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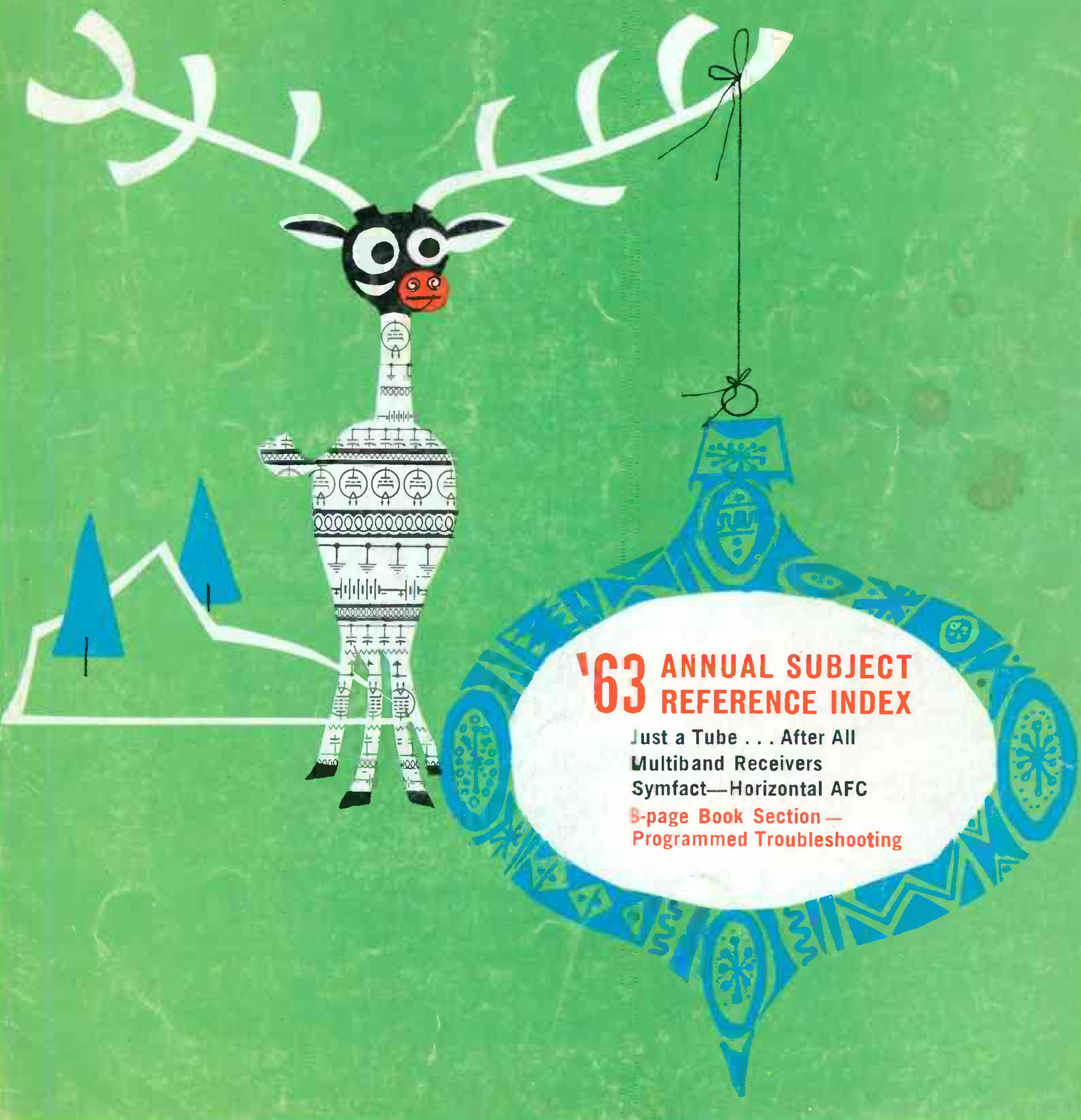

'63 ANNUAL SUBJECT REFERENCE INDEX

Just a Tube . . . After All

Multiband Receivers

Symfact—Horizontal AFC

8-page Book Section—
Programmed Troubleshooting

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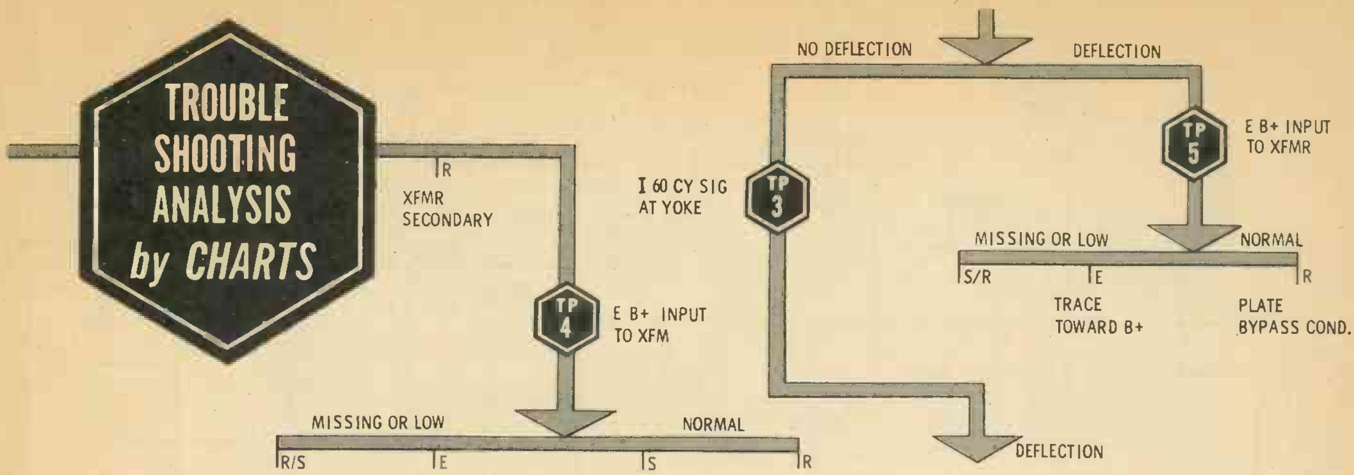
TROUBLE SHOOTING ANALYSIS by CHARTS



A new system of servicing that works in any set or circuit . . . by Edward F. Rice

Becoming expert in TV servicing requires developing the ability to make logical deductions based on cause-and-effect reasoning applied to specific practical problems. This skill is acquired by thorough study of testing procedures and routines, combined with hundreds of hours of actual work on chassis which have mechanical and electrical defects. The patterns of analysis described here are but one way of arriving at logical deductions, and they may not apply to every situation. However, the ability to make similar logical deductions under various circumstances is what enables each technician to develop his own original style of servicing.

Start

Most successful servicemen follow a definite series of tests in working out a particular symptom, in order to speed the process, and also to make sure some important fact is not overlooked. The value of using exactly the same series of tests whenever confronted with the same symptom cannot be overemphasized.

Samples of logical, complete test routines for two representative TV circuits are presented in this article. Each routine is built up around a sequence of carefully chosen Key Test Points where the test results will give definite indications as to which stages contain the fault. The remaining untested stages are then divided into groups for further testing, if necessary.

A special Servicing Chart summarizes each of the isolation procedures described. The following letters, or abbreviations, used on the charts indicate the types of tests to be made:

E	Voltage Measurement
R	Resistance Reading
Scp	Oscilloscope Waveform
S	Substitution of New Parts
I	Signal Injection
E/R	Use either voltage or resistance test, whichever is most convenient.

The testing procedure starts at the top of each chart and works progressively downward, with each test eliminating the tests on one side of the horizontal line below that particular test. When components are to be checked in order along any horizontal line, they will be listed from left to right in the order of frequency of failure.

The following are several examples of how the charts can be used in actual troubleshooting situations, right on your own service bench. There is an infinite number of possible solutions to any particular servicing problem; the charts are guides to tracking down the trouble source.

Loss of Vertical Deflection

When brightness is present, but there is no deflection of the electron beam in a vertical direction on the screen, a single horizontal scanning line extends across the center of the screen. The intensity of this line is increased because of its continuous sweeping across the same path, and the brightness should be turned down low until vertical deflection is restored.

There are two sections in the vertical-deflection system. Sometimes, as in Fig. 1, there are two distinct stages—an oscillator and an output amplifier.

If the oscillator is of the multivibrator type, it requires two tubes. Often these are combined in a single envelope, and dual-triode tubes, such as the 6SN7 and 12AU7, are frequently used. In circuits where the second tube of the multivibrator is also used as the vertical output tube, it is more difficult to isolate trouble into either the output stage or the oscillator stage, since they are combined, and both must be working in order for the multivibrator to oscillate.

Material for this article was adapted from the Howard W. Sams book "Television Servicing Training Manual" by Edward F. Rice.

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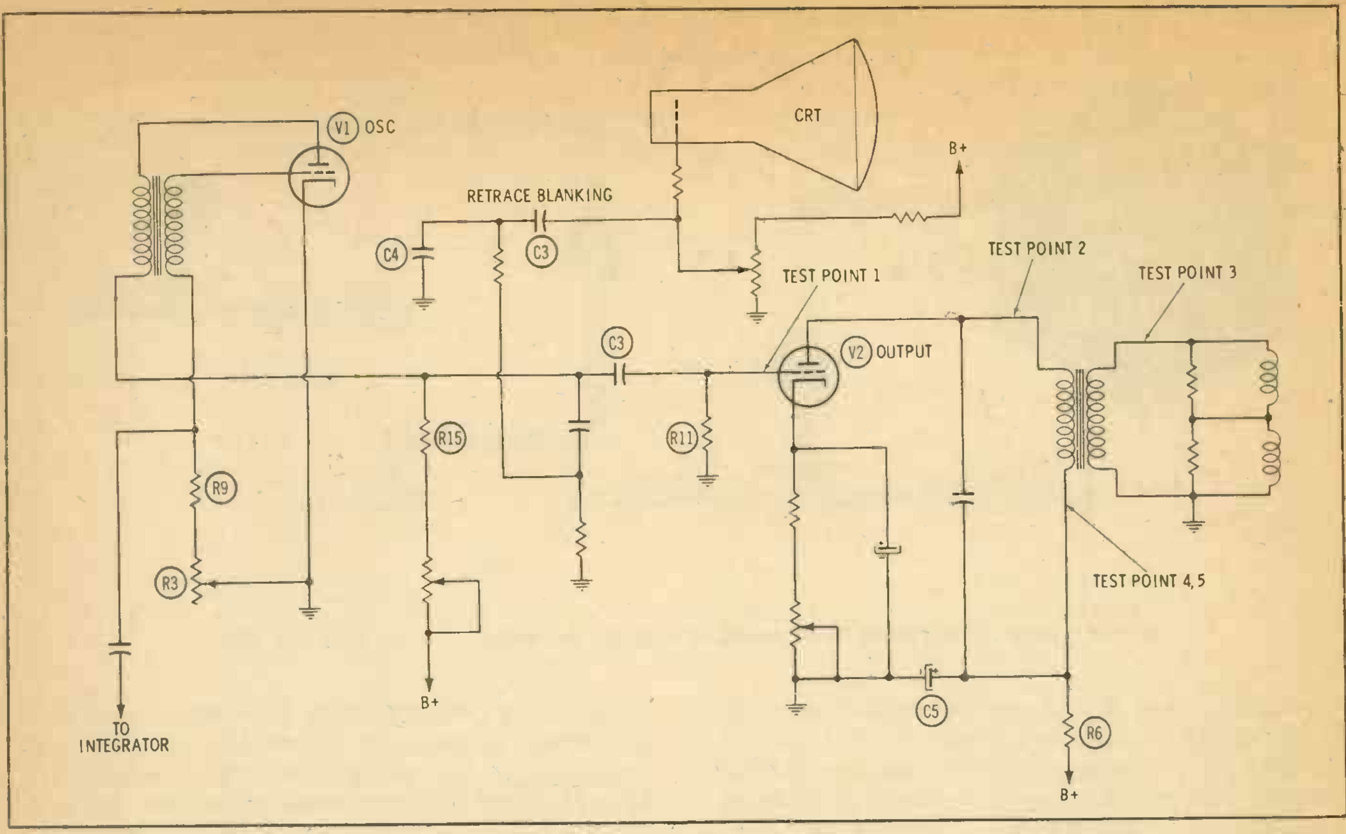

Fig. 1. Common blocking oscillator circuit used in a number of older receivers.

