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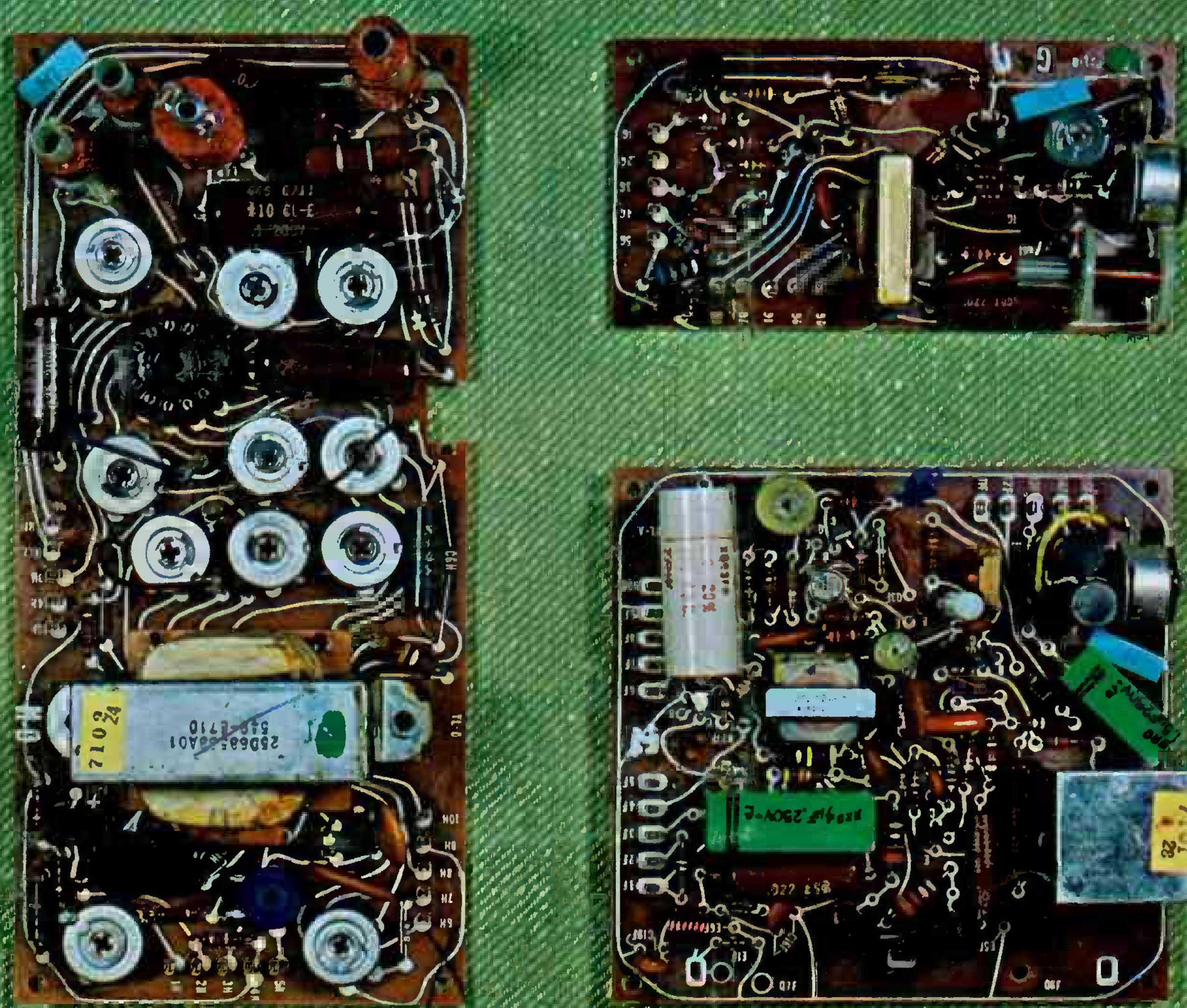

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- Many-Hued Rasters—Part 2
- Color TV Service Training
- An Introduction to FET's
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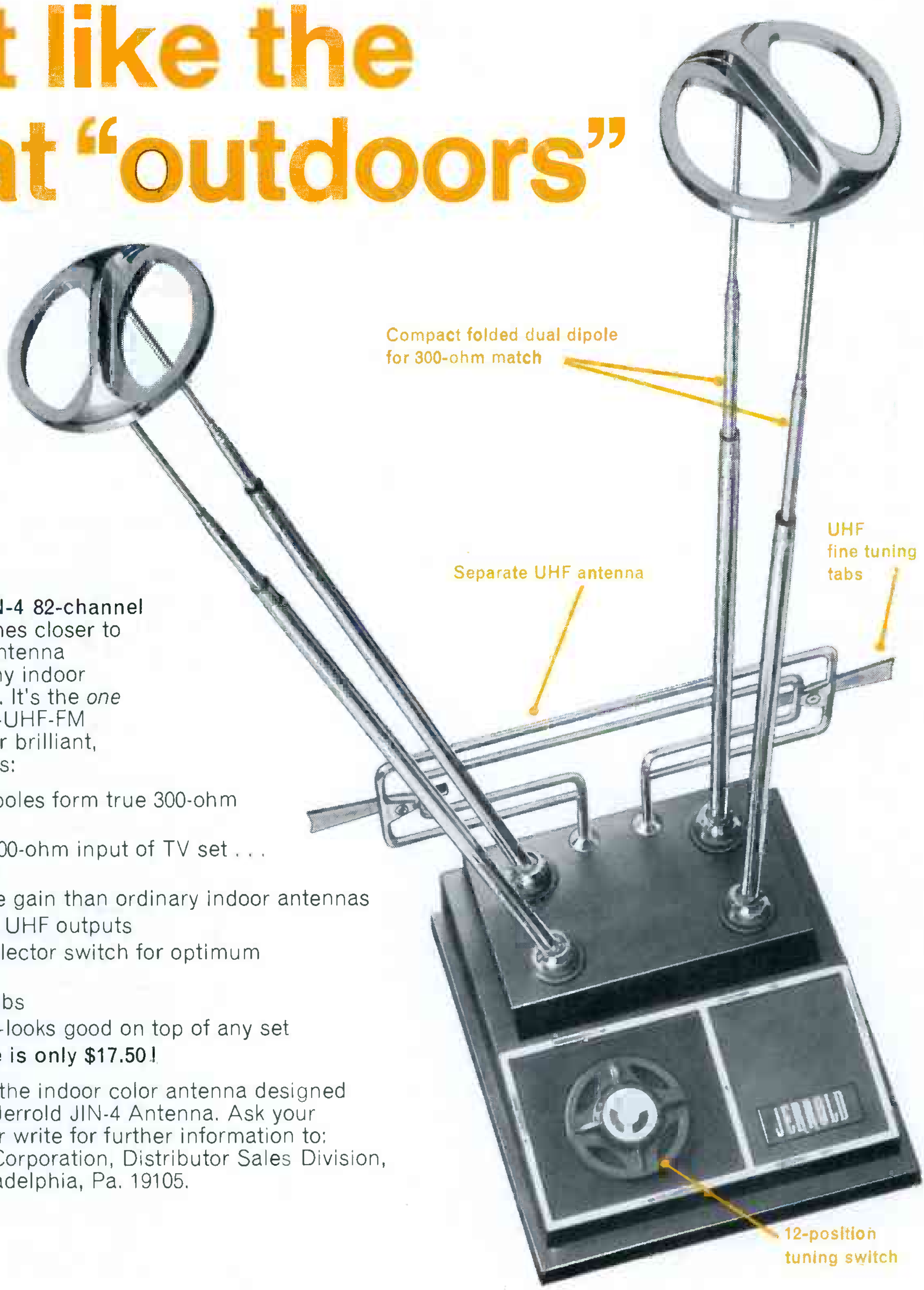

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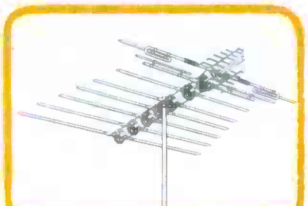

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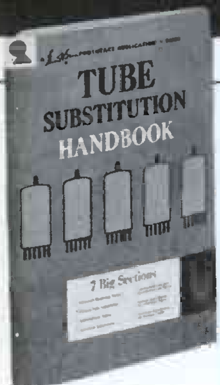

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TUBE SUBSTITUTION HANDBOOK

direct substitutes

Included are the older tubes that will substitute directly for the new tubes. This information supplements the sections in the Tube Substitution Handbook for American Receiving Tubes and Picture Tubes.

basing diagrams

The basing diagram for each new tube will help you in the servicing of new receivers when service literature is not available.

typical characteristics

The typical, or average, characteristics of each new tube can be of great help when troubleshooting new circuits.

easy reference

The direct substitution list will be cumulative each month. Thus, only the latest edition need be carried in the Tube Substitution Handbook.

Direct Substitutions

To Replace	Use
1BK2	1AX2
	1S2A
1BL2	*
2EG4	*
3BL2	3AT2
	3BN2
3BN2	3AT2
	3BL2
3JC6A	3HM6
	3HT6
	3JC6
	3JD6
4JC6A	4HM6
	4HT6
	4JC6
	4JD6
4JH6	4BZ6
5GH8A	5EA8
	5GH8
	5U8
6BY11	*
6CL3	6CJ3
	6CK3
	6DW4A
	6DW4B
6CM3	*
6EJ4	*
6JC6A	6HM6
	6HT6
	6JC6
	6JD6
6KT6	*
6KV6	*
6KY6	*
6LB6	*
6LC6	*
6LH6	*
6LJ6	*
6ME8	*
6MF8	*
6MK8	*
7KY6	*
7KZ6	*
8GU7	*

*No replacement at present time. See future editions of Tube Substitution Handbook

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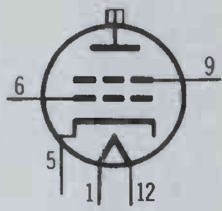
To Replace	Use
9GH8A	9EA8
9KX6	*
9LA6	*
12CL3	12CK3
	12DW4A
12FQ7	*
17CL3	17CK3
	17DW4A
17KV6	*
22KM6	*
25CM3	*
29KQ6	*
30KD6	*
34CM3	*
11SP22	*
11TP4	*
12BQP4	12BKP4
12BUP4A	12BUP4
12CBP4	*
12CEP4	*
12CNP4	12CFP4
12CQP4	*
12CSP4	*
12CTP4	*
15KP22	*

To Replace	Use
15LP22	*
16CHP4A	16CHP4
16CSP22	*
17EQP4	*
19GBP4	19CZP4
	19DAP4
19GJP4	19DQP4
	19DWP4
	19FCP4
19GJP4A	19DWP4
	19FCP4
	19FJP4
	19GJP4
19GVP22	*
19GWP22	*
19HAP4	*
21FBP22A	*
21FYP4	*
21GCP4	*
21GJP4	*
22JP22	*
22KP22	*
23FLP4	*
23GHP4	*
23HBP4	*
23HRP4	*
23HUP4	23HUP4A
23HUP4A	23HUP4
23HWP4	*
23HWP4A	23HWP4
25TP4	*
25WP22	*
25XP22	*
25YP22	*

General Specifications

High-Voltage Regulator
Fil.—6.3V @ 0.2A

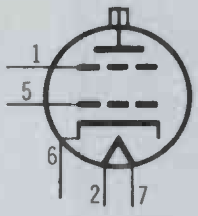
6EJ4



12HC

High-Voltage Regulator
Fil.—6.3V @ 0.2A

6LH6



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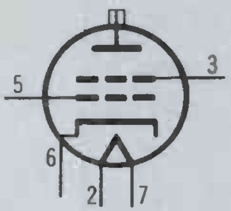
High-Voltage Regulator
Fil.—6.3V @ 0.2A

6LJ6

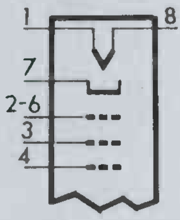


8MQ

General Specifications

Protection—tension band
Deflection—110°
Filament—6.3V @ 0.3A
Grid 2—400V

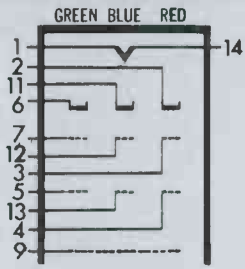
11TP4



8HR

Protection—tension band
Deflection—90°
Filament—6.3V @ 0.9A
Grid 2—110 to 300V

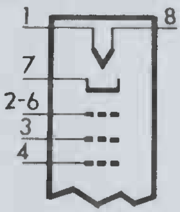
16CSP22



14BE

Protection—tension band
Deflection—114°
Filament—6.3V @ 0.45A (11 sec)
Grid 2—400V

17EQP4

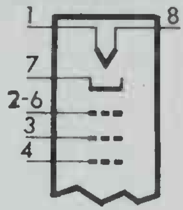


8HR

General Specifications

19GJP4A

Protection—tension band
Deflection—114°
Filament—6.3V @ 0.45A (11 sec)
Grid 2—400V

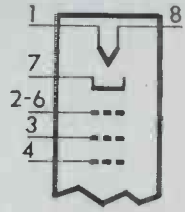


8HR

Suggested direct replacements: 19DWP4, 19FCP4, 19FJP4, 19GJP4

21GCP4

Protection—tension band
Deflection—114°
Filament—6.3V @ 0.45A (11 sec)
Grid 2—400V



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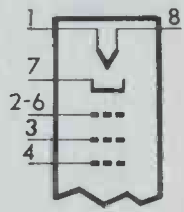
21GJP4

Protection—tension band
Deflection—114°
Filament—6.3V @ 0.6A
Grid 2—400V



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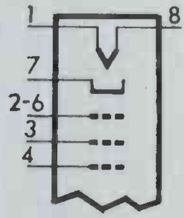
General Specifications

23HWP4A

Protection—tension band
Deflection—110°
Filament—6.3V @ 0.45A (11 sec)
Grid 2—50V



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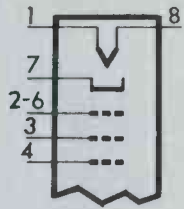
Suggested direct replacement: 23HWP4

25TP4

Protection—tension band
Deflection—110°
Filament—6.3V @ 0.6A
Grid 2—400V



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Solid-State DEFLECTION CIRCUITS PART 2

by Robert G. Middleton

Part 1 of this article discussed the operation of solid-state vertical sweep systems, horizontal AFC, and horizontal oscillator stages, along with an anaylsis of the troubles and troubleshooting techniques associated with these stages. Part 2 will complete our discussion of solid-state deflection circuits with an analysis of the horizontal output and high-voltage stages commonly employed in transistor TV receivers.

Operational Analysis

A typical horizontal-output and high-voltage configuration is shown in Fig. 11. This is a hybrid circuit that employs a high-voltage rectifier tube. As noted in Part 1 of this article, driver transistor Q602 is first cut off and then driven into saturation by the output from the horizontal oscillator. Fig. 12 shows the normal waveforms at the base and the collector of Q602. The rectangular waveform from the collector is transformer-coupled to the base of horizontal-output transistor Q603. We say that Q602 is operated in the switching mode; or, the collector has two extreme operating points as indicated at S and C in Fig. 13. Transition between cutoff (C) and saturation (S) is very rapid in normal operation.

Note diode D604 in Fig. 11; this diode helps to damp out the ringing of transformer T602 and also rectifies the overshoot and boosts the +DC supply for the preceding phase-splitter stage. Observe that Q603 also operates in the switching mode. In other words, the waveform at the base of Q603 (Fig. 12) drives the transistor rapidly into cutoff and then drives it rapidly into saturation When Q603 conducts, the yoke current increases linearly. Meanwhile, capacitor C617 is charging. At the end of the forward scan interval, the base waveform suddenly cuts off Q603. Due to the inductance of the horizontal-output system, a ringing oscillation starts.

Ringing begins with a large positive overshoot pulse that quickly reverses current flow through the horizontal-deflection coils and initiates flyback. This overshoot pulse at the collector of Q603 is stepped up by the horizontal-output transformer and is rectified by V601 to produce the 18-kv supply voltage to the picture tube. Conduction of V601 imposes a comparatively low-impedance load on T603 that limits the peak overshoot voltage. As the negative half cycle of ringing starts, damper diode D605 becomes forward-biased In turn, the low impedance imposed by conduction of D605 limits the negative ringing excursion. At the same time, C617 discharges linearly through the horizontal-deflection coils and D605 to ground. This discharge provides the first half of the ensuing forward-scan interval.

To summarize briefly, the first half of the forward scan occurs when Q603 is cut off, and while C617 discharges through the yoke and D605. The second half of the forward scan occurs (smoothly in normal operation) as Q603 is switched into conduction, and C617 is charged again through the yoke. Fig. 14 depicts the sequence of circuit action in the horizontal-output system. This understanding is of practical importance in troubleshooting, because it follows that distortion on the left-hand side of the raster is most likely to be caused by a defect in the damper circuit, while distortion on the right-hand side of the raster is most likely to be caused by a defect in the horizontal-output circuit.

General Discussion

The DC voltages and currents in horizontal-output systems used in transistor television receivers, are quite different from those in tube-type receivers. A general comparison is seen in Fig. 15. A transistor output stage operates at much lower DC voltages, but current is heavier than in a tube-type output stage. The current is not the same in all receivers, but it is normally higher in large-screen receivers. More power is required to scan a large-screen picture tube, and power is equal to the product of voltage and current. Note that a hybrid configuration is not employed in Fig. 15B; the high-voltage rectifier consists of the diode assembly X30. In general, resistances in transistor horizontal-output systems are lower (often very much lower) than resistances in tube-type horizontal-output systems.

You will find considerable variation in the circuitry of horizontal-output systems. For example, Fig. 16 shows an arrangement in which the horizontal transformer and deflection coils are connected in parallel between the main DC source and the collector of Q22. The driving waveform to the base is a rectangular pulse. A PNP transistor is used in this circuit. Hence, the drive waveform is a positive-going pulse. On the other hand, an NPN transistor is used in circuit of Fig 11, and a negative-going drive waveform is utilized. The sequence of circuit action in Fig. 16 is basically the same as explained in Fig. 11.

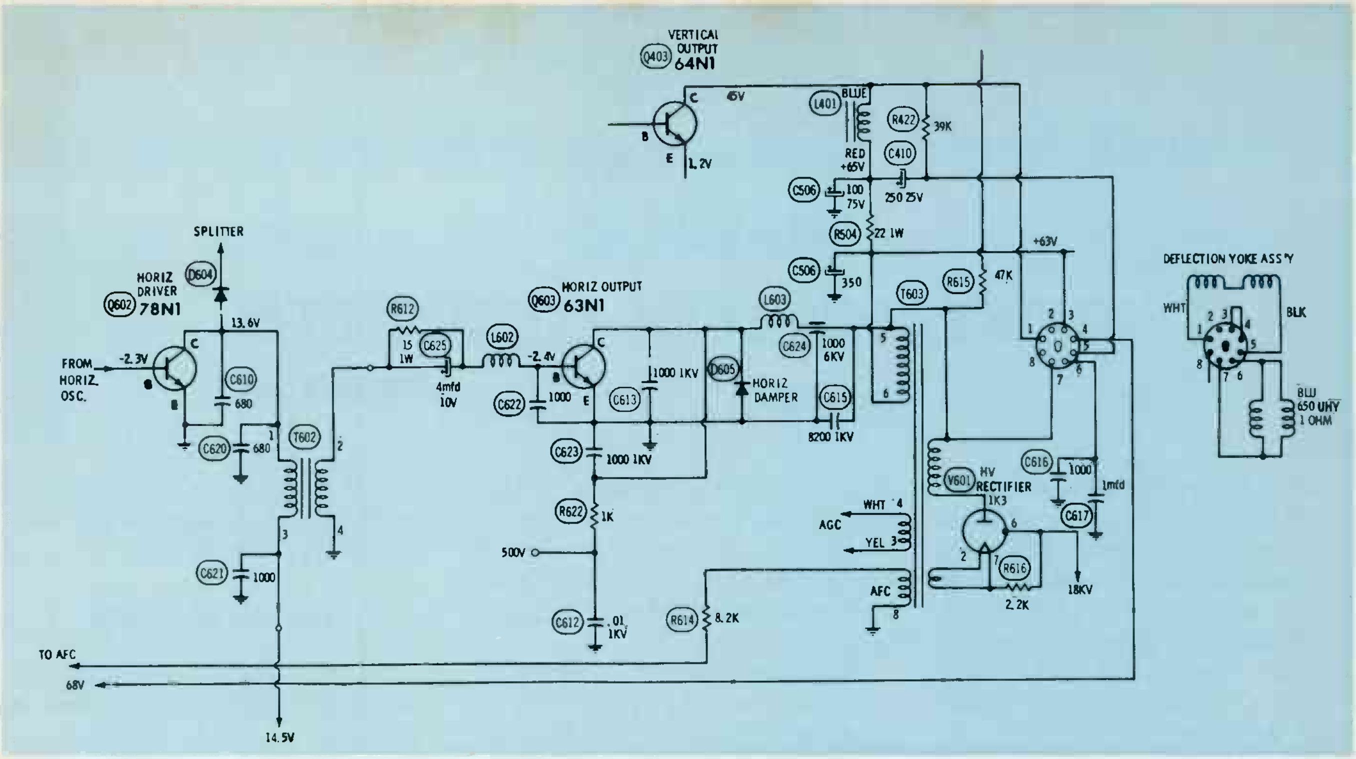


Fig. 11. A typical transistor horizontal-output and high-voltage configuration.

Transistor horizontal sweep systems include at least two auxiliary circuits (besides the high-voltage rectifier) to supply increased DC voltages to other sections in the receiver. Although these auxiliary circuits can be compared with the boost circuit in a tube-type receiver, they place a relatively light load on the flyback system of a transistor receiver. These DC voltages are utilized by the picture tube. The picture-tube types used in transistor television receivers often operate at lower voltages than those used in tube-type receivers, but they still require a higher voltage than most transistors. Two specific voltages are needed:

1. Voltages for the accelerating and focusing grids of the picture tube. From 100 to 250 volts are required in positive polarity.
2. Collector-supply voltage for the video-output transistor. This ranges from 50 to 100 volts and may be either positive or negative in different receivers.

The majority of transistor television receivers use subminiature tubes in the high-voltage rectifier circuit—often in a voltage-multiplier arrangement. As in all-tube receivers, filament voltage is obtained from windings on the flyback transformer. Output voltages range from 5 to 10 kv; 23-inch receivers require 17 kv. The high-voltage rectifier in typical receivers is a voltage tripler, as depicted in Fig. 16. However, the input waveform is not symmetrical, as is required for conventional tripling action. On the other hand, it is not a simple DC pulse. The input waveform contains damped oscillations following a spike, and negative peaks of this ringing waveform are rectified to produce greater DC output than could be obtained from half-wave rectification of positive pulses.

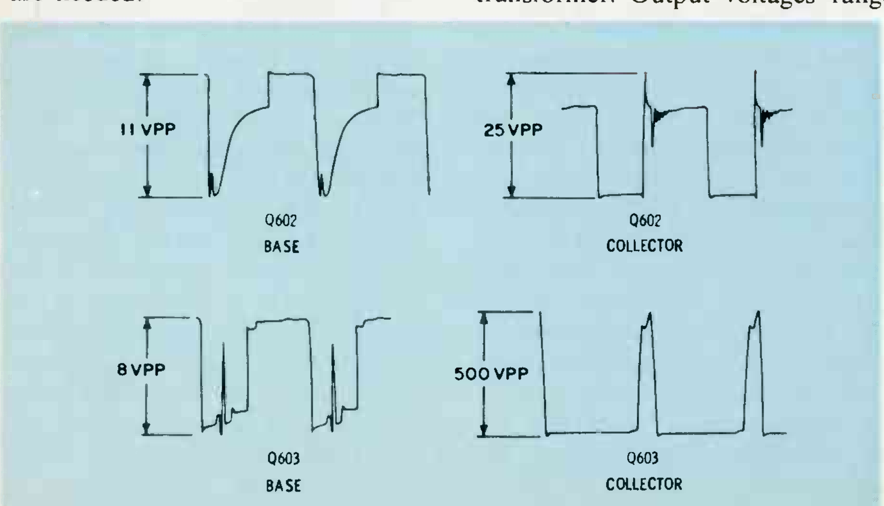


Fig. 12. Waveforms found in horizontal-output system of Fig. 11.

In Fig. 16 tubes V1 and V3 are driven into conduction on the large positive flyback pulses, while V2 conducts on negative swings of the waveform. The negative swings are coupled to the filament of V2 via C103. All three capacitors (C102, C103, and C104) are kept charged to a level that results in a DC output voltage of more than twice the value of the AC input voltage. An occasional receiver will employ a 110°, 23-inch picture tube requiring at least 20 kv of accelerating voltage, andcomparativelylarge current (about 0.5 amp.) in the horizontal-output circuit.

Horizontal-sweep systems are resonant circuits, whether in tube-type or transistor receivers. Fig. 17 depicts the essential circuit elements in a transistor horizontal-output stage. C1 resonates with the inductance of the flyback transformer and horizontal-deflection coils at a frequency of 50 KHz. C2 is a corrective or waveshaping capacitor required for linear scanning of wide-angle picture tubes. C3 is a filter capacitor. When the receiver is turned on, C3 is charged from supply voltage E_1 via the supply diode. In turn, operation of the stage is initiated with application of collector voltage to the transistor and a gating or drive waveform to the base of the transistor. Thereafter the flyback pulse is rectified by the recovery diode to charge C3. E_2, the voltage across C3, will be greater than the supply voltage by an amount determined by the transformer turns ratio.

All of the yoke current is distributed in paths through the transistor, the recovery diode, and C3. In typical operation, E_1 may be equal to 12 volts, and E_2 may be equal to 36 volts. In turn, the transistor current and recovery diode current is based on a 36-volt supply feeding the inductance of the horizontal-deflection coils and the capacitance of C2. Recognition of the resonant response of the system, which rings at 50 KHz when the transistor is suddenly cut off, is important in practical troubleshooting. If the resonant frequency is too low, foldover results. A subnormal ringing frequency also causes reduction in the high-voltage output.

Troubleshooting Procedure

Since various trouble symptoms can be caused either by defects in the horizontal-sweep section or in the horizontal-oscillator section, a preliminary localization test is often required. Always check the drive waveform at the base of the horizontal-output transistor first. If the drive waveform is weak, distorted, or absent, the logical conclusion is that the defect is in the horizontal-oscillator section. Note that the collector waveform in the horizontal-output stage can be checked with an ordinary low-capacitance probe. The waveform amplitude is small compared with the corresponding waveform in a tube-type receiver. Peak-to-peak voltages range from less than 100 volts to a maximum of 500 volts in large-screen transistor television receivers. Tests in the high-voltage circuit must be made with the same basic precautions as in tube-type receivers. In addition, you must not arc the high-voltage lead to ground in a transistor receiver. This can quickly ruin a semiconductor component.

Measurements of emitter or collector current in the horizontal-output stage are very useful, but they are often difficult to make. However, voltage measurements at the base and collector of the horizontal-output transistor will indicate whether the transistor is operating normally. With reference to Fig. 11, Q603 does not draw excessive current when signal drive is lost, but becomes cut off. This is also true of driver transistor Q602. There are, however, several unique symptoms which can occur in this type of circuit. For example, high voltage can be developed, although there might

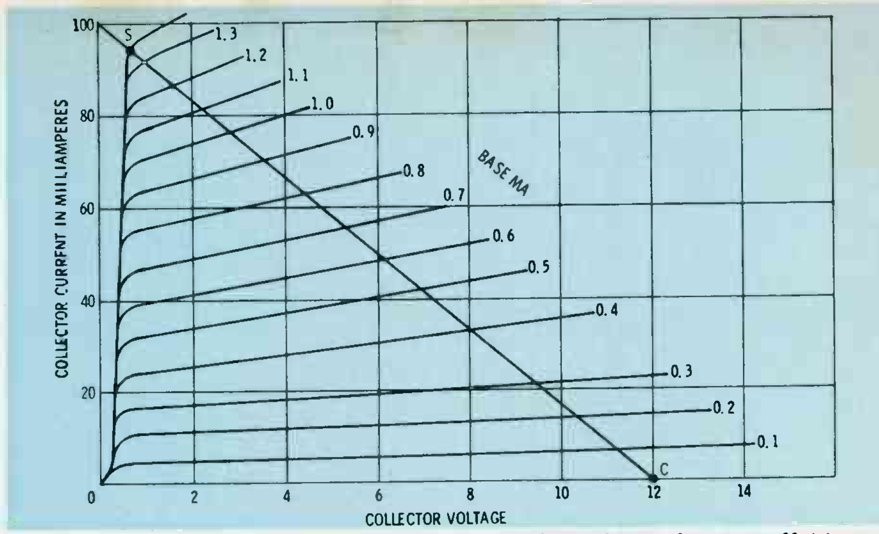


Fig. 13. Transistor operated in switching mode is driven from cutoff (c) to saturation (S).

