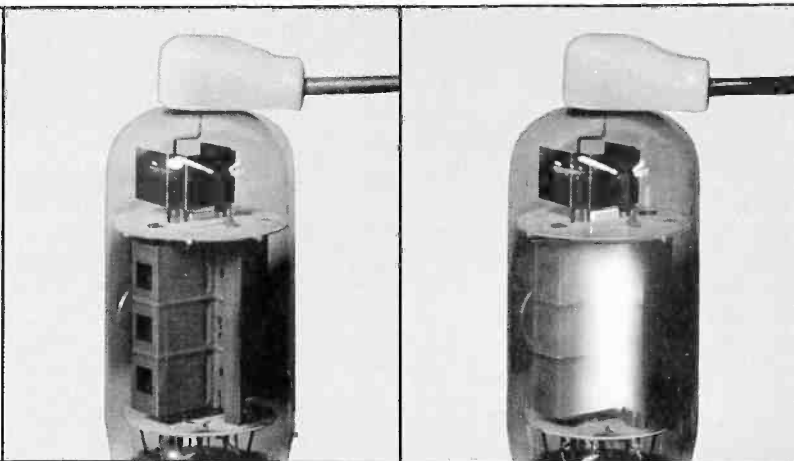


R. A. HUMPHREYS, TECHNICAL EDITOR This information in Sylvania News is furnished without assuming any obligations.

THE MAKING of a CALL BACK or

HOW TO KILL A HORIZONTAL OUTPUT TUBE

by G. L. Quint and C. Droppa



Service short-cuts can sometimes do more harm than good—especially when working on the horizontal deflection system in a color TV receiver. Permanent damage to the horizontal output tube can occur if its grid drive is removed or drastically reduced.

GRID DRIVE—EXCESSIVE PLATE DISSIPATION

In most color sets, the negative dc bias for the horizontal output tube is developed entirely by the drive signal supplied by the horizontal oscillator (Figure 1). If this drive is removed or substantially reduced, the plate current and plate dissipation of the horizontal output tube skyrockets. Normally, plate dissipation runs from 15 to 18 watts. This is well within the design rating and capability of the tube and will provide good life expectancy. However, with no drive, plate dissipation may increase as high as 150-180 watts. This, of course, exceeds the tube's plate dissipation rating some 5 to 6 times and is disastrous.

CIRCUIT PROTECTION

The only protection against excessive plate current is provided by a circuit breaker or fuse located either in the ac or dc power supply portion of the color receiver. The length of time it takes the circuit breaker or fuse to "trip" determines the extent of damage done to the tube. It is also

possible for these protective devices not to respond to increased plate current. This could result from the circuit being overfused during set design or the rating being increased when the set was serviced. If excessive plate current is drawn for a prolonged period, the horizontal output tube will fail.

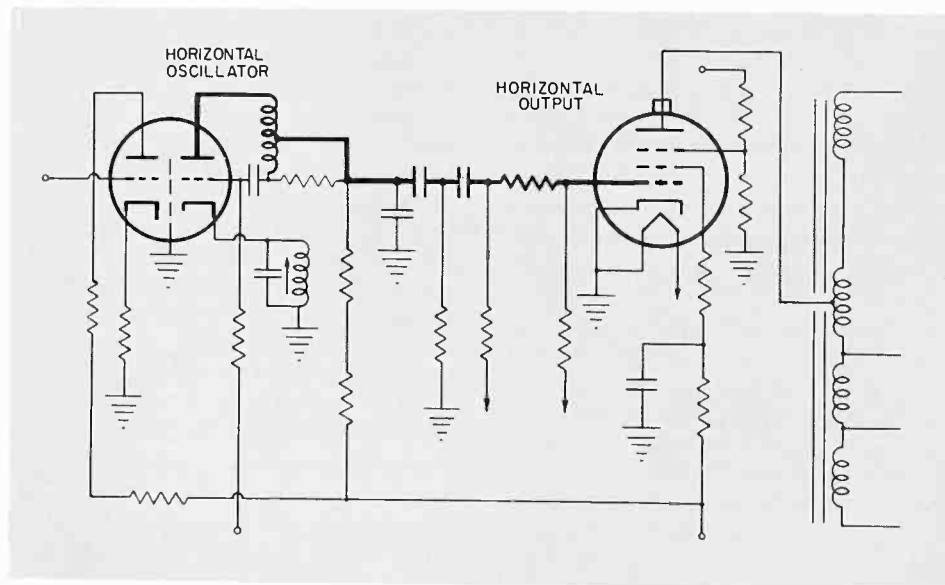


Figure 1— Typical Schematic Showing Circuit Relationship of Horizontal Oscillator and Horizontal Output Tubes.

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LABORATORY EVALUATION

Tests conducted by Sylvania's Commercial Engineering Tube Application Laboratory verify the damage that can be done to the horizontal output tube when it is operated even for short periods under high dissipation conditions. Various groups of tubes were operated with no grid drive for periods ranging from 5 to 120 seconds. Extent of damage was determined by measuring peak plate current before and after each test period. The difference in these measurements was expressed as a "percent slump" in plate current. Peak plate current is one characteristic that measures the tube's ability to provide proper scan and high voltage.

Removal of the drive signal from one group of horizontal output tubes, caused average plate current to rise from 200 ma to 650 ma. This caused plate dissipation to go from less than 15 watts at 120 volt line to 150 watts. The temperature of the plate rose to 575°C in approximately 10 seconds and glowed a bright red within 30 seconds. Additional tests with other groups of tubes showed a 3% slump in plate current after 5 seconds of "no drive", 30% after 30 seconds, 70% after 60 seconds, and 80% after 120 seconds.

It was concluded that slump in plate current was caused primarily by poisoning of the cathode by metals vaporized under the abnormal plate dissipation condition. It can be conservatively estimated (Figure 2), that even a moderate deterioration of 20% in plate current, due to loss of cathode emission, is the equivalent of 1000 hours tube life at 130 volt, high line operation. Operation of the horizontal output at abnormally high dissipation for even seconds is in effect taking away many hours of useful life. If the high dissipation condition persists, the tube will fail completely.

SERVICE TIPS TUBE REPLACEMENTS

As considerable damage can occur in a relatively short time with reduced or no grid drive, a suspected malfunctioning horizontal output tube should not be replaced until the horizontal oscillator is checked first. If the horizontal oscillator was not supplying sufficient grid drive, the new horizontal amplifier would of course be damaged. As a result, either an expensive tube is lost or a repair job is put out with a built in call back.

If the horizontal oscillator must be replaced, it is apparent that the set must be turned off first.

Consider the case where the serviceman may even have the new tube in his hand ready for replacement. If he doesn't turn the set off first, the elapsed time for removal, replacement, and for the new horizontal oscillator to heat up can be sufficient to cause enough damage to the horizontal output tube to appreciably shorten its useful life.

It is also possible to damage the horizontal output tube when replacing the horizontal oscillator even if the set is turned off first. This would occur if enough time wasn't allowed for the set to cool off before turning the set on again after replacement. If the horizontal output tube's heater hasn't cooled sufficiently, it would

ADDITIONAL PRECAUTIONS

In addition to the "drastically reduced" or "no drive" conditions, there are other operating conditions that can shorten the life of the horizontal output tube. For example, an improperly adjusted efficiency coil will increase plate current, plate dissipation, and temperature of the tube and needlessly limit useful life. The set manufacturer's instructions should be followed to assure optimum tube and circuit operation. Another condition that can produce excessive plate dissipation, though not normally encountered in service work, is operating the color set with the yoke unplugged. In this instance, the plate current of the horizontal output tube doesn't increase as drastically as it does without grid

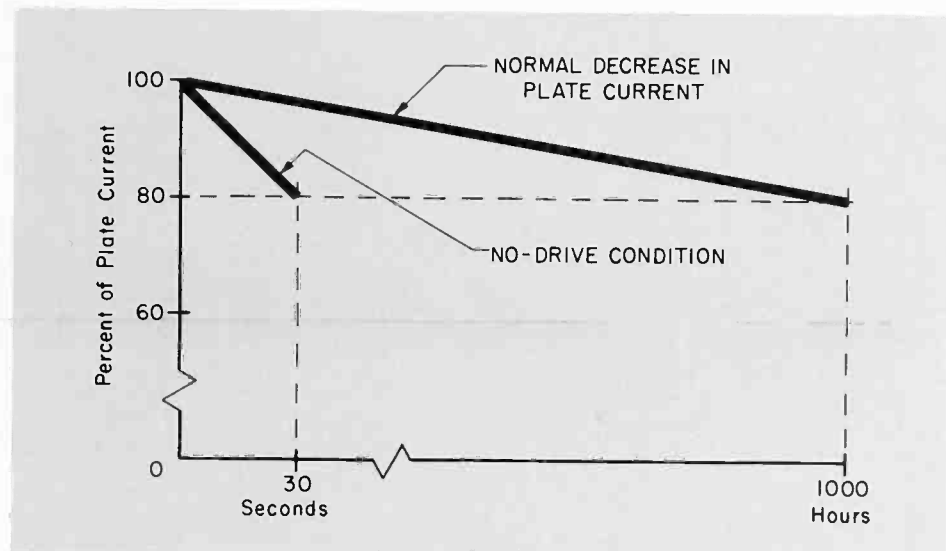


Figure 2—Horizontal Output Tube—Normal Plate Current Change With Life Versus Accelerated Change In Absence Of Grid Drive.

reach operating temperature before the cold horizontal oscillator replacement. Therefore, for a period of time the horizontal output tube would be functioning with insufficient grid drive. This situation can, of course, be avoided if the set is given enough time to cool off. A minimum of three or four minutes should be sufficient. As a special precaution, the horizontal oscillator can be preheated in a tube tester before it is plugged in. This would make sure it reached operating temperature before the horizontal output tube.

