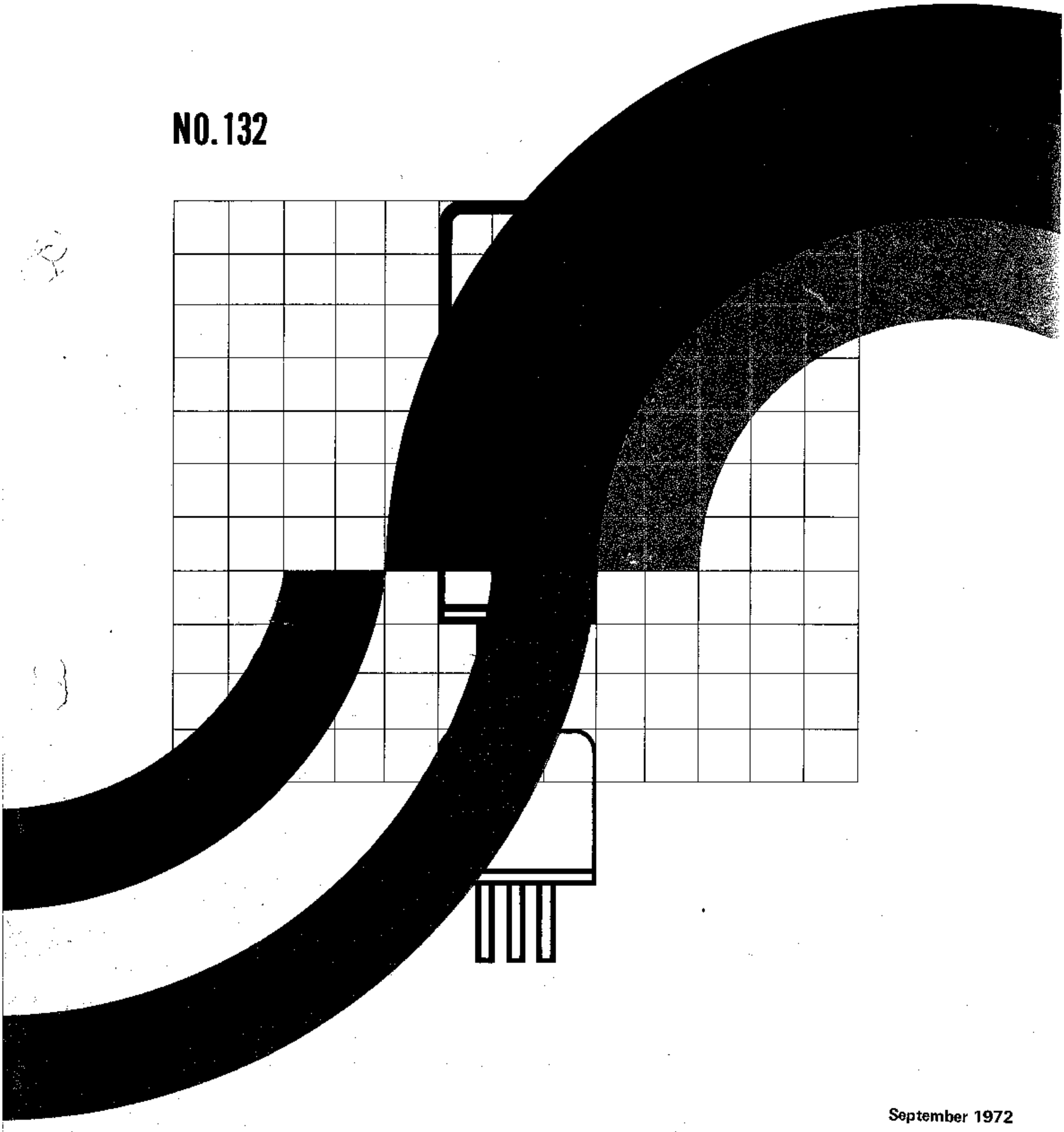
HITACHI ALL TRANSISTOR PAL C LOUR TV

SERVICE GUIDE

NO. 132



September 1972

CONTENTS

1. READ BEFORE USING THIS GUIDE . . .

This manual is intended to instruct TV servicemen on the principles of repairing all transistor colour television receivers and how to proceed with trouble-shooting as a means of alleviating the repair work. This guide describes how to replace defective components within and without printed circuit boards. A defective component can be determined by following the inspection procedures given in this book upon confirming a symptom displayed by the picture.

How to Apply this Guide

(1) Carefully observe the video symptom of a colour broadcast and single out—from among the symptoms pictured in the list of symptoms—the particular symptom identical with (or similar to) the symptom observed on the video.

(2) Turn to the page of this manual indicated by the name of the symptom.

(3) After carefully reading the description on trouble shooting, proceed with the inspection by following the procedures guided by arrow marks.

2. PRECAUTIONS ON TROUBLE-SHOOTING

1. Precautions on Inspection

When inspecting, adhere to the following procedures shown below:

(1) Carefully ascertain the symptom, then check the block presumably responsible for the fault to see whether or not there is solder bridging, disconnected wiring, and/or incomplete contact of components. If no abnormalities are noted during this check, follow the trouble-shooting procedures and—

(2) Determine which block is responsible for the fault. If this is accomplished, repair can be effected by replacing a defective block with a complete, new one. Also, when determining which component in the block is defective, proceed to the next step.

(3) Measure the voltage of electrodes on each transistor within the block concerned. (Always use a tester having internal resistance as high as possible. Since transistors have low impedance compared with electron tubes, an exact voltage value cannot be obtained by a tester of low internal resistance.) A defective component can be determined from the abnormal voltage value by following the trouble-shooting procedures.

2. Inspection of Transistors by Tester

Transistors faults are classified into the following three categories:

(1) Degradation of characteristic

(2) Disconnection of wire at junction

(3) Short of a junction

All the above faults are difficult to determine since they cannot be ascertained by an inspection procedure applicable to electron tubes (such as visual inspection, or checking by sound while shaking the component being checked). There is a method of quickly determining faults by using an advanced measuring instrument; however, this means is not available to everyone. Given here is a description on a simplified method of inspection, using a tester.

This method involves gaining a general idea by measuring forward and reverse resistances across the collector and base and across the emitter and base by using a tester. Since the emitter and base junction and the base and collector junction perform a function similar to that of a diode, the low or high resistance value is obtained depending on polarity when measuring their resistance. The former and the latter are referred to as forward resistance and reverse resistance respactively. In this case, pay attention, to the range of the tester. While a tester range of X1000 is applicable to ordinary transistors, a small range must be applied to large power transistors for output deflection and power source filtering to achieve exact measurements. Shown below is how the three above-listed symptoms affect the resistance values obtained when measuring with a tester.

(1) Degradation of characteristic—Difference between forward and reverse resistances decreases.

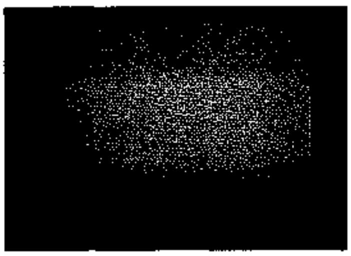
(2) Disconnection of wire at junction—Both forward and reverse resistances become infinite.

(3) Short of a junction—Both forward and reverse resistances become zero.

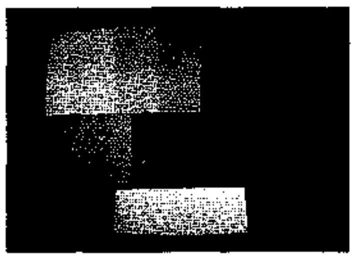
These measurements of resistance are to be performed with the transistor disconnected from the PCB (printed circuit board) concerned.

3. LIST OF SYMPTOMS

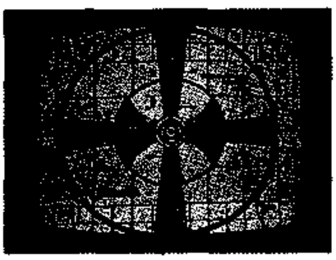
2. No Video



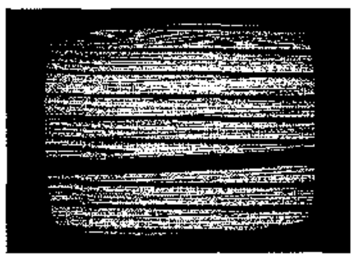
4. No Colour



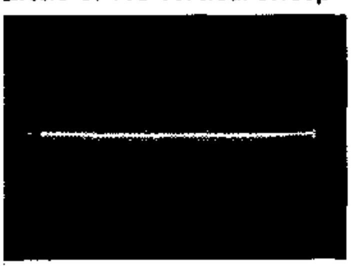
5. Poor white balance



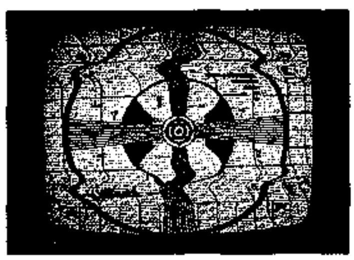
6. No horizontal and No vertical sync.



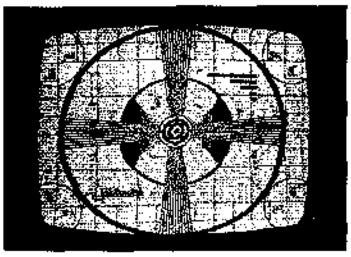
7. Little or No vertical sweep



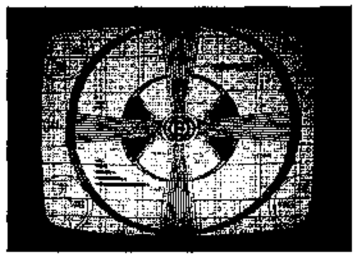
8. Picture twists



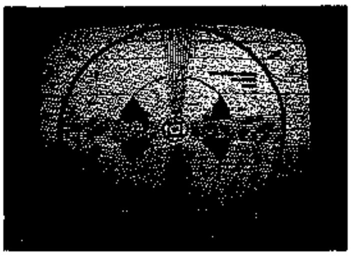
10. Improper S/N



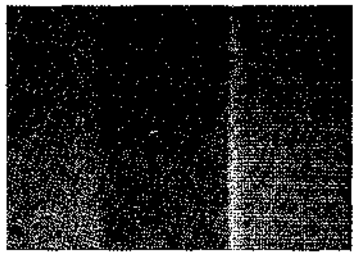
11. Multiple images



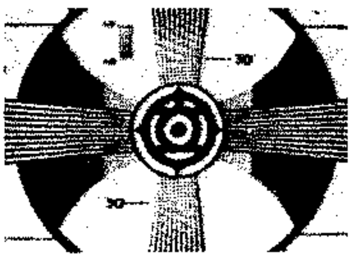
12. Saturated video



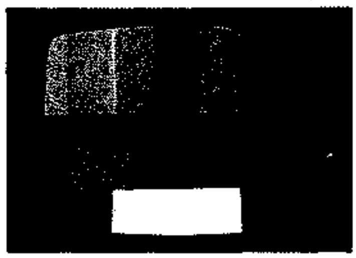
13. Venetian blind



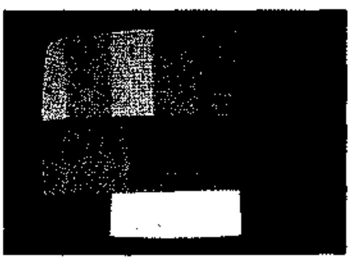
14. Chroma channel open on monochrome



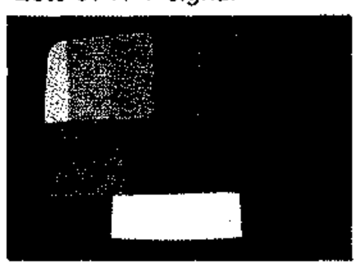
15. Incorrect colour
PAL switch on wrong phase



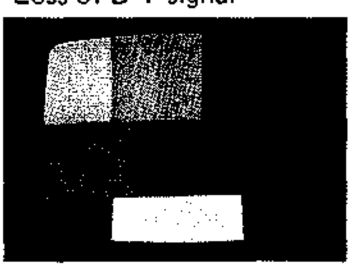
15. Incorrect colour
PAL switch not operating



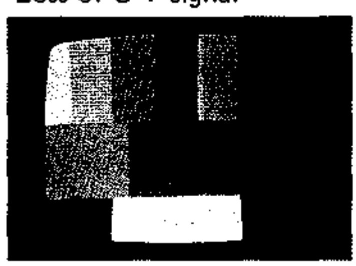
15. Incorrect colour
Loss of R-Y signal



15. Incorrect colour
Loss of B-Y signal



15. Incorrect colour
Loss of G-Y signal

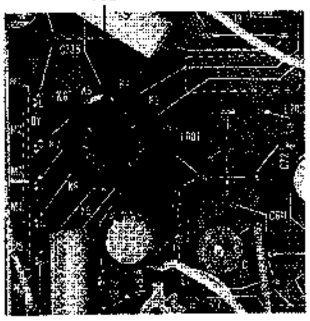


4. REPAIR PROCEDURES FOR EACH SYMPTOM

1. NO RASTER

+120V line check (Between chassis and connector K_5 on deflection output PCB)

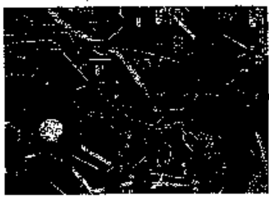
K5



(Deflection output PCB)

0~+10V

Check voltage between chassis and terminal K_5 on power PCB, with connector K disconnected



—K5

(Power PCB)

OV

Power supply circuit fault

F901, F902 1.6A Open

Check fuse F903 (1A) F905 (1A)

+150~ +170V

Faults of deflection and high-voltage circuits

Insert connector K; disconnect connector N

+120V line check (Between chassis and connector K_5)

+120V

(High-voltage block replacement)

Defective high-voltage block (FBT, selenium or silicon rectifier block)

0~+10V

Pulse clipper (V11N) Is CR24 OK?

+150~ +170V

Fault in horizontal driver or oscillator circuit

Performance check of HOR. OSC TR38 (2SA 12V)

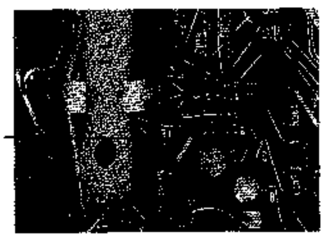
When normal condition (collector voltage: +2V base voltage: +13V)

When abnormal condition TR38, defective H. HOLD T701, defective

+120V

+12V line check (Between chassis and terminal B1 on power PCB)

B1



(Power PCB)

+12V

Video circuit defective

V_{BE} bias check of 3RD. VIDEO TR19 (2SA565 Ⓑ)

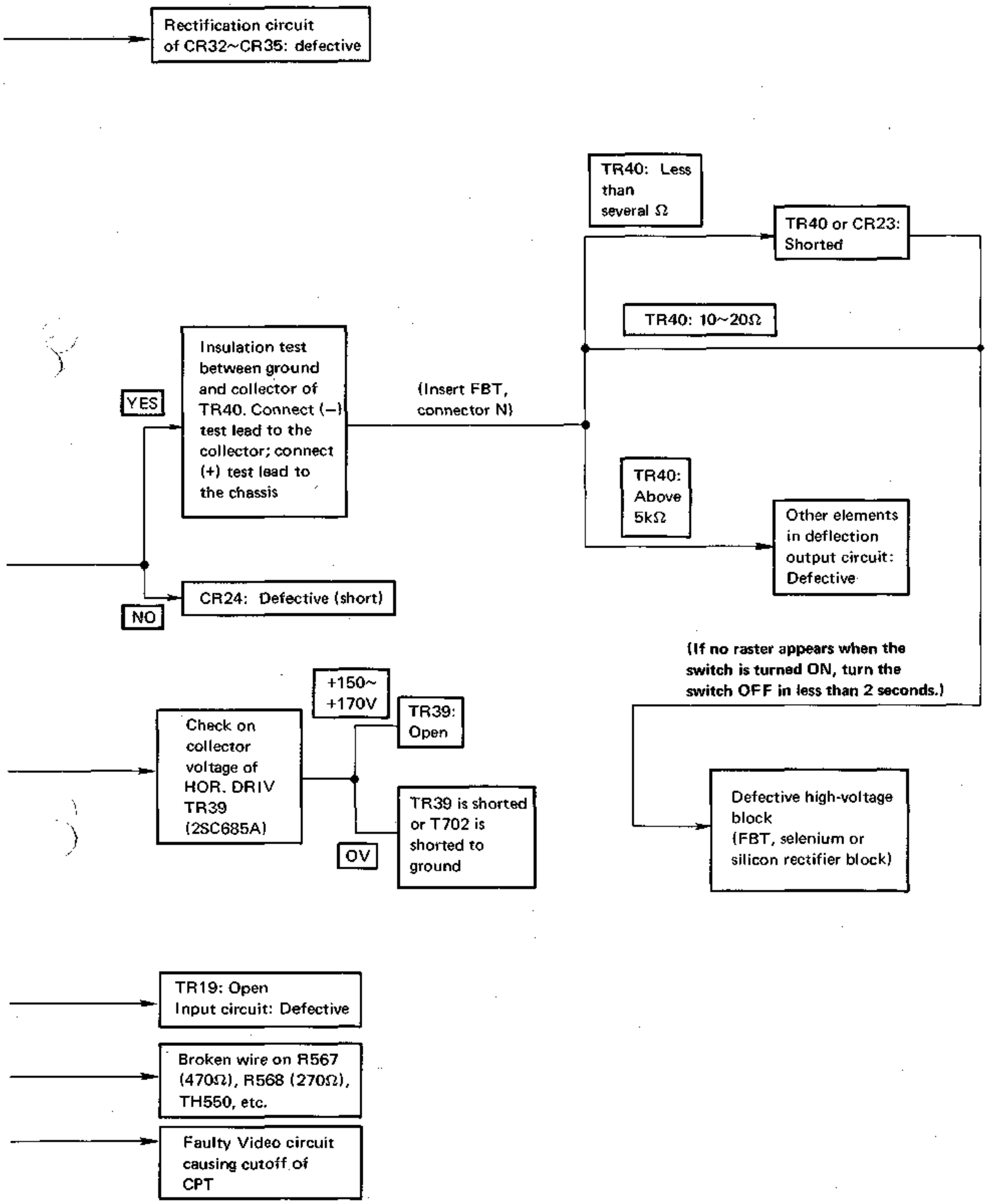
Reverse bias

Forward bias

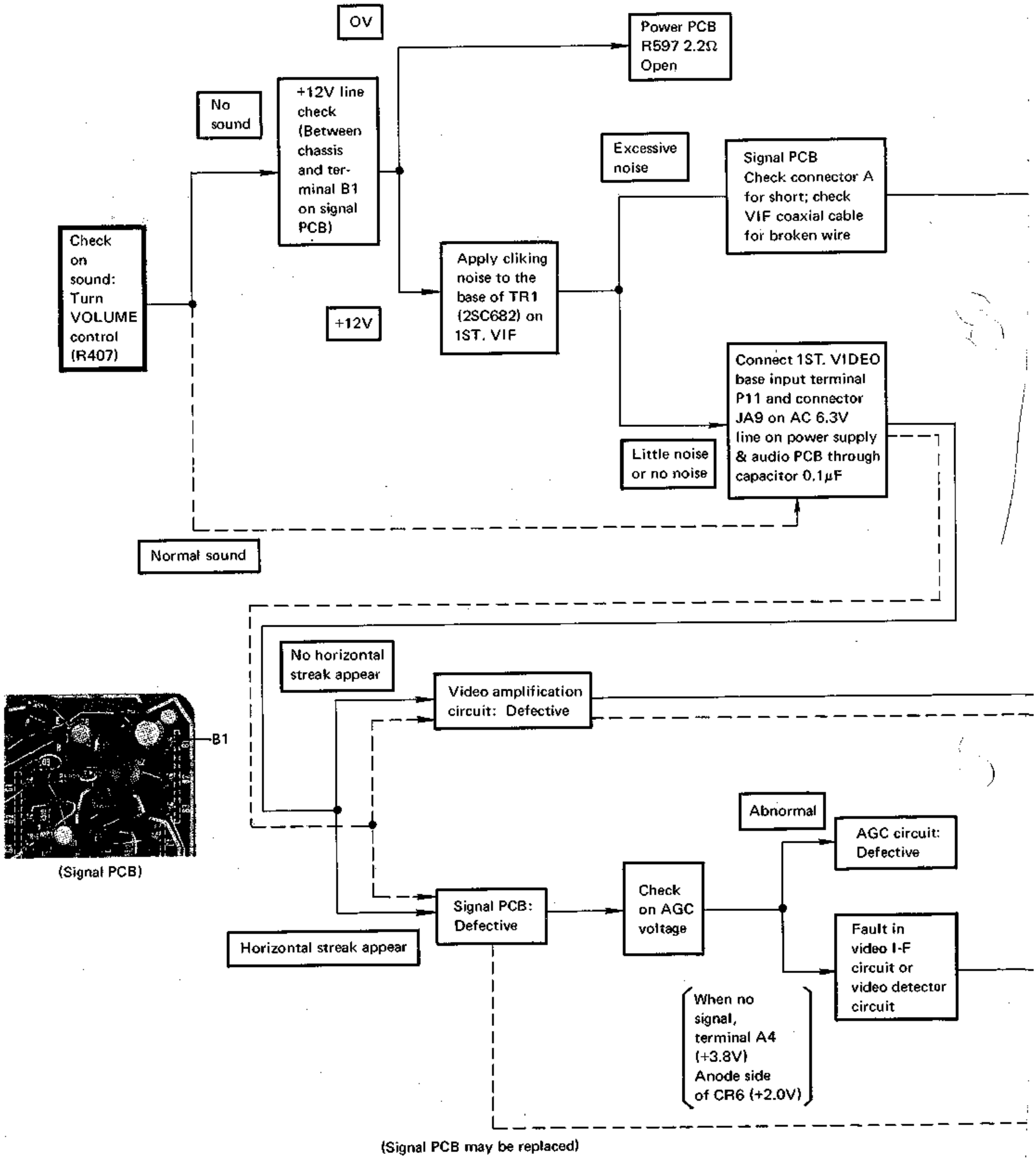
OV

R597 2.2Ω Open

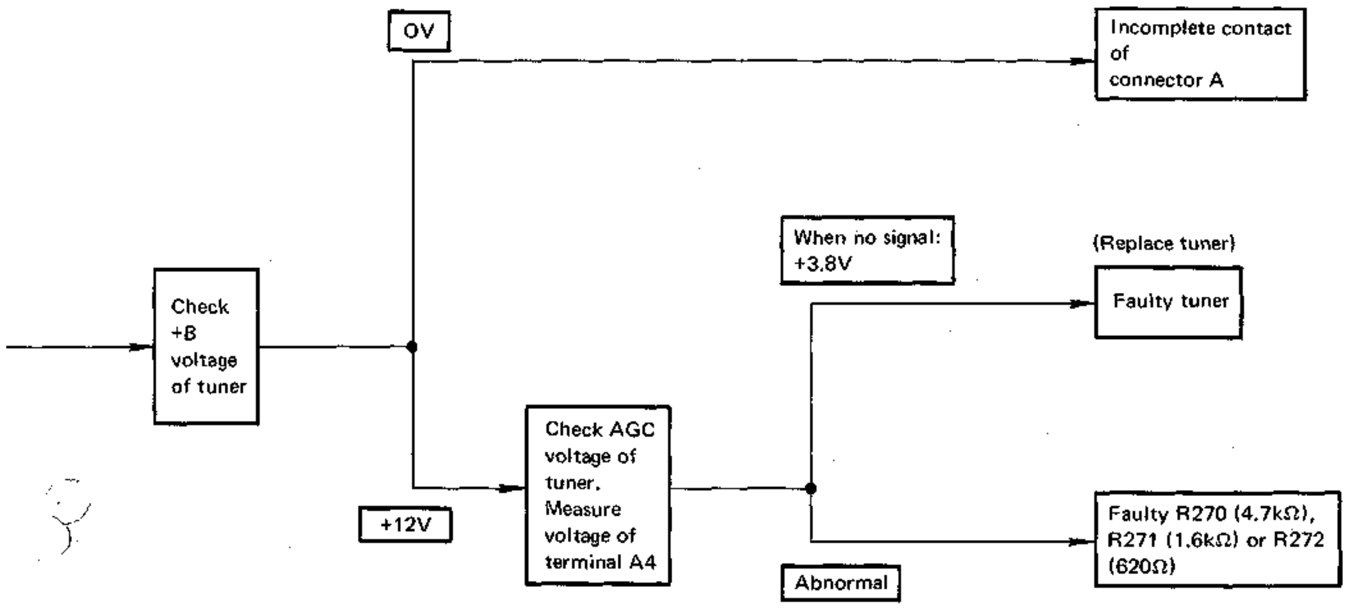
(This involves a shorted +12V line)