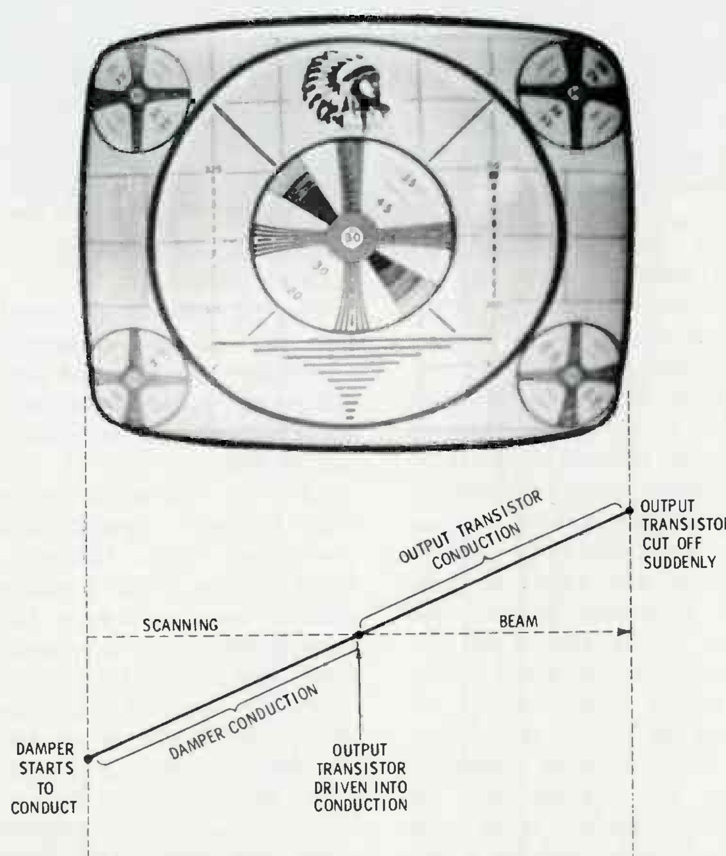


Fig. 14. Sequence of circuit action in horizontal output system.

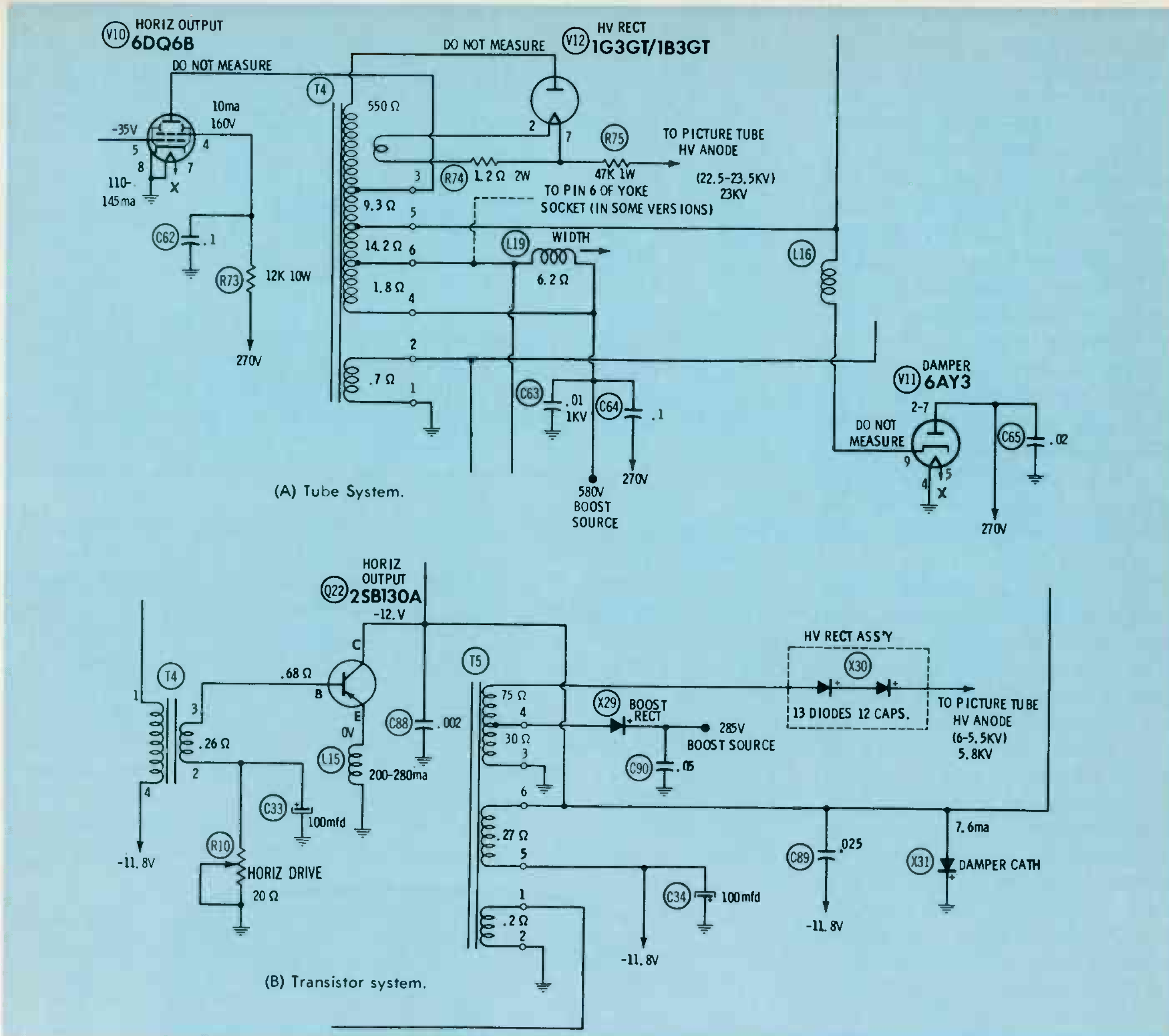


Fig. 15. Comparison of element voltages in horizontal-output systems.

be an open circuit in the horizontal deflection coils. In such cases, we see a straight vertical line on the picture-tube screen.

Another unique situation is that, in most cases, the horizontal-output circuit in Fig. 11 will continue to function with damper diode D605 open. Impaired operation continues because the horizontal-output transistor has the ability to function as a damper in case D605 is open. However, horizontal linearity will be poor at the left side of the picture. (Remember that defects in the damper circuit tend to affect the first half of the forward scan.) Note that the 500-volt boost voltage in Fig. 11 is not supplied from the damper diode action as in most tube-type receivers. Instead, a separate boost diode (SR601) rectifies the horizontal pulses from the collector of Q603 to supply the 500 volts of boost.

Suppose there is no raster. The first step is to check for high voltage with a DC voltmeter and high-voltage probe. If there is no high voltage, check next for AC pulses at the cap of V601 in Fig. 11. This can be done to best advantage with a high-voltage capacitance-divider probe and scope. However, if a suitable probe is not available, expedients such as a neon bulb, or stray pickup by a low-capacitance probe, can be used for a very rough check. In case the AC voltage is absent, either the driver stage or the output stage could be at fault. Check for drive at the base of each transistor with a low-capacitance probe and scope. This will often identify the defective stage. Then, DC voltage measurements will help to pinpoint the defective component within the stage.

Symptom Analysis

The common trouble symptoms analyzed in the following paragraphs are also displayed by TV receivers employing tube-type deflection circuits. However many of the circuit defects and troubleshooting procedures are unique to transistor circuits.

No Raster

When a no-raster symptom is caused by a defect in the horizontal-output system, capacitors are the most likely troublemakers. Scope waveform checks are most useful to pinpoint an open capacitor, while leaky capacitors can often be found by DC voltage measurements.

Possible causes of no raster are:

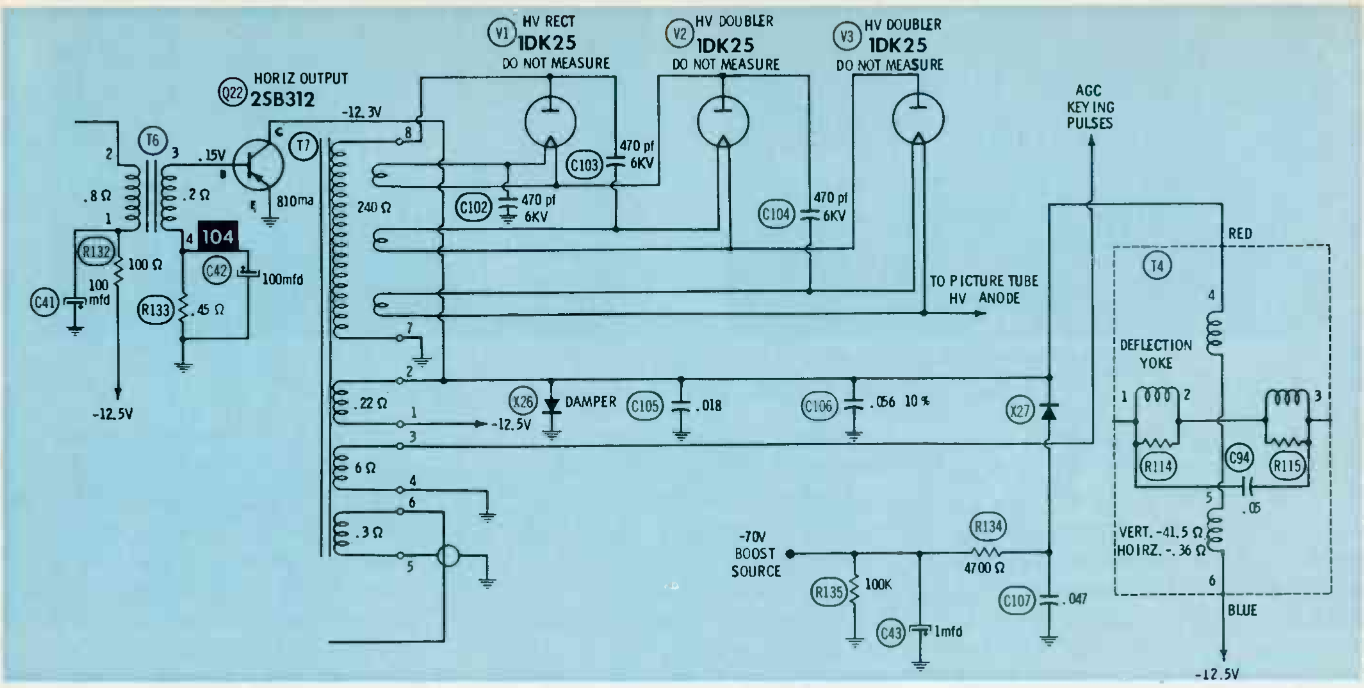
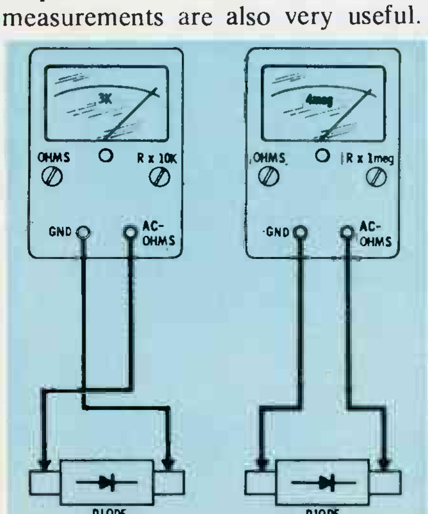


Fig. 16. Horizontal transformer and deflection coils connected in parallel between main DC source and Q22 collector.

a. Shorted shunt capacitor (C610, C622, and C613 in Fig. 11).
b. Open series capacitor (C625 in Fig. 11).
c. Defective rectifier (X30 in Fig. 15B).
d. Shorted filter capacitor (C612 in Fig. 11).
e. Collector-to-base leakage in the horizontal-driver transistor or horizontal-output transistor.
f. Defective transformer (T6 and T7 in Fig. 16).
g. Break in printed-circuit wiring, cold solder joint, or solder splash.

A shorted capacitor can be localized and often pinpointed by scope waveform checks. Voltage measurements are also very useful.



(A) Forward resistance. (B) Reverse resistance.

Fig. 18. Measurement of forward and reverse resistances of a diode.

For example, if C612 in Fig. 11 is shorted, the collector voltage at Q602 measures zero. An open coupling capacitor is quickly found by waveform checks. Defective

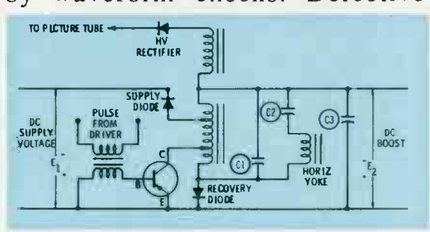


Fig. 17. Essential circuit elements in a transistor horizontal-output stage.

transformers are more difficult to analyze than faulty capacitors, unless a winding is open. When there is a breakdown in a transformer, the fault must usually be pinpointed by elimination. In other words, we suspect a transformer defect after the associated circuit components have been cleared by suitable tests. Collector-to-base leakage in a transistor is detected through incorrect DC voltage readings at the transistor terminals.

Aside from capacitor defects, semiconductor diodes that carry considerable current, such as a damper diode, are the more common troublemakers. A high-voltage rectifier, such as X30 in Fig. 15B, does not carry much current, but these diodes must withstand comparatively high peak-inverse voltages. This is a contributing factor to breakdown when a number of diodes are connected in series. Let us see why this is so. Fig. 18 depicts the measurement of forward and reverse resistances for a semiconductor diode with an ohmmeter. We know from experience that the measured value of reverse resistance will not be the same for different diodes. This is a matter of key importance when a number of diodes are connected in series.

The same problem exists here as when capacitors are connected in series in order to withstand high voltage. Consider the four series-connected capacitors shown in Fig. 19. If each capacitor is rated for 600 volts, the rating will not be exceeded if leakage resistances R1

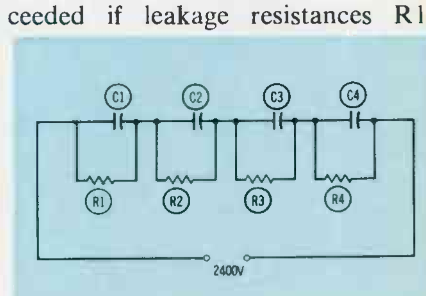


Fig. 19. Leakage resistance determines voltage drop across each capacitor.

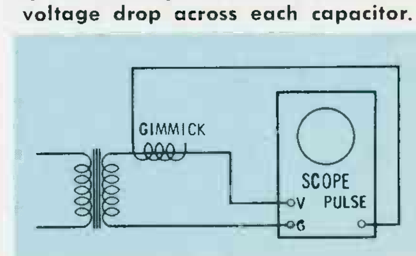
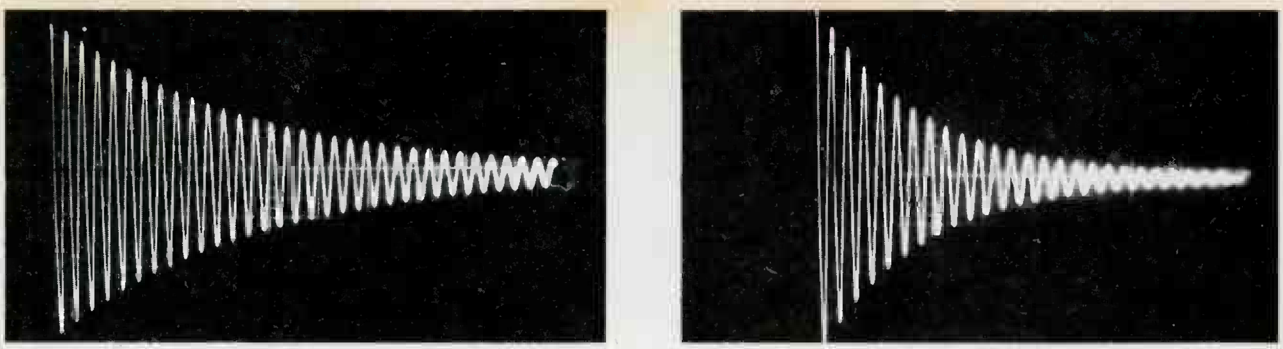


Fig. 20. Test setup for ringing test of a transformer winding.



(A) Pattern of good transformer. (B) Q one half of normal.

Fig. 21. Typical scope patterns obtained in ringing test.

through R4 are all exactly equal. In practice, however, the leakage resistances differ. Consequently, the capacitor with the highest leakage resistance must withstand more than its rated voltage. The same principle applies to the peak-inverse voltage that must be withstood by each semiconductor diode in a series connection. If one of the diodes develops a comparatively low leakage resistance, the other diodes in the series circuit will have to withstand higher inverse voltages and may burn out.

Insufficient Width

Insufficient width can be localized to best advantage by scope waveform checks. Measure the peak-to-peak voltage at the input and output of each stage. After the defective stage has been localized, DC voltage measurements will assist in pinpointing the defective component. Observe whether the symptom of insufficient width is accompanied by horizontal nonlinearity, and if so, whether the cramping occurs on the left side or right side of the picture. Remember that the first half of the forward scan is developed by the damper circuit, while the second half is developed by the horizontal-output circuit.

Possible causes for insufficient width are:

a. Leaky capacitor (C610 and C620 in Fig. 11).
b. Loss of coupling capacitance (C625 in Fig. 11).
c. Open damper diode (D605 in Fig. 11).
d. Collector-to-base leakage in a transistor.
e. Defective driver or output transformer.
f. Defective emitter-bypass capacitor (C42 in Fig. 16).

When an emitter bypass capacitor is open, the stage develops negative feedback, and the waveform amplitude is reduced. Loss of coupling capacitance, as in C625 (Fig. 11) results in reduced waveform amplitude because of the AC drop across R612. In addition, the time constant of the drive circuit is changed and the base waveform at Q603 becomes distorted. L602 is a peaking coil that is employed to maintain fast rise of the drive waveform. The peaking coil does not function as intended unless the reactance at each terminal is normal.

Leakage in a transistor reduces the waveform amplitude, because the beta of the transistor becomes subnormal. Measure the transistor element voltage when leakage is suspected.

Shorted turns in a transformer waste power and result in reduced waveform amplitude. If a transformer is disconnected from the circuit, a ringing test is very useful.

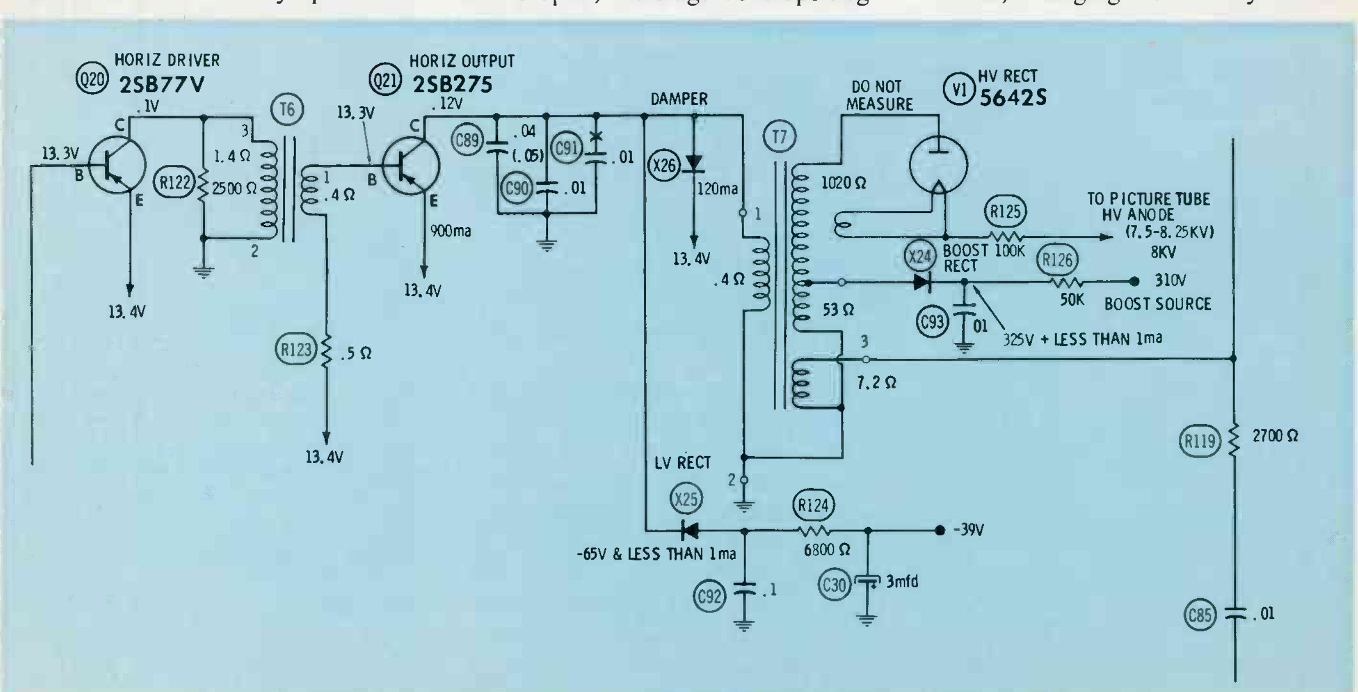


Fig. 22. R125 in this circuit is a high-voltage protective resistor.

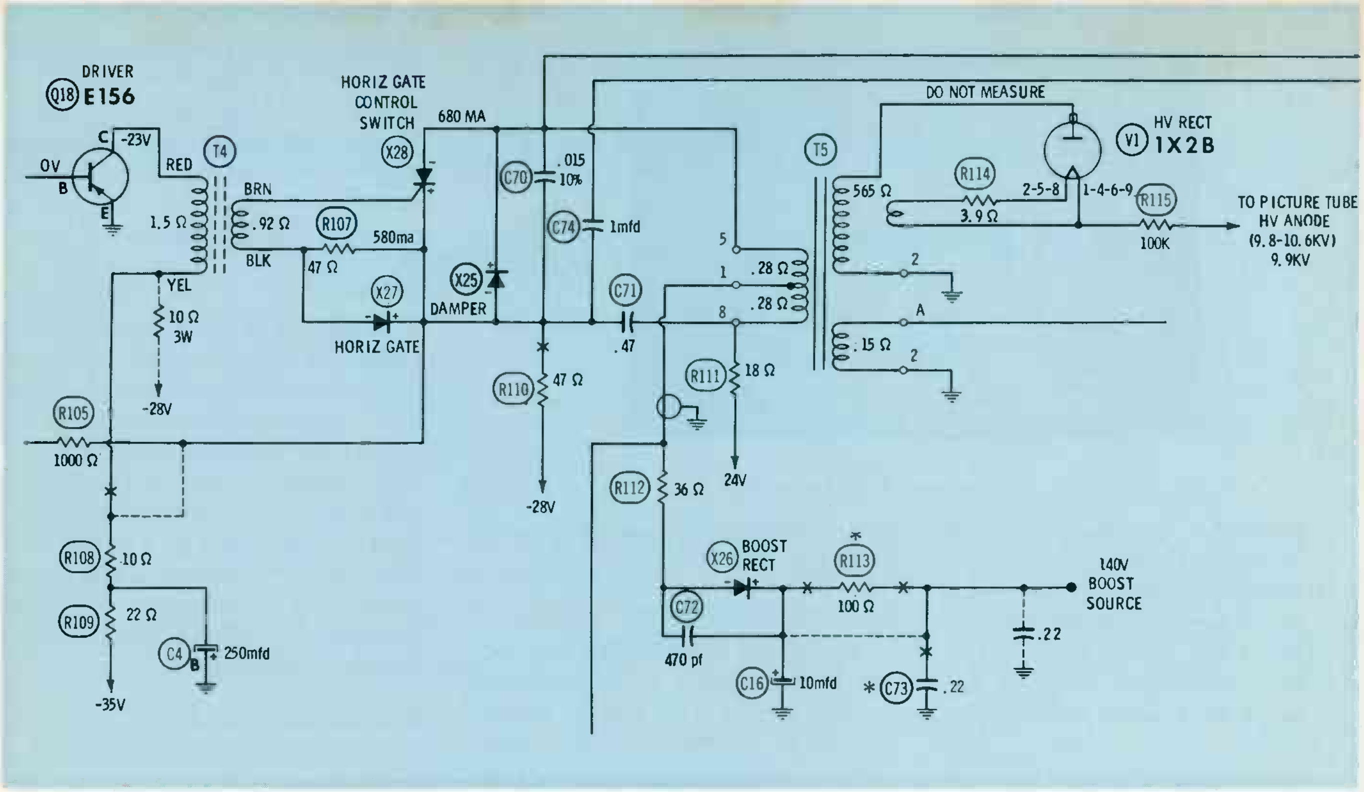


Fig. 23. Increase in R114 decreases filament voltage and causes blooming.

Fig. 20 shows a common setup for a ringing test. This is basically a Q measurement. Typical patterns are illustrated in Fig. 21. The Q of the winding is given by the rate of pattern decay. If the Q is reduced to one-half, the pattern decays twice as fast. Technicians are seldom interested in reading the actual Q value from the pattern, but only in making a comparative test. In other words, the ringing pattern of a known good transformer is compared with the pattern of a suspected transformer. Note that each winding on the transformer must be separately tested.

Blooming

Blooming is an abnormal enlargement of the raster (overscanning) accompanied by dimming of the picture. The basic cause is a decrease in the high-voltage output. Blooming can sometimes be partially corrected by adjusting the drive to the horizontal-output stage (R10 in Fig. 15B). However, more or less overscan may remain in evidence, and the picture may become dimmer than before. When the brightness control is turned up, the picture becomes defocused, and the control seems to "work backward."

Possible causes of blooming are:

a. Leaky high-voltage filter capacitor (C102, C103, and C104 in Fig. 16).
b. Defective high-voltage rectifier assembly (X30 in Fig. 15B).
c. Corona from high-voltage lead.
d. Defective high-voltage winding in the horizontal-output transformer.
e. Increase in value of the high-voltage protective resistor (R125 in Fig. 22).
f. Increase in value of a filament-dropping resistor (R114 in Fig. 23).

Leaky high-voltage filter capacitors obviously drain off current and reduce the output voltage. Corona also imposes an abnormal current drain. Some receivers employ a high-voltage protective resistor, as noted. The purpose of this resistor is primarily to avoid damage to the high-voltage system in the event of a short circuit in the picture tube; the resistor also serves a filtering function. In case the high-voltage lead is short-circuited, the protective resistor is likely to overheat considerably. In turn, its value can be greatly increased, and picture blooming may occur.

Some receivers also employ a filament-dropping resistor. This resistor is worked hard, because the filament of the high-voltage rectifier is supplied with a pulse voltage. Pulsed current tends to deteriorate a resistor faster than direct current does. When the value of the resistor increases, the filament voltage decreases. In turn, emission is reduced, and the high-voltage rectifier tube has abnormally high plate resistance. This has the same effect as an abnormally high value of protective resistance and produces picture blooming.

