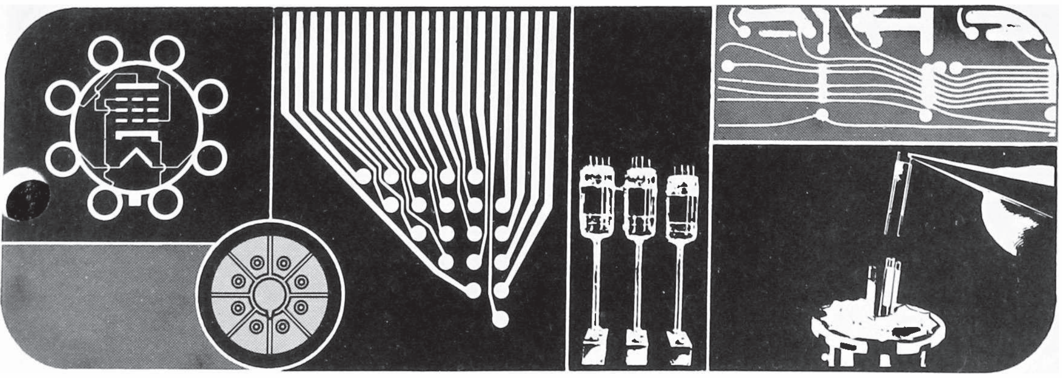

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Technical Section
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COLOR TV . . . .
HIGH VOLTAGE REGULATION
Part 1

by L. J. Songer and C. Droppa

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In color receivers, the picture tube beam current may be two or three times greater than a comparable monochrome set. Therefore, beam current changes due to brightness variations will cause appreciable change in the high voltage level. Because many circuits are dependent on the horizontal deflection system for proper operation, the dc and pulse voltages derived from the system must remain relatively constant. It is readily apparent then, that as brightness varies, HV regulation is a must for proper color operation . . . preventing appreciable changes in height, width, focus, hue and convergence.

To meet the HV regulation requirements of color, various circuits have evolved. Three systems currently in use include: (1) shunt, (2) pulse controlled, and (3) electronic bias feedback types. Each produces the required regulation, but in a different manner.

This article deals only with the Shunt and Pulse Controlled HV regulator systems. Electronic Grid Bias Feedback circuits will be the topic of Part II (a future issue of SYLVANIA NEWS). In addition to a general description and basic theory of operation, recommended set-up procedures and troubleshooting tips are included.

SHUNT TV REGULATION

General Description

The shunt type of HV regulation system, which has been in use a number of years, employs a type 6BK4 HV regulator. As shown in the simplified functional diagram of Figure 1, this type of system, in essence, has an automatically controlled resistor (HV regulator) connected in parallel with the picture tube. The picture tube can also be considered as an automatically variable resistor. Both are connected to the dc high voltage supplied by the HV rectifier. As brightness varies, the automatic action of these variable resistors maintain a constant dc high voltage because they keep a constant load on the horizontal deflection system.

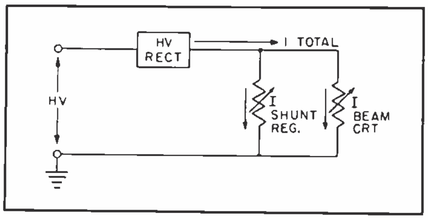


Figure 1—Simplified Functional Diagram —Shunt HV Regulation Systems.

Theory of Operation

As shown in the simplified circuit of Figure 2, the type 6BK4 HV regulator and corresponding circuits are connected across the dc high voltage supply. The cathode of the 6BK4 is returned to B+ and its grid is referenced to the boost supply through R_1. To insure correct bias between grid and cathode, R_1 in the boost circuit and R_2 in the grid return to ground should be a matched pair.

As with any television receiver, when brightness decreases, picture tube beam current also decreases. This causes the dc high voltage and, consequently, the boost voltage to increase. The increase in boost voltage is reflected to the grid of 6BK4 via R_1, causing it to increase con-