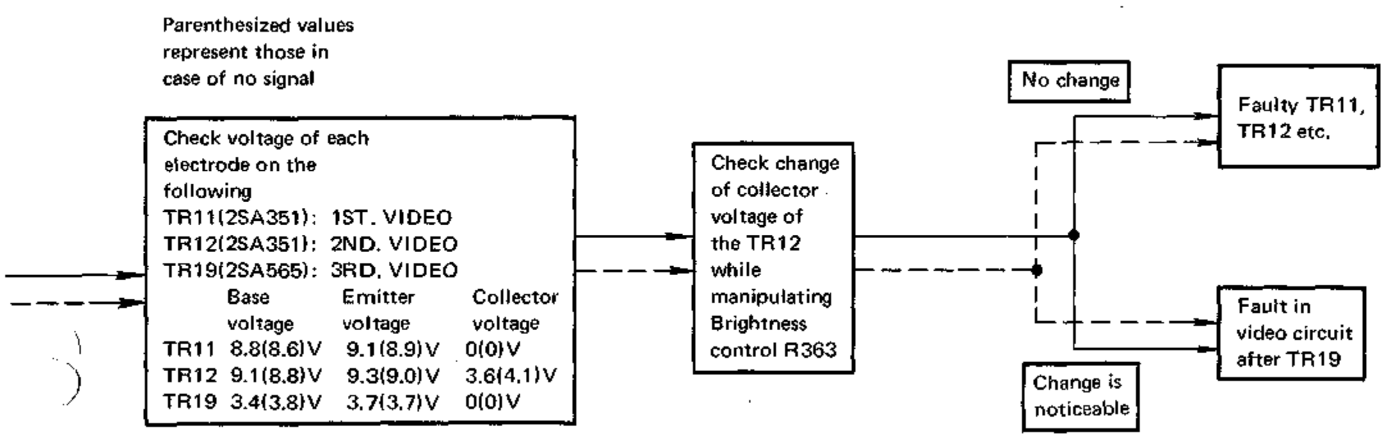

Rectification circuit of CR32~CR35: defective
TR40: Less than several Ω
TR40 or CR23: Shorted
TR40: 10~20Ω
YES
Insulation test between ground and collector of TR40. Connect (−) test lead to the collector; connect (+) test lead to the chassis
(Insert FBT, connector N)
TR40: Above 5kΩ
Other elements in deflection output circuit: Defective
NO
CR24: Defective (short)
(If no raster appears when the switch is turned ON, turn the switch OFF in less than 2 seconds.)
+150~ +170V
TR39: Open
Check on collector voltage of HOR. DRIV TR39 (2SC685A)
TR39 is shorted or T702 is shorted to ground
0V
Defective high-voltage block (FBT, selenium or silicon rectifier block)
TR19: Open Input circuit: Defective
Broken wire on R567 (470Ω), R568 (270Ω), TH550, etc.
Faulty Video circuit causing cutoff of CPT

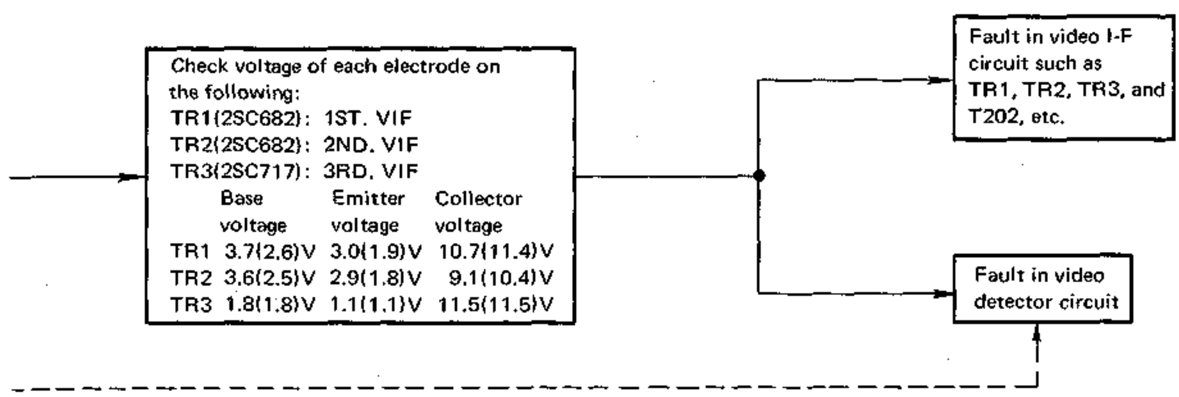
2. NO VIDEO



OV
Power PCB R597 2.2Ω Open
No sound
+12V line check (Between chassis and terminal B1 on signal PCB)
Excessive noise
Signal PCB Check connector A for short; check VIF coaxial cable for broken wire
Check on sound: Turn VOLUME control (R407)
Apply cliking noise to the base of TR1 (2SC682) on 1ST. VIF
+12V
Connect 1ST. VIDEO base input terminal P11 and connector JA9 on AC 6.3V line on power supply & audio PCB through capacitor 0.1μF
Little noise or no noise
Normal sound
No horizontal streak appear
Video amplification circuit: Defective
B1
Abnormal
AGC circuit: Defective
(Signal PCB)
Signal PCB: Defective
Check on AGC voltage
Horizontal streak appear
Fault in video I-F circuit or video detector circuit
When no signal, terminal A4 (+3.8V) Anode side of CR6 (+2.0V)
(Signal PCB may be replaced)


0V
Incomplete contact of connector A
When no signal: +3.8V
(Replace tuner)
Faulty tuner
Check +B voltage of tuner
Check AGC voltage of tuner. Measure voltage of terminal A4
+12V
Abnormal
Faulty R270 (4.7kΩ), R271 (1.6kΩ) or R272 (620Ω)


Parenthesized values represent those in case of no signal
Check voltage of each electrode on the following
TR11(2SA351): 1ST. VIDEO
TR12(2SA351): 2ND. VIDEO
TR19(2SA565): 3RD. VIDEO
Base voltage Emitter voltage Collector voltage
TR11 8.8(8.6)V 9.1(8.9)V 0(0)V
TR12 9.1(8.8)V 9.3(9.0)V 3.6(4.1)V
TR19 3.4(3.8)V 3.7(3.7)V 0(0)V
Check change of collector voltage of the TR12 while manipulating Brightness control R363
No change
Faulty TR11, TR12 etc.
Fault in video circuit after TR19
Change is noticeable


Check voltage of each electrode on the following:
TR1(2SC682): 1ST. VIF
TR2(2SC682): 2ND. VIF
TR3(2SC717): 3RD. VIF
Base voltage Emitter voltage Collector voltage
TR1 3.7(2.6)V 3.0(1.9)V 10.7(11.4)V
TR2 3.6(2.5)V 2.9(1.8)V 9.1(10.4)V
TR3 1.8(1.8)V 1.1(1.1)V 11.5(11.5)V
Fault in video I-F circuit such as TR1, TR2, TR3, and T202, etc.
Fault in video detector circuit

3. NO SOUND

Pull out connector F of the signal PCB; touch F2 of the disconnected connector with finger tip

Humming is audible

Fault lies before terminal F2

Check performance of colour circuit

Colour appears

Check collector voltage of TR17 (2SC458 Ⓑ) Is TR17 OK?

No colour appears

Fault in audio output circuit

Check collector voltage of TR44(2SC685A)

OV

Faulty R453, R454 1.5kΩ; Fuse F904 (315mA) Open

85~ 90V

Turn the Pull-on switch OFF; use a tester to apply voltage on terminal G1 of the Power supply & audio PCB. Set the tester range at the position of measuring insulation; contact the test leads with the chassis and terminal G1 respectively.

No noise is audible

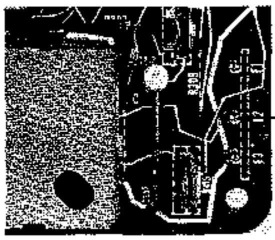
Faulty T451 (SOT), speaker and so on

Noise is audible

Check the voltage of each electrode while TR44 (2SC685A) AUDIO OUT are operating

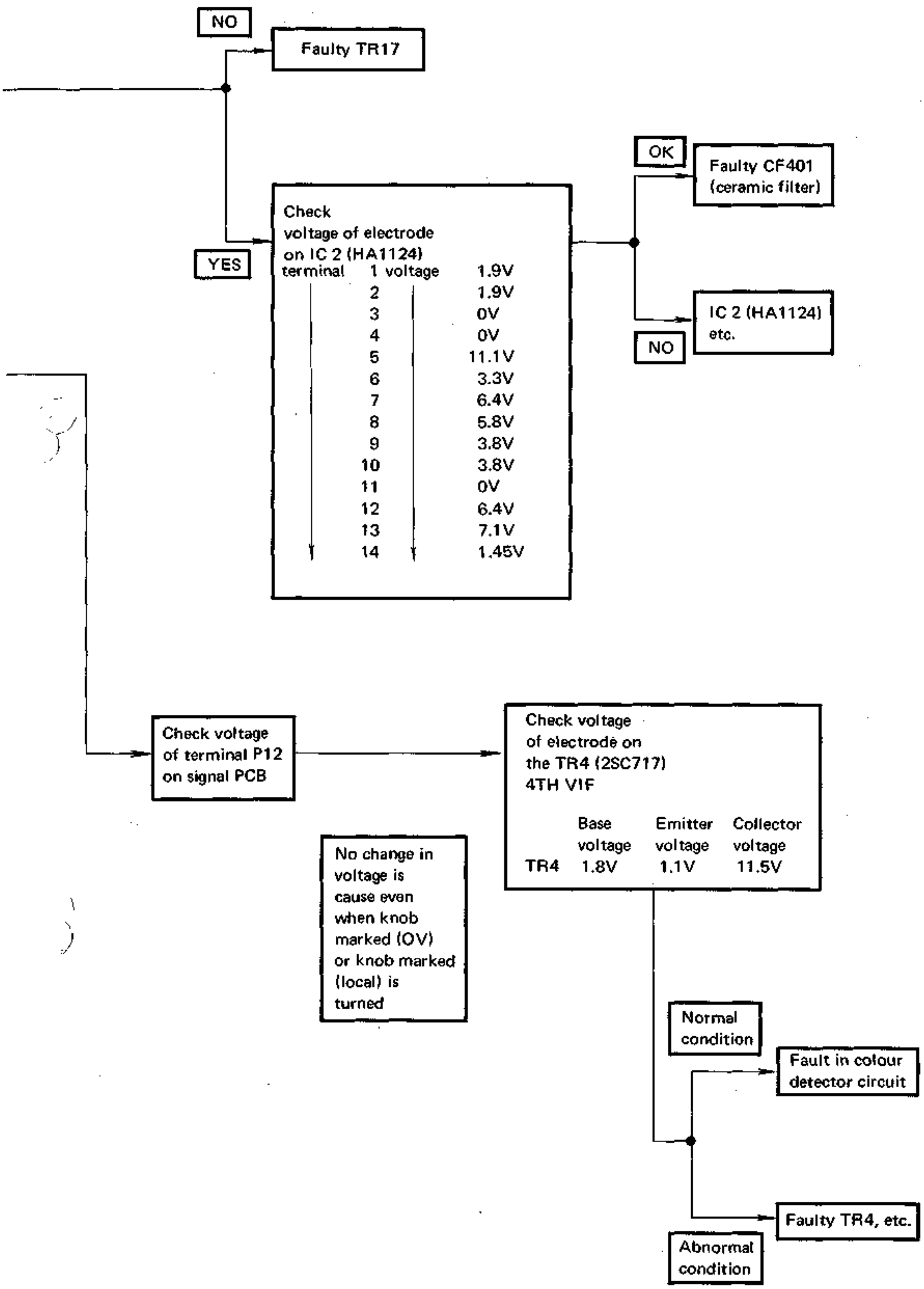
	Base voltage	Emitter voltage	Collector voltage
TR44	+6.2V	+5.6V	+88V

Faulty TR44 etc.



F2

(Signal PCB)


NO
Faulty TR17
YES
Check
voltage of electrode
on IC 2 (HA1124)
terminal 1 voltage 1.9V
2 1.9V
3 0V
4 0V
5 11.1V
6 3.3V
7 6.4V
8 5.8V
9 3.8V
10 3.8V
11 0V
12 6.4V
13 7.1V
14 1.45V
OK
Faulty CF401
(ceramic filter)
NO
IC 2 (HA1124)
etc.
Check voltage
of terminal P12
on signal PCB
Check voltage
of electrode on
the TR4 (2SC717)
4TH VIF
Base voltage Emitter voltage Collector voltage
TR4 1.8V 1.1V 11.5V
No change in
voltage is
cause even
when knob
marked (OV)
or knob marked
(local) is
turned
Normal
condition
Fault in colour
detector circuit
Faulty TR4, etc.
Abnormal
condition

4. NO COLOUR

Turn the colour control knob fully to the right or slide it upward

(Colour signals received)

Shorted P30 and HB4 terminals on Power PCB

Chrominance signal appears, but loss of colour sync.

Adjustment of colour sync. circuit (L1005)

NG

Check the burst amplifier circuit (TR14) (Check the collector wave form of TR14 when possible)

$6.0V_{p\text{-}p}$

OK

Improper adjustment of colour sync circuit

Normal colour appears

Fault in colour killer or fH/2 circuit

Check the fH/2 circuit TR1007, TR1008 (Check the wave form of terminal HC3 on PAL PCB when possible)

$2.5V_{p\text{-}p}$

No colour

Short the collector and emitter of TR15 (ACC circuit) on Signal PCB

Colour appears

Fault in ACC circuit

No colour

Fault in Band Pass Amp. or CW circuit

Check the Band Pass Amp. circuit (e.g. T501, TR13, TR1001, connector HF or D)

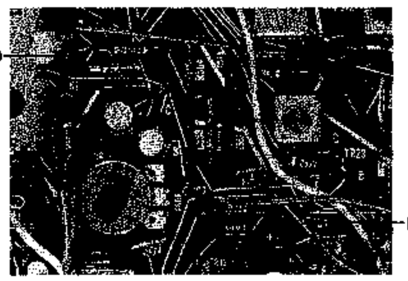
OK

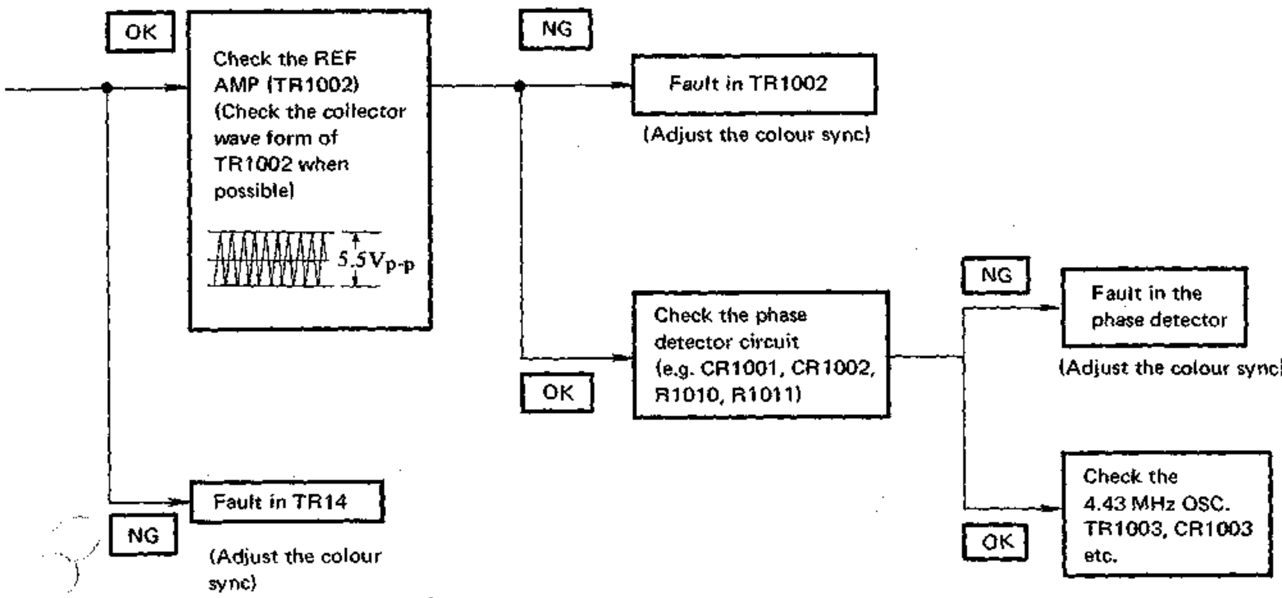
Fault in CW circuit

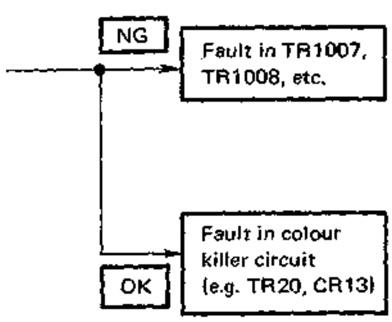
NG

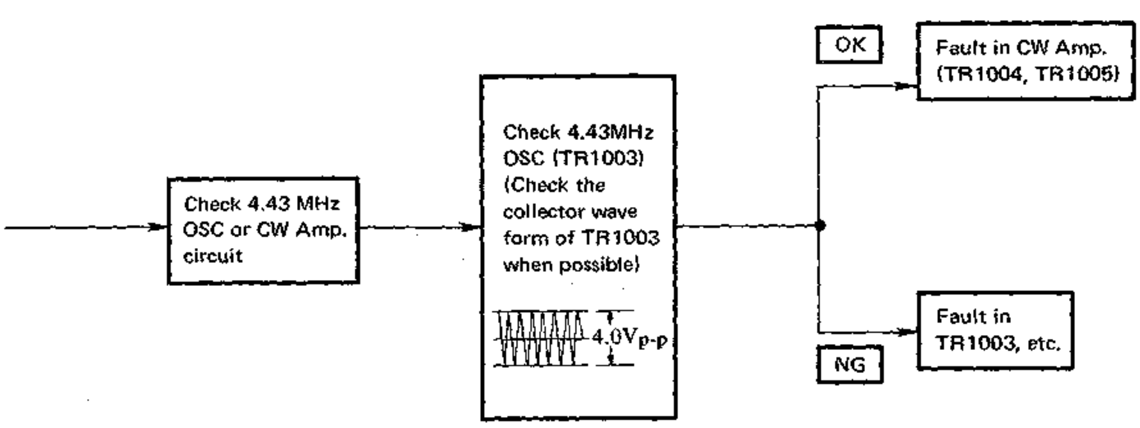
Fault in Band Pass Amp.

(Power PCB)




OK
Check the REF AMP (TR1002) (Check the collector wave form of TR1002 when possible)
5.5Vp-p
NG
Fault in TR1002
(Adjust the colour sync)
Check the phase detector circuit (e.g. CR1001, CR1002, R1010, R1011)
OK
NG
Fault in the phase detector
(Adjust the colour sync)
Check the 4.43 MHz OSC. TR1003, CR1003 etc.
OK
Fault in TR14
NG
(Adjust the colour sync)


NG
Fault in TR1007, TR1008, etc.
Fault in colour killer circuit (e.g. TR20, CR13)
OK

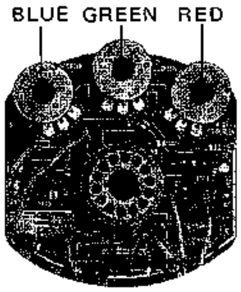

Check 4.43 MHz OSC or CW Amp. circuit
Check 4.43MHz OSC (TR1003) (Check the collector wave form of TR1003 when possible)
4.0Vp-p
OK
Fault in CW Amp. (TR1004, TR1005)
Fault in TR1003, etc.
NG

5. POOR WHITE BALANCE

Adjustment of white balance is impossible

Brightness is increased somewhat among red, green, and blue
→ Check on performance of screen control knob of the CPT of a circuit showing increased brightness

- Abnormal condition → Fault in screen circuit
- Normal condition → Defective power PCB



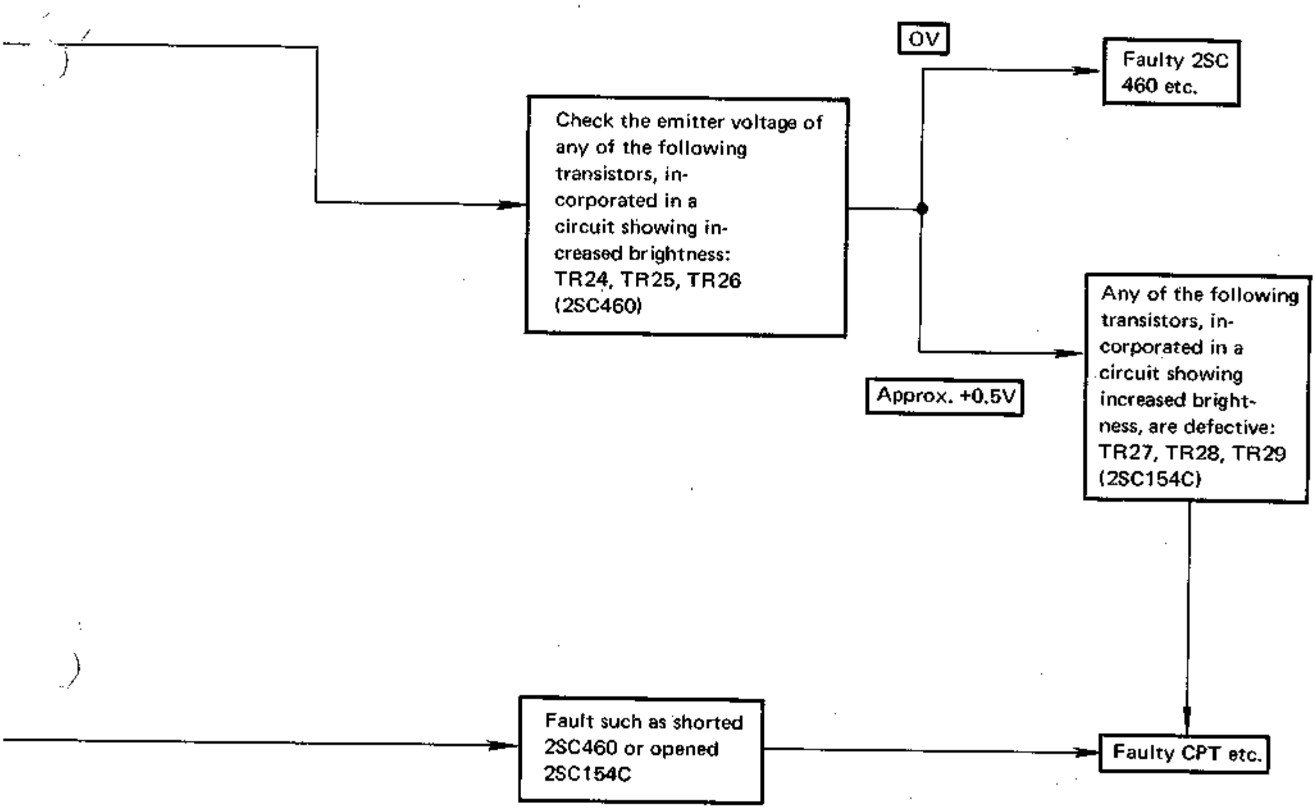
(CPT PCB)

Any of red, green, and blue fails to appear
→ Check or performance of the screen control knob of the CPT of a circuit in which any of the three colours fails to appear

- Normal condition → Defective power PCB → Check voltage of each electrode on any of the following transistors incorporated in a circuit in which any of the three colours fails to appear
- Abnormal condition → Fault in screen circuit

TR24, TR25, TR26 (2SC460)
TR27, TR28, TR29 (2SC154C)

2SC460	
Base voltage	+1.2V
Emitter voltage	+0.5V
Collector voltage	+5.4V
2SC154C	
Base voltage	+5.4V
Emitter voltage	+5.0V
Collector voltage	+90~+120V


Check the emitter voltage of any of the following transistors, incorporated in a circuit showing increased brightness: TR24, TR25, TR26 (2SC460)
0V
Faulty 2SC 460 etc.
Approx. +0.5V
Any of the following transistors, incorporated in a circuit showing increased brightness, are defective: TR27, TR28, TR29 (2SC154C)
Fault such as shorted 2SC460 or opened 2SC154C
Faulty CPT etc.

