Stan Cor's Corner

TIPS for the Serviceman

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Servicing The Vertical Sweep System

Practical hints on how to locate defects in the vertical deflection system as well as find suitable replacements for blocking oscillator and vertical output transformers.

The vertical deflection system in a television receiver is generally much simpler to analyze and service than the horizontal system. The typical vertical system has two stages, sometimes three, and feeds its signal into the vertical winding of the deflection yoke. There is no high-voltage stage associated with it, nor any automatic frequency control network.

The visual symptoms that appear when a defect develops in the vertical system will generally fall into one of the following categories:

Nonlinearity; foldover; non-synchronization; a trapezoidal pattern; and complete absence of any vertical deflection at all. Appropriate illustrations of the visual effect of each of these troubles are shown in Figs. 1 through 5.

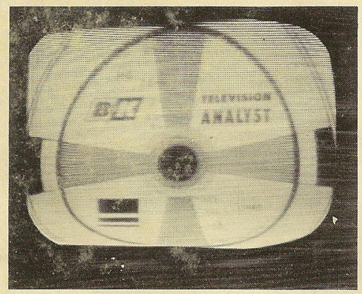

Fig. 1. Vertical nonlinearity (note egg shape of pattern).

Figure 1 demonstrates vertical nonlinearity. Note the uneven vertical spacing of the image. In the present illustration, the pattern is crowded together at the bottom, but this effect could develop anywhere in the image. To produce such an effect, the deflection wave would possess the form shown in Fig. 6. Note that it starts out in a linear (or straight) fashion, but then tends to develop a less steep rise near the end.

The difference between nonlinearity (Fig. 1) and foldover (Fig. 2) is really one of degree. For nonlinearity, the wave continues to rise, but at a less steep rate. In foldover, the wave rise is gradually reduced to zero; that is, it flattens out. See Fig. 7. Since the deflection voltage levels off, the electron beam in the picture tube stops moving downward. The point where it stops is the place where the white horizontal line is formed. Incidentally, while the picture in Fig. 2 is said to possess a foldover, this seldom occurs. The image simply bunches together at the point where the beam's downward motion ceases. A true foldover does occur occasionally, however.

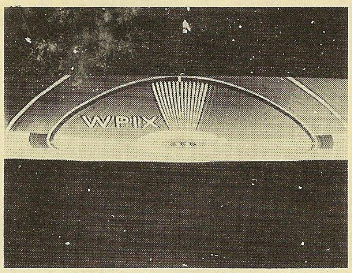

Fig. 2. An extreme case of vertical foldover.

Non-Synchronization produces the effect shown in Fig. 3. The image continues to slip or move vertically (up or down) and at no position of the vertical hold control will it lock in with the signal. This condition is caused either by the inability of the incoming vertical sync pulses to reach the vertical oscillator or, by a change in the oscillator component values so that the oscillator frequency cannot be brought close enough to the frequency of the sync pulses to effect a lock in.

A trapezoidal pattern, Fig. 4 (often termed keystoning), is due generally to a short in the vertical deflection windings of the yoke. It could also be caused by a sharp lowering in value in any of the components which shunt these windings. In the vertical system, these are either resistors or capacitors.

The final trouble, complete absence of any vertical deflection, is illustrated in Fig. 5. Here, no deflection voltage at all is reaching the deflection yoke. The reason might be an inoperative oscillator, a bad vertical output tube, a defective output transformer, or even a vertical deflection winding which has a defect. In spite of the many things that can cause this condition, it is usually one of the easiest troubles to isolate.

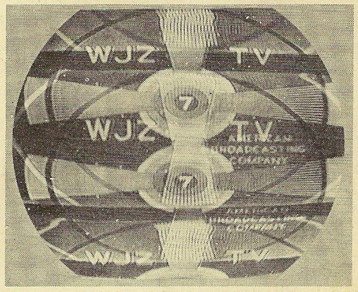

Fig. 3. Lack of vertical sync.