Horizontal Foldover

Horizontal foldover occurs when the sweep waveform has certain types of distortion, or when the ringing frequency of the horizontal system is too low. Waveform checks are advised in preliminary troubleshooting. If one or more of the sweep waveforms has appreciable distortion, the cause should be investigated. Defective capacitors are common causes. A low ringing frequency is usually the result of an unsuitable replacement component. In case a replacement transformer has too much inductance for the particular circuit, horizontal foldover can be anticipated. The "crossover" from booster to horizontal-output action must also be normal; otherwise, foldover appears in the vicinity of center screen.

Possible causes of foldover are:

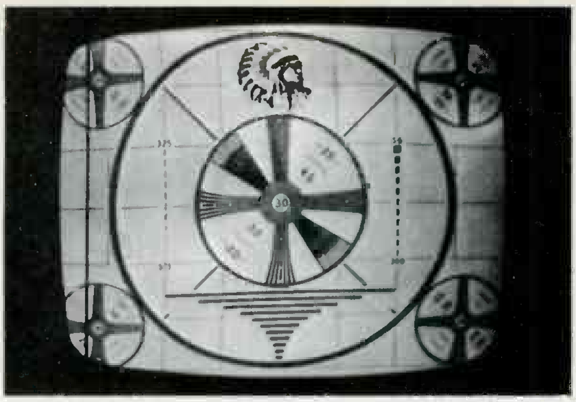


Fig. 24. Appearance of Barkhausen line.

a. Defective damper capacitor (C623 in Fig. 11).
b. Incorrect drive waveform due to transformer defect (T4 in Fig. 15B).
c. Defective output waveform due to inductor defect (L15 in Fig. 15B).
d. Defective gate diode (X27 and X28 in Fig. 23).

Crossover action with respect to the scanning beam is depicted in Fig. 14. If the damper discharge is too slow, or if the horizontal-output transistor starts to conduct too soon, the resulting crossover distortion is seen as a foldover in the center of the screen. Incorrect damper action is best analyzed by checking the damper current waveform. Unfortunately, however, this is usually impractical at the service bench. A few shops have a lab-type clamp-around current probe for the scope, which permits easy display of the current flow through the horizontal-deflection coils. The probe is merely clipped over the "hot" lead to the horizontal-deflection coils (no actual connection is made). Then, the damper action and horizontal-output action is displayed in the scope pattern.

Foldover can result from careless replacement of capacitors. For example, if C615 in Fig. 11 is replaced with a capacitor that has a 20% tolerance on the high side, foldover at the edge of the picture can be anticipated. In general, the more inductance that is shunted by a capacitor in the horizontal system, the more careful we must be concerning the capacitance tolerance. Off-value resistors in the horizontal system occasionally cause foldover, but resistors are the last components to check.

Horizontal Nonlinearity

Horizontal nonlinearity may occur in the absence of other picture symptoms, but it is usually accompanied by insufficient width, horizontal foldover, or overscanning. However, there are certain defects than can cause horizontal non-linearity without other symptoms, as follows:

a. Incorrect match of the output transformer to the horizontal-deflection coils.
b. Incorrect value of capacitor connected in series with the horizontal-deflection coils (C2 in Fig. 17).
c. Defective bypass capacitor (C617 in Fig. 11).

The impedance of the horizontal-output transformer must provide a reasonable match to the impedance of the horizontal-deflection coils. In turn, exact replacements are required. Even if the inductance value is correct, off-value winding resistance can cause a mismatch and result in nonlinearity. The time constant of the horizontal system is determined by a combination of inductance, capacitance, and resistance. Some circuits require closer capacitor tolerances than others. For example, C616 in Fig. 11 has a GMV rating (Guaranteed Minimum Value; or, +100 −0% tolerance). Both C615 and C617 have 10% tolerance ratings. If horizontal linearity were not a matter of concern, 20% tolerances would serve satisfactorily.

Barkhausen Lines

Barkhausen lines (Fig. 24) are encountered only in hybrid receivers that use a horizontal-output tube. The usual corrective measure is to try different tubes. If this is ineffective, a small magnet such as an ion-trap magnet can be placed around the output tube and oriented to eliminate the interference.

Keystoning

Horizontal keystoning is usually caused by shorted turns in one of the horizontal-deflection coils. However, if yoke replacement does not correct the difficulty, there is probably a defect in the horizontal-output transformer. In configurations such as shown in Fig. 11, defective decoupling capacitors sometimes produce a keystoning symptom. Accordingly, C506B and C506C should be checked.

Unstable Horizontal Sync

As noted previously, unstable horizontal sync can result from certain defects in the horizontal-sweep system. For example, the AFC winding on T603 in Fig. 11 might have shorted turns, or leakage to the core. Resistor R614 can increase in value, since it carries a pulse current. In Fig. 22, C85 could be defective. Leakage between printed-circuit conductors can also cause trouble.

Yoke Ringing

When the horizontal-deflection coils ring, broad vertical lines called ringing bars appear at the left side of the picture. This symptom is seldom encountered in transistor television receivers unless an incorrect yoke replacement has been made. In hybrid receivers that use a horizontal-output tube, ringing bars can occur just as in all-tube television receivers. Usually, we find that there is an open capacitor across one of the horizontal-deflection coils. This is called an anti-ringing capacitor and is used in tube-type output systems to resonate the deflection coils at exactly the same frequency. It is a general law of resonant circuits that if two coils are connected in series which do not resonate at the same frequency, a third resonant condition is established that is inadequately damped by the resistance of the horizontal system. ▲

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the magazine of electronic servicing

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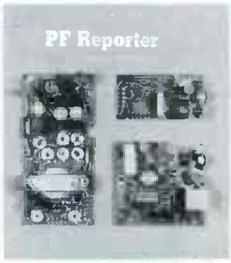
CONTENTS

ABOUT THE COVER

The three PC boards contain the deflection circuits from Motorola's new TS-915. Though not so common, solid-state color does exist. Transistorized black-and-white sets however, are featured in nearly every manufacturer's 1968 line. For more information on solid-state deflection, see page 9.



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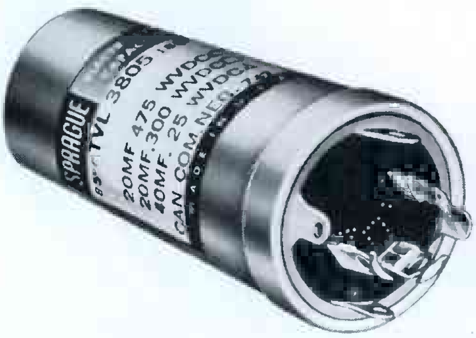

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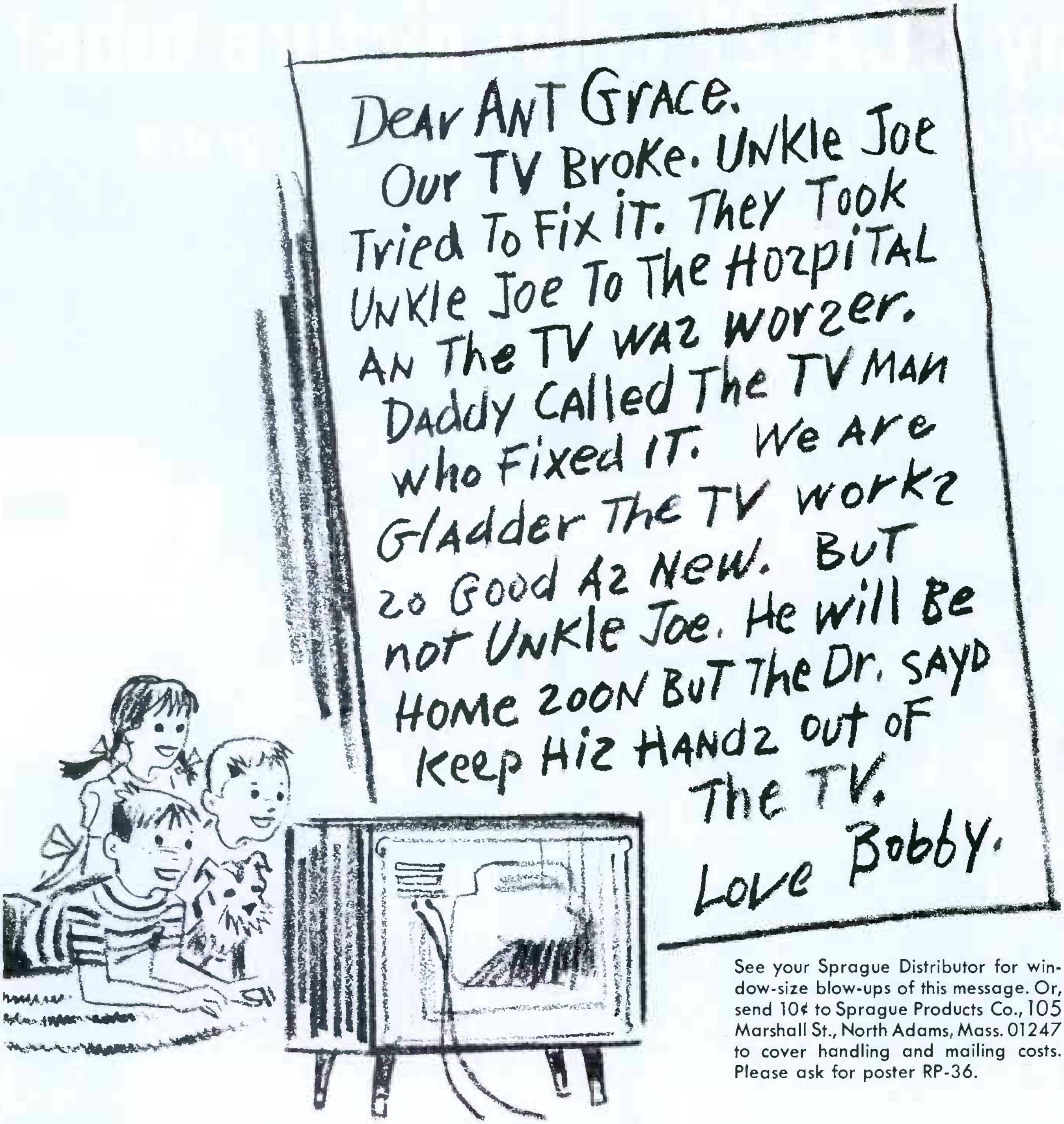

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LETTERS TO the EDITOR

Dear Editor:

While I was reading the July issue, I noted the letter from R. A. Schmalz of Evansville, Indiana. The cover photograph also caught my eye, but the tube was not familar, because I believe that this was a transmitting tube and not for reception.

I think perhaps Mr. Schmalz got his early receiving tube numbers mixed up a bit. There were no tubes made as early as 1916—either for transmission or reception. Again, if my old memory is within reason, I believe the first tubes made for reception were not the 201's (or 101's mentioned by Mr. Schmalz). I believe the first radio made by RCA used WX99's or WD11's. RCA first released the UV-200 about 1921. This tube required one ampere at 5 volts. These early tubes were quite critical as to voltage on the filaments and by varying the filament rheostat, one could control the amount of signal in a breadboard receiver.

It is true that experimental tubes were made around 1911, but not for the proverbial general public. The first tubes had only two elements, and the triode didn't come along till later.

The first tubes I bought (after messing around with a galena detector during the 1919 period) cost about $9 each. I recall burning out several tubes due to a mistake in my hookup, and I had to buy a new batch.

I believe the first 5-watt output tube was the 250 by RCA; the Cunningham equivalent was numbered CX-350.

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He's flying high. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. "I found my electronics lessons thorough and easy to understand. The CIE course was the best investment I ever made."

Why You'll Earn Top Pay

One reason is that the U.S. Government doesn't permit anyone to service two-way radio systems unless he is licensed by the FCC (Federal Communications Commission). And there simply aren't enough licensed electronics experts to go around.

Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A two-way radio user *must* keep those transmitters operating at all times, and *must* have them checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. Others charge each customer a monthly retainer fee, such as $20 a month for a base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

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Sylvania Argentina, S.A., a **General Telephone & Electronics International Incorporated** subsidiary, announced it has started construction work on a 96,700 square-foot plant in Buenos Aires. Sylvania Argentina manufactures black-and-white television picture tubes and lighting products.

The new facility will permit consolidation and expansion of manufacturing operation which are now contained in two older buildings in the center of Buenos Aires with a total of 74,000 square feet.

Sangamo Electric Company and **Monsanto Company** have signed a joint research and cross-license agreement for development of improved special application semiconductor devices and proprietary monolithic integrated electronic circuits.

The arrangement provides for an interchange of scientific, technical developmental and research information in a specific field. The cross-license arrangement grants a royalty-free, non-exclusive right for both parties to use patents resulting from the contract work. All rights and license are granted on a world-wide bias. Developments resulting from this agreement are expected to contribute to advance product designs to preserve the companies' respective established positions in an age of rapidly advancing technology.

After more than a century of operation in Western

The new RCA color picture tube provides a viewable area of 102 square inches and currently is being manufactured at the Company's plant in Lancaster, Pa.

The new tube weighs only 12½ pounds and has an overall length of slightly more than 15 inches. It features RCA's newly-developed rare earth phosphor and the recently introduced "Perma-Chrome" temperature-compensated shadow-mask assembly.

Adopts Certification

A resolution adopting the "Certified Electronic Technician" program of the National Electronic Association Inc. was recently passed unanimously by the Board of Delegates of the **California State Electronic Association.**

During the CSEA Convention, 14 California technicians attempted to pass the NEA examination. This would bring to 15 the number of states with NEA Certified Technicians registered.

Mergers & Expansions

Formation of **Amertest Products Corporation** in Jamaica, N.Y. has been announced by Larry Post, president of the firm.

Mr. Post, formerly national sales manager of Robins Industries Corp., is a veteran of more than 15 years in the electronic field. He announced that his company is marketing a wide range of replacement parts for

Pennsylvania, **Wall Manufacturing Company,** makers of a wide variety of industrial and domestic soldering products, moved their entire facilities to a new modern plant at Kinston, North Carolina. Construction of the building was completed in 1966 and production was begun in the Fall.

An enlarged progressive laboratory in the new plant has enabled Wall to carry on extensive product development and technological research. Among the recent innovations added to their previous models have been a patented interlocking system for quick changing of heating units, desoldering devices, plug-in sub-miniature lightweight soldering pencils, longer-life iron coated tips, and soldering pencil holders.

Because of the completely new beginning, older assembly line procedures were strategically replaced with newer, more efficient layouts resulting in an overall volume output increase and allowances for expansion. This has permitted Wall to supply their customers more readily from available stock and quality is carefully controlled.

Sarnoff Honored

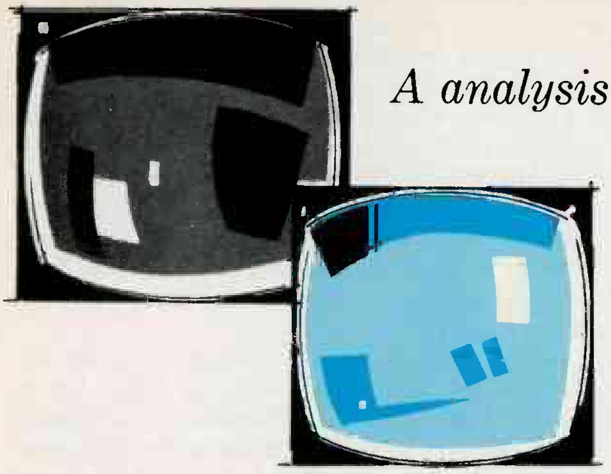
The 1967 Modern Pioneer in Creative Industry Award was presented to Brig. General David Sarnoff, Chairman of the Board of the Radio Corporation of America.

The Modern Pioneer Award, the highest individual recognition bestowed by the National Association of Manufacturers, was presented by NAM President W. P. Gullander on the first day of a two-day international industrial patents conference sponsored by NAM and six European industrial associations. The ceremony followed a luncheon address by General Sarnoff in which he described technological breakthroughs which will permit an electronic world patent system by 1975.

Noting that previous recipients of the award have included Henry Ford and Orville Wright, Mr. Gullander said General Sarnoff's imaginative contributions have so benefitted all people that he might be termed a "citizen of the world."

"His scientific and technological talents and genius for organization," Wr. Gullander continued, "have led to the creation of one of the most productive electronics and communications companies in the world. His quest toward bettering man's well-being and comfort is an inspiration and spark to creative men and women everywhere."

General Sarnoff, who recently celebrated his 60th year of service in the communications and electronics field, pioneered in the development of radio, television and electronics. He was elected President of RCA in 1930, at the age of 39. In 1947, he was elected Chairman of the Board and Chief Executive Officer. In 1966, he relinquished the post of Chief Executive Officer, continuing to serve actively as Chairman of the Board.▲



A analysis of the circuits and associated defects that produce

many hued RASTERS

BY ROBERT F. HEATON

In a previous issue (PF REPORTER, July, 1967), we discussed circuit areas and problems in color receivers that cause a change in the overall tint of the raster. In these instances, the entire picture becomes tinted to some predominant color. Troubles of this nature usually develop due to faults in the chroma amplifiers, drive controls, screen controls, and the picture tube itself (see Fig. 1). Naturally, these faults will affect black-and-white as well as color reception.

This article will discuss incorrect hues during reception of a color picture. These are caused by phasing errors in one of the color processing stages. To narrow our objective, we'll concentrate on those areas in a color chassis that can cause incorrect colors. We won't discuss problems of no color, weak color, distorted color, or loss of color sync.

The block diagram in Fig. 2 illustrates a typical color system. Any one of these stages can cause incorrect hues or distorted colors resulting in wrong or missing hues, but, generally, troubles developing in the stages which are shaded cause incorrect hues due to a phasing error. Distorted (or missing) colors result when any of the remaining stages are at fault. Isolating the particular stage causing incorrect colors is a matter of symptom analysis. Thus, we should become acquainted with interpreting between phasing and distortion symptoms, and develop service procedures to pinpoint either condition.

Phase Error Symptoms

Wrong hues as a result of phasing errors indicate faults in one or more of the stages which are shaded in Fig. 2. These circuits are responsible for producing and controlling the phase of the 3.58-MHz reference signal which is applied to the color demodulators. Naturally, when the phase is correct, all colors and hues are reproduced on the screen —flesh tones are flesh colored, red objects are red, etc. Adjustment of the tint (hue) control from one extreme to the other gives the normal range from green through flesh to purple faces.

When a large phase error exists, all colors and hues still appear in the picture—*a very important clue to phasing problems.* However, where flesh tones should be, some unnatural hue, such as green or blue, appears. Other objects, too, have the wrong hues, and the proper color tone cannot be obtained with the tint control. The control, when adjusted, will probably shift the hues (phase), but correct hues cannot be produced.

The symptoms produced on the screen with a small phase error are similar to those for a large error: All colors and hues are reproduced in the picture at all settings of the tint control. However, correct flesh

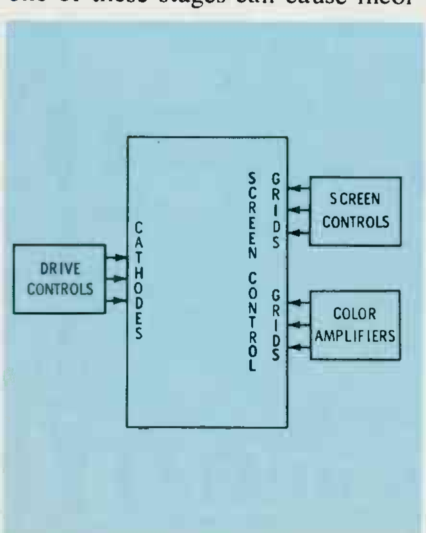


Fig. 1. Circuits which affect overall tint.

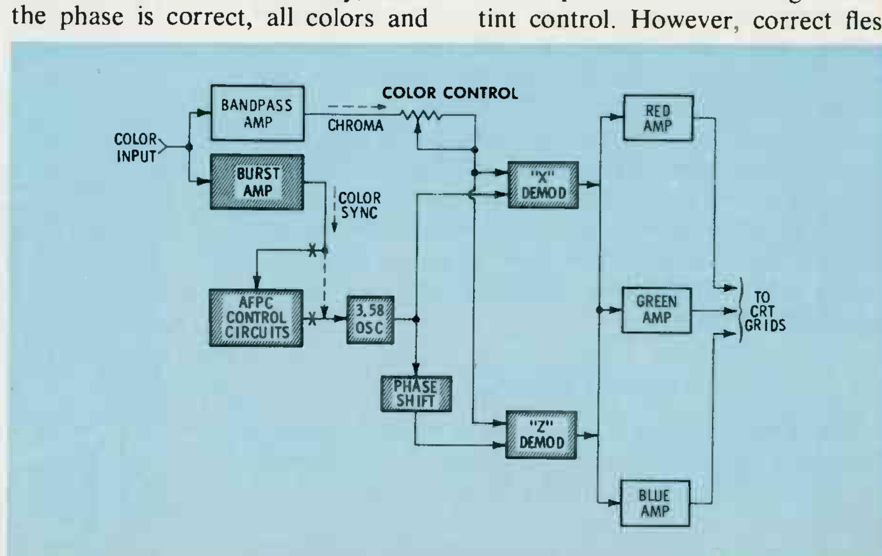


Fig. 2. Typical color block diagram.

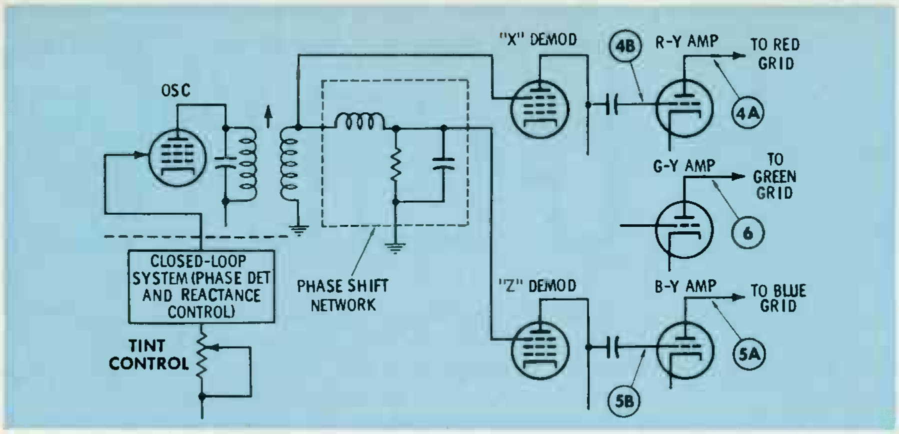


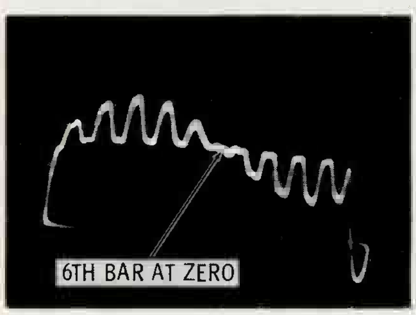
Fig. 3. Partial chroma circuit schematic.

— or object — hues are in their proper positions only at one extreme of the tint control range. Usually, alignment of the color sync (AFPC stages) is all that is necessary.

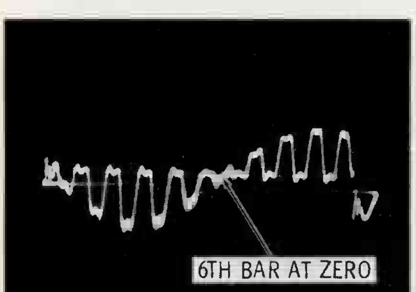
Troubleshooting Phase Error

Determining which stage is causing the phasing error is quite simple —if a definite procedure is established. Initially, the incorrect color symptom was probably noticed on a transmitted color program. However, a broadcast signal is less than desirable for servicing operations. Thus, we'll need a generator to supply a fixed pattern for analysis and an oscilloscope for signal tracing. Of course, we will also need a VTVM and the service information.

At the present time, the vast majority of color receivers demodulate the chroma signal to recover color difference signals (R−Y, B−Y, and G−Y). Regardless of whether high-level demodulators (demodulators drive the picture tube directly) or low-level demodulators (used in conjunction with color amplifiers) are used, the patterns viewed at the picture tube grids are approximately the same. Therefore, the service procedure described for one system is applicable to the other.



(A) Red grid waveform.



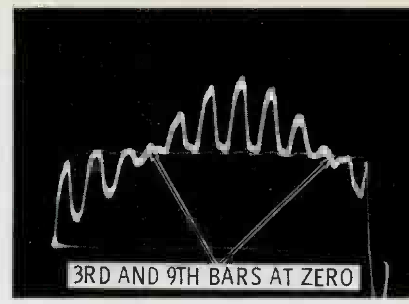
(B) R−Y amplifier grid waveform.

Fig. 4. R−Y waveforms for Fig. 3.

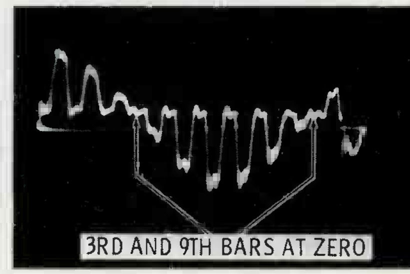
The first step is analysis of the color-bar pattern. This check is needed, for what may appear in a broadcast program as wrong hues may, in fact, be color distortion. For example, one of the color difference signals may be highly attenuated or missing completely. This could possibly give the impression of wrong hues due to phasing errors. If this is the case, the color bar pattern will have one of the primary colors missing. With wrong hues as a result of phasing error, all colors *do* appear in the pattern. Once the phasing defect is confirmed by analysis of the color bars, our next step is to eliminate the good sections or stages. A few important waveform checks in the color circuits can be used to isolate the trouble to a specific area.

Shown in Fig. 3 is a typical color demodulator system. Notice the dividing line between the stages that process color sync (burst), and the actual reference oscillator-demodulator stages. Now, as a phasing error can be caused by the AFPC system that controls the oscillator, we need a "quick check" to clear or condemn this section.

Regardless of the receiver, locate that demodulator which is fed directly from the 3.58-MHz oscillator.



(A) Blue grid waveform.



(B) B−Y amplifier grid waveform.

Fig. 5. B−Y waveforms for Fig. 3.

This is the "X" demodulator in Fig. 3; since the reference signal for the "Z" demodulator is phase shifted approximately 90° before reaching the grid. Our key "check point" here is either the input or the output of the R−Y amplifier. Inspect the signal waveform at either point, looking for the sixth bar to pass through zero. The typical R−Y waveforms at point 4A and 4B of Fig. 3 are shown in Fig. 4A and 4B respectively. It may be necessary to rotate the tint control to obtain the correct waveform.

An incorrect waveform at these points indicates a phasing error due to trouble in the AFPC-oscillator stages. Perform the alignment check of these stages according to the service data. This check will normally reveal which circuit is faulty.

Assume the waveform at point A of Fig. 3 is correct, but wrong hues are still produced on the screen. Under these conditions, check the signal waveform at the input or output of the B−Y amplifier. Figs.