6. NO HORIZONTAL AND NO VERTICAL SYNC

No horizontal and no vertical sync

Check the wave form at terminal B2 on the power PCB

12Vp-p

64.0μsec

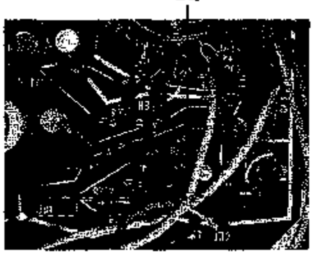
Abnormal condition

Fault in sync separator and/or noise canceller circuits

Normal condition

Fault in sync circuit after sync amplifier circuit

B2



(Power PCB)

Horizontal sync not adjustable, vertical sync adjustable

Check the wave form at terminal K4 on the power PCB

50Vp-p

64.0μsec

Abnormal condition

Incomplete contact of connector K on the deflection output PCB; faulty R709 1.5kΩ on the power PCB; etc.

Normal condition

Fault in horiz. sync circuit

No vertical sync, normal horiz. sync

Fault in vert. sync circuit

Check operating voltage of the following:
TR6(2SA15V) SYNC. SEP
TR5(2SC458 Ⓑ) NOISE. CAN

	Base voltage	Emitter voltage	Collector voltage
TR6	12.0V	12.0V	1.7V
TR5	1.6V	0.9V	0.9V

Check voltage of the anode and cathode of CR4, CR19 (1N60).
Anode voltage 9.0V, Cathode voltage 8.7V

Faulty TR5, TR6, CR4, CR19, etc.

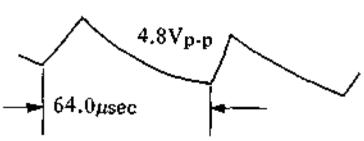
Check operating voltage of the following:
TR34(2SC458 Ⓑ) SYNC. AMP

Base voltage	Emitter voltage	Collector voltage
0.75V	1.7V	11.4V

Abnormal condition

Faulty TR34 etc.

Check voltage and wave form of the junction of R708 and R709 in the phase detector circuit



Check voltage of the junction of R708 and R709–13.5V
Check voltage of the junction of R706 and R707. (14.0V)

Fualty CR21, CR22, R709, etc.

Faulty

R601	2.4kΩ
C601	0.1μF
R602	1.2kΩ
C602	0.1μF

7. LITTLE OR NO VERTICAL SWEEP

(Deflection output PCB)

Check resistance between ground and collector on TR37 (2SC936) VERT. OUT (Connect ⊖ lead wire of tester to collector, and connect ⊕ lead wire of tester to ground.)

More than 40kΩ →

Check operating voltage of the following:
TR37(2SC936) VERT. OUT
TR36(2SA15V) VERT. DRIV
TR35(2SD75) VERT. OSC

	Base voltage	Emitter voltage	Collector voltage
TR37	1.2V	0.6V	108V
TR36	11.7V	12.0V	7V
TR35	9.2V	10.7V	12V

→ Faulty TR37, TR36, TR35, C603 22μF etc.

10 to 20Ω → Faulty TR37 R621 150Ω

8. PICTURE TWISTS

+120V line check (between chassis and connector K5 on Deflection out put PCB)

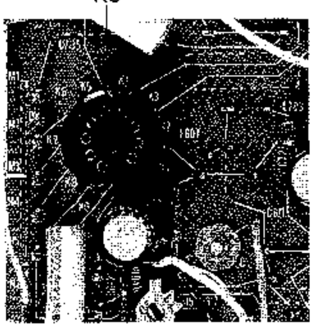
Approx. +90V

Fault such as opened VA903 (HV-46) or shorted CR37 (1N34A)

Approx. +150~+160V

Fault such as shorted TR41 or TR42 or TR43

K5



(Deflection output PCB)

9. HORIZONTAL SIZE CONSIDERABLY VARIES BY MANIPULATING THE BRIGHTNESS CONTROL

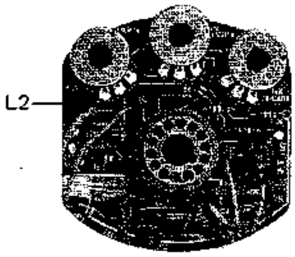
Turn the channel selector to a position where no signal is received.

→ Check voltage between the chassis and terminal L2 on CPT PCB.

→ Faulty T703 HV-R

No change in voltage effected by manipulating the Brightness control.

→ Faulty CR26 on CPT PCB



(CPT PCB)

10. IMPROPER S/N

Check the aerial, feeder or cable line and aerial terminal.

NG → Broken wire or incomplete contact of feeder or cable line.

OK → Check the VIF coaxial cable

NG → Broken wire of coaxial cable or conductor contacts housing.

OK → Check lead wire to the tuner and connector A on the Signal PCB.

NG → Incomplete contact of connector A or broken lead wire

OK → Signal PCB +12V line (Check voltage between the chassis and terminal B1.)

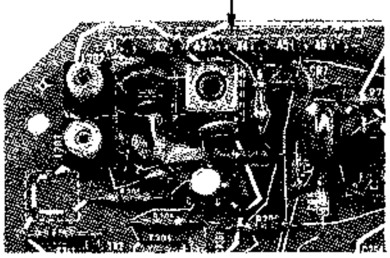
Below +5V → Pull out connector B of the Signal PCB; check voltage between the chassis and +12V line (terminal K2) on the Power PCB.

+12V

Below +5V

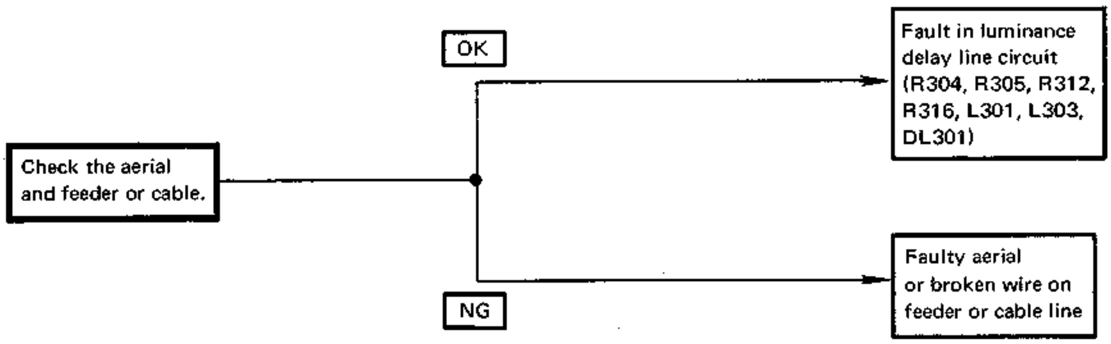
+12V → Check Signal PCB RF. AGC voltage (between the chassis and the anode of diode CR7 (1N34A))

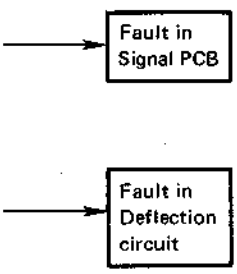
CONNECTOR A

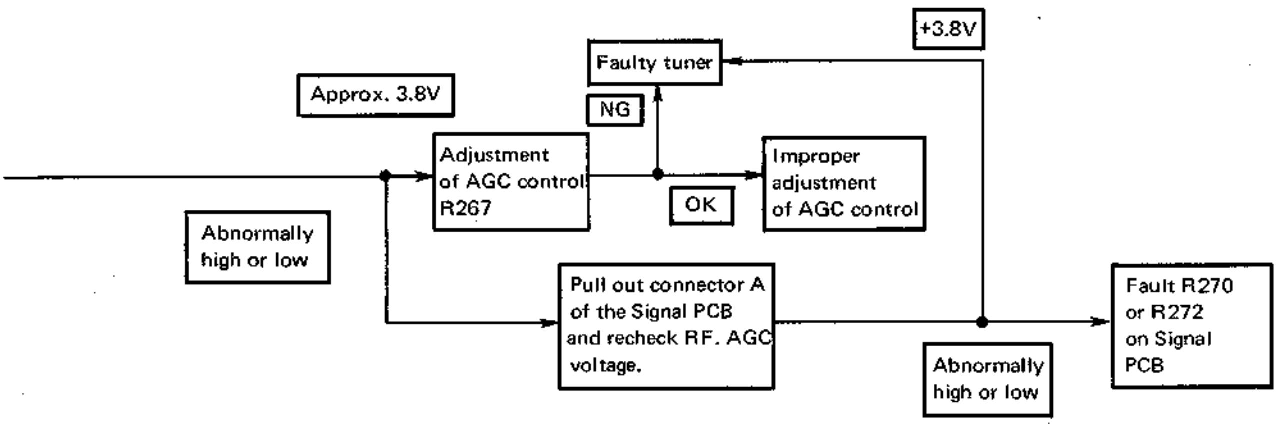


(Signal PCB)

11. MULTIPLE IMAGES







12. SATURATED VIDEO

Check performance of the brightness control.

- **Normal** → Check collector voltage of the TR24, TR25, TR26 (2SC460 Ⓒ) on Power PCB
  - +5~+6V in normal condition → Improper adjustment of sub Brightness Control (R308).
  - Abnormal → Fault in R567, R568, R569, TH550 on Power PCB.

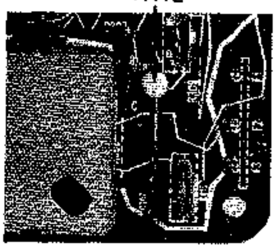
TR25

TR26 TR24

(Power PCB)

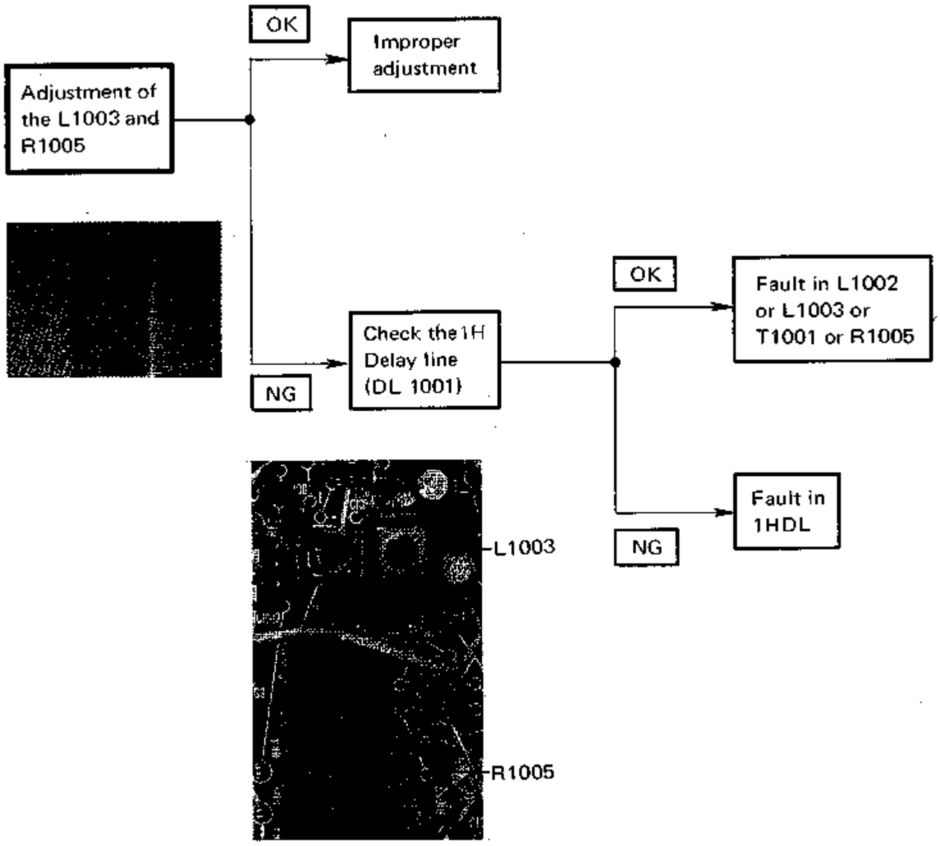
- **No change in brightness.** → Confirm whether emitter voltage of the TR12 (2SA351) varies by adjusting Brightness control.
  - Varies → Confirm whether collector voltage of the TR12 (2SA351) varies by adjusting Brightness control.
    - Varies → Fault in TR19 (2SA565) on Power PCB.
    - Does not vary. → Fault in TR12 (2SA351) on Signal PCB.
  - Does not vary. → Check lead wire connected to the connector D on the Signal PCB and control block.
    - OK → Fault in Brightness control Circuit (R309, R361, R362, R363)
    - NG → Incomplete contact connector D; broken lead wire.

TR12



(Signal PCB)

13. VENETIAN BLIND



(PAL PCB)

14. CHROMA CHANNEL OPEN ON MONOCHROME

Adjustment of the colour killer VR (R560) on Power PCB

- OK → Improper adjustment of colour killer
- NG → Check the colour killer circuit (TR20) on Power PCB
  - NG → Fault in TR20
  - OK → Fault in CR13 (1N34A), etc.

R560

TR20

(Power PCB)

15. INCORRECT COLOUR

PAL switch on wrong phase → Adjustment of fH/2 circuit on PAL PCB (L1008 and T1004)

PAL switch not operating → Fault in Flip-Flop circuit (TR1009, TR1010) or Incomplete contact of connector HE

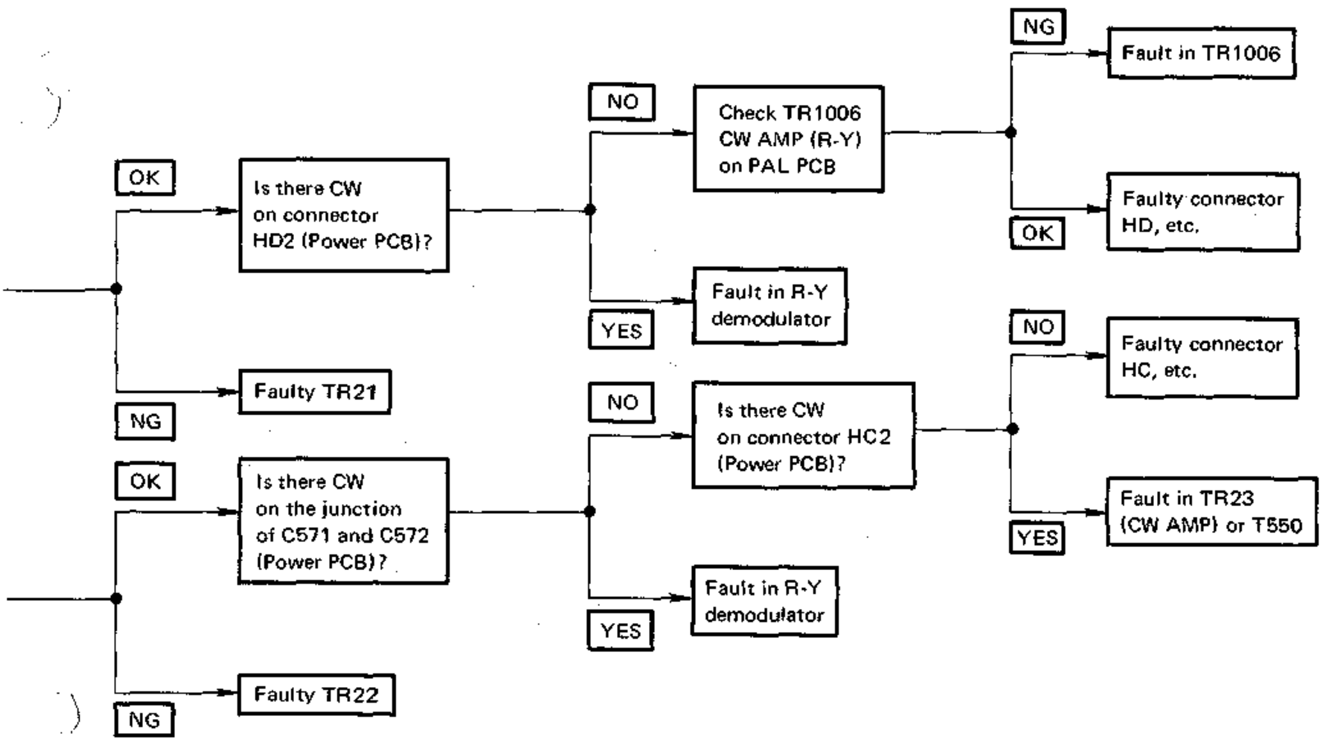
Loss of R-Y signal → Is there signal on Base of TR21 (2nd BPA on Power PCB)?

- YES → Check TR21
- NO → Faulty connector HB, etc.

Loss of B-Y signal → Is there signal on Base of TR22 (2nd BPA on Power PCB)?

- YES → Check TR22
- NO → Faulty connector HA, etc.

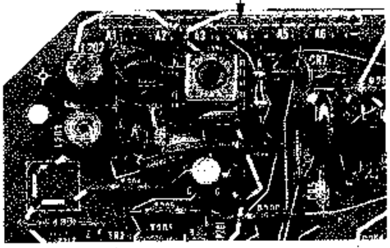
Loss of G-Y signal → Fault in G-Y matrix (e.g. R1239, R1240, C999)


NG
Fault in TR1006
NO
Check TR1006
CW AMP (R-Y)
on PAL PCB
OK
Is there CW
on connector
HD2 (Power PCB)?
Faulty connector
HD, etc.
OK
Fault in R-Y
demodulator
YES
NO
Faulty connector
HC, etc.
Faulty TR21
NG
NO
Is there CW
on connector HC2
(Power PCB)?
OK
Is there CW
on the junction
of C571 and C572
(Power PCB)?
Fault in TR23
(CW AMP) or T550
YES
Fault in R-Y
demodulator
YES
Faulty TR22
NG

16. NOT OPERATING AFC

- Does the voltage at terminal AFC on tuner vary by tuning?
  - YES → Faulty tuner
  - NO → Check the terminal A on signal PCB
    - NG → Incomplete contact connector A
    - OK → Check the coaxial cable of AFC (on signal PCB)
      - NG → Broken wire of coaxial cable
      - OK → Fault in AFC PCB or C001 (2pF)

CONNECTOR A



(Signal PCB)

5. SERVICE POINTS AND ADJUSTMENTS

INSTALLATION AND ADJUSTMENTS

UNPACKING—These receivers are shipped complete in cardboard cartons. Carefully take the receiver out of the carton and remove all packing material.

POWER—Plug the power cord into a proper AC power outlet and pull the Pull-ON switch ON.

PICTURE—First check operation on black and white programme. Then, if necessary, adjust Vertical Linearity, Vertical Height and AGC. Observe the picture for good black and white reproduction.

EXTERNAL AERIAL CONNECTIONS

When using a UHF or VHF aerial only, or both, connect the transmission line (s) to the proper aerial terminals at the rear of the receiver.

NOTE: When the colour TV receiver leaves the factory, all adjustments are throughly checked and corrected. It should seldom be necessary for the serviceman to make complete adjustments. However, several minor adjustments (such as Static convergence, Dynamic Convergence, Colour Purity and Black-and White Adjustments) may be required.

AUTOMATIC DEGAUSSING

All instruments are equipped with an automatic degaussing coil which effectively demagnetizes the picture tube each time the receiver is turned off.

The degaussing effect is confined to the picture tube since the coils are mounted around the rim-band of the tube.

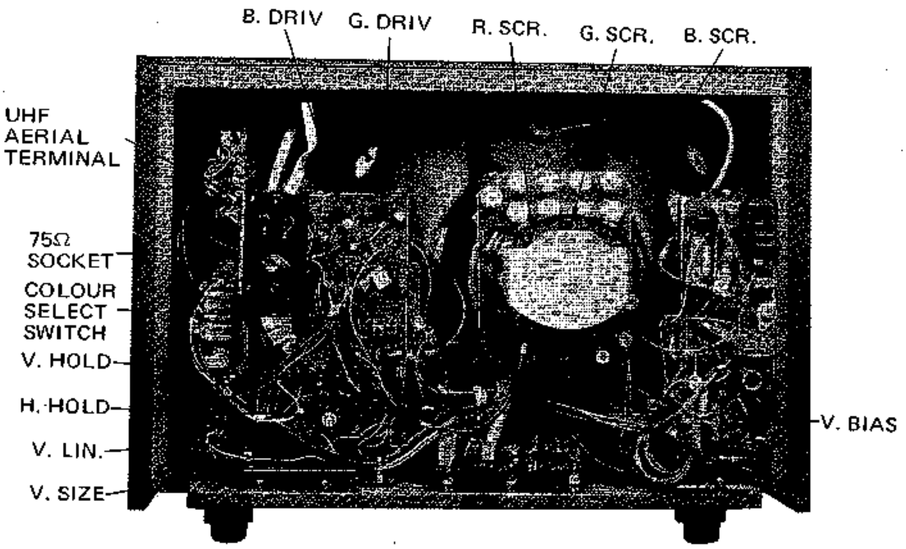
Should any parts of the chassis or cabinet become magnetized, it will be necessary to degauss the affected area by means of an external degaussing coil. Move the coil slowly around the parts to be magnetized, then slowly withdraw for a distance of six feet before disconnecting the coil from the AC power supply.

Prior to placing the set in its final position in the home for customer viewing, the set should be faced in a NORTH or SOUTH direction for external degaussing and purity adjustments. This will enable the internal automatic degausser to performs at maximum efficiency to correct for the final location and accidental magnetizing by appliances normally found in the home.

NOTE: Automatic degaussing will not correct impurities due to misalignment of yokes or purity rings.

HEIGHT AND VERTICAL LINEARITY ADJUSTMENTS

Adjust Size Control (R608) and the Vertical Linearity Control (R609) until picture or test pattern is symmetrical from top to bottom. Make a final adjustment to overscan mask slightly at both top and bottom.



REAR CHASSIS ADJUSTMENT

COLOUR PURITY ADJUSTMENTS

To facilitate colour purity adjustments, it is recommended that the purity adjustment be performed with the set located in the place that it will be used and facing in the correct position for viewing.

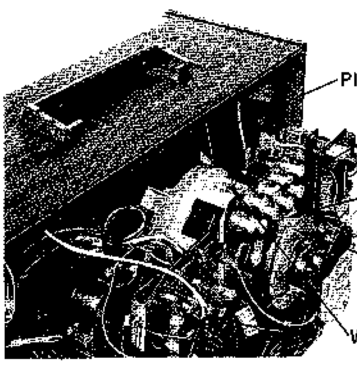
If the set will be moved around, then the purity adjustment should be made with the set facing north or south.

Rough centre convergence must be made before purity adjustment is attempted.

Purity adjustments are most accurate while observing one colour only (preferably red) and with no signal or noise on the screen.

1. To eliminate signal and noise, connector "A" may be removed from SIGNAL PCB or +5V DC may be applied to the R.F. AGC terminal on the tuner.
2. To disable the Blue and Green guns, position the "COLOUR SELECT SWITCH" on POWER PCB to its uppermost position.
3. Loosen the wing bolt and slide the deflection yoke back against the convergence magnet assembly.
4. Adjust for a uniform red area in the centre of the screen by spreading or rotating the purity magnet assembly located on the blue lateral magnet assembly.
5. Move the deflection yoke forward slowly while observing entire screen area. Position the yoke for best overall red screen, without shadow or purity error at outer edges of screen.
6. Tighten the wing bolt securely.
7. Remove the AGC bias on tuner or replace connector "A" to SIGNAL PCB.
8. Reactivate blue and green guns and observe all three beams.
9. If screen is not a uniform white, reconverge centre of screen and repeat purity adjustment.

NOTE: The correct position of the deflection yoke will vary according to temperature of the receiver. If the purity adjustment is made when the receiver is hot (1 to 2 hours of operation), set the deflection yoke as far away from convergence coil assembly as possible, within range of good consistent purity. If adjustment is made when the receiver is cold (up to about 10 minutes of operation, immediately prior to adjustment), set the deflection yoke as close to convergence coil assembly as possibly, within range of good consistent purity.



AGC ADJUSTMENTS

If adjustment is required.

1. Apply the signal of about 65 dB input signal strength to the receiver.
2. Connect VTVM between CR7 anode with ⊖ terminal and A4 with ⊕ terminal.
3. Adjust AGC control (R267) to zero indication on VTVM.