Typical Vertical Deflection Circuits

Before a fast, reliable servicing procedure is developed for the vertical deflection system, let us briefly note some of the various types of vertical deflection circuits. One of the first circuits used and one which is still employed to a considerable extent, is the blocking oscillator. Two forms of this circuit are shown in Fig. 8. The first illustration, Fig. 8A, has the blocking transformer connected between the grid and plate circuits. Note that the low-resistance winding is found in the plate circuit while the high-resistance winding is in the grid circuit. A deflection wave is developed across the combination of C3 and R5, while C2 serves simply as a coupling capacitor between this wave generating circuit and the vertical output amplifier. A triode tube is invariably employed here. This triode may be provided by a tube which contains only these elements, such as the 6J5 shown, or the triode may be part of a multi-section tube.

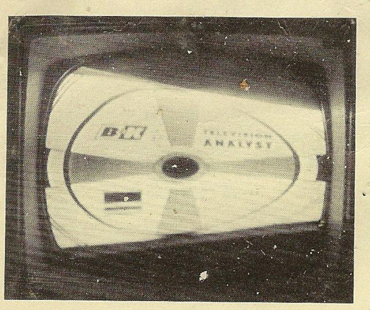

Fig. 4. A vertical trapezoidal or keystoning effect. (Taken with a B & K Television Analyst.)

The second blocking oscillator circuit is shown in Fig. 8B. Here the blocking transformer is connected between the grid and the cathode. Again, the high-resistance winding is in the grid circuit, but this time the low-resistance winding connects to the cathode. This is a significant difference and one that should be carefully observed whenever a replacement of the transformer is being made. (Incidentally, the same blocking transformer can be employed in either circuit if the stepdown ratio is the same.)

The deflection wave in the circuit of Fig. 8B is developed by C3 and R6. Capacitor C4 couples this signal to the grid of the vertical output amplifier. In essence, this portion of the circuit is similar to the wave generating section of Fig. 8A.

A typical output stage for both oscillators is shown in Fig. 9. This is a straightforward amplifier which feeds its signal either to an autotransformer (shown) or a two-winding transformer. From here, the signal goes directly to the deflection yoke.

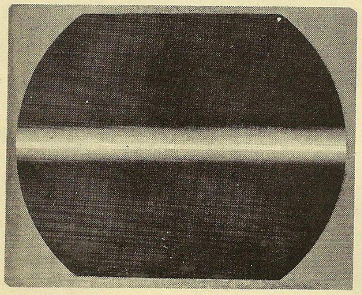

Fig. 5. No vertical deflection at all.

Another type of vertical oscillator is the two-stage multivibrator shown in Fig. 10. This circuit is actually nothing more than two amplifiers connected in cascade (i.e., series), with the output of the second stage fed back to the first. In this circuit, the feedback is provided by capacitor C5. The deflection wave is developed across C-3 and R-8.

The output of this multivibrator is fed to a vertical output stage which is similar to the output stage employed with blocking oscillators. The same three controls are found in this system that are found in the previous system.

Note that in the multivibrator system, there is only one transformer, and this is found in the plate circuit of the output stage. As before, this may be a conventional 2-winding unit or an autotransformer.

A later development of this system, which is used extensively today, combines the multivibrator and the output stage into one oscillator-amplifier circuit, such as the one shown in Fig. 11.

Controls in the vertical sweep system consist of a hold control, which regulates frequency, a height control and a linearity control. The height control governs the extent of the vertical sweep, but in actual operation it controls the lower half of the picture. The linearity control modifies the shape and amplitude of the deflection wave, but in actual operation it controls the upper half of the picture. There is a definite interaction between these three controls because of their position in the circuit and their effect on the deflection wave. Therefore, the adjustment of one usually requires some adjustment of the others.

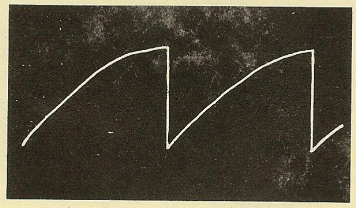

Fig. 6. This shape of vertical deflection wave will produce vertical nonlinearity.

Troubleshooting the Vertical System

Now that we have examined typical vertical deflection circuits, let us see where the defects previously attributed to the vertical system could originate. We will consider the vertical defects in the same order they were initially described.

