

H.G.CISIN'S

\$1

# RCA TV

A-1

**TROUBLE-INDICATING**

**TUBE LOCATION  
GUIDES**

**1947 - 1955 MODELS**

# RCA TV

## TROUBLE-INDICATING

# TUBE LOCATION GUIDES

By *H.G.Cisin, Consulting Engineer*

This compilation of tube location guides covers hundreds of RCA-Victor models from the earliest 1947 sets to latest 1955 models. Each guide shows positions of all tubes and also, by a novel copyrighted method, indicates the effect of each tube on the operation of the TV set. This system discards old style function names and instead, by simple code letters, tells plainly what each tube actually does.

This new method has been successfully applied in this book to RCA color TV sets, thus offering a rapid means of servicing tube troubles in these sets without the need for extensive theoretical knowledge of color TV.

This book also contains a TUBE SUBSTITUTION TABLE covering tubes most commonly used in TV receivers. Only tubes which can be substituted without changes in the TV set, are listed. In addition, a second table is provided, which lists commonly used TV tube types, classified according to their circuit function. This table is useful for checking tube functions in unfamiliar TV sets.

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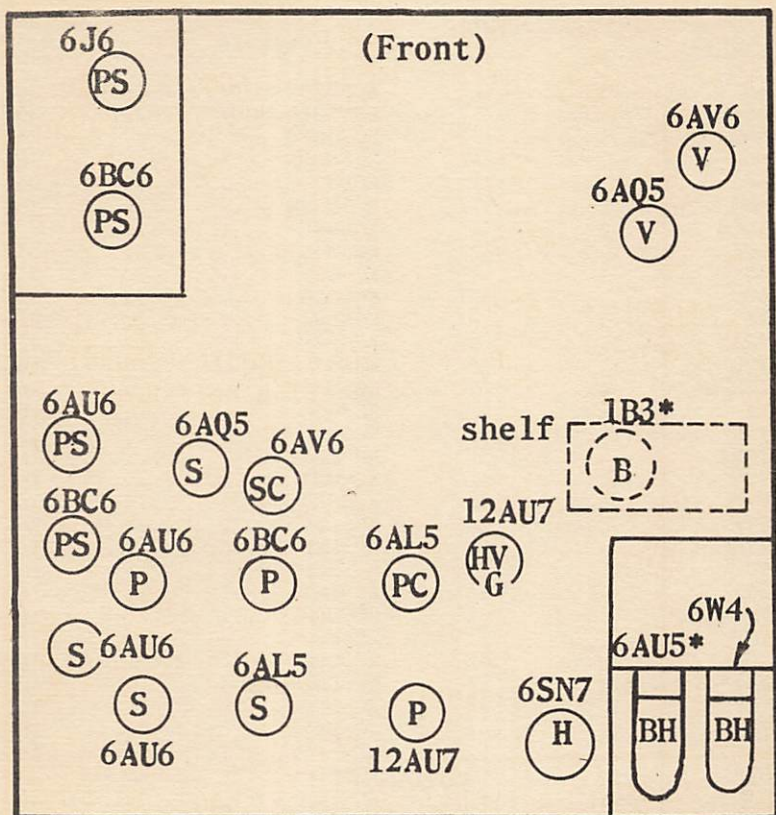
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\* All Channel Tuner

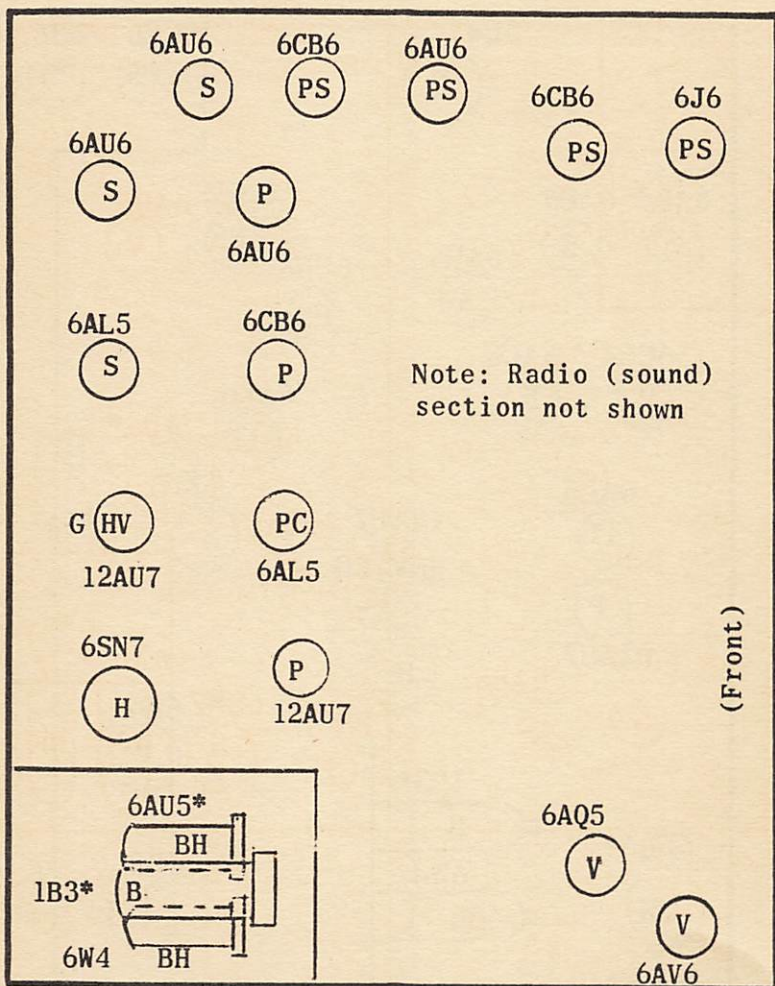


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 1

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

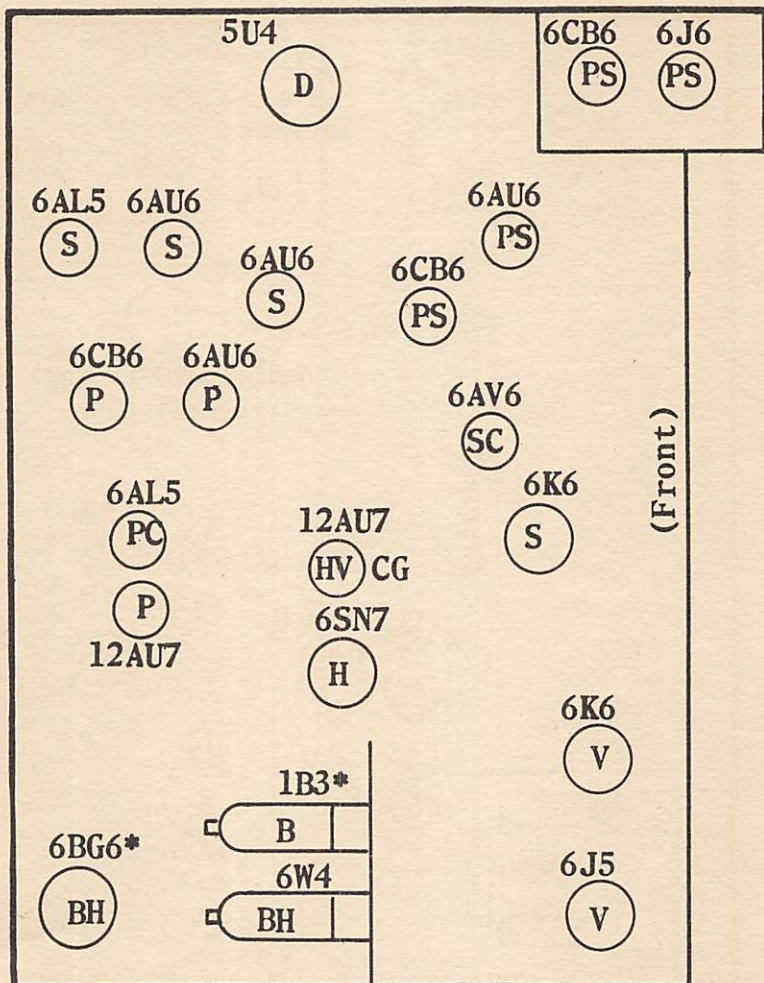




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 2

Picture -----	P	Horizontal movement and
Sound -----	S	bright area ----- BH
Picture and sound -----	PS	Picture, sound, br area D
Bright area -----	B	Background ----- G
Horizontal movement ----	H	Focus ----- F
Vertical movement -----	V	Contrast ----- C
Horizontal and vertical movement -----	HV	An asterisk (*) indicates the presence of high voltage.

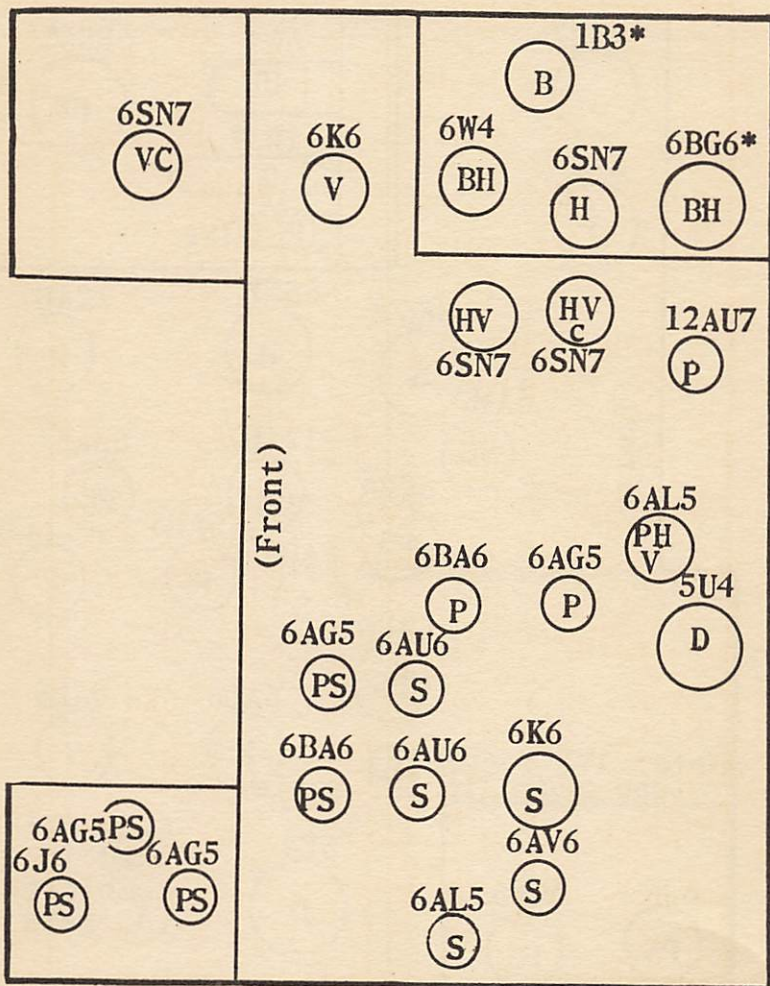


### TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 3

Picture -----	P	Horizontal movement and
Sound -----	S	bright area ----- BH
Picture and sound -----	PS	Picture, sound, br area D
Bright area -----	B	Background ----- G
Horizontal movement -----	H	Focus ----- F
Vertical movement -----	V	Contrast ----- C
Horizontal and vertical movement -----	HV	An asterisk (*) indicates the presence of high voltage.

