Selector to the channel 10 position.

( ) Adjust the sweep generator to a center frequency of 196 MHz, with a sweep width of 10 MHz.

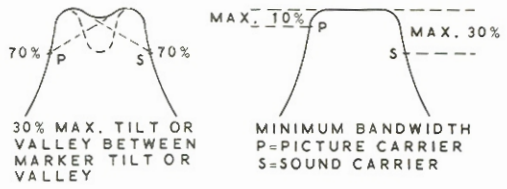
( ) Adjust the marker generator for markers at 193.25 MHz (picture carrier) and 197.75 MHz (sound carrier).

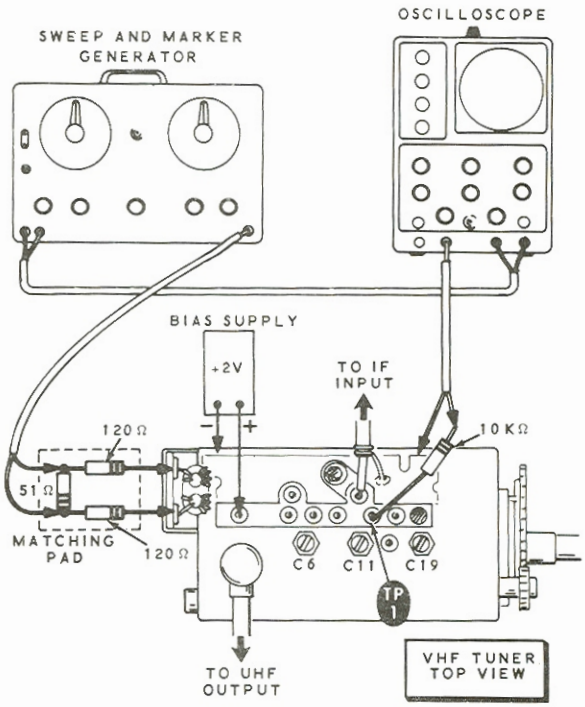
( ) Adjust capacitors C6 and C11 for the correct response, as shown.

( ) If the tilt or valley between the markers cannot be adjusted to within the 30% maximum tolerance, it can be brought within limits by physically compressing or expanding coil L5 for this channel.

( ) Check the other channels for the correct bandwidth and tilt or valley. Use the accompanying Tuner Frequency Chart on Page 79 for the correct marker frequencies for each channel. Compress or expand coil L5 to bring the tilt or valley within the 30% tolerance on any channels where the valley is over 30% of the overall waveform amplitude.

NOTE: If the bandwidth is too wide, or too narrow on most of the high channels, it can be corrected by compressing or expanding coil L9.





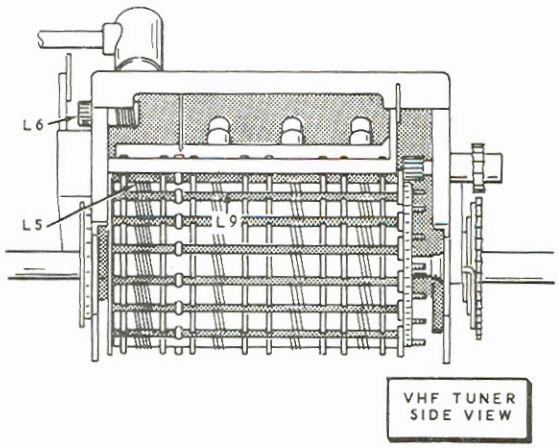


Figure 41

VHF OSCILLATOR ALIGNMENT

Do not use the following procedure unless the Fine Tuning control will not tune through a station.

( ) Connect the VHF antenna to the antenna input terminals of the tuner.

( ) Tune through each of the channels normally received in your locality. If the Fine Tuning control does not properly tune all of these channels, set the Channel Selector to the channel on which the Fine Tuning control has the least effect (the one that is farthest off frequency).

( ) Turn the Fine Tuning control two full turns clockwise, then turn it back counter-clockwise exactly one turn. This will center the Fine Tuning control mechanically for this channel.

( ) Adjust oscillator trimmer capacitor C19 to obtain the best sound and picture. This will automatically adjust the Fine Tuning range for all the other channels.

This completes the VHF tuner alignment.

TUNER FREQUENCY CHART

U.S. TELEVISION CHANNEL FREQUENCIES				
CHANNEL	BAND	CENTER FREQ. MHz	PICTURE CARRIER	SOUND CARRIER
2	54-60	57	55.25	59.75
3	60-66	63	61.25	65.75
4	66-72	69	67.25	71.75
5	76-82	79	77.25	81.75
6	82-88	85	83.25	87.75
7	174-180	177	175.25	179.25
8	180-186	183	181.25	185.75
9	186-192	189	187.25	191.75
10	192-198	195	193.25	197.75
11	198-204	201	199.25	203.75
12	204-210	207	205.25	209.75
13	210-216	213	211.25	215.75
45	656-662	659	657.25	661.75

UHF TUNER ALIGNMENT

NOTE: The complete VHF tuner and IF strip must be aligned properly before aligning the UHF tuner.

( ) Connect a UHF sweep generator to the UHF antenna terminals through the matching pad used in the VHF alignment procedure.

( ) Connect the oscilloscope and the bias supply to the VHF tuner as shown in Figure 41.

( ) Turn the VHF Channel Selector to the UHF position. Tune the UHF dial to channel 50.

( ) Tune the sweep generator to a center frequency of 698 MHz, with a sweep width of approximately 15 MHz.

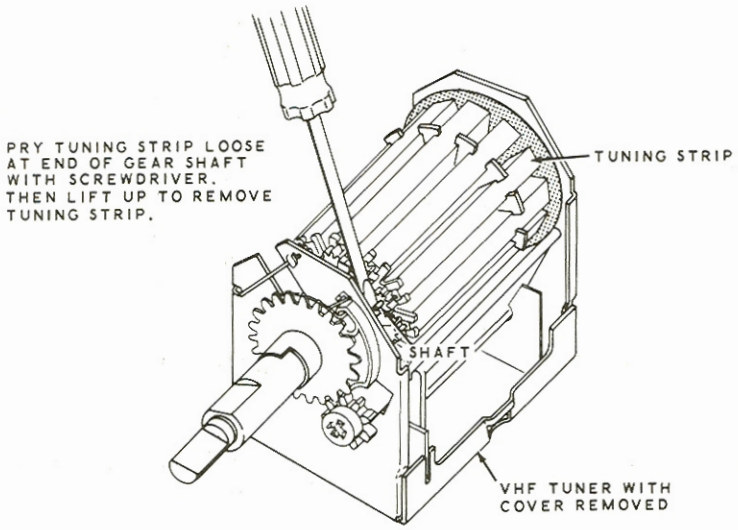
( ) Adjust coil L6 for a maximum gain and bandwidth. See Figure 41.

This completes the alignment procedure.

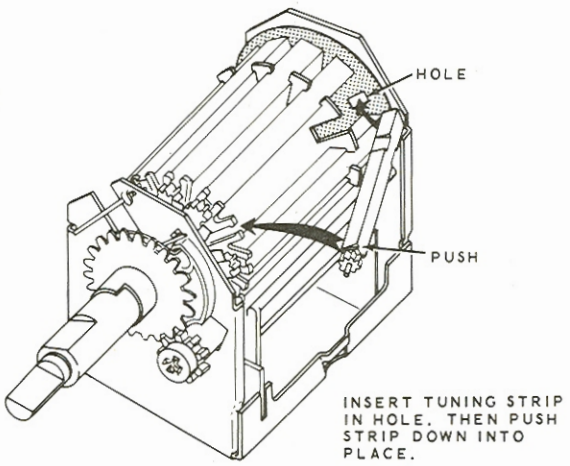
VHF TUNER REPLACEMENT PARTS LIST

PART No.	DESCRIPTION
235-1	Channel 1 UHF tuning strip
235-2	Channel 2 tuning strip
235-3	Channel 3 tuning strip
235-4	Channel 4 tuning strip
235-5	Channel 5 tuning strip
235-6	Channel 6 tuning strip
235-7	Channel 7 tuning strip
235-8	Channel 8 tuning strip
235-9	Channel 9 tuning strip
235-10	Channel 10 tuning strip
235-11	Channel 11 tuning strip
235-12	Channel 12 tuning strip
235-13	Channel 13 tuning strip
235-14	Balun antenna coil assembly