1. Nonlinearity. When this condition (Fig. 1) is encountered, the first place to check is at the vertical linearity control (see R3, Fig. 9 and R9, Fig. 11). If rotation of this control does not correct the trouble, check (scope) the deflection wave at the grid of the output tube. If it possesses the proper shape, then the nonlinearity is occurring in the output stage. Note that the wave should be straight or linear from just beyond its starting point right up to where retrace sets in. (Nonlinearity in the initial starting segment is permissible because during this portion of the cycle the beam is either blanked out or just off the screen at the top of the image.) On the other hand, if the deflection wave does tend to level off, Figs. 6 or 7, then the nonlinearity is being developed prior to the vertical output stage.

If the trouble is being developed in the output stage, check the tube for low emission, gas, or leakage. If the tube is OK, look for a defective component in the linearity network. This includes C2 and R4 in Fig. 9 and C7 and R10 in Fig. 11. If a pentode tube is serving as the output amplifier, check its screen-grid resistors for a change in value.

Also be on the lookout for a leaky coupling capacitor, C1 in Fig. 9 and C6 in Fig. 11. A leaky capacitor will upset the bias on the output tube and cause it to operate on a nonlinear portion of its characteristic curve. Thus, a leaky coupling capacitor can cause nonlinearity and/or foldover.

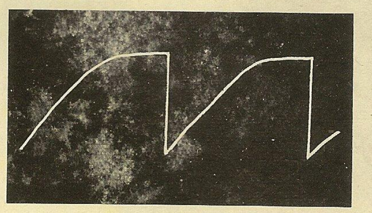

Fig. 7. This vertical deflection waveform will produce a foldover effect.

Nonlinearity can develop in the oscillator stage if the tube is weak or the B+ to the tube is low. Weak oscillations can also be produced in a blocking oscillator if a partial short circuit develops in the blocking transformer (T1 in Fig. 8A and 8B). Such a partial short will prevent the proper transfer of energy from primary to secondary windings and result either in no oscillations or weak oscillations. This is a difficult defect to uncover directly because a resistance measurement of either winding will hardly show the change in resistance produced by the partial short. The only sure test is to try another transformer in place of the suspected unit.

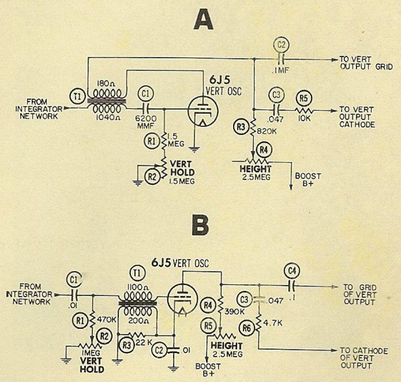

Fig. 8. Two forms of vertical blocking oscillators.

The most important item governing the replacement listing of a vertical blocking oscillator transformer is the primary to secondary turns ratio. The most common ratio is 1:4.2; however, two other ratios are also employed, 1:1.5 and 1:3.33 D.C. resistance of the primary and secondary winding may vary considerably, and yet the same turns ratio will be employed. Physical dimensions, mounting styles, and mounting centers are also observed, since blocking transformers with the same turns ratio are available with different mounting brackets.

When connecting a blocking transformer replacement unit into the circuit, careful attention should be paid to the color coding of the wires. Although there will be a few exceptions, the following color connections were used by all manufacturers. In a circuit arrangement, such as is shown in Fig. 8A, the blue lead goes to the tube plate, the red lead connects to B+ (through whatever dropping resistors may be employed), the green lead goes to the tube grid and the yellow lead connects to integrator network. In the circuit arrangement of Fig. 8B, yellow goes to the grid, green to the integrator network, red to ground and blue to the cathode of the tube. If these connections are not properly made, weak oscillations or possibly no oscillation will occur. Should you experience this condition, it can be corrected by reversing the connections of *either* the blue and the red leads *or* the green and yellow leads (not both). A few manufacturers have employed a copper band, wrapped around the transformer, as a shield against stray field pickup. If the replacement transformer does not possess this feature, it would be necessary to utilize the copper band from the original unit, on the replacement unit, to achieve the best results.