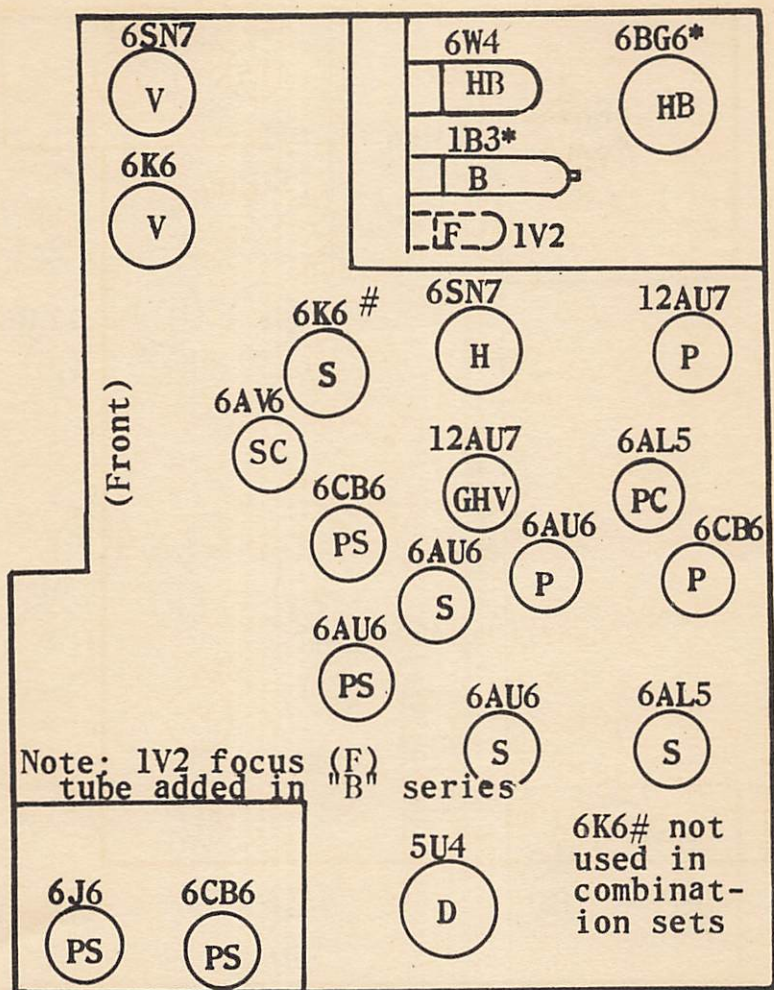




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 4

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement -----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

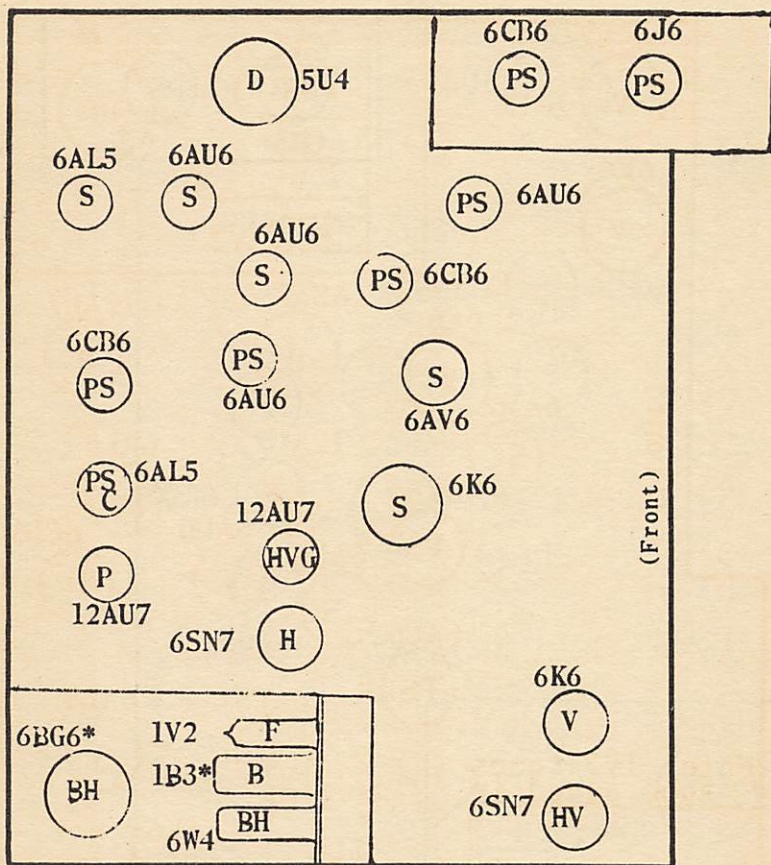


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 5

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

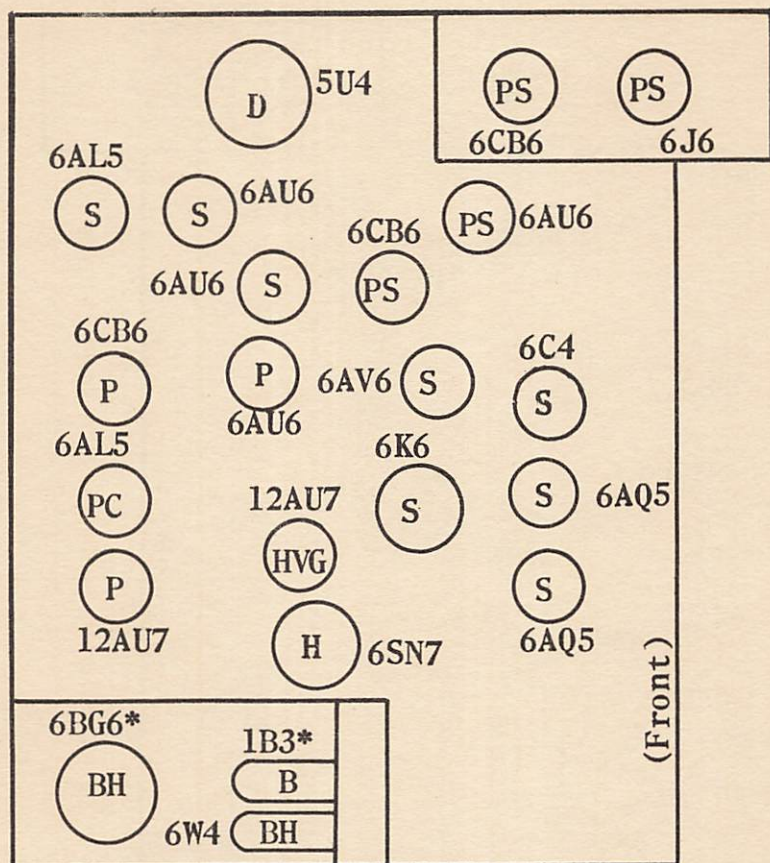




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 6

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

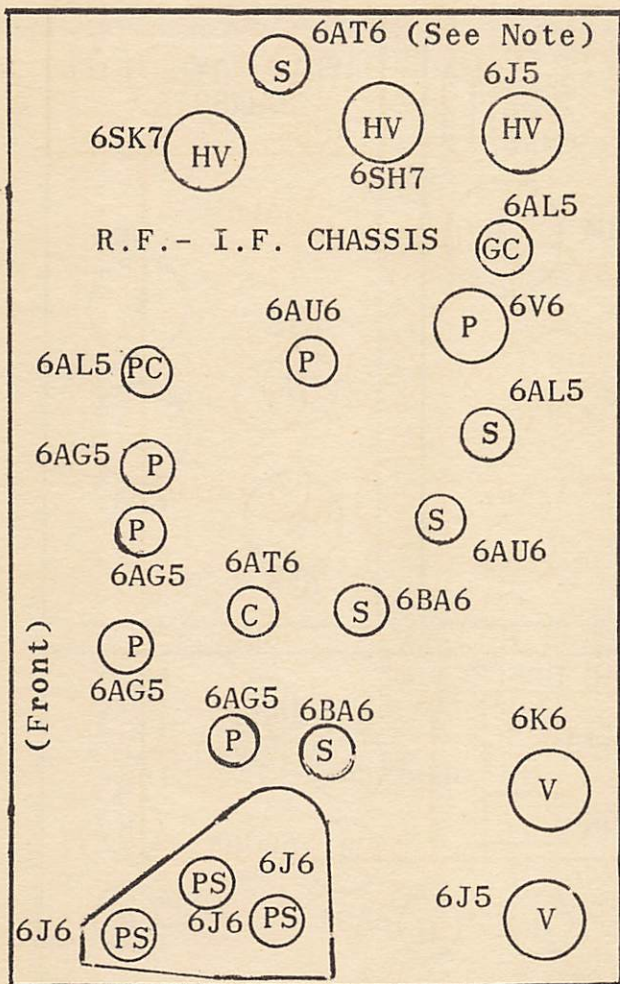


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 7

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

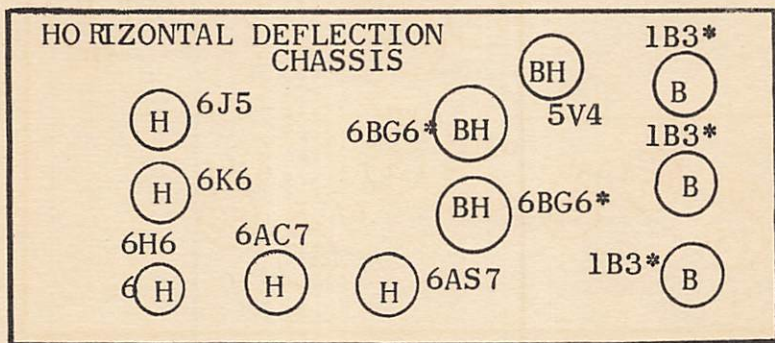
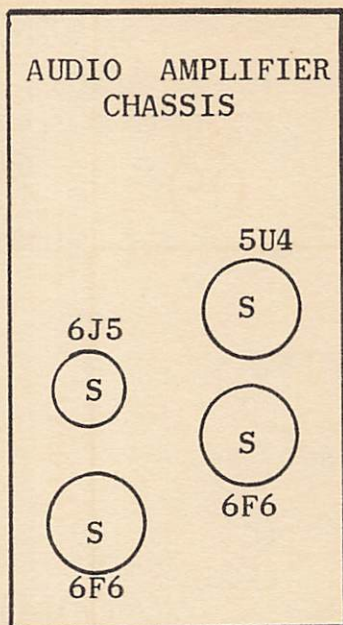
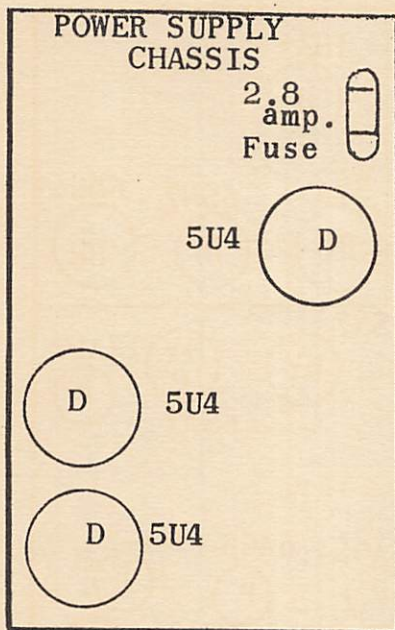




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 8a

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement -----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

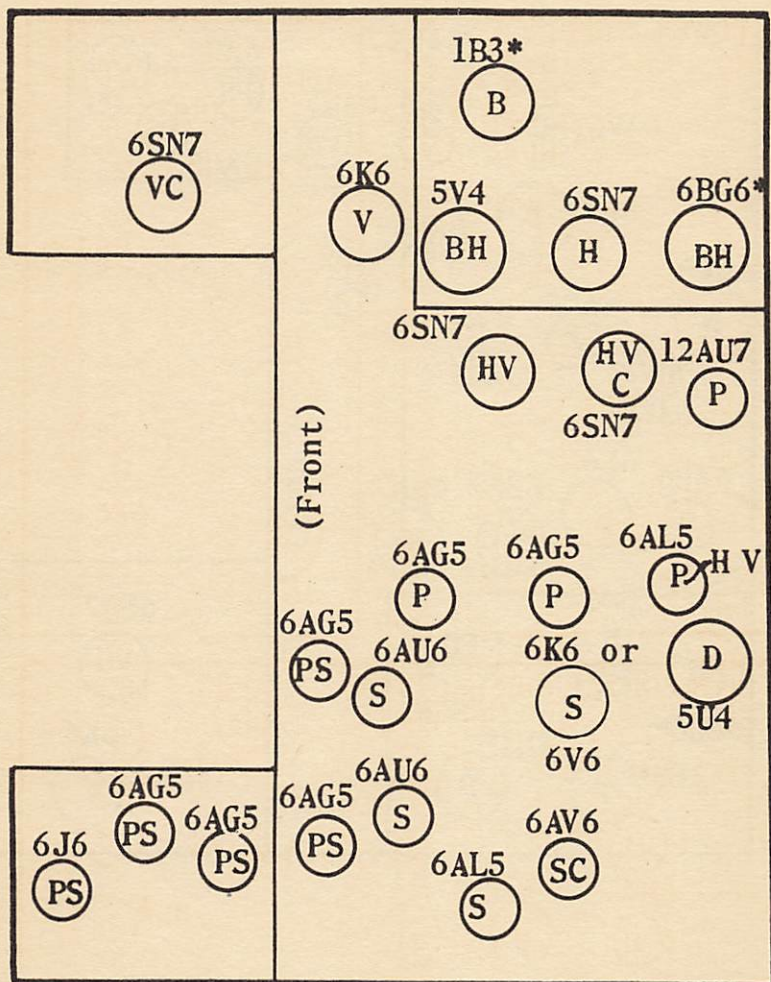


**TROUBLE INDICATING TUBE LOCATION GUIDE**

**NO. 8b**

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ---	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