It should also be noted that, under the "no drive" conditions, the flyback transformer and damper tubes may be subjected to currents and dissipations in excess of their ratings. Therefore, they too may be permanently damaged or result in call backs.

drive; however, the plate voltage becomes much higher, thus raising plate dissipation.

A high voltage rectifier failure caused by an internal short can also produce extremely high plate dissipation in the horizontal output tube. The short causes serious de-tuning of the flyback circuit. This results in most of the B+ power input to the horizontal deflection system appearing as plate dissipation instead of useful scan and high voltage to the picture tube. Consequently there may be service calls when both of these tubes have to be replaced due to their dependent failure mechanism.

Also, when servicing the horizontal deflection system, the circuit should not be inactivated by removing the top cap connector from the horizontal output tube. As shown in

Figure 1, B+ is still applied to the screen of the tube. Therefore, screen dissipation can become excessive and contribute to tube failure. Dissipation in the screen dropping resistor may also become excessive. This can cause its resistance value to change and result in eventual failure. This probable failure, however, can be preceded by a long period of operation with the horizontal scan and high voltage being adversely affected due to improper screen voltage. It is a good practice to

check the value of the screen dropping resistor when normal servicing techniques fail to restore optimum horizontal deflection operation. It is not uncommon for the value of this resistor to change with long usage.

The damper tube also should not be removed to inactivate the horizontal deflection system. A situation would occur similar to that caused by removing the horizontal amplifier top cap. Again, voltage would be removed from the plate of the horizontal amplifier, but not from the screen.

CONCLUSION

While the emphasis in this article has been placed on color set operation, the same precautions are applicable to black and white TV sets. By following these recommendations, the serviceman will avoid permanently damaging or shortening the life of the horizontal output tube, resulting in a call-back. The loss of profit and customer satisfaction from call-backs is well known.

TROUBLESHOOTING

TRANSISTOR TV



Transistor TV set sales continue to rise—hand-in-hand in an expanding service market.

In troubleshooting transistor sets, key measurements will generally localize the trouble. However, before probing around, taking measurements and replacing components, the serviceman should be aware of certain "DON'TS."

SERVICE DON'TS

Don't Be Careless—Transistors can be destroyed almost instantly. (This is in marked contrast with tubes which can often take moderate overloads for extended periods.)

Don't Change Components With Power On — The only time power should be on is when measurements are taken.

Don't Probe In Energized Circuitry—A short from base to collector will almost always destroy a transistor. (In direct coupled stages other transistors may be destroyed as well.)

Don't Forget—Clean Foreign Materials, Such As Metal Shavings, From The Insulators When Replacing Power Transistors—Such particles may pierce the mica insulator or prevent adequate heat transfer to the heat sink.

Don't Forget—Use Silicon Grease On Both Sides Of The Mica Insulator Used With Power Transformers — This insures heat sink efficiency.

Don't Solder Or Unsolder Leads Of Transistors Or Other Components Without A Heat Sink Between The Iron And Component—This prevents heat damage to heat sensitive components. (Long-nose pliers are good heat sinks.)

Don't Use Test Equipment That Is Not Well Isolated From The Line When Making Measurements On Equipment Which Is Connected To A Power Source (even though the equipment switch is turned off)—This prevents crossed grounds. Check all test equipment and use an isolation transformer on the chassis under test if necessary.

Don't Use Just Any Ohmmeter To Check Resistance—The voltage at the leads of some ohmmeters may exceed the current or voltage limitations of the transistors. (The lower resistance scales on 20,000 ohm/volt meters are usually safe for short and open tests.)

Don't Arc High Voltage Haphazardly—Arcing may cause small-signal transistor failure.

Don't Shunt Capacitors Without A Good Knowledge Of The Circuits—This can cause transistor failure especially if a high value capacitor is involved.

Don't Forget To Reverse Leads When Making Resistance Checks—The reading should be the same both ways. A different reading usually means a transistor junction is affecting the reading.

Don't Operate The Set With The Yoke Disconnected—This can cause excessive current in horizontal output stages.

Don't Operate The Set With Speaker Disconnected—This can cause excessive current in audio output stages.

Don't Forget—Many Transistorized Stages Are Direct Coupled—A malfunction in one stage may result in incorrect readings in another.

RULES-OF-THUMB FOR TROUBLESHOOTING

In troubleshooting transistorized TV sets, voltage readings are generally more valuable than resistance readings. If service literature is not available or inconvenient, certain rules-of-thumb may be used.

- Signal injection is a valuable tool to locate a faulty stage . . . small injectors are very handy. To use such a device, simply place the injector on a collector and lower the volume or contrast until the audio or picture signal is minimal. Then move the injector to the base. The volume or picture "interference" will improve proportionate to the gain increase . . . Very low impedance stages (such as the IF input may show deceptive lack of improvement since the injector's signal will be loaded.
- When measuring voltage at the emitter junction always put the negative lead on the N element.

Emitter junction bias is most easily measured directly between the base and the emitter.

Normal bias for germanium transistor amplifiers is 0.2 to 0.4 volts.

Normal bias for silicon type transistor amplifiers is from 0.4 to 0.8 volts.

Bias measurements may vary slightly, but large variations call for further investigation.

- When measuring resistance of a transistor with an ohmmeter at least two transistor leads must be disconnected from the circuit. Transistors can generally be checked with an ohmmeter as follows:

PNP

Put the negative meter lead on the base. Connect the positive lead to the collector and then to the emitter. The meter should show a low resistance. —Then reverse the leads by putting the positive lead on the base. The meter now should show a high resistance to both emitter and collector.

NPN

Put the positive meter lead on the base. Connect the negative lead to the collector and then to the emitter. The meter should show a low resistance. —Then reverse the leads by putting the negative lead on the base. The meter should show a high resistance to both emitter and collector.

- Small-signal transistors generally have 1 to 5 ma of current in the emitter circuit.
- The voltage across the emitter resistor should be about the same as the resistor value in K ohms if 1ma of current is being drawn through it. For example: a 4.7 K ohm resistor will drop 4.7 volts at 1 ma.

NOTE: These are general rules. There may be exceptions in some sets.

Booklet Explains Causes — Effects — Solutions of TV Interference



Early in 1961 the Washington Television Interference Committee made available to the television service industry an 18-page booklet dealing with TV interference, its cause, effects and cure. An item in the Winter, 1961 edition of SYLVANIA NEWS brought more than 1200 individual requests for copies from interested readers.

The booklet has had further dis-

tribution both nationally and internationally. Several thousand copies of a third reprint are now available. FREE single copies of this helpful booklet may be obtained by writing to: Harold R. Richman, Editor, WTVIC TVI Aids, 3908 Lake Boulevard, Annandale, Virginia, 22003.

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PINCUSHION CORRECTION IN LARGE SCREEN RECEIVERS

by W. D. Murphy

The introduction of the new rectangular large screen color picture tube has imposed some circuit requirements not found in the earlier color receivers. In addition to increased deflection and convergence power, these new color picture tubes require "pincushion" correction to reduce picture distortion at the edges.

The increased deflection power requirements are met by operating the sweep tubes at higher input power and using specially designed sweep components. Convergence requirements are more exacting because both the larger deflection angle and the larger screen tend to make any slight misconvergence more evident to the viewer.

Pincushion distortion results from the large deflection angles and produces a picture like the one in Figure 1A. This pincushioning is caused by the edges of the picture tube screen being farther from the deflection yoke than is the center of the faceplate. This results in "bowing" of any straight lines in the picture. In black and white receivers, pincushioning is corrected by the use of small permanent magnets mounted near the deflection yoke. Their magnetic fields slightly bend the beam, pulling the sides outward, and at the same time, pulling the corners in toward the center. The electron beam is shifted at right angles to the magnetic lines of force from the pincushion magnet; the corrected picture is shown in Figure 1B.

Partial pincushion correction may also be designed into the deflection yoke by slightly changing the winding dimensions. The resulting distorted fields from the yoke produce a

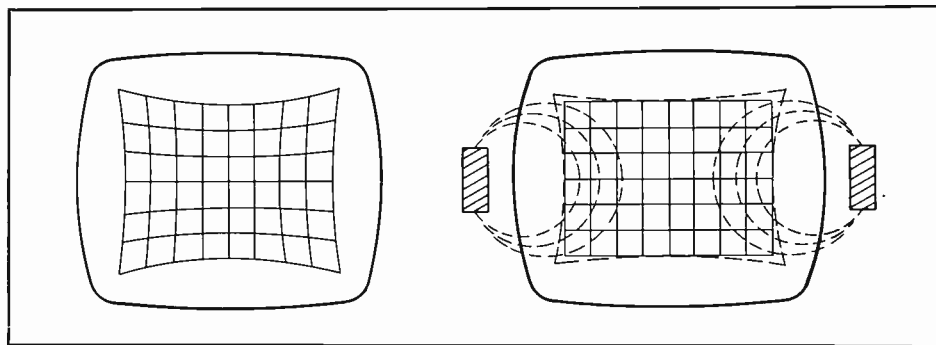


Figure 1—Pincushion Distortion and Its Correction

raster which is opposite to the raster produced by the picture tube "pincushion" characteristics.

These techniques however cannot be used with color tubes as the pincushion magnets and non-uniform yoke fields would cause severe impurity in the three color fields. Pincushion correction circuits for modern large screen color sets operate by slightly changing the vertical and horizontal scan currents in the deflection yoke. Again looking at Figure 1A, suppose that near the top of the picture, both the left and right sides were deflected slightly downward by the vertical yoke, while the top center was slightly deflected upward. This will remove the top pincushioning. Bottom pincushioning is removed by reversing the corrective deflection. The added deflection is a "parabolic" waveshape with the peaks occurring during retrace time.