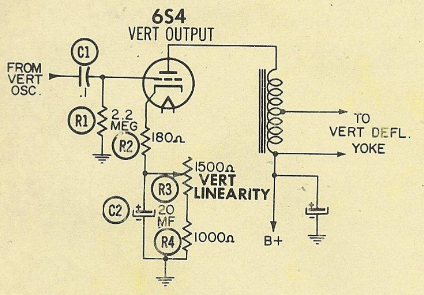

Fig. 9. A typical vertical output stage suitable for the blocking oscillators shown in Fig. 8.

Thus far, we have been discussing weak oscillations in a blocking oscillator. The same conditions can be caused in a multivibrator circuit by an increase in resistance in any series resistor (such as R4, Fig. 11) in the feedback network, by a weak tube, by low B+, or by increases in load resistors.

2. Foldover. Foldover is a more aggravated condition of nonlinearity and this can readily be seen from the waveform. In Fig. 6, for example, this type of wave will cause nonlinearity, but no foldover. In the second waveform, Fig. 7, the top levels off and, at this point, a definite white bar appears horizontally across the screen.

Again, localization of the defect causing this condition can be made by scoping the deflection wave at the grid of the vertical output tube. If the wave appears normal here, the trouble is in the output stage. On the other hand, if the waveform is bent over, check in the oscillator stage, particularly the wave generating network (C3 and R5 in Fig. 8A; C3 and R6 in Fig. 8B; C3 and R8 in Fig. 10; and C4, C5, and R7 in Fig. 11).

For the trouble to develop in the output stage, the following are likely causes:

a. A defective tube.
b. Low B+ on tube.
c. A short circuit in the linearity network.
d. A defect in the output transformer.

Of these possible sources of trouble, detection is most difficult in the output transformer unless a complete open circuit exists here and then, of course, no vertical deflection at all will take place. However, if all of the other components in the output stage appear to be good, and the picture on the screen has foldover, another output transformer should be tried.

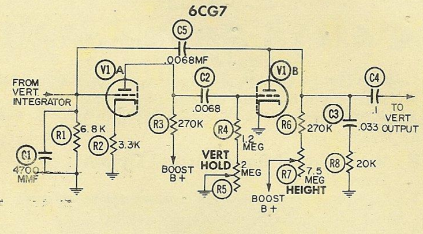

Fig. 10. A multivibrator circuit.

There are three important factors of a vertical output transformer which govern the recommendation (replacement listing). They are:

A. Primary Impedance.

The primary impedance of the replacement unit should be reasonably close to the impedance of the original unit. (This impedance is measured with a fixed D.C. current flowing through the primary winding and a given amount of 60-cycle voltage applied across it.) In design this impedance is determined by the characteristics of the vertical output circuit (i.e., tube parameters, available voltage, etc.).

Use of a transformer with too low an impedance would cause foldover to occur, plus an increased current flow through the output tube. This could reduce the life of the tube. Use of a transformer with too high an impedance will result in reduced output power, and hence difficulty in attaining the necessary height.

B. Primary-To-Secondary Turns Ratio.

In early receivers, 10:1 (isolation type) and 11.4:1 (autoformer type) turns ratios were used predominately. However, in the past 6 or 7 years other turns ratios have been employed. Present day replacement units range, in turns ratio, from 5:1 to 50:1, and if the same approximate turns ratio is not used, between the output tube and the vertical deflection yoke windings, nonlinearity and insufficient height may occur.

C. Current-Carrying-Capacity of the Primary Winding.

The characteristics of the vertical output tube and its circuit dictate the required current-carrying-capacity of the transformer design. If a transformer primary winding must carry 30 MA.D.C. and the replacement unit is designed for 20 MA., it is likely that the transformer may overheat and foldover could occur. This would be due to the fact that the air gap in a transformer designed to handle 20 MA. would be different than the air gap in the unit designed for 30 MA. A current flow higher than the unit is designed to handle could cause the core to saturate, and when this happens no change in flux will be produced for the peak current variations. This is equivalent to leveling off of the deflection wave and the visual result would appear as a white horizontal line or bar across the screen. A few manufacturers have employed a copper band, wrapped around the transformer, as a shield against stray field pickup. If the replacement transformer does not possess this feature, it would be necessary to utilize the copper band from the original unit, on the replacement unit, to achieve the best results.