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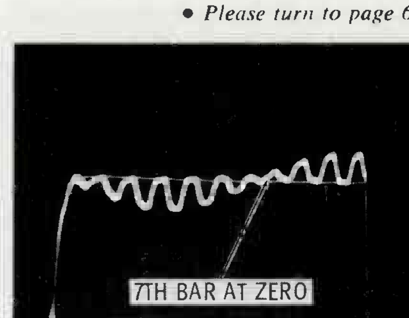
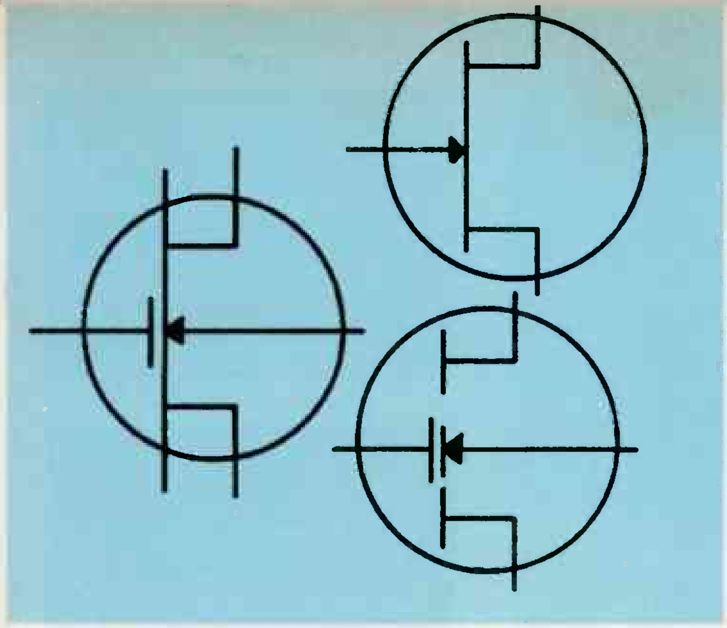


Fig. 6. Green grid waveform.



an introduction to FET'S

Although this device is constructed of semiconductor material, it behaves more like a vacuum tube than a transistor. In addition, it has features which make it more suitable to certain applications than either the tube or conventional transistor.

by Thomas H. Lynch

Through a concerted industrial effort, the field effect transistor is beginning to find favor with commercial equipment manufacturers. It is actually an old device, but semiconductor manufacturers only recently have been able to produce it consistently and at an economical price. One manufacturer (Texas Instruments) has made quite an effort to prove the worthiness of FETs in commercial RF applications. Other manufacturers, such as Motorola, Siliconix, Union Carbide, and RCA, also have produced many ideas for application of FETs to consumer products.

Scott, Harmon Kardon, and Heathkit were among the first to bring out home entertainment equipment using FETs. RCA has recently described a developmental solid-state color TV that utilizes 20 MOSFETs out of approximately 50 semiconductors in the set. The next year or two should see a large increase in the use of FETs in commercial equipment.

Device Features

The FET has a number of features that makes it superior to the transistor, diode, and tube for many applications. Some of these are:

1. Square Law Operation. The FET drain current is proportional to the square of the gate voltage. This feature makes the device ideal for mixers in TV, FM, and AM tuners, since it produces just the second harmonics necessary for mixer operation. Other devices such as tubes, transistors, and diodes produce third order and other harmonics in addition to the second order. This causes cross-modulation distortion, a defect that takes considerable effort to reduce.

2. Low Noise. Because the FET is a majority carrier device, it is not as noisy as transistors which depend upon both majority and minority carriers for operation. This feature makes the FET the logical choice for low noise phono and tape preamplifiers, TV and FM tuners, and communication receivers.

3. High Input Impedance. This feature, similar to that of vacuum tubes, considerably simplifies the design of amplifiers since the input of one stage does not load down the output of a preceding stage. The large coupling capacitors and tapped interstage transformers associated with transistor circuitry are not needed with FETs.

Basic Theory

For everyone familiar with tubes, FETs should present no problem. This is kind of a saving grace for those who never gained a familiarity with transistors.

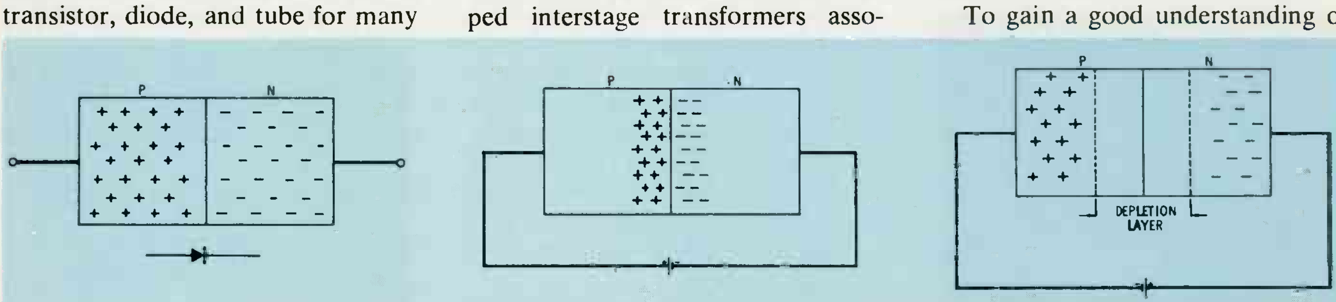
Let us begin by comparing terminology:

TUBE	FET
Plate	Drain
Grid	Gate
Cathode	Source

The FET terminology was chosen for obvious reasons. The source generates the electrons or holes (the reverse of electrons), the gate modulates (or controls) the current flow, and the drain receives the flow.

In vacuum tubes, a flow of electrons begins at the cathode and travels through a grid to the plate. A voltage can be put on the grid to either increase or decrease the flow of electrons. FETs operate in almost the same manner, and have characteristics similar to tubes.

To gain a good understanding of



(A) No bias. (B) Forward bias. (C) Reverse bias.

Fig. 1. PN junction characteristics.

the FET, first consider a semiconductor diode rectifier. It is composed of two types of semiconductor material as shown in Fig. 1A. The first kind of material is N-type. It has a surplus of electrons represented by (−) in the diagram. The other (P-type) material has an excess of holes (or places where electrons could fit) represented by (+)'s.

In Fig. 1B, we have connected a bias voltage across the diode. The electrons from the negative terminal of the battery repel the negative charge (electrons) of the N-type material. The positive charge in the P-type material is likewise repelled by the positive connection of the battery. The negative and positive charge meet at the junction. Now assume one electron from the N-type material can combine with a "hole" in the P-type material. In order to maintain balance, an electron from the negative terminal of the battery jumps into the N-type material. Likewise, a "hole" jumps from the positive terminal of the battery into the P-type material (or an electron goes from the P-type material to the positive terminal of the battery). This completes the circuit and one electron of current has flowed through the "forward

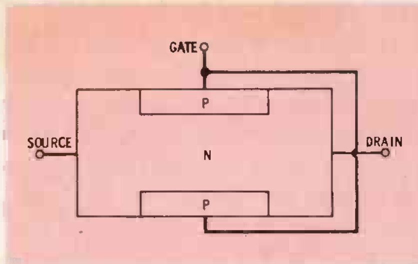


Fig. 2. N-channel junction FET.

biased" diode. A very large current can be made to flow through the diode depending upon the amount of electrons the battery can supply.

Fig. 1C depicts the condition known as "reverse bias". In this case, the electrons and holes are forced away from the PN junction by the attraction of the battery. No current flows because there are no electrons or holes to combine at the junction. In fact, an area next to the junction of the N and P-type material is void of electrons and holes respectively. This area is called the "depletion layer", and will increase in width with an increase in applied voltage. Here lies the key to understanding a FET.

A cross-sectional view of an N-channel Junction FET is shown in Fig. 2. This type is most nearly like a tube in that it requires a positive voltage on the drain (plate) and a negative control voltage on the gate (grid). When the gate voltage is zero, current is allowed to freely conduct from the source to the drain as shown in Fig. 3A. When an increasing negative voltage is connected to the gate as shown in Figs. 3B and 3C, the flow of electrons is reduced. This is because the depletion layer restricts the current flow as it becomes bigger, much like a water control valve. This phenomenon allows the FET to amplify and perform the same functions as that of a tube. It should be noted that since the gate junction is reversed biased, no gate current flows. This is the same as a tube grid.

The P-channel Junction FET operates in the same manner, except all the voltages are reversed. Holes flow from the source to the drain now (or equivalently electrons flow from the drain to the source).

Both of the preceeding types always conduct current with zero gate voltage. For this reason it is sometimes referred to as a "depletion" type since the correct gate voltage depletes the current flow.

The next major type, the MOSFET, can be made so that at zero gate voltage either the drain current flows (depletion type) or does not flow (enhancement type).

Fig. 4A shows a cross-sectional view of a depletion mode MOSFET (only the N-channel version is shown and discussed, the P-channel being the exact opposite). The MOSFET has one more connection called the substrate, which is in most cases connected to the source. The term channel comes from the fact that when the device is conducting current, a channel of N-type material exists between the N-type drain and source. The key to the MOSFET operation is the capacitor formed by the metal gate, the silicon-dioxide insulator, and the silicon semiconductor. Hence, the name: Metal-Oxide-Semiconductor. Since an ideal capacitor does not conduct current, the gate electrode has no leakage current with both positive and negative signals (the grid of a tube draws current with a positive voltage).

When the gate voltage is zero as shown in Fig. 4A, the existing N-channel can conduct electrons from the source to the drain. If a negative

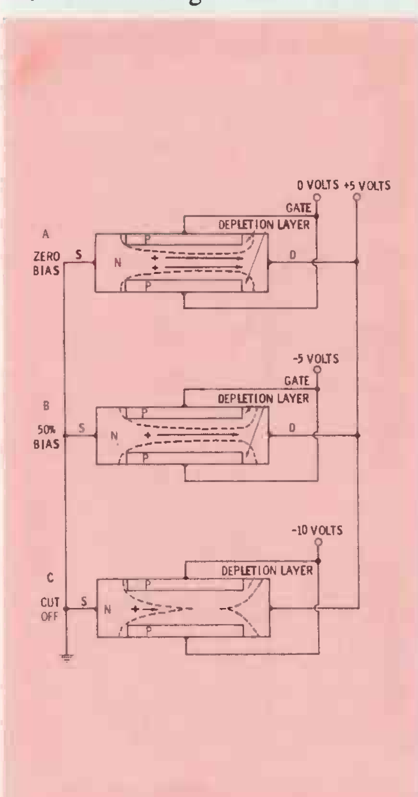


Fig. 3. Effect of bias on J-FET.

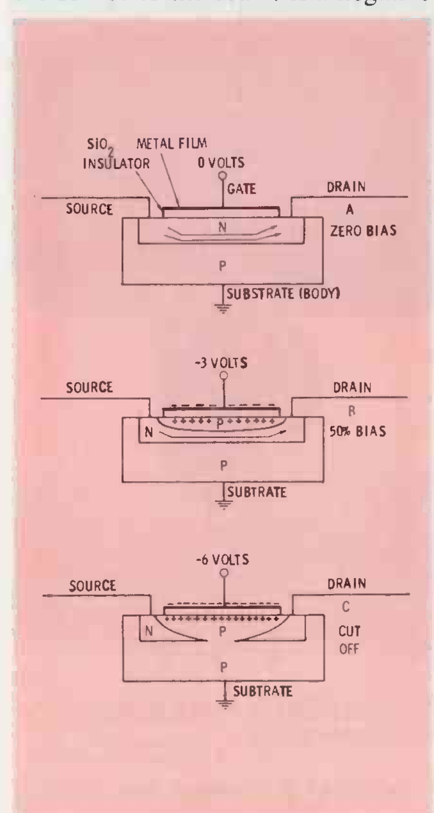


Fig. 4. N-channel depletion MOSFET.

gate voltage is applied, the MOS capacitor will charge up. This causes positive (+) carriers (holes for electrons) to be drawn toward the negative electrons on the gate and thus force electrons out of the N-channel as shown in Fig. 4B. The channel is now smaller and less current will flow from the source to the drain. If a large negative voltage is applied to the gate, enough electrons will be forced out of the channel to "pinch it off" (Fig. 4C). Under this condition, a NPN junction is formed. It will not conduct current because for both polarities of drain to source potentials there exists a reverse-biased PN junction.

The enhancement type MOSFET operates in the opposite manner as shown in Fig. 5. With zero gate voltage, there is no channel to conduct current. If a positive voltage is put on the gate, electrons are drawn toward the gate creating an N-channel. A drain to source current can not flow.

Test Procedures

As with virtually any device, the FET can fail. However, it does not, as a rule, degrade in performance over a long period of time as does a tube. In this respect, the FET is similar to the transistor in that it can be somewhat sensitive to external circuitry failures. We can therefore talk about two types of failure problems—catastrophic circuit failure, and device failure.

Catastrophic Circuit Failure

The FET has certain specified voltage limits which, if exceeded, can cause permanent device failure. Therefore, when a device fails or is suspected of failure, the first check should be of the operating voltages to determine if they are in excess of the normal values. The usual result of an over-voltage stress is a short circuit in the device (because of excessive current flow).

Device Failure

FETs can malfunction in the same way as transistors by becoming leaky. This is often the result of poor device construction techniques. Usually the gate conducts current when it shouldn't. As with tubes, this problem can be detected in high impedance circuits by measuring the voltage drop across the

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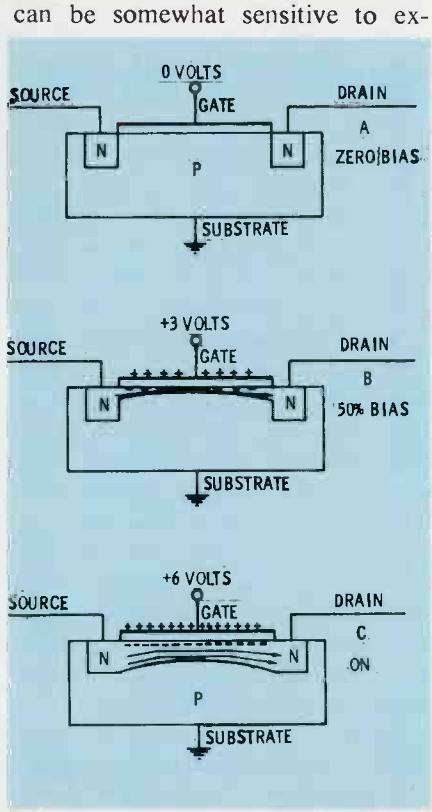


Fig. 5. N-channel enhancement MOSFET.

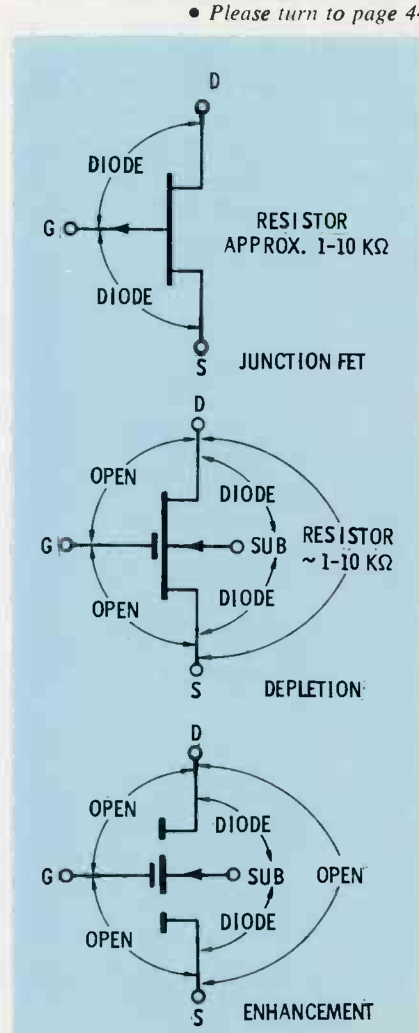


Fig. 6. FET resistance checks.

Electronic Service Shop

Sharp competition and a progressive electronics industry have spawned a new breed of electronic technician—the service shop owner and operator. Not only must he be a highly proficient service technician, but he must also measure up as a sound businessman. The following article is about one such man and the techniques he employed to meet the challenge of this dual role.

by Richard T. Bogh

The image of Gregory Ellis started a few short years ago when he first hung the "Radio/TV Service Center" sign over his front door. Since then, profits from his service shop have been steadily increasing each year. Greg maintans a modest shop with Fred and Sid as his only employees, but together they operate the busiest, most lucrative electronic repair shop in town.

Greg Ellis has established himself as a hard-working, honest-dealing, sharp-eyed individual; factors that aid him in making his repair shop the best in the business. If we examine Greg's "strategy" of operating a profitable business, we will discover some interesting ideas that may be of use to other service dealers.

In the beginning, Greg realized that he should purchase the most reliable, efficient equipment in the industry. But he also realized that the equipment alone was not enough to assure maximum profits. He must have responsible service, creative promotional activities, and ample adverising in such media as newspapers, radio, and direct mail. He must have imagination enough to create attractive window displays to draw the attention of potential customers. These concepts, coupled with personal selling, would start Greg on the path to a successful business establishment.

Personal selling is one of the most important aspects in running a profitable business. It constitutes that day-to-day contact with customers and potential customers in both business and social activities. To establish himself as a reputable businessman, Greg knew that he had to develop his sales personality, increase his knowledge of the technical aspects of his business, and learn to understand the basic needs and motivations of his customers. These "selling points" would bring the customers into his shop to purchase his products and services.

A person with an effective sales personality usually has the following characteristics:

1. A genuine interest in his work.
2. Enthusiasm.
3. A professional attitude, and confidence in his ability.
4. Patience and tact.
5. A sense of humor.
6. Decisiveness.
7. Ability to put himself in the other fellow's situation.
8. Courteous, pleasant, and friendly.

Although the average customer may know very little about the technical aspects of the work being performed on his radio or TV, he expects the serviceman to know his business. Therefore, Greg Ellis made sure that he and his men kept abreast of the latest technical information and instruction. Technical efficiency does a lot to build customer confidence in the firm, but this knowledge must be coupled with a good business attitude.

Whether it is a product or a service, most people buy something when they feel they have a need for it. The need may be obvious, as when a TV set malfunctions, or the need may be brought to light when the salesman suggests that a new antenna will improve reception. Greg realized that he had to understand the motivations of his potential customers. His shop was in business to alleviate inconvenience and displeasure to the American family. Knowing this, he made sure his advertising stressed the *service* he could perform.

All good advertising and sales promotion is not produced on Madison Avenue. Greg produced some excellent promotional ideas, using his own imagination and knowledge of the business. Although he received some campaign ideas from electronic distributors and manufacturers, he used a lot of ideas of his own.

Direct mail is one method of getting your name and message to a specific group of potential customers. The big advantage of direct mail is that it allows you to direct your message to a limited area or a particular segment of the population at a relatively low cost. You can obtain a list of names from various sources. The list is important, so make sure that you do not get a lot of names that will result in no additional business. Your record of past customers, the telephone directory, city directory, and personal knowledge can provide many lists. You can also buy lists for $10 to $15 per thousand names.

The simplest way to handle direct mail is to use the professionally prepared material available from your distributor and manufacturer. The easiest and least expensive type of direct mail to prepare consists of postcards with your store name, address, and phone number stamped on the back. Greg used some other approaches too. He made up calendars and used local high school sports schedules to advertise his business. Greg didn't expect spectacular results from one mailing, so he kept his direct mail pieces lively and up-to-date. He knew that continuity of advertising was important. He also followed three basic rules in his direct advertising:

1. Know what you expect your mailing to produce, and word your copy accordingly.
2. Drop "dead names" from your mailing list immediately.
3. Include your present customers in all mailings.

Because of the relatively low cost of newspaper advertising (and the fact that practically all families read the newspaper), Greg used the local community newspaper as an effective advertising medium for his service. Ads can be placed in newspapers on very short notice. Greg found this out when a local storm hit the area and he immediately advertised his ability to repair antennas damaged by the high wind.

Greg tried to reach all income groups in his community. He ran a few ads on the same page as the TV/radio program listings in his local paper. Greg realized that newspaper ads are short-lived since most people keep a newspaper only a day or so. Therefore, he would run a series of ads during a single week.

When Greg asked one of his new customers why he came to his store, the reply was, "The Yellow Pages." If the cost is in line with your advertising budget, the classified telephone directory is a must in your community. It is estimated that fifty percent of the families in an area refer to the classified directory at least once a week. It is a good investment to spend a little extra money on this medium to provide yourself with more than just a listing. An ad that occupies at least two inches, with special copy that distingushes you from other service shops in the area, will almost certainly pay for itself in new business. e.g. Advertise that you are a color TV specialist.

Since Greg was in the business of television and radio repair, he decided to run a few commercial on the local broadcasting stations. He realized that most of the people in his town listened to the local station sometime during the day. In many places, however, radio commercials are fairly expensive. This is particularly true in the large metropolitan areas where you pay for coverage far beyond the geographic area you can profitably service. But radio advertising can prove very profitable in some rural areas not adequately covered by the local newspaper.

Greg rounded out his promotional activities with little extras that didn't cost too much. He made sure that his repair truck was freshly painted, clean, and labeled with his own service shop identification. He ran cooperative displays in some of the local stores to advertise his business. He made special offers throughout the year, and used the various campaign material that he received from his distributor. He found that simple door-knob hangers were pretty effective for direct home advertising. He used these during special sales or promotional campaigns.

Gregory Ellis's advertising was the first step toward promoting his image. He was beginning to draw potential customers from their homes and places of business into his shop. Now he had to deliver on his promises.

First impressions are pretty important. Greg knew that his place of business had to be attractive enough to invite customers and practical enough to *keep* them. He had to create customer confidence at the point of purchase.

One day, Greg stood outside his shop and asked himself the following questions:

1. If I were a stranger, would the outside appearance of my shop make a good impression on my customers?
2. Is the sidewalk in front of my shop swept regularly?
3. Do I have a clean, attractive sign to identify my business?
4. Is my window glass clean at all times?
5. Are my special signs and placards professionally prepared, or do they give the impression of being lettered by someone in a hurry to get back to the workbench?
6. Do I decorate my windows with different items from time to time?
7. Is the overall exterior appearance of my shop clean, neat, inviting, and attractive?

Greg found that he could honestly answer his own questions in the affirmative. He felt confident that the outside appearance of his service shop would be pleasing to the eye. Now, what about the inside? Once the customer walks through that door, he must be met with the same degree of attractiveness.

As Greg strolled through his front door, he asked himself some questions about his shop's interior:

1. Is the interior well lighted?
2. Is the shop always swept, neat, and orderly?
3. Is there an attractive reception area for customers?
4. Is the counter area neat and uncluttered?
5. Is the tube and parts inventory neatly and attractively displayed?
6. Does the shop need a coat of paint?
7. Do I have interesting display material placed around the shop?
8. Would a customer be impressed by the order and efficiency of my shop, particularly the work area?

Greg felt that his shop would not let him down. It wasn't necessarily a big financial investment that created this confidence; just the fact that he had been conscientious enough to do something about the store's appearance.

Greg was a pretty good man to work for, but he was awfully demanding about one thing. He insisted that his employees keep a neat, clean appearance. He knew that customers might tolerate a messy shop, but they would not overlook dirty, sloppy clothes or a two-day growth of beard. Not that he expected his men to shave twice a day or wear their best suits to work, but he required them to have neat, clean clothes and an orderly appearance. Greg realized that maintaining a neat appearance was pretty hard to do in his business, so he took the liberty of purchasing shop clothes for his men. Whenever they dealt with a customer at the counter, they could make a good impression. When they finished, they slipped back into the shop clothes and continued their work.

Greg felt that his service shop was more than just a repair department. He knew that his customers would spend some time in his place of business, and they would feel more comfortable in pleasant surroundings. Anyway, just look at the added advantage of advertising in your own store!

Needless to say, Greg first thought of this problem before he even opened his shop. He wanted his shop to be pleasing to the eye *and* convenient for his work. He took special pains with such things as lighting plans, time saving arrangements, the sales counter, the small parts shelves and bins, the work area, the test and storage area, and even the shelves and cabinets for his technical data and records. One of the manufacturers he represented even supplied him with some modern shop plans for his business.

Ellis's Radio/TV Service Center was up-to-date on the latest developments. Greg's men were well trained and efficient. But he realized that his customers would not necessarily assume this. So, he made sure that the qualifications and experience of his servicemen were prominently displayed. He exhibited the training degrees, course completions, anniversary plaques, and achievement awards on his walls. He made sure that the color TV and solid-state qualifications took a front seat to all others. After all, you have to let the customer know that you are qualified to handle the latest products on the market.

Greg figured that he should stress two main things inside his shop: (1) highly accurate equipment and (2) skilled personnel. But that one main thought kept coming back to him, "I must be able to back up all of this with outstanding service and fair pricing."

What about the customer who wants to wait around for awhile? Greg decided to make it a little easier for him. He purchased a couple of comfortable chairs and a small table. He made sure that the table was covered with interesting reading material that pertained to his business. He subscribed to several electronic magazines, and even included some consumer magazines on radio, television, movie, stereo, and phonograph news. The customer might note that Greg sells phonograph records and tape for tape recorders. Well, why not? After all, he is in the entertainment business, and it appears that he is knowledgeable about all sorts of electronic entertainment products.

Greg also purchased his own customer-operated free tube testing apparatus. Quite a number of people drop by the shop to test tubes, and what better place to do it? They seem to feel a little proud at finding their own bad tube, but they also feel pretty secure because it was discovered in a radio/TV repair shop where professional aid is available. They also know that Greg has a complete inventory of all tubes. He displays the tubes prominently and is always willing to offer advice and information.

Well now, Greg was certainly ahead of the game inside the store. But what about the potential customer that is walking by outside? Greg knew that his outside appearance was good, but did it say anything to that man getting out of his car across the street? Gregory Ellis's first concern was a sign. After careful consideration, he came to the conclusion that he needed a large, outdoor, illuminated sign. It should be bright, colorful looking, and the night illumination would make his shop name visible for blocks. He realized that it was a permanent display that would keep selling for him continuously.

Then Greg really went to work. He made sure that his store window was always fresh and appealing. He used many of the stand-up displays received from his distributor. He included electric display clocks, plaques, and items of merchandise, but was careful to move them around occasionaly. Cardboard fades in the sunlight, and familiarity breeds contempt.

Greg made sure that he indicated the special services his shop offered. He put up a sign in the front window advertising his free tube test service. From time to time, he displayed a complete list of the services he offered and the products he sold.

Greg felt that the most important notice in his front window display was the guaranteed service display. Such a guarantee can be dangerous, especially if you are not completely confident of your own abilities; however, such a guarantee is a tremendous drawing card. It promises effective, competent service on your part. Greg realized that his guaranteed service would be put to the test whenever one of his repair jobs was below par. But by living up to the promise, he created an image that could only result in profits.

Greg made sure that the customer knew exactly what was being guaranteed and for how long. He stressed the terms of his guarantees with the most sales appeal, but he left no room for misinterpretation. It would be too late to explain the terms of his guarantee after being called back to the customer's home.

Gregory Ellis's next area of consideration was the service call. Aside from his shop, this is the most important part of his work. But it is a part of the business that can make or break a repair center. Being invited into someone's home carries a lot of responsibility. Many people, especially housewives, are very reluctant to call for service in the home unless they know the person quite well. This is an excellent opportunity for the serviceman to make a good name for himself.

The first thing Greg did was to prepare a checklist for his employees. He concluded that the list would remind the servicemen of their responsibility, and would insure that his customers could always count on his shop for considerate and quality service.

CUSTOMER RELATIONS CHECKLIST

1. Be well-groomed — clean clothes, clean shave, shined shoes, etc.
2. Introduce yourself by name.
3. Wait to be asked inside.
4. Be pleasant and courteous.
5. Show that the job is finished by turning on the set and tuning it before you leave.
6. Show genuine regard for the customer's property.
7. Clean up any litter before you leave.
8. Don't engage in "personal" conversations.

9. Attach a service sticker to the set when you are finished.
10. Leave a business card if the customer is not at home.
11. Promise only what you can deliver.

Greg realized that a service call was more than a repair job. It was a form of advertising and sales promotion. A good impression on the customer could mean more business in the long run. One of the best forms of advertising is by word of mouth, and customers tend to advertise (unconsciously) when they are impressed with a product or service.

When Greg made a call, he had a lot of things going for him. His panel truck was in good condition with his store name written on both sides. His uniform, as well as his repair kit, also carried the name of his service. He always made sure that the *inside* of his tool and tube kit was as neat as possible. The customer may not know much about the items inside, but he will notice the trouble you have to go through to find the right tool.

There were a lot of little things going for Greg during a service call. He was always friendly and outgoing, but he maintained an air of professionalism that showed he meant business. After all, the customer is paying for a service, not entertainment from the serviceman. He *never* put test equipment on top of a set without a protective pad. He always wiped off the TV face plate before leaving. He made sure that the set was put back exactly in the same position with coasters in place under the legs when he finished.