BLACK AND WHITE TRACKING ADJUSTMENTS

The purpose of this adjustment is to obtain good black and white reproduction at the normal usable range of contrast and brightness controls.

1. Turn Brightness control, Contrast control and Sub-brightness VR (R308) on the Signal PCB to minimum.
2. Place the Tint control in the centre position and place the Drive VR (R321), (R317) in the almost centre position.
3. Connect P34 and P35 on the Power PCB with a short clip.
4. Apply a 220 kΩ resistor between the K5 terminal (+120V) of the Power PCB and the N3 terminal of the Deflection PCB.
5. Adjust the screen VR control (R805, R806 and R807) to view RED, GREEN and BLUE horizontal lines, each appearing weakly on the screen.
6. Remove a short clip connecting P34 and P35, the resistor of K5, N3; set the Sub-brightness VR at a position in the vicinity of the central position; turn up the brightness control to the extent that a weak picture is reproduced on the screen.
   Under the above condition, effect white balance of low brightness by weakening highly saturated colours.
7. Turn up the Brightness and Contrast controls to increase brightness and contrast, adjust the Blue and Green Drive VR's (R321 and R317) to effect white balance of high brightness.
8. Afterward adjust the Sub-brightness VR (R308).

PRESET CONCENTRIC FINE TUNING

Tune in all stations to see that the local oscillator is adjusted to the proper frequency to receive all channels. Adjust fine tuning on all channels that can be received locally. Once this is done these channels are permanently fine tuned.

CENTRE CONVERGENCE ADJUSTMENTS

Either cross hatch or dot pattern should be used to set convergence at centre of screen. Centre convergence is performed with red, green and blue magnet adjustments mounted on convergence circuit board assembly around neck of picture tube and with blue lateral magnets (Refer to Figure 1) to produce white dots in the centre of screen. Set Brightness to provide small dots which are distinct enough for viewing.

Converge red and green dots first and then converge blue dots. Vertically mis-matched blue dots may be adjusted by blue lateral magnets. Recheck colour purity. After correcting for purity error, recheck centre convergence. The dot movement pattern is illustrated in Figure 2. The thumb screw adjustment of red, blue and green centre convergence magnets can be rotated in either direction continuously. The blue lateral magnet is adjusted by means of knurled outer rim. If more range is needed, the magnet holding assembly can be rotated 180° by turning the rectangular magnet holder while holding the outer knurled rim.

DYNAMIC CONVERGENCE ADJUSTMENTS

A cross-hatch pattern generator should be used.

After centre convergence adjustments have been made, proceed with the following steps and Figures.

1. Remove the red and the green PLUGS as shown in Figure 3.
2. Observing RED and GREEN horizontal centre lines, connect the plugs with terminals according to one case (A), (B), (C), as shown in Figure 4.
3. Disable blue gun by setting S301 (COLOUR SELECT SWITCH) to its mid-position.
4. Adjust R860 to converge bottom R/G horizontal lines and R861 to converge top R/G horizontal lines at centre line of screen.

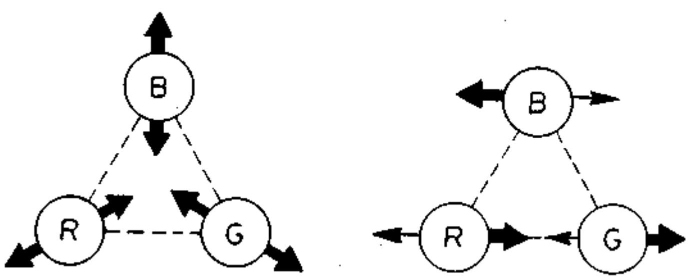


FIGURE 2. DOT MOVEMENT PATTERN

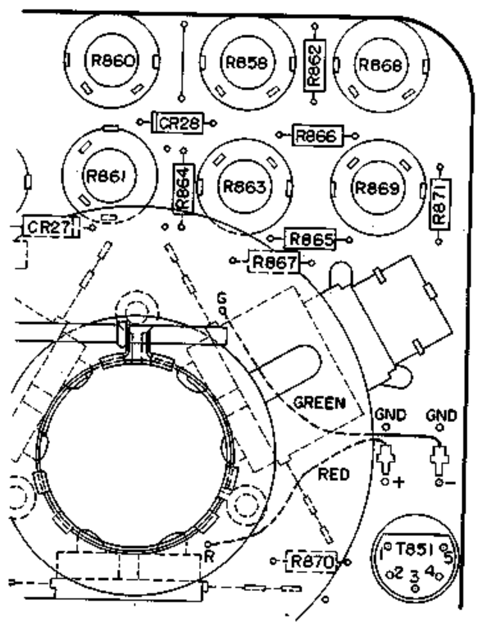


FIGURE 3

PLUG (R)
into + terminal
PLUG (G)
into GND terminal

PLUG (R)
into + terminal
PLUG(G)
into - terminal

PLUG (R)
into GND terminal
PLUG (G)
into + terminal

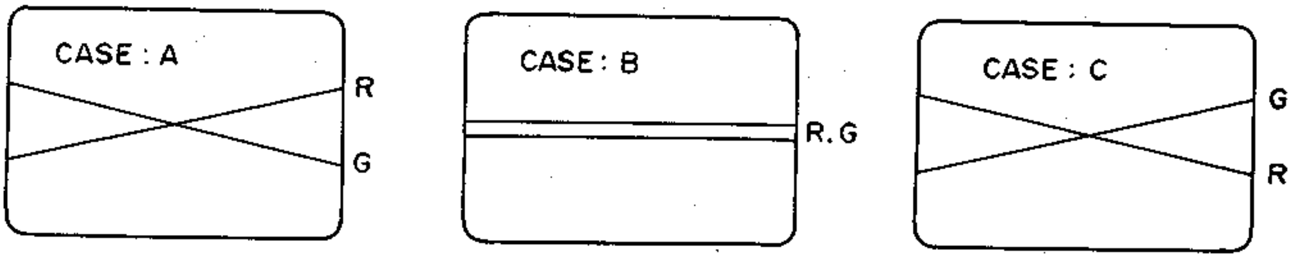


FIGURE 4

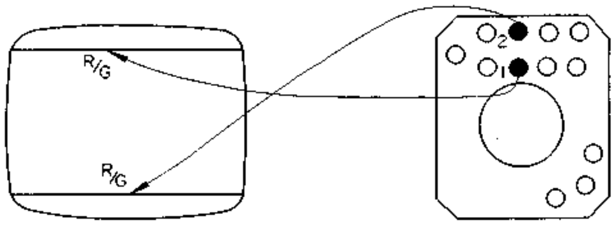


FIGURE 5. ADJUSTMENT OF R860 AND R861

5. Adjust R858 and R863 for convergence of R/G vertical centre line.

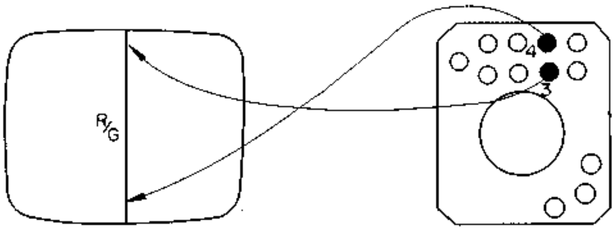


FIGURE 6. ADJUSTMENT OF R858 AND R863

6. Adjust alternately R852 and L851 for right and left side convergence of R/G vertical lines.

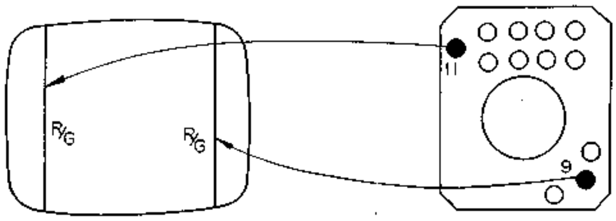


FIGURE 7. ADJUSTMENT OF R852 AND L851

7. Adjust alternately R851 and L852 for convergence of R/G horizontal centre line.

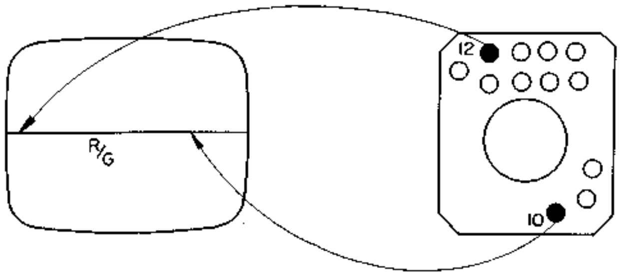


FIGURE 8. ADJUSTMENT OF R851 AND L852

8. Energize blue gun and check centre convergence. If necessary, readjust centre convergence and controls to compensate for interaction due to previous adjustments.
9. Adjust R868 and R869 for uniform displacement of blue horizontal lines along centre vertical lines.

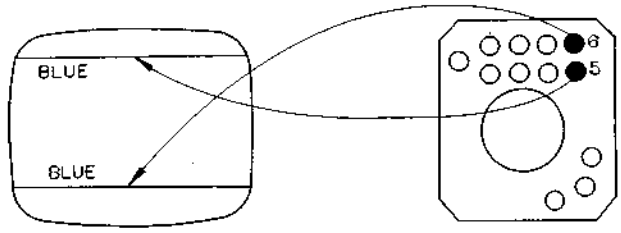


FIGURE 9. ADJUSTMENT OF R868 AND R869

10. Adjust R855 and T851 for straight horizontal blue centre line.

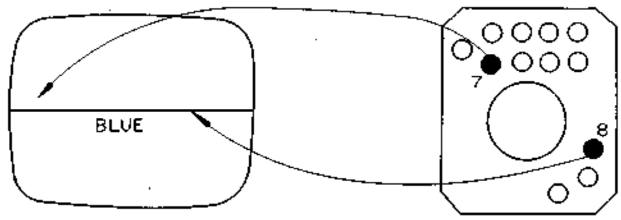


FIGURE 10. ADJUSTMENT OF R855 AND T851

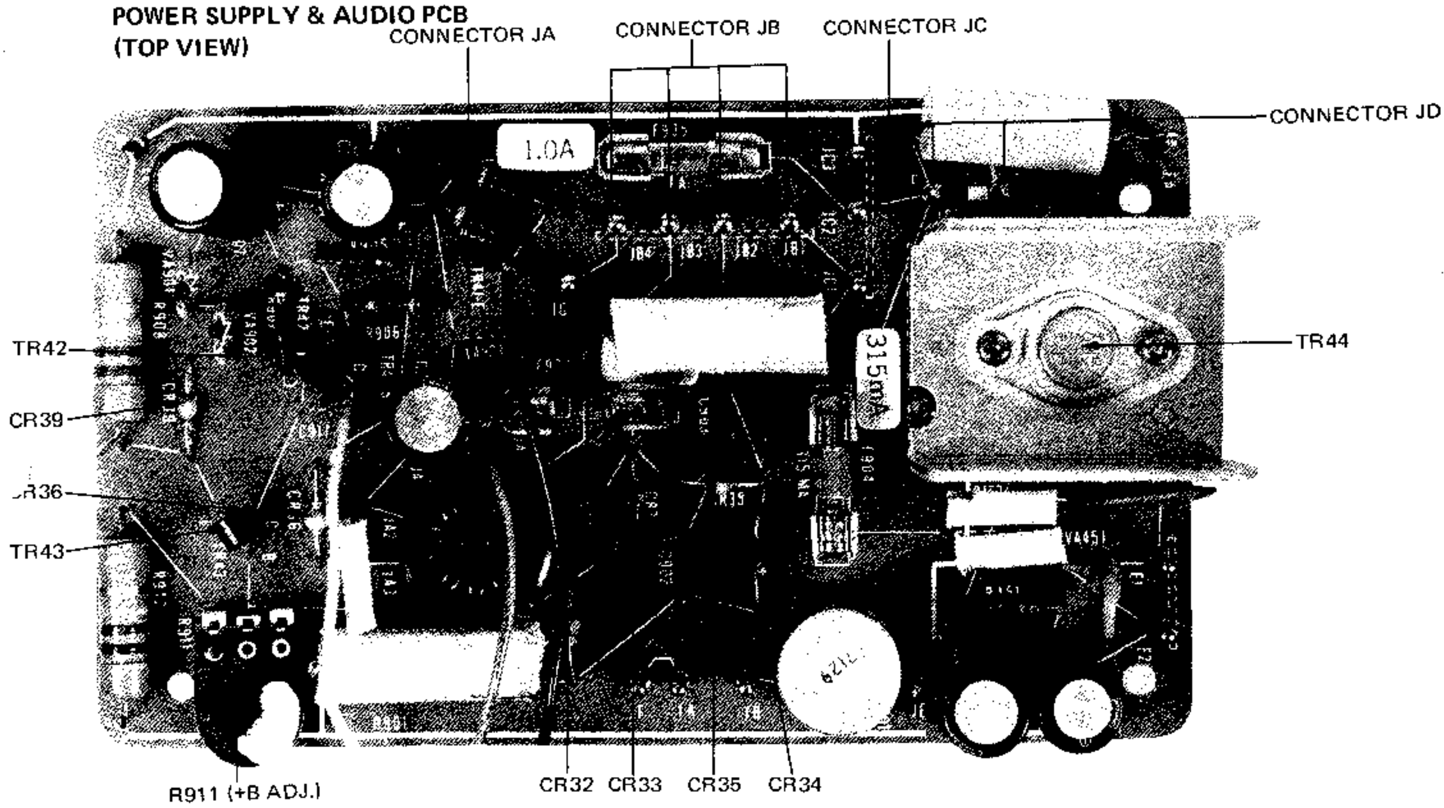
11. If necessary, readjust centre convergence magnets and dynamic convergence controls for best convergence. When RED and GREEN horizontal lines do not converge at the left and right of the picture, remove the plug, the green magnet and adjust centre convergence. Observing RED and GREEN horizontal lines connect the receptacles as shown in Figure 4 according to the condition of RED and GREEN horizontal lines convergence.

WIDE BLUE FIELD CORRECTION

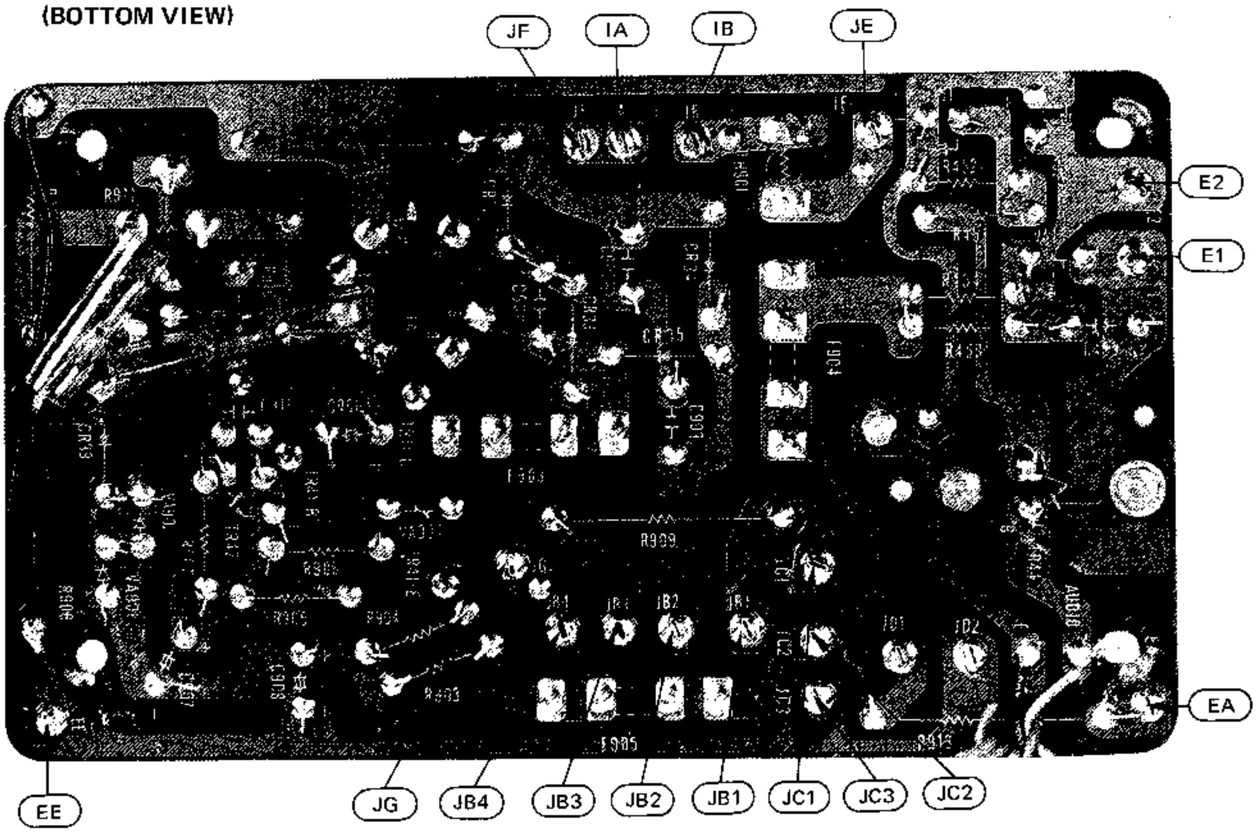
The wide blue field adjustment is an adjustment for the correction of misconvergence of blue vertical lines at the sides of the picture. When adjustment is necessary, rotate the convergence yoke assembly slightly.

6. PRINTED CIRCUIT BOARDS

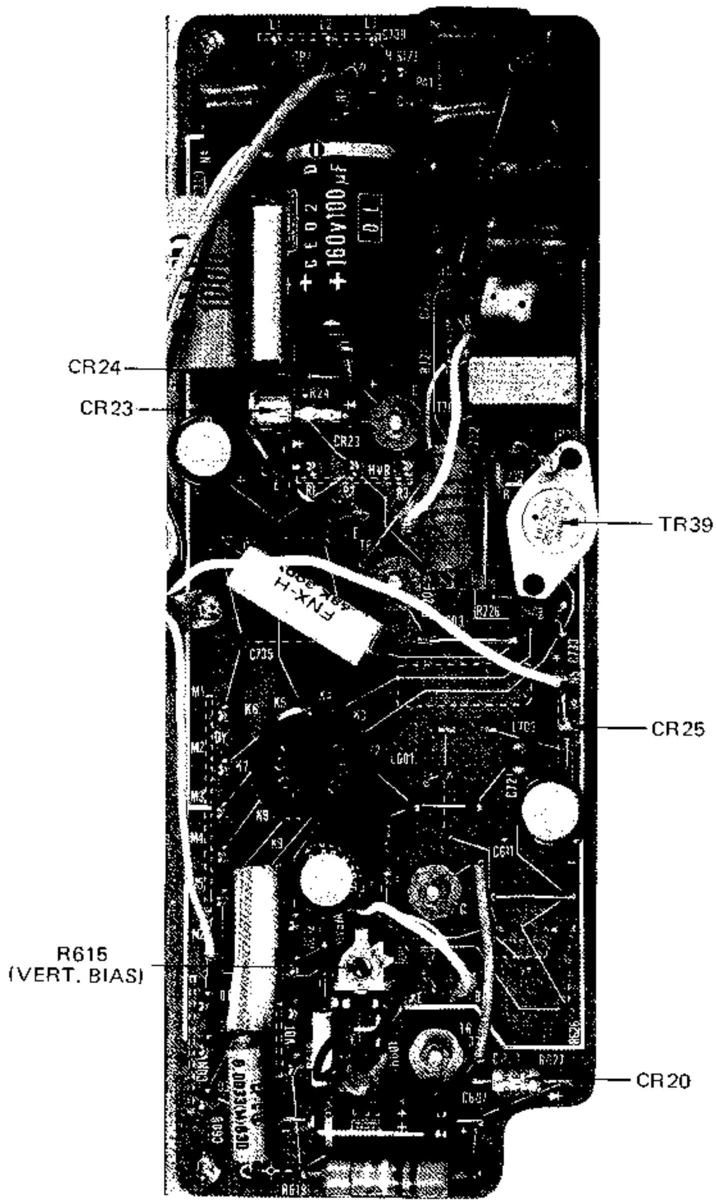
POWER SUPPLY & AUDIO PCB
(TOP VIEW)



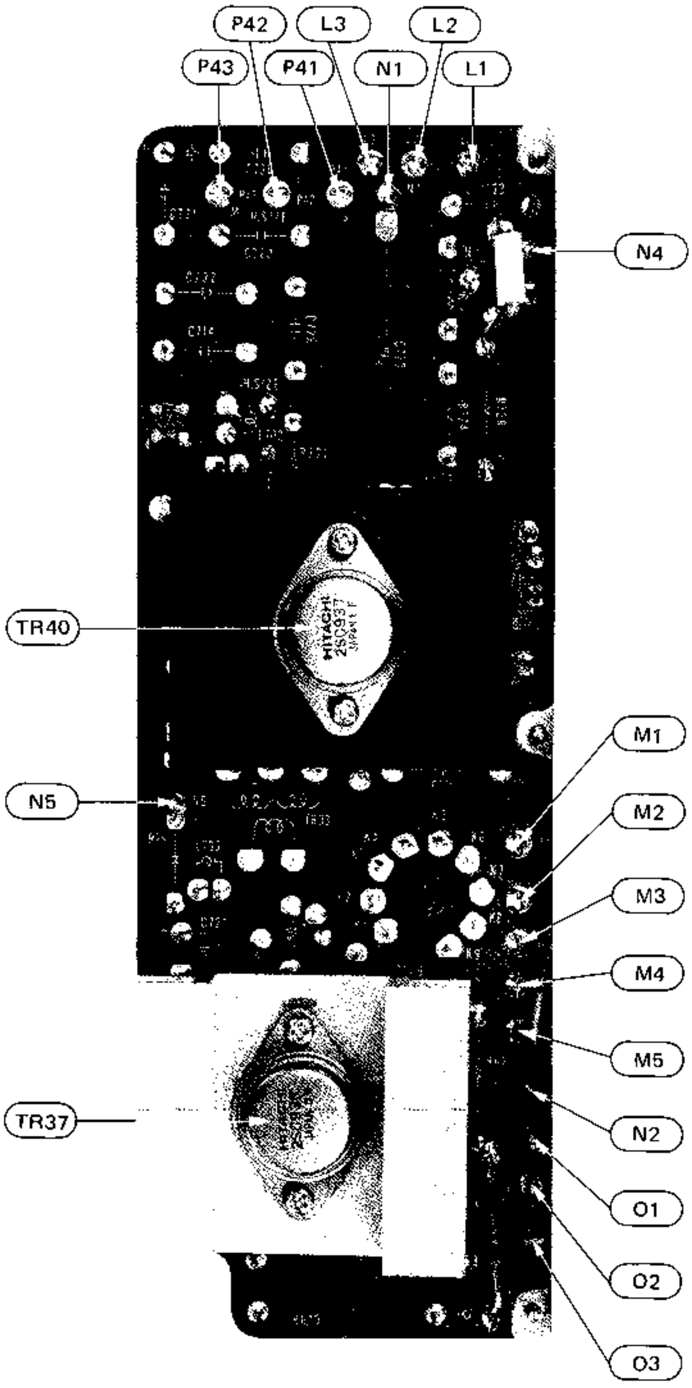
(BOTTOM VIEW)