Figure 2 shows how the horizontal frequency currents (at 15.750 KHz) are combined with vertical deflection current in the yoke. The two currents add to produce an undistorted picture across the top and bottom. The

sketch shows, however, that the 15 KHz waveshape must be reversed from top to bottom and is zero at the center (vertically).

Figure 2 also shows how horizontal pincushioning can be corrected by varying the screen voltage to the horizontal output tube at a 60 Hz rate. This effectively increases the picture width at the center and reduces picture width at both top and bottom.

PINCUSHION CORRECTION CIRCUITS

Vacuum Tube Circuits

Now that we have determined the basic requirements, let's see how they are met in various receivers. The vertical pincushion correction requirements are the most complex and will be examined first.

In Figure 2, we saw that the horizontal rate (15 KHz) signal was reversed in polarity as the tube was scanned from top to bottom and that no correction voltage was applied to the center. Figure 3 shows the basic pincushion correction circuit

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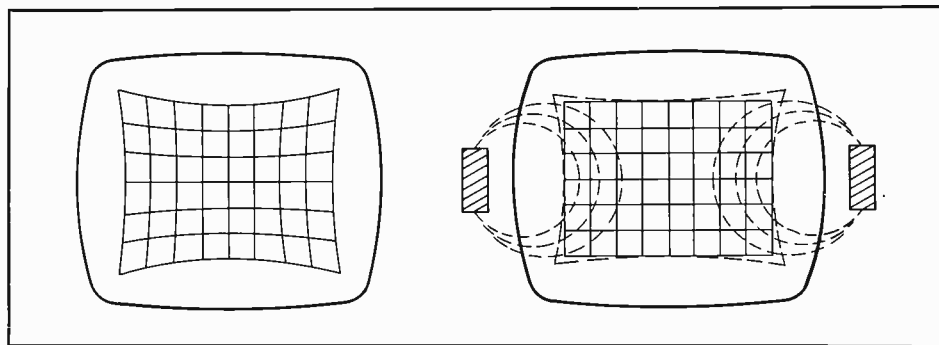


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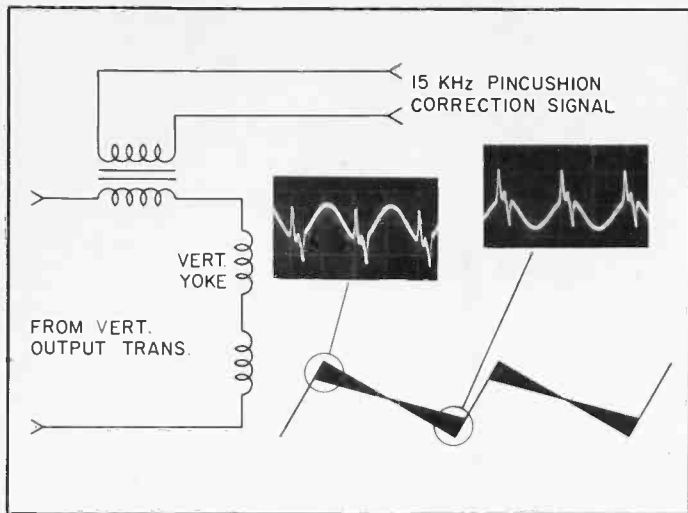
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PINCUSHION CORRECTION CIRCUITS

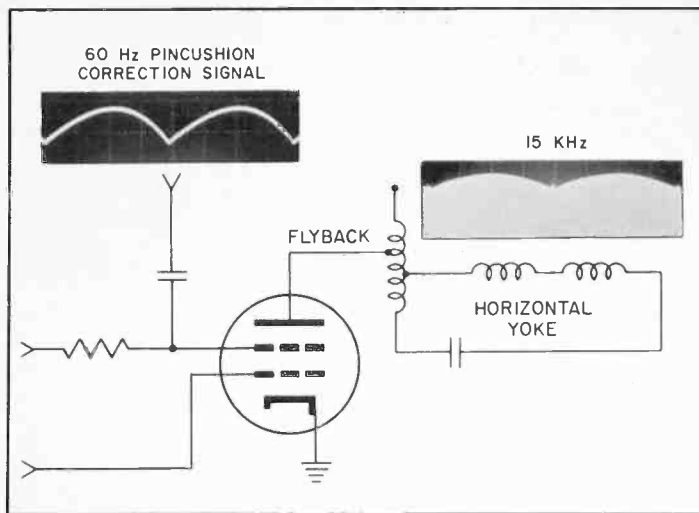
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A. Vertical Correction



B. Horizontal Correction

Figure 2—Basic Pincushion Correction Circuits for Color Receivers

used in the Sylvania D02-1 receiver. A 15 KHz signal from the "boost" supply is applied to both the triode and pentode grid. The plate transformer is connected so the signals from each plate will cancel one another when the two tube sections have equal gain. Also connected to the two grids are 60 Hz sawtooth voltages from the vertical deflection circuits. These two 60 Hz signals are of opposite phase. As the vertical scan progresses from top to bottom, first the pentode is conducting, with the triode cut off. Toward the center of vertical scan, both tube sections conduct, resulting in very little 15 KHz output from the transformer. Finally, the triode contributes to the output, with the 15 KHz output 180° reversed from that at the top. The transformer secondary is tuned to approximately 15 KHz by the .18 μ f capacitor. The secondary is connected in series with the vertical yoke windings, and adds 15 KHz current to the vertical scan. The resonant transformer circuit shapes the current into approximately a sine wave; transformer tuning acts as a pincushion "phasing" control so the peaks of the signal occur at the center of each horizontal scan cycle. Figure 3 shows how the sine wave can provide satisfactory correction, although of not a parabolic waveshape.

A somewhat simpler pincushion correction circuit is shown in Figure 4. Only one tube section is used. When the tube is cut off by the 60 Hz vertical scan voltage, the 15 KHz signal is coupled directly from boost supply to the pincushion transformer. As the tube gain is increased, it bucks out more and more of the directly coupled signal and, at full gain, the tube overrides the other signal. This provides the required phase change in the correction signal. The remainder of the circuit is similar to that of Figure 3.

Saturable Transformer Circuit

The circuit of Figure 5 provides pincushion correction in a relatively simple, tubeless circuit. The heart of the circuit is a "saturable core transformer" which is connected to both the horizontal and vertical yoke windings.

The multiple-winding, three leg, saturable core transformer has several unique properties not found in a conventional transformer. The center windings are the "control" coils, the two outer windings are the "load" coils. By varying the current in the control coils, it is possible to vary the characteristics of the two outer legs. When the control current becomes large enough to saturate the core, any current flowing in the load windings will induce a current back into the control winding. Figure 5 shows the control coils connected in series with the vertical windings of the deflection yoke. Thus the saturable transformer is "controlled" at a 60 Hz rate. The two

load coils are connected in series with the horizontal yoke and have 15.75 KHz current flowing through them. Vertical yoke current is maximum at both top and bottom of the picture, saturating the core first in one magnetic "direction" and then the other. This reversal of saturation direction also reverses the polarity of the 15 KHz correction signal coupled back from the load to the control windings. At the center (from top to bottom), the 15 KHz signals in the outer legs cancel each other. Therefore, no correction is applied to the picture tube.

In Figure 5, an additional center tapped inductance is connected to the control windings. In the earlier tube circuits