REMOVING TUNING STRIP

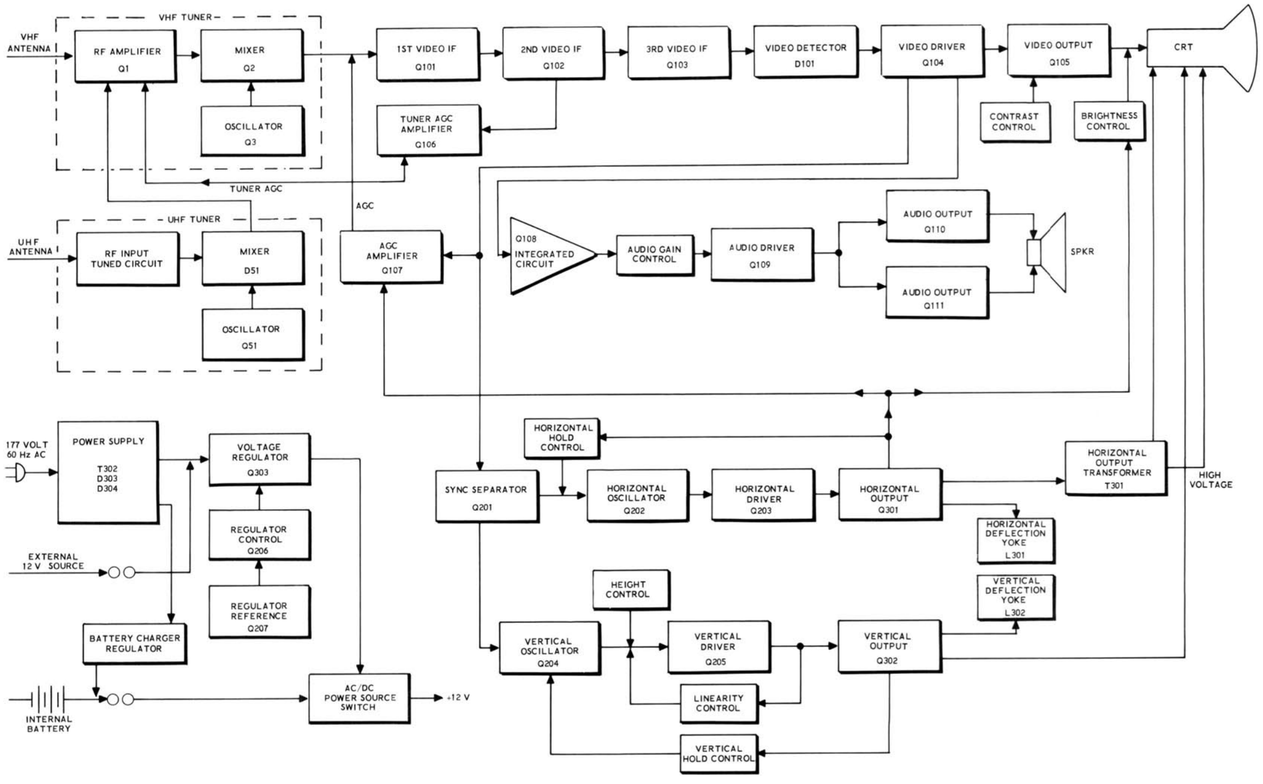


INSTALLING TUNING STRIP



SPECIFICATIONS

Picture Size	12" overall diagonal, 74 square inch viewing area.
Deflection	Magnetic, 110 degrees.
Focus	Electrostatic.
Antenna Input Impedance	300 Ω balanced.
Tuning Range	VHF TV channels 2 through 13 (memory-type Fine Tuning).
	UHF TV channels 14 through 83 (planetary drive tuning).
Picture IF Carrier	45.75 MHz.
Sound IF Carrier	41.25 MHz.
Sound IF	4.5 MHz.
Video Response	To 3.5 MHz.
Audio Power Output	500 Milliwatts into 24 Ω load (speaker impedance = 24 Ω).
Front Panel Controls	UHF Coarse Tuning, UHF Fine Tuning. VHF Coarse Tuning, VHF Fine Tuning. Off/On/Volume, Brightness, Contrast, Vertical Hold, Horizontal Hold.
Rear Chassis Controls	Height, Vertical Linearity, AGC, Low Voltage Adjust.



BLOCK DIAGRAM

Diode Complement.	1 - 1N82A: UHF mixer. 1 - 1N295: Video detector. 2 - 1N191: AGC gating, horizontal gate. 1 - 16U1: Dual; A Horizontal automatic phase control. 1 - #56-16: Low voltage regulator (zener). 1 - #57-27: CRT preheat rectifier. 2 - #57-42: Low voltage power supply. 1 - #57-45: High voltage rectifier (15.5 KV). 1 - DRS-102: Horizontal damper.
Transistor Complement.	1 - 6MO380: UHF oscillator. 1 - S1286: VHF RF amplifier. 1 - S1276: VHF mixer. 1 - S1296: VHF oscillator. 1 - SE5023: 1st video IF amplifier. 1 - SE5024: 2nd video IF amplifier. 1 - SE5025: 3rd video IF amplifier. 4 - 2N3692: Video driver, AGC amplifier, tuner AGC, Sync separator. 2 - 2N3566: Audio driver, low voltage regulator reference. 1 - S2090: Audio output (NPN). 1 - S2091: Audio output (PNP). 3 - 2N3638: Vertical oscillator, vertical driver, low voltage regulator control. 1 - 2N3731: Horizontal output. 1 - MP1613: Vertical output. 2 - 2N3567: Horizontal oscillator, Horizontal driver. 1 - 2N3923: Video power output. 1 - 40050: Low voltage regulator.
Integrated Circuit.	1 - CA3013: audio IF amplifier, FM sound detector, first audio driver. (Consists of 12 transistors, 12 diodes, 15 resistors.)
Power Requirements.	105-125 volts AC 60 Hz at .35 amperes (40 watts). 12 volts DC at 1.7 amperes (20 watts).
Overall size.	11-1/2" high x 15-3/4" wide x 9-5/16" deep.
Net Weight.	20 lbs.
Accessory.	Model GRA-104-1 Accessory Portable Battery pack and charging circuit.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (fold-out from Page 97) and to the Block Diagram (fold-out from Page 82) while reading this Circuit Description. The part numbers on the Schematic are arranged in the following groups to help you locate specific parts on the Schematic, chassis, and circuit boards:

0 - 49	Parts in the VHF tuner.
50 - 99	Parts in the UHF tuner.
100-199	Parts on the audio - video circuit board.
200-299	Parts on the sync - sweep circuit board.
300-399	Parts mounted on the chassis.
400-499	Parts in the integrated circuit (Q108).

NOTE: This manual uses the new IEEE (Institute of Electrical and Electronic Engineers) and international standard term "hertz" as the basic unit of frequency. The terms are used as follows:

Hz (hertz) = cps (cycles per second).
kHz (kilohertz) = kc (kilocycles per second).
MHz (megahertz) = mc (megacycles per second).

TUNERS

VHF TUNER

The signal from the VHF antenna is changed from a balanced to an unbalanced signal in input balun coil L1. From L1, the signal passes through a high-pass filter which attenuates all frequencies below channel 2. This filter consists of capacitors A, B, C, and D in the P.E.C. (printed electronic circuit); coils L2, L3, and L4; and capacitor C1.

The desired TV channel is selected by one of the thirteen turret-mounted channel strips. There are twelve VHF channel strips and one UHF converter strip. Each of the VHF strips contains an antenna coil (L5), and RF coil (L9), a mixer coil (L12), and an oscillator coil (L14). The UHF converter strip which is in the channel 1 position of the VHF tuner, will be described later with the UHF tuner.

The input signal from the high-pass filter is coupled through coil L5 and capacitor C2 to the base of RF amplifier transistor Q1. The amplified signal at the collector of transistor Q1 is coupled by the transformer action of coils L9 and L12 to the base of mixer transistor Q2. Coil L9 and capacitors C5, C6, and C8 tune the output of transistor Q1 to the frequency of the channel.

Coil L12 and capacitors C9, C11, and C12 tune the input of transistor Q2 to the same frequency. Neutralizing capacitor C7 controls the amount of feedback voltage to transistor Q1.

Transistor Q3 is connected as a Colpitts oscillator. Coil L14 and capacitor C19 tune the circuit to oscillate at a frequency 45.75 MHz above the video carrier frequency (41.25 MHz above the audio carrier frequency). The oscillator signal is coupled through capacitor C17 to the base of mixer transistor Q2.

The RF signal from transistor Q1, and the oscillator signal from transistor Q3, beat together in mixer transistor Q2 to produce the IF (intermediate frequency). The video IF signal is 45.75 MHz and the audio IF signal is 41.25 MHz. These IF signals are coupled through transformer T1 to the output jack on the VHF tuner.

The gain of RF transistor Q1 is controlled by an AGC (automatic gain control) voltage, which will be discussed later.

UHF TUNER

When the UHF converter strip (channel 1 in the VHF tuner) is in the circuit, the following changes take place; coils L16 and L17, and two shorting bars convert transistors Q1 and Q2 into two additional IF amplifier stages; VHF oscillator Q3 is stopped; and B+ voltage is applied to UHF oscillator transistor Q51.

The UHF tuner is divided into three compartments, as shown by dotted lines on the Schematic. These three compartments house the RF circuit, the mixer circuit, and the oscillator circuit. The compartment shields prevent undesirable feedback.