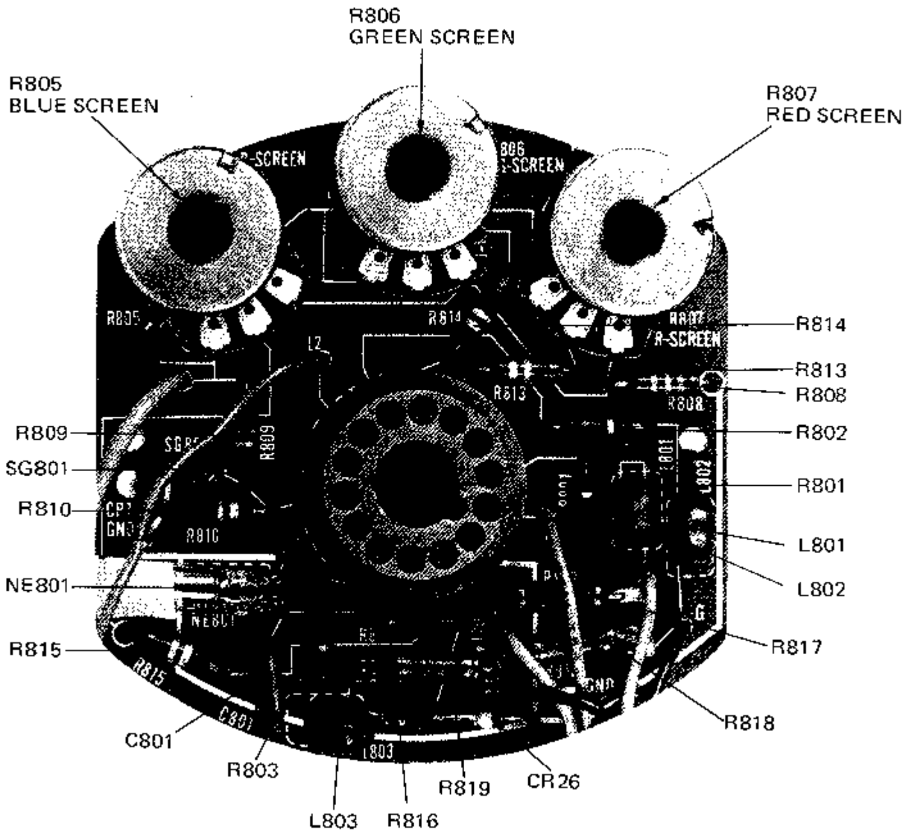
DEFLECTION OUTPUT PCB
(TOP VIEW)



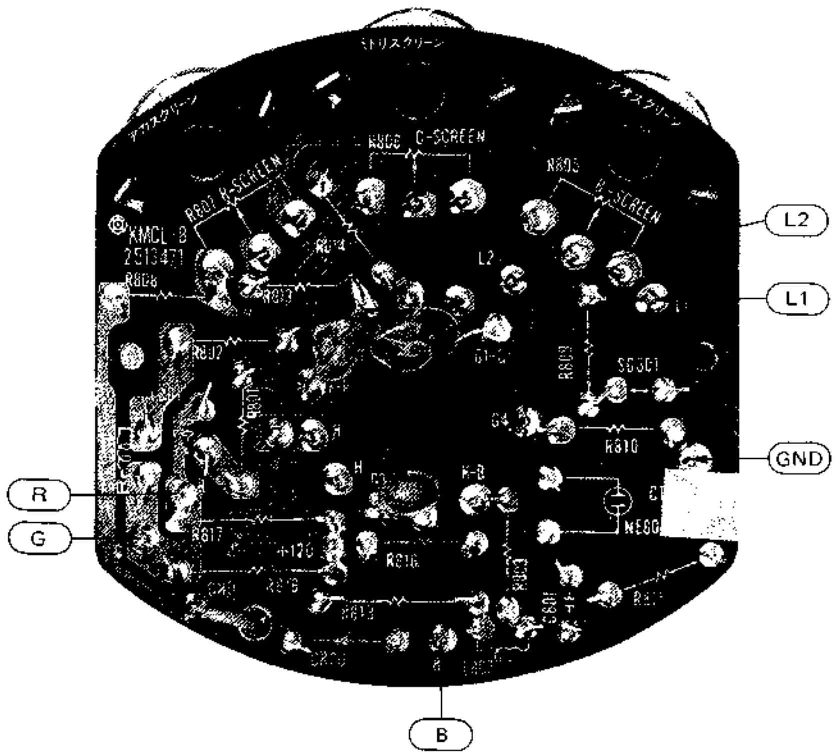
(BOTTOM VIEW)



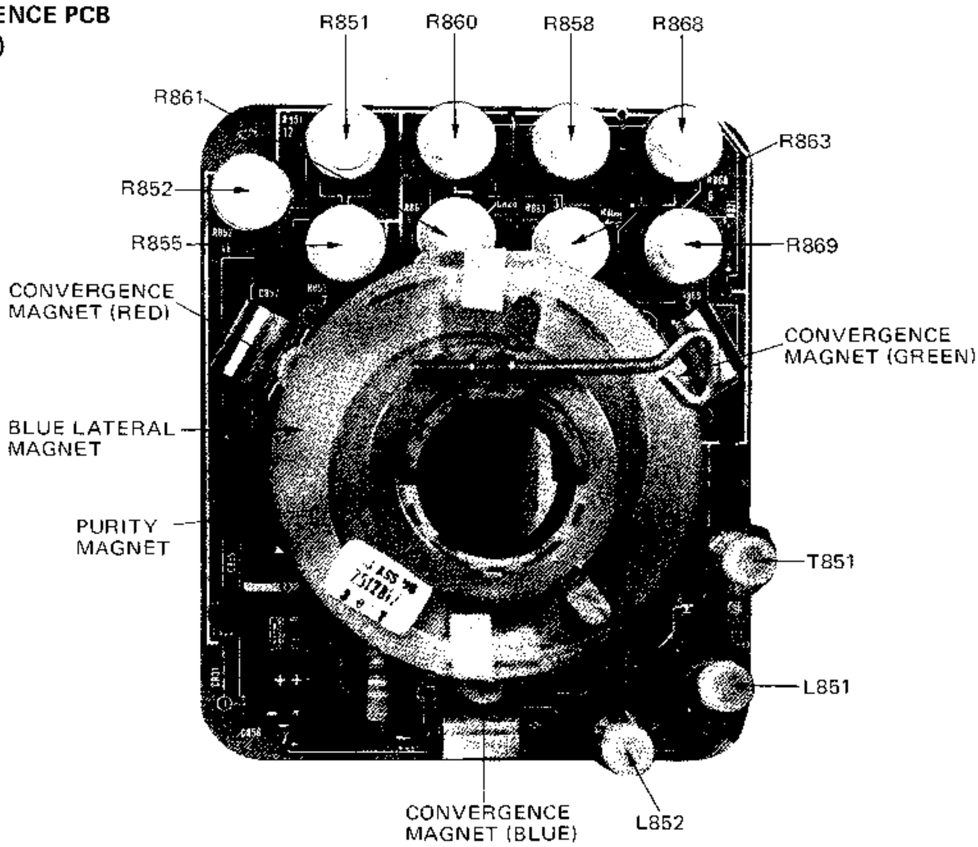
CPT PCB
(TOP VIEW)



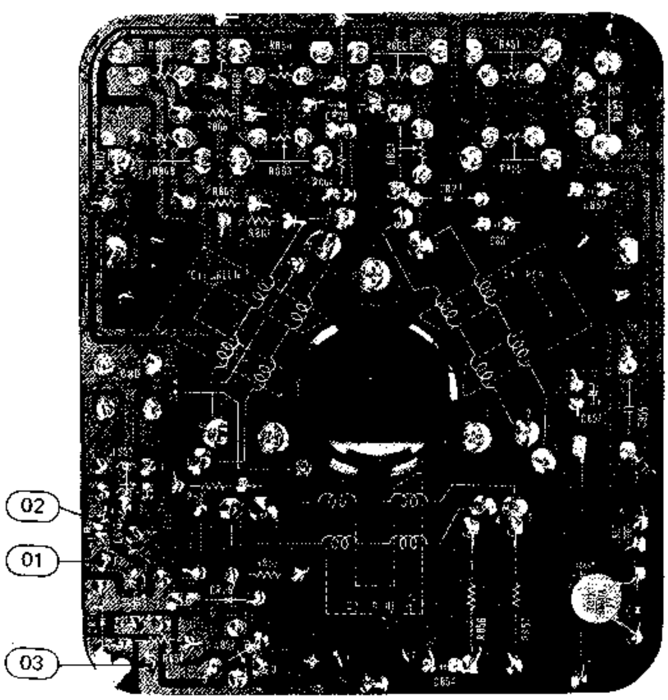
(BOTTOM VIEW)



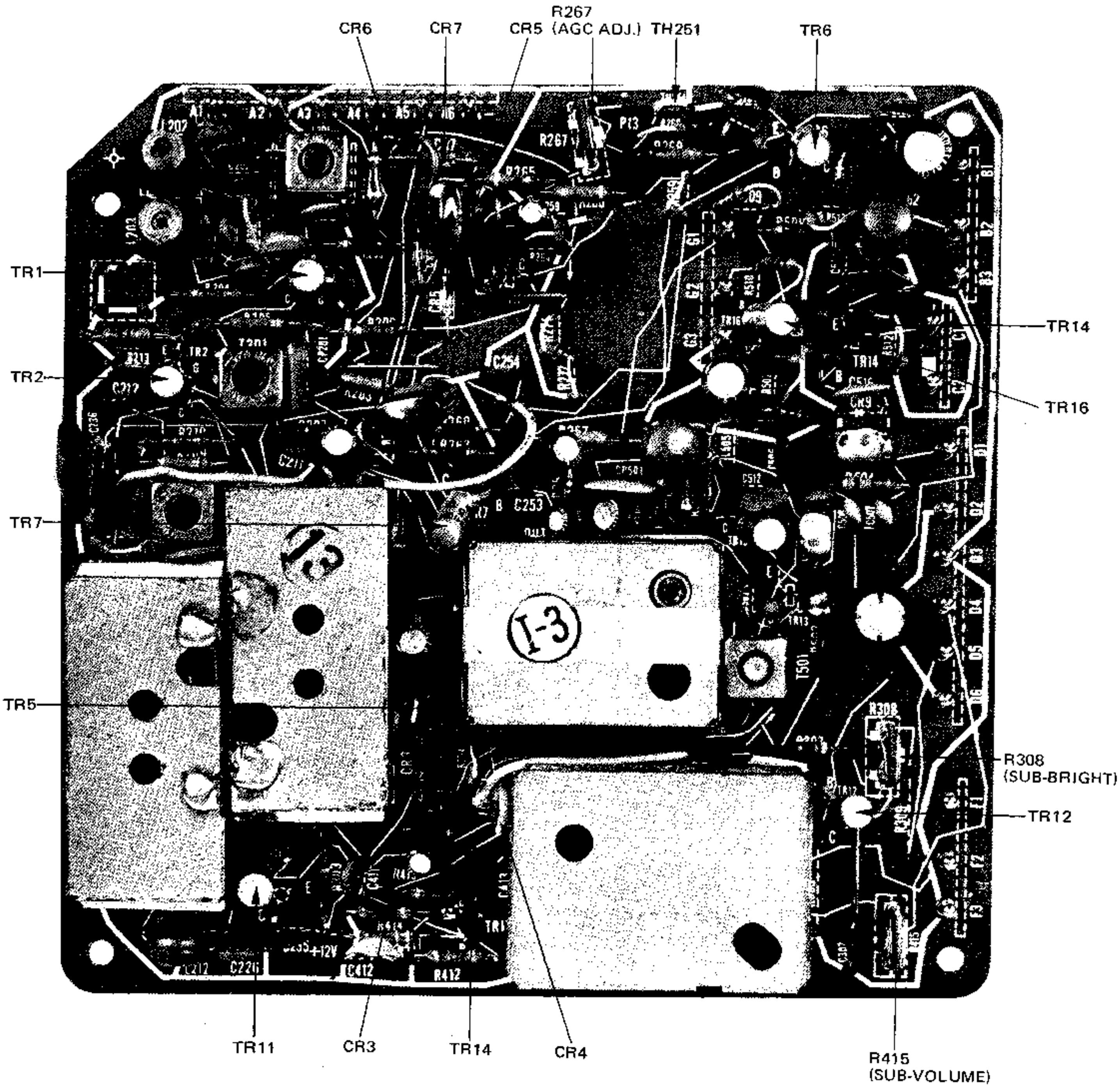
CONVERGENCE PCB
(TOP VIEW)



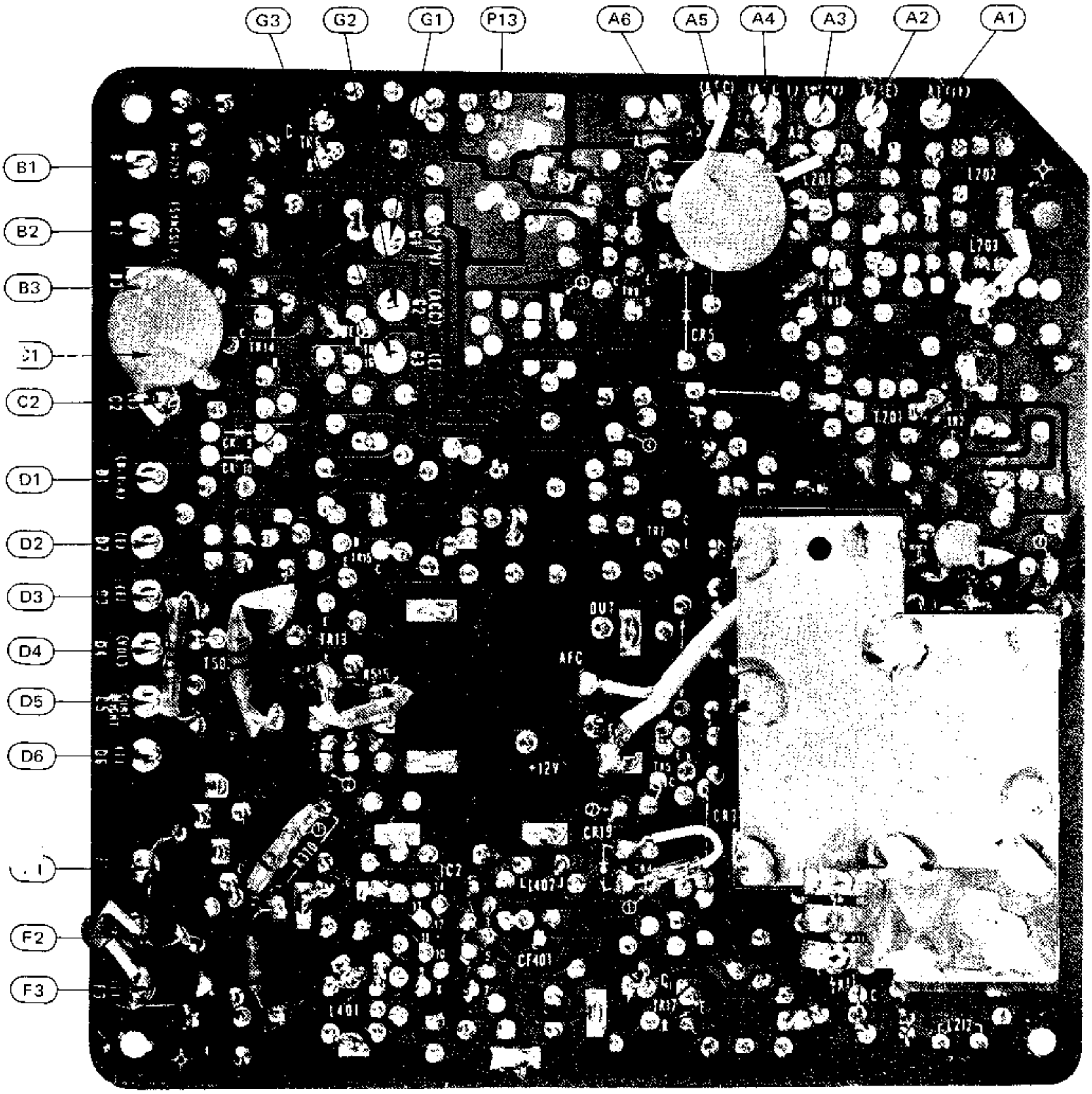
(BOTTOM VIEW)



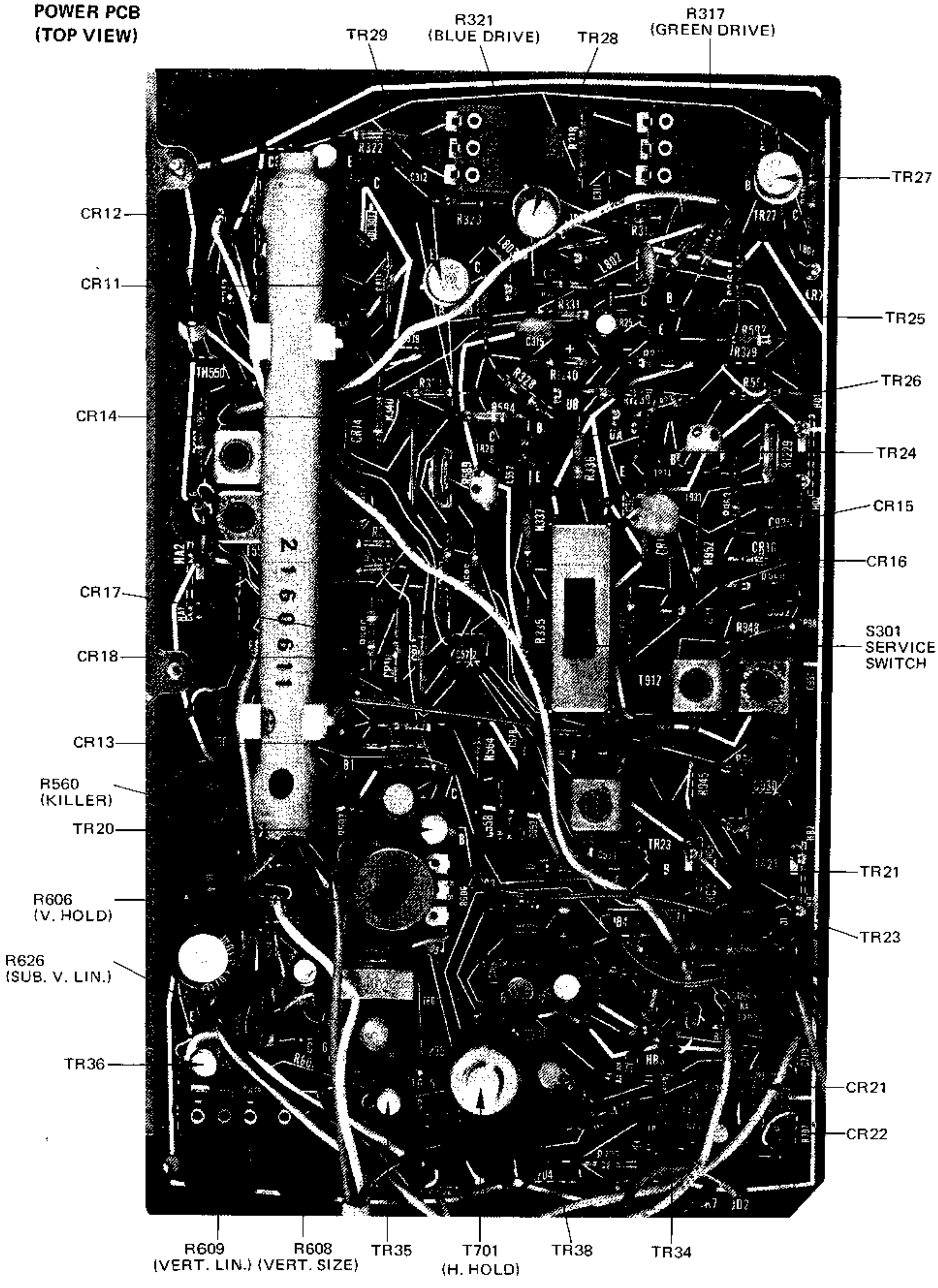
SIGNAL PCB
(TOP VIEW)



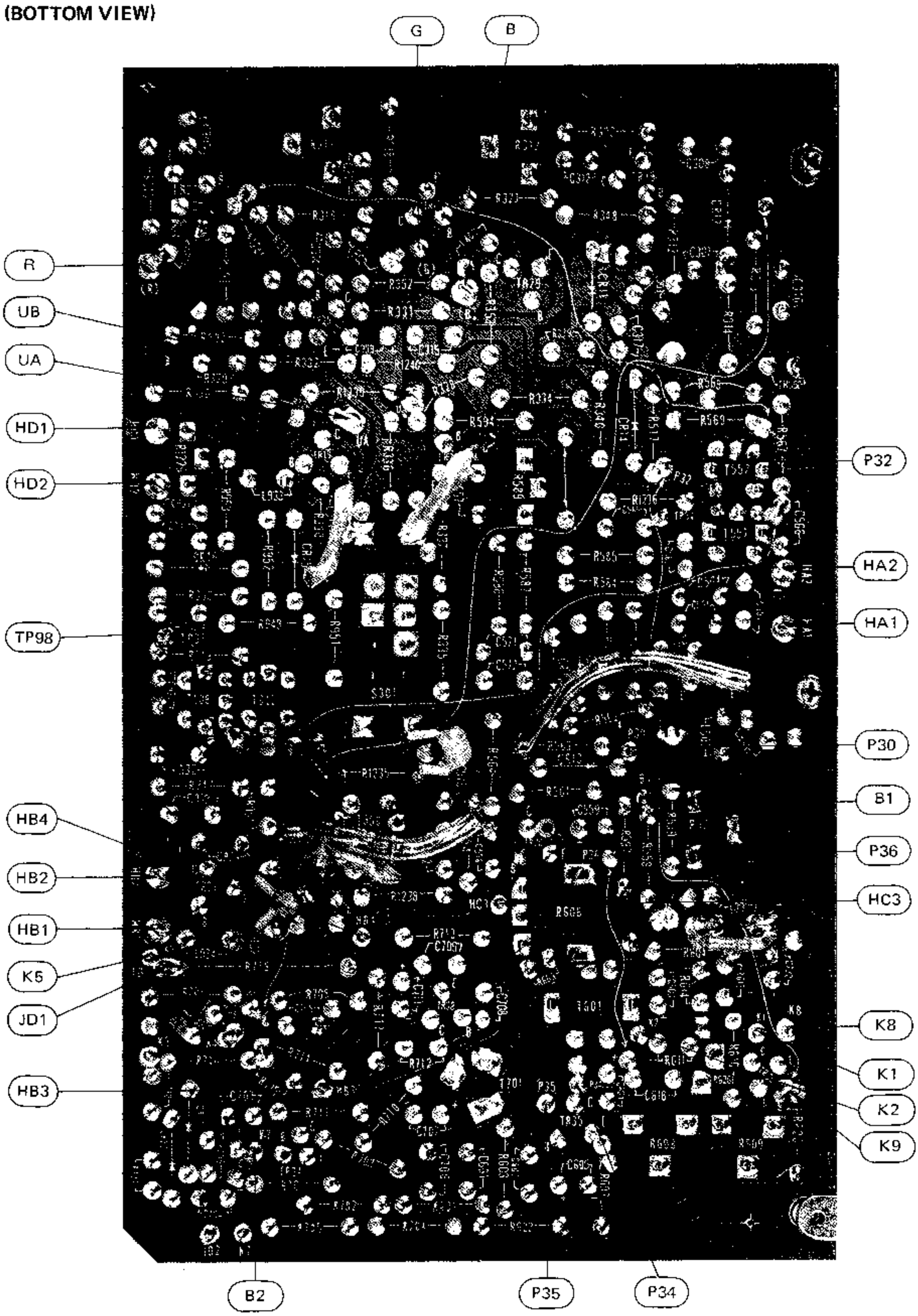
(BOTTOM VIEW)