There is also a single-tube system where only one tube is used as an oscillator, and the output to the yoke is taken directly from this oscillator without amplification. A beam-power pentode is generally used as the oscillator.

Test Point 1

Isolation of Faulty Stage. Since the voltage at the grid of most vertical output stages is in the vicinity of 100 volts peak to peak with a frequency of 60 cps, it is very convenient, reliable, and inexpensive to use the 60 cps, 120 volt AC line voltage as a signal source for injection at Test Point 1.

A 0.1 mfd capacitor should be inserted between the signal injection probe and one side of the line to obtain a test signal. It may be necessary to try both sides of the line, particularly in the case of a transformerless chassis. A special homemade probe will be useful—a capacitor which has an insuated clip attached at one end and a simple probe at the other.

Of course, the deflection resulting from these tests is not normal, and the linearity is not good, because the signal is a sine wave and not a sawtooth, but it serves the purpose.

Another way to obtain this signal is to attach a clip lead in series with a 0.1 mfd capacitor to some source of filament voltage in the receiver. The chief disadvantage of this method is that if the filaments are wired in parallel, the voltage available is never more than 12, and often only 6 volts, which is not enough to give good indications on the screen. If the filaments are wired in series, the voltage will still be less than that needed, with the additional danger of grounding the filament line during the testing process and burning out a tube or two.

A much better system is to connect the secondary winding of an ordinary audio output transformer (the voice coil winding) across the 6 volt filament source, and take the signal source from the primary. Most transformers will supply about 100 volts when used this way. With one end of the primary connected to B minus, the other end becomes a signal-injection source.

When there is no vertical deflection, the first step to take is substitution of the vertical tubes. If these do not prove to be the trouble, testing should proceed to Test Point 1 on Chart I.

If there is no deflection with a 60 cps, 100 volt signal injected at the grid of the vertical output tube, the fault is isolated to the output stage only.

Test Point 2

Plate of Output Tube. Injecting the same 60 cps signal at the plate of the output tube further divides this stage into its output (plate) and its input (grid and cathode) circuits. If the transformer and the yoke are working, deflection will be seen on the screen. If one of these two parts has failed, there will be no deflection.

Test Point 3

Signal Injected At Yoke. By again injecting the same signal at the yoke, if no deflection was seen at the previous test point, the yoke or transformer can be further isolated. Since the yoke may draw considerable current at this time, it is recommended that the probe be touched to the yoke lead only momentarily. Deflection may not extend over the entire screen as in other tests.

If no deflection results from this test, then the yoke should be checked with an ohmmeter. In some circuits, a connection is made from the vertical yoke windings to the grid or cathode of the CRT to improve retrace blanking of the vertical sweep. This retrace circuit should be disconnected, and either the signal injection at the yoke repeated or the components in the retrace circuit tested. The secondary of the transformer may be shorted, and this, too, should be checked with an ohmmeter, if the yoke is not disconnected from the transformer at the time a signal is injected into it.

When the source signal is injected into the yoke and deflection is produced, but the test signal does not produce deflection when injected at the plate of the output tube, it is clear that something is wrong with the plate circuit of the output tube. Any one of several approaches can be taken from this point. Since a voltmeter is easy to use and its indications are definite, it is a convenient instrument for isolating some of the parts in the output plate circuit.

Test Point 4

B+ To Output Transformer. If voltage is missing at the end of the output transformer primary opposite the plate connection, then the transformer is excluded as a cause of no deflection, and the decoupling network (R6 and C5) between the transformer primary and B+ should be checked (Fig. 1). If voltage is present, then the transformer primary should be measured with an ohmmeter and any other parts connected between the plate of the tube and the B+ end of the primary should be substituted.

Test Point 5

B+ To Output Transformer. Further tests are necessary if injection at the plate produces deflection. Referring to the right side of Chart I under Test Point 2, if injection at the output plate produces deflection, the yoke and the transformer primary are eliminated as suspects. Attention should immediately be turned to the voltage supply for the output plate, and a voltage measurement at the B+ end of the primary should be taken. If proper voltage is present at this point, the decoupling network, or any other part in series with it, is not at fault.

The only remaining possibility of failure is in the cathode circuit of the output tube. This circuit contains the linearity control, in most chassis, and also a large electrolytic capacitor. These should be examined with an ohmmeter.

Test Point 6

Signal At Oscillator Plate. If there is deflection when the test signal is injected at Test Point 1, obviously the fault must lie in the oscillator stage or in the coupling components between the oscillator and output stages.

The 60 cps test signal should now be injected at the plate of the oscillator stage or the plate of the first

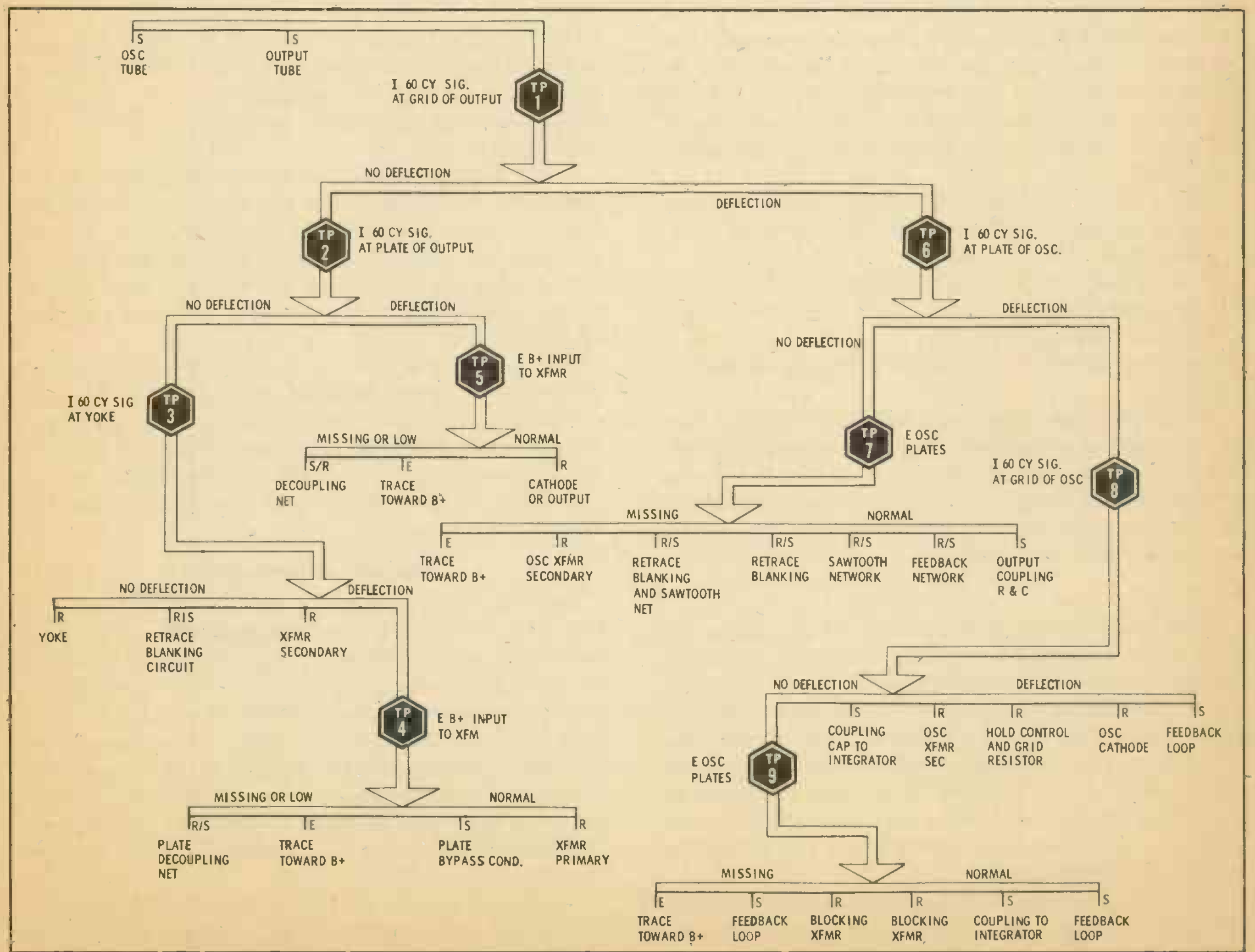

Chart I—Programmed Troubleshooting Steps For Tracing Vertical Sweep Trouble.

tube in the combination multivibrator and output circuits. This is Test Point 6 in Chart I on the right and just below Test Point 1.

Test Point 7

Voltage At Oscillator Plates. If the test signal injected at the plate of the oscillator (or the plate of the first tube in the combination multivibrator and output circuits) produces no vertical deflection, the fault is isolated to the coupling components between the stages. The possibility that the plate of the oscillator might be grounded through a faulty connection at the socket, or that a blocking-oscillator transformer might have its plate winding shorted to the core, must not be overlooked. In a blocking oscillator, it is possible that the plate winding of the transformer is open and there is no continuity from the plate pin to the coupling capacitor leading to the grid of the output stage. The sawtooth network (R8 and C9) must also be checked at this time.

For the reasons mentioned above, Test Point 7 is a voltage measurement at the plate of the oscillator. If the voltage is less than 50 volts, or missing completely, a valuable clue is gained; and if the voltage is nearly normal, testing proceeds in a different direction.

Plate voltage is missing. If the oscillator plate voltage is missing or very low, the parts in series between the plate and B + are suspected. Tracing toward B + can locate the component which has failed. Part, or all, of the vertical section of a receiver is often operated from the boost source, and the technician should not be surprised to find that his readings with the VTVM lead him to the horizontal output section. The parts to be checked are shown on Chart I, to the left under Test Point 7.

Plate voltage is normal. When the oscillator plate voltage is normal, or slightly low, the following parts are suspected:

1. Retrace blanking circuit C3 and C4.
2. Sawtooth network.
3. Feedback network.
4. Coupling network R11 and C3 to grid of output tube.

The feedback network (not used in blocking oscillator circuits) is a common cause of oscillator failure. The parts to be checked are shown on Chart I at the right under Test Point 7. The possibility of a failure in the coupling capacitor and grid resistor of the output stage must not be overlooked.

Test Point 8

Signal At Oscillator Grid. If the 60 cps signal injected at the plate of the oscillator produces deflection, the fastest way to isolate the fault to either the plate or grid circuits of the oscillator is to inject the test signal at the grid of the oscillator. Even though the oscillator may not oscillate, due to some failure in its grid circuit or in the feedback loop, a signal injected at the grid of the oscillator will cause it to operate as an amplifier, and thus it can be determined if it is capable of driving the output stage.

When no deflection results. "No deflection" means the oscillator stage is completely inoperative—not even capable of passing a signal through to the output. Test Point 9 is a measurement of plate voltage on the tube and is the next test to take.

Test Point 9

Voltage At Oscillator Plate. At Test Point 9 with very low plate voltage, or none at all, and no deflection at Test Point 8, the VTVM is used to trace toward B + in the same manner described earlier.