NOTE: Some of the inductances in the UHF tuner are so small that they are actually short pieces of wire. Although these are not shaped like coils physically, they are represented as coils or loops in the Schematic.

The input signal from the UHF antenna is inductively coupled from coil L51 to the RF tuned circuit of coil L52 and capacitor C51A. This tuned circuit rejects all frequencies except the desired UHF channel. The desired signal then passes through an opening in the mixer compartment shield to the mixer tuned circuit of coil L53 and capacitor C51B.

In the oscillator compartment, transistor Q51 is tuned to oscillate 45.75 MHz above the video carrier frequency (41.25 MHz above the audio carrier frequency). Coil L57, and capacitors C51C, C53, and C54 form the tuned oscillator circuit. Coil L56 couples the oscillator signal back to the mixer compartment through coil L55.

The oscillator signal and the tuned RF signal combine in mixer diode D51, resulting in a difference frequency, or IF signal. This IF signal is coupled through RF choke L54 and the shielded cable to the junction of coils L6 and L7 in the VHF tuner. Coil L6 tunes the circuit to the IF frequency. The shorting bar on the UHF converter strip connects the signal from coil L6, through capacitor C2, to the base of transistor Q1, which is now used as an IF amplifier.

Coils L16 and L17 on the UHF converter strip replace coils L9 and L12 on the VHF channel strip. This tunes the output of transistor Q1 and the input of transistor Q2 to the IF frequency. The IF signal from Q2 is then coupled through transformer T1 to the output jack on the VHF tuner, and through the shielded cable to the audio-video circuit board.

AUDIO-VIDEO CIRCUIT BOARD

The audio-video circuit board contains the IF amplifiers, the video amplifier and output stages, the audio detector amplifier and output stages, and the AGC amplifiers. Each of these stages will be described separately.

IF AMPLIFIER CIRCUITS

The IF signal from the VHF tuner is coupled to the primary of transformer T101. Two adjacent channel traps are in parallel with the primary of T101. The 39.75 MHz adjacent channel picture trap consists of coil L101 and capacitors C101 and C102. The 47.25 MHz adjacent-channel-audio trap consists of coil L102 and capacitor C103. These traps tune out the unwanted signals from strong TV stations operating on channels adjacent to the one selected by the tuner.

The secondary of transformer T101 is tuned to the IF frequency by capacitors C104 and C105. From C104, the IF signal is coupled to the base of first video IF transistor Q101. An AGC (automatic gain control) voltage is applied to the base of transistor Q101 through resistor R102. A complete description of the AGC circuit will be given later.

From the collector of Q101, the amplified IF signal is tuned by transformer T102 and coupled through capacitor C111 to the base of second video IF transistor Q102. The negative feedback winding of T102 and capacitor C107 couple a portion of the IF signal back to the base of transistor Q101 as neutralization to stabilize the stage.

The second video IF stage is identical in operation to the first video IF stage, except that the tuner AGC voltage is taken from the emitter circuit of transistor Q102.

Third video IF transistor Q103 does not require neutralization. The amplified IF signal from the collector of transistor Q103 is coupled through transformer T104 to detector diode D101, which removes the IF carrier signal. A filter network that consists of coil L103 and capacitors C125 and C126 forms a low-pass "tweet" filter to suppress any remaining IF carrier from the video and audio signals.

The composite video signal and the 4.5 MHz sound IF signal appear across peaking coil L104 and diode load resistor R121, and are coupled to the base of video driver transistor Q104. Resistors R117 and R118 form a voltage divider to provide the correct bias voltage for the base of transistor Q104.

Emitter follower stage Q104 matches the high impedance of the detector circuit to the low input impedance of video output transistor Q105. Transistor Q104 also serves as a conventional amplifier for the audio signals and sync signals that are taken from its collector by transformer T105.

VIDEO OUTPUT CIRCUIT

The video signal from the emitter of transistor Q104 is coupled through coil L105 and capacitor C133 to the base of video output transistor Q105. Coil L105 traps out the 4.5 MHz beat frequency to prevent interference with the video signal.

Contrast control R125 is in the emitter circuit of video output transistor Q105. It controls the proportion of the emitter resistor that is bypassed through capacitor C134, and thus controls the gain of transistor Q105. Varying the gain of Q105 varies the contrast of the picture on the CRT (cathode ray tube) screen.

The amplified video signal from transistor Q105 is coupled through capacitor C135 to the cathode of the CRT. The Brightness control, R128, and resistors R127 and R129, determine the amount of bias voltage on the cathode of the CRT and thus control the brightness of the raster.

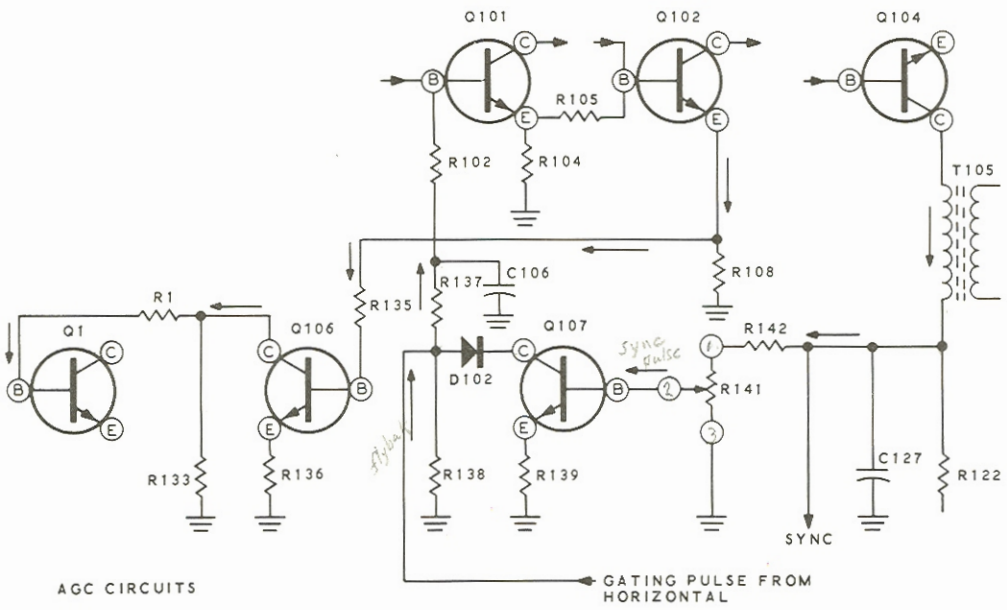


Figure 42

AGC CIRCUITS

Refer to Figure 42.

To maintain a fairly constant picture and sound output with varying signal input strengths, AGC (automatic gain control) is applied to three stages in this receiver.

The sync signal that appears across transformer T105 and resistor R122 is coupled through capacitor C202 to the sync separator circuit. Some of the sync signal is also applied through resistor R142 and AGC gain control R141 to the base of AGC amplifier transistor Q107.

AGC amplifier Q107 is controlled by the average level of the horizontal sync pulses, which vary in level with the strength of the received signal.

Horizontal pulses from the emitter of transistor Q301 are coupled through capacitor C214 and diode D102 to the collector of Q107. Resistors R137 and R138 form a voltage divider to bias diode D102. Transistor Q107 conducts only when the horizontal gating pulse is present at its collector and the horizontal sync pulse is present at its base.

Resistors R137 and R102 and capacitor C106 form a filter network to smooth out the gated pulses from Q107 and supply a DC bias voltage to the base of first video IF amplifier transistor Q101. The amount of bias on Q101 is controlled by the average level of the horizontal sync pulse at the base of transistor Q107 and the level of the horizontal pulse that is used for gating.

Transistor Q101 is reverse biased to conduct more heavily in the absence of a signal. A stronger received signal develops more AGC voltage. The larger AGC voltage is applied to transistor Q101 and the gain of the stage is reduced.

Bias for transistor Q102, which is also reverse biased to conduct more heavily in the absence of a signal, is taken from the emitter of Q101 through resistor R105. Therefore, the gain of the second IF stage is also reduced when a stronger signal is received. The voltage drop across resistor R108, in the emitter circuit of transistor Q102, is coupled through resistor R135 to the tuner AGC amplifier transistor, Q106.

Automatic gain control of the RF stage in the tuner helps keep the mixer stage from overloading on strong signals. The tuner AGC voltage is applied from the collector of Q106 through resistor R1 to the base of RF amplifier Q1. As stronger received signals develop more AGC voltage, the positive base bias on Q1 is increased and the gain of the stage is reduced.

The greatest advantage of a gated AGC circuit is that noise pulses, and fast changes in the input signal level, such as those caused by passing airplanes, have little effect on the AGC voltage because the AGC amplifier conducts only during the horizontal sync pulse retrace time.