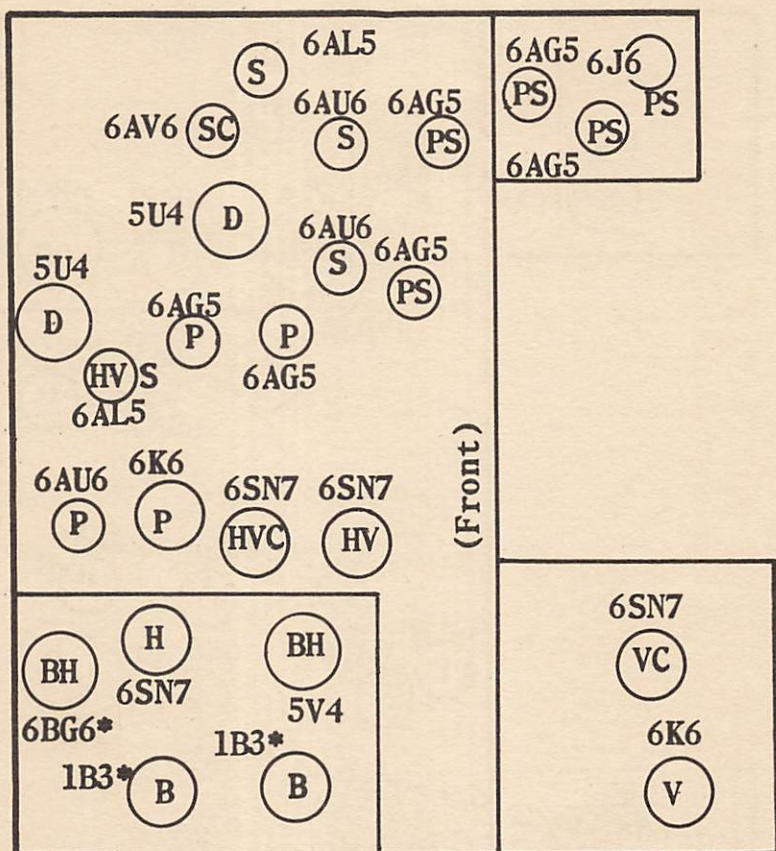




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 9

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ---	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

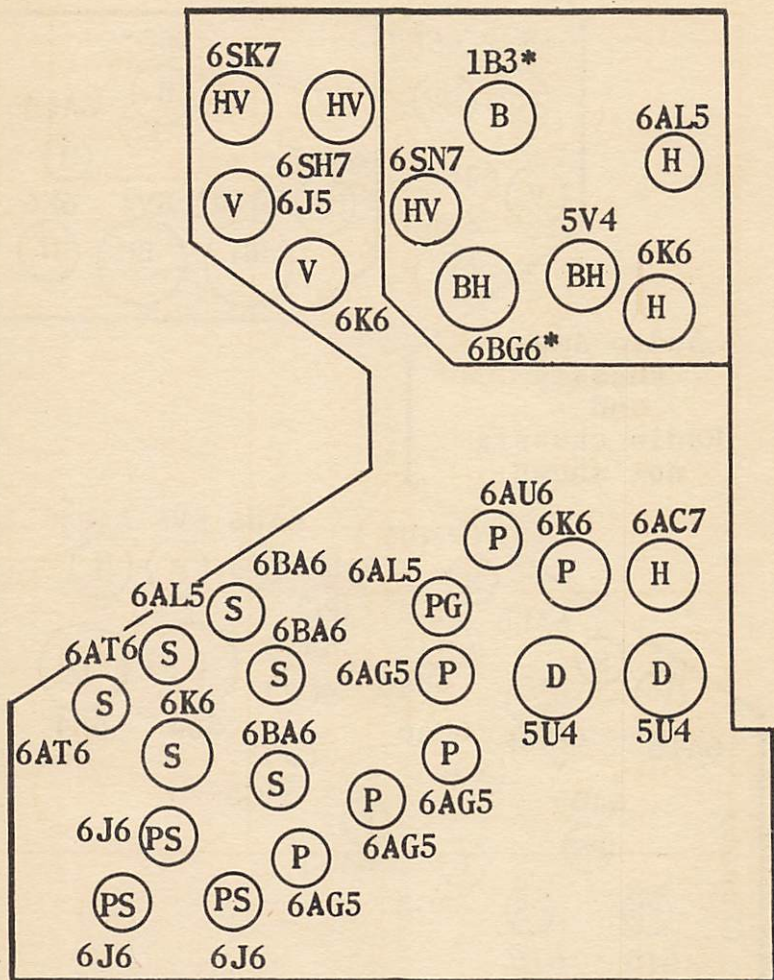


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 10

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ---	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