When plate voltage is normal. If normal or slightly low plate voltage is found at the oscillator, the fault is isolated to the parts shown on the right of Chart I under Test Point 9. The blocking-oscillator transformer, when one is used, should be checked with an ohmmeter and the resistance compared with that given by the manufacturer. The possibility of leakage between grid and plate windings or leakage to the core must not be overlooked. The coupling capacitor to the integrator should be substituted if sync is applied to the grid of the tube. The feedback loop components should also be substituted.

When Deflection Results from Injection into Grid. If deflection results from signal injection into the oscillator grid at Test Point 8, then it is apparent the oscillator has stopped because of a lack of feedback, since the tube is able to amplify a signal and drive the output stage. The suspected parts are listed on the right side of Chart I, under Test Point 8. These are all associated with feedback with the exception of the hold control, grid resistor, and oscillator cathode circuit.

These parts should be checked in addition to any feedback components because the test signal could be transferred through the oscillator stage by means of capacitive coupling through the tube, even when the stage is defective.

Many experienced technicians have learned to examine the white line across the screen and to decide, from its appearance, whether the oscillator or the output stage has failed. This can be done if one works on familiar models repeatedly, but it is not very reliable unless considerable experience can be brought to bear on the problem.

The problem of "no vertical" can be approached successfully in many different ways. Because the vertical circuits are less complicated than other stages in a television set, and usually only two stages are involved, this circuit affords an excellent opportunity for the technician to develop his own analytical ability and his own testing routines.

Horizontal Instability

Now that you understand the use of the charts in this system of programmed troubleshooting, we can go on to an example of trouble that is much more difficult to understand and pinpoint. *Horizontal instability* is one of the most common "tough dog" service problems. It often stumps technicians of impressive experience, unless they have learned to use step-by-step tracing methods like those shown in these charts. Let's see how these special charts (Chart II) can be used to locate and pinpoint this trouble in almost any type of circuit.

Horizontal instability takes three main forms on the screen: smooth horizontal bending, erratic horizontal tearing, or complete loss of horizontal sync.

Smooth horizontal bending is usually the result of

60 or 120 cps hum modulation of video information and sync pulses.

Erratic horizontal tearing and flag-waving are symptoms of failure in the sync, video, or horizontal sweep sections. The B+ filters and the AGC may also be involved, since they are associated with these stages. The symptom is present when parts of the picture tear out to the left in an irregular manner. When the symptom is confined to the top of the screen only, it is called flag-waving because the top of the raster appears to flap or flutter back and forth in the manner of a flag waving in the breeze.

Complete loss of horizontal sync is disclosed when the oscillator is running off frequency and cannot be brought back on frequency with the horizontal controls.

Erratic Horizontal Tearing and Flag Waving

The experienced technician first makes certain that no distortion of the raster due to a horizontal sweep (not sync) defect, is involved in the case. The following system of troubleshooting is for *video* instability in a normal, straight raster. The video information may be removed from the screen by turning to an unused channel, or by removing the last video-IF or video-output tube in parallel-filament receivers; the raster should be examined for evidence of curved vertical edges or hum modulation. This is facilitated by temporarily misadjusting the centering.

Once the symptom has been identified as horizontal tearing or flag-waving, isolation of the defect can be started with Test Point 1.

Test Point 1

Scope Video Output Stage. In receivers using keyed AGC, the AGC voltage can be upset because of the loss of control over horizontal frequency. Therefore, the waveform at the grid of the video output may show distortion which is not the result of a defect in the tuner, IF, or detector. For this reason, substituting fixed AGC bias is recommended before observing the waveform. When simple AGC is used, the substitution of fixed bias is not necessary at this time.

If fixed bias clears up the trouble and a normal waveform (Fig. 2) is found at the video output stage, then the AGC circuit is at fault. If fixed bias does not produce normal operation, it is clear that AGC was not the trouble. The bias voltage should be left connected, and the analysis should move to Test Point 1.

The contrast control should be turned to maximum and a good signal tuned in. If the waveform at the grid or plate of the video output stage signified distortion of the sync pulses as shown in Fig. 2C or 2D, the oscillator, sync, and AFC sections are eliminated as possible causes of failure, and further testing should move to the power supply and picture signal circuits. If the pulses are normal at the grid of the video output tube (Fig. 2A) and faulty at the plate (Fig. 2B), the defect will be found in the video output stage or in the components affecting the plate-load impedance of the stage. If a normal pulse is found at the plate of the stage, all picture signal circuits are eliminated as suspects, and the analysis should move to the sync, AFC, and oscillator circuits.

When sync is compressed. After all suspected tubes have been replaced, substitution of the B+ filters is in order. The filters should be disconnected one at a time and a new one substituted for each. All plate and screen voltages in the tuner and video IF should be measured, and tracing toward B+ must be carried out whenever an abnormal voltage is found. Tube socket adapters can be used to advantage to make measurements in the tuner more convenient. Screen bypass capacitors and coupling capacitors between stages should not be overlooked.

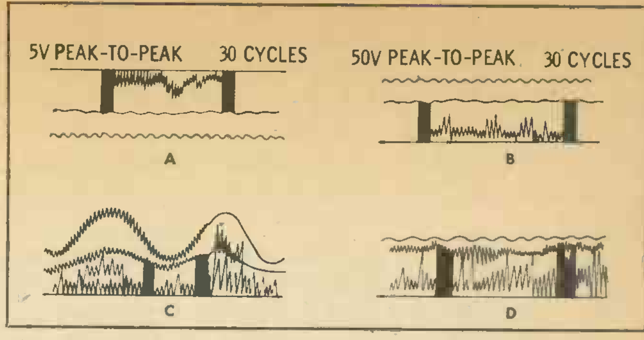

Fig. 2. Plate and grid waveforms of video output stages.

The detector diode is frequently a germanium crystal, and this should be substituted with a unit having the same characteristics; or, it can be checked with an ohmmeter. The resistance in the reverse direction should be at least 100 times that in the forward direction. The actual values of resistance are not important, because they depend on the current supplied by the ohmmeter and will vary with different types of meters.

Fig. 3 shows components which compensate for losses of low frequencies in the video output stage. Poor low-frequency response causes a change in the shape of sync pulses, making it impossible for the following stages to function properly. The technician needs to know the response characteristics of his scope, as well as the amount of low-frequency loss that can be tolerated in receivers, to accurately analyze this indication. In rare instances, horizontal tearing can be caused by poor alignment of the video IF stages or tuner.

When sync is normal. This indicates that the defect is in the sync, AFC, or horizontal oscillator. Test Point 2 is chosen because it separates the oscillator from the other two sections. The test consists of complete AFC alignment.

Test Point 2

Remove Correction Voltage and Align AFC. The procedures for AFC alignment vary greatly in different

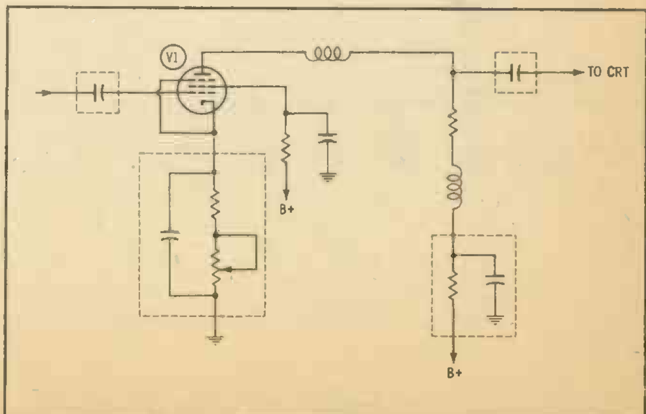

Fig. 3. Components that affect low-frequency response.

models, and Synchroguide circuits require entirely different treatment. A generalized procedure will be given here which can be used if the manufacturer's instructions are not available.

The AFC alignment of a cathode-coupled multivibrator with dual-diode phase detector is performed as follows:

1. Remove the AFC control voltage by disconnecting the lead from the grid of the multivibrator or by grounding this grid with a clip lead. Grounding this point will not stop the operation of the oscillator.
2. Short out the stabilizing coil in the plate lead of one section of the multivibrator with a short jumper across the coil.
3. Set the hold control to the middle of its range and adjust any other frequency control in the circuit to bring the oscillator as close as possible to 15,750 cps. This will be indicated on the screen by a very slow rolling of the horizontal blanking bar across the screen from right to left, or vice versa. If there is no other control, the oscillator frequency must be adjusted with the hold control.
4. Re-establish the AFC control voltage, which was removed in step 1, and place a zero-centered VTVM on the grid to measure the control voltage.
5. Remove the short from the stabilizing coil and adjust it for zero voltage on the VTVM when the picture is in sync. It may be necessary to readjust other controls in order to do this.
6. The end result should be an AFC correction voltage that is zero when the oscillator is on frequency, and the voltage must vary several volts in either direction as the hold control is turned.

The purpose of making this alignment is threefold: (1) provides assurance that the stages are adjusted correctly; (2) makes it apparent that the defect is in the oscillator if the oscillator cannot be made to run at 15,750 cps in step 3; (3) places the defect in the AFC phase detector or sync section if the oscillator can be made to operate on frequency, but the voltage from the control circuit cannot be made to vary properly in steps 5 and 6.

The AFC alignment of *Synchroguides* (Fig. 4) differs slightly from alignment of the cathode-coupled multivibrator and is performed as follows:

1. Tune in a station and set horizontal hold control R2 to the center of its range, even if this throws the oscillator off frequency.
2. Adjust L1, the top of the oscillator transformer, until the picture is locked in on the screen.
3. Locate point C on the underside of the oscillator transformer. (In many models, phasing coil L3 is separate from the tank coils and located some distance away on the chassis.) Point C is in the junction of L3 and the center of the oscillator tank coil. It is also the junction of capacitor C1 and resistor R1.
4. Attach a scope to point C and adjust the scope to view two horizontal pulses. If attaching the scope throws the oscillator off frequency, a low-capacitance probe must be used or an isolating resistor inserted in series with the scope probe.
5. Adjust the lower slug in oscillator transformer L3 until the pattern shown in Fig. 4 can be seen on the scope. It may be necessary to readjust L1 at the same time if moving the slug in L3 throws the