G3
G2
G1
P13
A6
A5
A4
A3
A2
A1
B1
B2
B3
C2
D1
D2
D3
D4
D5
D6
F2
F3
AFC
+12V
CR5
CR19
T50
TR13
L401
CF401
TR17
L202
L203

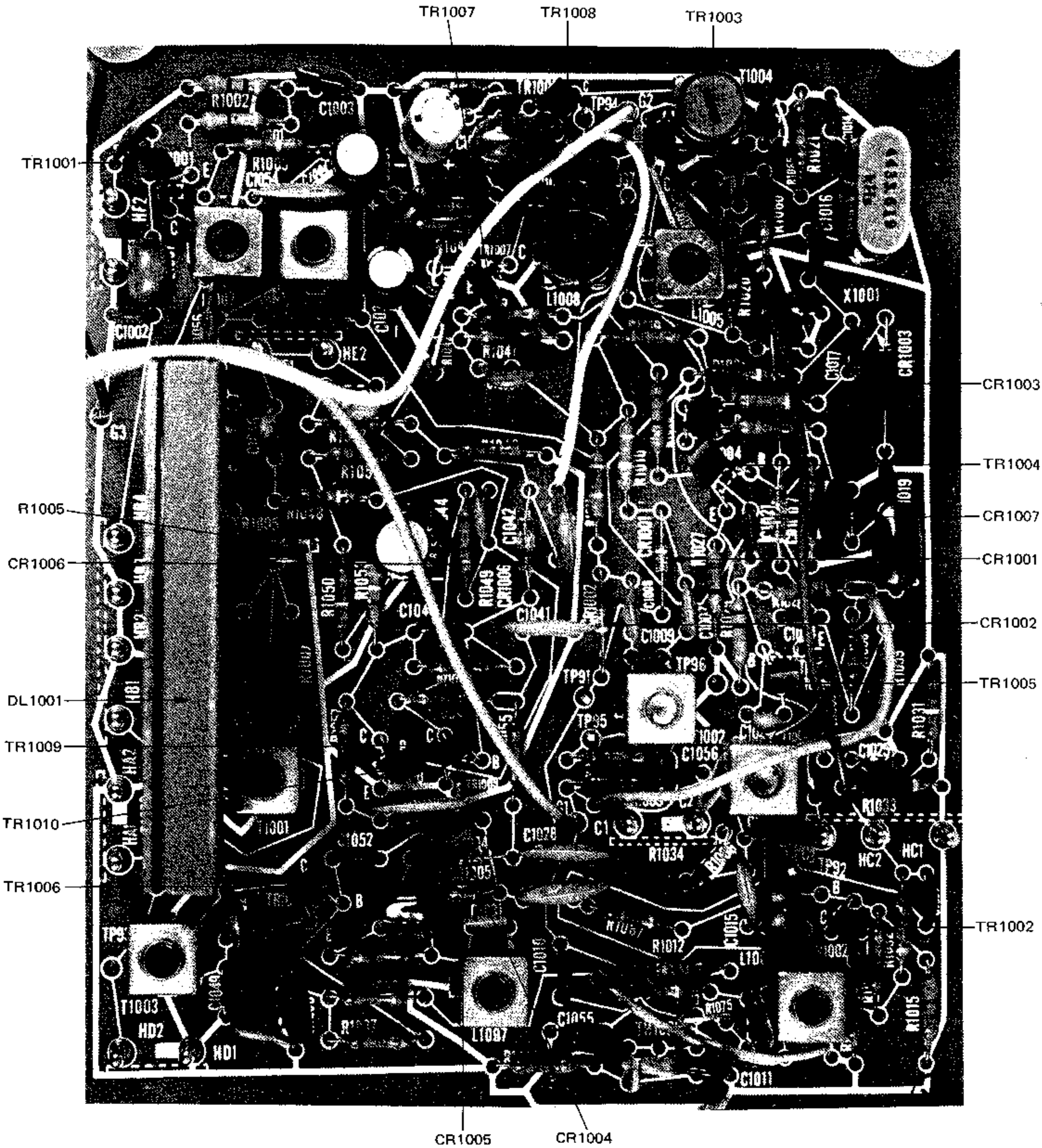
POWER PCB
(TOP VIEW)



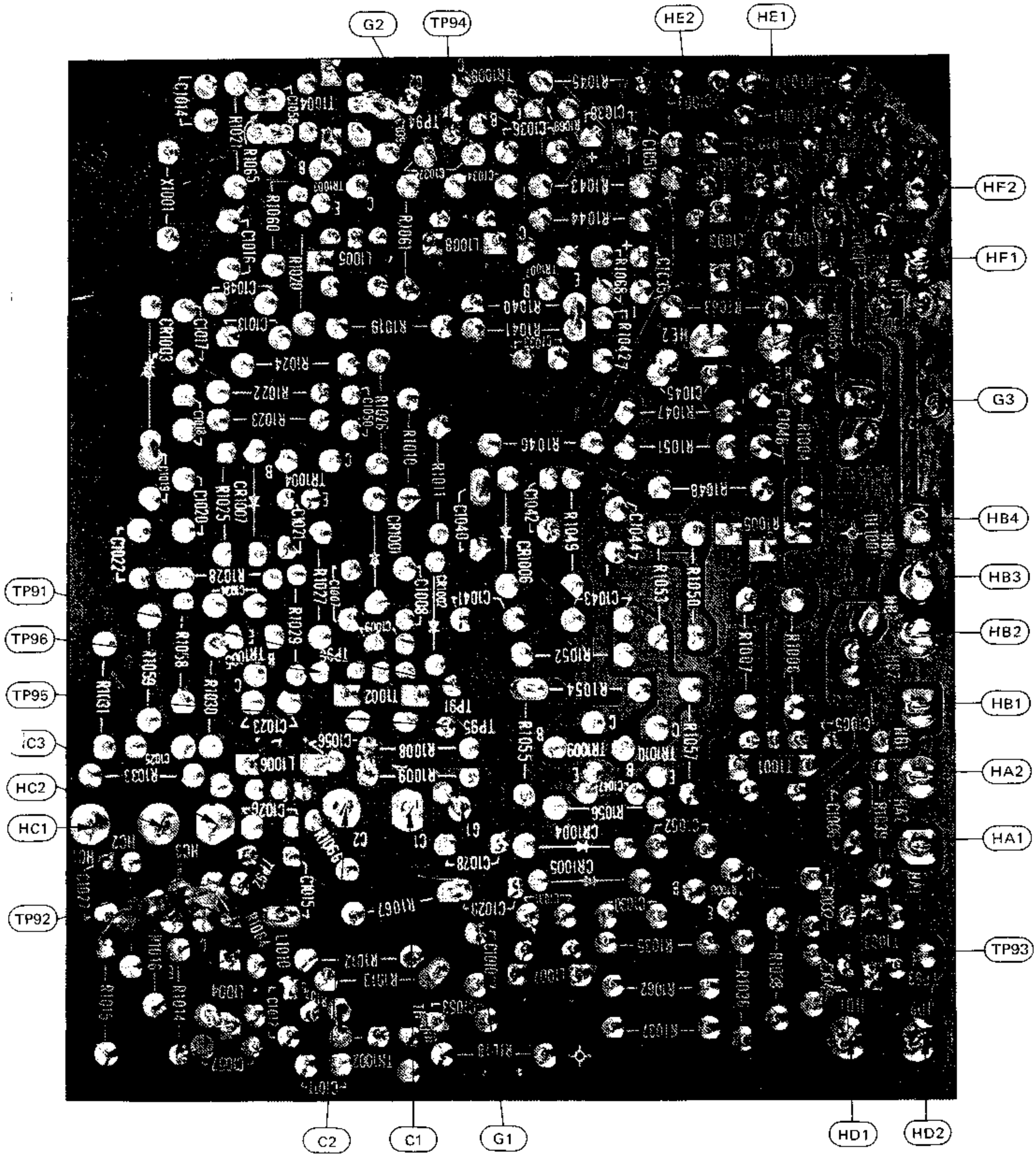
(BOTTOM VIEW)


G
B
R
UB
UA
HD1
HD2
TP98
HB4
HB2
HB1
K5
JD1
HB3
P32
HA2
HA1
P30
B1
P36
HC3
K8
K1
K2
K9
B2
P35
P34

PAL PCB
(TOP VIEW)

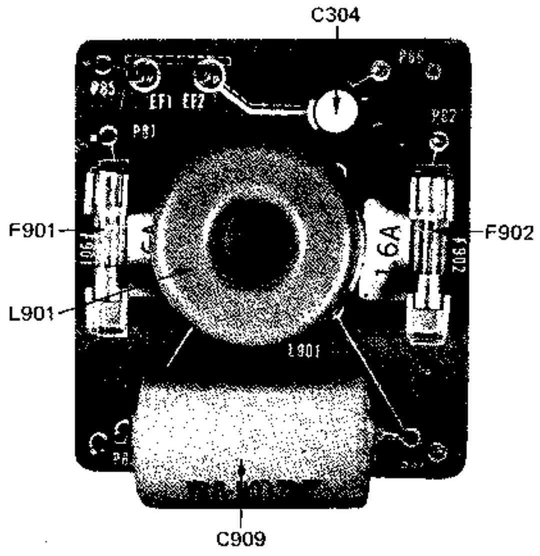


(BOTTOM VIEW)

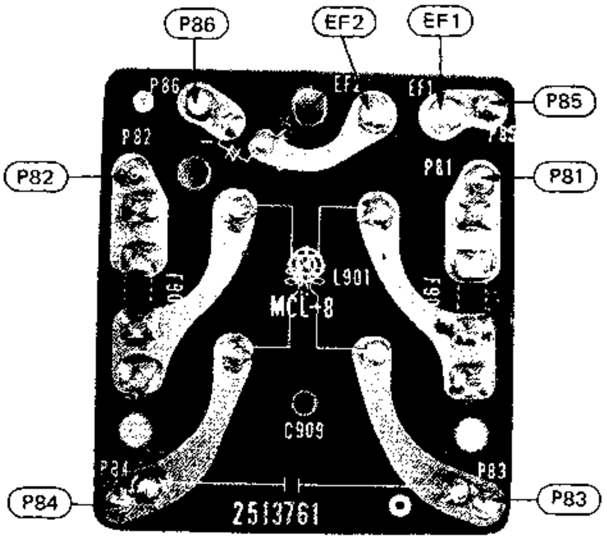


G2
TP94
HE2
HE1
HF2
HF1
G3
HB4
HB3
HB2
HB1
HA2
HA1
TP93
TP91
TP96
TP95
C3
HC2
HC1
TP92
C2
C1
G1
HD1
HD2

FILTER PCB
(TOP VIEW)

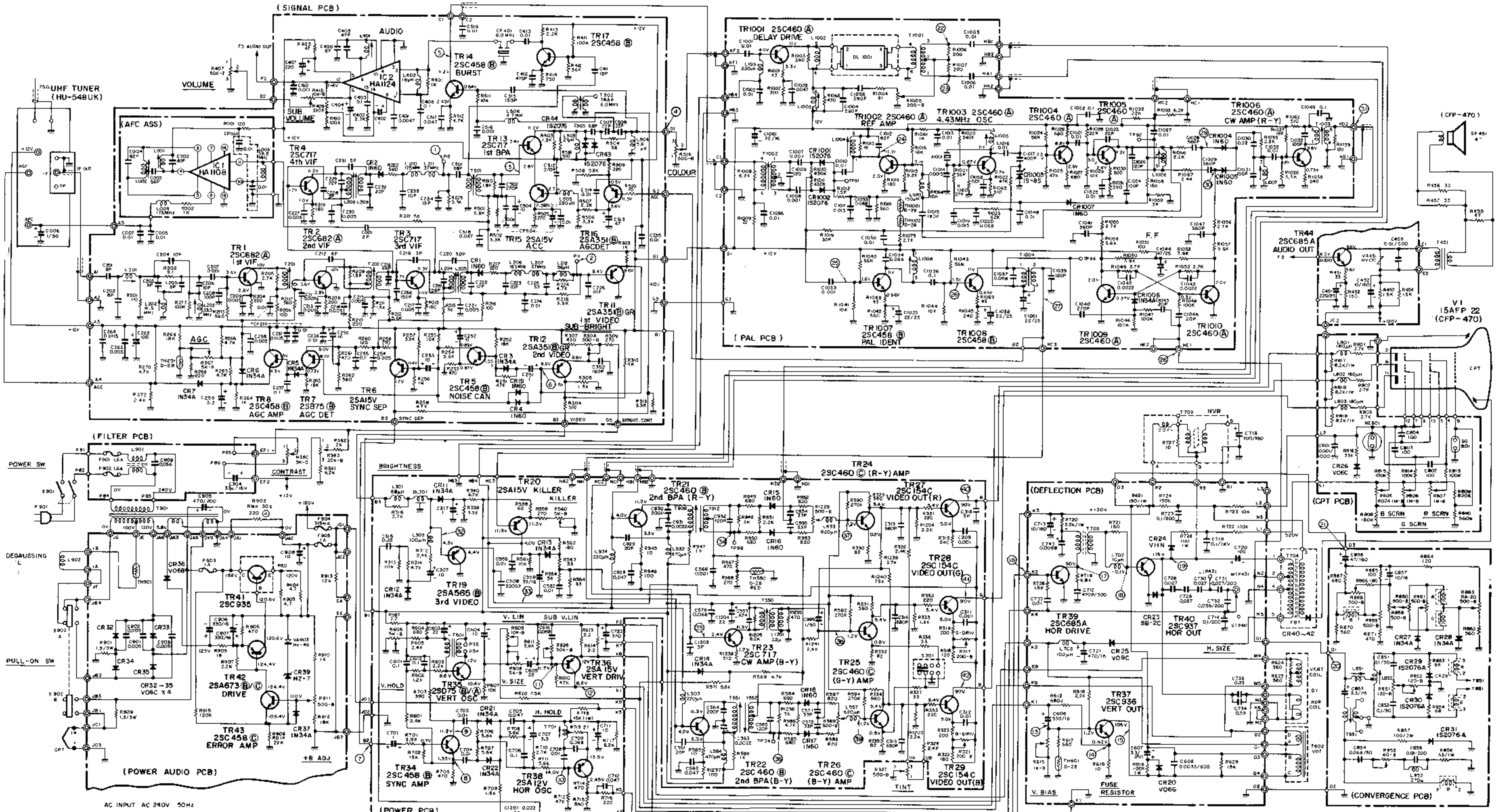


(BOTTOM VIEW)

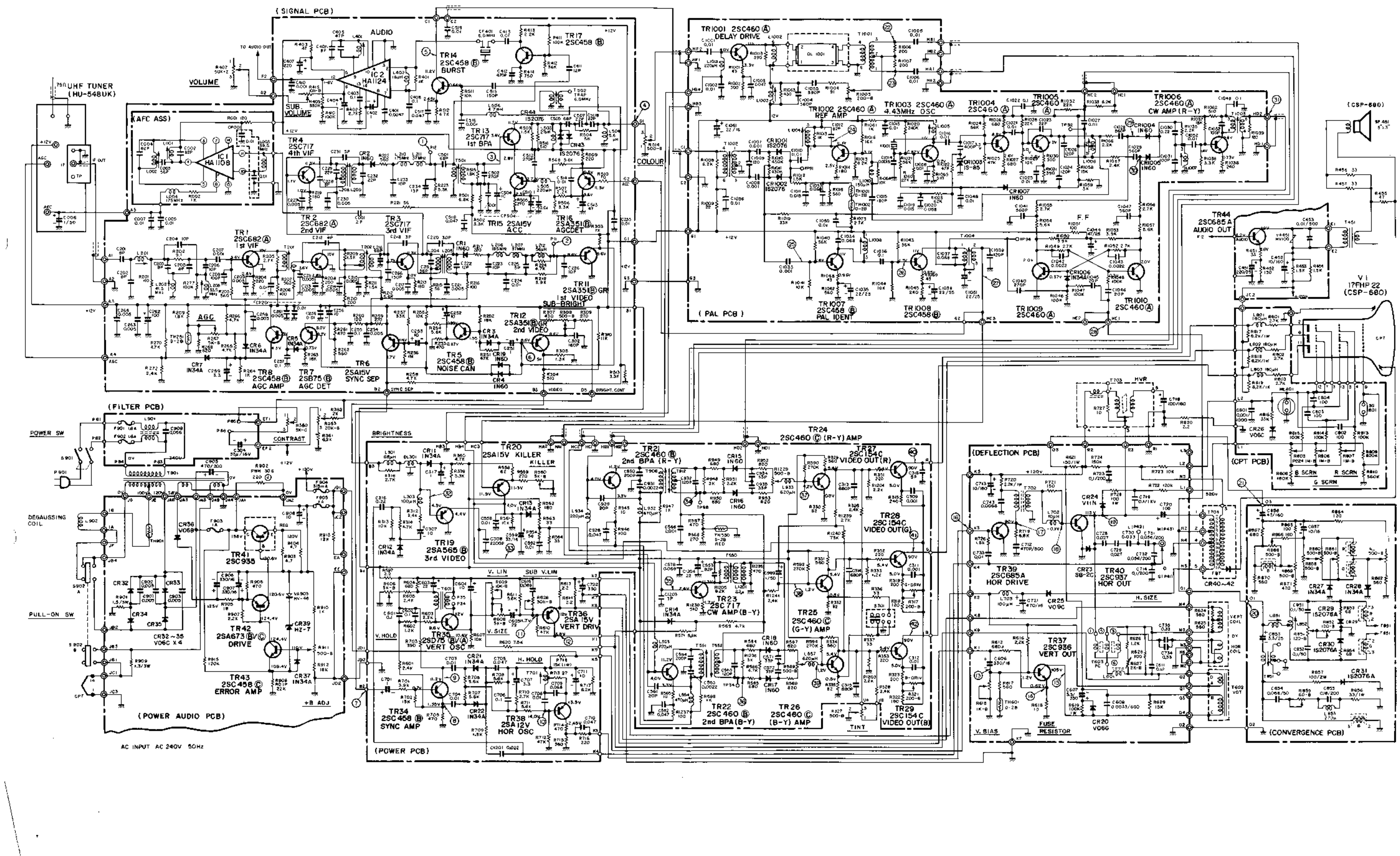


7. FUNDAMENTAL CIRCUIT SCHEMATIC DIAGRAMS

CFP-470 (HS/UK)

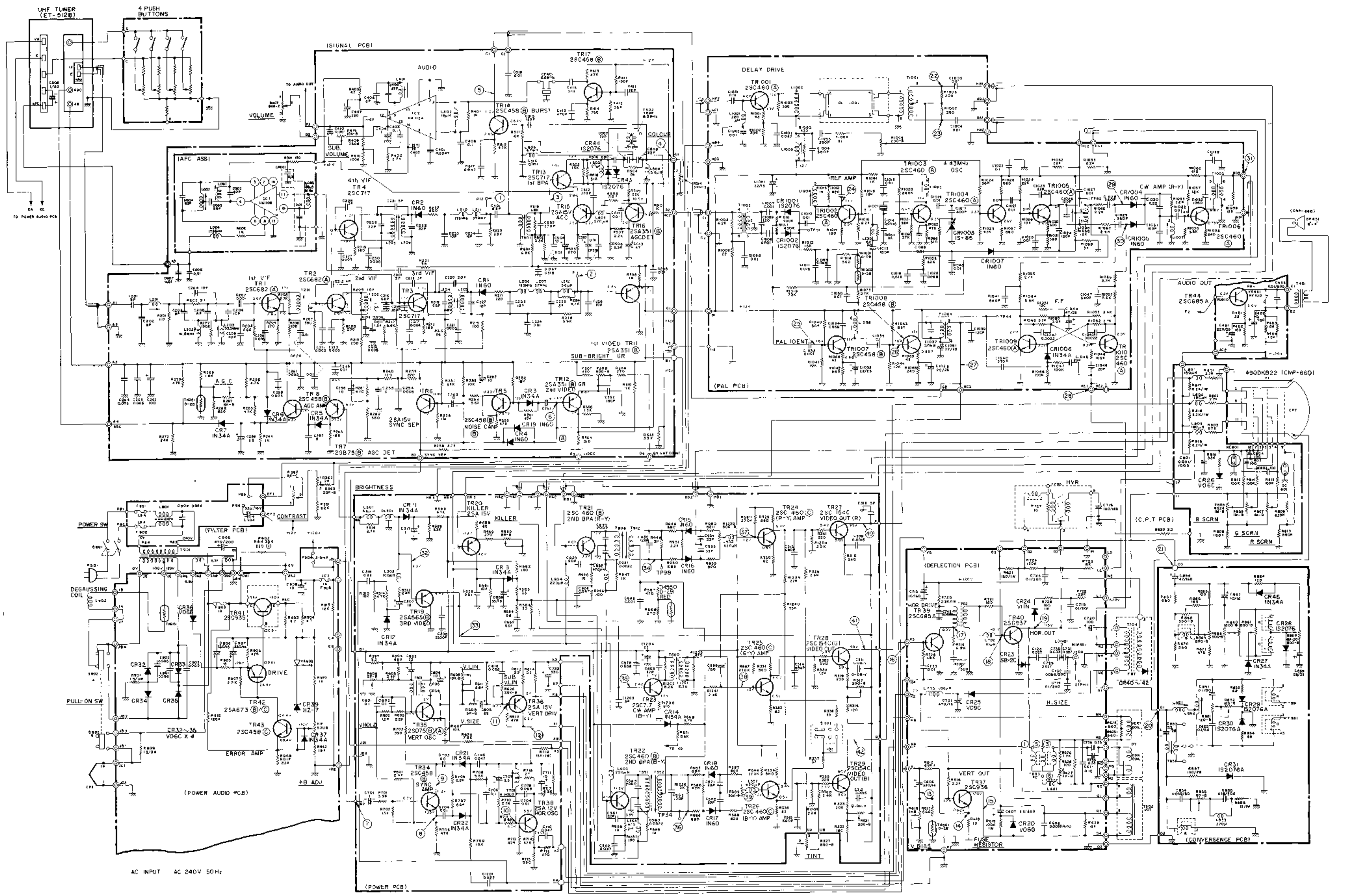


CSP-680 (HS/UK)

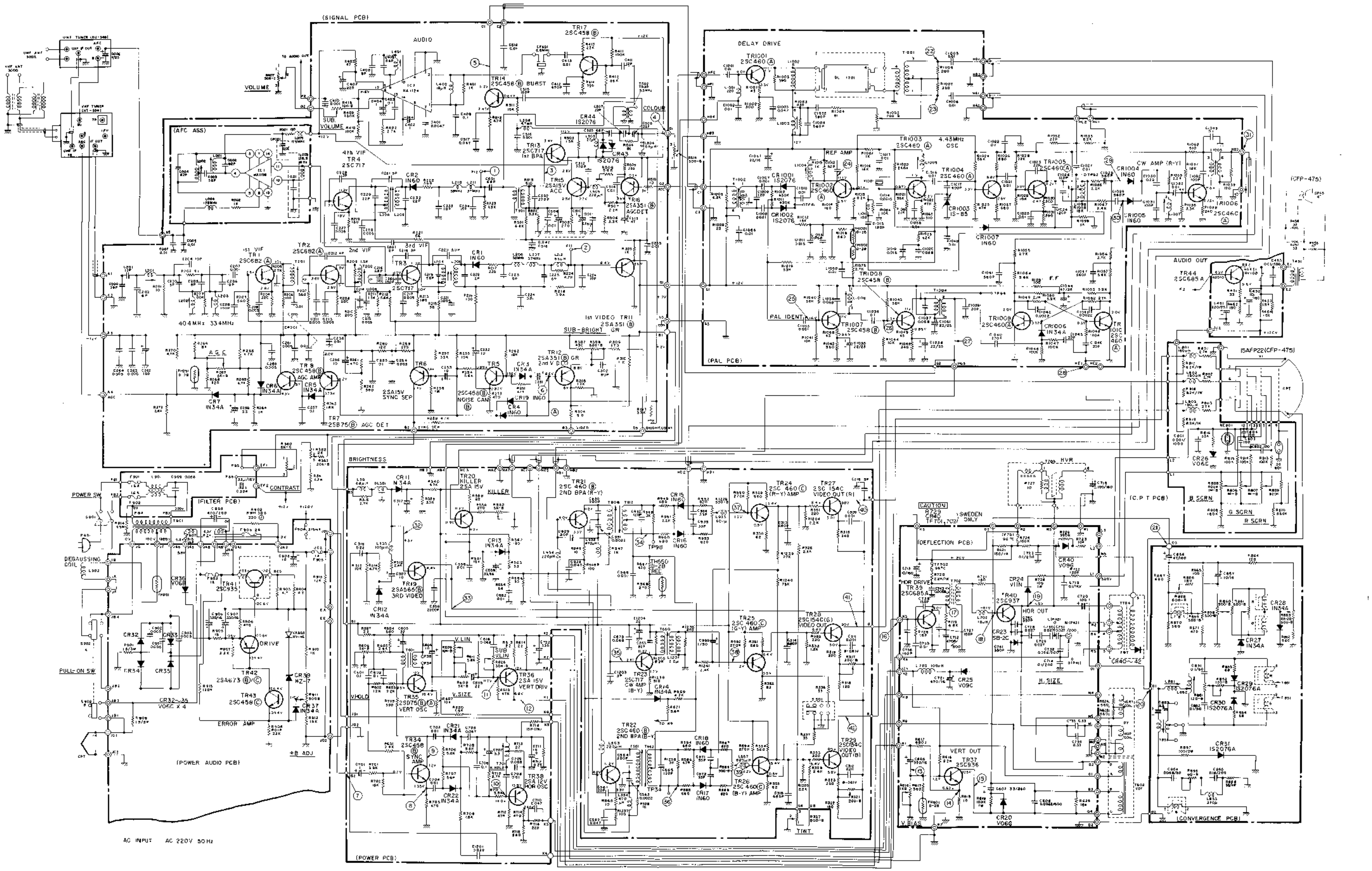


UHF TUNER
(HU-548UK)
(SIGNAL PCB)
(AFC ASS)
VOLUME
SUB VOLUME
AUDIO
TR14 2SC458 Ⓑ BURST
TR17 2SC458 Ⓑ
TR4 2SC717 4th VIF
TR13 2SC717 1st BPA
TR15 2SA15V ACC
TR16 2SA351Ⓑ AGCDET
TR2 2SC682Ⓐ 2nd VIF
TR3 2SC717 3rd VIF
TR1 2SC682Ⓐ 1st VIF
TR11 2SA351ⒷGR 1st VIDEO
SUB-BRIGHT
TR12 2SA351ⒷGR 2nd VIDEO
TR5 2SC458Ⓑ NOISE CAN
TR6 2SA15V SYNC SEP
TR8 2SC458Ⓑ AGC AMP
TR7 2SB75Ⓑ AGC DET
COLOUR
TR1001 2SC460Ⓐ DELAY DRIVE
TR1002 2SC460Ⓐ REF AMP
TR1003 2SC460Ⓐ 4.43MHz OSC
TR1004 2SC460Ⓐ
TR1005 2SC460Ⓐ
TR1006 2SC460Ⓐ CW AMP (R-Y)
TR1007 2SC458Ⓑ PAL IDENT
TR1008 2SC458Ⓑ
TR1009 2SC460Ⓐ
TR1010 2SC460Ⓐ
(PAL PCB)
(CSP-680)
TR44 2SC685A AUDIO OUT
V1 17FHP22 (CSP-680)
(FILTER PCB)
POWER SW
CONTRAST
DEGAUSSING COIL
PULL-ON SW
TR41 2SC935
TR42 2SA673ⒷⓋⒸ DRIVE
TR43 2SC458Ⓒ ERROR AMP
+B ADJ
(POWER AUDIO PCB)
AC INPUT AC 240V 50Hz
BRIGHTNESS
TR20 2SA15V KILLER
KILLER
TR19 2SA565Ⓑ 3rd VIDEO
TR24 2SC460Ⓒ (R-Y) AMP
TR21 2SC460Ⓑ 2nd BPA (R-Y)
TR27 2SC154C VIDEO OUT(R)
TR28 2SC154C VIDEO OUT(G)
TR23 2SC717 CW AMP (B-Y)
TR25 2SC460Ⓒ (G-Y) AMP
TR22 2SC460Ⓑ 2nd BPA(B-Y)
TR26 2SC460Ⓒ (B-Y) AMP
TR29 2SC154C VIDEO OUT(B)
TINT
V. LIN
SUB V.LIN
V. HOLD
V. SIZE
H. HOLD
TR35 2SD75ⒷⓋⒶ VERT OSC
TR36 2SA15V VERT DRIV
TR34 2SC458Ⓑ SYNC AMP
TR38 2SA12V HOR OSC
(POWER PCB)
(DEFLECTION PCB)
TR39 2SC685A HOR DRIVE
TR40 2SC937 HOR OUT
TR37 2SC936 VERT OUT
H. SIZE
V. BIAS
FUSE RESISTOR
MVR
(CPT PCB)
B SCRN
R SCRN
G SCRN
(CONVERGENCE PCB)