Greg is in the habit of leaving bad tubes behind. In his opinion, this makes the customer feel that he is dealing with an honest firm. He knows that the tube is bad, and he doesn't wonder if the serviceman is re-using the tube at a later date.

When Greg has to take the set into the shop for repair, he always arranges for a loaner to be left with the customer. Such a service is not always expected, but it will do a lot to build that good image among customers. It is difficult to keep loaners, though; its surprising how many of them he sells as "second sets."

A good businessman tries to promote new business. Gregory Ellis is no exception. During his service calls, Greg is always on the lookout for new opportunities for sales or services. If he notes a stereo or tape recorder in the home, he reminds the customer of his service in those areas. He discusses the items with them and gives them some little hints. He knows that the customer sometimes feels relieved to discuss such items with an expert. Just as a person likes to talk about that bad back to a doctor, many Radio/TV owners like to talk about their entertainment devices with a man who understands them inside and out.

To sum it up, Gregory Ellis realizes the important significance of the service call. He is actually bringing his own shop into the customers' home. As long as he delivers effective, courteous service on his calls, he knows that his business will prosper and grow.

To be a member of a community means much more than just operating a business in a certain town. It means taking public pride in your town, and taking part in its activities. Greg was an active member of his community, and he demonstrated his interest in many ways. Needless to say, his image didn't suffer a bit.

Civic and service clubs, community welfare groups, business organizations, fraternal clubs, church organizations, and the PTA all provide opportunities for you to take an active interest in your community and meet and become friendly with potential customers. Greg realized that it was impossible to become active in all of the organizations in his town, so he joined the ones that brought the most pleasure to him.

Jack Hawley, a fellow member of the local Rod and Gun Club, was a real electronics bug. Greg and Jack had quite a lot in common, so Greg gave him a hand with some of his repairs. Greg's church was having trouble with its color TV in the recreation room, so Ellis's Radio/TV Service Center donated its services in repairing it. Greg soon built an image as an honest businessman, but not one who was considering the money factor only. His community loyalty was admired.

He supported local drives and fund raising campaigns, and was always ready to lend a helping hand. He sponsored a local little league baseball team. He even got the community started on a "Business Day," where all the local merchants held "open house" to familiarize the members of the community with the operation of the various businesses in town.

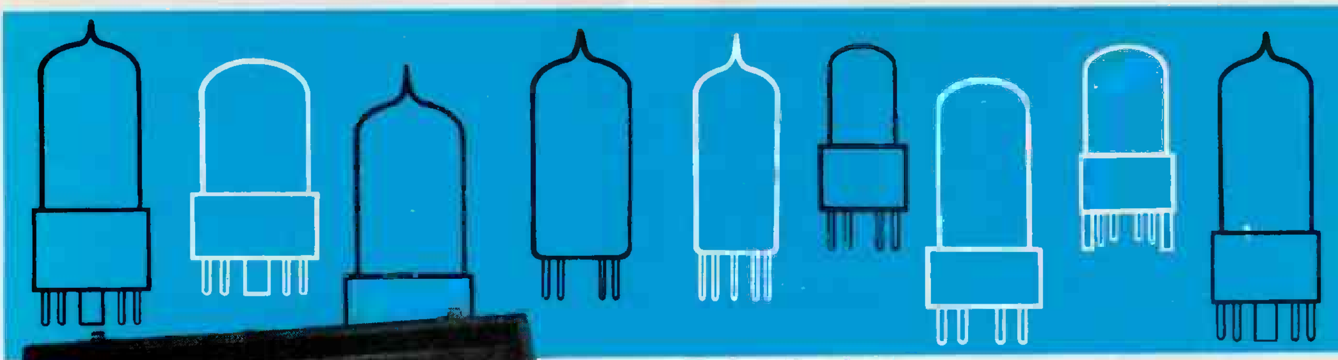
So, Gregory Ellis's image took on another side. He was much more than a business man. He was an important, active, contributing member of the community. He enjoys being one of the civic leaders in his community, and, to be perfectly honest about it, it is the best advertising money can buy.

Although Greg was in competition with the other Radio/TV service dealers in town, he kept in close and friendly contact with them. He realized that to be a success in his own business, he had to be respected by his peers. He was not in business to run any one down or "crush" any competition.

He is a member of the local dealers association and several professional organizations. These memberships keep him up to date on the latest electronic developments, and give him a common ground for discussion with other people in the same line of business. But Greg is more than a fixture at the meetings of the associations. He contributes time and effort for various projects. He submits articles to the local house organ and he has been chairman of several committees. He takes pride in his profession and his fellow businessmen.

Some time ago, Greg realized that there would be times when he could not handle all of the business coming his way. He felt that it would be much better to give the customer an honest suggestion concerning other dealers than to try and hold on to all the business himself. For instance, he knew that Tommy Rankin down the street was quite an expert in car radios. Whenever a problem arose concerning one of these, Greg referred the customer to Rankin. Rankin, in turn, often sent customers to Greg for special service jobs such as antenna installation. Greg felt that such a system made everyone a winner. The customer

• *Please turn to page 80*



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BOOK REVIEW

Understanding UHF Equipment: John D. Lenk; Howard W. Sams and Co., Inc., Indianapolis, Indiana, 1967; 144 pages, 5½" × 8½", soft cover, $3.25.

Prior to 1964, many television technicians were not particularly concerned with UHF. However, in April of that year, an FCC ruling went into effect that required all television receivers produced after that date to be capable of UHF reception. Because of increased UHF TV activity, and because of the increased use of the UHF spectrum by various communications services, most service technicians have found it necessary to acquaint themselves with UHF.

This book is intended to serve just that purpose—to provide a basic understanding of UHF equipment and concepts. Chapter 1 gives a general introduction to UHF and discusses the major differences in UHF circuitry and the effects of UHF signals on components, tubes, and mechanical construction. Antennas, propagation problems, and transmission lines are dealt with in Chapters 2, 3, and 4, respectively. Chapter 5 covers resonant circuits, including resonant cavities and tuning stubs. Microwaves and associated subjects such as wave guides, klystrons, magnetrons, and traveling-wave tubes are discussed in Chapter 6. UHF oscillator circuits and tube types are analyzed in Chapter 7.

Chapter 8 deals with transmitter circuits. UHF receiver circuits are the subject of Chapter 9. Typical UHF TV tuner and converter operation is also covered in this chapter, along with receiver characteristics. UHF servicing techniques and test equipment are presented in the final chapter. ▲

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Introduction to FETS

(Continued from page 36)

gate (grid) bias resistor with a VTVM. Less common are device failures caused by vibration or shock. This causes the internal connections of the device to break open.

Simple tests can be usually performed with an ohmmeter to check a FET for failure. We take advantage of the fact that a PN junction will allow current to flow in one direction only. If the ohmmeter shows first a low resistance then a high resistance (or vice versa) when the probes are reversed, we then have a good indication of a diode. When a PN junction of a FET fails due to an over voltage or current stress, the usual result is a short. Because of this, the device can usually be first checked in-circuit. When checked with an ohmmeter out-of-circuit, the various types of FETs will show characteristics as in Fig. 6. Compensation should be made for the shunting resistors when checking the FET in-circuit.

Special Precautions

There are some special handling techniques to be taken with the MOSFET because of the delicate nature of the gate to channel capacitor. The dielectric is approximately four microinches thick and has virtually infinite (10^{15}) resistance. As a result, the capacitor can hold a charge for a long period of time. Because of this ability, it can charge up to a voltage which will cause the capacitor to break down by merely stroking the device leads through your hair. If the following handling precautions are observed, there should be no difficulties.

1. Out of Circuit: Keep MOSFET leads shorted together
2. Installation: a. Short MOSFET leads, b. Ground soldering iron tip

For those of you who wish to learn more about FETs, the following book should be worthwhile:

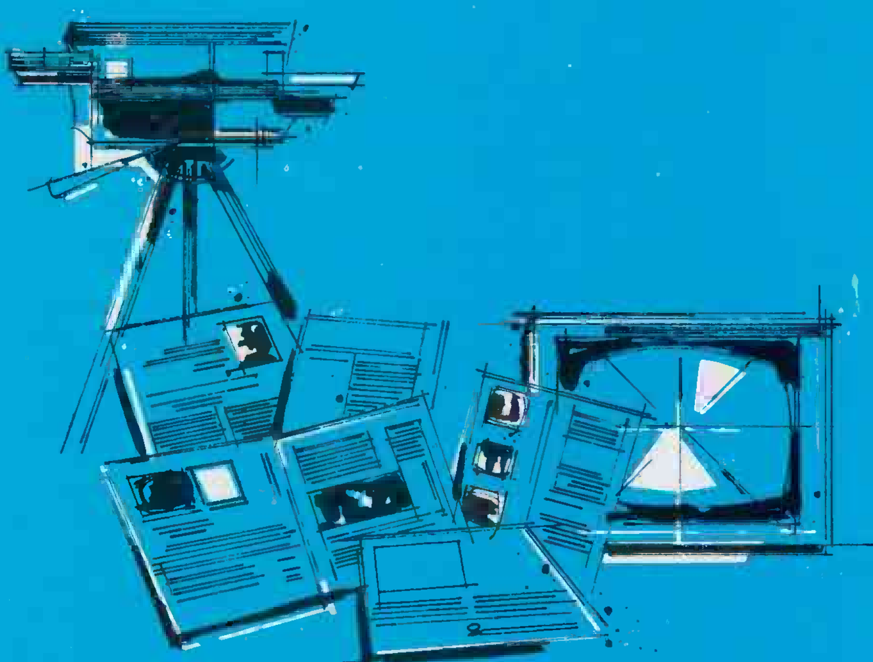
Gosling, William; Field Effect Transistor Applications, John Wiley and Sons, Inc., 1965.

Semiconductor manufacturers also have available many good application notes on FETs. The Motorola AN-211 is a good one. ▲

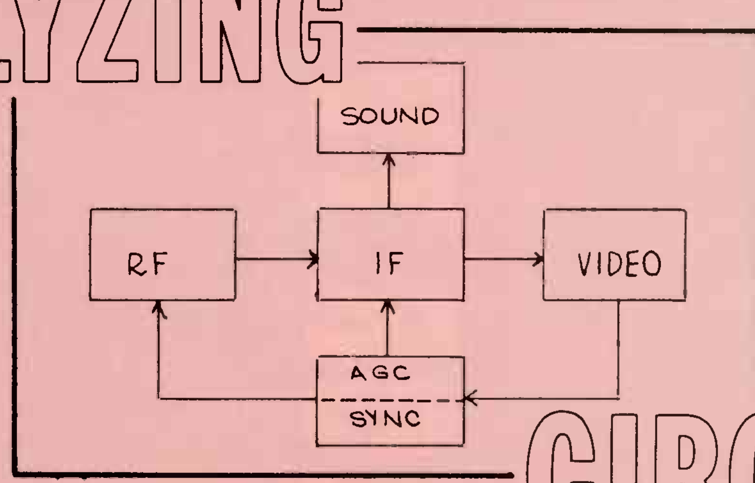
PART 2

COLOR TV

service training



ANALYZING CIRCUITS



A color receiver may be divided into sections for the purpose of study. One of these is composed of those circuits which are more or less similar to their counterparts in a b-w receiver. As we shall see, some of these circuits are almost identical to their b-w ancestors, while others have been modified extensively to meet the more demanding requirements of color reception. The remaining circuits of the color receiver have functions which are related specifically to color and have no b-w counterparts. This lesson will deal principally with the circuits in the first category. Fig. 1 is a functional block diagram of a color receiver. The circuits which are practically unchanged from their b-w counterparts are shown unshaded, those which have b-w counterparts but have been extensively modified are shaded, and those circuits which are peculiar to color are crosshatched.

Receiver Bandpass

Before discussing the specific circuits used in RF and video IF amplifiers of color receivers, let's consider the bandpass requirements of a color receiver as opposed to black-and-white. Present-day b-w receivers of good design usually have an overall response from the mixer to the video detector output that is 3 to 3.25 MHz wide at the 6dB points. This means simply that a video signal component at 3 MHz would produce only one-half the output voltage at the detector as one having a frequency of perhaps 2 MHz.

Typical color receivers of modern design have responses which are 3.58 to 4.0 MHz wide at the −6dB points. This is necessary to allow the color burst to pass through the IF strip and, more important, to allow the upper sideband of the color subcarrier to pass. From the first lesson, you will recall that the color burst has a frequency of 3.58 MHz and that the upper sideband extends to about 4.2 MHz. While it may appear that these frequencies cannot pass the IF strip, we shall see later that the relative attenuation of these frequencies in the IF strip is compensated by the tuned circuits of the chroma bandpass amplifier.

Still another requirement of the IF and RF bandpass of a color receiver is the shape of the curve. Because of the tendency of the color subcarrier and the 4.5-MHz intercarrier audio signal to beat in the chroma circuits and produce interference in the picture, the output stage of the video IF must have excellent 4.5-MHz trapping. (The sound is recovered from a point preceding this trap.) It is also important that the slope of the IF response curve on each side of the lower −6dB point be constant so the overall response through the chroma amplifier will be smooth from 3.0 to 4.2 MHz.

RF Tuner

The function of the RF amplifier and mixer of a color receiver is the same as it is in a b-w receiver. It must tune to the 12 VHF channels and to the output of the UHF tuner with a reasonably constant noise figure across the band. However, the requirements for bandpass are more stringent, and the need for low noise is more pronounced in color, especially in fringe areas. Thus, a tuner which was entirely satisfactory for b-w reception might prove inadequate for color.

Although a tilt or sag in the response curve of a monochrome tuner might be compensated in the IF amplifiers, it is necessary to provide uniform response across the band for proper reception of color signals. A tuner having a response similar to Fig. 2 would produce excellent results in a color receiver. It is interesting to note that since color receivers have become so popular, some of the manufacturers are adapting their color tuners to their black-and-white sets. Two examples of this are the RCA tuner Model KRK118 and Zenith tuner Model 175-503.

With the exception of tube failures, both color and b-w tuners present only a moderate number of service problems. It is important

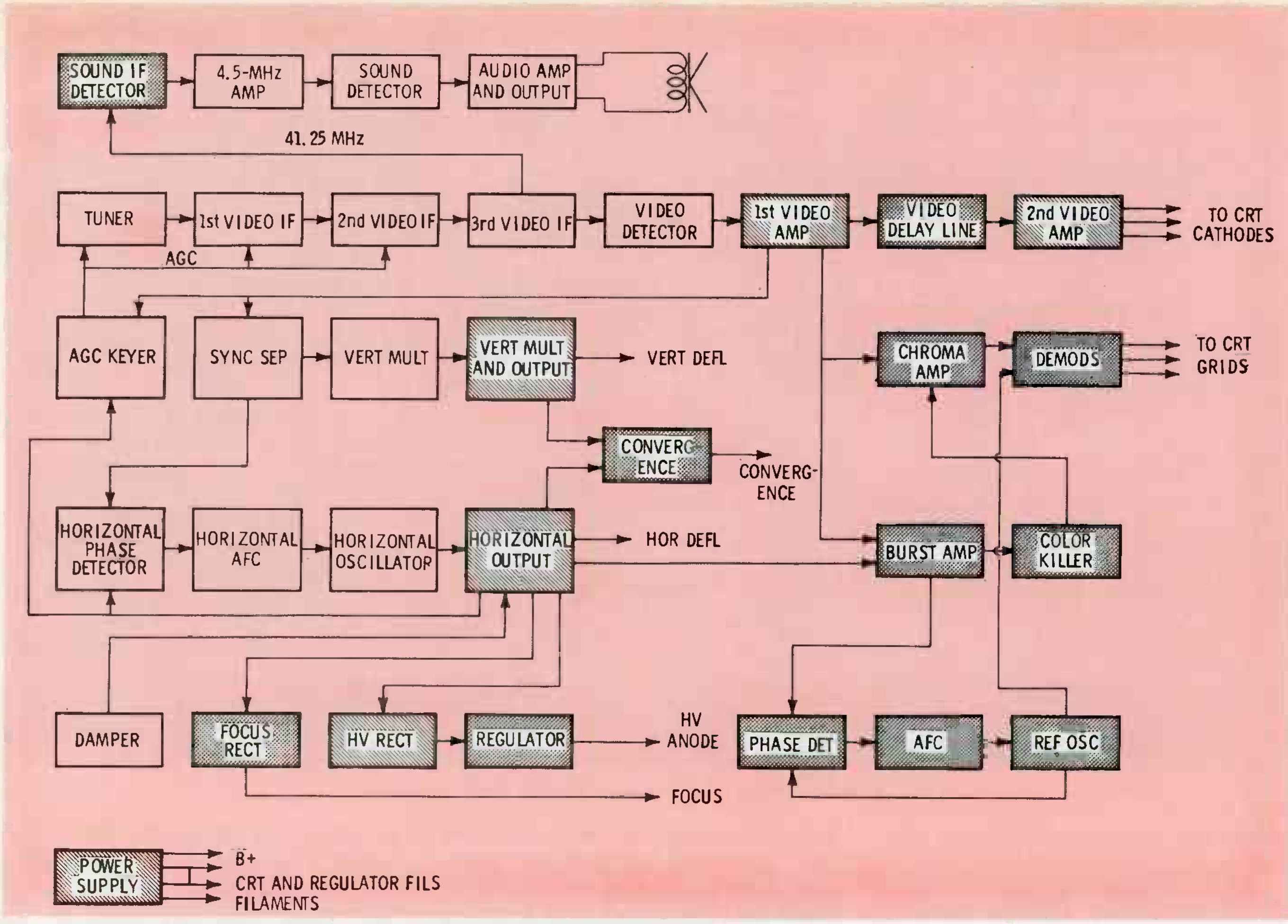


Fig. 1. Functional block diagram of a typical color receiver.

that the technician appreciate fully the necessity of accurate alignment and careful repair techniques when dealing with color tuners. It is possible to "repair" a tuner using slipshod methods or improper alignment procedures only to find that color reception has been seriously impaired even though b-w reception is reasonably good. Many of the compromises which have become common practice in b-w receivers cannot be made in tuners used in color receivers.

Video IF Amplifiers and Detector

Although the function of the IF amplifiers in a color receiver is essentially the same as for a monochrome set, the bandpass requirements are more stringent just as they were in the tuner. First of all, the purpose of the section is to amplify and select a certain band of frequencies as shown in Fig. 3. Notice that the sound carrier frequency is lower than the video carrier. This is due to the fact that the local oscillator in the tuner is tuned to a frequency above the channel and thus the sideband positions are reversed. The transmitted upper sideband becomes the IF lower sideband and vice versa.

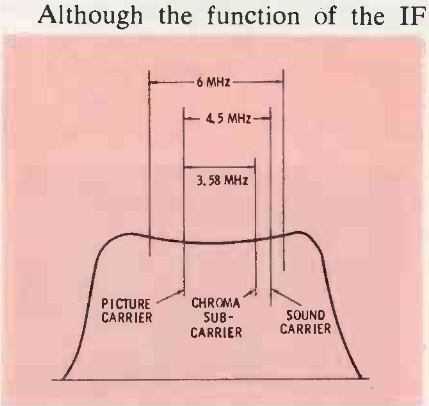


Fig. 2. Ideal tuner bandpass curve.

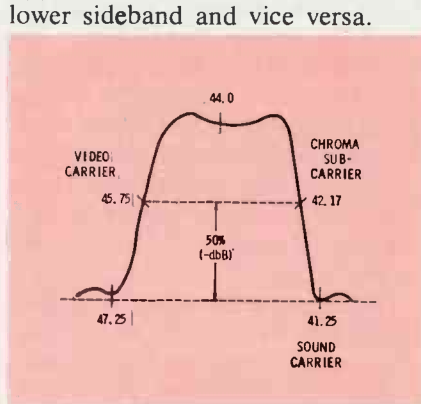


Fig. 3. Typical IF bandpass curve.

In the past dozen or more years, the video IF amplifier has evolved from a very complex circuit with six stages of amplification to contemporary designs with as few as two stages only slightly more complex than those used in present-day black-and-white receivers. The IF amplifier and video detector (RCA chassis CTC19) shown in Fig. 4 is a typical two-stage circuit.

The mixer plate coil, L202, and the coupling transformer, L2, are tuned to approximately the center of the passband, and C14 controls the bandwidth of the combination by changing the amount of coupling. When properly adjusted, these components produce a passband at the grid of V1 having −6dB points at 42.17 and 45.75 MHz. A2 is a sound trap which attenuates the sound carrier and produces a "notch" at 41.25 MHz. The combination of the tuned circuit, L1 and C13, and R19 form a second trap tuned to the sound carrier of the adjacent channel. Fig. 5 shows the actual bandpass curve seen at the plate of V1. At the time of observation, L3 was swamped and,

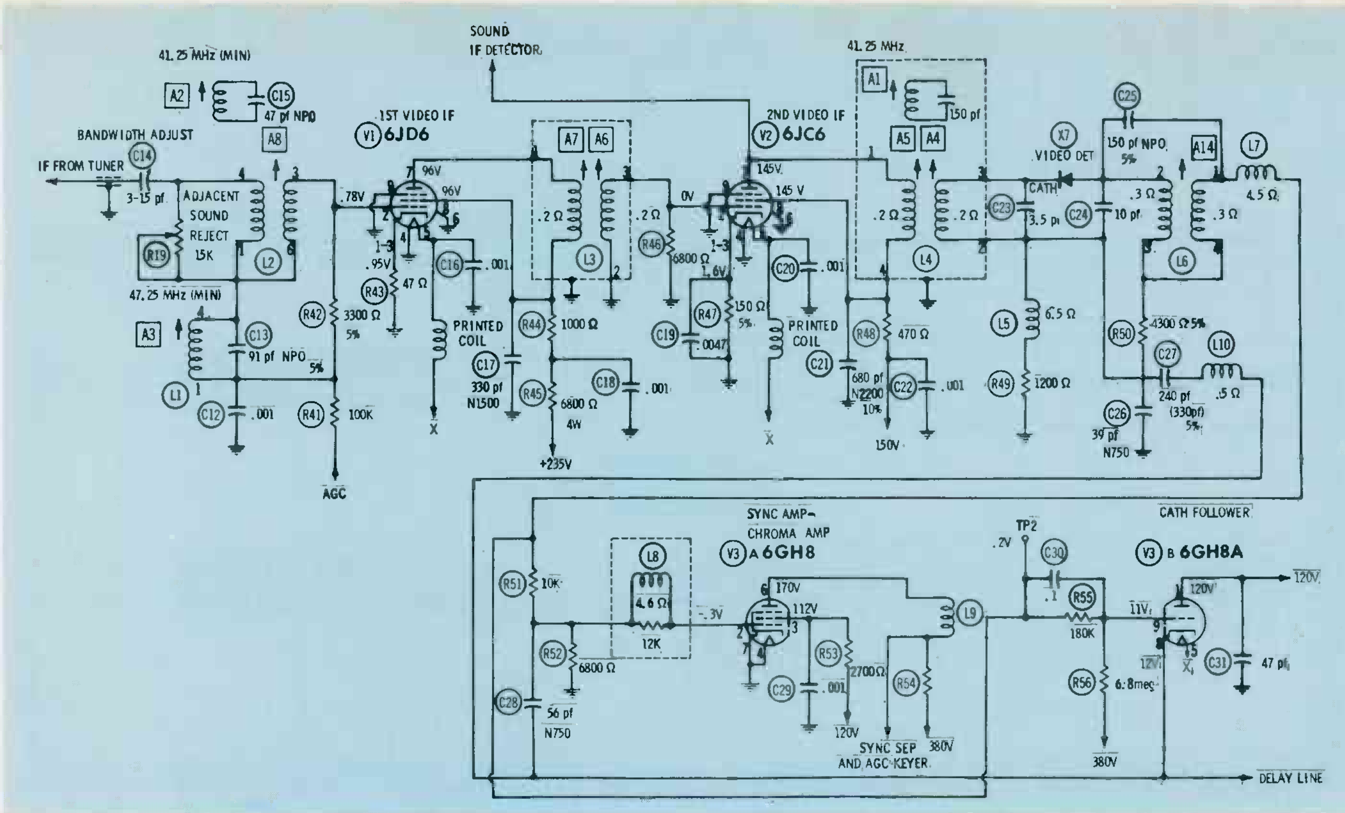


Fig. 4. IF amplifier and detector of RCA CTC 19 chassis.

therefore, had no effect on the curve.

L3 is the interstage coupling circuit between V1 and V2. It is a fairly conventional double-tuned circuit and is adjusted so that a symmetrical curve having a 3.58-MHz bandpass appears at the plate of V2 when the plate circuit is "swamped."

The output of V2 is developed across two separate loads. The shunt-fed sound takeoff coil, L14, is resonant at the sound IF (41.25 MHz). The audio must be recovered in front of the video detector because the sound IF freuency is trapped out before video detection. The remainder of the audio circuit will be discussed later.

The second plate load of V2 is L4 which consists of a double-tuned coupling transformer and a 41.25-MHz sound trap. The coupling transformer is overcoupled to increase its bandwidth and the two slugs are adjusted for symmetry and bandwidth so that the video output appears as shown in Fig. 6. Naturally, the sound trap (A1) is tuned to trap out the 41.25-MHz sound carrier.

A final 4.5-MHz sound trap, A14, is located in the output of the video detector. Notice that there is a total of three sound traps in the receiver. These are necessary to completely remove the 4.5-MHz beat from the video section, as even a minute signal will beat with the chroma subcarrier in the color demodulator and cause interference.

The IF section of Admiral's 1G1155-1 chassis (Fig. 7) is typical of the three-stage IF amplifier currently in use. The interstage circuit between the mixer plate and V1 is similar to the circuit employed in the RCA chassis except that it does not have a 41.25-MHz sound trap. L4, L6, and L7 comprise a staggered triple with the three transformers single-tuned to 45.75, 42.5, and 43.8 MHz, respectively. Notice that the sound IF takeoff is from the last IF amplifier plate as it was in Fig. 4.

The input to the video detector is trapped at 41.25 MHz to attenuate the sound carrier, and a 4.5-MHz trap in the output of the detector further attenuates the sound. Although it is not shown in Fig. 7, there is one more 4.5-MHz trap which is located in the grid circuit of the first chroma bandpass amplifier. Thus, both the Admiral and RCA have the same number of traps, one adjacent-channel trap and three sound traps, although their locations in the circuit are different.

Notice that the first and second IF amplifiers are "stacked." That is, the plate supply of the first tube is taken from the cathode of the second. This circuit is used in many receivers, both color and monochrome, and has the following advantages: (1) Since the plate voltage does not have to be dropped by a bleeder, the load on the power supply is decreased. (2) The second IF amplifier acts as a voltage regulator for the first IF stage to improve its stability and signal-to-noise ratio. (3) The AGC voltage which is applied to the grid of the first IF amplifier is amplified and applied to the cathode of the second

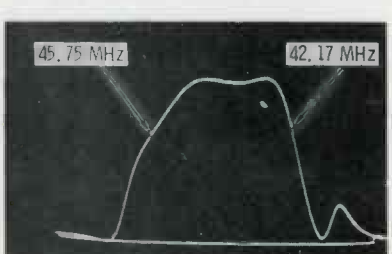


Fig. 5. Response curve at V1 plate.

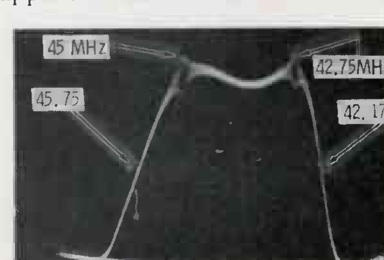


Fig. 6. Overall IF response curve.

stage to improve the overall AGC action.

Referring once more to Fig. 4, there are two outputs from the video detector. One of these drives a cathode follower and its output ultimately reaches the CRT cathodes as the Y, or luminance, signal. The second output from the detector drives a sync and chroma amplifier, and this amplifier, in turn, supplies signal to the sync and AGC circuits as well as to the chroma bandpass amplifier.