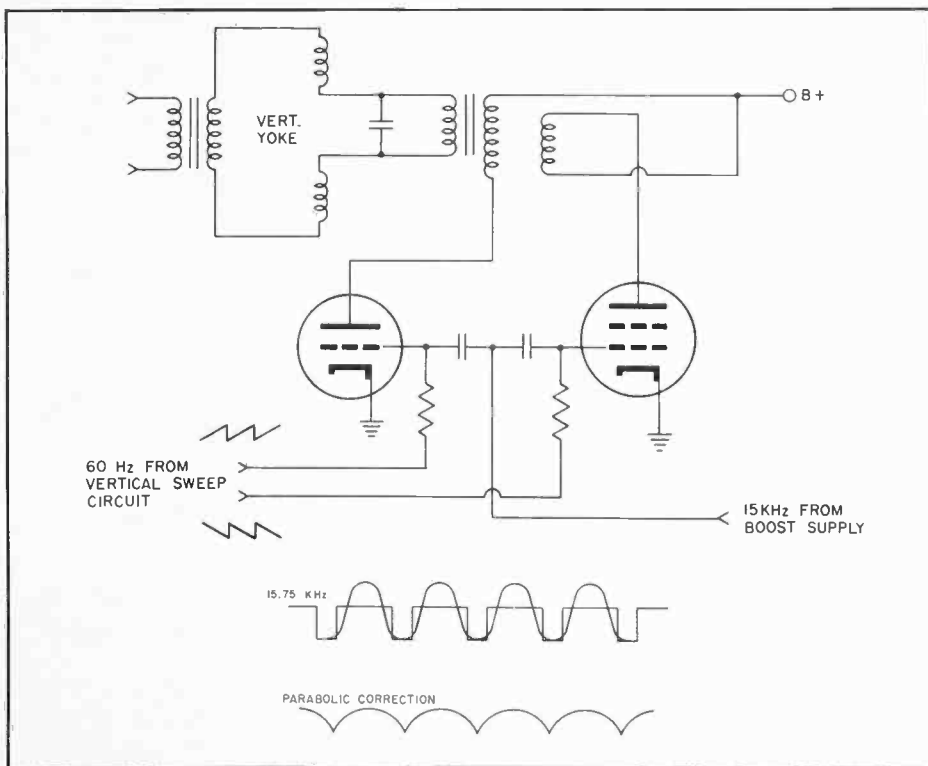


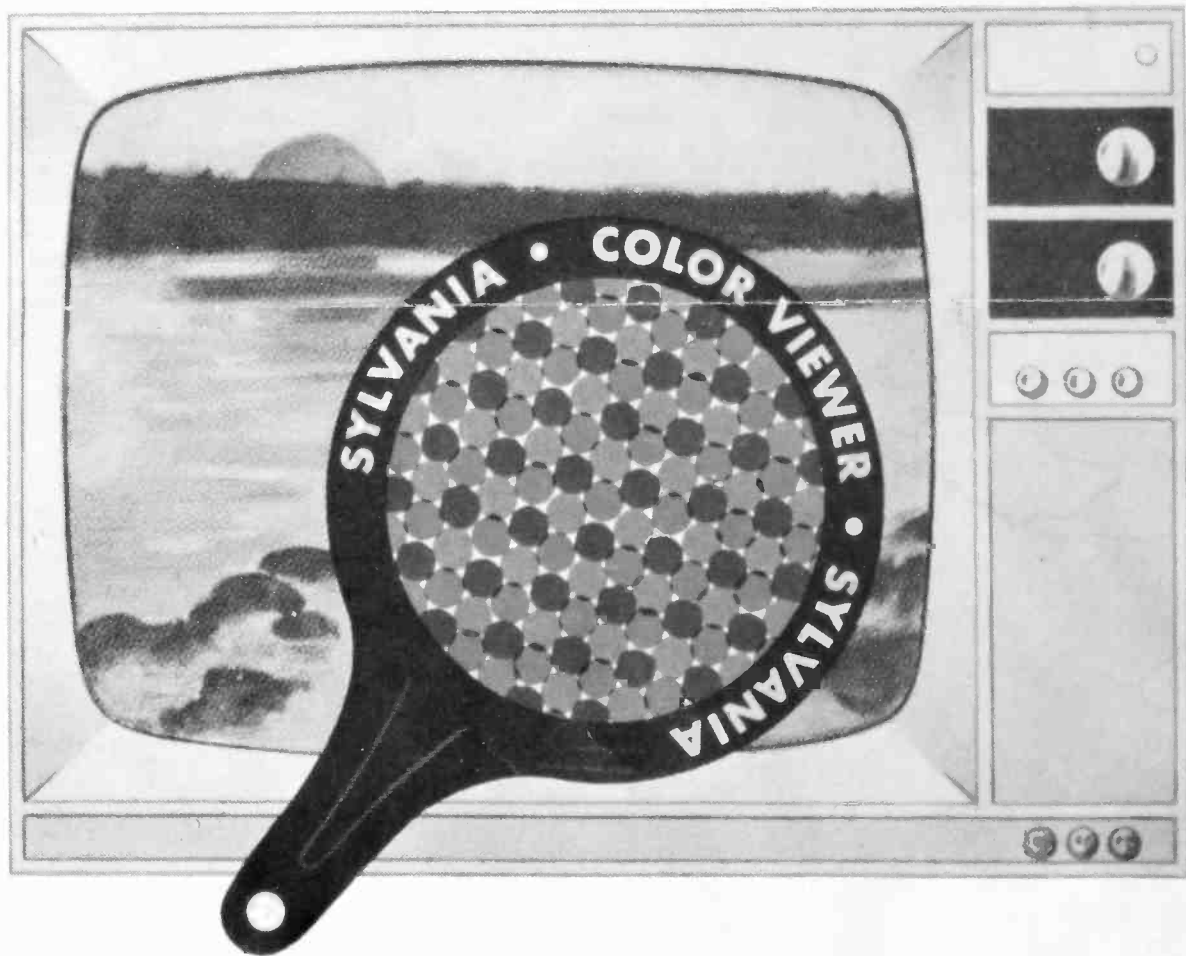
Figure 3—Basic Vertical Pincushion Correction Circuit Used in Sylvania 25" Color Receiver

Dealer Section

Winter 1966 □ VOL. 33, NO. 4

MARVIN CHANNING, EDITOR, Published for the Professional Radio-TV Service Dealer

NEW FROM SYLVANIA! "THE COLOR VIEWER"



The Sylvania "Color Viewer" is our latest time-saving device for the television serviceman. It ends the chore of having to open the back of a TV set and work on the picture tube so the individual displays can be seen. You now have a quick, easy means of studying the various color fields produced by the receiver even when

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THE NUTCRACKER

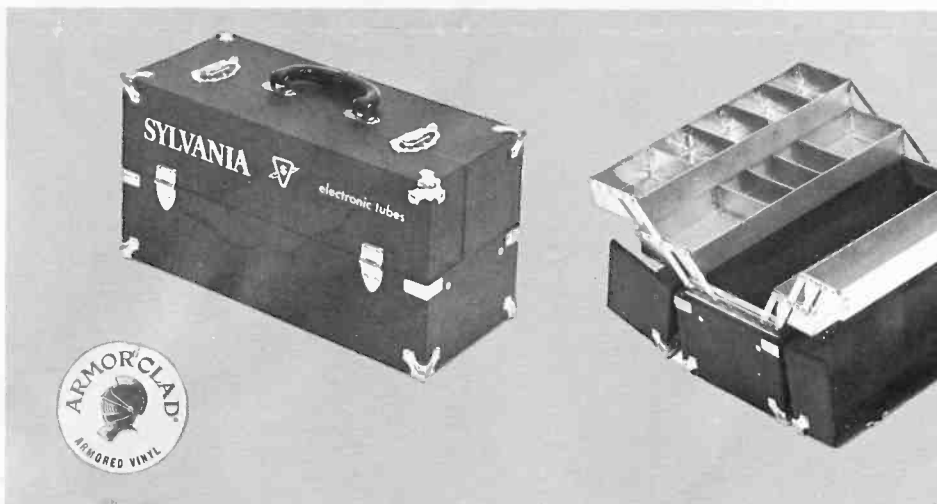
he is really an enchanted prince. In an adventurous journey through magic lands, the girl helps him find his palace.

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Tchaikovsky's immortal "Nutcracker Suite," is played by the Philharmonic orchestra of Budapest.

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ADDITIONS, SILVER SCREEN 85

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16CJP4	16" 114° Kimcode III	Motorola	23HLP4	23" 110° Kimcode III With Mounting Ears	Motorola
16CMP4	16" 114° Kimcode III	Emerson	23HUP4	23" 110° Kimcode III	RCA
17EMP4	17" 114° Kimcode III	Philco	23HWP4	23" 110° Kimcode III With Mounting Ears	Emerson
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17LP4B	17LP4, 17LP4A, SG17LP4A, 17SP4, 17VP4, 17VP4B	21AWP4A	21AWP4, SG21AWP4A
17QP4B	17QP4, 17QP4A, SG17QP4A, 17UP4, 17YP4	21EP4C	21EP4, 21EP4A, SG21EP4B
21AMP4B	21ACP4, 21ACP4A, SG21ACP4A, 21AMP4, 21AMP4A, 21AQP4, 21AQP4A, 21BSP4, 21CUP4	21FP4D	21FP4, 21FP4A, SG21FP4C, 21FP4C
		21WP4B	21WP4, 21WP4A, SG21WP4A
		21XP4B	21XP4, 21XP4A, SG21XP4A
		21ZP4C	21ZP4, 21ZP4A, 21ZP4B, SG21ZP4B
		24CP4B	24ADP4, 24CP4, 24CP4A, SG24CP4A

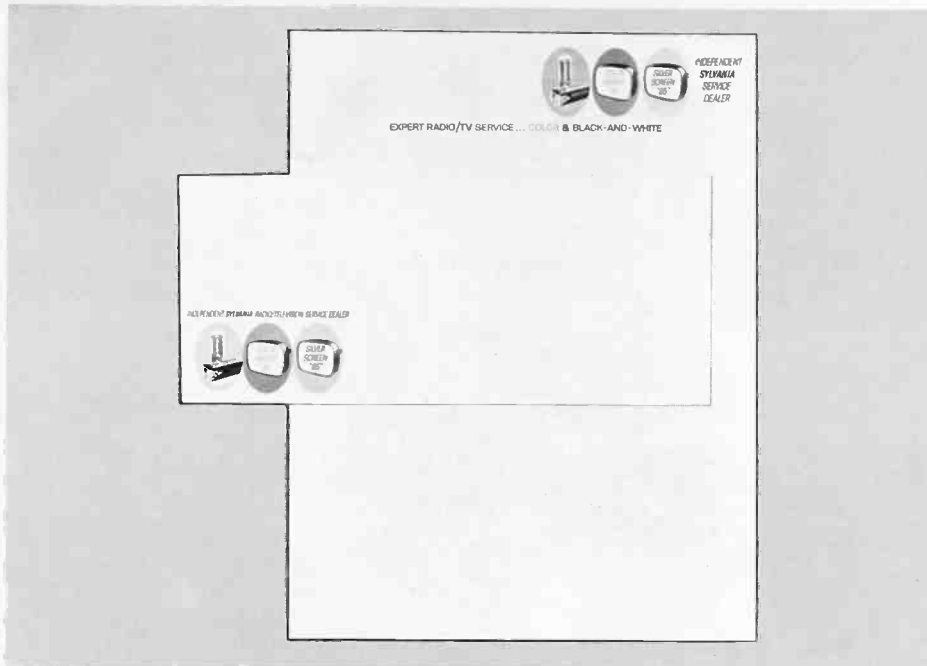


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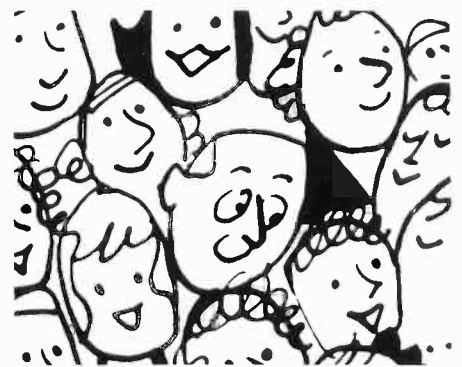
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him is Mrs. DiBeneditto, Sylvania Area Sales Manager Tony Garcia, Mrs. Guido Santilli, standing next to her husband who is Secretary of Laurel Electronics, Mrs. Anthony Coccio, standing next to her husband, the President of Laurel Electronics. The young man is Theodore Grieder, grandson of the Coccio's.