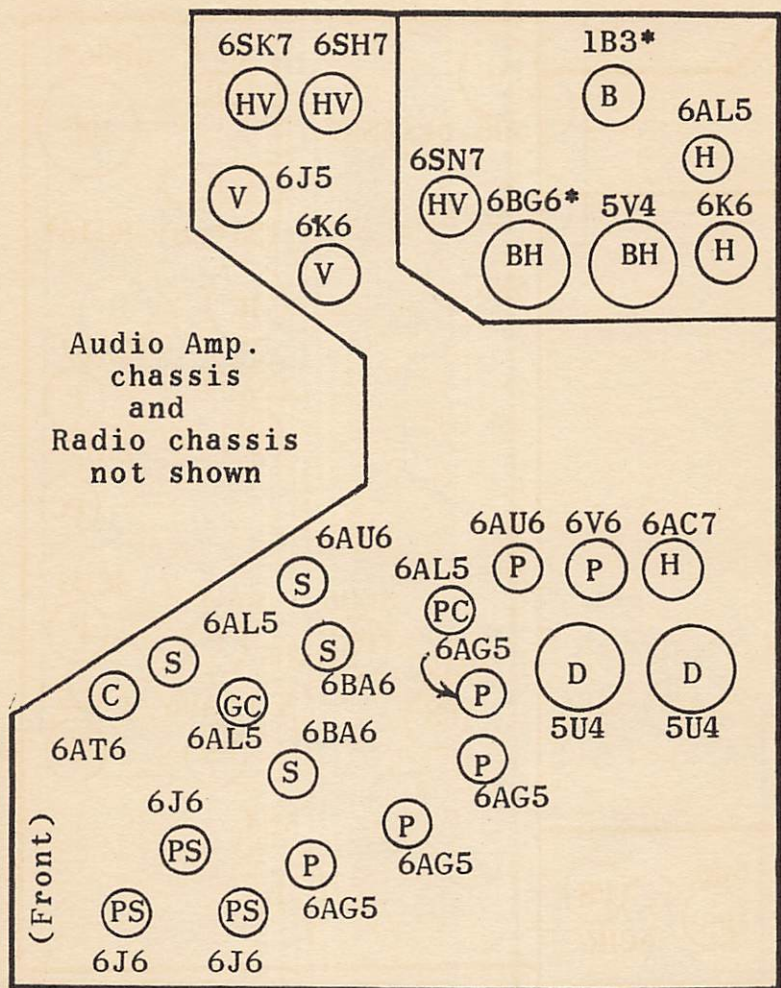




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 11

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

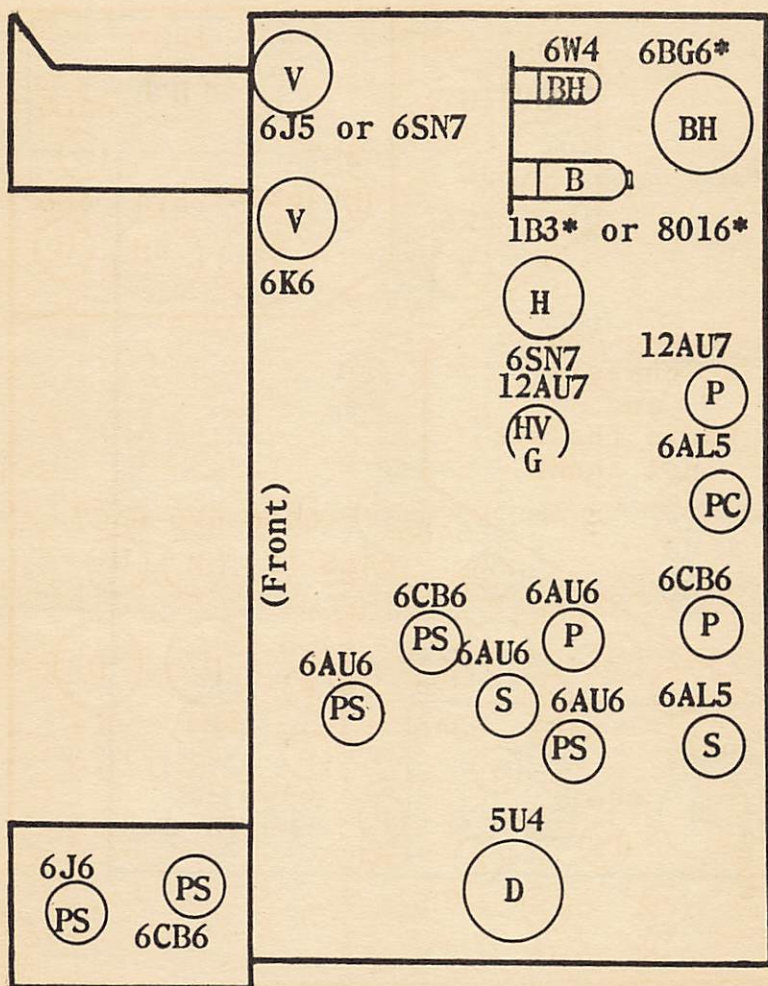


TRouble INDICATING TUBE LOCATION GUIDE

NO. 12

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

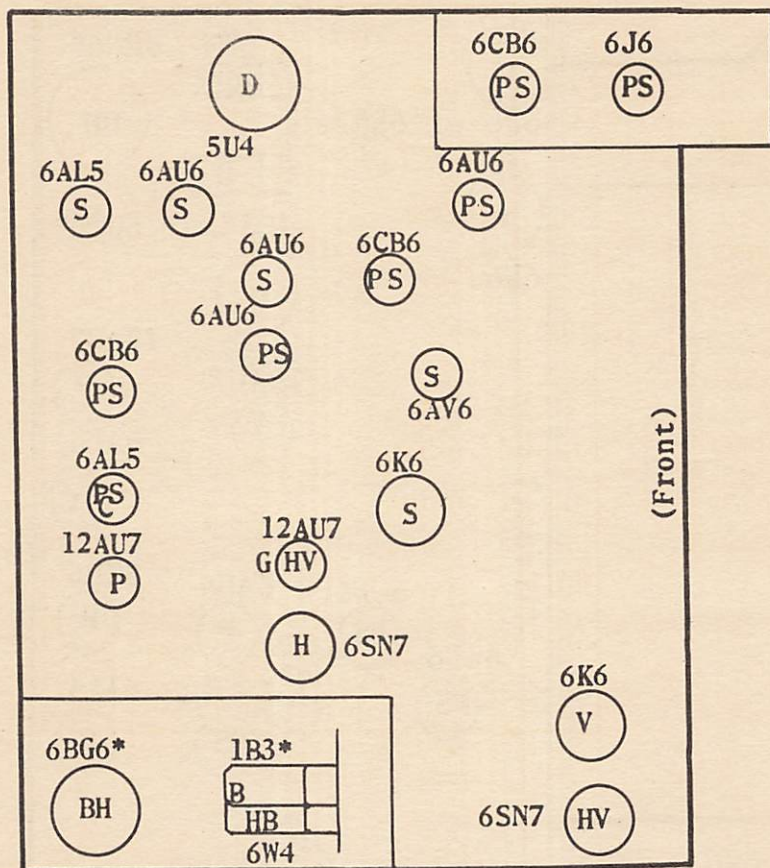




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 13

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

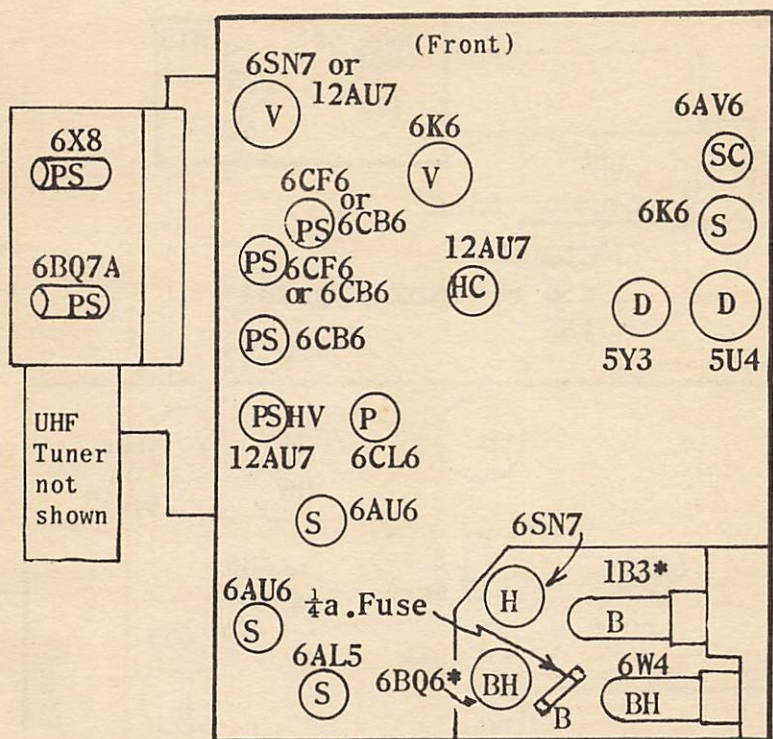


## TRouble INDICATING TUBE LOCATION GUIDE

NO. 14

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

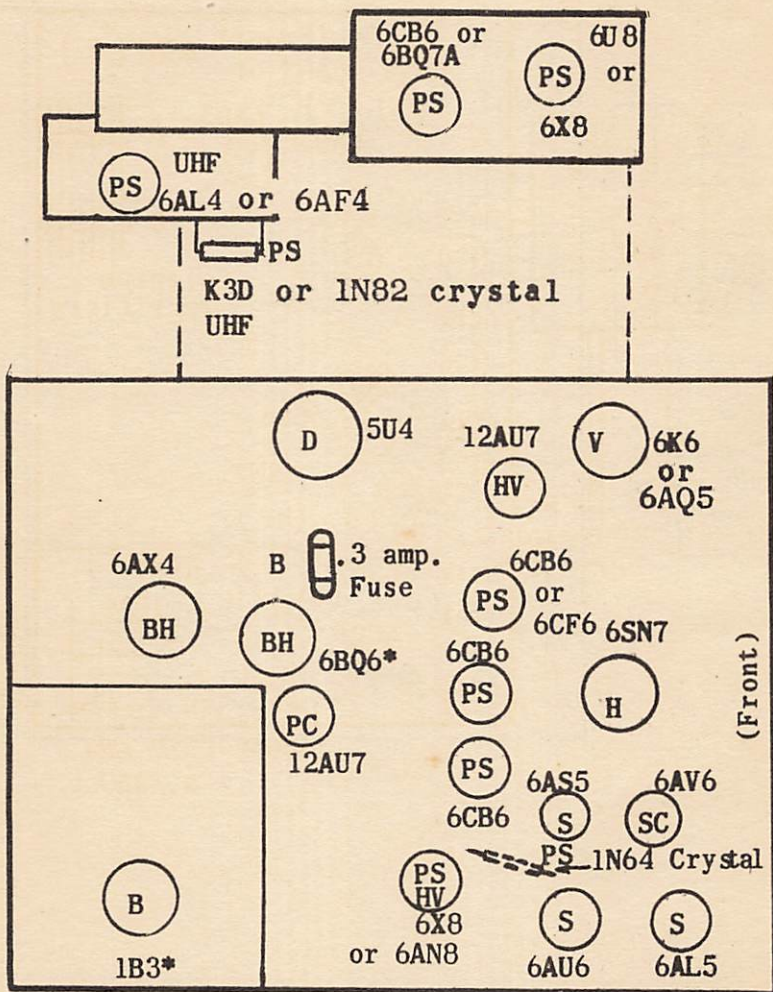




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 15

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical movement -----	HV	An asterisk (*) indicates the presence of high voltage.	

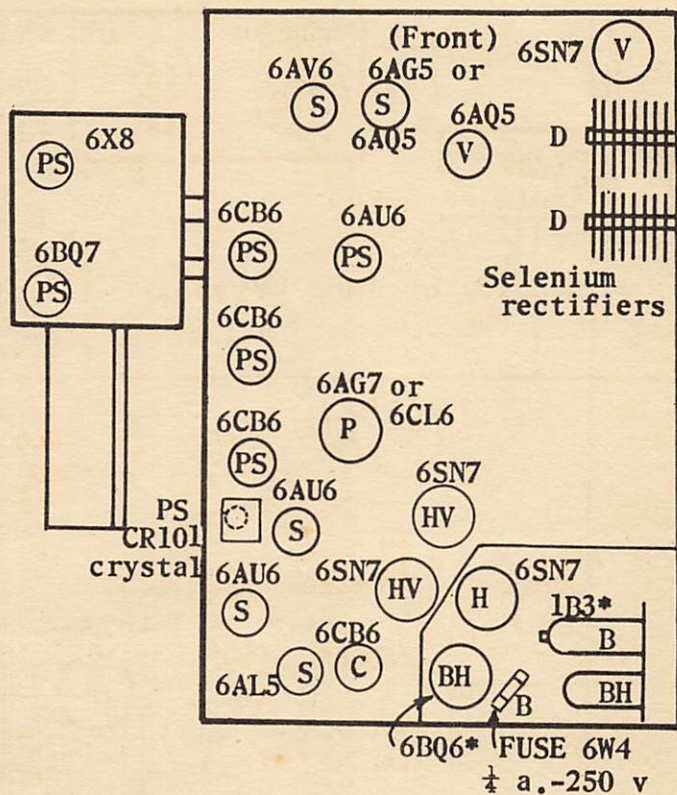


TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 16

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

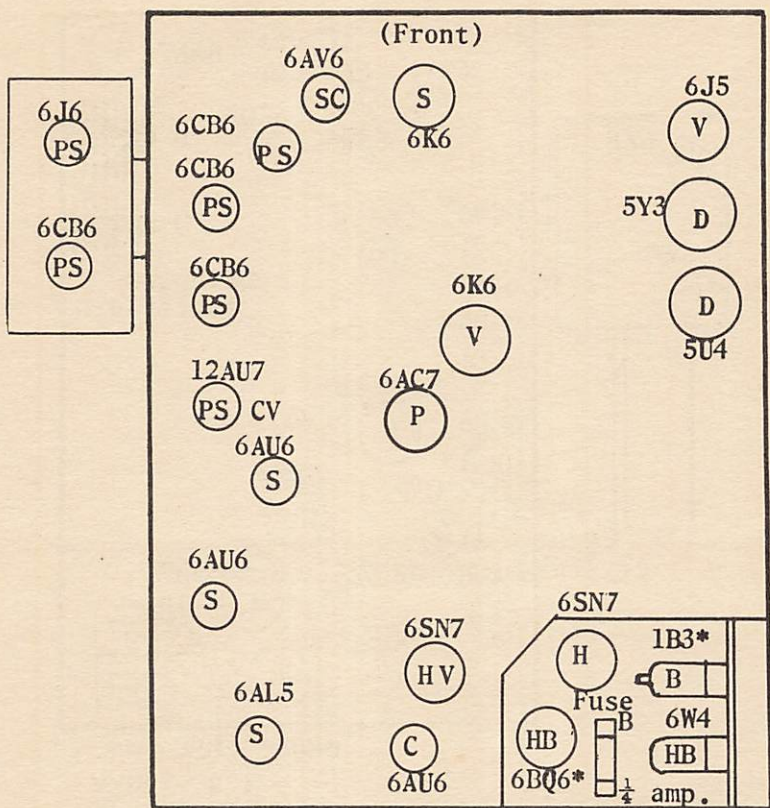




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 17

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

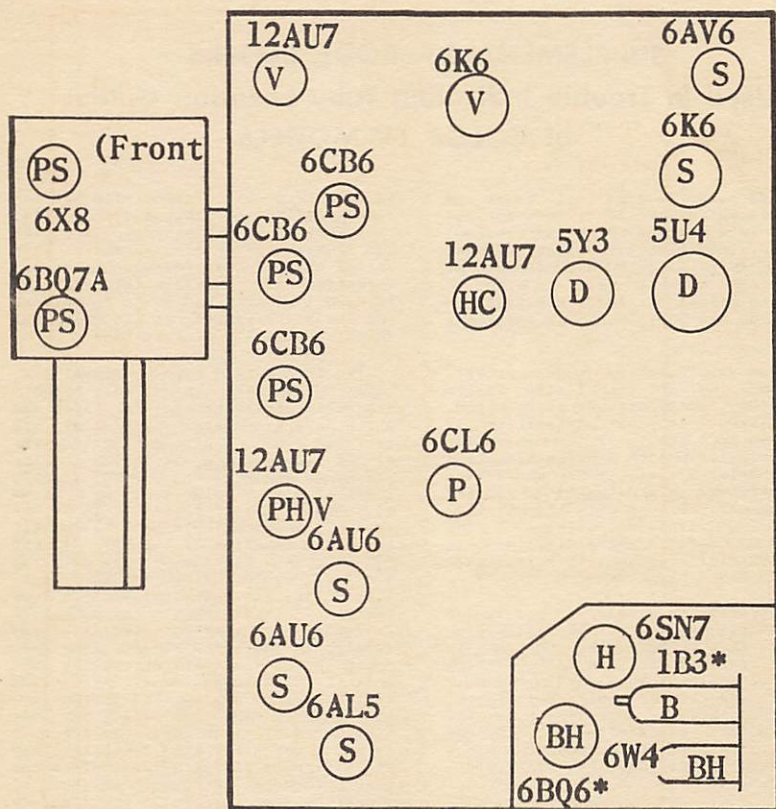


## TROUBLE INDICATING TUBE LOCATION GUIDE

### NO. 18

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	





## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 19

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

# SUPPLEMENTARY CODE LETTERS

## Used in Trouble Indicating Tube Location Guides of COLOR TV MODELS

Since color TV sets use tubes and crystals which have functions not employed in black and white (monochrome) receivers, additional code letters must be used to supplement the ones shown at the bottom of each chart in order to show the effect of these new-function tubes on the performance of the color TV set.

These supplementary code letters, their meaning and the effects of the tubes they represent are given below. In addition, a short explanation is given in each case, of the reason for the inclusion of each new-function tube in the color TV set. Those who desire more extended information on the subject of color TV will be able to get this from H. G. Cisin's recent book, "THE ABC OF COLOR TV", which explains in non-technical language, this fascinating new development.

If trouble in a color TV set is due to defective tubes, it is possible to correct this trouble through the use of a Trouble Indicating Tube Location Guide, without any knowledge of the theoretical aspects of color television. It is desirable however to know the basic points of similarity and the points of difference between the black and white TV set and the color TV receiver.

Color TV reception is an extension of black and white reception. More than half the circuits in the color TV receiver are identical with those in the black and white set. Minor changes are involved in about 25% of the black and white circuits and about 25% of the circuits of color TV are entirely new. Thus, r.f. tuner, video i.f. amplifiers, video detector and video amplifier, low voltage power supply, sound section, sync separator and AGC, vertical and horizontal deflection circuits are essentially the same in monochrome and color TV receivers. Even the high voltage power supply has been changed only slightly in the color set. This explains why letters previously used with the black and white Trouble Indicating Guides can also be used with color guides.

However, as explained above, the added circuits needed for color reception call for new codes. In the color TV set, these added circuits are employed after the video detector, and are called the "chrominance" channel. The color set also retains video amplifiers after the video detector which

in many respects coincide with the video amplifiers of black and white sets. This portion of the circuit is called the "luminance" or "Y" channel. This latter channel carries brightness information only and when the color set is used for black and white reception, the luminance signal is the only one which reaches the picture tube.

The transmitted color TV signal contains not only the conventional brightness information needed for black and white reception plus horizontal and vertical sync pulses and blanking pulses but in addition, it includes color sidebands known as "I" and "Q" signals together with a color sync signal known as a "color burst" signal. It is beyond the scope of this book to explain the exact function of the "Y", "I" and "Q" signals. For the purpose of using a color Trouble Indicating Tube Location Guide, it is sufficient to know that these three signals reach a "mixer" or "adder" in varying intensities and combine in the adder to reproduce red, green and blue signals originally present at the transmitter. After being amplified they are applied to the special color picture tube which may employ three electron guns, one for each color, or may use a single gun tube having alternate strips of red, green and blue phosphors onto which the beam of electrons from the single gun is directed by grids of parallel wires called color grids. In either case, a picture in natural color is reproduced.

Special function tubes are necessary to separate the "I" and "Q" signals and to keep them in correct phase relationship. Other tubes are needed to permit the color TV set to operate as a black and white receiver. Still other special tubes and circuits perform the color mixing function mentioned above. The code letters for these special function tubes and additional explanations are given below.

\* \* \* \* \*

Ab - Blue adder. At this stage the "Q", "I" and "Y" signals are combined in correct amplitude and polarity to reproduce the blue signals as viewed at the transmitter. The adder is generally one triode section of a double triode such as the 12BH7, the other section serving as an output tube. If this tube is defective, blue will be absent and red-green will predominate during color reception. Any televised objects which are solely blue will appear as very



dark or black. Failure of the blue adder tube or its associated output section will also affect black and white reception. The visual result will be as though a blue filter had been placed over the screen preventing the normal amount of blue (11%) from contributing its share to the picture.

Ag - Green adder. Performs the same function as the blue adder but the proportions of the three combined signals are such as to reproduce the green transmitted signals. If the green adder is defective, green will be absent from the color picture and red-blue will predominate. A solely green area will appear dark or black. If green is used in combination with other colors it will be removed and the remaining colors will be accentuated. Yellow, which is formed by a combination of red and green, will be changed to red, while white, under these conditions, will turn to magenta. Naturally, black and white reception will also be affected.

Ar - Red adder. Performs the same functions as the blue and green adders, but proportions of the three combined signals are such as to reproduce the red transmitted signal. Green and blue light will predominate if the red adder is defective and the image will assume an overall blue-green(cyan) hue.