INTEGRATED CIRCUIT

Integrated circuit Q108 is a linear network of transistors, diodes, and resistors that are connected in a wide-band amplifier and sound detector circuit. Because of space limitations, all coils and capacitors are wired externally to the integrated circuit. Refer to the inset on the Schematic Diagram for the internal circuit of Q108.

The 4.5 MHz sound IF signal is coupled from transformer T105, through capacitor C131, to the base of transistor Q108-1 in the integrated circuit. Each of integrated circuit transistors Q108-1, -2, -3, -4, -5, -6, -7, and -8 functions as an emitter-follower or common-base amplifier for the 4.5 MHz signal. The complete circuit constitutes a differential amplifier. From the collector of common-base amplifier Q108-8, the 4.5 MHz signal is coupled to sound detector transformer T106. The demodulated signal from sound detector circuit is then coupled through voltage amplifiers Q108-11 and Q108-12, and out of the integrated circuit, to the Volume control.

Integrated circuit transistors Q108-9 and Q108-10 and diodes D401 and D402 regulate the bias voltage for the other integrated circuit transistors.

Sound Detector

Refer to Figure 43.

Sound detector transformer T106 and the balance of the integrated circuit are redrawn in Figure 43. The windings of transformer T106 are numbered L1, L2, L3, and L4 in this Figure. L4 is just a few turns of wire tightly wrapped around the bottom of primary winding L1.

Diodes D405, D406, and D407 are reverse-biased to exhibit the characteristics of capacitors. They are drawn as capacitors in Figure 41 to help you follow their function in this circuit description.

The 4.5 MHz audio IF signal that was amplified by the first eight transistors in the integrated circuit is applied across the primary (L1) of transformer T106. Capacitors C138 and C139 tune the primary and secondary of T106 to 4.5 MHz. Consider a separate voltage induced by the primary into each of the other three windings. L4, which is closely coupled to the primary, introduces a voltage that is in series with both L2 and L3. This voltage across L4 is relatively constant in amplitude as long as the voltage across L1 does not change.

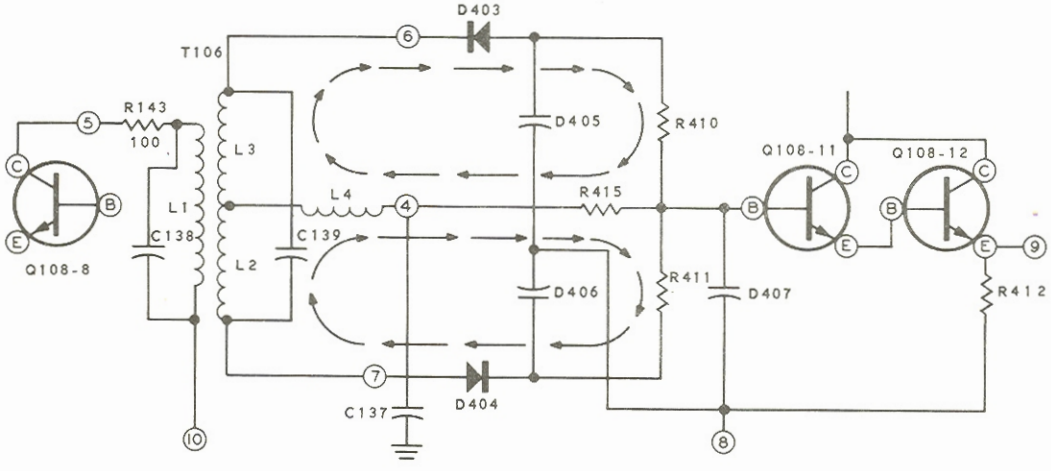


Figure 43

Notice that each diode, D403 and D404, has its own loop through which its current flows (indicated by the arrows). Current flowing in diode D404 is controlled by the voltage induced in L2 and L4, which charges diode D406. (Remember that diodes D405, D406, and D407 are reverse-biased to act as capacitors.) Current flowing in diode D403 is controlled by the voltage induced in L3 and L4, which charges diode D405. Current flows in both directions through L4, since this coil is common to both loops.

At the 4.5 MHz IF center frequency, when the signal is unmodulated, the diode currents are equal and cancel each other. Thus, there is no voltage variation across D407 at the junction of R410 and R411, and no audio voltage is coupled to transistor Q108-11.

When the IF frequency deviates from 4.5 MHz, due to FM modulation, the current in one diode loop increases while the current in the other diode loop decreases. These changes are caused by a change in the phase relationship between the signal across L2 and L3. Now current flows through L4 and R415 in the direction of the larger signal, and an output voltage is developed across L4 and R415.

The amplitude of this audio output voltage is determined by how far the IF frequency deviates from the 4.5 MHz center frequency. The frequency of this audio output voltage depends on how often the IF frequency deviates from the 4.5 MHz center frequency.

The audio voltage appearing at the junction of R415 and D407 is coupled directly to the base of transistor Q108-11. Transistors Q108-11 and Q108-12 are direct coupled as emitter followers to match the relatively high impedance of the sound detector circuit to the lower impedance of the audio amplifier circuit.

AUDIO CIRCUITS

The audio output from terminal 9 of the integrated circuit, is coupled through resistor R145 to the Volume control. Resistor R145 and capacitor C141 provide de-emphasis by attenuating the higher audio frequencies that were accentuated at the transmitter. This network also filters out any 4.5 MHz carrier frequencies that might remain after detection.

From the Volume control, the signal is coupled through capacitor C142 to the base of driver transistor Q109, where it is amplified. Resistors R147 and R148, which are connected as a voltage divider from the emitter circuit of the output stage, provide base bias for Q109. Resistors R151 and R155 form the collector load for driver transistor Q109. These resistors are also part of the bias network for output transistors Q110 and Q111.

The amplified signal from the collector of Q109 is coupled directly to the base of transistor Q111 and through isolation resistor R151 to the base of Q110. These two transistors are connected in a complementary symmetry output circuit. In this circuit, PNP transistor Q111 and NPN transistor Q110 are connected in a class B emitter-follower configuration. A negative-going AC signal at the base of the output transistors will cause Q111 to conduct, charging capacitor C144 through the voice coil of the speaker. When the signal goes in the positive direction, Q110 will conduct and discharge capacitor C144 back through the voice coil.

SYNC-SWEEP CIRCUIT BOARD

The sync-sweep circuit board contains most of the parts for the sync separator circuits and the horizontal and vertical sweep circuits, but some of the parts in these circuits are mounted on the chassis. Refer to the part numbers (and NOTES) on the Schematic Diagram to determine whether a part is on the circuit board or on the chassis.

SYNC SEPARATOR

From the collector of transistor Q104, the video signal with positive-going sync pulses is coupled through capacitor C202 and the parallel combination of capacitor C201 and resistor R201 to the base of sync separator transistor Q201. Capacitor C202 charges during the conducting period of transistor Q201 and then discharges through resistor R202.

The discharging of capacitor C201 develops a bias on the base of transistor Q201 that is proportional to the level of the signal applied. The bias is such that transistor Q201 conducts only during the time of the sync pulse signals.

The time constant of resistor R201 and capacitor C201 prevents large noise pulses from turning off transistor Q201 for a period of several sync pulses and disrupting the synchronization of the sweep circuits.

The amplified sync pulses are coupled from the collector of transistor Q201, through capacitor C203, to the horizontal circuit. The sync pulses are also integrated by the network of resistor R223 and capacitor C218, and then coupled to the vertical oscillator circuit by capacitor C221.

HORIZONTAL OSCILLATOR

The horizontal oscillator circuit of transistor Q202 is capable of free-running at a frequency of 15,750 Hz in the absence of a synchronizing signal from the sync separator.

When transistor Q202 conducts, a positive voltage is produced at pin 1 of transformer T201 and is coupled back through resistor R215 and capacitor C208 to the base of transistor Q202, holding Q202 in saturation. When capacitor C208 becomes charged, transistor Q202 stops conducting. Capacitor C208 then discharges through Horizontal Hold control R213. The time it takes to discharge capacitor C208 is governed by the setting of the Horizontal Hold control. When the voltage at the base of transistor Q202 lowers sufficiently, the transistor again conducts and the cycle is repeated.

The frequency of oscillation is established by the primary inductance of T201, the RC time constant of R215, C208, the network of R214, Horizontal Hold control R213, and the voltage at the junction of resistors R208 and R212. The DC voltage at this junction, which is applied to lug 2 of the Horizontal Hold control is a reference voltage on which the sync pulses act. This action will be described later. Diode D203 and resistor R217 keep the collector of transistor Q202 from going positive with respect to the supply voltage to damp out ringing in the circuit.

Transformer T201 couples the oscillator signal to driver transistor Q203 in such a direction that the transistor conducts when transistor Q202 conducts and is cut off when Q202 is cut off. The amplified oscillator signal is coupled through transformer T202 to horizontal output transistor Q301.