Dealers' Digest

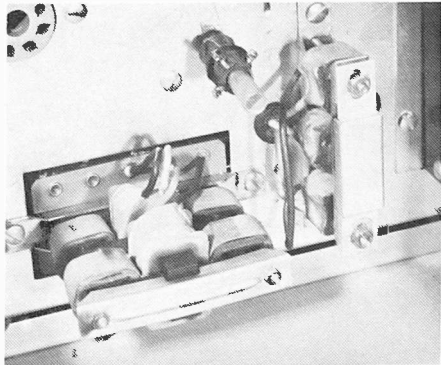


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We're sorry, but unused items cannot be returned or acknowledged.

(Figures 3 and 4), the transformer secondary circuit was tuned to 15 KHz, providing maximum power transfer into the yoke circuit. The inductance in Figure 5 also tunes the control winding to the horizontal frequency to couple a greater amount of pincushion correction current back into the vertical yoke circuit. Without the additional external inductance, the transformer windings would not tune to 15 KHz. The additional coil is adjustable to act as a "pincushion phase" control similar to that used in the tube circuits. The center tap on this inductor is connected to the midpoint of the two yoke damping resistors. This



Saturable Core Transformers used in Typical Pincushion Correction Circuit

maintains the symmetry of the yoke for 60 Hz currents. A variable resistance across the tuned circuit adjusts the overall amount of 15 KHz current applied to the yoke, and is the "pincushion amplitude" control. Voltage dependent resistor R1 limits the peak currents flowing through the load windings.

Horizontal Pincushion Circuits

A 60 Hz parabolic wave exists at the B+ side of the vertical output transformer, across the decoupling circuit. The wave is used for providing the pincushion correction as shown in Figure 6A. Capacity coupling is used to vary the screen voltage (and the scan width) of the horizontal output tube. There is no adjustment to this circuit.

Some 25" rectangular color sets use a saturable transformer circuit to control the horizontal scan width. Figure 6B shows a multiple coil transformer having the control windings supplied with a slight DC bias plus a 60 Hz "control" signal obtained from the deflection circuit. The load coils are connected across part of the flyback transformer, and act as a variable "width coil", depending upon the 60 Hz control current. This circuit increases the picture width at the center (top to bottom) and reduces it at the top and bottom by varying the loading on the flyback circuit.

PINCUSHION CORRECTION ADJUSTMENTS

Because the circuits discussed have relatively few "active" components, they are not likely to cause trouble except in case of a complete component failure. In the tube operated circuits, a weak tube would probably

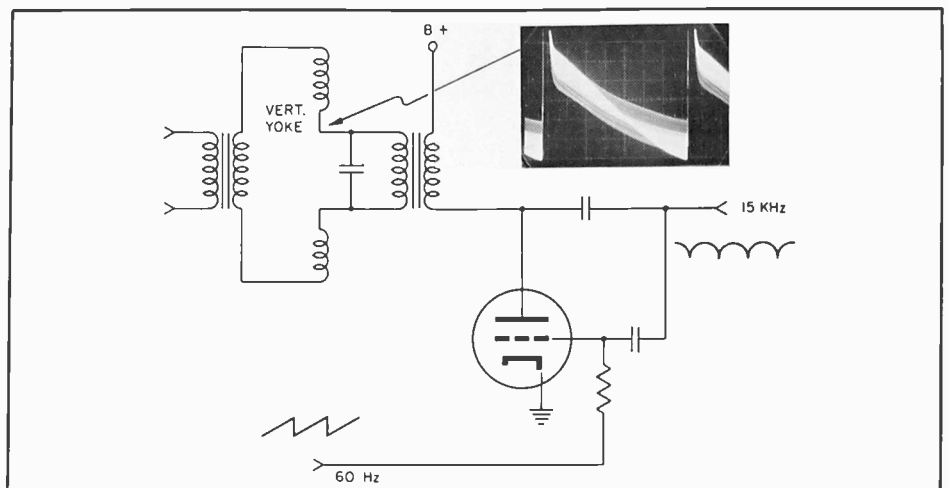


Figure 4—Simplified Pincushion Correction Circuit

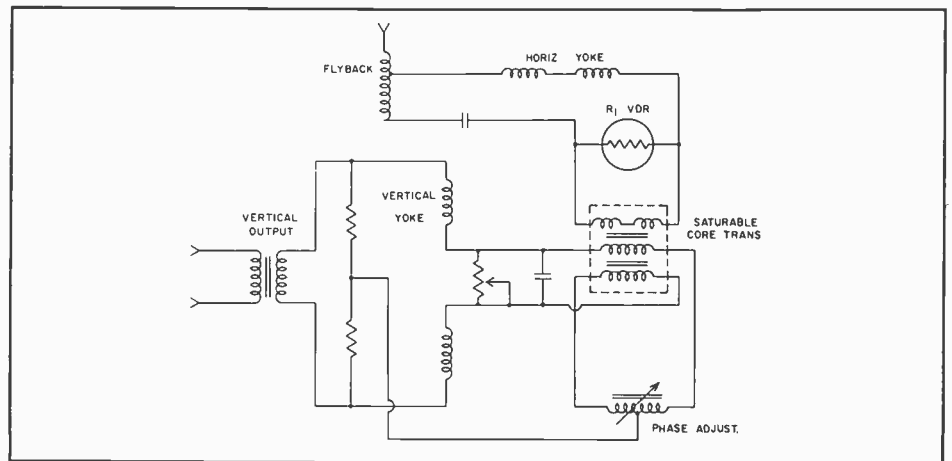


Figure 5—Saturable Core Transformer Circuit



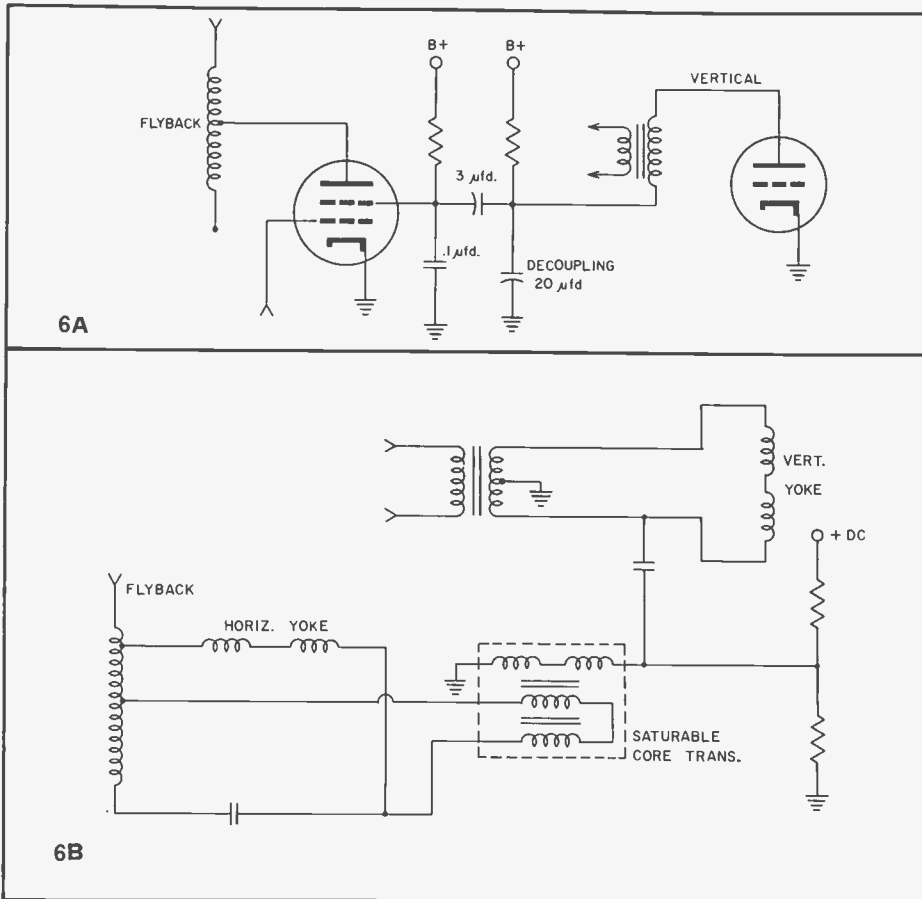


Figure 6—Two Basic Approaches to Horizontal Pincushion Correction

go unnoticed by the customer. Therefore, the serviceman should observe the picture for any obvious pincushion defects during service calls. Other component defects would likely cause a severe reaction on the horizontal or vertical scan circuits, rather than affecting only the pincushion correction circuits.