Ba - Burst amplifier. Receives and amplifies the incoming burst signal from video amplifier. The burst signal is transmitted just after the horizontal sync pulse, but before the end of the blanking period. It has a frequency of 3.58 mc and is of short duration, consisting of only about 8 cycles. The color burst signal furnishes the local 3.58 oscillator the needed information as to the correct frequency and phase of the color subcarrier. If the burst amplifier tube is defective, the color of the viewed picture will not be a reproduction of the color being televised. If the colors are all wrong in a picture and color fidelity control fails to correct the trouble, this is definite indication of defective color sync and might be due to a defective burst amplifier tube.

Bp - Chroma band pass amplifier. This tube is part of a circuit used to hold back black and white portions of the signal, while allowing free passage of the color sub-carrier and its sidebands. An inoperative tube in this amplifier would result in lack of color. If regulation of the chroma control (a potentiometer at the output of the band-pass filter) fails to give more vivid colors, lack of vividness may be caused by a weak chroma amplifier tube.

Bt - Ballast. One or more resistors within a ventilated metal case, with plug-in base similar to base of vacuum tube. Plugs into tube socket same way as a tube. Used for controlling or reducing voltage in low voltage

power supply circuits. Provides ventilation for resistors likely to overheat and makes resistor replacement as easy as plugging in a tube. A burn-out of a ballast resistor results in a "head" set since it means absence of low voltage with consequent lack of picture, sound and raster.

Crc - Crystal frequency control. Used to keep the 3.58 mc oscillator at this exact frequency. Failure of Crc might result in oscillator drift with consequent incorrect coloring all through picture.

Crd - Crystal video detector. Used in color TV sets in place of tube detector. Since sound is taken off before the crystal video detector in color TV sets, absence of picture or weak picture with sound and raster normal could be caused by defective crystal. Fault would be present on both monochrome and color reception.

Crn - Crystal mixer. Used in tuner in place of tube mixer. Defective crystal at this point would result in weak or absent sound and picture with normal raster. Fault would show up on both monochrome and color reception.

Crr - Crystal ringing circuit. Employs a 3.58 mc quartz crystal. This is excited by the color burst at the start of each horizontal line. If color burst is absent, no 3.58 mc oscillations are generated. Some color sets use this ringing circuit; others use Crc.

Crs - Crystal sound detector. This is at the input to the sound system and is known as the first sound detector. A 1N60 germanium crystal is used, usually similar to the one used for the video or "Y" detector, Crd. Failure of this crystal will affect sound without affecting picture or raster.

Ds - Synchronous detector, also called phase detector. A 6AN8 double triode is often used for this purpose with grid and plate of each triode connected together so that each section of the tube acts as a diode. The phase detector receives two input signals, one from the burst amplifier and one from the color phasing amplifier. In this circuit the frequency and phase of the color burst are compared to the frequency and phase of the crystal controlled 3.58 mc oscillator. If any difference develops between the two a corrective d.c. voltage is produced and applied to a reactance tube connected across the resonant (tuning) circuit of the oscillator. This causes a change in plate current which automatically brings the oscillator frequency into synchronism with the color burst.

There is a close resemblance between the automatic phase control system (APC) and the horizontal automatic control systems used in some black and white receivers. The APC system performs the same function as the crystal ringing circuit, but in a different way. A



defective synchronous detector will result in faults described under Burst Amplifier (Ba).

Ds(I) and Ds(Q) - "I" demodulator and "Q" demodulator. The functions of these demodulators is to separate the chrominance signal into "I" and "Q" signals. In some color receivers, the chrominance signal is separated into color difference signals, known as Red minus "Y" and Blue minus "Y" signals. In the RCA model CTC2B, the chrominance signal is separated into a "Q" signal and a Red minus "Y" signal. When a color signal is being received, the output of the two demodulators is proportional to the original "I" and "Q" signals at the transmitter. A faulty Ds(I) tube may eliminate the "I" signal leaving only the "Q" signal. In this case red and cyan are dropped completely leaving only green and some magenta. All other colors will appear as shades of gray or black.

A defective Ds(Q) tube will result in picture losing green and magenta. For example a green field will appear as a shade of gray. It should be noted that these faults could also be caused by failure of other tubes (or components) anywhere in the circuits between the demodulators and the mixer. For example, an "I" amplifier tube may become defective, causing loss or great reduction of the red hue (since red is the predominant component of the "I" signal). Here again, green and blue, the colors left in the picture, will be accentuated. Consequently, when specific color defects develop such as outlined above, it is logical to check (by substitution) all tubes either in the circuit carrying the "I" signal or in that which carries the "Q" signal depending on the color or colors affected.

Gc - Green, blue and red d.c. restorer tube. Actually a three-function triple diode tube is used, one for each of the three primary colors - red, blue and green. These function the same as the d.c. restorer in the black and white receiver, controlling background brightness for each color and maintaining black level reference. A defective d.c. restorer may affect only the brightness of its particular color signal or it may even cause that color to be absent from the picture.

Ip(I) and Ip(Q) - Phase inverter. Also called phase splitter. Two phase splitters are used, one for the "I" signal and one for the "Q" signal. In each case, a triode stage is used with one signal taken off at the plate and the other at the cathode. Signals taken off a triode at these points will be reversed and are said to differ in phase by 180 degrees. The four signals thus obtained (two "Q" and two "I" signals) then go to the mixer. The "Y" signal is also brought to this mixer. Defective Ip(I) or Ip(Q) tubes will produce the color faults discussed under Ds(I) and Ds(Q).

Kc - Color killer. The function of this tube is to disable the color (chrominance) channel while the set is being used for black and white reception. Its operation is governed by a positive pulse from a winding on the horizontal output transformer and upon a negative voltage (from the phase detector) produced by the color burst. This negative voltage is only present during color reception -- the only time when a color burst appears in a signal. It biases the color killer to cut-off, preventing it from operating and hence permitting color reception. During black and white reception, however, current is able to flow in the color killer tube, thus producing a negative voltage across a resistor in its plate circuit. This voltage is applied as a negative bias to the chrominance amplifier thus preventing the chrominance channel from operating. If the color killer tube becomes defective while black and white transmission is being received, the chrominance channel will pass signals and color will appear on the picture tube screen. Random color specks will be seen and the picture will present a mottled appearance.

Ky - Keyer or gating tube. A tube used to control the functioning of a circuit, another tube or group of tubes in a predetermined time sequence or under predetermined conditions. For example, the tube which amplifies the pulse from the horizontal output transformer which is used to switch the burst amplifier on and off, is a keyer. The action of this tube is such that the amplifier and hence the entire color sync circuit is cut off except at the time the color burst is active. A defective keyer will result in picture faults similar to those described under burst amplifier.

Oc - Color oscillator. This may be a tube or a crystal. When a tube is used it is crystal controlled. Frequency of either type oscillator is set at 3.58 mc and is kept in accurate step with the 3.58 mc signal at the color transmitter by means of the amplified color burst signal. Color information is transmitted by two sets of signals of identical frequency, but different phase. These two signals, the "I" and "Q" signals differ in phase by 90 degrees. Their carrier, known as the color sub-carrier, is eliminated from the transmitted signal to prevent interference during black and white reception. However, this carrier must be re-inserted at the receiver before the "I" and "Q" signals can be separated (demodulated), and this is an important function of the color oscillator. Failure of the color oscillator would prevent the reception of color transmission.

Q - Quadrature amplifier. A tube used in the stage following the color oscillator tube (Oc) for amplifying the 3.58 mc signal before passing it to the phase shifting system. The signal which passes through the quadrature amplifier



undergoes a phase shift of 90 degrees at the output of the amplifier tube and it is then passed to the "Q" demodulator. Hence, a defective quadrature amplifier tube will result in a picture fault such as described under the heading, Ds(Q).

R - High voltage regulator. A tube which provides precise regulation of the high voltage output. The three-gun color picture tube is quite critical as regards steady voltage requirements. Hence it is necessary to maintain the high voltage load constant regardless of whether the picture is bright or dim. Regulation is accomplished by means of a regulator tube placed across the high voltage line. RCA model CTC2B employs a 6BK4 triode as a shunt regulator which acts automatically to keep the voltage steady under varying load conditions. Non-functioning of this tube would result in variations in scanning linearity as well as changes in the various operating potentials of the tube itself.

Re - Reactance Control. This is a tube connected across the tuning circuit of the color oscillator. It is supplied with correction voltage from the phase detector which enables it to keep the color oscillator in exact time with the color burst, as explained in more detail above under Ds.

Ry - "R" minus "Y" Amplifier. As mentioned under Ds(I) and Ds(Q) some color sets separate the chrominance signal into two signals, one of which is an "R" minus "Y" signal. The tube which amplifies this signal is called the "R" minus "Y" amplifier. A defective tube at this point would tend to reduce or eliminate red hues in the image.

Sr - Selenium Rectifier. Many color TV sets use conventional selenium rectifiers in the low voltage power supply. A defective selenium rectifier will result in a dead set or if partially operative will result in a lowering of the low voltage to a point where picture may have reduced height, width and brightness and sound may be weak or absent.

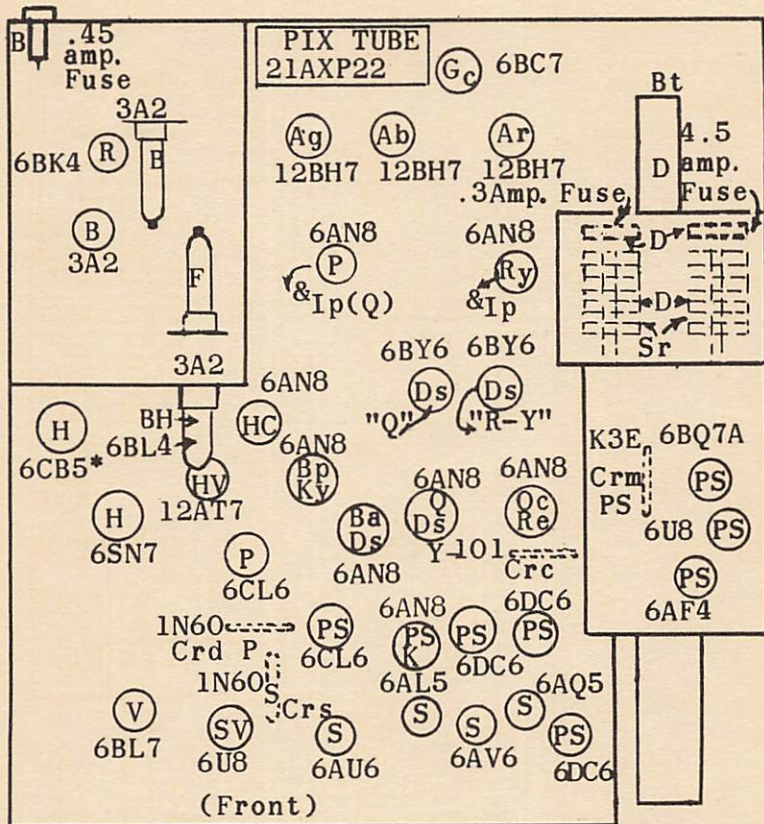
Vc - Vertical Convergence Amplifier.

The function of this tube is to supply a corrective varying voltage to certain elements of a tri-color picture tube having a flat phosphor dot screen. In addition to the d.c. convergence voltage and focus voltage applied to such tubes, additional dynamic voltages must be supplied because the distance the electron gun beams must travel from the plane of the deflection yoke to the central section of the shadow mask is less than the distance that the beams must travel when they are deflected away from the center. Thus, if the beams are arranged to converge and focus when they are at the center, they will cross over at some point before they reach the mask when scanning some other section than the center. The result would be a mis-registered picture. To remedy this condition, the d.c. potential on the convergence electrode must be varied in such a manner as to produce a larger convergence voltage as the deflection angle increases. The same condition also applies to the focus.

For the horizontal dynamic focus and convergence circuit, voltage is derived from the cathode circuit of the horizontal output tube and applied through an amplitude control to the grid of the horizontal convergence amplifier. Voltage for the vertical dynamic focus and convergence circuit is derived from the vertical output amplifier. It is then applied to a vertical convergence amplifier. Some circuits use only vertical convergence amplifier. The output of the convergence amplifier is combined with d.c. focus and d.c. convergence voltages obtained from the high voltage power supply. Convergence amplifiers are unnecessary where color picture tubes are used which have curved shadow masks and phosphor dot screens, as in the case of the 21AXP22.

Failure of a convergence tube will cause red, green and blue colors to be seen individually and will tend to give the effect of a poorly focused picture.

NOTE: While the above code letters cover the special function tubes used in color TV receivers, it is possible for certain tubes, not in the color channel, to affect color operation. These are the tubes in the luminance or "Y" channel which extends from the point where the color and monochrome signals separate to the mixer, where the "Y" signal is finally combined with the "I" and "Q" signals. When tubes in the luminance section fail, the immediate visual effect is a darkening of the picture. Yellow is the color most affected by the removal of the brightness, whereas blue is the least affected. Hence, if a tube in the "Y" section is defective, yellow will appear darkest, blue brightest, red next to blue, then magenta, then green through cyan, then yellow.