HORIZONTAL OUTPUT

Horizontal output transistor Q301 conducts when driver transistor Q203 is cut off, and is cut off when Q203 conducts. Retrace begins when transistor Q301 cuts off. The trace current through horizontal deflection yoke L301, and through the primary of transformer T301, is abruptly halted. The rapid decay of current in the circuit (transistor Q301, coil L301, capacitor C302, and the primary of transformer T301) causes the circuit to oscillate at approximately 70 kHz for one-half cycle. This produces a pulse of approximately 11 microseconds duration. This duration is determined by the resonant frequency of the above circuit.

During the time of the positive retrace pulse, capacitor C302 is charged. At the end of the pulse period, retrace is completed and C302

discharges through yoke coil L301, transformer T301, and diode D205, causing a trace on the CRT. A portion of the pulse energy is stored in capacitor C232, adding to the 12 volt supply voltage and producing a boosted voltage of 22 volts for use in other circuits. After approximately one-half of the trace time, transistor Q301 is turned on and continues to provide a linear increase of current through the yoke coil and transformer until another retrace cycle starts.

During retrace time, the horizontal flyback waveform causes voltage pulses to be induced in the windings of transformer T301. One winding steps up the primary voltage to a very high level. This high voltage is rectified by diode D301 and coupled to the 2nd anode of the CRT.

Another winding on transformer T301 provides a 150 volt negative pulse, which is coupled through the network of resistor R222 and capacitor C216 to grid 2 of the CRT. This voltage pulse cuts off the CRT electron beam during horizontal retrace. Capacitor C217 keeps noise pulses from modulating the picture.

The pulse at the emitter of transistor Q301 is reduced by resistor R219, rectified by diode D204, and filtered by capacitor C215 to supply +135 volts to the video output transistor, the CRT, and the neon dial lamps.

The voltage pulse at the emitter of transistor Q301 is also divided across capacitors C213 and C214 and is coupled to the collector circuit of transistor Q107 to key the AGC action.

Part of the signal from the horizontal output stage is coupled back through capacitor C207 to the horizontal discriminator circuit. This pulse is integrated by the network of C204, and R211, and is impressed on diodes D201 and D202.

The horizontal discriminator circuit consists of diodes D201 and D202, and resistors R205 and R206. The horizontal sync pulse from sync separator transistor Q201, and the horizontal output pulse from the emitter of transistor Q301, are compared in this discriminator circuit. The result of this comparison is a voltage that is proportional to the phase difference between the two pulses. When the two pulses are in phase, no voltage results. If the pulses are out of phase, the resulting voltage either adds to, or subtracts from, the voltage at lug 3 of the Horizontal Hold control. Therefore, this voltage adjusts the horizontal oscillator frequency to the exact frequency of the sync pulses in the received signal. Any tendency of the horizontal oscillator to drift results in a compensating voltage that synchronizes the oscillator.

VERTICAL SWEEP CIRCUITS

The negative-going sync signal from the collector of transistor Q201 is integrated by the circuit of resistor R223 and capacitor C218 to remove the horizontal pulse from the sync signal. The vertical sync pulse passes through capacitor C221 to the base of vertical oscillator transistor Q204.

When transistor Q204 conducts, a large negative-going retrace voltage is developed across vertical output choke L303. This voltage is divided across resistor R228 and capacitors C222 and C219 and coupled through resistor R224 and capacitor C221 to the base of transistor Q204, causing the transistor to conduct even more.

When retrace is completed, capacitor C221 is left with a charge that cuts off transistor Q204. The time required to discharge C221, and therefore the frequency of the vertical oscillator, is determined by the setting of the Vertical Hold control. The vertical sync pulse locks-in the oscillator with the frequency of the received sync signal.

While transistor Q204 is cut off, sawtooth forming capacitors C223 and C224 are charged with a negative-going sawtooth voltage through resistor R227 and Height control R226. The amount of the charge across the capacitors is adjusted by the Height control.

When transistor Q204 conducts, it effectively short circuits and discharges the sawtooth capacitors.

Transistor Q205 is an emitter follower that acts as a low-impedance driving source to the base of transistor Q302. Some of the voltage from the emitter of transistor Q205 is fed

back through resistor R234 and Vertical Linearity control R233 to capacitor C224. This allows the shape of the sawtooth waveform to be adjusted, thus controlling the vertical sweep linearity.

The amplified sawtooth waveform at the collector of transistor Q302 is coupled through capacitor C226 to the vertical deflection yoke.

The negative-going pulse at the collector of transistor Q302 is coupled through resistor R237 and capacitor C225 to the grid of the CRT. This pulse cuts off the electron beam during vertical retrace time. Resistor R239 is the CRT grid load resistor and capacitor C227 keeps noise pulses from modulating the picture.

POWER SUPPLY CIRCUITS

Refer to Figure 44.

This Television Set will operate from the 110-130 volt AC power line, from an external 12 to 18 volt DC source, or from the 12 volt Battery Pack Accessory, Model GRA-104-1. Voltage regulation is provided when operating from an external AC or DC source. The Battery Pack Accessory is automatically recharged when the Receiver is connected to an AC power line.

120 VOLT AC OPERATION

When the line cord is connected to a 120 volt AC line, power transformer T302 steps down the line voltage to approximately 14 volts on each side of the secondary winding. Diodes D303 and D304 form a full-wave rectifier circuit. Approximately 18 VDC is developed and filtered across capacitor C303.

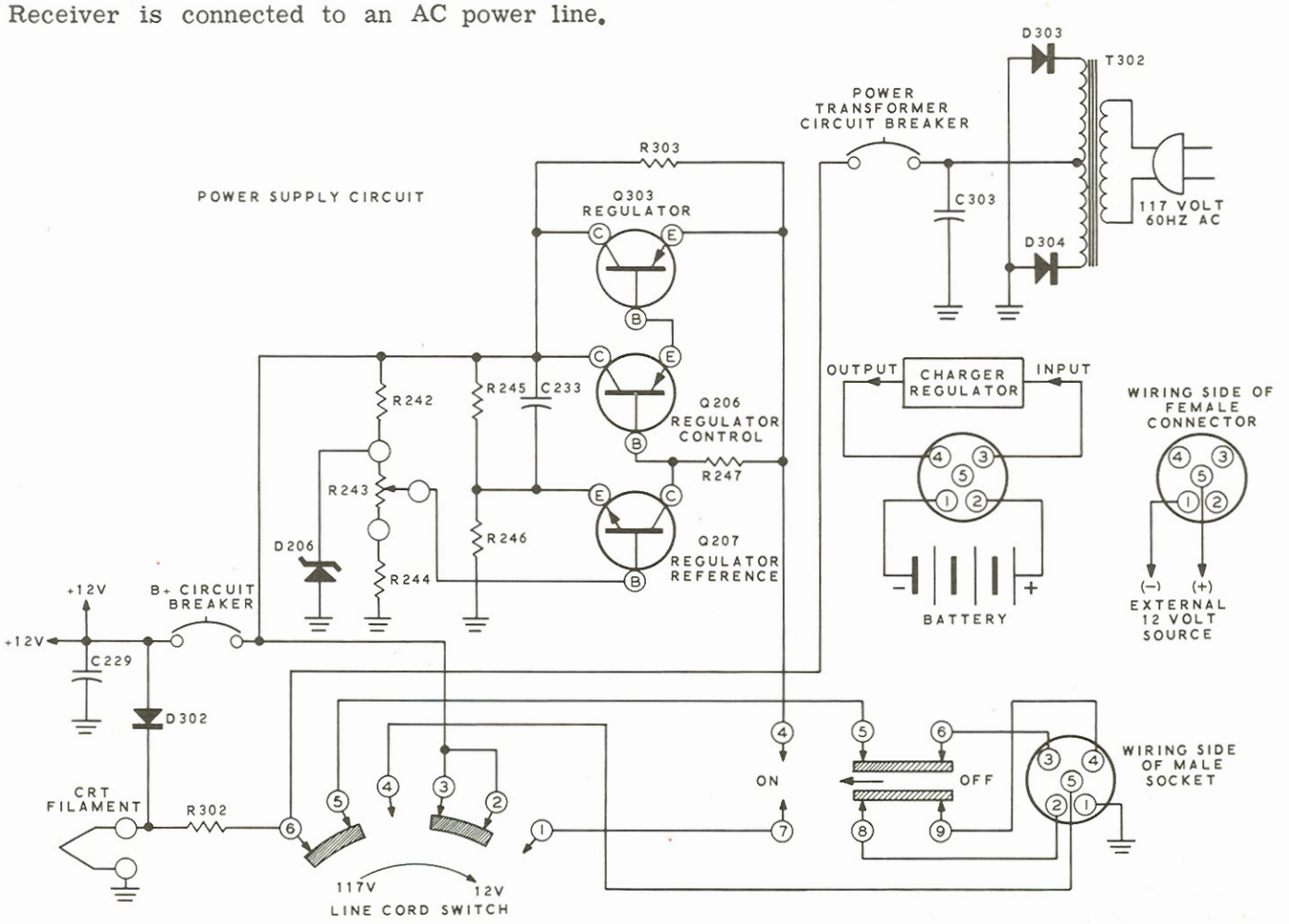


Figure 44

The power transformer circuit breaker limits the total current that can be safely drawn by the entire TV Set. This circuit breaker especially protects against overloads in the voltage regulator circuits.