Pincushion adjustments are best made when observing a crosshatch pattern from any of the portable signal generators available for color servicing. The amplitude and phase controls behave somewhat like the convergence controls and are adjusted alternately to give straight horizontal lines across the top and bottom of the screen. The horizontal control is similarly adjusted to produce straight vertical lines at either side. By rotating the controls through their entire range you can quickly determine if they are operating properly.

SUMMARY

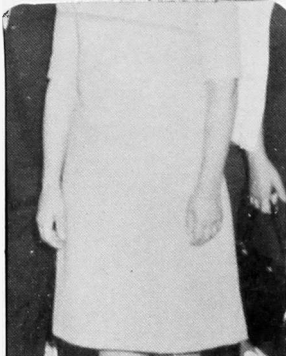
We have seen that the large screen, 90° color tubes cannot use the familiar "pincushion" magnets to correct for the inherent distortion in wide angle deflection systems. A brief look at the electrical requirements for pincushion correction showed that they could be met by coupling a slight amount of 15 KHz energy into the vertical deflection coils, and by changing the horizontal scan size at a 60 Hz (vertical) rate.

There are two basic pincushion correction circuits for coupling the 15 KHz signal into the vertical yoke: the vacuum tube-balanced transformer combination, and saturable transformer circuits. Correction for distortion at the side is accomplished by either a saturable transformer type of "width control," or by varying the horizontal output tube screen voltage.

Pincushioning service problems are relatively minor in the new color receivers because of the few "active" components. Adjustments can be readily made when observing a crosshatch pattern.


At first glance, the various pincushion correction circuits that are used in present large screen color receivers may seem complex because of their interconnection between the two deflection systems. However, when they are "pulled out" and examined, you will find them relatively simple. With a good understanding of these circuits, servicing problems can be handled with ease.

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SYLVANIA NEWS
WINTER, 1966

Printed in U.S.A.

R. A. HUMPHREYS, TECHNICAL EDITOR This information in Sylvania News is furnished without assuming any obligations.

Principles of COLOR TV Purity-Practical Viewpoint

By

R. L. Carr and W. D. Murphy

Overnight the serviceman has been expected to become an expert in the field of color TV receiver set-up and adjustment. Although thoroughly versed in the mechanics of performing such adjustments as "purity, convergence, etc.," the actual "why" of these adjustments may be a bit obscure. With a good understanding of the principles associated with the adjustments, the serviceman can more readily diagnose and correct applicable problems.

This article deals with the "why" associated with the adjustments for purity. The word purity is used to describe uniformity of color in the primary fields (red, blue, and green) as well as all combinations of these fields. For example, the blue field is considered pure when the blue raster is a uniform blue, with no significant contamination from red or green light. The white field is considered pure when there is no significant difference in tint from area to area due to disproportionate amounts of the primary colors. Therefore in the simplest sense, good purity to the home viewer is the ability of the picture tube to reproduce a true and uniform color at any point on the screen, i.e., if the received picture contains a solid yellow object, the color of the object should have the same degree of yellow throughout.

Color purity should not be confused with picture convergence which will be discussed in detail in a subsequent article. Where purity involves the uniformity of color, convergence pertains to accurate registration of the three color image

components of the picture over the entire screen. It is apparent that good purity is absolutely essential for optimum picture fidelity. No amount of convergence adjustment will compensate for poor purity.

In order to fully understand the principles of "purity," it is necessary to first examine the techniques involved in the manufacture of the color picture tube itself.

If you were to look at the color photograph reproductions in this article through a magnifying glass, you would find them composed of an array of small individual color dots, rather than continuous colored spectrums. Some areas are composed of a mixture of two or three different colored dots to create a desired color.

The faceplate of a color picture tube is similarly constructed, but with dots of three different types of phosphors. One type emits red light, one type green, and the third type blue. It is the combination of these three different phosphors, excited by three separate electron beams, that makes possible the display of a colored TV picture. The dots are so small and closely spaced that, without the aid of a magnifying glass, they cannot be readily observed separately. There are approximately 7000 individual phosphor dots per square inch of the screen, or nearly one million over the entire faceplate of a 21 inch color picture tube; however each of the three electron guns (red, blue, and green) within the picture tube must separately excite only its corresponding phosphor.

PICTURE TUBE MANUFACTURE—

Shadow Mask Principle

Proper operation of the three separate phosphors of the picture tube is made possible by the use of a perforated shadow mask placed between the electron "guns" and the picture screen, and by optimizing the angle of approach of the three electron beams through the mask perforations. FIGURE 1 shows the principle of the shadow mask and also indicates the precise pattern in which each phosphor dot is placed on the screen. There is one hole in the shadow mask for each group of three phosphor dots. Because of the placement of the shadow mask with respect to the phosphor dots, an electron beam approaching from the proper angle can strike only one of the three dots. By reviewing the manufacturing process of color picture tubes, we see how the three electron beams excite only the correct phosphors.

The phosphor dot pattern is produced by a photographic process using the shadow mask itself to precisely locate each dot. For each of the three colors, the inner surface of the faceplate is coated with a mixture of phosphor and light sensitive photoresist material. The photoresist material normally used has the characteristic of hardening when exposed to ultraviolet (UV) light, and when hardened, it secures the phosphor to the faceplate. With the required phosphor and photoresist material on the entire screen, a

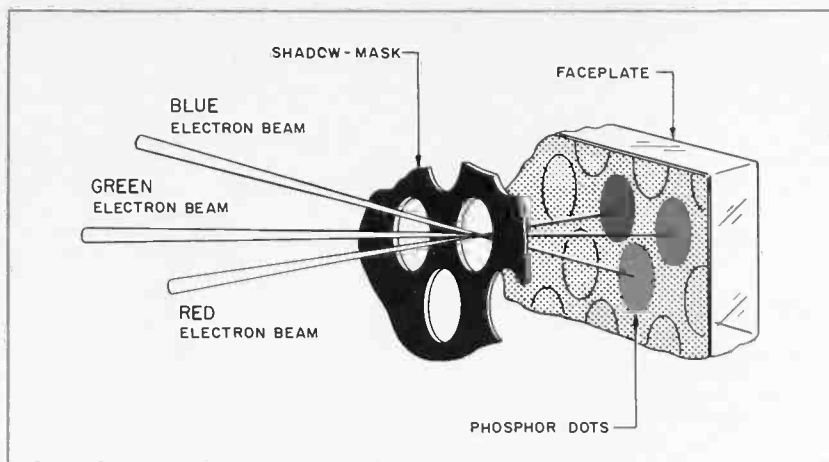


FIGURE 1—A Simplified Illustration of the Shadow Mask Principle.

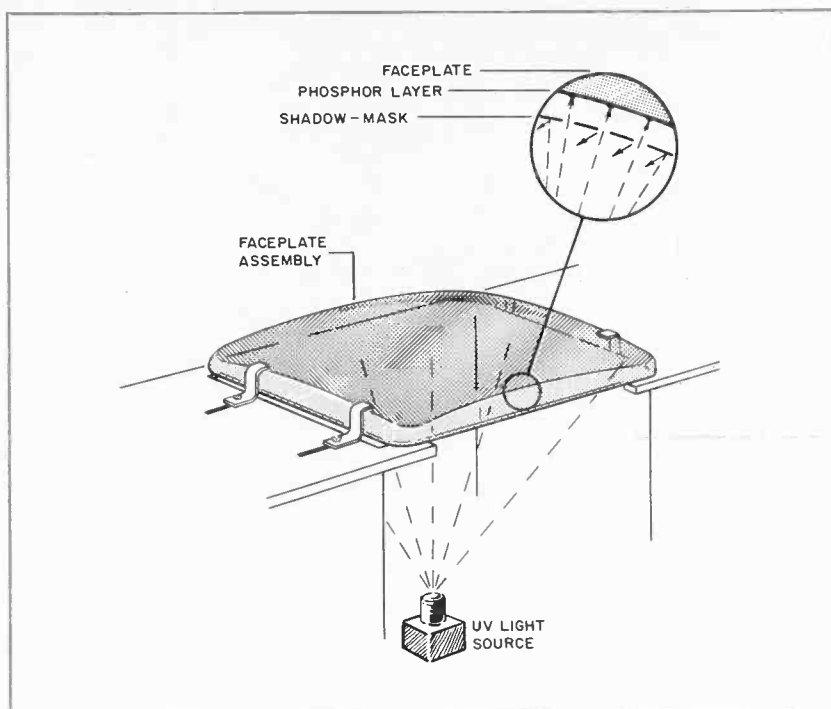


FIGURE 2—Exposure of Faceplate to Located Phosphor Dots.

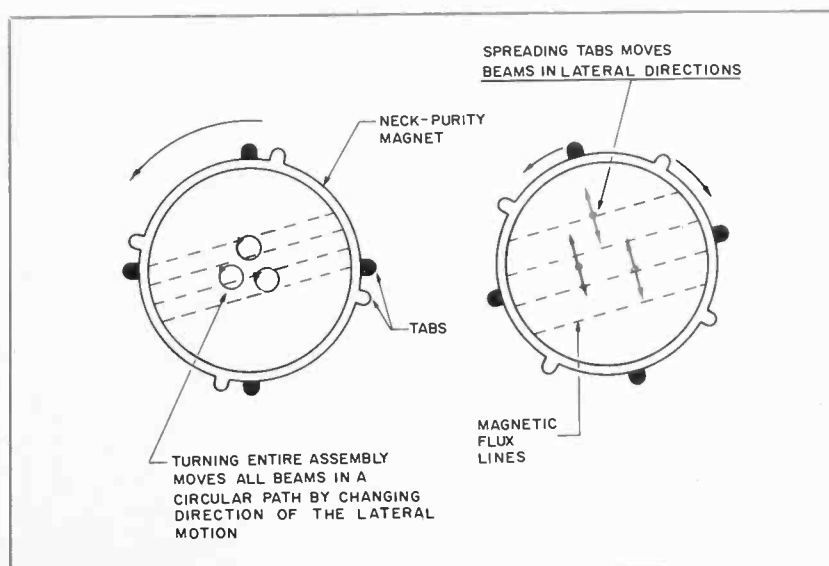


FIGURE 3—Function of Neck Purity Magnets. Magnets Position Beams to Pass Through Point Source.

shadow mask is then mounted to the faceplate. The shadow mask is precisely located by a suspension system which assures accurate positioning for repeating the process with each of the phosphor colors.