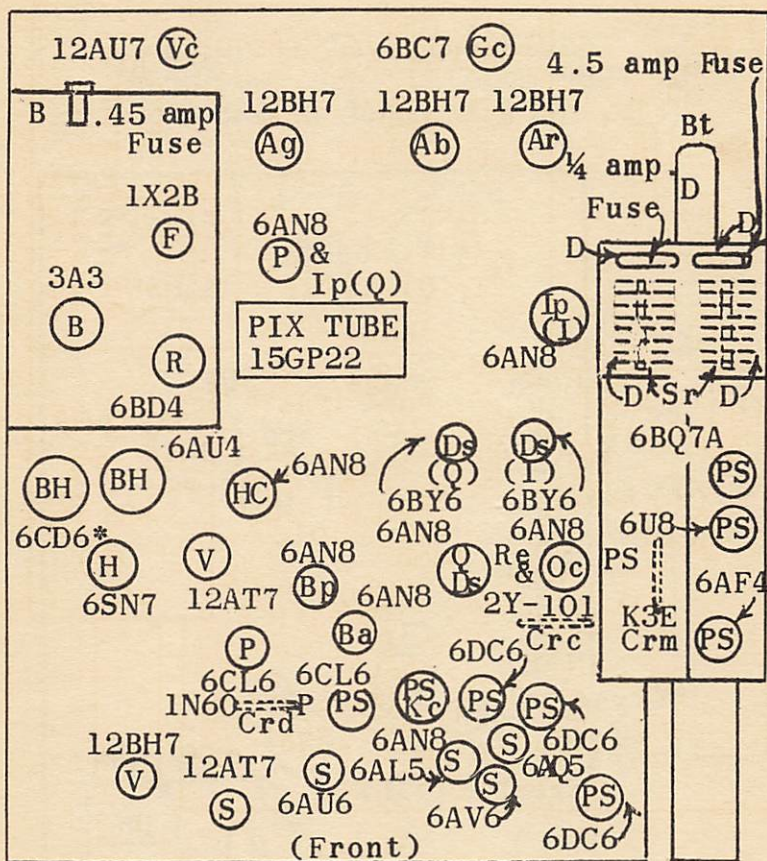


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 20

Picture -----	P	Horizontal movement and
Sound -----	S	bright area ----- BH
Picture and sound -----	PS	Picture, sound, br area D
Bright area -----	B	Background ----- G
Horizontal movement ----	H	Focus ----- F
Vertical movement -----	V	Contrast ----- C
Horizontal and vertical		An asterisk (*) indicates
movement ----- HV		the presence of high voltage.



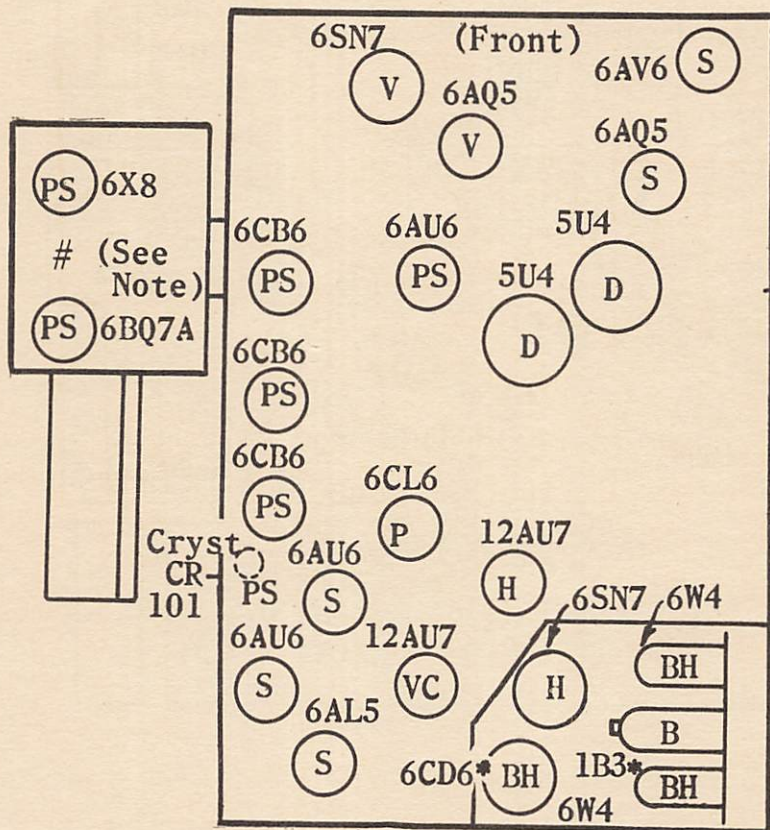


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 21

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

Note: Models followed by suffix "U" (UHF models) use two 6BQ7A tubes, 6AF4 instead of 6X8 & 6S4

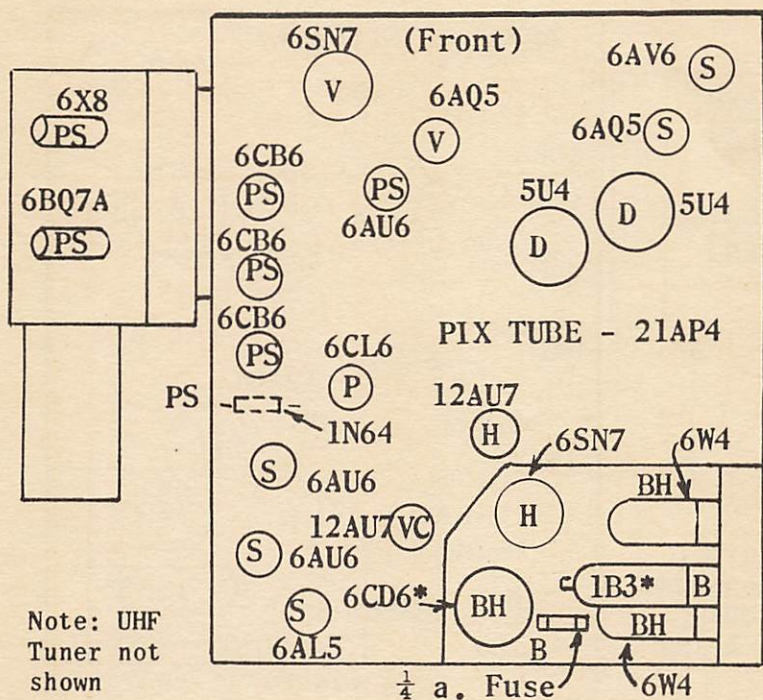


TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 22

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

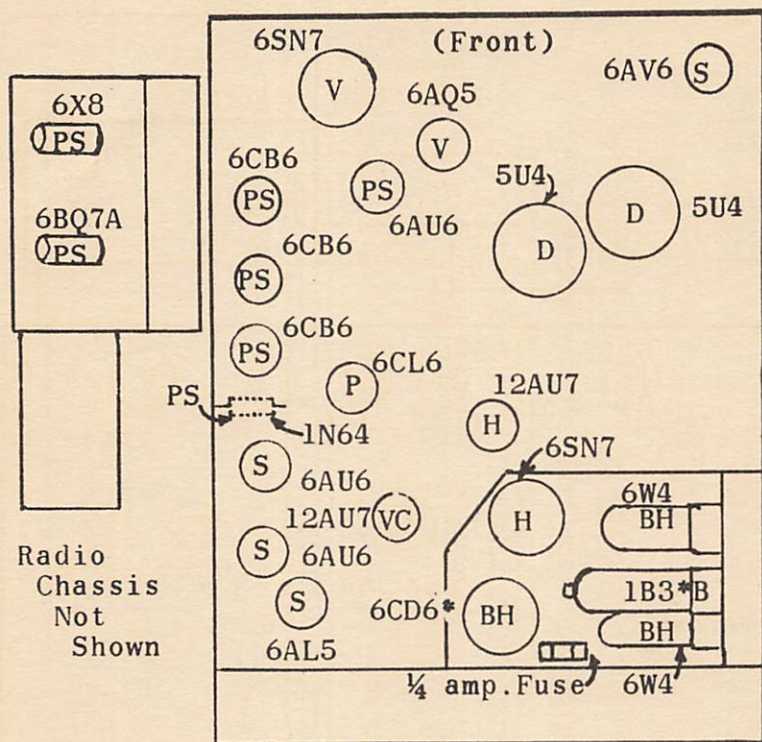




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 23

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

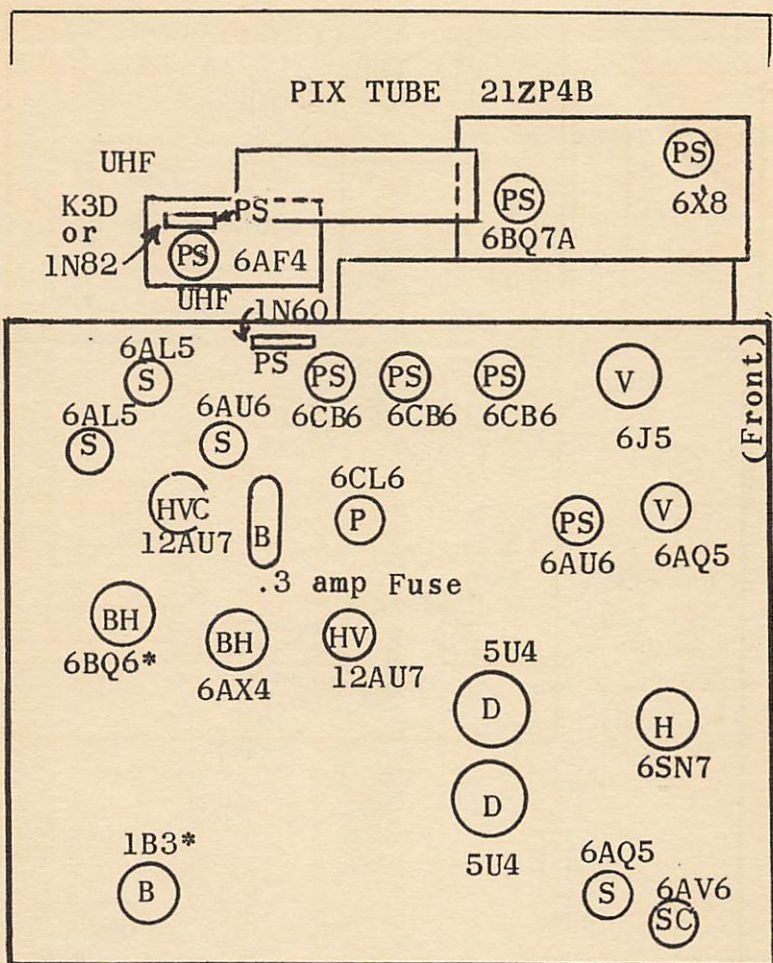


## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 24

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	





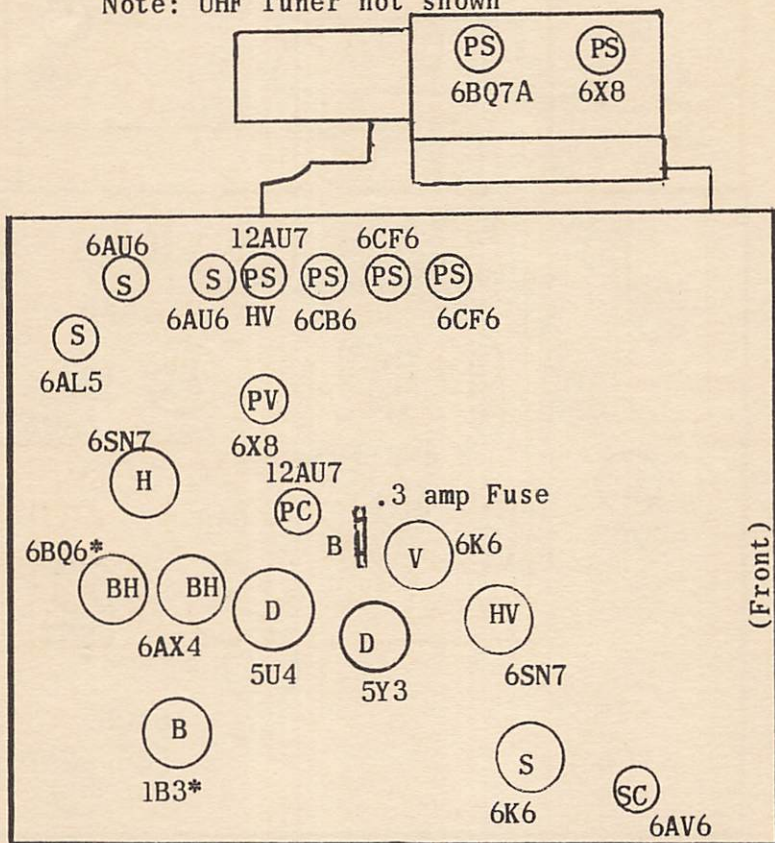
## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 25