The video detector employed in the Admiral chassis (Fig. 7) has only one output which goes to the first video amplifier. Then the video signal is distributed to the sync, AGC, Y, and chroma circuits.

Sound IF and Audio

Except for the point of takeoff and the separate sound IF detector, the sound system of a color receiver is essentially the same as those in monochrome receivers. The sound takeoff point in a color receiver is normally the plate of the final video IF amplifier because one or more sound traps following this point severely attenuate the sound signal before it reaches the video detector. Fig. 8 shows the sound IF and audio section of Zenith Chassis 24MC322.

The 4.5-MHz sound signal is developed by the sound and sync detector which is connected to the plate of the third IF amplifier. The detector output is amplified by V6A and the sync pulses are supplied to the AGC and sync circuits. The 4.5-MHz signal is amplified further in V6B and then detected by the quadrature detector, V8A. The remainder of the circuit is so familiar that no further explanation is warranted.

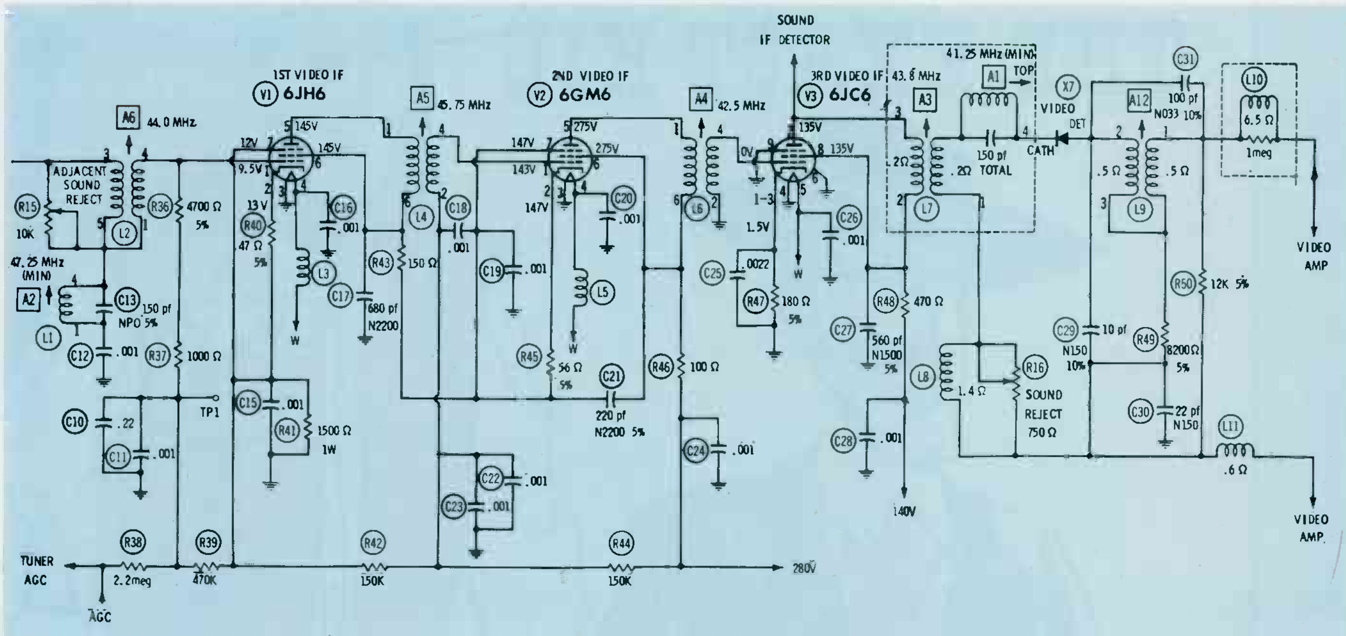


Fig. 7. IF amplifier and detector of Admiral 1G1155-1 chassis.

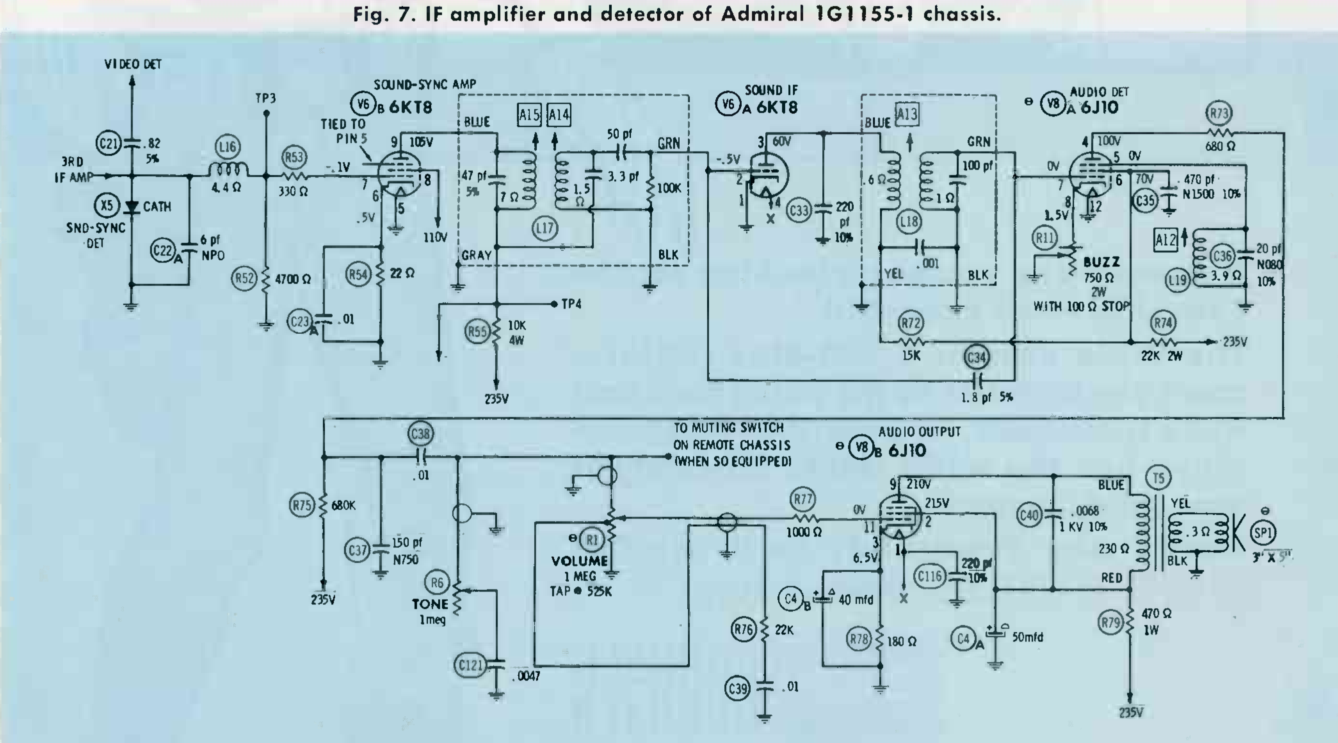


Fig. 8. Sound IF and audio section of Zenith 24MC32 chassis.

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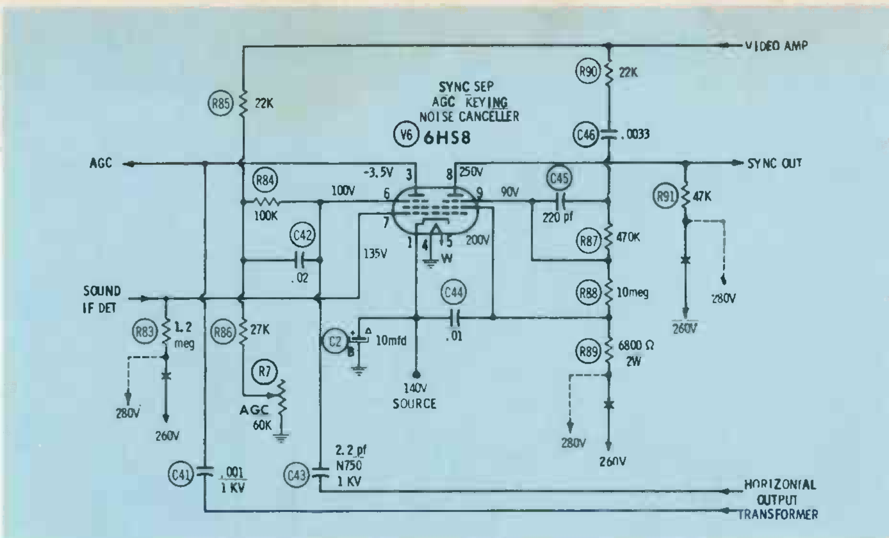

Fig. 9. AGC keyer, sync separator, and noise canceller of Admiral chassis.

AGC and Sync

Although it is conventional in operation, the AGC circuit is very important in color reception since variations in signal level in the video and chroma circuits will cause the color of the image, as well as the brightness, to vary.

The AGC keyer, sync separator, and noise canceller circuit of the Admiral Chassis 1G1155-1 is shown in Fig. 9. During retrace time, the plate (pin 3) is supplied with a positive pulse from the high-voltage transformer. At the same instant, a positive sync pulse is applied to the suppressor grid (pin 6). Also, at the same instant, a negative sync pulse is applied to the control grid; but its normal amplitude is insufficient to hold the tube in cutoff and we shall ignore it for the moment.

With both the plate and suppressor grid driven positive, V6 conducts and charges the top of C41 negative. C41 tends to discharge between pulses, but the time constant during discharge is so long that the voltage remains substantially constant between sync pulses. Since the amplitude of the pulse applied to the plate is constant, the amount of charge on C41 is determined by the amplitude of the sync pulses applied to the suppressor grid and, of course, the bias set by the AGC control. Thus an increase in the amplitude of the sync pulses causes a greater negative charge to accumulate on C41 and this decreases the gain of the receiver.

If a noise spike should appear on top of (coincident with) a horizontal sync pulse, it seems that the charge on C41 would be excessively negative. This would cause a radical increase in AGC voltage and result in varying contrast on the CRT. To preclude this, negative sync pulses are applied to the control grid of V6. If a noise spike appears on top of the sync pulse, the tube simply does not conduct and the AGC voltage remains unchanged until the next normal sync pulse arrives.

The voltage developed on C41 has high-amplitude pulses superimposed on it and these must be filtered out before the voltage can be used for AGC. This is accomplished by the long time constants of R35, C9 and R38, C10.

The sync circuit is conventional. The right side of V6 remains cut off except when positive sync pulses are applied to its suppressor grid. The sync pulses are amplified and inverted by V6 and fed to the deflection circuits. The control grid of V6 is common to both sides, and a noise spike "riding" a sync pulse also holds this side of V6 in cutoff. As a result, one sync pulse does not appear at the output, but this does not cause the deflection circuits to fall out of sync.

Luminance Circuits

The main function of the luminance channel is to amplify the output of the video detector to a level which is sufficient to drive the CRT cathodes. The channel may have one, two, or three stages depending on the video output level, the delay-line loss, gain per stage, etc. Fig. 1 shows two stages since this number is a reasonable compromise among several modern sets.

While the luminance channel is similar in many respects to the video amplifier of a b-w receiver, it performs some additional functions. In many sets, the first luminance (or video) amplifier is used to amplify the signal fed to the sync and AGC circuits. In other sets, these signals are amplified separately or in conjunction with the sound IF signal. Some manufacturers take the chroma signal directly from the video detector to the chroma bandpass amplifier while others take this signal from the output of the first video amplifier. The luminance channel also introduces a specific delay in the brightness signal, contains the brightness and contrast controls, and has means for setting the signal levels at each of the individual CRT cathodes.

Fig. 10 was chosen to illustrate the luminance channel because it performs all of the functions mentioned above. The output of the video detector passes through a 4.5-MHz trap and a peaking coil to the grid of V4A. The level of the composite video at this point is approximately 2.5 volts.

Four outputs are derived from the plate circuit of V4A. A signal having a sync-pulse amplitude of 60 volts is taken from the bottom of L10 and fed to the chroma section. A 35-volt signal from the bottom of R59 goes to the sync separator, and one having an amplitude of 20 volts goes to the AGC keyer. The fourth output is applied to the grid of V4B through L12 and R61. These components reduce the high-frequency response to attenuate the chroma subcarrier sidebands. A portion of the output of the vertical output tube is also coupled to this grid to provide vertical blanking. In modern color receivers, it is common practice to inject the vertical blanking pulse into the luminance channel.

The delay line driver, V4B, is a triode because a fairly low output impedance is required. The type of delay line driver varies among sets of different make, but it is characterized by relatively low output impedance. Notice that the plate load resistor of V4B is only 6800 ohms. To drive the delay line, some manufacturers use a cathode follower,

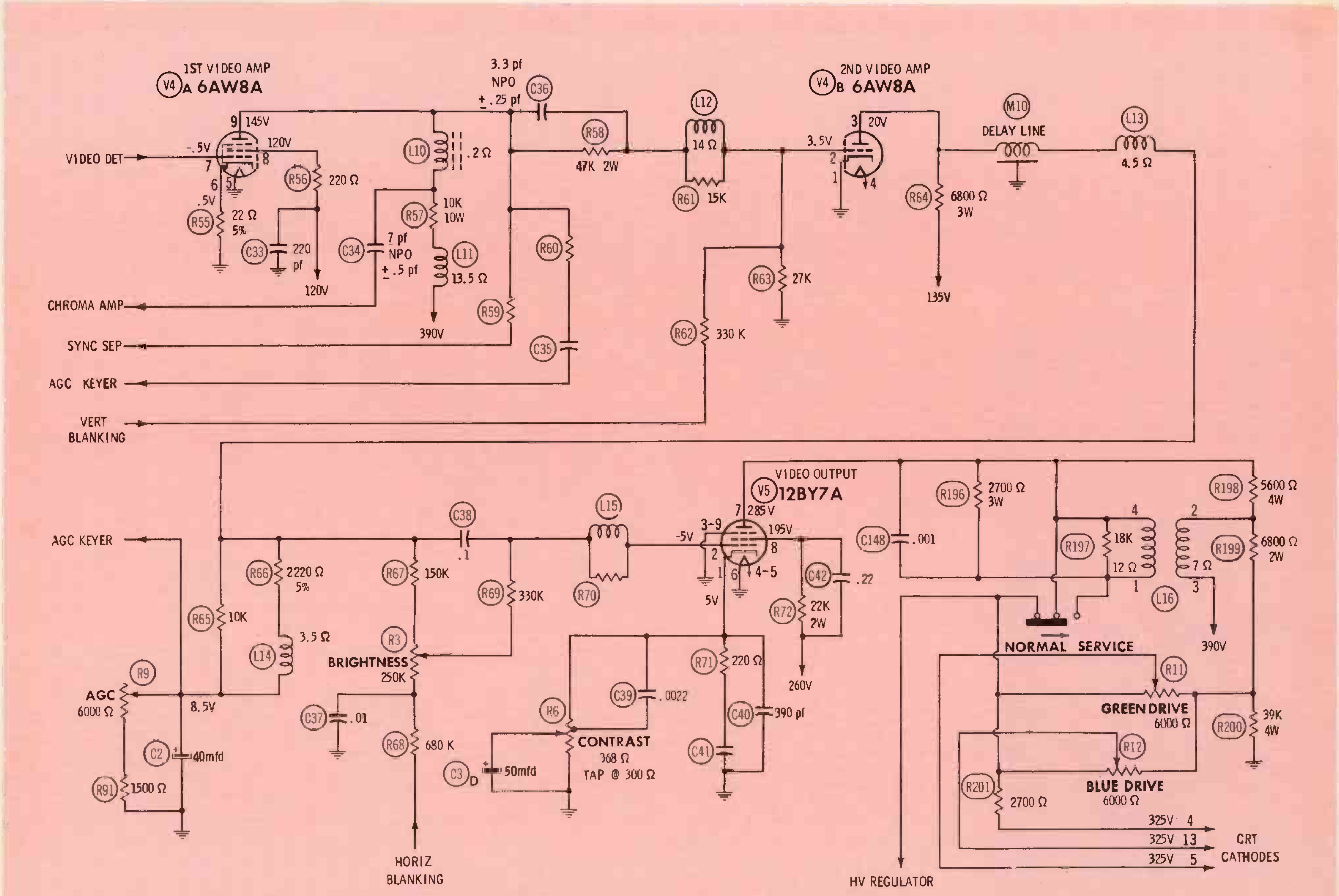

Fig. 10. Luminance channel of General Electric FY chassis.

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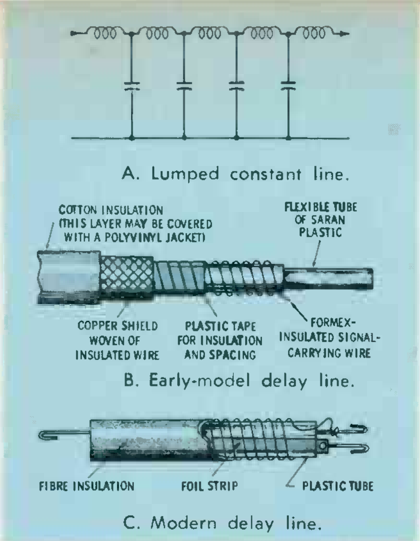


Fig. 11. Evolution of delay lines.

others use a bootstrap amplifier, and still others employ a transistor.

One characteristic of any amplifier circuit is that signals passing through it are delayed by an amount which is inversely proportional to the bandpass. Since the bandpass of the luminance channel is more broad than that of the chrominance channel, the transit time is about 1 microsecond less. If no correction were made, the Y signal would be presented on the CRT before the chrominance signal and the color would "trail" the black-and-white image approximately N/64 inches, where N is the width of the raster in inches.

Although the term "delay line" may be new to some technicians, all have worked with transmission lines and coaxial cables which are, in reality, delay lines. As we all know, the velocity of propagation (speed) in a line is less than it is in free space, and so any transmission line could be used as the delay line in the luminance channel. The velocity of an electromagnetic wave is 300 meters per microsecond in free space but only 200M/usec in RG-59/U cable. Thus 200 meters (656 feet) of RG/59U would produce the desired delay.

Unfortunately for the cable manufacturers, more convenient delay lines have been developed. Delay lines consisting of lumped constants (Fig. 11A) have been used in many applications, but a "distributed constants" line is somewhat more economical. Fig. 11B is a drawing of the cable used in an early General Electric receiver (Model 15CL100). The inner conductor is wound around an insultating tube to increase its inductance, and a coating of powdered aluminum and styrene increases the shunt capacity. In this manner, a 1-microsecond delay is achieved in only 18 inches of this cable. Fig. 11C shows a more recent delay line which is only about 5 inches long.

Four signals are applied to V4 (Fig. 10). In addition to the delayed luminance signal and vertical blanking pulses, horizontal blanking pulses are inserted through R68 to the bottom of the brightness control. The brightness control determines the DC potential at the grid which, in turn, controls the plate voltage of V4 and, ultimately, the CRT cathode voltages. Notice that the lower ends of R65 and L14 are connected to the slider of the AGC control and the cathode of the AGC keyer. As the cathode bias of the AGC keyer tube is made more positive, the AGC voltages is decreased, resulting in greater receiver gain and a darker picture. However, this same bias which is applied to the cathode of the AGC keyer is applied to the grid of V5. Thus, as an increased signal tends to darken the picture, the CRT brightness is automatically increased.

The contrast (video gain) control located in the cathode circuit of V5 functions in much the same fashion. As the resistance is decreased, the contrast is increased and the plate potential is reduced. This reduces the CRT cathode potentials to increase the brightness.

The network in the plate circuit of V5 splits the signal into three separate signals which, in turn, are fed to the three CRT cathodes. While the red drive is fixed, the blue and green cathodes are connected through drive controls to provide for gray scale adjustments. In the "service" position, the service-normal switch shorts the primary of L16 and removes the luminance signal from the CRT. (Another switch section is used to remove the vertical sweep.)

An output is taken from the common ends of R11, R12, and R201; and, after it is integrated or filtered, it is used as the control voltage for the high-voltage regulator. For example, if the brightness control is set for less brightness, the DC level of the CRT cathodes is made more positive. This increased positive level increases the conduction of the shunt regulator to compensate for the reduced conduction of the CRT. Thus, the load on the high-voltage power supply remains constant.

Some of the receivers which were checked incorporated some type of video peaking control in the luminance channel. This control changes the high-frequency response of the video amplifier to give a sharper or softer picture. If it is a back-of-set control, it should be set according to the owners preference.

One important characteristic of all luminance amplifiers is often ignored by many technicians. Since all the stages in the channel are direct coupled, a moderate change in voltage level at one point in the circuit may have drastic effects elsewhere. For example, suppose that R55 in the cathode circuit of V4A increases in value enough to make the cathode potential rise to 1 volt. If this were a conventionally coupled amplifier, there would be very little change in operation since the tube would continue to function reasonably well with a moderate increase in bias. Not so in a chain of direct-coupled amplifiers! The increase in positive cathode bias will cause the plate voltage to rise. Since the two succeding plates are direct coupled, this change in level is amplified just like any other signal. The voltage gain from the grid (or cathode) of V4A to the CRT is about 40, so the .5-volt change at the cathode of V4A will cause the CRT cathodes to change about 20 volts. The change at the CRT cathodes would be positive, so a noticeable decrease in brightness would result.

Because of this characteristic, it is very important to be sure that an abnormal voltage near the output of the channel is actually being caused by a component in that specific area. Often the cause of trouble is far removed from the point where the symptoms are first detected. It is sound practice to check back towards the input until a point is reached where everything is normal and then examine the components just after this point.

Power Supply

The power supplies of color receivers are quite similar to those

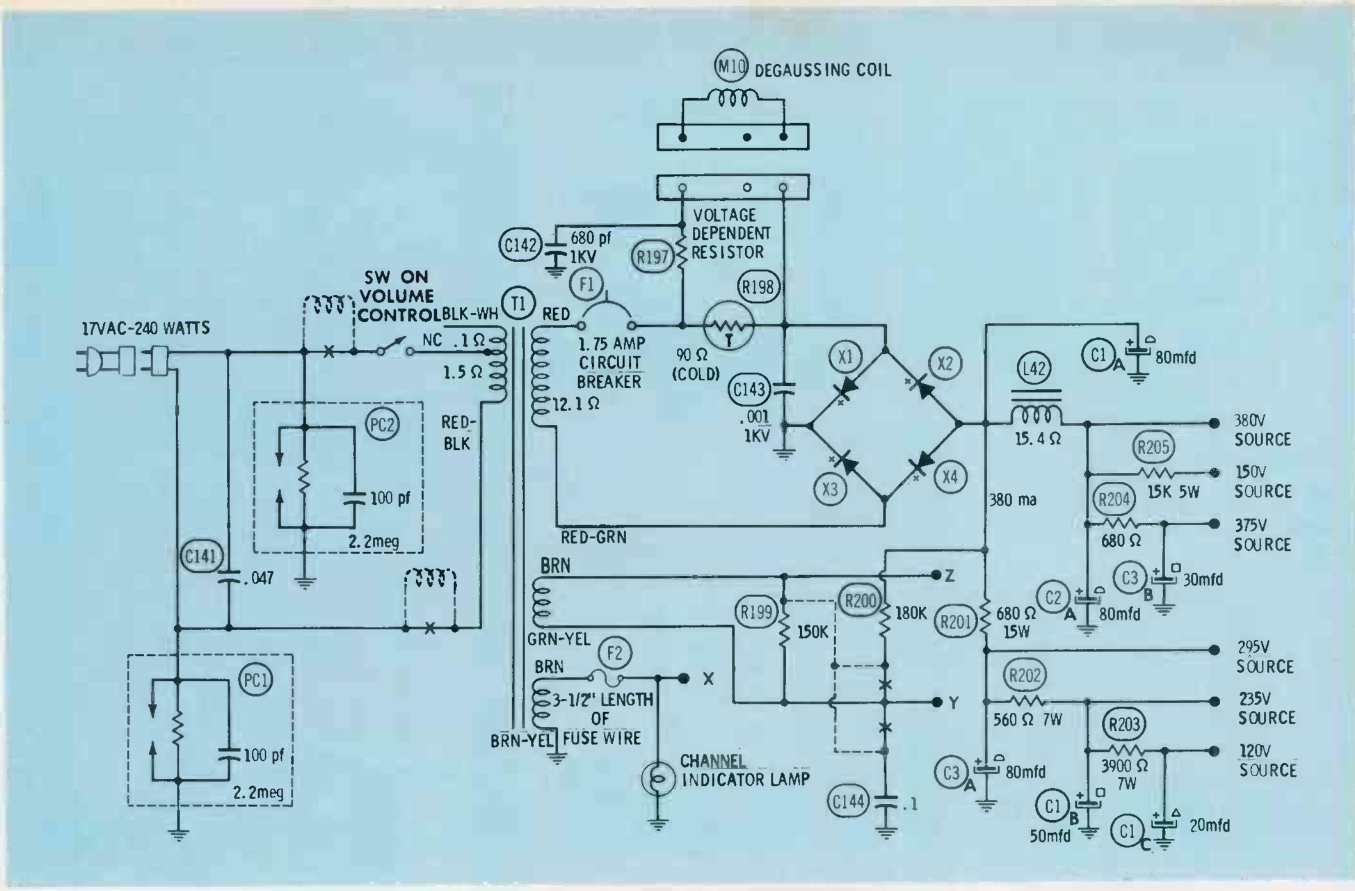


Fig. 12. Power supply of RCA CTC19 chassis.

found in many b-w receivers. Fig. 12 is the power supply of the RCA CTC19 chassis. While this power supply uses a full-wave bridge rectifier, full-wave doublers are used by some manufacturers. Some receivers use B+ voltages as low as 280 volts, but a B+ source nearer 400 volts is more popular. All the sets checked used a power transformer with a step-up winding for the rectifier and a separate filament winding for the shunt regulator and CRT. This winding is connected to B+ to reduce the heater-cathode potential of these tubes.

Nearly all present-day sets feature automatic degaussing and the circuit in Fig. 12 is typical. When the receiver is off, the resistance of R198 is high while the resistance of R197 is low. When the set is turned on, AC flows through the rectifier and the degaussing coil which are effectively in series. A small current flows through R198, causing it to become warmer. This warming action decreases the resistance of R198 and this decreases the voltage drop across M10 and R197. R197 is voltage sensitive, that is, its resistance increases as the applied voltage decreases. The action of R197 and R198 is cumulative, and so the current through the degaussing coil falls to zero after a few seconds.

Summary

Referring to Fig. 1, the color receiver circuits may be divided into three groups. One group comprises those circuits which are similar or identical to circuits found in b-w receivers: tuner, IF strip and video detector, most of the sound circuit, AGC keyer, sync separator, and the deflection oscillators. The video amplifiers, power supply, high-voltage supply, and deflection output circuits have b-w counterparts; but these circuits have been modified extensively to adapt them for color. The third group includes the circuits which do not have counterparts in a b-w receiver. These are the chroma circuits, sound IF detector, convergence circuits, video delay line, high-voltage regulator, and the focus rectifier.

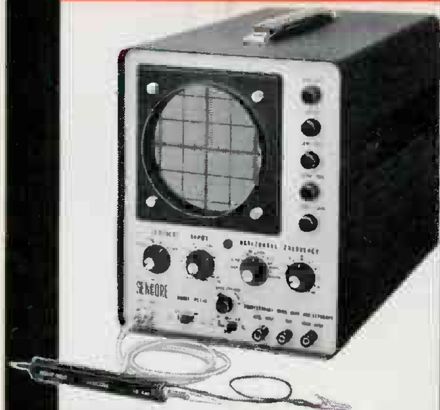
The tuner and IF circuits are modified only slightly to increase the response near the upper edge of the video passband. Additional traps are required to prevent interaction between the 4.5-MHz sound carrier and the 3.58-MHz chroma information. The additional traps make it necessary to move the sound takeoff point "forward" and use a separate sound IF detector. Otherwise, the sound system is conventional. The AGC and sync circuits are nearly identical to the ones found in monochrome receivers.