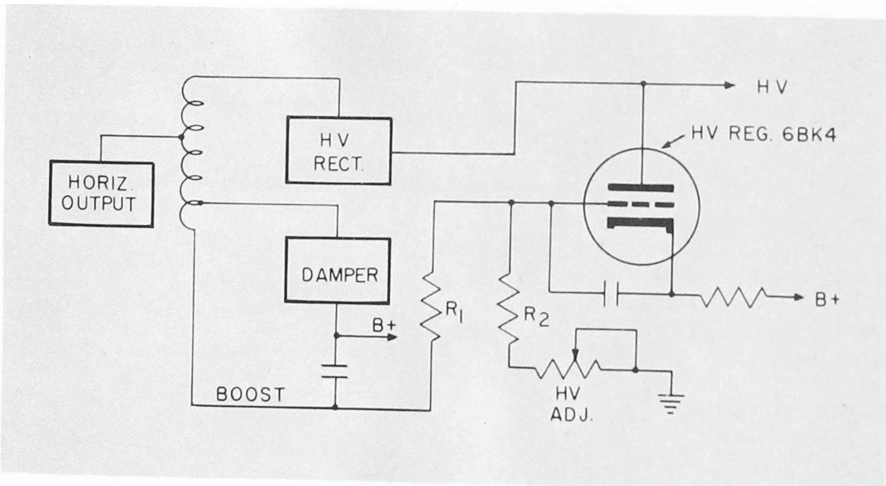
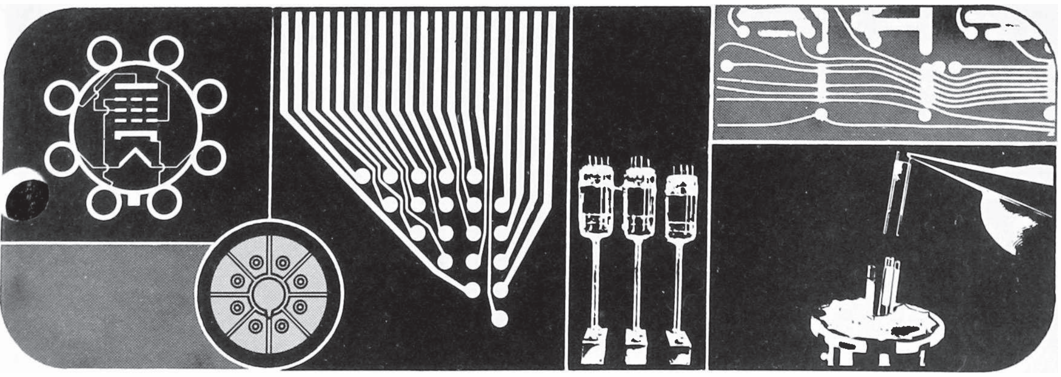


Figure 2—Simplified 6BK4 Shunt Regulator Circuit.



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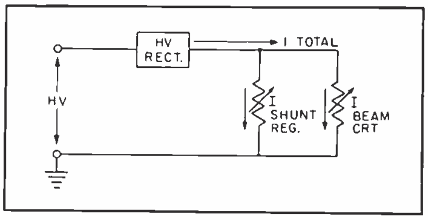

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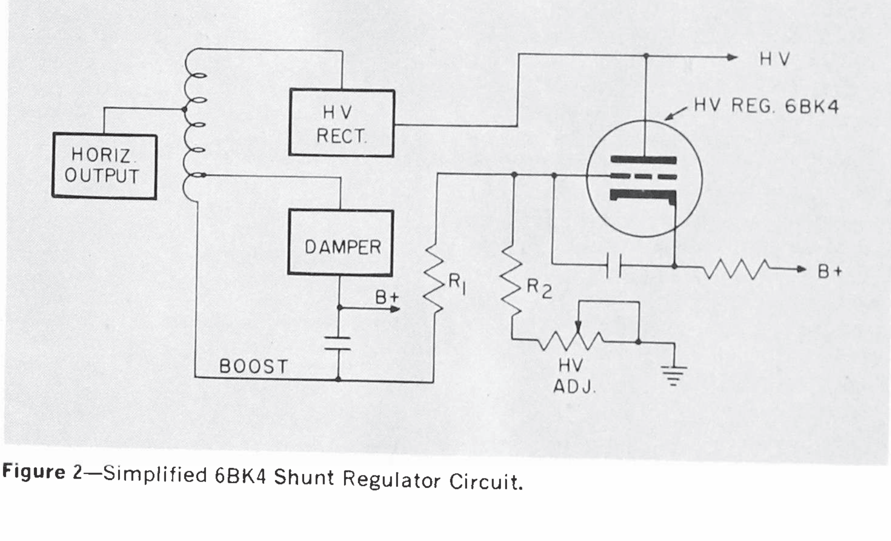

Figure 2—Simplified 6BK4 Shunt Regulator Circuit.

duction. The resultant increase in 6BK4 plate current is sufficient to lower the high voltage to its original and proper level. Further, a constant current through the HV rectifier is also maintained.