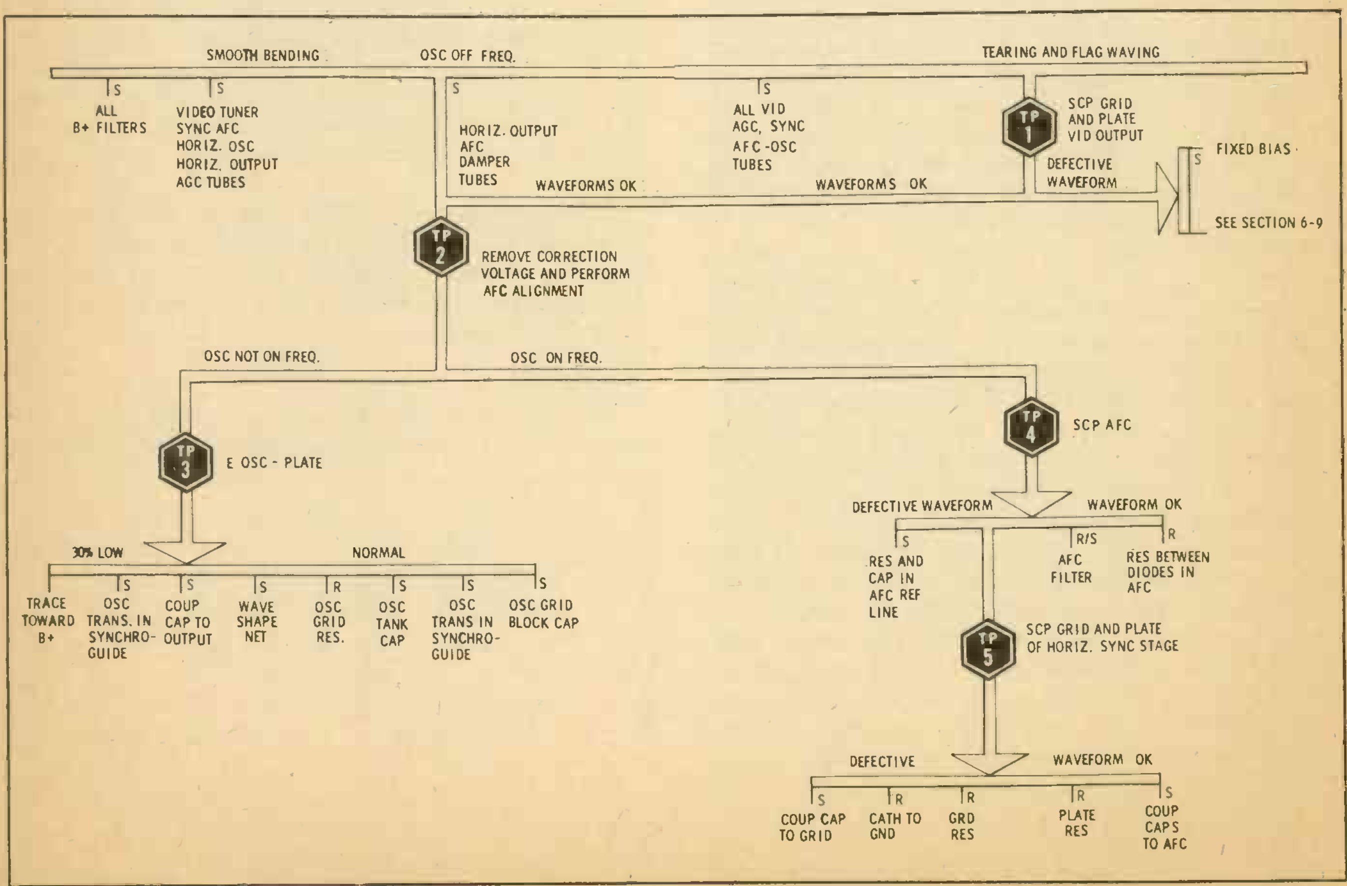

Chart II—Programmed Troubleshooting Steps For Tracing Horizontal Instability.

oscillator off frequency. Do not change the position of the hold control. The pattern on the scope must be obtained with the picture locked in on the screen; if the receiver is out of sync when the pattern is obtained on the scope, the waveform is meaningless.

6. Turn the hold control to test its range. If the receiver will not stay in sync over the middle one-third of the control range, adjust the range locking screw, if there is one. It is not necessary to adjust the horizontal drive control.

If these adjustments of the *Synchroguide* cannot be made successfully, it is necessary to determine whether the defect is in the control section (V1) or in the oscillator (V2). R3 should be disconnected at the point marked X, and a 100K resistor connected in series between R3 and ground. Another attempt should be made to get the oscillator on frequency by adjusting the hold control, L2, and L3. If the oscillator can be tuned to frequency and held there without evidence of the horizontal-tearing symptom, it is safe to assume that the defect is not in the oscillator. The oscillator will, of course, be somewhat unstable when the control voltage is disconnected, but the symptom of tearing will not be present if the oscillator is functioning properly.

Test Point 3

Voltage at Oscillator Plates. The following tests apply to both *Synchroguides* and multivibrators. When the oscillator cannot be operated at 15,750 cps by manipulation of the hold control (with the control voltage disabled), any part in the oscillator circuit may be suspected as the cause of the symptom. Test Point 3, a measurement of the oscillator plate voltages, will reveal whether the fault is in the grid circuit or in the plate circuit. If the oscillator were not running, a somewhat lower voltage on the plates might be expected because of excessive plate current; but since the oscillator is running, any decrease in plate voltage is a definite indication of trouble in the plate circuit. The parts to be checked are listed on Chart II to the left under Test Point 3.

With normal plate voltages, the suspected parts are in the grid circuit, as listed at the right under Test Point 3.

When Oscillator Operates on Frequency. If the AFC alignment procedure shows that the oscillator can be made to operate on frequency by manual operation of the hold control, components in the AFC or in the sync section are suspected of causing the trouble.

Test Point 4

Scope at AFC. Test Point 4 separates the AFC and the sync stages. In the diode type, a scope used on all the input waveforms to the AFC circuit will show if proper pulses are arriving at this circuit. The scope sweep should be set at 7875 cps to view two horizontal pulses. There may be two points at which sync pulses of opposite polarity are fed to the AFC. These pulses should be exactly the same in shape and in peak-to-peak voltage. If they are not the same, except for the reversal in polarity, coupling capacitors C1 and C2 from the AFC to the sync stages should be substituted (Fig. 5). It is also necessary to view the reference pulse from the oscillator or horizontal output, as the

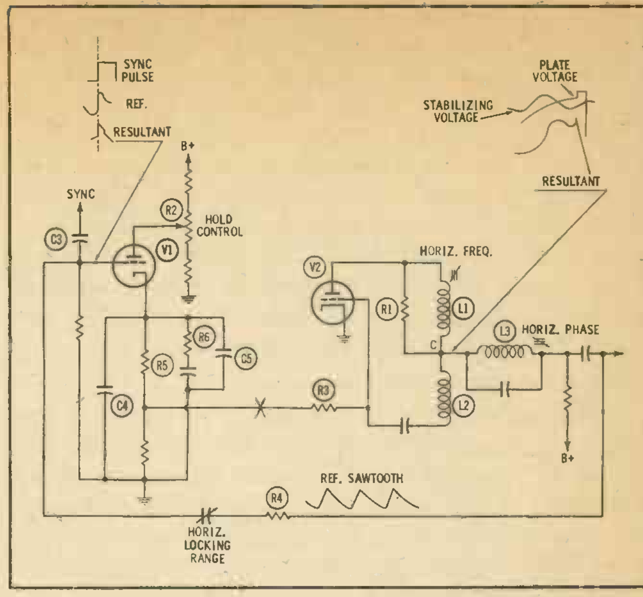

Fig. 4. Waveforms and controls in *Synchroguide* stage.

pulse must also have the correct polarity and peak-to-peak voltage.

Defects in the reference pulse can usually be corrected by replacing C3 and R1. Sometimes only the phase of the pulse is incorrect, and it may look normal on the scope; so replacement of these two parts is advisable in any case. A few models develop instability in the horizontal oscillator because of changes in the horizontal output transformer which affect the phase of the reference pulses. When this happens, R1 and C3 may need to be replaced with parts of slightly different values (rather than change the transformer) in order to restore stability to the horizontal sync.

In *Synchroguides*, Test Point 4 is at the grid of the control tube, and the waveform to be expected is shown in Fig. 4. It is difficult to recognize the parts of this waveform when viewing it under operating conditions, but any deviation from the ideal pattern will lead the technician to suspect R4, C3, or C6 of having failed.

If the waveforms at Test Point 4 are normal, there are still some parts in the control-voltage filter network which must be checked. These are C4, C5, C6, R2, and R3 in Fig. 5; and in the *Synchroguide* (Fig. 4), they are R5, R6, C4, and C5.

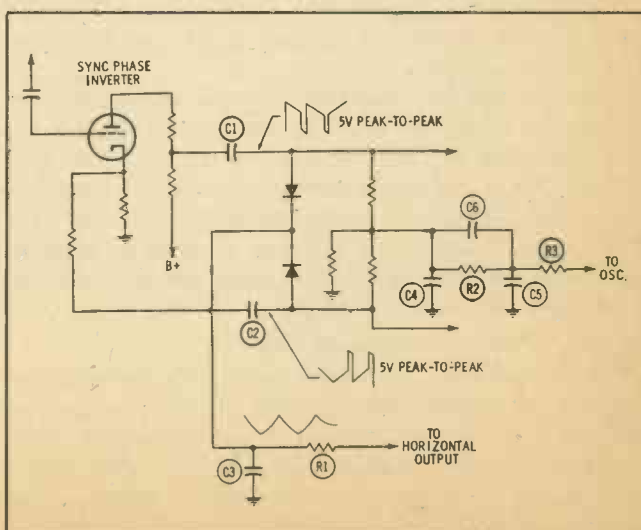

Fig. 5. An example of a dual-diode horizontal AFC circuit.

When oscillator operates on frequency. Each sync stage can be analyzed with a scope at its grid and plate. It is necessary to test only those stages of the sync section which handle horizontal sync; so if a separate vertical-sync amplifier or clipper is used, it need not be checked. The frequency of the scope sweep should be 30 cps for checking in the sync stages, because this allows the technician to see all horizontal pulses for a complete frame and, therefore, to detect a defect more easily. All components in the sync stage can be suspected of having failed, but coupling and bypass capacitors are the most likely to do so.

Horizontal Oscillator Off Frequency

When the horizontal oscillator is very far off frequency, a squealing noise can often be heard, and sometimes the raster will become dim or disappear completely. Even without the high-pitched squealing, this symptom can easily be recognized because it produces black horizontal ribbons on the screen and no picture can be discerned.

If the condition is intermittent and occurs after the receiver has been operating for a few hours, it is nearly always due to trouble in the horizontal oscillator tube. When replacement of this tube does not completely correct the symptom, alignment of the AFC will restore stability to the receiver. Often stability in *Synchroguides* can be restored by turning the tuning slug on phasing coil 3 one-fourth to one-half turn counterclockwise (Fig. 4).

In severe cases, the oscillator cannot be brought back on frequency with any of the controls; turning the control in one direction will have very little effect, and turning it in the other direction will result in a "Christmas-tree" effect. This effect is manifested when the entire horizontal system breaks into intermittent oscillation at a frequency far removed from 15,750 cps. It results in a very bright foldover in the middle of the screen accompanied by a large number of light horizontal lines of different lengths extending outward from the center. It appears much like the familiar, ragged shape of a Christmas tree displayed in bright white at the center of the screen and is accompanied by a very high-pitched squealing that emanates from the high-voltage compartment. This defect puts a great overload on the horizontal output transformer and on the oscillator transformer when one is used. The receiver should not be left running in this condition for long periods of time.

Chart II shows a number of tubes that should be substituted. They are listed in order, with those most likely to cause this trouble first on the list. The procedures for isolating this symptom are the same as those used for horizontal tearing, and begin with Test Point 2 on Chart II. In addition, it must be remembered that the horizontal-output stage and the yoke are involved in the case of Christmas-tree effect.

Loss of Vertical and Horizontal Sync

When a receiver has a great error in horizontal frequency, the screen becomes full of black horizontal lines due to the malfunction of the horizontal oscillator. This makes it difficult to tell if the vertical oscillaor is also off frequency; so what may appear to be only a complete loss of horizontal sync may actually be a loss of both vertical and horizontal sync. This calls for a different analysis, as the defect is almost always in the sync section if both vertical and horizontal oscillators are running off frequency. The defect must be in a stage affecting both oscillators, yet not affecting the video gain or contrast of the receiver, nor causing raster distortion.

In a few instances, AGC or noise-canceller defects can cause complete loss of sync, but this is usually accompanied by a noticeable change in contrast. Either an obvious overloading condition prevails, indicating loss of AGC, or lack of sufficient contrast exists, indicating video or AGC trouble. It is also possible that misalignment of the receiver can cause the condition, but when this occurs there is usually some difficulty in tuning both sound and picture simultaneously.

Test Point 5

Scope Grid and Plate of Sync Stage. When the out-of-sync condition can be recognized as a failure in the sync stages, analysis is simple. A scope should be placed at the input to the sync section, which is at the coupling capacitor to the video output or detector. If a normal waveform is found there, the scope should be moved to the plate of the stage, and thence to the grid of the next stage, and so on until the point is found where the sync pulses disappear. When more than one stage is used in the sync section, and the vertical and horizontal pulses are taken from separate plates, it is necessary to examine only those stages *before* the first take-off point.