3. Lack of Synchronization. Inability of the image to lock in or remain in sync can usually be traced to some trouble in the oscillator or some prior stage. The first thing to determine when unstable sync is encountered, is whether suitable sync pulses are reaching the oscillator. To do this effectively, the vertical oscillator should be disabled so that the voltage it produces does not obscure the incoming sync pulses. If the tube filaments are wired in parallel, simply remove the oscillator tube from its socket. If the filaments are series-wired, either a dummy tube (possessing an active filament) may be used or one of the plate or grid leads disconnected from the tube socket so that the stage becomes inoperative.

With the oscillator out of commission, check the incoming pulses. If these are not reaching the oscillator, trace back through the circuit until you find the place where the signal path is broken. If the sync pulses are reaching the oscillator—and instability is still present—check the components which determine the oscillator frequency. These are: C1, R1 and R2, in Fig. 8A; C1, R1, and R2 in Fig. 8B; C1, C5, R1, C2, R4, and R5 in Fig. 10; and C1, C2, R1, C6, and R8 in Fig. 11. Also check the deflection wave generating components. If this circuit is open, instability to sync in, will also occur.

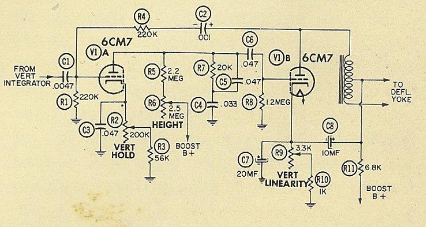

Fig. 11. A multivibrator which incorporates the vertical output stage in its circuit.

4. Trapezoidal Pattern. A trapezoidal or keystone pattern stems from a defect in the vertical section of the deflection yoke. This has been covered in detail previously.

5. No Vertical Deflection. A complete lack of any vertical deflection, as indicated

by a narrow horizontal bar on the screen, can be caused by a defect almost anywhere in the vertical system. When this condition is encountered, the first step is to check the vertical oscillator. This is best done with an oscilloscope connected across the wave-generating circuit. If no oscillations are being developed, check the tube and other components in the oscillator. In blocking oscillators, the transformer is a possible offender because in high humidity climates, the copper tends to erode, resulting in an open circuit. This tendency is particularly marked in areas lying near the ocean.

If a deflection wave is present at the oscillator output, then the open circuit must exist in the output amplifier circuit, in the output transformer or even the yoke. It is possible for the vertical yoke winding to be defective and still have the horizontal winding function satisfactorily. Electrically, the two windings are essentially independent of each other.

A partial short in the vertical output transformer will lead to reduced height of the image, with possible nonlinearity. Another common fault, is a complete open circuit, with no output at all. Such open circuits will be quickly revealed by either no positive voltage on the plate of the output tube or by a simple continuity check.

Related Information On Replacement Selection

When seeking a suitable replacement for a vertical blocking oscillator transformer or a vertical output transformer one of the following reference sources should be consulted:

a. Your Local Parts Distributor
b. T.V. Replacement Guide(s)
c. Howard W. Sam's "Photo Facts"
d. Manufacturers' Data
e. Any other reliable source.

When checking these sources be sure to use any and all specific information you may have pertaining to the original unit (i.e., the part number, chassis and/or model number, etc.). Particularly the part number. Also be sure your reference sources are up to date.

An important characteristic, that must be observed about the original unit, is whether or not it is an auto-transformer or an isolation transformer. Until recently all vertical blocking oscillator transformers were isolation type transformers. However, this cannot be said about vertical output transformers, since manufacturers have employed both types for the past ten or eleven years. Basically a vertical output transformer consists of a primary winding and a secondary winding. These two windings are brought out (terminated), either, as a two-winding-four-lead unit commonly referred to as an isolation type, or, as a tapped single winding-three-lead unit commonly referred to as an auto-transformer (or auto-former). In the auto-former type there is an electrical continuity between leads (i.e., one winding is internally connected to the other winding). Variations of