The luminance channel performs the same functions as the monochrome video amplifier and also it has some additional features. It provides for video delay, performs the retrace blanking, incorporates the brightness control, and, of course, it drives three CRT cathodes instead of one. The luminance channel is direct coupled and this can lead to service problems for the unwary technician.

The power supply is essentially a "beefed up" b-w power supply. The usual B+ output is about 400 volts with a current drain near 500 ma. Automatic degaussing is accomplished by the power supply as an additional function.

The next in this series of lessons will cover the high-voltage and deflection circuits. The remainder of the lesson will be an introduction to the chroma circuits. ▲

CIRCUIT ANALYZERS



PS 127—Wide Band 5" Oscilloscope with direct reading P to P volts. **$199.50**

SM 112B — Combination VTVM-VOM with automatic scale indication. **$89.95**

SS 137—Sweep Circuit Analyzer for both black & white and color TV. **$94.50**

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NOTES ON TEST EQUIPMENT

analysis of test instruments ...operation...applications

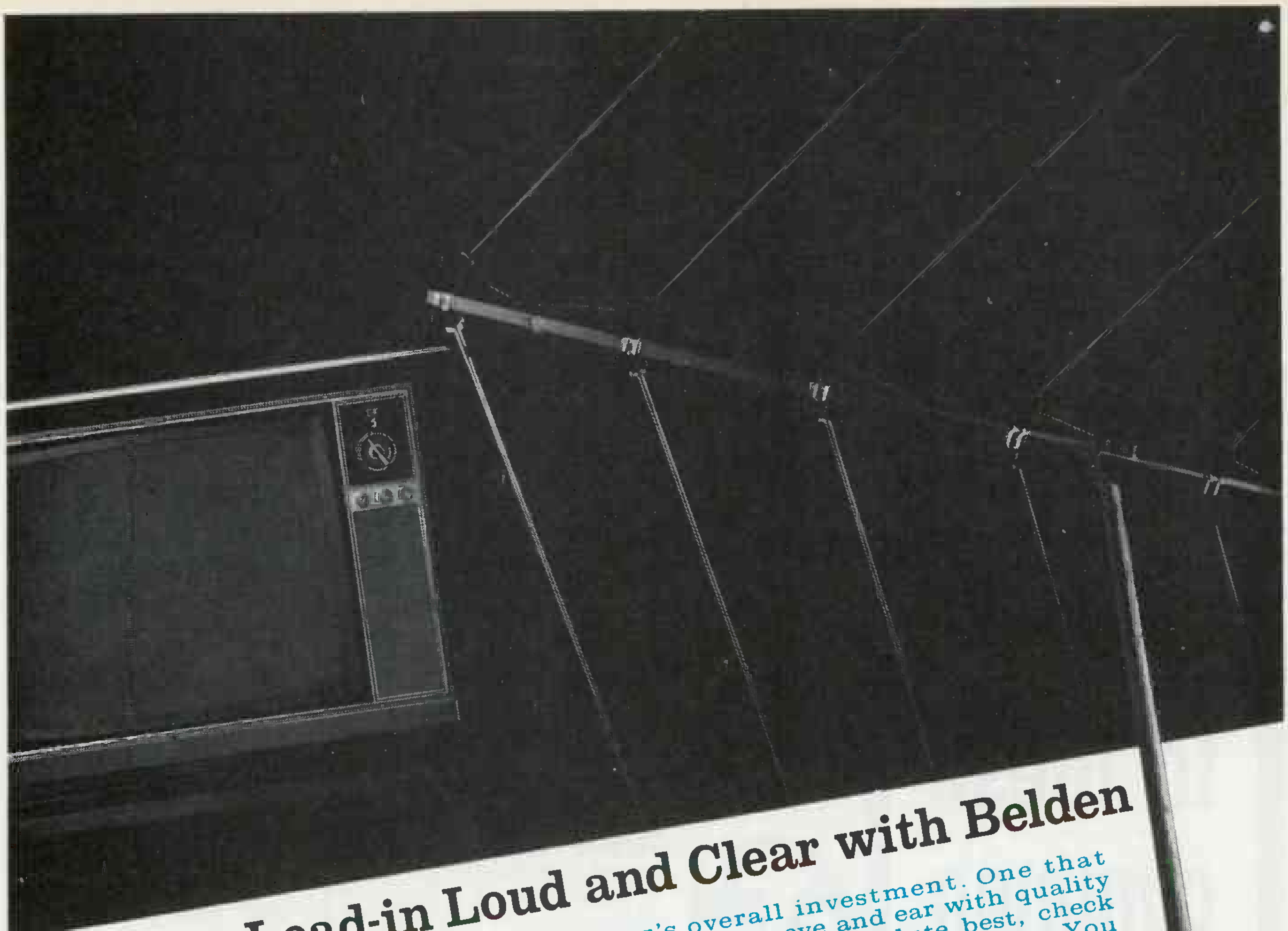
By T. T. Jones

CRT Analyzer

Hickok's new Model CR 35 CRT tester (Fig. 1) has an outstanding feature which at first glance may be overlooked. All supply voltages are continuously variable—and metered. With this feature, one can use a tube manual as easily as the setup book and still get a fast, accurate test of a CRT's condition. It's reasonable to assume that there will be a lot of beat-up, scuffed-up CR 35's still doing their duty in 1982.

Since the grid and screen voltages draw little current, they are

Fig. 1. Hickok's CR 35 CRT tester.



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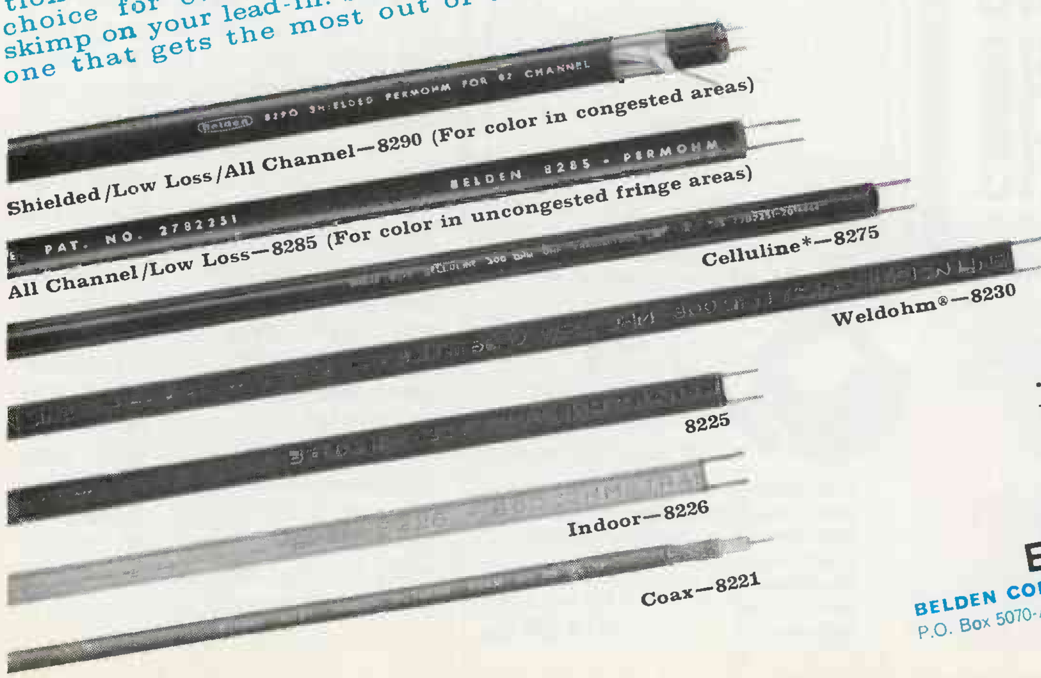

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Circle 23 on literature card

controlled by conventional techniques—just a simple variable voltage divider. The heater circuit however, bears a closer look.

The heater circuit is shown in Fig. 2. It's rather simple, but as far as we know unique in low-cost test equipment. The output of the transformer (about 35 VAC) is rectified by the SCR. The turn-on time of the SCR is controlled by the UJT, which in turn is controlled by the time constant of R1, R17, and C3.

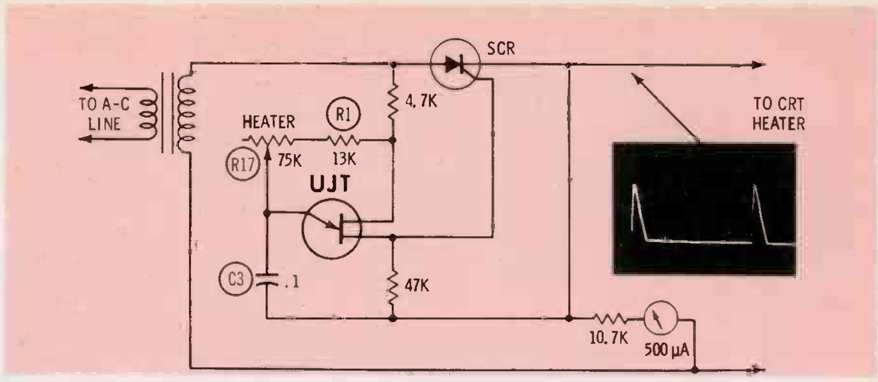


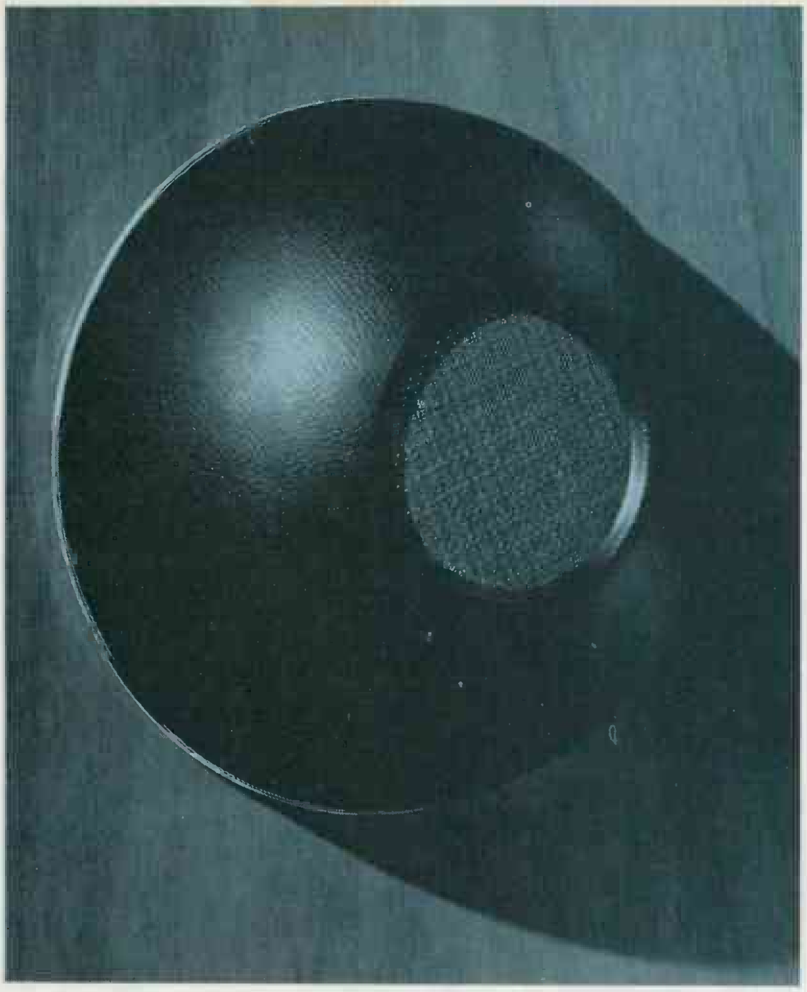
Fig. 2. Partial diagram of power supply.

R17 varies this time constant, and therefore controls the turn-on time of the SCR. Fig. 2 also shows the CR 35's output waveform for a 6.3-volt heater. Note that even though the waveform is about 24 volts p-p, the duty cycle is low and the average power delivered to the heater is the same as if the output voltage were 6.3 volts RMS.

The shorts-open test is a little different than most CRT testers. In this test, there are separate tests for shorts and opens. In the "shorts" test, the meter reads heater voltage, and the necessary adjustments can be made while testing for shorts. In this test, all the test lights should be off. Switching to the opens test, the meter reads line voltage. This is really just a feature, because with all supply voltages variable, low or high line voltages may be compensated. In the "opens" test, all indicator lights should be on.

The CR 35 also includes cutoff and life tests, a shorts remover feature, and three levels of rejuvenation. The last two features utilize the charged capacitor method, now almost standard in CRT testers.

The instruction manual packed with the CR 35 is especially well-written. The operating instructions are step-by-step, with no superfluous information. The circuit description is adequate, though one may need some background in SCR's and UJT's to fully understand that part of the manual. The set-up book is bound in the instruction manual, so we wonder what provisions will be made for updating this part of the manual. (Though as we noted before, the CR 35 can easily be used with the information in any tube manual.)



Updating the actual instrument will be a simple task. As new tube sockets are introduced, adaptors such as those shown in Fig. 1 may be constructed. ▲

For further information circle 45 on literature card

Hickok CR 35 Specifications

CRT's tested:

All presently manufactured TV types—both color and black-and-white.

Tests Performed:

Interelectrode shorts, emission, cut-off voltage, life test.

Corrective functions

Three levels of cathode rejuvenation, removes shorts.

Size (HWD):

10¾" x 10½" x 5¼".

Weight:

9 pounds.

Power requirements:

117 VAC 60 Hz.

Price:

$99.95.

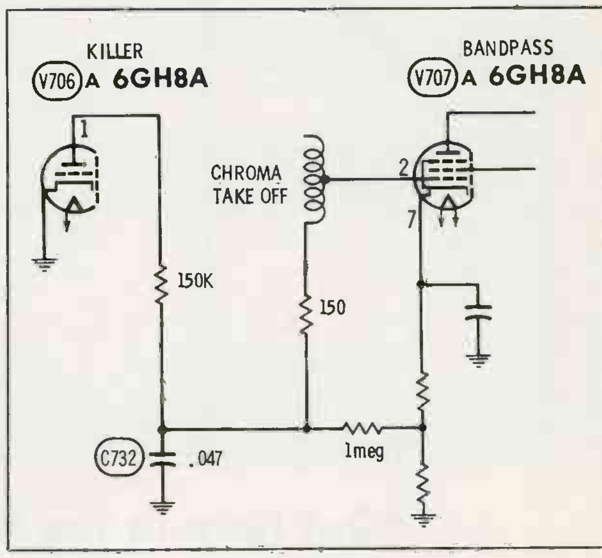
COLOR COUNTERMEASURES

SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE

Chassis: Magnavox T918

Symptoms: Overall tint on screen. Varies with setting of Hue control

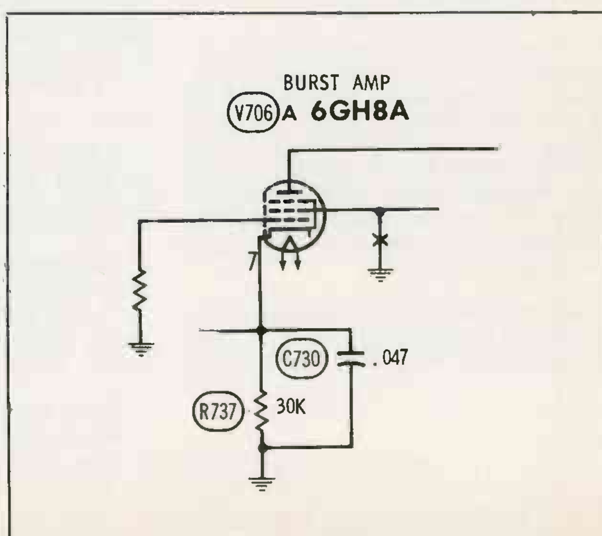
Tip: Check for open C732 in grid of bandpass amp. This cap is used to bypass horizontal pulses from color killer stage.



Chassis: Magnavox T918

Symptoms: Critical color sync.

Tip: Check for open C730 in burst amp cathode.



(Continued from page 33)

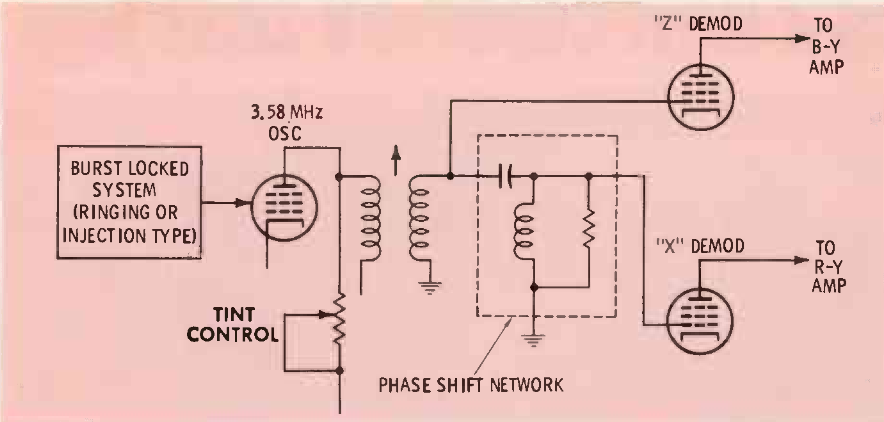


Fig. 7. Injection type oscillator driving X and Z demodulators.

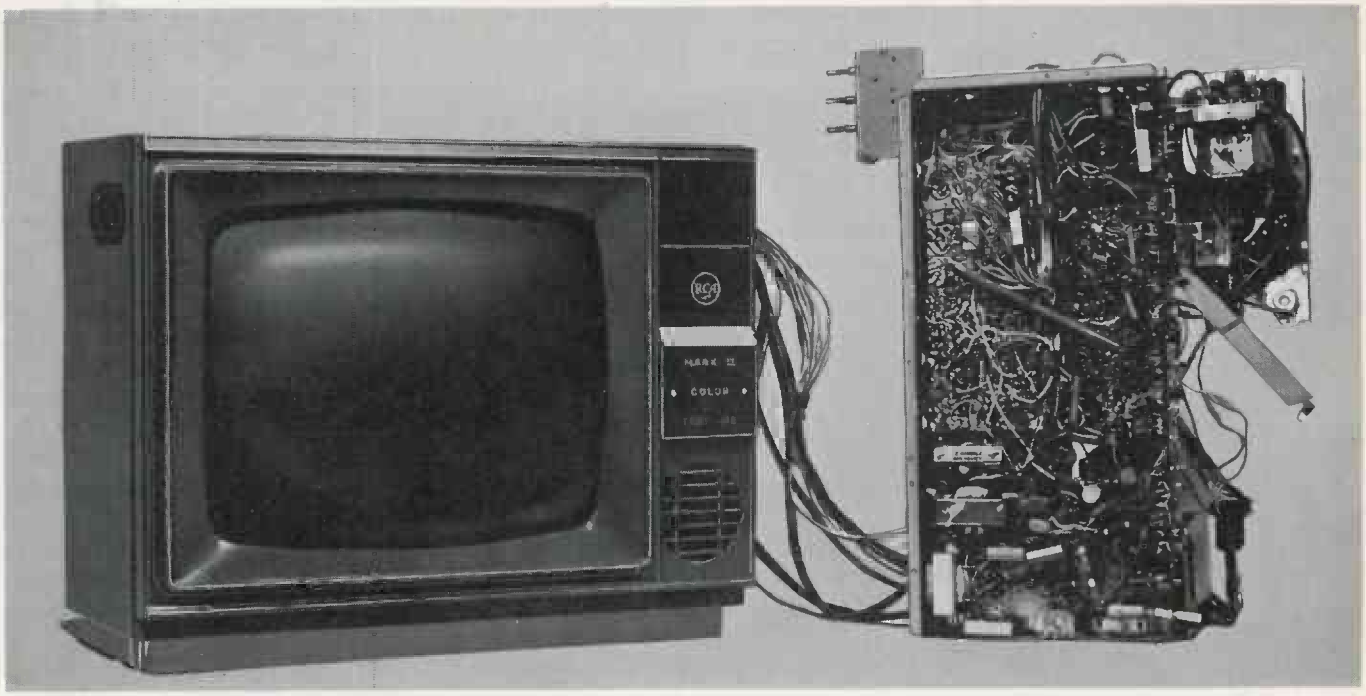
5A and 5B illustrate the correct waveforms at the corresponding points of Fig. 3. Notice in the B − Y signal (to the blue grid), that the third and ninth bars pass through zero. When making this check, *do not* adjust the tint control from its previous setting. If an incorrect waveform is viewed, check the phase shift network associated with the demodulator, and/or the demodulator operating conditions — voltages, resistance, etc. If a correct B − Y waveform is observed, look for trouble in the G − Y amplifier circuits. Check for the waveform shown in Fig. 6, with the seventh bar passing through zero.

Some late model color chassis use an *injection* type oscillator. In such circuits, the "Z" demodulator may be directly driven while the "X" demodulator receives the phase-shifted reference signal. A typical arrangement is illustrated in Fig. 7. Troubleshooting involves the same procedures just discussed. However, the initial waveform check in this instance should be made at the output of the B − Y amplifier.

Points To Remember

Let's review the important symptoms of incorrect hues due to phasing errors. (1) All colors and hues will appear in the picture; (2) objects or faces will not have the correct tone— flesh may be green, purple, etc.; (3) the tint control, when adjusted, shifts hue, but correct color cannot be obtained within the control's range. Prior to checking the demodulators, clear or condemn the stages that control oscillator frequency and phase. These are the burst amplifier, color sync phase detector, oscillator control stage, and oscillator. Check for proper color difference waveforms at the outputs of the demodulators for faster trouble location. The "key" check point is the demodulator driven *directly* from the 3.58-MHz oscillator. Be sure you consult waveform information given in service data. ▲

RCA announces 2 new color-TV test jigs



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Airline
GEN-1967A/B (63-1967) 904-1
GHJ-8247, GHJ-8257A 904-1

Aristocrat
AA-550, AA-551 900-1

General Electric
Chassis KC 903-1

Hitachi
CNA-1900T 902-1

Hoffman
Chassis 913-000356/366, 913-187486 904-2

Olympic
Chassis CTC19, CTC21 904-3
Chassis CTC20 905-1

Packard Bell
Chassis 88-21 905-2

RCA Victor
AJ115W (Ch. KCS159H) 902-2
AJ024A/B/H/, AJ025C/E/M/W (Ch. KCS165A) 900-2
Chassis KCS156J/P 903-2
Chassis Chassis KCS160C/E/F/N/P 901-2

Sylvania
19P46 Series (Ch. A06-1/-2) 901-3
19T54 Series (Ch. A07-1) 903-3
Chassis D05-1, D05-2 905-3

Truetone
WEG1605A-66, WEG1803A-77 902-3

Westinghouse
BP19A870, H-P3090A (Ch. V-2483-2/-3) 900-3

The following TV sets are given schematic coverage in the Extra Contents.

Airline
GMW-17447A, GMW-17447B 903-9-5

Motorola
XP303CW (Ch. 12TS-458) 901-9-S

Penncrest
4621A-48, 4622A-46, 4623A-47, 4631A-48, 4632A-46 .... 903-9-S
4877B-48, 4878B-46, 4886A-49, 4887A-47 .... 901-9-S

Sears
7100 (Ch. 564.10012) 904-9-S
8103 (Ch. 562.10330) 904-9-S
8167 (Ch. 564.80030) 905-9-S

Production Change Bulletins

RCA Victor
Chassis CTC16A/AB/E/F/H/L/M/P 905-4
Chassis KCS136XD/XE, KCS152E, KCS164B 903-4

▲

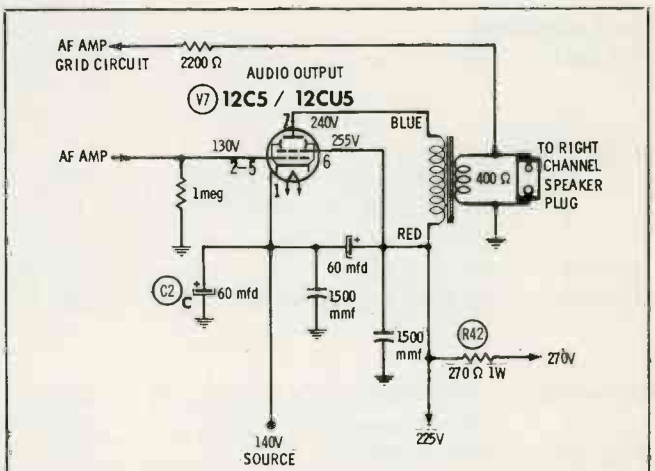
THE TROUBLE-SHOOTER

Audio and Video Output Trouble

Several months ago, the plate supply resistor (R42) in a deForest Model DKW (PHOTOFACT Folder 527-1) burned out because of a shorted audio output tube. The 12C5 tube and R42 were replaced. Since that time, we have returned approximately every three months to replace the 12C5 because of grid leakage. In this chassis, grid leakage in the audio output tube causes symptoms similar to AGC trouble.

Another problem concerns Admiral Chassis 20B6CB (PHOTOFACT Folder 431-1). We have run across three or four of these chassis with the same trouble. If the contrast is turned down, both the sound and the video go off. Adjusting both the AGC and "fringe lock" controls does not correct the trouble. Any suggestions?

ALVIN T. JEFFREY
Bensenville, Ill.



The 140-volt supply is taken from the cathode of the audio output tube, and is supplied to the cathode of the AGC keying tube. Thus, the AGC could be affected by trouble in the audio output. Repeated failures of the 12C5 are probably caused by improper cathode bias on the tube. This is the result of a change in the cathode circuit, which includes the three IF's and AGC keying tube. However, the most probable cause of your trouble is either C2 or C38.

Your Admiral problem appears to be caused by R30, which is either open or changed to a high value. The contrast control is parallel to R30, and the cathode-to-ground resistance of the video amplifier can be varied from 167 ohms to zero ohms when the control is set fully clockwise. With R30 open, rotating the control only 60° from maximum clockwise causes maximum cathode resistance. ▲

PRODUCT REPORT

for further information on any of the following items, circle the associated number on the Catalog & Literature Card.

Service Center
(46)

Pictured here is a TV workbench that has a 17" x 31" work space, test equipment storage drawer, and shelf. Complete with operating chassis, tuner, and all pictures tube hardware, **Setchell Carlson's** Service Center Bench can also be adapted to other manufacturer's TV models.

Features of the unit include picture tube connections on a readily available panel, yoke connections up front, adapter unit for servicing this manufacturer's early color chassis, jumper cables for operating units separate from the main chassis, antenna connections to the tuner on the main panel, and a tuner power socket for testing separate tuner units. Price of the unit, complete with instruction manuals and unit cross-reference charts, is $250.

Solid-State Splitter
(47)

This new solid-state amplified splitter, called the Homer, provides TV

"the ANTENNA that captures the RAINBOW"

No two reception areas are alike in the number of stations, UHF and VHF, station channel frequencies, and signal strengths.

FINCO has developed the Color Spectrum Series of antennas – "Signal Customized" – to exactly fit the requirements of any given area. There is a model scientifically designed and engineered for every area, even the most troublesome, and for all combinations of signal conditions.

Engineering studies show that a receiving antenna should have more gain as channel frequency is increased – that is, channel 6 more than channel 2, channel 13 more than channel 7, and UHF from channel 14 on up . . .

1 – to compensate for signal strength loss
2 – to compensate for down-lead loss
3 – to meet receiver requirements for more signal to operate properly

FINCO Color Spectrum Antennas obtain this frequency dependent characteristic through a newly developed principle of spacing between elements. Gain increases as frequency increases. This new FINCO engineering break-through, combined with superior flat response patterns and unusually high front-to-back ratios, assure the finest COLOR and B & W reception possible . . . everywhere.

Write for full information on "Signal Customized" Antennas:

THE FINNEY COMPANY

34 West Interstate Street • Dept. 310 • Bedford, Ohio 44146

Circle 31 on literature card

COLOR SPECTRUM ANTENNAS are "signal customized" for better reception.