When the point is found where sync pulses are not present, the VTVM should be applied to the plate of the suspected stage. If voltage is normal, the cathode and grid circuits should then be examined with an ohmmeter, and grid-to-cathode voltage should be measured to ascertain the condition of the coupling capacitor.

When special voltages utilizing a bleeder network are used on a grid or cathode, the resistors in the bleeder are a frequent cause of incorrect grid or cathode voltages.

This is also true when stacked B+ is used. The voltages of a stage may depend on current drawn by some other section of the receiver, and the cathode may be operated considerably above ground potential with the grid returned to a special point which has the proper voltage relationship to the cathode voltage. If the grid is grounded through some defective component, the stage will be inoperative. The schematic should be consulted to determine what the normal results of tests in these circuits should be.

Conclusion

From the foregoing examples, you have seen how you can use "programmed" troubleshooting charts to analyze and trace trouble in the easy or the difficult circuits of any television receiver. Many other such charts are included in the book from which this material was adapted, and they cover almost every circuit in a TV set, from power supply to picture tube. You can develop charts like this of your own, and build your own servicing techniques around them. The key to successful servicing is in using a logical approach, whether you develop your own, or use these charts. Just be logical, and servicing will be easy. ▲

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including Electronic Servicing

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ABOUT THE COVER

We're rounding out another year with a full bag of choice servicing features, and have popped in a surprise package: a complete Subect Reference Index for your 1963 issues, presented a whole month earlier than in previous years.

Letters to the Editor

Dear Editor:

May I inquire what happened to the shunting resistor over coupling capacitor C2 in the August *Symfact?* Was it lost, strayed, stolen, or did the supply run out?

Clair C. Rausch
Detroit, Michigan

We had plenty of resistors, Clair, but the typesetter ran out of A's. As you found when you read the text, the title should have been "AC-Coupled CRT Circuits."—Ed.

Dear Editor:

I very often take time to read the worthy articles in PF Reporter. Let me say that, in all my experience, the July article "Keeping Your Service Sold" by E. S. Wright is one of the most noteworthy.

As manager of a wholesale electronics distributor, I've heard good and bad comments about all types of radio and TV technicians. At times, it has irked me to hear bad comments about technicians whom I know are technically capable and qualified men. Where, then are these men falling down, to deserve such unfavorable comments?

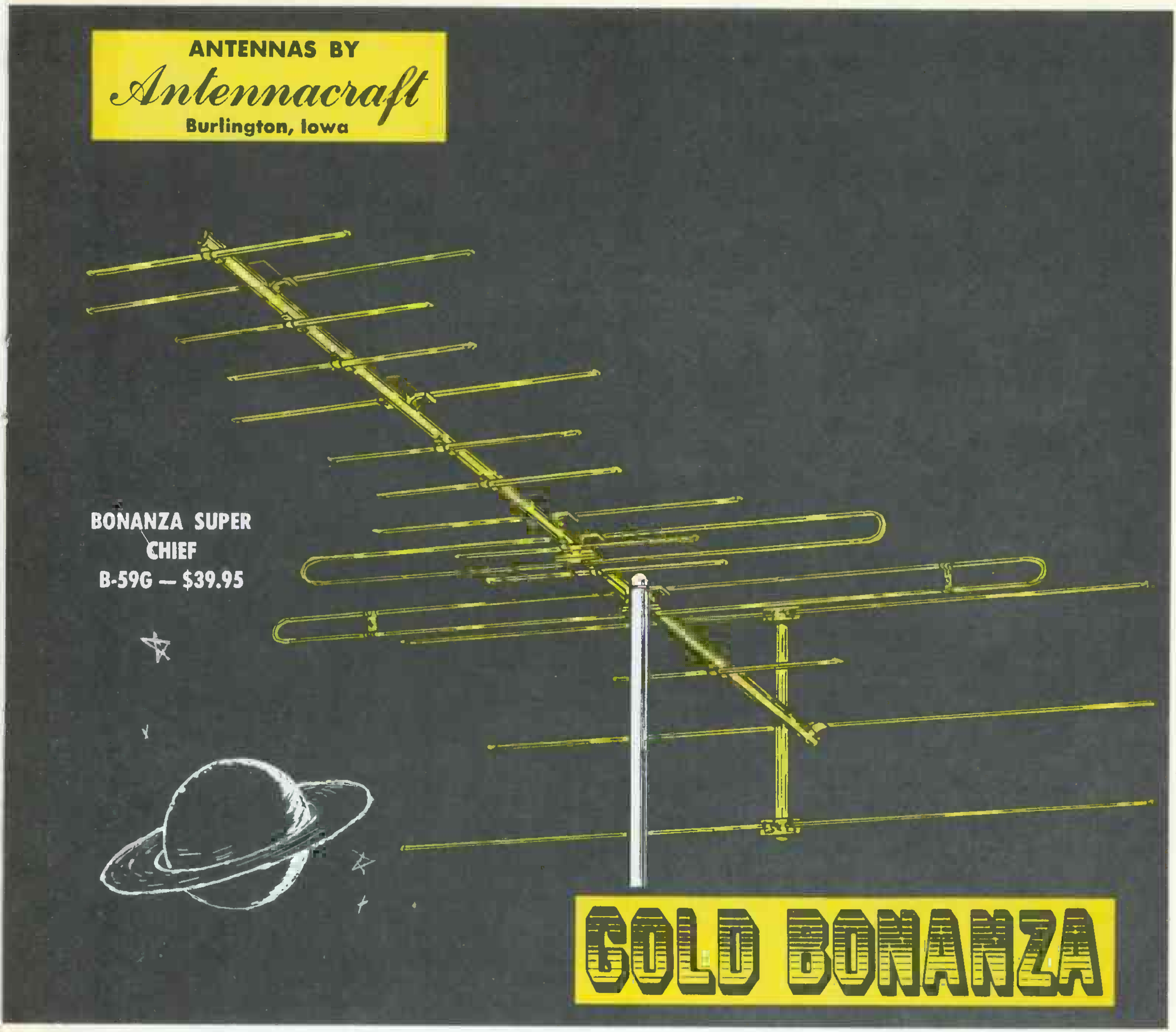
Reading this article recalled the old days when I started a new job servicing radios. I had many months of servicing experience, but I was young and inexperienced in human relationships. I was sent along with an older man to service a big battery-powered set. When we arrived, the customer complained of poor performance and distortion. My experienced companion spent some time tapping tubes, checking the antenna, and brushing out dust. Finally, he reversed the A-battery clips and behold—the troubles were solved!

Back in the car, I remarked, "That radio sounded like it had a reversed A-battery when we first walked in. Why didn't you try that right away?" I'll always remember his answer, "I know it did. But this way the customer feels he got his money's worth. If I'd told him he'd made the stupid mistake of hooking up one battery wrong last time he changed them, he'd have resented paying us just to point out his error."

The article "Keeping Your Service Sold" was most appropriate. I'd like to see such an article reprinted and offered to distributors for handing out to their technician customers through their monthly statements. I, for one, would distribute them widely.

L. T. Souders
Manager, Nelson Radio & Supply
Fort Walton Beach, Fla.

Many thanks, Mr. Souders. We agree that service technicians qualified in customer psychology would earn more respect and more money. I wonder how many other distributors would spread reprints of articles like this one?—Ed.



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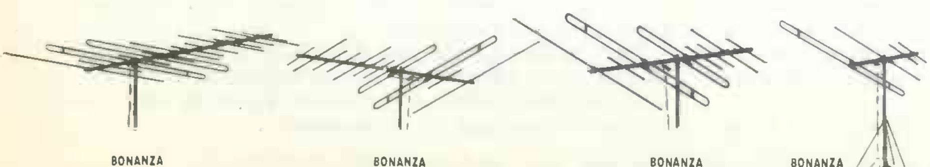

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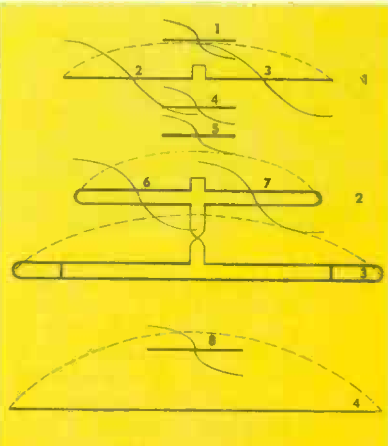

Diagram illustrates the high and low band system.
High band—solid lines
Low band—broken lines

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The Troubleshooter

answers your servicing problems

Tiresome Buzz

Have you any suggestions as to how I can eliminate buzz from the sound in a Sparton Model 211M10 (PHOTOFACT Folder 311-15)? I haven't been able to cure this complaint, even by realigning the set.

JOE M. STEPANICH

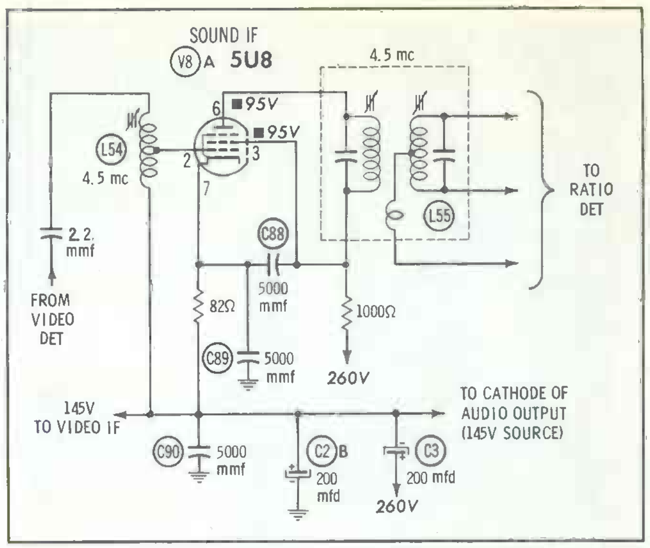
Chicago, Ill.

Tough-dog buzz troubles have so many possible causes that your first concern should be to isolate the faulty section of the set.

Make absolutely sure the filters on the low B+ (145 volt) line are in A-1 condition, so no buzz from the audio output stage will be fed back to the sound IF or video IF circuits. Then, carefully inspect the vertical sync pulses in the output waveform of the video detector; if these are either compressed or exaggerated, they can introduce 60-cps "buzz pulses" into the intercarrier sound signal fed from the detector to L54.

If the AC and DC inputs to the sound IF are both clean, concentrate your attention on the sound IF and detector stages. Outright replacement of the 5 mfd stabilizing capacitor in the ratio detector circuit is the best way to assure maximum AM rejection in this stage. Also check C88, C89, and C90 in the sound IF by bridging them with good capacitors. If L54 does not peak sharply at 4.5 mc, replace it. Change L55 as a last resort.

Don't overlook the possibility that sync pulses might be



coupled into the sound circuits through faulty lead dress, or by leakage in the socket of V8 from the triode section (sync phase inverter) to the pentode section (sound IF).

If the video-detector waveform contains distorted sync pulses, check back through the front-end circuits. Did you replace all RF and IF tubes to make sure none were leaky? In addition, did you substitute for the AGC bias voltage? The set might have slight AGC trouble, even though no obvious symptoms such as picture overloading have been noted. The local-fringe switch might be giving trouble; AGC filter C75 could be defective; or there might be something wrong with the grid circuit of the sync separator, which normally supplies a negative voltage to the AGC line to supplement the bias developed at the video detector.

Easy CRT Swap

I'm working on a set that needs a new picture tube to replace a bad 17QP4. Would it be practical to substitute a 17LP4 that I happen to have in stock?

LUTHER A. EVANS
Cuba, Mo.

These 70° tubes are electrically and physically similar, except that magnetic focus is used in the 17QP4 and electrostatic focus in the 17LP4. You merely remove the permanent magnet originally used for focusing, and devise a wire connection for feeding a DC voltage to pin 6 (the focus anode) of the new tube. The lead can be returned to ground, low B+, high B+, or boost, whichever gives best results. In one similar job I just completed, 135 volts from the low B+ line did the trick. You might include a resistor (approximately 100K) in series with the focus lead as protection against arcing inside the CRT. Add centering rings salvaged from a discarded yoke.