CNP-860 (HS/UK)


UHF TUNER (ET-512B)
4 PUSH BUTTONS
VOLUME
SIGNAL PCB
AUDIO
DELAY DRIVE
AFC ASS
PAL PCB
AUDIO OUT
BRIGHTNESS
CONTRAST
POWER SW
FILTER PCB
DEGAUSSING COIL
PULL-ON SW
ERROR AMP
POWER AUDIO PCB
POWER PCB
DEFLECTION PCB
CONVERGENCE PCB
C.P.T PCB
AC INPUT AC 240V 50Hz
TINT
V.SIZE
V.LIN
H.SIZE
HOR OUT
VERT OUT
HOR DRIVE
FUSE RESISTOR
KILLER
ACC
AGC
B SCRN
G SCRN
R SCRN

CFP-475 (HS/AG, HS/SA)



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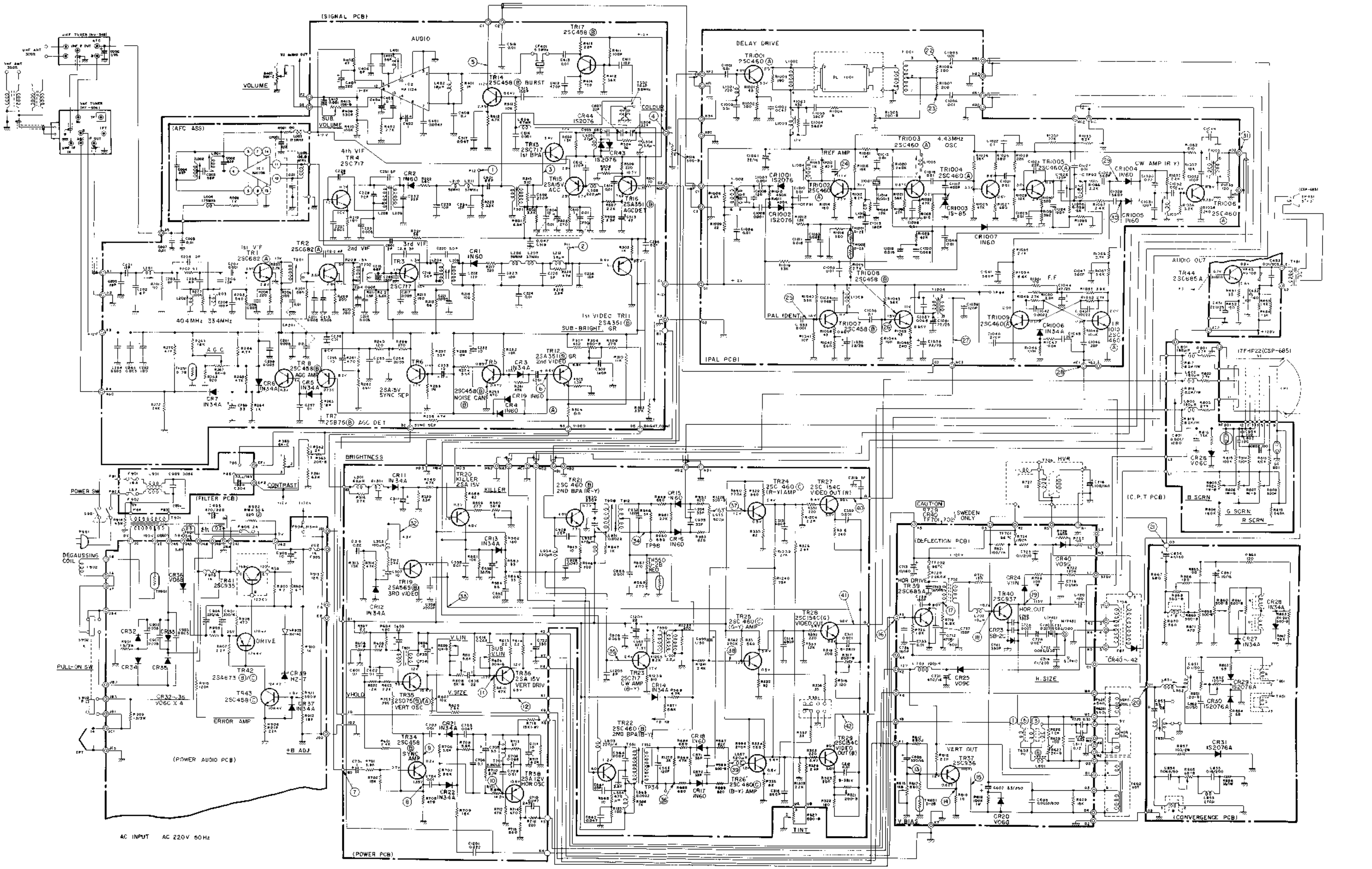
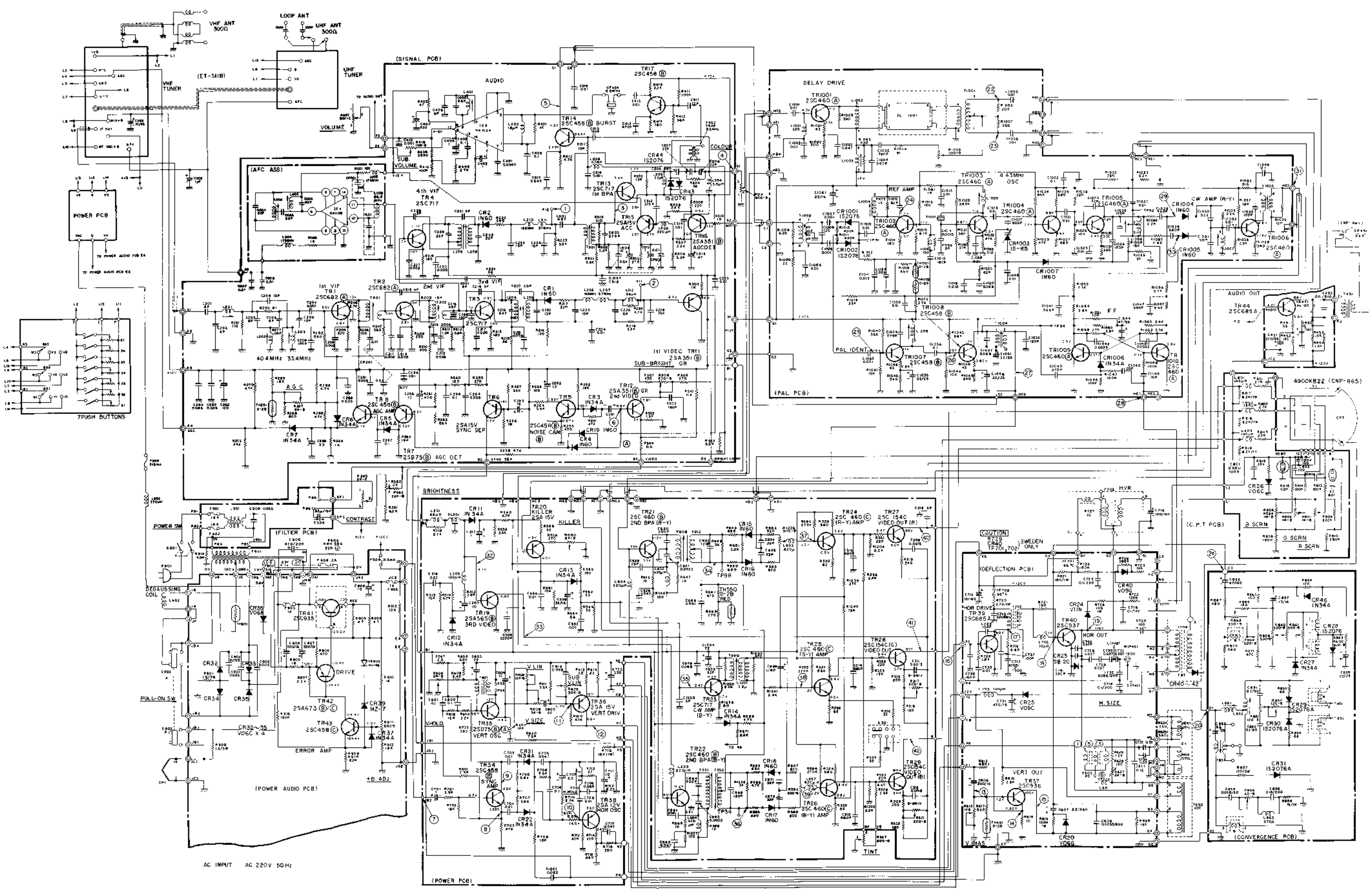
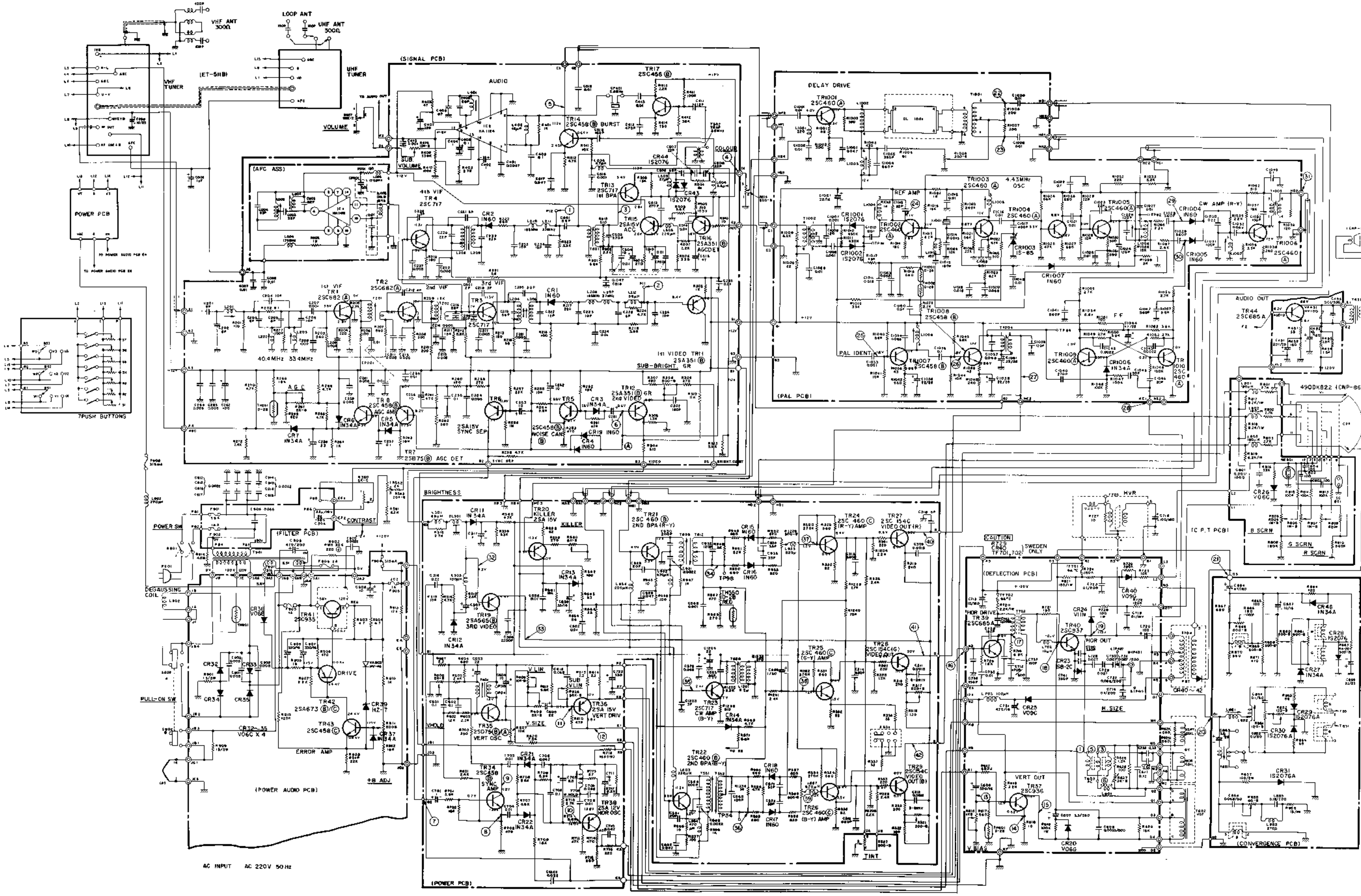


CNP-865 (HS/AG, HS/SA)



CNP-865 (HSE)



8. SPECIFICATIONS ON HITACHI COLOUR TV RECEIVERS

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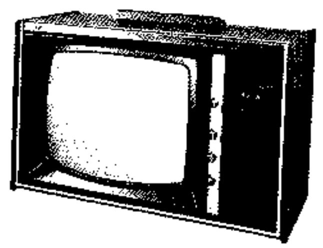
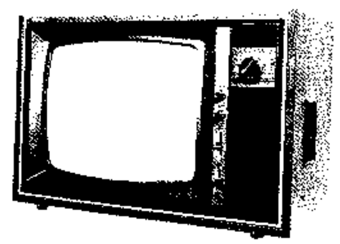
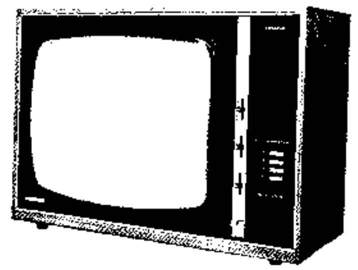
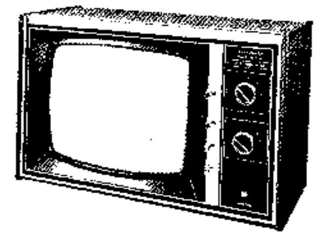
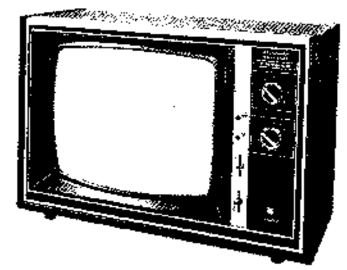
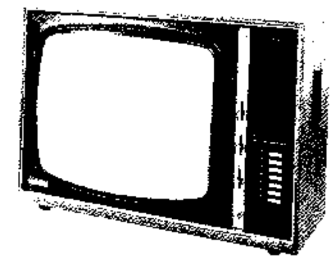
						
AERIAL INPUT IMPEDANCE	75 ohms unbalanced	75 ohms unbalanced	75 ohms unbalanced	300 ohms balanced	300 ohms balanced	300 ohms balanced
CONVERGENCE	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic
FOCUS	Electrostatic	Electrostatic	Electrostatic	Electrostatic	Electrostatic	Electrostatic
INTERMEDIATE FREQUENCIES Picture IF Carrier Frequency Sound IF Carrier Frequency Colour IF Frequency Sound IF Frequency Colour Sub-Carrier Frequency	39.5 MHz 33.5 MHz 35.07 MHz 6.0 MHz 4.43 MHz	39.5 MHz 33.5 MHz 35.07 MHz 6.0 MHz 4.43 MHz	39.5 MHz 33.5 MHz 35.07 MHz 6.0 MHz 4.43 MHz	38.9 MHz 33.4 MHz 34.47 MHz 5.5 MHz 4.43 MHz	38.9 MHz 33.4 MHz 34.47 MHz 5.5 MHz 4.43 MHz	38.9 MHz 33.4 MHz 34.47 MHz 5.5 MHz 4.43 MHz
TUNING RANGE	UHF 21-68	UHF 21-68	UHF 21-68	VHF 2-12 UHF 21-68	VHF 2-12 UHF 21-68	VHF 2-12 UHF 21-68
PICTURE TUBE	15AFP22	17FHP22	490DKB22	15AFP22	17FHP22	490DKB22
POWER INPUT	AC 240V, 50 Hz (for U.K. usage) AC 200V, 50 Hz (for Hong Kong usage)	AC 240V, 50 Hz (for U.K. usage) AC 200V, 50 Hz (for Hong Kong usage)	AC 240V, 50 Hz (for U.K. usage) AC 200V, 50 Hz (for Hong Kong usage)	AC 220V, 50 Hz	AC 220V, 50 Hz	AC 220V, 50 Hz
POWER CONSUMPTION	100W	100W	100W	90W	100W	100W
SPEAKER	10 cm (4")	8 x 12 cm (3" x 5")	10 x 15 cm (4" x 6")	10 cm (4")	8 x 12 cm (3" x 5")	10 x 15 cm (4" x 6")
SOUND OUTPUT	1W	1.5W	2W	1W	1.5W	2W
DIMENSIONS (W x H x D)	545 x 353 x 421 mm (21-1/2" x 13-7/8" x 16-9/16")	614 x 418 x 443 mm (24-3/16" x 16-1/2" x 17-7/16")	631 x 446 x 467 mm (24-7/8" x 17-9/16" x 18-3/8")	545 x 353 x 421 mm (21-1/2" x 13-7/8" x 16-9/16")	614 x 418 x 443 mm (24-3/16" x 16-1/2" x 17-7/16")	631 x 446 x 467 mm (24-7/8" x 17-9/16" x 18-3/8")
WEIGHT	21 kg (46 lbs)	26 kg (57 lbs)	28 kg (62 lbs)	21.5 kg (47 lbs)	26.5 kg (58 lbs)	28.5 kg (63 lbs)

9. THE PRINCIPLE ON TRANSISTOR OPERATION

1. Diode

The combination of N-type semiconductor and P-type semiconductor face to face (shown in Fig. 1) which conducts rectification is termed a PN junction. A crystal detector or a selenium rectifier virtually follows the same principle.

Consider the operation principle by referring to Fig. 1. In (a) of the figure, with no voltage applied thereon, the P-type section has holes and the N-type section has free electrons contained therein. By applying mimus (−) voltage to the P-type section and plus (+) voltage to the N-type section, the holes move in the direction of the negative electrode. Since the holes move from a neutral section, a negatively electrified crystal grid remains around the contact surface after the move is effected, drawing the holes in the direction of the contact surface. In other words, when the holes move by some degree, they are pulled by both the negative electrode and the negatively electrified crystal grid, thus ceasing to further move beyond a certain degree. This is true of the free electrons as well. When the free electrons move a certain distance, the force drawn by the positive electrode and that by the positively electrified crystal grid are balanced, checking the free electrons from moving beyond a certain distance. As a result, the carrier only moves over a short distance, checking the electric current from flowing. The direction in which the electric current does not flow is referred to as reverse direction; the voltage applied to check an electric current from flowing (shown in (b) in the figure) is called reverse direction voltage.

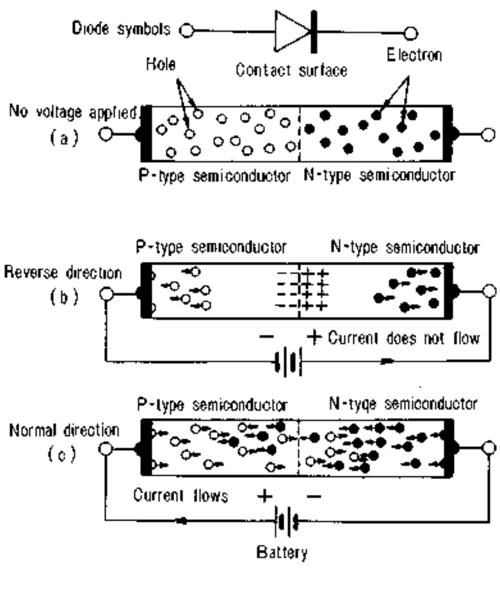


FIGURE 1. Characteristics of PN junction

In a semiconductor junction such as that shown in (c), Fig. 1, when negative voltage is applied to the N-type and positive voltage on the P-type, the holes are repulsed by the positive electrode of a battery and enter the region of the N-type. The free electrons are repulsed by the negative electrode of the battery and enter the region of the P-type. This action results in neutralization of the holes and the free electrons respectively, creating a shortage in the supply of holes and free electrons. To velieve this shortage, holes and free electrons are supplied from the battery to enable the electric current to continue running. This occurs in the forward direction, and voltage thus applied is termed regular direction voltage.

As described above, a characteristic of the diode of the PN junction is that the electric current flows feasibly and does not flow in a certain direction, this characteristic amply serving to conduct proper rectification.

2. PNP Transistor

Shown in Fig. 2 is a model of a PNP transistor. It comprises an N-type semiconductor sandwiched between two P-type semiconductors. The bottom section is called a P-type emitter (E), the intermediate section an N-type base (B), and the top section a P-type collector (C). The emitter corresponds to the cathode, the base to the grid, and the collector to the plate of a triode, respectively.