FIGURE 2 shows a faceplate and shadow mask assembly being exposed to a UV light source. A suitable lens system focuses this light into an extremely small "point source." Its position coincides with the path of electrons from a "gun" in the completed picture tube. The only UV light reaching the photosensitive faceplate is that which passes through the holes in the shadow mask. Following exposure, the shadow mask is removed and, after suitable processing, the unexposed phosphor and photoresist material is washed away. This leaves the screen coated with phosphor dots for the first color. To produce and locate phosphor dots for the remaining two colors, the same technique is employed. More photoresist material is applied, the UV light is positioned to correspond to the applicable color "gun," and the entire process is repeated. Each time, the same shadow mask must be used in locating each dot. Because of the precise identity between holes and dot patterns produced, neither the mask nor the faceplate can be substituted throughout the manufacturing process for any tubes.

Additional manufacturing steps include the sealing of the completed faceplate assembly to a funnel, positioning and sealing the three electron "guns" to the neck, exhausting, and processing of the internal parts for satisfactory operation of the finished tube.

PURITY—A Prime Factor in Color Picture Tube Adjustment

The first step in setting up a color picture tube is purity adjustment. The "red" gun must light only red phosphors, the "blue" gun blue, and the "green" gun green. The "red" gun electron beam must be made to pass through the same point at which the UV "point source" of light was located during exposure of the screen. Then, whenever an electron originating in the "red" gun passes through the shadow mask, it will hit only a red phosphor dot. The same applies to the "blue" and "green" guns and their respective phosphors.

A purity magnet surrounding the neck of the color picture tube is used to shift the three electron beams so they can be placed in the proper

Dealer Section

SPRING, 1966

VOL. 33, NO. 1



MICHAEL CRAIN, EDITOR, Published for the Professional Radio-TV Service Dealer

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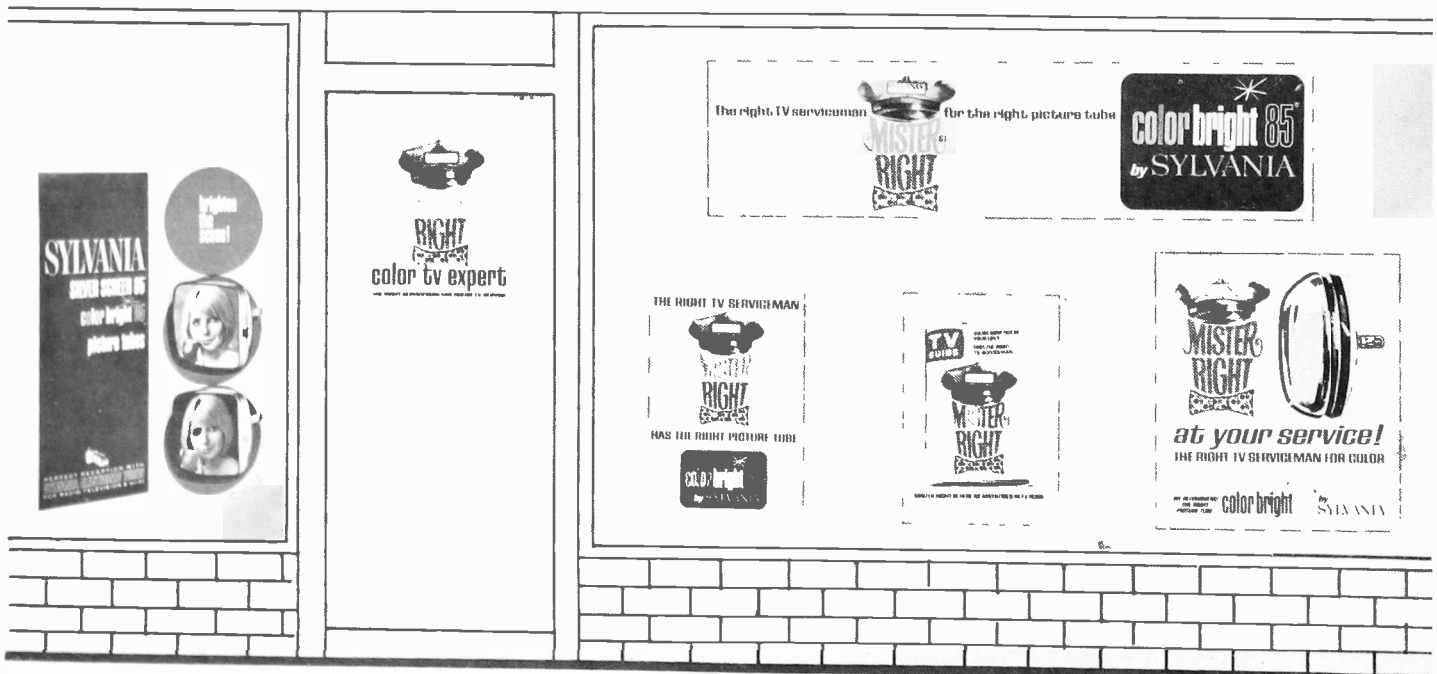
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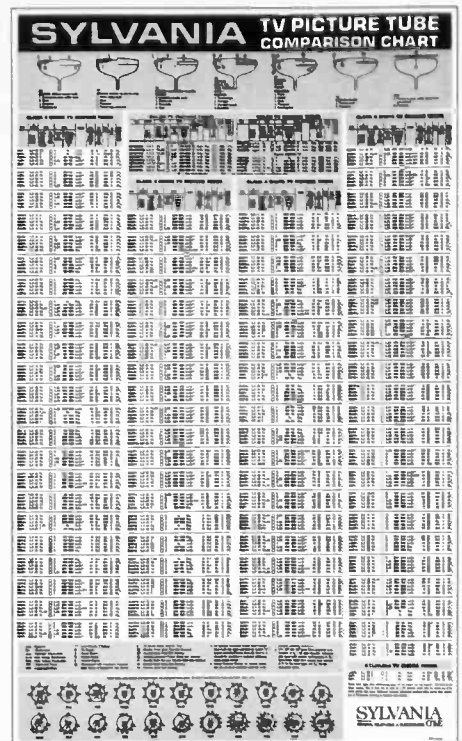
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19DSP4	19EFP4	RCA	23FAP4		Andrea, Delmonico
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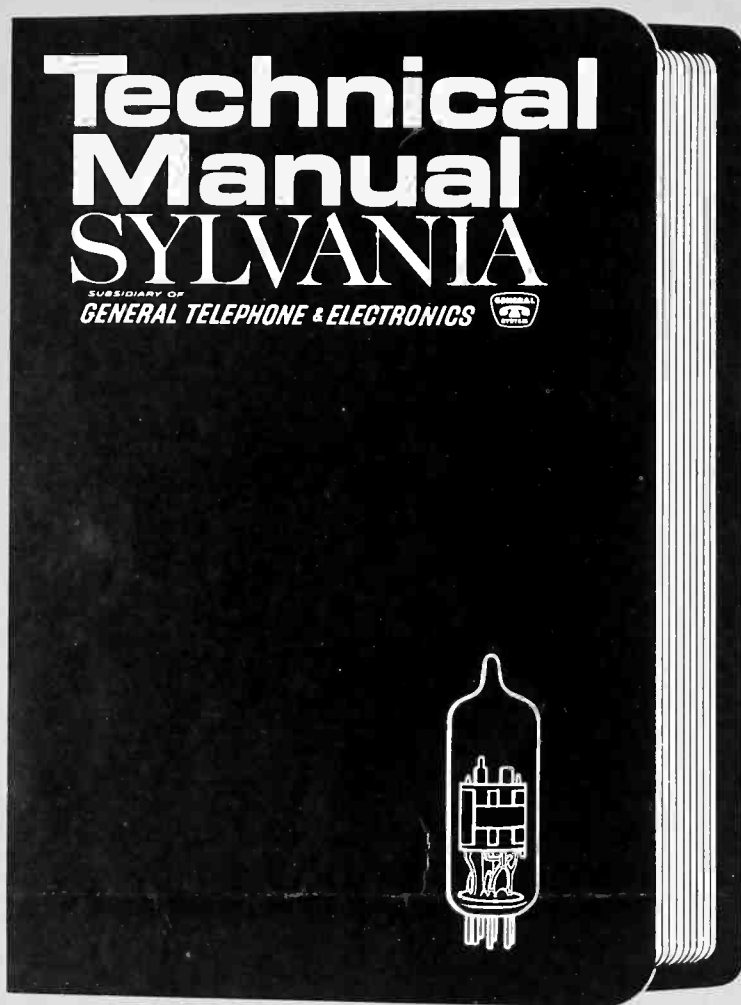
Seneca Falls, New York, as part of a bus excursion sponsored by Banner Electronics.

They viewed the step-by-step production of the *color bright* 85tm tubes; plus Sylvania's research, production and testing facilities.

The group indicated that they were impressed with Sylvania's modern

tube operations and that the tour proved both enlightening and enjoyable.