Ten Years of Vertical Roll

In reference to Wayne Schaffter's letter in September *Troubleshooter*, we've also experienced chronic trouble with loss of vertical sync in the Silvertone 2100 and similar models. We cure it by installing an improved sync and vertical feedback pack that has been made available by Sears, and replacing all the 200 and 400 volt capacitors in the vertical circuit with new dipped *Mylar* 600 volt types.

KEN DIXON
Wichita Falls, Texas

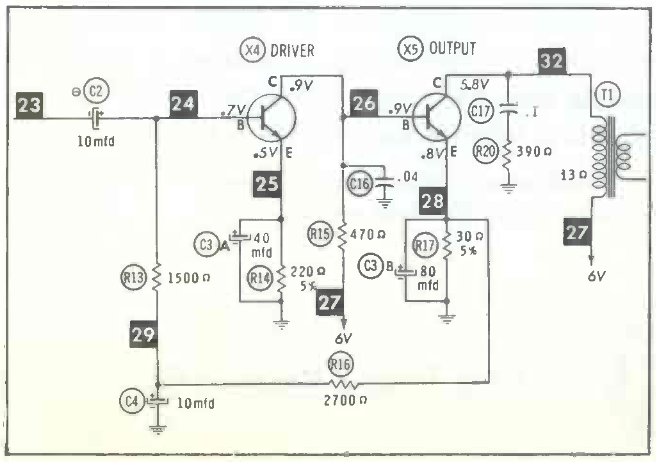
This is a good service hint for 1961 and 1962 sets using the 528.51700 and similar chassis (PHOTOFACT Folder 514-2). The component combination bearing Sears part number 13-23-3 can be replaced with 13-24-3. Unfortunately, Sears used the model number 2100 on quite a few 1952-model sets as well as on '62s, and Mr. Schaffter has been having trouble with one of these old-timers. I suspect he's solved his problem by now.

Rapid Drain

The owner of an Emerson Model 555V transistor radio (PHOTOFACT Folder 575-5) complains of short battery life. According to the schematic, the total current drain should be 10 ma with no signal applied, or 20 ma at normal volume. I find a reading of 24 ma, regardless of signal conditions or control settings, but have been unable to locate a definite cause of the apparent increase in the load on the battery.

LEON HOUFF
Covington, Va.

The most likely cause of this trouble is a leaky audio driver or output transistor, or greater than normal base-emitter bias on one or both of these stages. If the bias is excessive, this is quite probably due to leakage in one of the emitter-bypass capacitors—C3A or C3B. I'd suggest checking or substituting for both transistors and both sections of the dual capacitor.



The Electronic Scanner

news of the servicing industry

Pick A Card

An assortment of greeting cards is now being given free to TV service dealers with the purchase of twelve **Perma-Power** Vu-Brites. Birthday cards, get-well cards, anniversary cards, and cards for other occasions are included in this special offer. In all, twenty-four cards — with envelopes — are packaged with the brighteners.

Your Role in Color TV

According to Lysle O. Shanafelt, Manager of **RCA's** Distributor Sales Coordination, TV servicemen play a key role in the rapidly unfolding drama of color television. Mr. Shanafelt pointed out that consumer demand for color TV would not increase unless color receivers are serviced properly and deliver satisfactory performance. The RCA executive discussed several avenues of effective merchandising which can help servicemen increase sales. Among the factors he stressed were: technical ability, salesmanship, advertising and sales promotion, business management, selling nationally advertised parts, and creating goodwill by participating in community projects.

Competition Over

The winning display in their "national products display" competition for dealers has been announced by **Pearce-Simpson, Inc.** According to a panel of judges, the winning display showed both originality and boldness in color concept. More than any other entry, it represented effectively and completely the many types of marine electronics equipment available, by displaying them attractively for maximum customer exposure.

TAME Is Formed

Twelve antenna manufacturers met recently in Cleveland, Ohio for the purpose of forming TAME—Television Accessory Manufacturers Institute. The group was conceived as a common effort against the uncontrolled growth of community antenna systems throughout the country. It is not the systems which serve an unmistakable technical need that are under fire, but those in areas where good TV reception has been attainable for years with a properly designed TV antenna installation.

New Managership

The appointment of Joseph L. Stracuzzi to Manager of Consumer Products was announced by Wayne W. Cawley, President of **Cadre Industries Corp.** Mr. Stracuzzi assumes full responsibility for production of Cadre two-way radio products and "Betacom" solid-state intercom systems.

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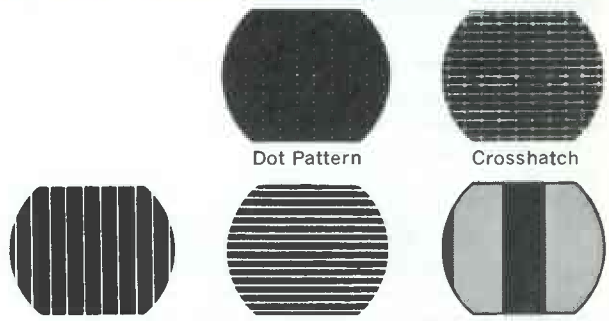

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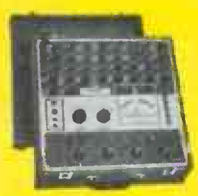

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Circle 11 on literature card

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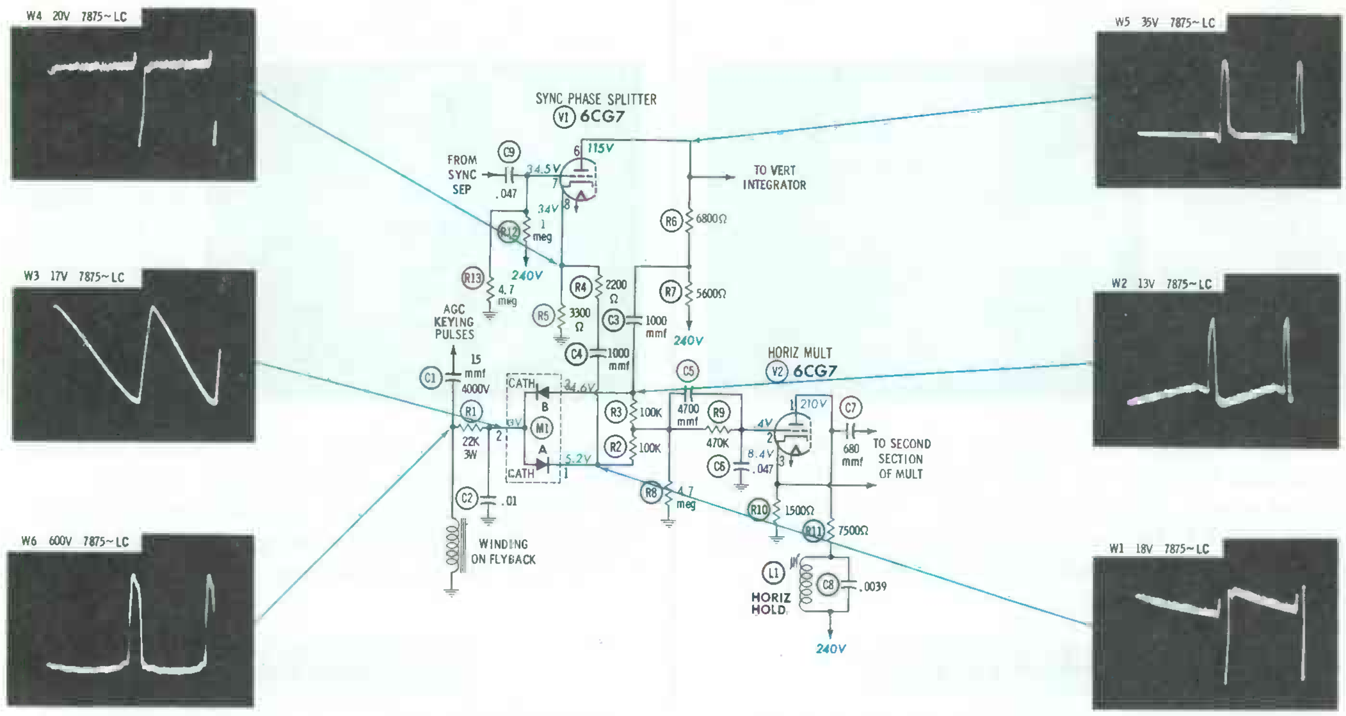
Horizontal AFC

Series Type



DC VOLTAGES taken with VTVM, on inactive channel; L1 adjusted for zero volts on grid of V2.

WAVEFORMS taken with wideband scope; low-cap probe (LC) used to obtain all waveforms shown.

Normal Operation

Two major types of dual-diode phase detectors are used for synchronizing cathode-coupled horizontal multivibrators. Common-cathode diodes were covered in November, 1963 *Symfact;* other design, using series-wired diodes, is illustrated by circuit shown here—from TraVler Chassis 1094-273. Series circuit requires both positive and negative sync-pulse inputs; so, it is always preceded by sync phase splitter like V1. Pulses developed at cathode and plate of splitter are coupled to opposite ends of diode unit, in proper polarities to drive both diodes into conduction. Nearly equal amplitudes of pulses in W1 and W2 set up balanced condition, with M1A and M1B conducting equally if multivibrator is in sync. Balance is "tipped" one way or the other by shift in phase of W3 (sample of horizontal sweep signal). This sawtooth is produced by integrating flyback pulse W6 in network R1-C2. When multivibrator is timed correctly, W3 will be passing through zero axis of its steeper slope at moment when sync pulses cause diode conduction. Result is equal bias on each diode. Slight change in phase of W3, due to multivibrator drift, causes instantaneous voltage other than zero on lead 2 at sync-pulse time; then one diode conducts more than other. This unbalance shifts DC voltage level at junction of R2-R3 (nominally zero), and change is passed along to grid of V2 to pull multivibrator into sync. In effect, both sections of M1, together with R2 and R3, constitute a balanced bridge.

Operating Variations

VOLTAGES No-signal voltages on schematic are little affected by control adjustments, and are useful for spotting some troubles. AFC voltages fall short of perfect balance, but are within practical tolerance. With sync signal present, voltages on M1 and V2 vary as L1 is adjusted. To set definite reference point, and simultaneously isolate trouble to either multivibrator or AFC, simple "free-wheeling" test should be made promptly: Temporarily ground pin 2 of V2, and adjust L1 until picture is almost in sync. (If this point cannot be approached, multivibrator is faulty.) Remove ground lead and measure voltage at pin 2. If AFC circuit is normal, sync will become stable and reading will be zero—within fraction of volt. As L1 is varied, pin 2 voltage should change. Operation may not be perfectly zero-centered; this particular circuit stays firmly in sync at control voltages ranging from −.5 to +2.5 volts, and tolerates momentary swings to −3 or +4 volts. With zero volts on pin 2, voltage on leads 1 and 3 of M1 should be greater than without signal, but still almost equal (for example, 6.6 and −6.8 volts on leads 1 and 3, respectively).

WAVEFORMS With diodes in circuit, small sawtooth in addition to pulse is seen in W1 and W2. Adjustment of L1 shifts position of pulse in relation to sawtooth. Small amount of video on base line of W4 and W5 is normal.