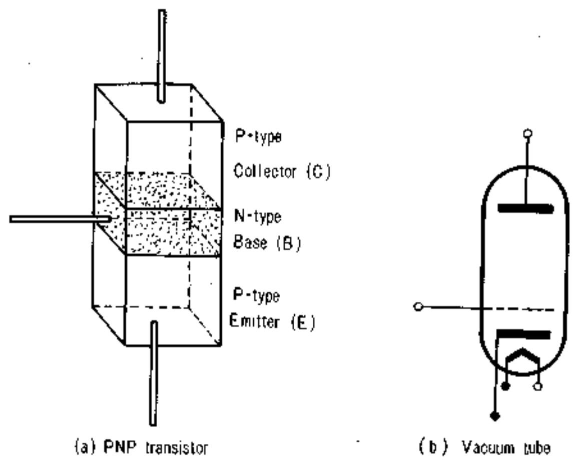
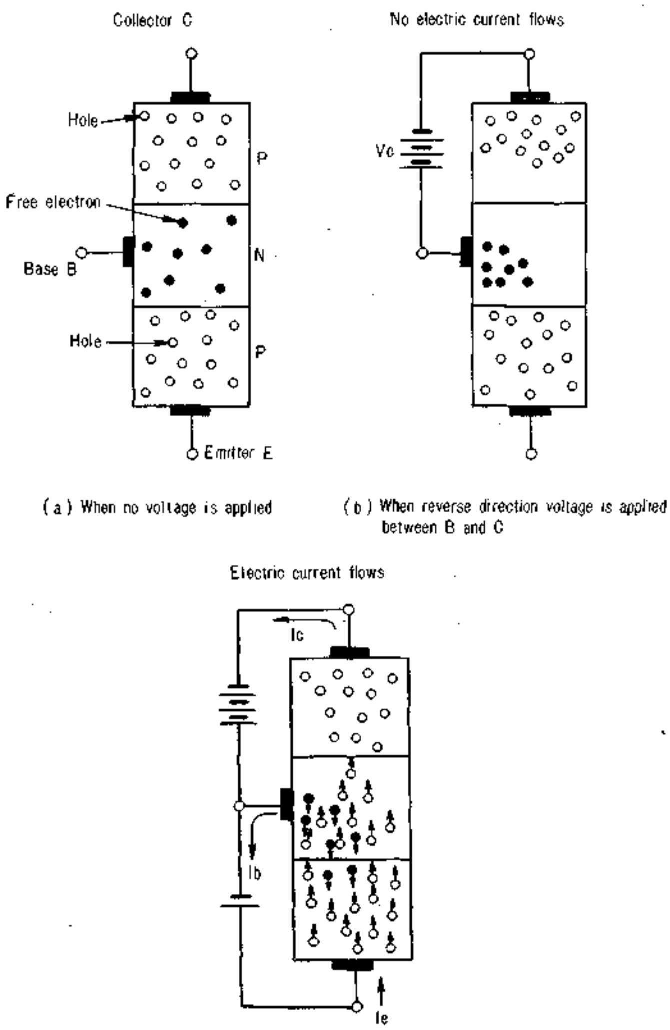


FIGURE 2. Principle and Construction of Transistors

Fig. 3 illustrates the methods of applying voltage to have a transistor effect amplifying action. Reverse direction voltage is applied to the contact surface of the base and the collector, as well as to the contact surface of B and C. By applying reverse voltage, free electrons around the contact surface are drawn to the base electrode, holes are drawn to the collector electrode and a condition is brought about where virtually no carriers remain around the contact surface of B and C; thus, no electric current at all flows there. Meanwhile, when the holes are brought around the contact surface of B and C by a certain means, the holes are repulsed by the plus (+) electrode of the base and drawn by the negative voltage of the collector electrode, thus starting to move toward the collector at high velocity.



(a) When no voltage is applied

(b) When reverse direction voltage is applied between B and C

(c) When forward direction voltage is applied between E and B

FIGURE 3. Methods of applying Voltage

Under such a condition, when forward direction voltage is applied to the EB contact surface (as shown in (c), Fig. 3), the holes of the emitter run into the region of the base over the EB contact surface one after another. Holes having run into this region diffuse at high velocity in the direction of the BC contact surface of thick density, in such a manner that air particles move from a section of high pneumatic pressure (or high pneumatic density) in the atmosphere down to a section of low pneumatic pressure (or low pneumatic density). This creates a certain amount of wind of the holes blowing from the EB contact surface up to the BC contact surface. Holes reaching the BC contact surface are subjected to an intense electric force of the base collector, being suctioned up into the collector (similar to a vacuum tube). Thermoelectrons emitted from a cathode are controlled by the voltage of a grid, run through the grid, and are suctioned up by an intense electric force of a plate, thus reaching the plate. The only difference is that the holes, having passed the EB contact surface, reach the BC contact surface by diffusive force in the case of the former.

The collector current can be largely controlled through application of slight forward direction voltage on the EB contact surface, having it conduct amplification action. This is exactly the same as applying a small amount of signals to the grid of a vacuum tube to largely fluctuate the plate current, inducing the grid to conduct amplifying action. However, in the case of a transistor, a hole is recombined with free electrons of the N-type while it is passing through the region of the N-type base, eliminating from 1% to 5% of the holes having flowed therein from the emitter. The free electrons, having been exhausted in the region of the base, are supplemented by the base electrode. Flowing in of negative free electrons from the base electrode is equivalent electrically to flowing out of positive holes in the direction of the base electrode. In other words, the existing difference between a vacuum tube and a transistor lies in the fact that in a transistor from 1% to 5% of the base current flows therein; while in a vacuum tube, no grid current flows therein. The proportion of current flowing in the base to that flowing in the collector is called the current amplification factor, expressed by β (hfe). For instance, in the case of Ib=0.02 mA, Ic=0.98 mA, and Ie=1 mA (shown in Fig. 4), current amplification β is

$$\beta=\frac{Ic}{Ib}=\frac{0.98mA}{0.02mA}=49 \text{ times}$$

In other words, when voltage is applied to the base to effect a base current of 0.02 mA flowing therein, a current of 0.98 mA—or 49 times as much the base current—flows through the collector.

This proportion of emitter current to collector current is called the current transmission factor, expressed by α. In the illustration given above, the current transmission factor α is

$$\alpha=\frac{Ic}{Ie}=\frac{0.98\,mA}{1mA}\doteqdot 0.98 \text{ times},$$

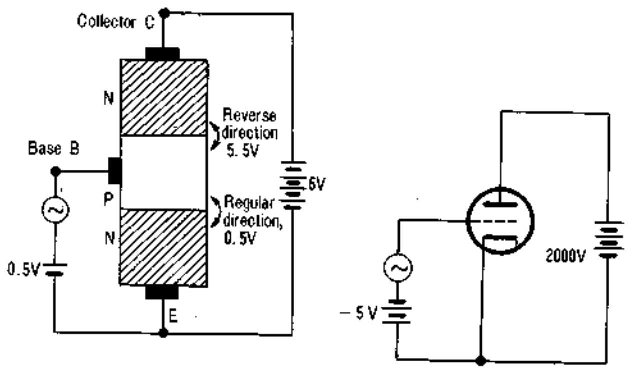
and it is smaller than 1. The following relation exists between β and α:

$$\beta=\frac{Ic}{Ib}=\frac{\frac{Ic}{Ie}}{\frac{Ie}{Ie}-\frac{Ic}{Ie}}=\frac{\alpha}{1-\alpha} \qquad \beta=\frac{\alpha}{1-\alpha}$$

3. NPN Transistor

Besides the PNP transistor described in par. 2, above also available is an NPN transistor comprising a P-type germanium semiconductor sandwiched between two N-type semiconductors (shown in Fig. 4). Amplifying action of the NPN-type transistor is virtually identical with that of a PNP transistor. It is explained in this chapter in simplified form.

In an NPN transistor, reverse direction voltage is applied to the BC contact surface, and forward direction voltage is applied to the EB contact surface, in the same manner as mentioned in the PNP transistor. Being slightly different from the conventional manner of applying voltage (shown in Fig. 3), in an attempt to ease the reader's comprehension, we recommended applying voltage on this NPN transistor in the same manner as in a conventional case of applying voltage to a vacuum tube, making reference to Fig. 4.

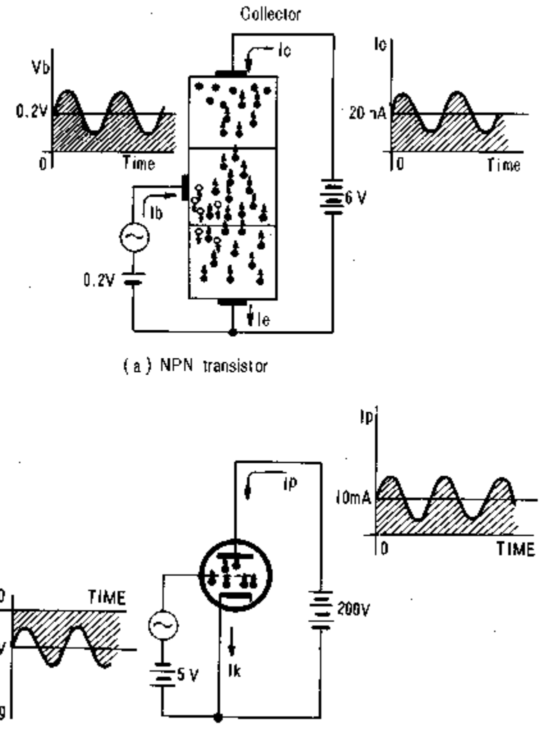


(a) NPN transistor (b) Vacuum tube

FIGURE.4 Methods of applying Voltage

Reverse direction voltage of 5.5V is applied to the BC surface as noted in the figure, thus virtually eliminating free electrons from around the BC contact surface. Meanwhile, since forward direction voltage is applied to the EB contact surface, free electrons (unlike holes in the PNP transistor) flow into the region of the base one after another out of the emitter (an N-type semiconductor), over the EB contact surface (see Fig. 4). Then the free electrons are diffused in the direction of the BC contact surface of less free electron density (by a flow of electrons blown from the emitter to the collector). Reaching the BC contact surface, the free electrons are suctioned up into the collector by quite large electric energy, because positive voltage has been applied to the collector and negative voltage has been applied to the base. While free electrons pass through the region of the base, from 1% to 5% of these free electrons are recoupled with the holes until they are rendered nonexistent, resulting in a situation where holes become insufficient in the base region. Since the holes are replenished by the base electrode, it results in flowing base current equivalent from 1% to 5% of the emitter current into the base region. As in the case of a vacuum tube, which was thought to have plate current flowed into a cathode when thermoelectrons flowed from the cathode to the region of the base, flowing of free electrons from the emitter to the collector—in the case of an NPN transistor—can be considered equivalent to the flowing of collector current to the emitter.

Explained otherwise, the base current is caused to flow in by a small quantity of voltage applied to the EB contact surface, and the collector current multiplied by β of the base current flows in the direction of the emitter. When a small quantity of alternating current signals is applied to the base under such a condition, forward direction voltage applied to the EB contact surface is fluctuated by a quantity equivalent to the alternating current signals, creating some fluctuation in the base current. Then an amperage equivalent to the fluctuation in this base current, or a collector current amounting to β times the alternating current base signal current, runs from the collector to the emitter, conducting amplifying action (See Fig. 5).

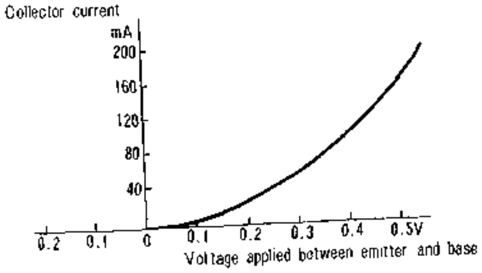


(a) NPN transistor

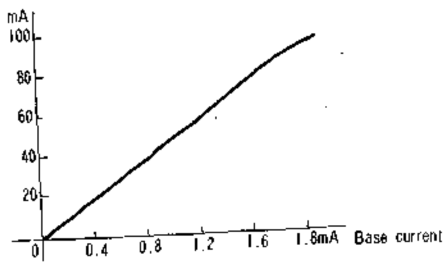
(b) Vacuum tube

FIGURE. 5 Amplifying Action of NPN Transistor

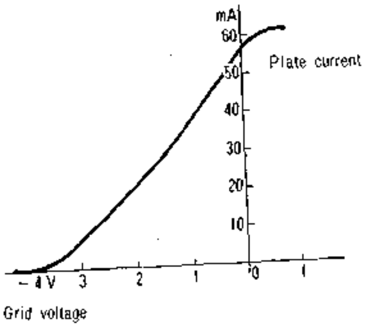
Fig. 6 shows the amount of collector current flowing when applying voltage between the emitter and the base, and the quantity of the collector current flowing when flowing the base current, measured on a transistor employed for practical use (2SB75 transistor).



(a) Vbe-Ic curve



(b) Ib-Ic curve

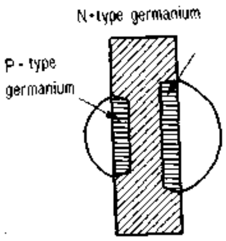


(c) Eg-Ip curve (vacuum tube)

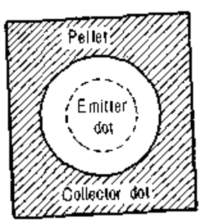
FIGURE 6. Characteristics Curves

4. Construction of Transistors

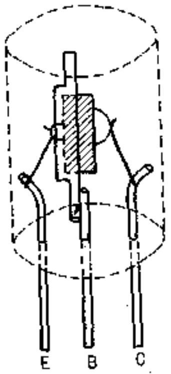
Shown in Fig. 7 are some typical drawings of transistors employed for practical purposes.



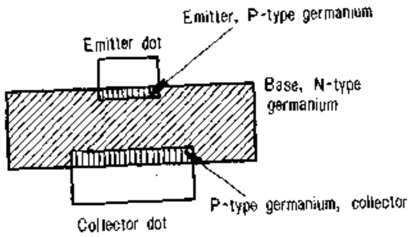
(a) Section



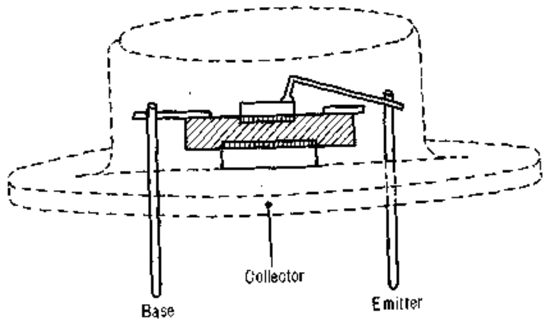
(b) Front view



(c) Assembly of transistor for small power



(d) Section



(e) Assembly of transistor for large power

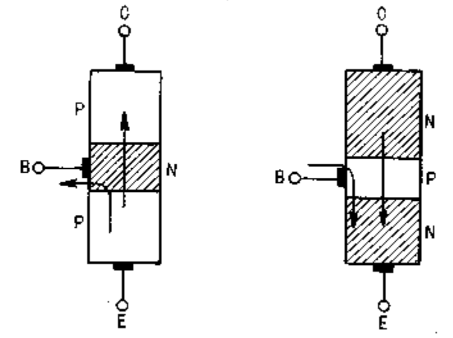
FIGURE 7. Construction of Transistor

Regarding section (a) of the drawing, the semicircular section on the left side is an emitter electrode composed of a trivalent element called indium (In). The oblong section in the centre is a base made of N-type germanium mixed with a pentavalent, element, arsenic (AS), in a pure semiconductor. The larger, semicircular section on the right is a collector electrode also made of trivalence. The square-shaped section (b) in the centre, an N-type semiconductor, is usually called a pellet. When the emitter indium and collector indium are applied to this pellet and heated in a furnace, a trivalent indium is melted into the pellet, and a P-type germanium crystalline layer is formed on both sides of the pellet. A PNP transistor is formed in the centre of the pellet in this manner; an assembly of these items is shown in (c) of the figure. Those shown in (d) and (e) represent a power transistor whose collector is directly soldered to a case to ensure effective, efficient diffusion of heat generated within the transistor.

5. Basic Transistor Circuits

To avoid utilizing the space and complexity of illustrating detailed construction of the transistor on a circuit diagram, shown here are rough sketches involving certain key symbols. Shown in Fig. 8 are the symbols of a transistor circuit. The arrow designates the direction in which the electric current flows, and it also represents an emitter electrode. A collector electrode is to be positioned on the opposite side of an emitter, and a base electrode is to be arranged on the other side of an emitter and a collector.

In the circuit shown in Fig. 9 (b), since it proves somewhat inconvenient due to the necessity of arranging a pair of batteries (one for applying forward direction voltage between section B and E, the other for applying the same between C and E) an amplification circuit such as that shown in Fig. 10 (a) has been especially devised for simplification. Generally termed an emitter-grounded CR-coupled amplifier, it corresponds to a cathode-ground CR-coupled amplifier usually employed when using vacuum tubes for circuit construction.



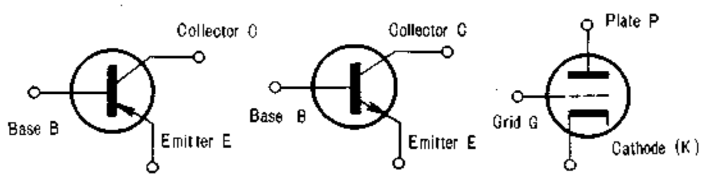
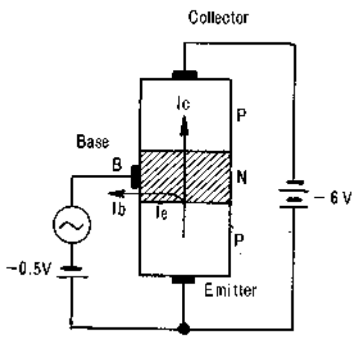
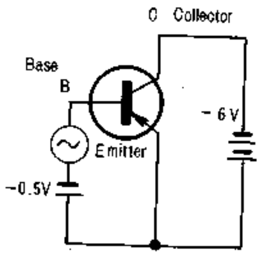


FIGURE 8. Transistor Symbols

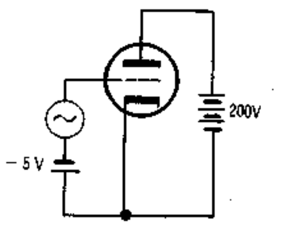
The amplification methode is described in pars. 3 and 4, above; the basic circuits for amplification, including the necessary symbols, are shown in Fig. 9.



(a) Amplification principle

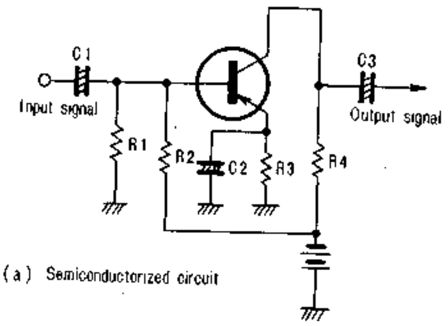


(b) Basic circuit for amplification

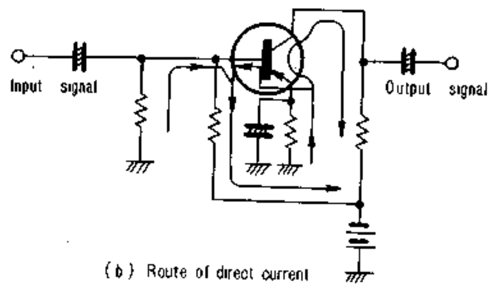


(c) Amplification circuit by vacuum tubes

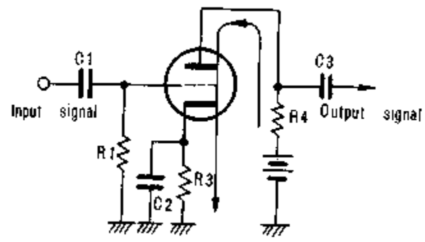
FIGURE 9. Basic Circuits



(a) Semiconductorized circuit



(b) Route of direct current



(c) Vacuum tube circuit

FIGURE 10. CR–coupled Amplifier

R1 and R2 are bias resistors. To bias is to influence or dispose in one direction; for example, as with a direct voltage. Here a negative grid bias was applied to a grid to cause each vacuum tube to conduct distortion-free amplification; the vacuum tube is induced to conduct amplification by biasing the grid to the negative side. As in the case of a transistor, it is also necessary to apply bias voltage between the emitter and the base to ensure perfect, distortion-free amplification, and to apply a forward direction voltage of 0.1–0.5V between B and E. R1 and R2 divide the source voltage of −6V, creating a forward bias voltage of 0.1−0.5V. Called a coupling capacitor, C1 applies only alternating-current signals to the base, preventing DC bias voltage of the base free from leaking out, or keeping outside DC voltage free from being applied directly to the base. In other words, it keeps the bias voltage free from the affects of any outside cause. Called a stabilizing resistor, R3 may well be thought of as displaying the same performance as a cathode bias resistor usually employed for a vacuum tube cathode. C2 is called a bypass capacitor; it effects an AC emitter current pass, keeping the R3 free from AC voltage (since AC signals deteriorate amplification) should the R3 be so subjected. R4 is a load resistor; AC signal voltage is generated by collector signal current tuning through R4, and amplified AC signals can be extracted from this load resistor. In other words, R4 is assigned the role of extracting amplified AC signal voltage. C3, a coupling capacitor, transfers amplified AC signal voltage to the adjacent transistor in the same manner as the capacitor C1.

C1−Coupling capacitor: AC signals flow through it halting DC voltage.

R1, R2−Bias resistors: Apply forward direction bias voltage of 0.1−0.5V between the emitter and base, ensuring distortion-free amplification.

R3−Stabilizing resistor: Same as above.

C2−By-pass capacitor: AC emitter current pass through it, preventing AC voltage from being generated in the emitter.

R4−Load resistor: Extracts amplified AC voltage.

C3−Coupling capacitor: Transfers AC signals to the next stage, and stops DC voltage.

6. Forward direction bias; Reverse direction bias

Negative bias voltage was applied to the control grid to ensure distortion-free amplification by a vacuum tube. It may be more accurately expressed to say that reverse direction bias voltage is applied to the control grid, since an increase in negative bias voltage of the control grid results in a reduction of plate current. Let us consider the reason for this. In this case, either a PNP-type or a NPN-type transistor is available. When an emitter is employed as the standard, and negative voltage of the base is increased, the collector current increases in the PNP transistor; conversely, in the NPN transistor, the collector current decreases. Therefore, the use of only the term "bias" renders the metter ambiguous, creating difficult and complicated comprehension. In place of this situation, we recommend using the terms forward direction bias and reverse direction bias. The forward (direction) bias represents a bias that increases amperage; reverse (direction) bias represents a bias that reduces amperage or stops a current. Relation between the voltage, bias and amperage of each am plifier is listed simply as shown in Table 1, below.

Table 1 Relation Between Voltage, Bias, and Amperage of Each Amplifier

Voltage of amplifier	Negative voltage, high	Negative voltage, intermediate	Voltage 0	Positive voltage, intermediate	Positive voltage, high
Grid voltage of vacuum tube (with cathode used as reference)	Reverse bias, large, cutoff	Reverse bias, intermediate, intermediate current	Bias 0, current large	forward bias, intermediate; saturated	forward bias, large; saturated
Base voltage of PNP-type (with emitter used as standard)	forward bias large; large current	forward bias intermediate, current intermediate	Bias 0, cutoff	Reverse bias intermediate, cutoff	Reverse bias large, cutoff
Base voltage of NPN-type (with emitter used as standard)	Reverse bias, large, cutoff	Reverse bias, intermediate, cutoff	Bias 0, cutoff	forward bias intermediate, amperage intermediate	forward bias large, amperage large

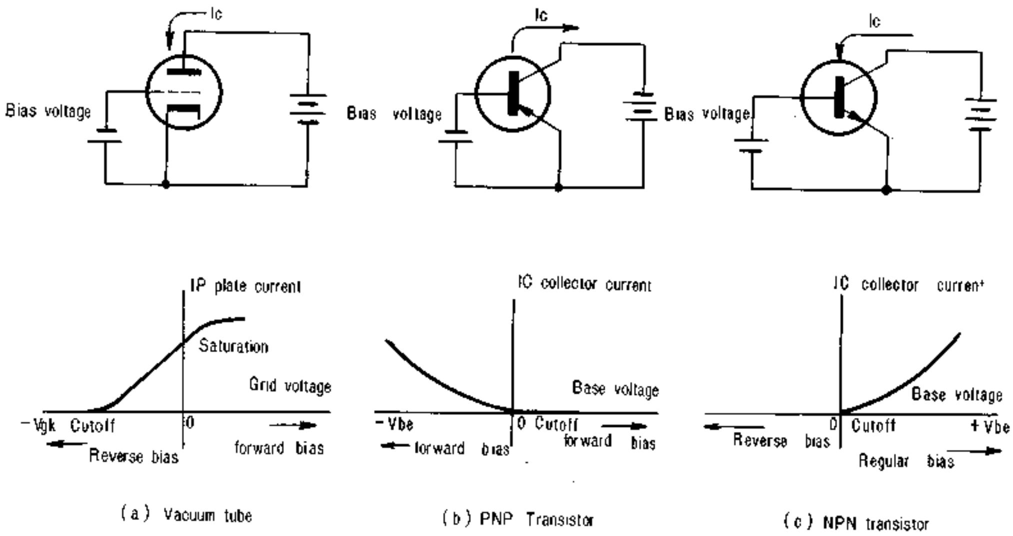


FIGURE 11. Each Amplifier and Bias