The DC voltage leaving the power transformer circuit breaker is reduced through resistor R302 and coupled to the filament of the CRT (cathode ray tube). Diode D302 is reverse biased, or open circuited, with the Off-On switch in the Off position. This puts about half voltage on the CRT filament to keep it warm, which allows the tube to reach full brightness quickly when full power is applied.

The DC voltage is also coupled through contacts 6 and 5 of the Line Cord switch to contact 5 of the Off-On switch. When the Off-On switch is in the On position, the DC passes through contacts 5 and 4 to the input of the voltage regulator circuit at the emitter of regulator transistor Q303. The voltage regulator circuit will be described later.

The output of the voltage regulator passes through the B+ circuit breaker, which protects the regulator circuits from overloads. The regulated DC voltage across capacitor C229 is coupled to the various circuits throughout the TV Set.

Diode D302 passes the regulated DC voltage to the CRT filament. The CRT reaches full heat quickly due to the preheat voltage supplied through resistor R302. The reverse bias of diode D302 keeps the reduced preheat voltage from passing to the B+ circuits when the power is turned off.

VOLTAGE REGULATOR

The voltage regulator maintains a constant 12 volts DC output, under varying supply voltage and load conditions, when the TV Set is operated on an AC power line or from an external 12 volt DC source. The regulator does not operate when the Set is used with the Accessory Portable Battery.

The input to the voltage regulator circuit is from contact 4 of the Off-On switch. The input voltage is applied to the emitter of transistor Q303 and through resistor R247 to the base of transistor Q206 and the collector of Q207.

The collector voltage of Q303 is divided across resistors R245 and R246. The voltage at the junction of these two resistors, which is proportional to the voltage between the collector of Q303 and ground, is coupled to the emitter of transistor Q207.

Capacitor C233 provides a low impedance AC path across resistor R245. Any change of voltage at the collector of transistor Q303 will produce a proportionate change across resistor R246 and at the emitter of transistor Q207.

The voltage at the collector of transistor Q303 is applied through resistor R242 to zener diode D206. The characteristics of a zener diode hold the voltage across it constant. Part of this constant voltage goes through control R243 to the base of transistor Q207. Control R243 is adjusted to provide the correct bias from emitter to base of transistor Q207. The Q207 collector current through resistor R247 sets the bias on Q206, and thus on Q303, to establish the voltage at the collector of Q303 at 12 volts.

If the voltage at the collector of Q303 changes, at either a fast or slow rate, the emitter voltage at Q207 changes and causes Q303 to conduct more, or less, as required to supply a constant voltage output from the collector of transistor Q303. If a low resistance short develops in the B+ circuit, Q303 is automatically turned off.

The regulated voltage is then coupled through the B+ circuit breaker to the B+ circuits of the TV Set.

EXTERNAL BATTERY OPERATION

When the TV Set is operated from an external 12 to 18 volt source, such as an automobile or boat battery, the AC line cord must be inserted into the receptacle on the rear of the cabinet. This changes the position of the line cord switch and connects the external source to the Off-On switch.

The two leads of the female 5-pin connector are attached to the external source, and the connector of the chassis. The negative source is connected through pin 1 of the male socket to ground. The positive source connects through pin 5 of the socket to contact 4 of the line cord switch.

Since the AC line cord plug is in the line cord switch receptacle, the line cord switch is in the 12 volt position. Contacts 4 and 5 of the line cord switch pass the positive 12 volts to contact 5 of the Off-On switch.

Line cord switch contact 6 is not in the circuit, and resistor R302 does not supply preheat voltage to the CRT filament. This conserves battery power, although the CRT filament will take approximately 15 seconds to reach operating temperature when the Off-On switch is turned On.

When the Off-On switch is turned On, its contacts 5 and 4 connect the positive source voltage to the input of the voltage regulator. The regulator circuit was described previously.

BATTERY PACK ACCESSORY AND CHARGER CIRCUITS

When a Heathkit Model GRA-104-1 Battery Pack Accessory and charger regulator is installed on the TV Set, and its female 5-pin connector is attached to the male 5-pin socket on the rear of the chassis, the power circuits operate as follows:

Pin 1 of the male socket connects the negative lead of the battery to ground. Pin 2 connects the positive lead of the battery to contact 8 of the Off-On switch. With this switch in the On position, the positive battery voltage passes through contacts 8 and 7 to contact 1 of the line cord switch.

When the line cord plug is inserted in the line cord switch receptacle on the rear of the chassis, the battery voltage passes through switch contacts 1 and 2 to the B+ circuit breaker and 12 volt B+ supply line. Note that contact 6 of the line cord switch is not in the circuit and the CRT filament does not receive preheat voltage. The CRT filament voltage is supplied through diode D302 and requires approximately 15 seconds to reach operating temperature when the Off-On switch is turned On. Thus, there is no drain on the battery when the Off-On switch is turned off.

When the Battery Pack Accessory is installed, and the line cord is connected to a 120 volt AC source, the battery is charged automatically whenever the Off-On switch is turned Off, On, and then Off again. The charging circuit is described as follows:

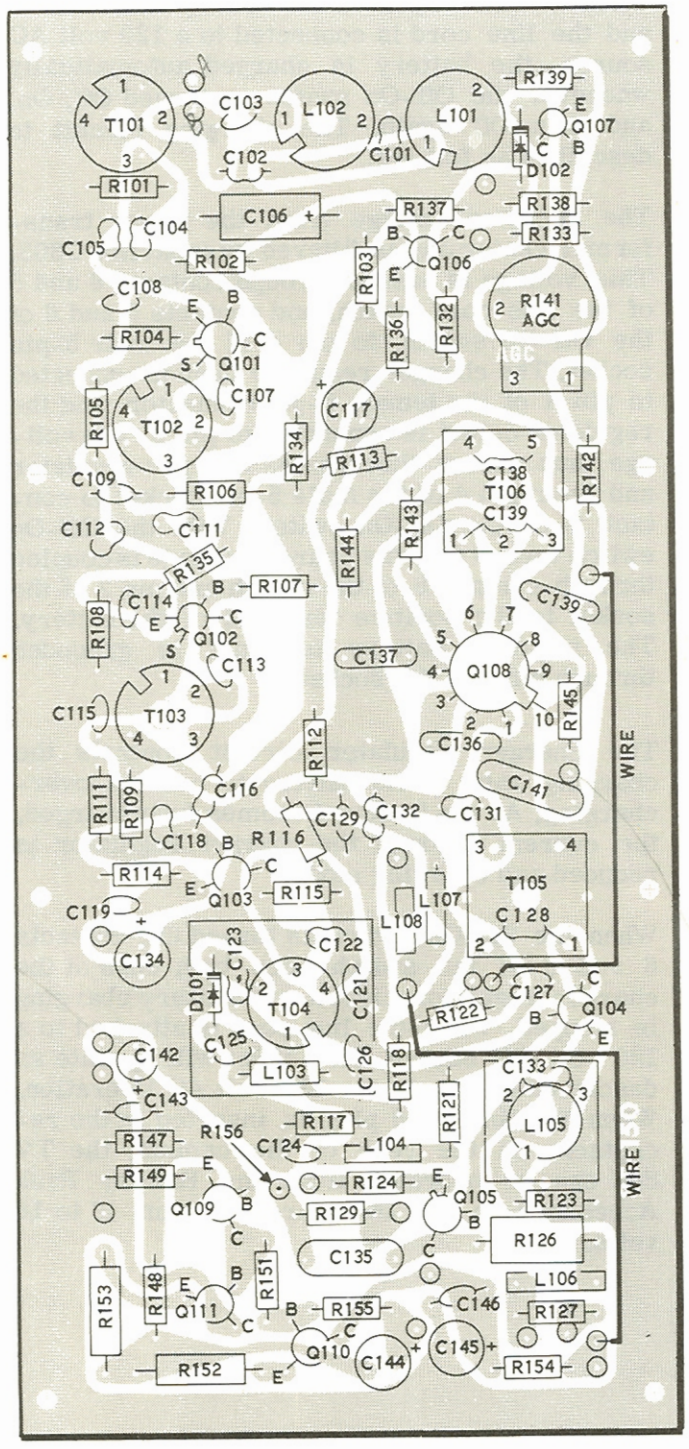
The rectified voltage from the power transformer center-tap is filtered by capacitor C303. This voltage is passed through contacts 6 and 5 of the line cord switch, and contacts 5 and 6 of the Off-On switch, to pin 4 of the male 5-pin socket. The charger regulator input is connected to pin 4 of the female 5-pin connector, and the regulator output is connected to pin 3. The voltage thus passes through the charger regulator and from pin 4 of the male 5-pin socket to contact 9 of the Off-On switch. With the Off-On switch turned Off, the charger voltage is coupled through contact 8 of the switch and pin 2 of the socket to the positive terminal of the battery. The negative battery terminal is grounded through pin 1 of the socket.