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

PIX TUBE 21EP4A  
21AP4

Note: UHF Tuner not shown

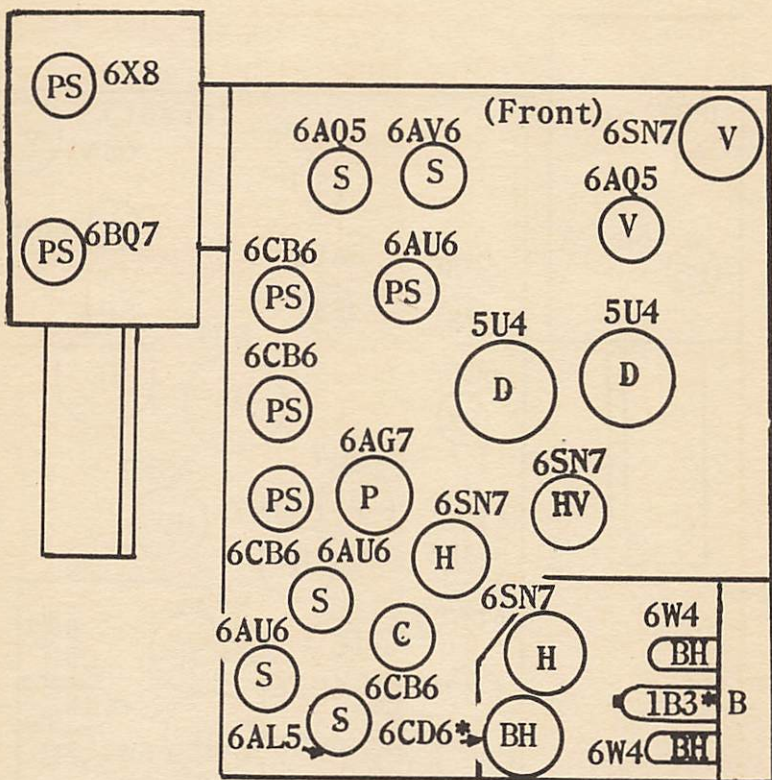


TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 26

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

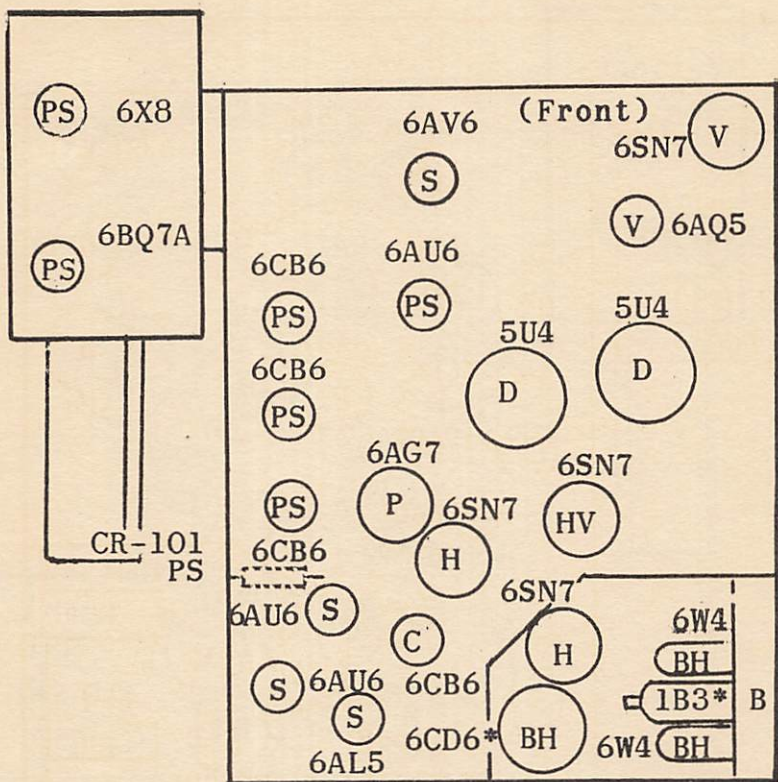




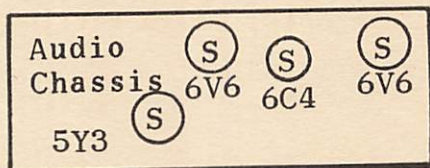
## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 27

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	



Radio  
Chassis  
not  
shown

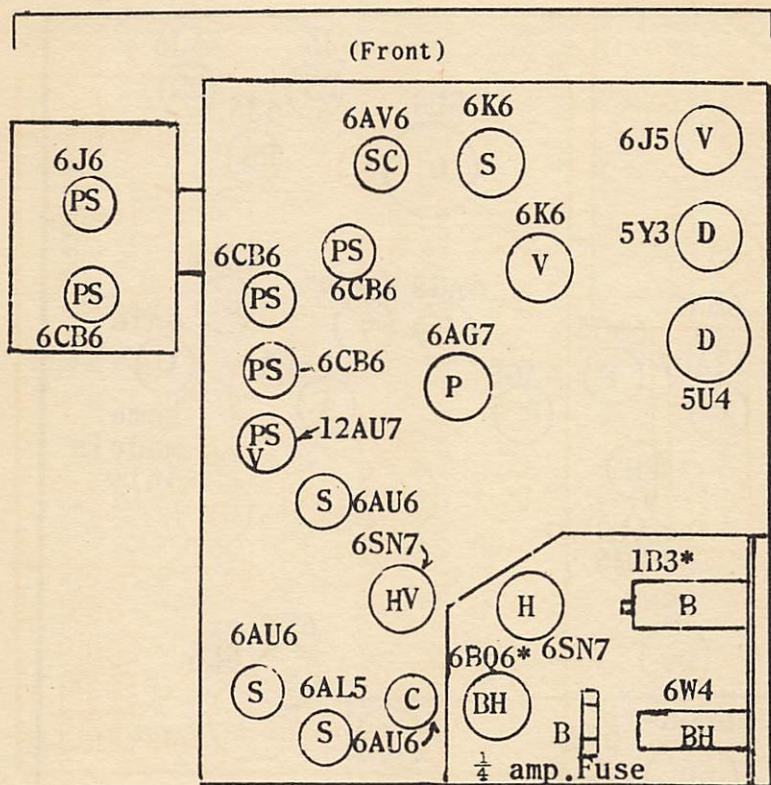


### TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 28

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

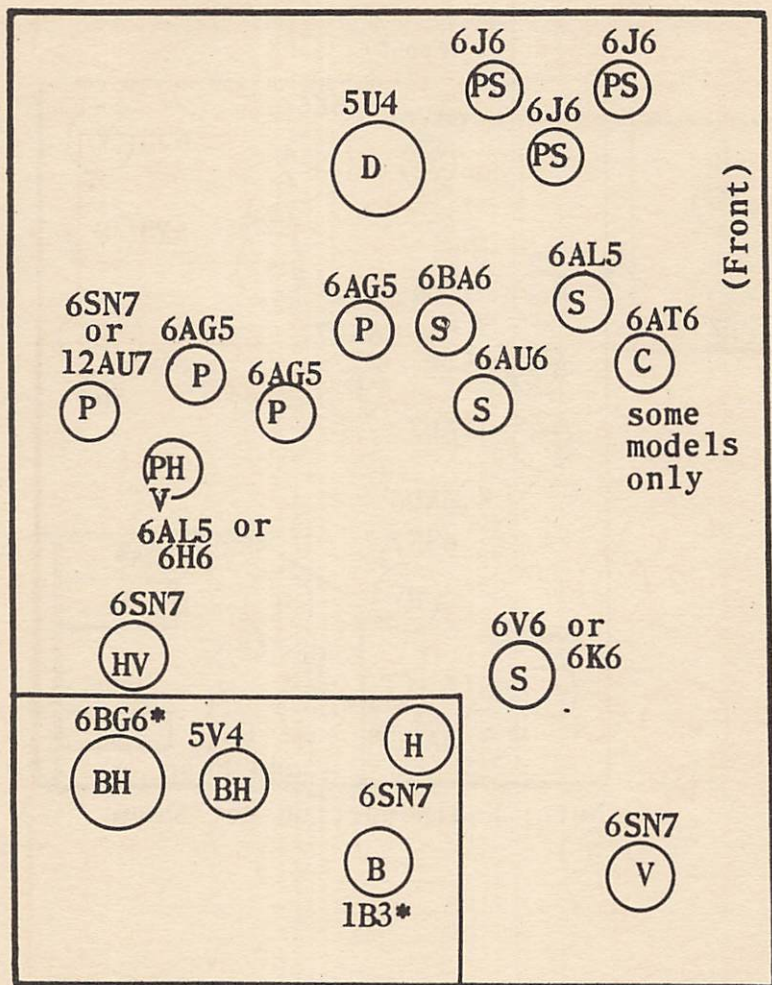




## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 29

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ---	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	



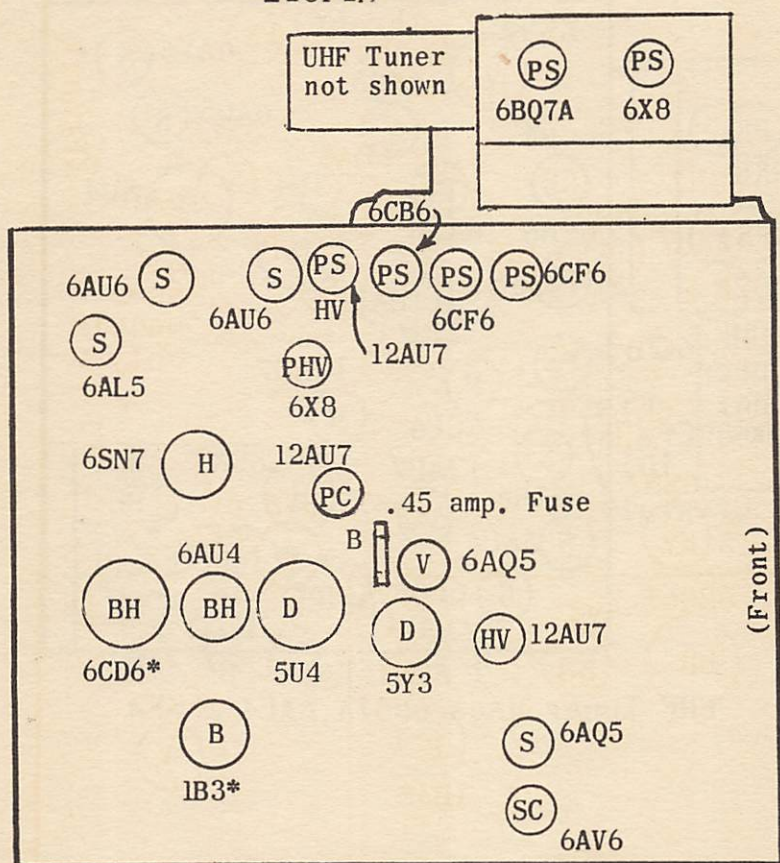
## TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 30

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	



PIX TUBE  
24CP4A

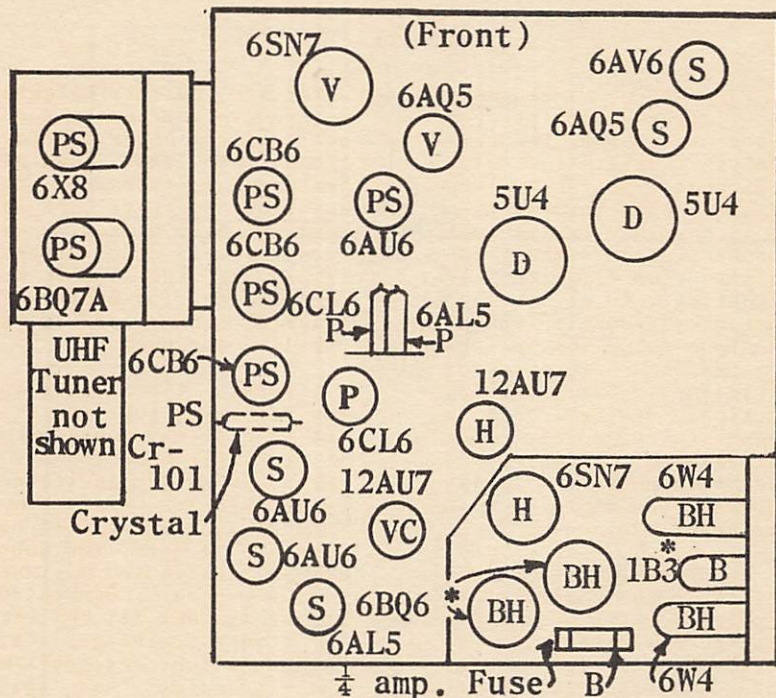


TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 31

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	

PIX TUBE - 27MP4



UHF Tuner uses 6BQ7A, 6AF4 & 6S4

TROUBLE INDICATING TUBE LOCATION GUIDE

NO. 32

Picture -----	P	Horizontal movement and	
Sound -----	S	bright area -----	BH
Picture and sound -----	PS	Picture, sound, br area	D
Bright area -----	B	Background -----	G
Horizontal movement ----	H	Focus -----	F
Vertical movement -----	V	Contrast -----	C
Horizontal and vertical		An asterisk (*) indicates	
movement -----	HV	the presence of high voltage.	