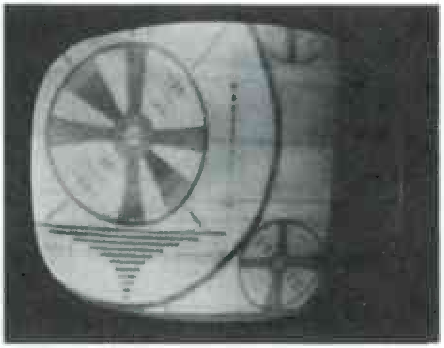
SYMPTOM 1

Lock Out of Phase

Severe Smear
Due to Phasing Ghost

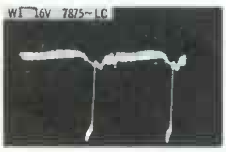
M1 Installed Backwards

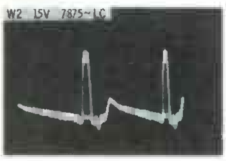
Symptom Analysis



Picture remains fairly steady (though jittery) with horizontal blanking bar visible near either left or right side of screen. Bar can be "flipped" to one side or the other with L1, but attempt to adjust for normal phasing always causes complete loss of sync.

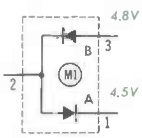
Waveform Analysis





W3 is normal; this proves trouble is not due to reversed connections on flyback winding. Both W1 and W2 contain satisfactory sync pulses, but lack of sawtooth component in W1 and unusually strong sawtooth in W2 point to erratic operation of AFC. Wrong positioning of sync pulse on sawtooth portion of W2 is simply a consequence of phase error in horizontal sweep signal.

Voltage and Component Analysis



This "trouble" can be solved in a jiffy by just reinserting M1 to the proper polarity, but the error is so obvious it's easily overlooked. Know the symptoms of a reversed diode unit, and you won't have to waste time in unnecessary troubleshooting. Instead of taking for granted that the original unit is installed correctly, check the circuit wiring to make sure! If you were tackling this problem by the voltage-measurement method, you'd find all voltages close to normal—with or without signal—but there would be a negative voltage on lead 1 of M1 and a positive voltage on lead 3, with practically no variation as hold control is turned.

Best Bet:* *Inspect circuit wiring or check voltages.

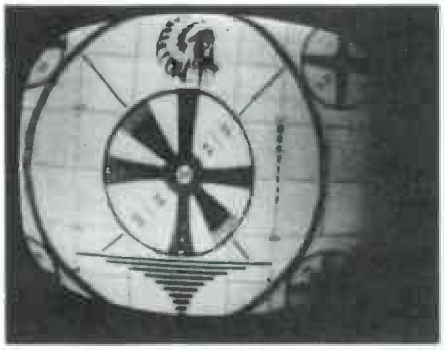
SYMPTOM 2

Intermittent Horizontal Sync

Slight Phasing Error

C3 Leaky

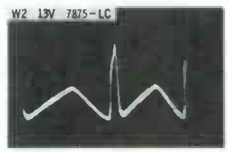
Symptom Analysis

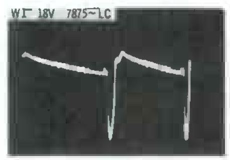


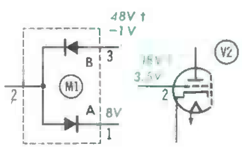
Picture locks in solidly, but L1 needs readjusting when set is turned on, and again after thorough warm-up. Tipoff to phasing fault is visible black border at right of screen, and milky phasing ghost at left. Attempt to correct it throws picture out of sync.

Waveform Analysis

Normal amplitude of sync pulses in W1 and W2 isolates fault to AFC. W2, taken at point of most stable sync, shows pulse shifted to right of usual position on sawtooth. L1 can be adjusted to place pulse in W1 on negative peak of sawtooth, without losing sync; this point is beyond normal hold-in range. Waveforms call attention to phasing error, but do not pinpoint its cause.







Voltage and Component Analysis

DC voltages (with no sync applied) clearly show unbalanced conduction of AFC diodes, but do not pinpoint exact cause. One thing is sure: Fault is not in R2 or R3, because voltage drops across these resistors are equal. On active channel, grid voltage of V2 has hold-in range of +3 to +7 volts; multivibrator must be detuned to maintain sync. Removing M1 kills raster, and high positive voltages appear in AFC. Most likely source of these voltages is leakage from B+ through C3, severe enough to register on ohmmeter. Faults in C2, C4, R2, R3, and M1 can cause similar symptoms, with smaller DC-voltage changes.

Best Bet:* *Remove M1 and check voltages in AFC.

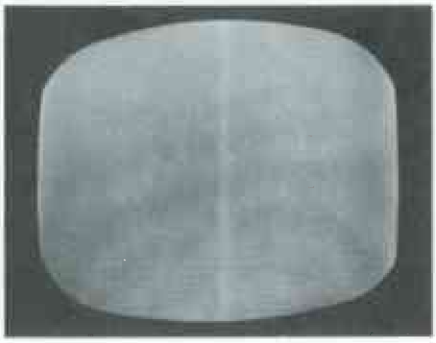
SYMPTOM 3

No Picture on Strong Stations

Decreased Width; Drive Line

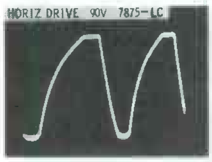
M1A Open

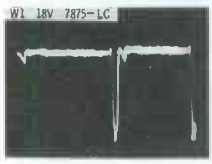
Symptom Analysis



Trouble looks like blocked IF due to loss of AGC. Disconnecting antenna or switching to weak station brings in picture, but horizontal sync is very unstable. Grounding grid of V2 restores normal sweep and lets keyed AGC circuit operate properly, restoring video.

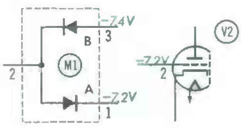
Waveform Analysis





Reduced width is explained by weak, distorted drive signal at grid of horizontal output (should be 150 volts). AFC waveforms are not clear enough to be analyzed, until set operation is stabilized by connecting multivibrator grid to ground. Then W2 is nearly normal, but W1 is not—it has same shape as W4. Lack of sawtooth means M1A is not conducting. W3 is okay.

Voltage and Component Analysis



With no sync signal applied to AFC, routine tests with VTVM spot negative voltages at both lead 1 and lead 3 of M1, as well as on grid of V2. Switching to active channel has little effect on these voltages. When pin 2 of V2 is grounded, voltages on both ends of M1 decrease by one or two volts, but remain negative. Positive voltage should normally be developed at cathode of M1A; so, obviously, this diode is not conducting. Negative voltage originates at lead 3, and is slightly lower at lead 1 because of voltage drop across R2-R3. Similar symptoms are seen if common-cathode dual diode is installed by mistake.

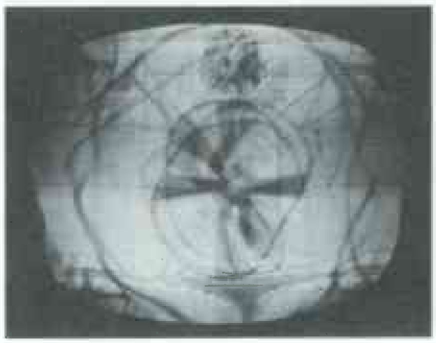
Best Bet:* *Break AGC-AFC feedback loops to isolate.

SYMPTOM 4

Intermittent Horizontal Sync

Worst on Strong Stations

C5 Open

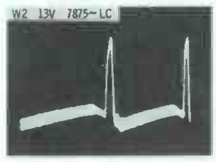


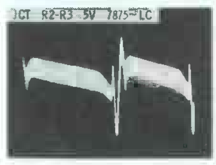
Symptom Analysis

On local channels, keyed AGC cuts in and out of operation when L1 is adjusted, causing violent shaking of picture. Weak signal gives steadier picture, but is still troubled by intermittent horizontal bending and loss of sync on signal interruptions.

Waveform Analysis

To avoid confusion in analyzing waveforms, picture should be made as stable as possible by keeping signal strength low and critically adjusting L1. W2 (shown), W1, and W3 look reasonably normal, but spurious 5 volt waveform is found at junction R2-R3, where less than 0.5 volt ripple should appear. Grid of V2 is free from ripple, indicating normal C6 and bad C5.





NO VOLTAGE CLUES

Voltage and Component Analysis

Conventional DC voltage readings, on inactive channel, do not reveal any abnormal conditions in AFC or surrounding circuitry. With station signal applied, clues are hard to obtain because of difficulty in maintaining sync. Nothing significant is turned up, anyway, as proved by this one set of readings: +1 volt on pin 2 of V2, same thing at junction R2-R3, +8 volts at lead 1 of M1, and —6 volts at lead 3 of M1. Grid voltage is well within hold-in range of multivibrator-AFC system, and equal voltage drops of 7 volts across R2 and R3 indicate AFC bridge circuit is capable of normal balance when proper input signals are applied.

Best Bet:* *Pinpoint defect with scope.

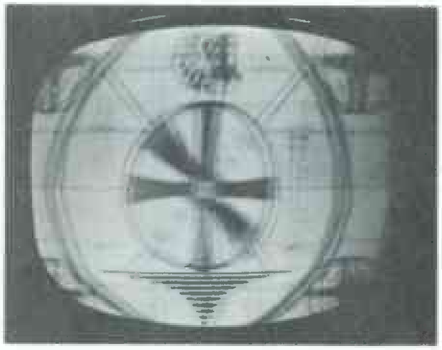
SYMPTOM 5

Horizontal Sync Touchy

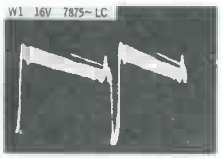
Lost Every Few Minutes

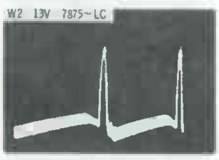
R1 Increased in Value

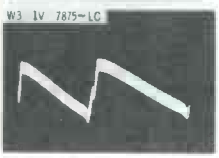
Symptom Analysis



Multivibrator reacts normally to grid-grounding test. When ground lead is removed, AFC throws multivibrator off frequency. Sync can be restored by backing out L1 slug, but is extremely critical—picture soon begins to jitter, and falls out of sync.



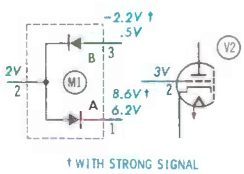




Waveform Analysis

On weak station signals, picture can be held in sync long enough to view waveforms. W1 and W2 look almost the same as in Symptom 4, and display no definite evidence of trouble. Main clue is W3, which has approximately normal shape, but amplitude of only 1 volt. Considerable "hash" in W3 indicates high impedance from lead 2 of M1 to ground; thus, increased value of R1 is more likely cause of signal loss than shorted C2.

Voltage and Component Analysis



Abnormal +2 volts on lead 2 of M1 does not necessarily pin down trouble to sample-signal circuit; could be indirect result of fault elsewhere. In this case, however, unequal voltage drops across M1A and M1B are supporting evidence of trouble at lead 2. They reveal increased conduction of M1A and decreased conduction of M1B, a logical result of applying positive bias to anode of A and cathode of B. R1 rose to 1 meg in this case; sometimes opens completely. It may appear burned, aiding visual inspection.

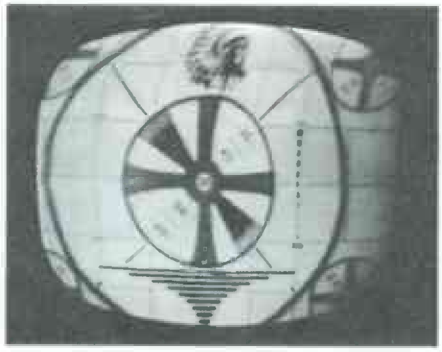
***Best Bet:** Pinpoint with scope or by examining circuit.*

SYMPTOM 6

Horizontal Phasing Error

Intermittent Pulling at High Contrast

R5 Increased in Value

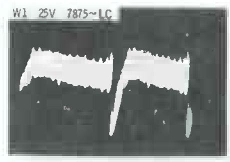


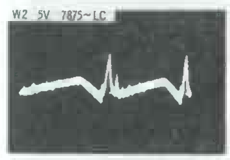
Symptom Analysis

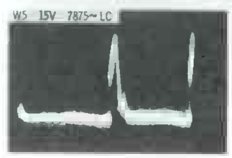
Visual indications are approximately same as in Symptom 2—picture pulls away from right edge of screen and may show phasing ghost at left. Attempt at correction makes sync less stable. Horizontal bending of picture varies with program material.