The charger regulator circuit controls the charging rate to the battery to prevent overcharging. As the battery becomes fully charged, the current through the charger regulator is reduced and charging stops.

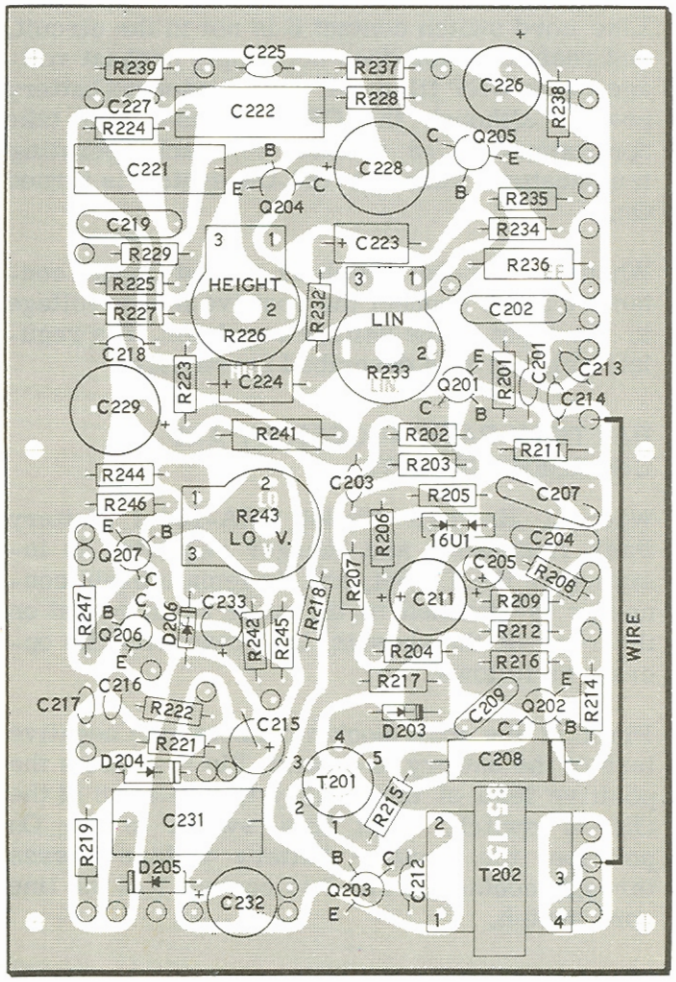
When the Off-On switch is turned On, contacts 6 and 9 of the switch open both ends of the charger regulator circuit and battery charging is stopped. When the line cord is attached to a 120 volt AC source, the TV Set will operate as described earlier under 120 Volt AC Operation. When the line cord plug is inserted in the receptacle on the rear of the cabinet, the TV Set can be operated from the Battery Pack Accessory or any DC source of from 12 to 18 volts.

CIRCUIT BOARD X-RAY VIEWS

(VIEWED FROM FOIL SIDE)