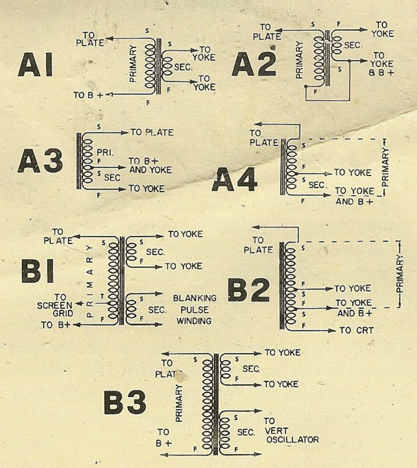

Fig. 12. A Basic Vertical Output Transformers

1. Isolation
2. Isolation connected as an Autoformer
3. Autoformer
4. Autoformer

B Variations of Basic Vertical Output Transformers

1. Tapped primary for screen connections and isolated blanking pulse wdg.
2. Autoformer with blanking pulse wdg.
3. Combination vertical blocking oscillator and vertical output.

these two basic transformers are: tapped primary for screen grid connection; addition of a third winding specifically designed to deliver vertical blanking pulses (brought out separately as two leads or as a tap [single lead] of an auto-former); also, used by some manufacturers (in a unique circuit), a combination—vertical blocking oscillator and output transformer. (Figs. 12A & B illustrate the various forms of vertical output transformers as shown on a schematic).

It would be well to note, at this point, that a three lead auto-transformer type can be replaced by a four lead isolation type, simply by connecting the start of one winding to the finish of the other winding, and using this as the tap. Since the transformer is not marked to indicate starts and finishes, it is possible to connect the finish of one winding to the finish of the other winding. Should this occur the two windings would be bucking and the visual result would be insufficient height and possibly an upside-down picture. This can easily be corrected by reversing the connections of one winding.

It is also possible to replace an isolation type with an auto-former type, but due to necessary circuit changes, when this replacement is indicated it should be accompanied with adequate installation notes.

The question arises; how do you go about determining a suitable substitute or replacement for a vertical blocking oscillator transformer or a vertical output transformer when you have no information at all regarding the part number, model number or chassis number? To make matters worse the trade name of the receiver is either obliterated or one which is not listed in any reference sources.

Since most receivers utilize five to six other transformers and many coils, it may still be possible to identify the model and/or chassis number. Normally one or more of the parts are marked with a part number or numbers. Check for part numbers on the power transformer, flyback, filter choke and audio output transformer. Now take an up-to-date cross-reference and use it in reverse, that is, attempt to find a listing which shows part numbers that are the same as, or similar to, the numbers you found on the other parts in the receiver. Using this method you may find the correct chassis listing, and from this obtain the proper replacement recommendation for the defective part.

However, should the above method fail to produce any information, as a last resort it will become necessary to use the trial and error method of substitution. Since the vertical blocking oscillator transformer has one-of-three turns ratios and the physical construction is also a criteria, the substitution method here is not too difficult.

Substitution of the vertical output transformer is not quite as easy. The turns ratio, primary impedance and current-carrying-capacity of the vertical output transformers used in original equipment were often varied. These factors are difficult to determine not only because they require a special test set-up, but also because the unit is defective. Therefore it becomes necessary to try one transformer after another, until you find a unit which will produce adequate results, or employ a multi-tapped-ratio vertical output transformer such as the Stancor VO-109.

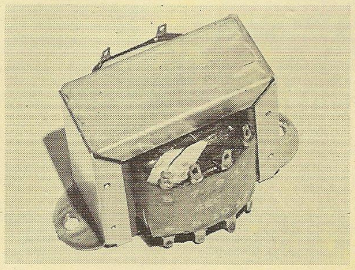

Fig. 13. Stancor's multi-ratio vertical ouput transformer—Part No. VO-109.

The VO-109, shown in Fig. 13, possesses two primary windings and a secondary winding with a number of taps. Several typical circuits are shown on the instruction sheet (packaged with the unit) and the one closest to that employed in the receiver should be selected. After the transformer is connected into the circuit, various secondary tap connections should be tried until the greatest height and best linearity are obtained. It may be necessary to try several circuit arrangements before you achieve the desired results. The multi-tapped-ratio unit may then be left in the circuit, or if you desire to use it as a bench test unit, a replacement unit possessing the same turns ratio may be selected.

More later, Stan