Check this chart for the FINCO "SIGNAL CUSTOMIZED" Antenna best suited for your area

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION	Strength of VHF Signal at Receiving Antenna Location: NO VHF	VHF SIGNAL STRONG	VHF SIGNAL MODERATE	VHF SIGNAL WEAK	VHF SIGNAL VERY WEAK
NO UHF		CS-V3 $10.95	CS-V5 $17.50 CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 CS-V18 $56.50
UHF SIGNAL STRONG	CS-U1 $9.95	CS-A1 $18.95	CS-B1 $29.95	CS-C1 $43.95	CS-C1 $43.95
UHF SIGNAL WEAK	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

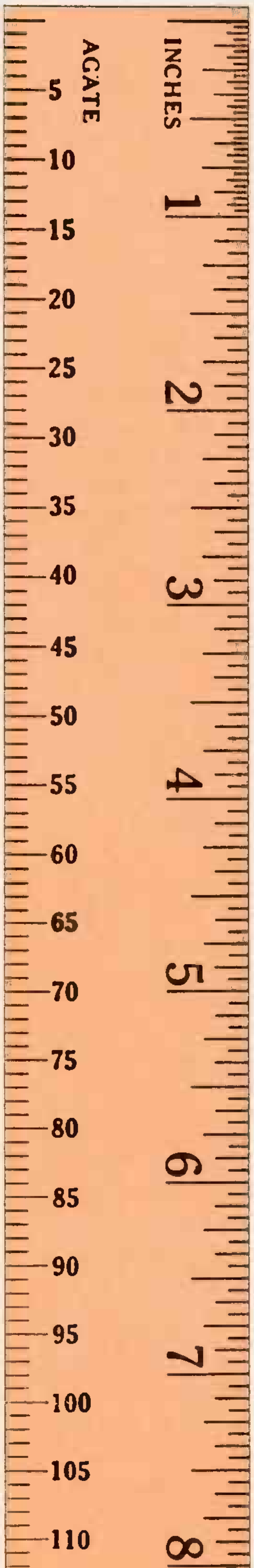
Circle 31 on literature card

and FM reception on up to four sets operating from a single antenna. Manufactured by **Blonder-Tongue Laboratories, Inc.,** the unit features a unique circuit called I.C.E.F. (Inductive Coupled Emitter Feedback).

Employed for the first time in any RF amplifier, the new I.C.E.F. circuit combines the low distortion and strong signal handling properties of the common-base circuit with the low-noise, high-gain properties of the common-emitter configuration.

The amplified splitter (Model HVB-3P) nearly triples (9dB) TV or FM signals when operating two sets from a single antenna and doubles (6 dB) the signal gain with four sets. Interaction between sets is reduced by 14 dB of inter-set isolation. The unit uses 75-ohm coax; five BTF-591 solderless male coax connectors for RG-59 sable are supplied with the splitter. Measuring 4⅛" x 1⅞" x 1⅞", the unit can be mounted anywhere indoors where an AC outlet is available. Because it draws less power than an electric clock, the Homer remains on at all times. Price is $27.50.

NOW...a full-sized VOM in a palm sized "package"



160 Volt-Ohm-Milliammeter
Complete with alligator clip leads and operator's manual. $50.00

Carrying Case—
Cat. No. 2225 .... $ 9.50

Accessory Leads—
Probe Tip Lead—
Cat. No. 2055 .... $ 2.75

Simpson 160 Handi-VOM®

Simpson Handi-VOM gives you the ranges, the time-saving conveniences and the sensitivity of a full-sized volt-ohm-milliammeter—yet it's only 3-5/16″ wide, weighs a mere 12 ounces. Recessed range-selector switch never gets in the way . . . polarity-reversing switch saves fuss and fumble. Self-shielded taut band movement assures high repeatability and freedom from external magnetic fields. Diode overload protection prevents burn-out—permits safe operation by inexperienced employees and students. The demand is BIG, so get your order in to your electronic distributor, TODAY!

RANGES

ACCURACY: ±3% FS DC, ±4% FS AC
DC VOLTS: 0-0.25, 1.0, 2.5, 10, 50, 250, 500, 1000 @ 20,000 Ω/v
AC VOLTS: 0-2.5, 10, 50, 250, 500, 1000 @ 5000 Ω/v
DC MICROAMPERES: 0-50
DC MILLIAMPERES: 0-1, 10, 100, 500
DB: −20 to +10, −8 to +22, +6 to +36, +20 to +50
"O" REFERENCE: 1 MW into 600Ω
RESISTANCE: Rx1, Rx10, Rx100, Rx100, Rx10K
(30 Ω center)

AGM DIVISION

Simpson
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Export Dept: 400 W. Madison Street, Chicago, Illinois 60606, Cable, Simelco

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IN INDIA: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

WORLD'S LARGEST MANUFACTURER OF ELECTRONIC TEST EQUIPMENT

Circle 34 on literature card

Color Tele-Amp For VHF/FM

(48)

Two new amplifiers/splitters, designed especially for color reception, are announced by **JFD Electronics Co.** Model HBV2 is for 300-ohm installation of up to 4 sets. Model HBV2-75 is for 75-ohm installations of up to 4 sets. Both can be added to existing antenna installations for a gain of up to 7 dB to each set.

Both models feature etched copper circuit boards with poly-U sealant and two frame-grid, low-noise tubes for VHF. Wideband response is preserved by the inherent low interelectrode capacitance and high-input impedance of 6HA5 tubes.

A 4-set splitter network completely isolates each output, preventing interaction between sets. Amplifier, power supply, and signal-splitter circuits are integrated in one compact design. Two pairs of outputs facilitate attaching and dressing of transmission lines to respective sets. The gold housing is perforated to keep components cool. A hanging bracket permits vertical or horizontal mounting, and felt pads protect furniture finish.

Both models operate on 117 VAC at 20 watts. Model HBV2 (300 ohm) sells for $29.95; Model HBV2-75 (75 ohm) is priced at $34.95.

Soldering Iron

(49)

This new 12-volt soldering iron, designated as model TCP-12, is designed for field servicing of communications, marine, automotive, aircraft and telephone equipment, as well as for hobby models. The tool operates from any 12-volt battery, or 12-14-volt AC/DC power supply.

The lightweight, pencil-type unit includes a 12′ power cord with battery clips. It also incorporates **Weller's** "temperature control" system, which affords minimal battery source power drain, long tool and tip life, and rapid recovery. The tool comes with a 700° F., 3/16″ screwdriver tip. Other tip configurations and temperature ranges are also available. A similar tool is available for 24-28-volt operation. Model TCP-12 is priced at $10.95.

MOVING?

Don't lose touch . . .
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CIRCULATION DEPT.
4300 W. 62nd St.,
Indianapolis, Ind. 46206

Nut Driver

(50)

This self-adjusting nut driver automatically adapts itself two ways to meet the needs of the assembly worker, maintenance man, and service and repair man. First, a series of nested steel sockets at the end of the driver shaft automatically adjust themselves correctly to the size of the hex nut involved, accommodating seven sizes ranging from ¼" to 7/16". Secondly, the hollow shaft of the driver enables it to accommodate bolt extensions up to a length of 1 7/16".

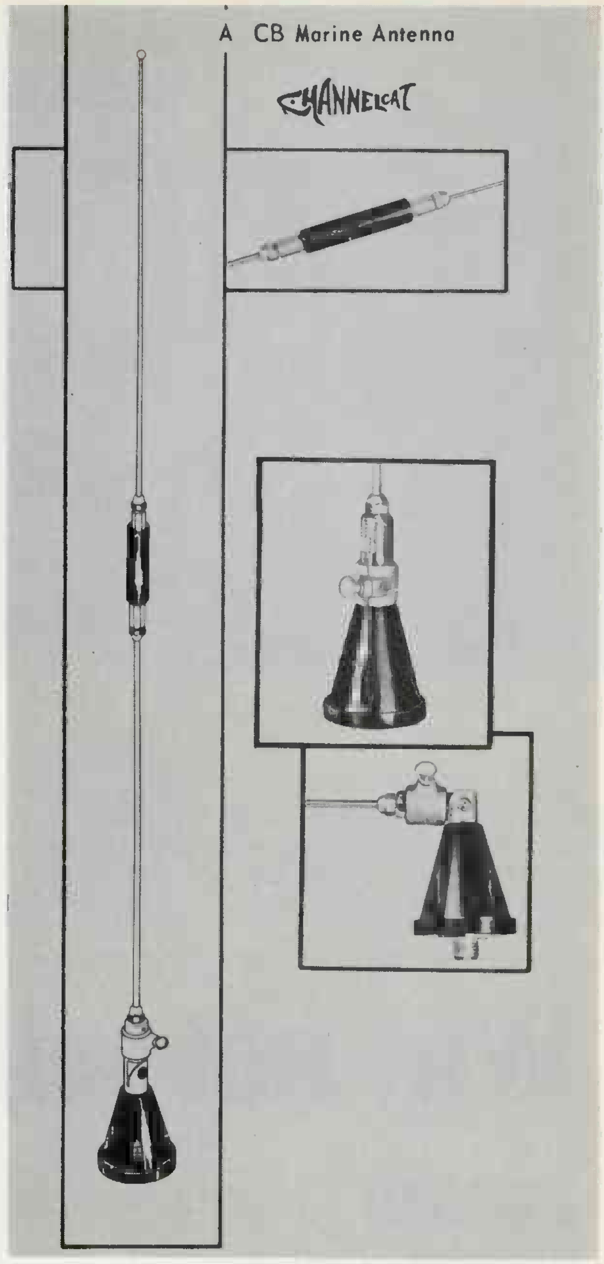
The combination of self-adjustments make this a versatile and time-saving nut driver. One driver does it all, eliminating the need for an array of individual drivers of various sizes. The **Vaco Products'** tool is compact in size for use in tight places and is easy to operate, requiring the user only to press it upon the hex nut and turn it. The chrome-plated shaft contains a corrosion-proof internal mechanism and tempered-steel springs. The nested sockets are also of tempered steel. A solid and comfortable grip is assured by the Comfordome handle. The nut driver is priced at $3.85.

Marine CB Antenna

(51)

A new Citizens Band marine antenna, the "Channel Cat," is announced by **Mosley Electronics.** Designed to eliminate the need for radials or other ground systems, this salt water protected antenna is effective even on wood and fiberglass boats.

Constructed of stainless steel, the unit is 8'3⅜" high and weighs 2 lbs. assembled. Loading is through a wa-



terproof coil at the center of the antenna. A high Q transformer enclosed in the waterproof, hinged base provides impedance matching. Impedance at the feed point is 52 ohms.

Two accessories are available to increase the versatility of the antenna: the Swiv-L-Mount for applications requiring angle mounting, and the U-1 universal clamp for a variety of mounting applications. Price of the Model CC-27-A marine antenna is $36.78.

Hand-Held Transceiver

(52)

This 100mw hand-held transceiver features a crystal controlled superheterodyne receiver and an audio-output level sufficient to permit operation in noisy areas. Other features of the **E. F. Johnson** unit include a built-in battery meter for easy checking of battery strength and a case equipped with a leather carrying strap.

A license is not required to operate this transceiver. The units can be used as business appliances, and for personal two-way communications at the campsite, out on the lake, or while hunting. Contractors and farmers will find them useful for short range communication in the field, or on the job. Price of the transceiver is $29.95.

CRT Tester

(53)

A fast and accurate color tracking test is one feature of the new CRT Champion, Model CR143, recently introduced by **Sencore, Inc.** The unit is fully automatic, eliminating the need for logging and comparing of individual gun readings. With separate G2 screen grid controls, each color gun is set up and then automatically compared to the others for tracking. This test is in accordance with CRT manufacturers' test procedures and essential when claiming credit on factory defective color CRT's.

Functions of the instrument include all standard color and b-w CRT tests such as shorts, emission, and life test (using pure DC). A line adjust control assures accuracy when checking critical tubes where line voltage fluctuations might cause incorrect readings. Rejuvenation and shorts removal are accomplished with an automatic rejuvenation circuit. Three rejuvenation positions are provided for saving faulty tubes or equalizing gun currents in color tubes. The unit is equipped with plug-in sockets for fast testing of all CRT's and easy updating. The unit is housed in a brushed chrome panel and vinyl-clad steel case with detachable hinged cover. It measures 10" × 9" × 3½", weighs 11 lbs., and is priced at $99.50.

CB Base Station

(54)

Equipped with a built-in, solid-state pre-amplifier, **Pearce-Simpson's** new Guardian 23B CB base station is designed for use with a high-impedance desk microphone instead of the usual palm mike. The use of a desk mike enables the operator to have both hands free while communicating. In addition, the audio sensitivity of the desk mike permits the operator to be

up to 1½' away from the mike and still maintain 100% modulation. Price of the unit (without desk microphone) is $269.00.

Color Alignment Kit

(55)

Shown here is a new alignment tool kit designed especially for color TV. Contained in the **GC Electronics** kit are eight hex ends that cover virtually all iron core transformer adjustments and two screw driver tops, plus an extender for "long reach" applications. The kit (Part No. 8454) is packaged in a compact Pocket Saver and each tool is color coded for easy identification. Price is $2.49. ▲

Electronic Servicing

(Continued from page 40)

got his item repaired (and was impressed by the dealer honestly and unselfishness), and Greg received a good deal of respect from the other dealers.

Education is a continuous process. Greg realized that a fast-moving industry like electronics will leave a person behind if he doesn't keep up with it. For this reason, Ellis decided to study and learn as much as he could about his field. He enrolled in some of the electronic courses taught at the local college, and even took some correspondence courses. One of the manufacturers he represented offered a "teach yourself" instruction course in troubleshooting. Greg found that he could study such courses in his spare time, without taking time out from his business or social life.

But Greg is more than a radio/TV repairman; he is also a successful businessman with financial responsibilities. He improved himself in this area by reading up on management practices. He understands business motives and objectives and he applies this knowledge to his own firm.

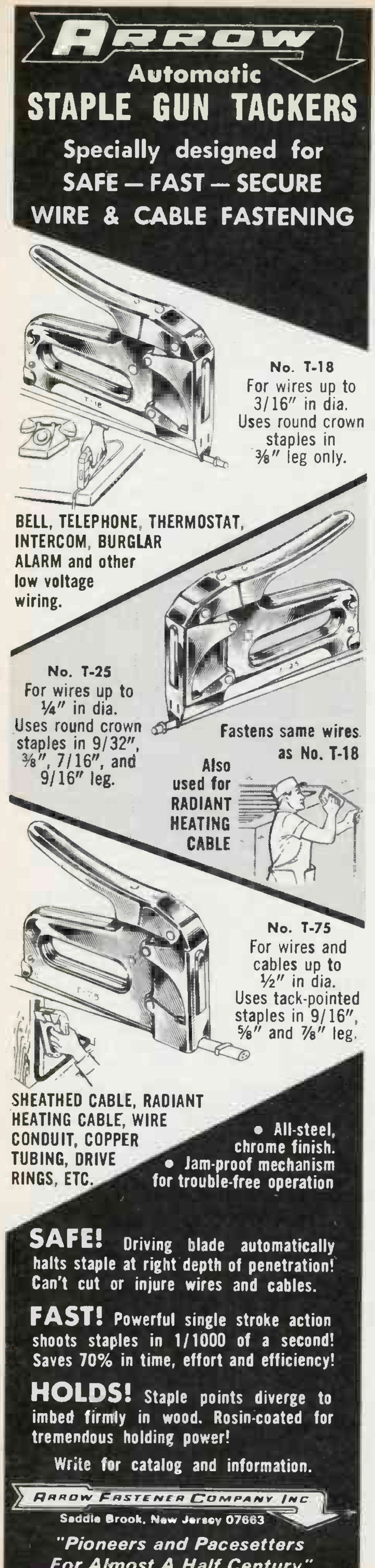
Greg is never embarrased to seek advice from other professionals. He regularly consults his lawyer to make sure that his business is in a good legal condition. His contracts, agreements, and guarantee promises could become sticky unless checked out by people who know all of the ramifications. Greg contracted a local CPA to perform audits on his books from time to time. He also receives advice from the accountant on financial matter such as expense accounts, car allowances, etc.

Gregory Ellis has a valuable business in hand, and he makes sure that his interests are protected in event of a disaster. His insurance is always up to date, and he makes sure that he notifies his insurance company of any changes or additions that affect his polcy.

He keeps on good terms with his local banker, and utilizes his credit to make improvements on his store and to "tide him over" slow periods. He also makes sure that any payments due the bank are always on time. In the early days, it was sometimes a struggle, but Greg's financial standing was always sound and honest.

Yes, Gregory Ellis has created quite an image for himself. He is recognized in his community as an outstanding man to do business with. His store is attractive and neat, his employees courteous, and his service is expert.

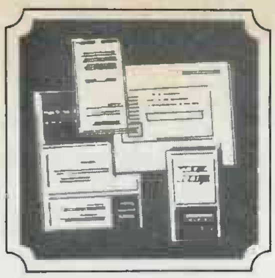
Gregory has not just concentrated on one aspect of his business, he has improved his standing in all areas. He has recognized the need for a blend of high-quality service with diverse, effective public relations. He takes an active part in community affairs, heeds the advice of professionals, and remembers that the customer's attitude is his road to success. Because of this, Gregory Ellis's profits have increased, and will continue to do so. He remembers that his image is a very important part of his business. It can mean better profits *or* bankruptcy. ▲



Circle 42 on literature card

INDEX TO ADVERTISERS

Circle 43 on literature card



$FREE$ CATALOG AND LITERATURE SERVICES

*CHECK "INDEX TO ADVERTISERS" FOR FURTHER INFORMATION FROM THESE COMPANIES

ANTENNAS

91. *ALLIANCE* — Colorful 4-page brochure describing in detail all the features of Tenna-Rotors.
92. *ANTENNACRAFT* — 12-page catalog listing complete Antennacraft line of UHF, VHF & FM antennas for all types of installations.
93. *COLORMAGIC*—Form FR-28-C describes a complete line of antennas and accessories.
94. *CORNELL-DUBILIER* — New 4-page brochure with instructions for installation of AR10B Skyline Series rotor.*
95. *DELHI*—Twelve-page catalog introducting a complete new line of home TV towers, ham towers, citizen's band towers, masts and telescoping masts.
96. *FINNEY* — 6-page color brochure (form 20-413) lists new color spectrum antennas for VHF-UHF-FM, VHF-FM, and UHF.*
97. *JERROLD* — New 4-page full-color catalog describes the new Paralog Plus antennas.*
98. *JFD* — Color Laser and LPV antenna brochures. New 1967 dealer catalog covering complete line of log-periodic out-door antennas, rotators, and accessories.
99. *MOSLEY* — Information on new Mosley MATV system for up to 8 TV/FM sets. Includes TV antenna, distribution system and outlets.*

AUDIO

100. *ATLAS SOUND*—Catalog 567 illustrates complete line of speakers, horns, microphone stands and booms, transformers, patio speakers, and accessories.*
101. *DUOTONE* — Catalog of accessory and maintenance items for the audiophile.*
102. *GIBBS*—Information on complete line of reverberation units for use in automobiles.
103. *JENSEN*—New catalog 1090-B lists complete line of replacement speakers.
104. *NATIONAL TEL-TRONICS* — 2-color spec sheet lists phonograph plugs and jacks, terminal strips, speakers, and microphone connectors.
105. *OXFORD TRANSDUCER* — Bulletin A-109 features speaker installation in automobiles, hospitals, and recreation rooms.*
106. *RACON* — Full-line catalog lists horns, drivers, sound columns, microphone stands, and accessories.
107. *SONOTONE*—8-page catalog, SAH-115, lists microphones, stands, and parts and accessories.
108. *SWITCHCRAFT*—Bulletin 172 describes Model 307TR, a new, battery-operated mixer for studio, home, or remote use.

COMMUNICATIONS

109. *AMPHENOL* — 2-color spec sheets on new Model 650 CB transceivers and Model C-75 hand-held transceiver.
110. *MOTOROLA* — New brochure tells how to reach people on-the-move through use of personal two-way radio.*
111. *PEARCE-SIMPSON*—16-page color brochure includes illustrations and specs on complete line of CB, business, and industrial radios.

COMPONENTS

112. *BUSSMANN* — Bulletin on BUSS Fustat Box Cover Units offers simple, low-cost way to protect work bench tools against damage and burnout. Units fit standard outlet or switch box, have fuse-holder plus a plug-in receptacle, pilot light, switch, etc.*
113. *BIRNBACK* — New, 2-color, 64-page complete catalog includes specs and illustrations of wire, cable, tubing, electronic accessories and hardware, switches, and components.
114. *CENTRALAB*—24-page replacement parts catalog No. 33GL.
115. *CHICAGO MINIATURE LAMP WORKS* — Specifications of miniature lamps and barretters are included in catalog CM-1. Catalog CMT-2 lists specs of subminiature lamps.
116. *LITTELFUSE* — Pocket-sized TV circuit breaker cross-reference gives the following information at a glance. Manufacturer's part number, corresponding Littelfuse part number, price, color or b/w designation. A second glance gives trip ratings and acquaints you with a line of caddies. Ask for CBCRP.*
117. *ONEIDA* — 32-page catalog lists complete line of hardware, wire, sockets, plugs, jacks, clips, switches, resistors, capacitors, and other replacement items.
118. *SOUNDOLIER* — Flyer AC-2 includes specs on audio attenuators, T-pads, L-pads, potentiometers, and autotransformers.
119. *SPRAGUE*—C617, a complete catalog of the Sprague line.*
120. *TRIAD*—Replacement catalog and TV guide, TV-67/68.
121. *WALSCO* — Phono drive wall chart, FR-250-W, and supplement, FR-250-WS, give latest replacement data.
122. *WORKMAN*—New coil catalog lists general and exact replacements for radio and TV schematic drawings and illustrations of all coils.*

SERVICE AIDS

123. *CASTLE TUNER* — How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
124. *ELECTRONIC CHEMICAL* — Catalog sheets on aerosol sprays for servicemen.
125. *G.C.* — FR-67G flyer on color harnesses, FR-67A complete Audio-tex catalog.*
126. *ILLINOIS BRONZE* — Brochure lists aerosol chemicals, lubricants and finishes.
127. *INJECTORALL* — New 1967 catalog of chemicals and alignment tools.
128. *MIDSTATE TUNER* — 24-hour service on any make tuner is described in a colorful brochure.
129. *PERMA-POWER* — Chart shows correct brightener for every TV set in the field.*
130. *PRECISION TUNER*—Mailing kit and replacement tuner list for same-day service.
131. *QUALITY TUNER SERVICE* — Introductory letter describing costs and service on all makes of TV tuners. Repair tags and shipping labels included.
132. *RAWN*—Bulletins on repair ideas using Plas-T-Pair knob and plastic repair kits. Also, bulletins on tuner cleaners and circuit coolers. Includes price sheets.
133. *SPRAYWAY* — Brochure on C-60 solvent cleaner and degreaser.
134. *WESTERN TUNERS REBUILDERS*—Overhaul service on TV tuners.

SPECIAL EQUIPMENT

135. *VACO*—Catalog No. T-210 describes new quick-connect terminals and insulators.
136. *WINEGARD*—FactFinder No. 250 gives detailed information on 7 new booster/coupler amplifiers in 82-channel and VHF models. New 40-page MATV catalog features Ultra-Plex amplifier system.

TECHNICAL PUBLICATIONS

137. *CLEVELAND INSTITUTE OF ELECTRONICS*—Free illustrated brochure describing electronics slide rule and four lesson instruction course and grading service.*
138. *3 M COMPANY* — "Taping Tips for Electronic Servicing," a 32-page booklet for professionals and hobbyists.
139. *PHILCO*—Information about Tech Data & Business Management service. Also, free parts catalog.*
140. *RCA INSTITUTES* — New 1967 career book describes home study programs and courses in television (monochrome and color), communications, transistors, industrial, and automation electronics.*
141. *SAMS, HOWARD W.*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics, including special new 1967 catalog of technical books on every phase of electronics.*
142. *SIMPSON*—88-page booklet "1001 uses for the 260 VOM."

TEST EQUIPMENT

143. *B & K*—New 1967 catalog featuring test equipment for color TV, auto radio, and transistor radio servicing, including tube testers designed for testing latest receiving tube types.*
144. *EICO* — New spec sheet describes model 100A4 multimeter with DC sensitivity of 100K ohms per volt.*
145. *HICKOK*—Quick reference catalog No. 67D gives brief descriptions and prices for complete test equipment line.
146. *JACKSON* — New catalog lists complete line of "service engineered" test equipment.
147. *LECTROTECH*—Two-color catalog sheet on new Model V6-B color bar generator, the latest improved model of the V6. Gives all specs and is fully illustrated.*
148. *MERCURY*—All-new-low-price color dot bar generator and Model 2000 conductance tube checker all for under $100.
149. *PRECISION APPARATUS*—Illustrated catalog describing signal generators, oscilloscopes, and meters.
150. *SECO*—Operating manual for the HC8 in-circuit current checker.*
151. *SEMITRONICS*—Brochure on the new Model 1000 transistor tester.
152. *SENCORE*—8-page full color catalog plus a new 4-page supplement catalog.*
153. *SIMPSON* — 16-page catalog No. 2076, features 15 VOM's with specifications plus other types of test equipment.
154. *TRIPLETT*—Literature sheet on the new model 600 transistorized VOM.*

TOOLS

155. *ARROW*—Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to ½" diameter.
156. *DIAMOND*—16-page booklet, W-68, lists wrenches, pliers, snips, and electronic tools.
157. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering methods for speeding and simplifying operations on PC boards.
158. *PORTABLE TOOLS, INC.*—Form 1614 describes "Shopmate" electric screw driver model 1895.
159. *VACO* — Catalog SD-66X describes 5 tools available with imprinting for promotional use.
160. *XCELITE*—Bulletin N567 lists two sets of nut drivers with color coded handles and plastic cases.*

TUBES AND TRANSISTORS

161. *GENERAL SEMICONDUCTOR* — 26-page reference list covering 3000 zener and reference diodes.
162. *IR*—Transistor cross reference guide—22 pages of detailed specifications on universal silicon and germanium transistors and a complete listing of more than 5000 devices which they replace.
163. *SYLVANIA* — 42-page book lists 750 types of picture tubes with interchangeability, basing diagrams, and key characteristics.*
164. *RADIO CORP. OF AMERICA*—PIX 300, a 12-page product guide on RCA picture tubes covering both color and black-and-white. Includes characteristics chart, terminal diagrams, industry replacement, and interchangeability.*

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As a service to its readers, PF REPORTER makes this postpaid card available for your convenience in obtaining current manufacturers' literature.

To use the card simply:

a. Circle the numbers corresponding to the numbers of the items appearing either on page 82 or in the "Product Report" department.

b. Print your name and address and check your occupation.

c. Include ZIP code—requests may not be filled without it.

d. Tear out lower half of this insert and place in mailbox.

Note the deadline date — Requests received after this cannot be handled.

Subject Index on Reverse Side

PF REPORTER SUBJECT REFERENCE INDEX—SEPTEMBER, 1967

(NOTE: Code letters CCM, NTE, and TS indicate *Color Countermeasures*, *Notes on Test Equipment*, and *The Troubleshooter*, respectively.)

Your service reputation is the cornerstone of your business. That's why there's no room to compromise with quality in the components you install.

RCA HI-LITE picture tubes enable you to offer your customers TODAY'S COLOR . . . incorporating the latest technology of the world's most experienced picture tube manufacturer. They're the same tubes that go into today's original equipment sets.

RCA's new Perma-Chrome process for rectangular picture tubes, for example, means locked-in color purity from the moment the picture comes on. Faster servicing for you. Added customer satisfaction.

Install an RCA HI-LITE and you literally "up-date" your customer's set while, at the same time, enhancing your service reputation.

RCA Electronic Components and Devices, Harrison, N.J.

RCA®

The Most Trusted Name in Electronics