In the above photo, Irving Wolfe, president of Banner Electronics is at the far right with (right to left) John Taylor and Bob Hoffman of Sylvania. Bob Alm, also of Sylvania, is in the first row (kneeling) at the left.



SYLVANIA TECHNICAL MANUAL

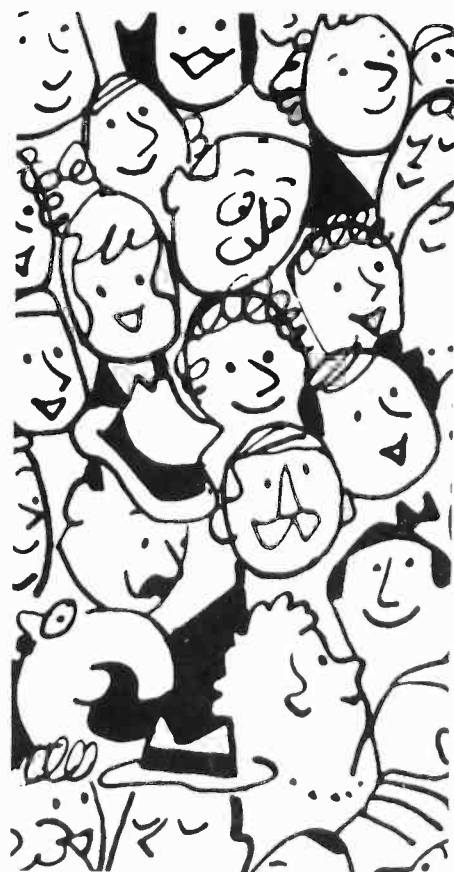
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From: Edward Kelley (House of Music —Submitted Without Address)

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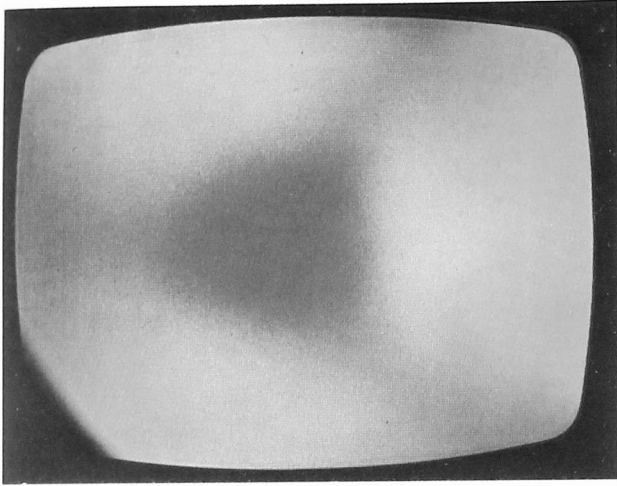
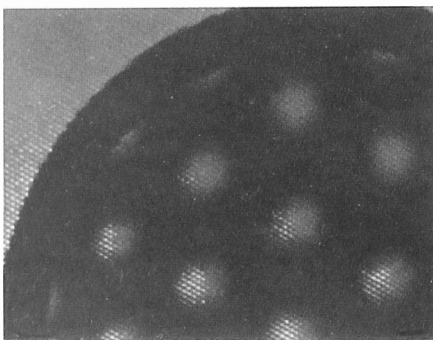


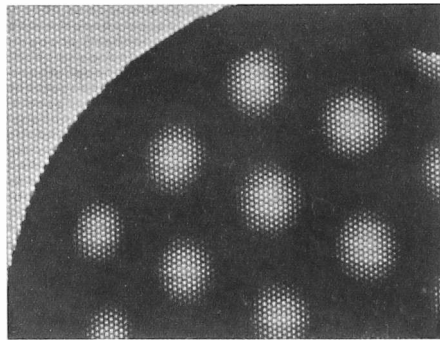
FIGURE 4 — Purity is Correctly Adjusted when Red Area is Centered.

this point must fall on red phosphor dots only.

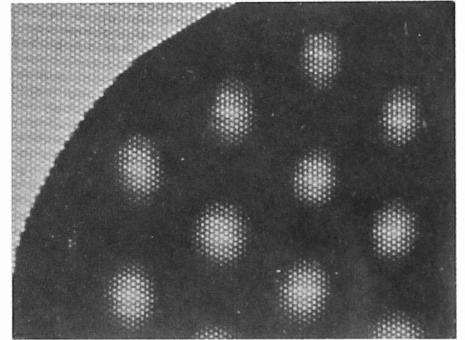
After center purity is achieved, the deflection yoke must be repositioned to obtain a pure red field over the entire screen. In passing through the deflection yoke, the "red" gun electron beam's direction of travel is gradually bent, depending on the magnetic field strength provided by the yoke current; however, it appears as though the electron beam had originated from a "point source" within the yoke. By proper yoke positioning, the "point source" or deflection point is now located within the picture tube at the point of the original UV light source. Thus,



Red Field



Green Field



Blue Field

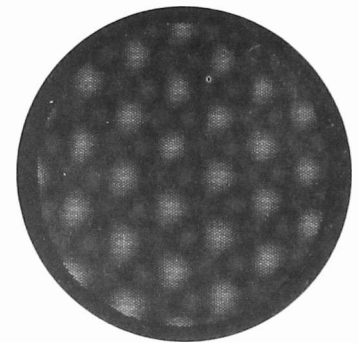
FIGURE 5—Color Field Impurities.

location. FIGURE 3 shows its effect on electron beam position. The initial purity adjustment is made with only the "red" gun operating since improper purity is more easily seen on a red field as compared to a blue or green field. In theory, when a pure red field has been achieved, the blue and green fields should also be pure. In practice however, a slight readjustment of the purity magnet is usually required to obtain purity of all three colors simultaneously. This is due to slight variations which may occur during tube manufacture, inherent differences in the patterns by the three beams, or perhaps component variations. In some cases all three primary fields can appear pure, but the white field exhibits non-uniformity. This can often be improved by changing the purity magnet adjustment without significantly altering the purity of the primary colors. At the present time, with black and white programs still outnumbering those presented in color, it is generally desirable to have

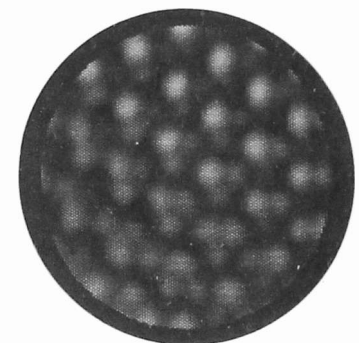
a uniform white field, even if it must be achieved at the expense of slight impurities in the individual color fields.

The yoke has no effect on purity in the center portion of the screen. Purity at the center is determined by the position of the purity magnet only. With only a small portion of the screen to observe, this purity adjustment can be made with relative ease.

When adjusting for center screen purity, the yoke is moved toward the rear of the picture tube neck. This deliberately causes impurity in all but the center portion of the screen where there is minimum deflection of the electron beam (see FIGURE 4). The strength and direction of the purity magnet field has been adjusted to produce a relatively small area of pure red, centered on the screen. The purity magnet positions the electron beam from the "red" gun so that it passes through the point at which the UV light source was located. By design, any electron passing through



A. Pure White Field.



B. Effect of Stray Magnetic Fields.

NOTE: The satisfactory achievement of optimum color purity does not complete the set-up procedures for a color picture tube; convergence is also required and will be discussed in a subsequent article.

FIGURE 6—Effects of Stray Magnetic Fields.

regardless of the deflection angle, the "red" electron beam will fall on the proper red phosphor dots. Red purity is then achieved over the entire screen, and, as mentioned previously, the blue and green fields should also be pure.

Purity of the red field is obtained when the beam strikes completely on each red phosphor dot. However, due to slight errors in adjustment, the beam may only partially land on the red phosphor dots. If a portion of the beam strikes the blue or green phosphor dots, the resultant red field impurity is readily apparent as shown in FIGURE 5; also shown are examples of blue and green field impurities.

Stray Magnetic Fields— Effect on Purity

Because the phosphor dots were positioned optically, each dot falls exactly on a straight line passing through the "point source," shadow mask, and the faceplate. Any magnetic field in the vicinity of the faceplate and shadow mask will cause a bending of the electron beam. This

may result in the wrong phosphor dots being excited, or that the beam may only partially land on the desired phosphor. The shadow mask and much of the mounting hardware for the picture tube are made of magnetic material, and as such, can easily be magnetized by stray fields thus setting up areas on the screen where the electron beams are slightly shifted from their correct position.

A pure "white field" located in a corner of the screen is shown in FIGURE 6A. FIGURE 6B shows the same field with improper beam landing caused by a small magnet attached to the faceplate. Since the effects of purity misadjustments and stray magnetic fields have a similar appearance, it is necessary to eliminate any stray magnetic fields prior to making purity adjustments. To offset and neutralize these stray fields, all magnetic parts of the faceplate, nearby chassis, and mounting assembly must be "degaussed" by being subjected to an intense AC magnetic field which is slowly reduced in strength to zero. This has the effect

of either removing a stray area of magnetization, or in the case of the earth's field or other externally caused field, of partially counteracting it with an opposing field. The actual degaussing procedure will not be discussed except to point out that it should be done prior to any adjustments made with the purity magnet and yoke.

Conclusion

With a good understanding of the principles associated with "purity," the color TV serviceman can more readily diagnose and correct applicable problems. This article has been devoted only to the fundamentals involved in the color picture tube. For complete picture tube set-up and alignment procedures, refer to SYLVANIA NEWS, Technical Section, Spring 1964, Vol. 31, No. 1.

Subsequent issues of SYLVANIA NEWS will include practical tips for making purity adjustments, a new and simple method for checking purity, and the fundamentals associated with "convergence."

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