Conversely, as brightness increases, picture tube beam current increases, resulting in a decrease in dc high voltage and boost voltage. This causes less current to flow through 6BK4, resulting in the desired increase in high voltage.

Set-Up Procedures

Regardless which type of HV regulation system is used, each color set manufacturer has a prescribed high voltage set-up procedure. This procedure should be followed to insure optimum performance and component life. Most color sets use a high voltage of 25KV, but the appropriate set schematic or maintenance manual should be checked to be certain. A brief high voltage set-up procedure for the shunt HV regulation system is as follows:

(1) Turn the brightness control to minimum, extinguishing the picture—all the HV rectifier current now flows through the 6BK4.

(2) Then adjust the HV control for 25 KV, or the value shown on the set schematic—the HV control changes the bias of 6BK4.

The 6BK4 regulator current should also be checked. If it draws only 300 μa at zero beam current, the picture tube can only draw 300 μa before regulation is lost. In most sets using the shunt regulation circuit, for good regulation, the 6BK4 HV regulator current should be at least 850 μa and not more than 1400 μa . . . at zero beam and 120 volt line. Regulator current can usually be determined by measuring the voltage drop across the 1000 ohm resistor in the cathode circuit.

Some color deflection systems contain an efficiency coil. This coil should be adjusted to provide minimum horizontal output cathode current. Since the cathode current rarely exceeds 250 ma, a 0-500 ma DC-meter is adequate for the check. If the coil is not properly adjusted, the horizontal output may operate at excessive plate dissipation . . . resulting in shorter tube life and possible failure.

Troubleshooting

A defective 6BK4 and associated HV regulation circuitry can cause high voltage, focus, width, blooming and convergence problems. Monitoring the regulator current (as discussed in the set-up procedures) and the high voltage is one of the easiest ways to resolve these problems.

When working on the HV regulation circuit, it is recommended the following precautions be observed:

(1) Don't operate the set more than necessary if it has a blooming raster or no raster at all, and

(2) Don't pull an arc from the high voltage supply to determine the presence of high voltage. Use a high voltage probe capable of measuring at least 30 KV.

Failure to observe these precautions can result in serious damage to the various components, including the picture tube.

Common trouble symptoms and probable causes are given in the Troubleshooting Table. In addition, since the vertical oscillator is also returned to the boost supply in many color sets, malfunctions in the horizontal deflection system may also affect vertical scan. Also, if trouble has existed in the HV regulator circuit and has been corrected, the horizontal output tube should be checked for possible damage. Insufficient drive to the horizontal output tube can be disastrous. Further, after making HV regulation circuit repairs, make sure the efficiency coil (if applicable) is properly adjusted.

PULSE CONTROLLED HV REGULATION

There are two pulse controlled HV regulation circuits currently in use. They are identified by the type of HV regulator tube employed: 6HS5 or 17KV6. Although operation of these tubes differ, the principal of achieving HV regulation is the same. The 6HS5 is a compactron beam triode and the 17KV6 is a novar beam power pentode similar to a horizontal output tube.

General Description

Unlike the shunt HV regulation system, the pulse controlled regula-

TROUBLESHOOTING TABLE

<table>
<tr><th rowspan="2">TROUBLE SYMPTOMS</th><th colspan="3">PROBABLE CAUSES</th></tr>
<tr><th>6BK4</th><th>6HS5</th><th>17KV6</th></tr>
<tr><td rowspan="9">Reduced HV, Poor Focus, Short Scan, Blooming, Misconvergence</td><td colspan="3">HV control not properly adjusted</td></tr>
<tr><td colspan="3">Efficiency coil not properly adjusted</td></tr>
<tr><td colspan="3">Low grid drive to horizontal output</td></tr>
<tr><td colspan="3">Weak or inoperative tube (HV regulator, damper, HV rectifier, horizontal output)</td></tr>
<tr><td colspan="3">Change in resistance value of HV regulator grid circuit</td></tr>
<tr><td colspan="2">Leaky or shorted capacitor from HV regulator G1 to K</td><td></td></tr>
<tr><td></td><td>Decrease in timing pulse amplitude</td><td></td></tr>
<tr><td colspan="2"></td><td>Change in value of control and screen grid resistance (17KV6)</td></tr>
<tr><td colspan="2"></td><td>Leaky or shorted capacitor between G2 and plate (17KV6)</td></tr>
<tr><td>Excessive picture tube and focus voltage</td><td colspan="3">Inoperative HV regulator</td></tr>
<tr><td>Noise streaks in picture</td><td colspan="3">Corona or sputter arcing—poor lead dress, inoperative tube</td></tr>
<tr><td>Arcing, horizontal deflection circuit</td><td colspan="2"></td><td>Open in plate to grid feedback circuit (17KV6)</td></tr>
</table>

tors act as a variable load on the primary of the horizontal flyback transformer. As shown in the simplified functional diagram of Figure 3, the pulse controlled HV regulator acts as an automatically variable resistor shunted across a portion of