## TV Tube Substitution Guide

Very often, unexpected tube failure in a television set necessitates the temporary substitution of a different type tube for the original one. In many cases it is possible to make such a substitution without impairing the efficiency of reception. In still other instances, substitution of one type tube for another may result in a lowering of efficiency, but still may be highly desirable as a temporary expedient for maintaining uninterrupted reception until the faulty tube can be replaced with its exact duplicate.

In general, it is seldom desirable to rewire or to replace sockets in order to make tube substitutions on a TV set. Therefore, the tubes suggested for substitution purposes in this guide have been restricted to those which may be plugged directly into the same socket used by the original tube, without any changes whatsoever.

In substituting one tube for another in a television set, it is necessary to know whether the heaters or filaments are connected in series or in parallel. This information may be obtained readily without consulting a diagram. If a burnt out tube is to be replaced and all other tubes remain lit, the heaters are in parallel. If the tube to be replaced is merely suspected of being

defective, but still lights up, remove it from its socket. If any other tube or tubes then show loss of heater glow, the tube in question is part of a series system hookup. However, if all other tubes remain lit, the tube to be replaced has its heater or filament connected in a parallel arrangement.

Certain type tubes in the following tube substitution list may be used only in parallel connected circuits. These are indicated by an asterisk (\*) after the tube designation. If no asterisk is used, the tube may be substituted in either series or parallel connected heater systems. If the letter t in parentheses (t) follows a tube designation, this indicates that this tube is recommended as a temporary substitute, since it will not operate as efficiently as the original tube.

Hundreds of requests have been received for this Tube Substitution Guide. As far as we know, it is the only one of its kind, and it should prove valuable in keeping TV sets in operation in circumstances where exact tube replacement is at times impossible.




TABLE NO. 1

Covering the Substitutions Available for Over Fifty Tubes  
Most Often Used in TV Sets

<u>TUBE</u>	<u>SUBSTITUTE</u>	<u>TUBE</u>	<u>SUBSTITUTE</u>
1B3	8016	6AQ5	6BM5
1X2	1X2A		6BF5*(t)
5AX4	1AX2 (t)	6AT6	6AV6
	5AZ4		6BF6
	5U4		6BK6
	5V4		6BT6
	5W4		6BU6
	5Y3	6AU5	6AV5 *
	5Z4		6BD5 *
5U4	5AX4	6AU6	6BA6
	5AZ4		6BD6
	5T4		6AG5
	5W4		6AJ5*(t)
	5Y3	6AV5	6AU5 *
	5Z4		6BD5 *
	5Y4	6AV6	6AQ6 *
5Y3	5AX4		6AT6
	5AZ4		6BT6
	5T4	6AX4	6U4
	5U4		6W4
	5V4	6AX5	6U4
	5W4		6W5 *
	5Z4		6X5 *
6AC7	6AB7	6BA6	6AU6
	6AJ7		6AG5
	6SD7 *		6BC5
	6SJ7		6BD6
	6SS7		6CB6
	1852		6CG6
	1853	6BC5	6AG5
6AF4	6AN4		6AJ5 *
			6AN5*(t)
6AG5	6AJ5 *		6AK5 *
	6AK5 *	6BD5	6AU6*(t)
	6BC5		6AV6*(t)
	6CF6	6BF6	6BU6
	5590 *	6BH6	6BJ6
	5591 *		6AS6 *
	9001 *	6BK7, 6BK7A	6BQ7
	9003 *		6BZ7
6AH6	6AJ5 (t)	6BL7	6BX7
	6AU6 (t)		6SN7 *
	6BC5 *	6BQ7, 6BQ7A	6BK7
	6BD6 *		6BZ7
6AK5	6AG5 *	6BZ7	6BK7
	6AJ5		6BQ7
	6BC5*(t)	6CB6	6AG5
6AL5	5726		6BC5
6AN4	6AF4		6CF6
	6T4		6AK5*, 6AJ5 *



TABLE No. 1 (Cont'd)

<u>TUBE</u>	<u>SUBSTITUTE</u>	<u>TUBE</u>	<u>SUBSTITUTE</u>
6CD6	6BG6 *	6Y6	6K6 *
6J5	6AD5		6L6 *
	6AE5		6U6 *
	6AF5		6V6 *
	6C5	12AT7	12AU7
6K6	6F6 *		12AV7 *
	6L6 *		12AX7
	6U6 *		12BH7 *
	6V6 *	12AU7	12AT7
6L6	6F6 *		12AV7 *
	6K6 *		12AX7
	6U6		12AY7
	6V6	12AV7	12AT7 *
	1614		12AU7
6SN7	6BL7 *		12AY7
	6BX7 *		12BH7
6SQ7	6SR7	12AX7	12AT7
	6ST7 *		12AU7
6SR7	6SQ7		12AV7 *
	6ST7 *		12AY7
	6SZ7 *		12AZ7 *
6T8	6AK8		12BH7 *
	6R8	12AZ7	12AT7 *
6U4	6AX5		12BH7 *
	6W4	12BH7	12AZ7 *
6V6	6F6 *	12BZ7	12AX7 *
	6K6	12SN7	12SL7 *
	6L6 *		12SX7
	6U6 *	25L6	25A6
	6Y6 *		25B6
6W6	6G6 *		25C6
	6L6 *		25N6
6X5	6AX5 *	8016	1B3
	6W5 *		

Note: TROUBLE INDICATING TUBE LOCATION GUIDES of any make or model TV set can be obtained by writing to Harry G. Cisin, Amagansett, N.Y. enclosing Tube Chart from back of set together with 50¢ and stamped self-addressed envelope. Be sure to state make and model number of set. In the case of Magnavox sets, it is necessary to give chassis numbers. Serial numbers should not be given.

# Functional Classification of TV Tube Types

TABLE No. 2

## A RAPID MEANS OF CHECKING TUBE FUNCTIONS IN UNFAMILIAR TV SETS

Many different types of tubes are employed in present-day TV sets, each one having been selected because of its ability to perform a particular function to best advantage. Some tubes are especially well adapted to handle more current than others and hence are used as output tubes. Certain types are designated to function as high voltage rectifiers, others are made particularly for service as low voltage rectifiers. Certain types of miniature tubes are widely used as r.f. amplifiers because of their high mutual conductance and low inter-electrode capacitance.

Due to the large number of new tube types constantly being developed, type designations are apt to be misleading when used to determine tube functions. Hence the need for a table such as this one, which has been compiled from a study of over fifty different makes of television receivers. It will be noted that in some instances, practically all TV manufacturers employ the same type tube for a certain purpose. In the case of many other tube functions however, a wide

variety of tubes may be used. For example, the tube selected by most manufacturers to perform the dual function of discriminator and a.f. amplifier is the 6T8. On the other hand as many as eight different tube types are in common use as horizontal output tubes.

This table should be useful in tracing the circuit of an unfamiliar TV set, especially where the diagram of the set is not available. In many instances, it may be possible to determine the function of most of the tubes in a TV receiver by checking tube designations with the table.

The tubes listed in this table under any given function are not necessarily interchangeable. In order to determine whether one tube may be substituted for another without any circuit changes, it is necessary to consult Table No. 1. The letters in parenthesis after each tube function heading correspond to the code letters used in the Trouble Indicating Tube Location Guides in the preceding pages of this book.



Tube Types Most Often Used in TV Sets  
Classified According to Function

A.F. Amplifier (S)	6A16 6AV6 6SQ7GT	Horiz. Blanking & Sync. Clippers (HV)	12AU7	Horiz. Multivibrator (H)	6SN7GT	Pix I.F. Amp. (1st & 2nd)(P) or (PS)*	6AG5 6CB6 6BC5	Sync Limiter (HV)	6AG5 6AUG
A.F. Amp. & Bias Clamper (SC)	6AV6	Horizontal Oscillator (H)	6SN7GT 12SN7GT	Horizontal Output (H)	6AV5GT 6RQ6GT 25AV5GT 6AU5GT 6CD6GT 25BQ6GT 6BD5GT 19BG6GT	Pix I.F. Amp (1st, 2nd, 3rd & 4th) (P) or (PS)*	6AG5 6BC5	Sync Limiter & Ver. Osc. (HV)	6BF6 6SN7 12AV7
A.G.C. Keying (C)	6AG5 6AUG	Horizontal Phase Detector (H)	6H6 12H6	Horizontal Output (H)	6AV5GT 6RQ6GT 25AV5GT 6AU5GT 6CD6GT 25BQ6GT 6BD5GT 19BG6GT	Pix I.F. Amp (3rd) (P) or (PS)*	6AUG 6CB6	Sync Separator (HV)	6AB4 6AUG
A.G.C. Keying & Vertical Output (VC)	12BH7	Low Voltage Rectifier (D)	5U4G 5Y3GT 6U4GT	Horizontal Sync. Discriminator (H)	6AL5	Ratio Detector (S)	6AL5	UHF I.F. Amp. (PS)	6BQ7 6BQ7A 6BZ7
Audio Output (S)	6AC7 6AQ5 6J6 25L6GT	Noise Inverter (HV)	12AV7 12AU7	Horizontal Sync. Discriminator (H)	6AL5	Ratio Detector & A.F. Amp. (S)	6AL5 6AT6	UHF Osc. (PS)	6AF4 6AUG
Converter (PS)	7F8 6BH6 6J6 6X8	Noise Limiter & Blanking Amp. (HV)	12AU7	Low Voltage Rectifier (D)	5U4G 5Y3GT 6U4GT	Ratio Detector & A.F. Amp. (S)	6AL5 6AT6	Vertical Amp. (V)	6BL7 12AU7
D.C. Restorer, Sync. Sep. & Sync Phase Inverter (HWG)	6SN7GT 12AU7	Vertical Output (V)	6AC7 6AQ5 6J6 25L6GT	Vertical Oscillator (V)	6AB4 6AUG 6BZ7 6C86	R.F. Amplifier (PS)	6AG5 6BK7 6BK7A 6BQ7 6BC5 6BQ7A	Vertical Multivibrator (V)	6SN7GT 12BH7 12SN7GT
Damper (BH)	6AU4GT 6AX4GT 6AX4GT	Vertical Output (V)	6SN7GT 12AU7	Vertical Oscillator (V)	6AB4 6AUG 6BZ7 6C86	Ratio Detector (S)	6AL5 6AT6	Vertical Output (V)	6AHGT 6C66 6SN7GT 6V6GT
Discriminator & A.F. Amp. (S)	6T8	Video Amplifier (P) or (PS)*	6SN7GT 12AU7	Vertical Output (V)	6AB4 6AUG 6BZ7 6C86	Rectance Tube (H)	6AC7 6AUG	Vertical Output (V)	6AHGT 6C66 6SN7GT 6V6GT
High Voltage Rectifier (B)	1B3GT 1X2 1X2A	Video Amp. & 1st. Sync. Sep. (HV) and (P) or (PS)*	6SN7GT 12AU7	Vertical Output (V)	6AB4 6AUG 6BZ7 6C86	Rectance Tube & Osc. (Re)	6AN8	Video Amplifier (P) or (PS)*	6AC6 6AG7 12AT7 12AU7
Horizontal A.F.C. (H)	6AC7 6AG5 6AH6	Video Detector (P) or (PS)*	6AL5	Vertical Output (V)	6AB4 6AUG 6BZ7 6C86	Sound I.F. Amp. (S)	6AG5 6AUG	Video Detector & A.G.C. Rectifier (P) or (PS)* (C)	6AL5 6AUG
Horiz. A.F.C. & Horiz. Osc. (H)	6SN7GT	Video Detector & A.G.C. Rectifier (P) or (PS)* (C)	6AL5	Vertical Output (V)	6AB4 6AUG 6BZ7 6C86	Sync. Amp. & Sync. Sep (HV)	6SN7GT 12AU7	Video Detector & A.G.C. Rectifier (P) or (PS)* (C)	6AL5 6AUG
		Video Det. & D.C. Restorer (P) or (PS)* and (G)	6AL5	Vertical Output (V)	6AB4 6AUG 6BZ7 6C86	Sync Clipper & Horiz. Blanking (HV)	12AU7	Video Det. & D.C. Restorer (P) or (PS)* and (G)	6AL5 -6C4
		Video Det. & Sound I.F. (PS)	6AUG	Vertical Output (P) or (PS)*	6AC7 6AG7 6SN7GT 6CB6	Sync Clipper & Vert. Osc. (HV)	6BF6 6SR7 12AV7	Video Det. & Sound I.F. (PS)	6AUG
				Vertical Output (P) or (PS)*	6AC7 6AG7 6SN7GT 6CB6	Sync Clipper & Vert. Osc. (HV)	6BF6 6SR7 12AV7	Video Output (P) or (PS)*	6AC7 6AQ5 6AG7 6AUG 6CB6

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