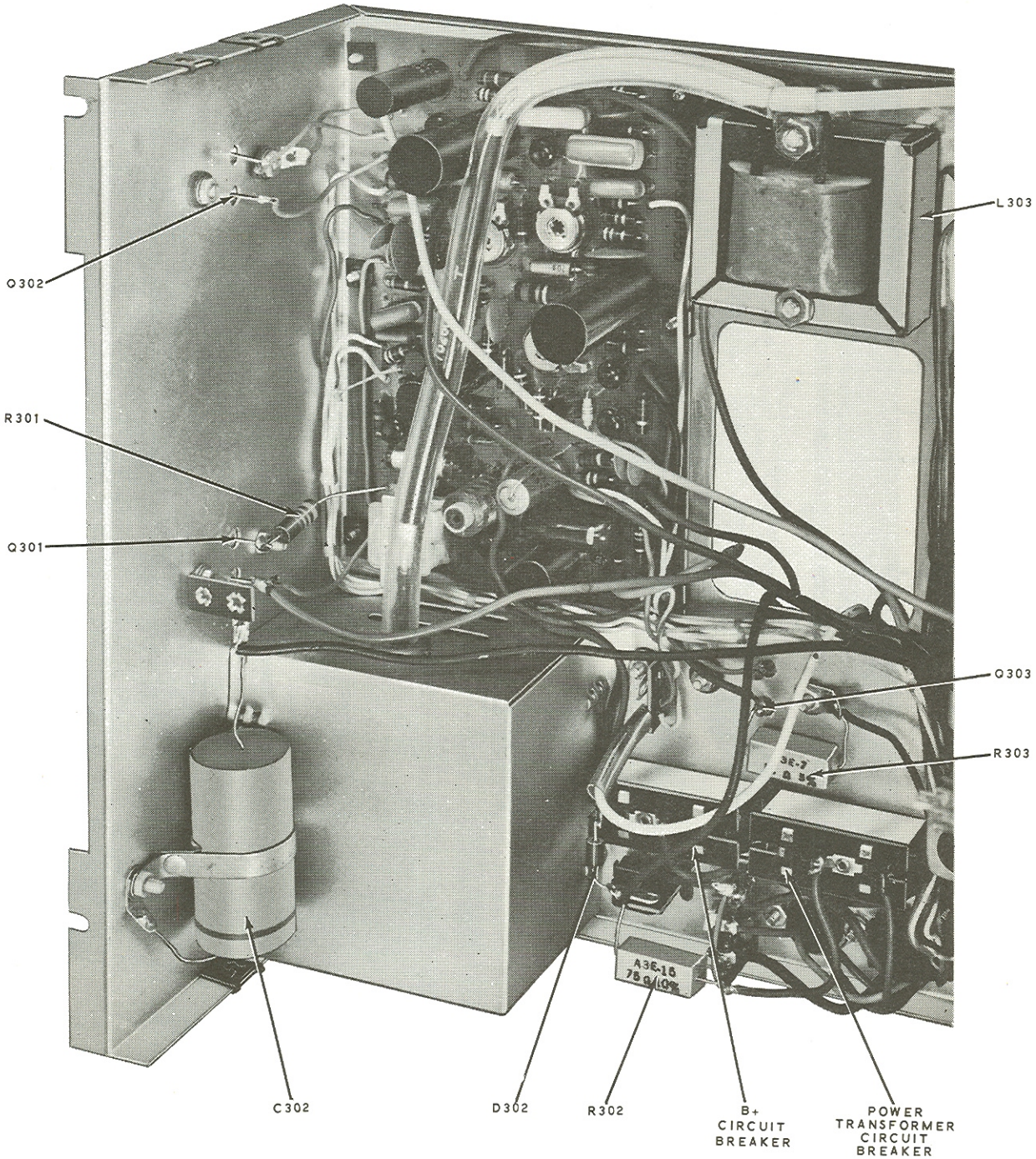


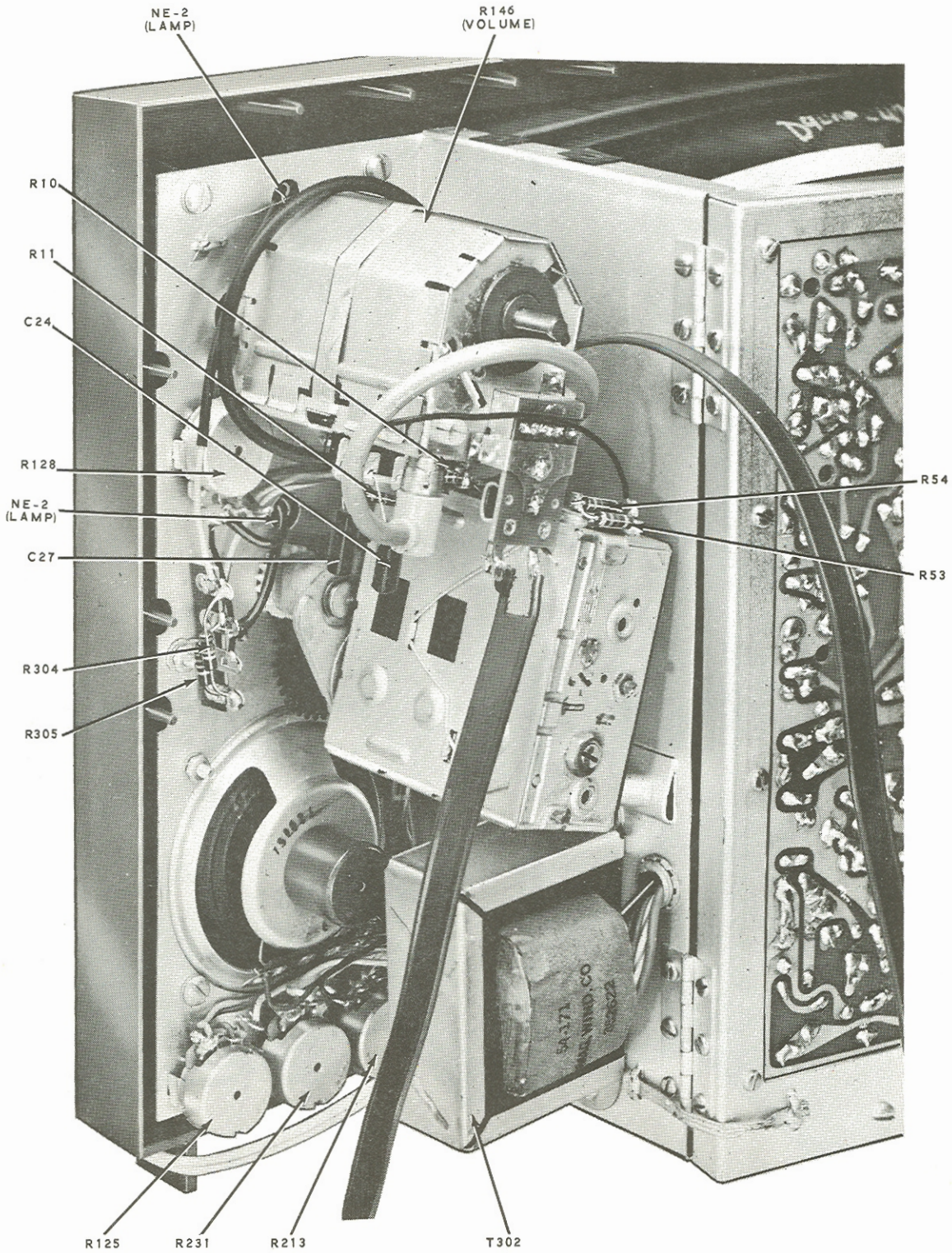
AUDIO-VIDEO CIRCUIT BOARD

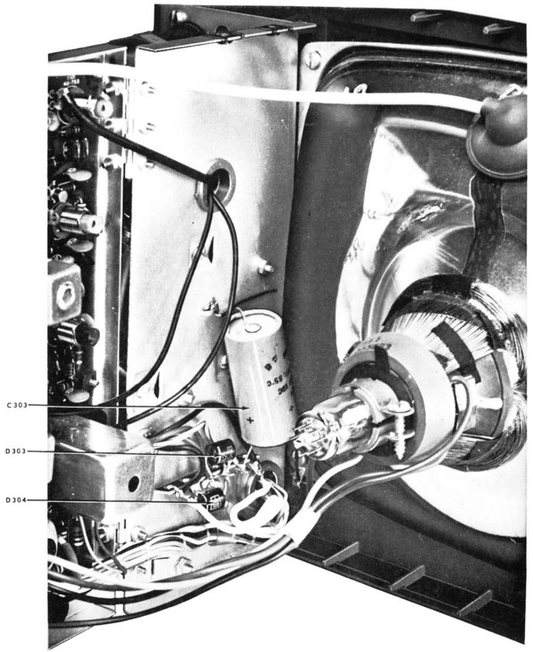


SYNC-SWEEP CIRCUIT BOARD

CHASSIS PHOTOGRAPHS




NE-2
(LAMP)
R146
(VOLUME)
R10
R11
C24
R128
NE-2
(LAMP)
C27
R304
R305
R54
R53
R125
R231
R213
T302



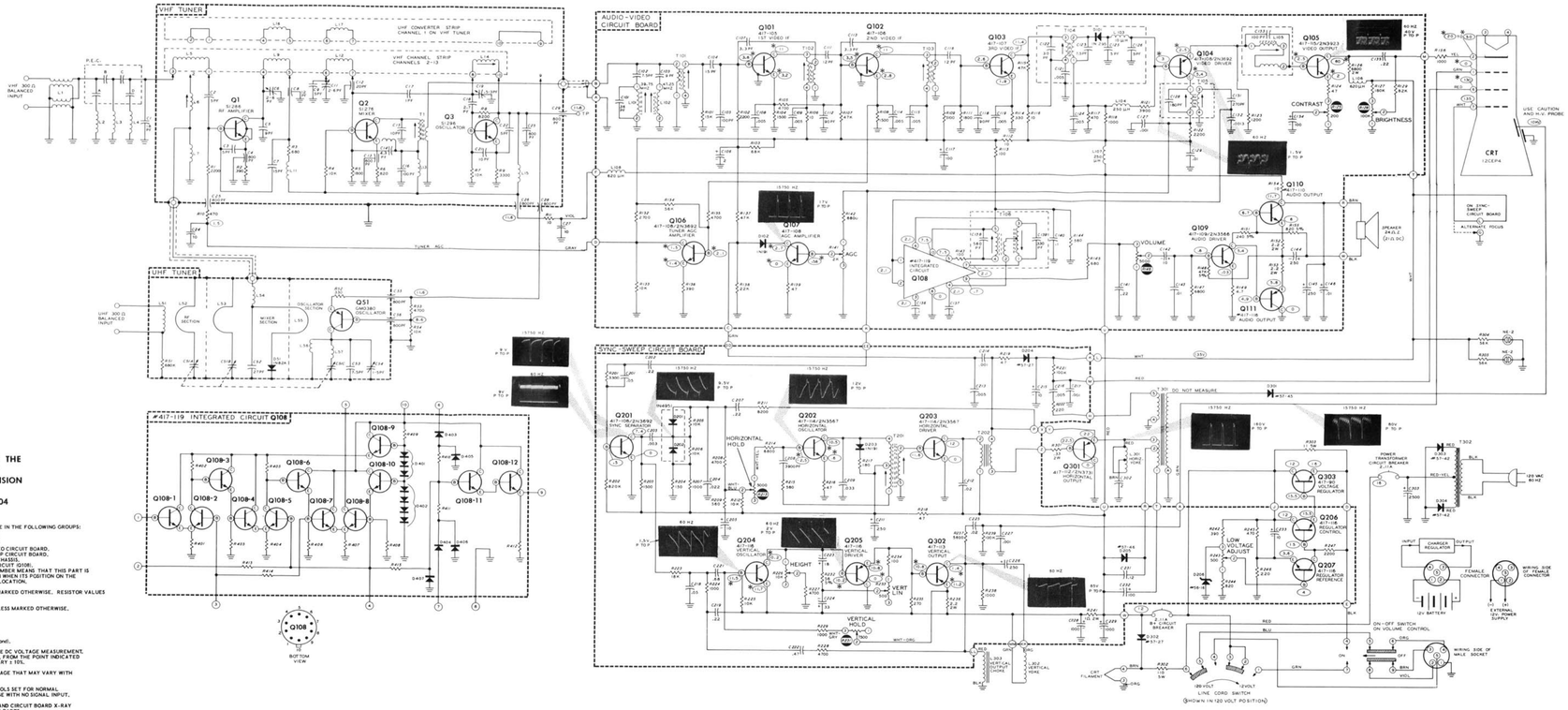
SCHEMATIC OF THE HEATHKIT® PORTABLE TELEVISION SET MODEL GR-104

NOTES:

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:

0 - 49	PARTS IN THE VHF TUNER.
50 - 99	PARTS IN THE UHF TUNER.
100 - 199	PARTS ON THE AUDIO-VIDEO CIRCUIT BOARD.
200 - 299	PARTS ON THE SYNC-SWEEP CIRCUIT BOARD.
300 - 399	PARTS MOUNTED ON THE CHASSIS.
400 - 499	PARTS ON THE INTEGRATED CIRCUIT.

2. ⬭ THIS SYMBOL AROUND A PART NUMBER MEANS THAT THIS PART IS MOUNTED ON THE CHASSIS, EVEN WHEN ITS POSITION ON THE SCHEMATIC SUGGESTS ANOTHER LOCATION.
3. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, MEG=1,000,000).
4. ALL CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.
5. PF (picofarad) = μμf (micromicrofarad).
6. Hz (hertz) = cps (cycles per second).
   kHz (kilohertz) = kc (kilocycles per second).
   MHz (megahertz) = mc (megacycles per second).
7. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT. ⬭ THIS SYMBOL INDICATES A NEGATIVE DC VOLTAGE. THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±10%.
8. *⬭ THIS SYMBOL INDICATES A VOLTAGE THAT MAY VARY WITH ASSOCIATED CONTROL SETTING.
9. ALL VOLTAGES MEASURED WITH CONTROLS SET FOR NORMAL PICTURE ON 117 VOLT AC LINE VOLTAGE WITH NO SIGNAL INPUT.
10. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.



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