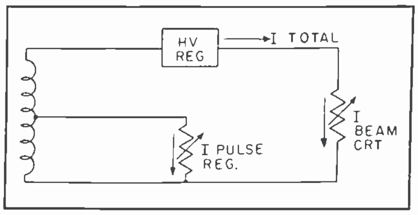

Figure 3—Simplified Functional Diagram—Pulse Controlled HV Regulation System.

the flyback transformer.

The pulse controlled HV regulator is based on the loading and unloading of the horizontal flyback transformer's primary winding . . . and reflects this change to the high voltage tertiary winding. Like the shunt regulator, the grid of the HV regulator is returned to boost. When the picture tube beam current increases due to a brightness increase, the high voltage and flyback pulse voltages of course tend to decrease. When this occurs, the automatic action of the pulse regulator will cause these voltages to increase to their original level. The opposite action takes place when brightness decreases.

Theory of Operation

6HS5 CIRCUIT—The operation of the 6HS5 pulse controlled HV regulation circuit of Figure 4 is controlled primarily by two parameters:

(1) A dc voltage obtained from the boost supply to vary conduction of HV regulator 6HS5, and

(2) Narrow timing pulses of constant width and amplitude, obtained from the horizontal oscillator to permit 6HS5 to conduct *only* during retrace. (During trace, the plate of 6HS5 is at less than B+ potential. With the cathode at B+ and the grid negative with respect to the cathode, the tube is cut off.)

As established previously, high voltage and boost voltage varies inversely with brightness . . . as brightness increases, high voltage and boost voltage will decrease. As with the shunt regulator, the boost voltage changes are used to control conduction of the HV regulator to achieve high voltage regulation. As shown in the simplified circuit of Figure 4, the timing pulses obtained from the horizontal oscillator, and the dc

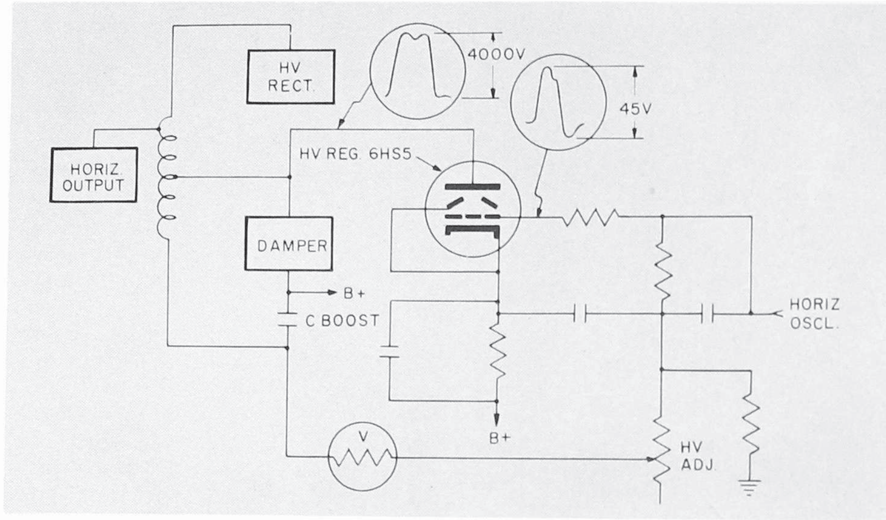

Figure 4—Simplified 6HS5 Pulse Controlled HV Regulation Circuit.

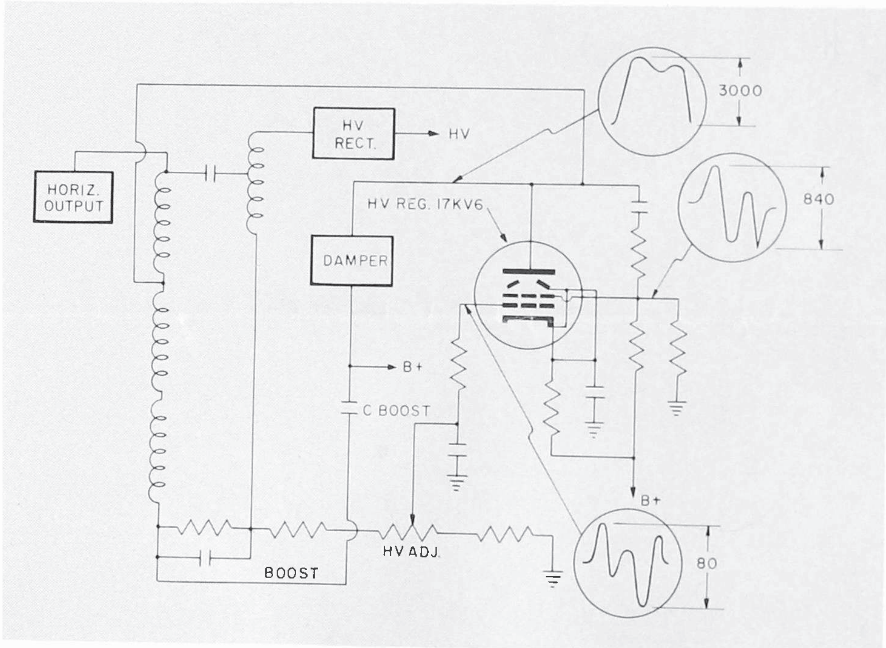

Figure 5—Simplified 17KV6 Pulse Controlled HV Regulation Circuit.

voltage obtained from boost, are applied to the grid of 6HS5. Conduction of this HV regulator tube during retrace is controlled by the amount the boost voltage exceeds the tube's preset bias level. Its cathode is at B+ potential and its plate, at this time, is at the same potential as the damper cathode.

As brightness decreases, the picture tube beam current of course decreases, and both the high voltage and boost voltage will tend to increase. This action is reversed since the boost voltage increase is reflected to the grid of 6HS5, causing it to go into conduction during retrace. As the 6HS5 conducts, the pulse voltage in the flyback transformer primary is lowered. This decrease is reflected to its tertiary winding, causing the high voltage to decrease to its original level.

Conversely, as brightness increases, high voltage and boost voltage will tend to decrease. Conduction of 6HS5 during retrace will decrease, increasing the pulse voltage in the flyback primary, which in turn is reflected to its tertiary, raising high voltage to normal. The picture tube loads the flyback tertiary directly and the pulse regulator loads the primary. Since the pulse voltage input to the HV rectifier is held relatively constant by the pulse regulator during retrace, the picture tube anode potential is also held relatively constant.

17KV6 CIRCUIT—As stated previously, HV regulation with the 17KV6 circuit is achieved in basically the same way as with the 6HS5 circuit. The significant difference is in the operation of the 17KV6 HV regulator and the additional circuitry required.

With the 17KV6 circuit, the timing pulse is obtained from the flyback transformer Figure 5, instead of the horizontal oscillator. It is applied to the screen grid and not the control grid. As with the 6HS5 circuit, the boost voltage is the primary regulation control factor and is applied to the control grid.

Set-Up Procedures

Set-up procedures for both the 6HS5 and 17KV6 pulse controlled HV regulation circuits are essentially the same as for the 6BK4 shunt system. However, when the picture is extinguished, there is no load on the system. This is because the HV regulator shunts the flyback transformer and not the high voltage power supply.

Troubleshooting

As with the 6BK4 shunt regulation system, a defective HV regulator (6HS5 or 17KV6) can cause high voltage, width, blooming and convergence problems. The same troubleshooting precautions are applicable. Also, if the horizontal deflection circuit has been defective, both vertical scan and the horizontal output should be checked. Further make sure the efficiency coil is properly adjusted. Common trouble symptoms and probable causes are given in the Troubleshooting Table.

CONCLUSION

HV regulation is essential for optimum color television operation. Of the three systems currently in use, we have discussed two: shunt and pulse controlled. The third, electronic bias feedback, will be the topic of Part II.

The shunt system acts as a variable load on the high voltage power supply to achieve HV regulation; the pulse controlled types act as a variable load on the flyback transformer. Set-up and troubleshooting procedures are essentially the same (exceptions are noted). Common trouble symptoms usually include loss of raster, narrow raster, blooming, poor focus or misconvergence.

With the shunt system, good HV regulation can be expected up to a beam current of 1400 μa. At this beam current, there is only an 800 volt change in high voltage. With the pulse controlled systems, relatively good regulation can be expected up to 1000 μa of beam current. A high voltage change of 1100 volts at this range is reasonable.

With all of the HV regulation systems used in color TV, the scan remains relatively constant until the beam current exceeds the system's limits. When this happens, blooming and defocusing of the raster occurs.

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