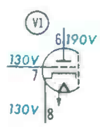
Waveform Analysis

These waveforms were taken with contrast control at high setting, to aid in locating cause of horizontal twist. As anticipated, W1 is full of video. It's also somewhat stronger than normal, whereas W2 is weak; this unbalance explains phasing error. W5 is weak, and pulses in it fluctuate so much the waveform is hard to lock in. W4 (26 volts) contains much video. Something's wrong in circuit of V1, drastically upsetting its operation.





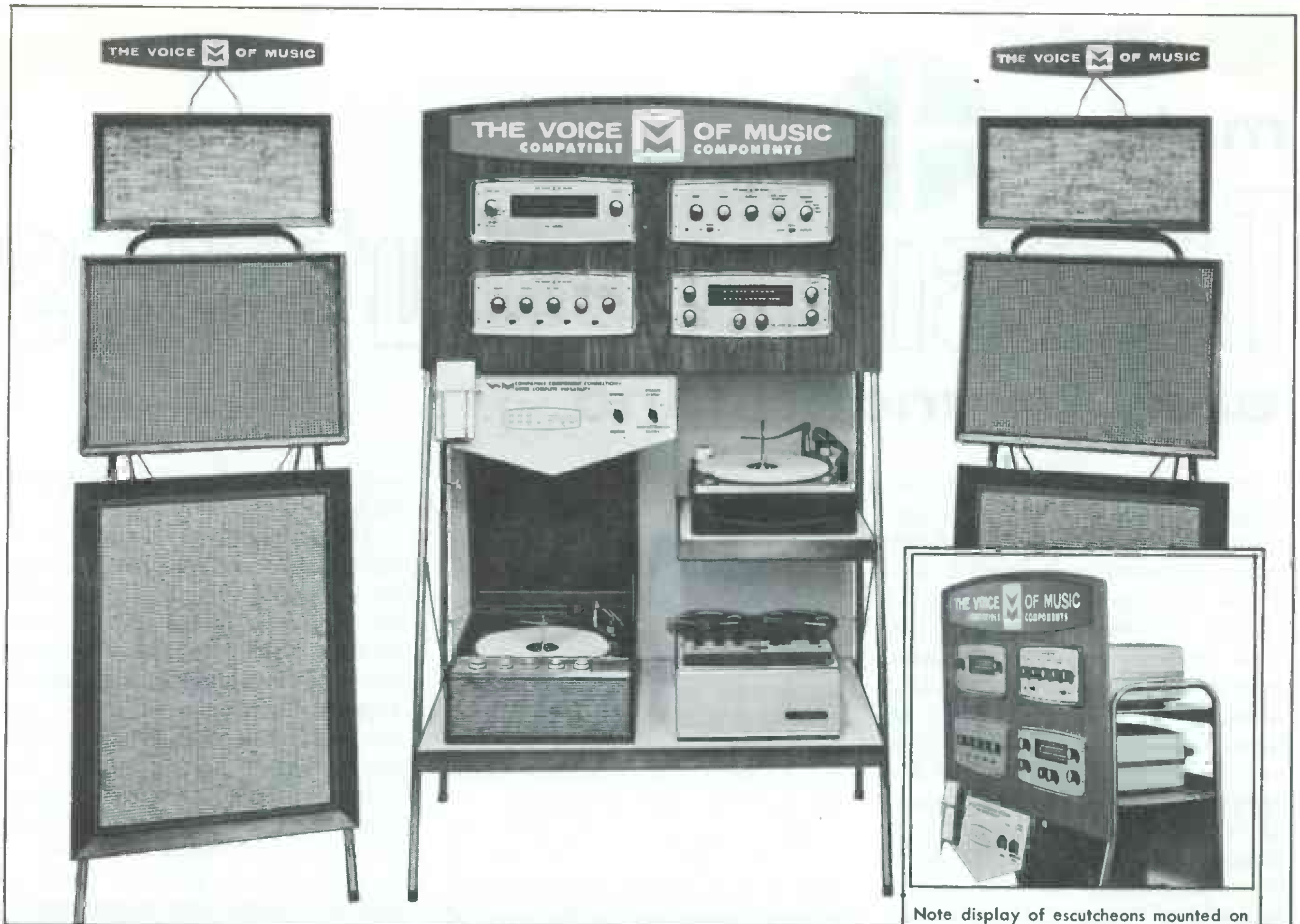




Voltage and Component Analysis

Extremely high voltages on grid and cathode of V1 flash a warning—easily misinterpreted unless normal biasing method of this stage is understood. Input signal is like W4, and circuit is designed to draw heavy grid current in intervals between sync pulses, to swamp out stray video. Positive voltage is fed to grid to maintain grid current; resistances in bias circuit determine grid and cathode voltages. Operating point is wrong, in this case, because value of hard-working R5 has risen to nearly 10 times normal.

***Best Bet:** Isolate with scope; follow up with VTVM.*



Note display of escutcheons mounted on walnut facing, with control switches below

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Circle 12 on literature card

by Patrick M. Craney

making Transistor Outputs easy to understand

"A transistor audio amplifier, like its vacuum-tube counterpart, is operated in such a manner that all the signal impressed on its input is amplified and appears at its output."

This statement illustrates the basic similarity that exists between transistor and vacuum-tube circuits. Actually, there is no difference in signal handling — merely a difference in how the DC voltages are developed and used. As far as signals are concerned, the transistor is comparable to a triode tube: The emitter is functionally the same as the cathode, the base performs the same duties as the grid, and the collector is analogous to the plate.

Since the transistor is a solid-state device, rather than having open electrodes like a vacuum tube, it has lower values of impedance and higher values of capacitance between terminals. Besides these characteristics, the transistor has another which distinguishes it from the tube: finite DC resistances across the junctions between elements. These DC resistances account for the fact that a small voltage or current variation (which wouldn't normally affect tube operation) will greatly upset the operation of a transistor circuit.

Troubleshooting

Troubleshooting transistor output stages is basically no different from troubleshooting tube outputs; the only real difference lies in circuit details such as the values of components and voltages used. As far as the signal is concerned, you can use the same troubleshooting methods in both types of circuits.

For example, if you desire to check the audio section of either a tube or transistor set, you can touch a metal tuning tool to the input of the last IF amplifier and listen for noise from the speaker. Also, when you want to check the speaker and output transformer of any set in which DC voltage is fed through the output-transformer primary, you can momentarily open the supply line and listen for a "click" from the speaker. Of course, the latter test is easier in tube circuits, where you can merely pull the output tube. It's seldom that a transistor can be simply unplugged; most generally, you have to open the transformer lead carrying the collector current, and listen for the click when you bridge the break.

There's one handy trick in troubleshooting transistor radios, besides the techniques adapted from servicing tube-type sets: Being current devices, transistors can be closely monitored by metering the current supplied to them — or simply the total current drain of the radio. Notice in Figs. 1, 3, and 4 that the normal current rating of the radio is given. In Fig. 3, since the output stage is a single-ended circuit which is conducting at all times (with or without a signal), the current rating does not change as signal is applied. In the push-pull circuits of Figs. 1 and 4, however, the outputs are cut off when no signal is impressed on them; as a result, there is less overall drain than when they are amplifying audio. Thus, when the volume is turned up, more signal is impressed on the audio stages, and more current is drawn from the power supply.

Many times, defective audio components or transistors can be spotted merely by lifting the power-supply line and inserting a milliammeter in series with it and the audio circuitry. Should the audio-circuitry voltage lead be inaccessible, just open the lead coming from the power supply to the entire radio.

Understanding the Circuit

It is impossible to effectively troubleshoot a circuit you don't understand. Many technicians adhere to the "hit and miss" method simply because they don't fully comprehend transistor circuitry. We will try to brighten some of these dark corners by explaining the AC and DC paths and how to troubleshoot them.

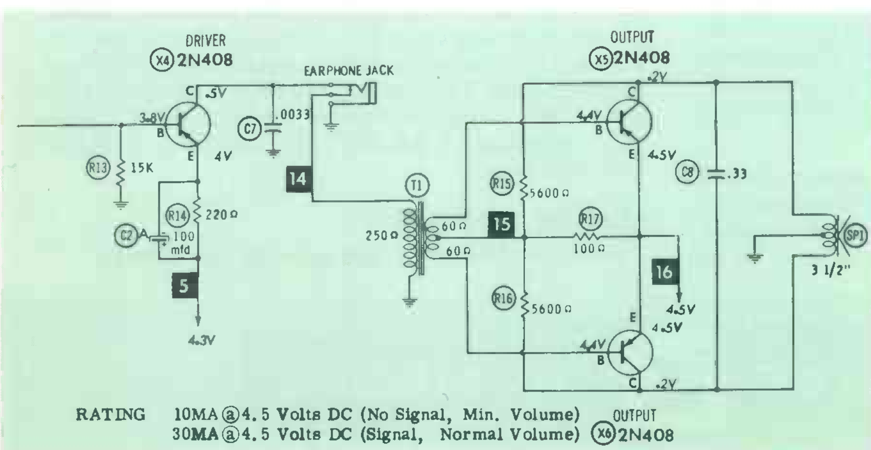


Fig. 1. PNP driver and output stages operating in the common-emitter mode.

Push-Pull Audio Output

Fig. 1 shows a simple push-pull output circuit typical of those used in small pocket radios. Since this is the most common design in use today, we will delve into its operation first. The audio signal voltage, which is fed to the driver from the detector via the volume control, is available at the earphone jack—thus providing a convenient way of checking the input to the push-pull stage. All the transistors are PNP and operated Class A. Notice that all operating voltages for both transistors are obtained from the same 4.5 volt source (Point 16). As you can see, the operating potential for the emitters is the full 4.5 volts. Base-emitter (B-E) bias is developed by the divider networks consisting of R17 in series with R16 or R15 and the voice coil of the speaker. A voltage established by the IR drop across R17 is delivered to the bases via the secondary of the input transformer. The 0.2 volt found on each collector is developed across one-half the total voice-coil resistance.

With the voltages thus established, audio coming from the driver causes the two transistors to conduct in push-pull; that is, X5 conducts on one half-cycle while X6 is cut off, and X6 conducts on the other half-cycle while X5 is cut off. If the conduction of one transistor should change, for any reason, distortion would occur. For example, if R15 should increase in value to, say, 6200 ohms, and the base of X5 rose to 4.45 volts, X5 would conduct less than it should. There would then be short periods of time when both transistors would be in cutoff, instead of one starting conduction exactly when the other one ceased. You can thus see why audio distortion would occur.

To assure equal conduction of both transistors in a push-pull amplifier, it is very important that the bias voltages on each transistor be balanced. The best method of checking the balance is by connecting a VTVM from the base of one transistor to the base of the other and noting any voltage difference. Any reading at all indicates improper circuit operation, which may be caused by several things.

In Fig. 2, notice the internal resistance of the base-emitter junction, represented by a dotted resistor. This and the other internal resistances of the transistor, as well as R1, R2, and R3, will have a direct effect on bias. If the B-E junction, for instance, decreases in resistance, it will have the same effect as if an external bleeder resistor were connected between base and emitter. The voltage on the base will then be brought nearer the emitter voltage. The output current of the transistor will be reduced—or, in severe cases, cut off completely. This condition can best be caught by voltage inspection. If the voltage is okay on the collector of one transistor, but not on its base, suspect the base resistor or the B-E junction.

In Fig. 1, if the base voltage is incorrect on one of the output transistors but not on the other, the trouble could lie in R15 or R16, in the secondary of T1, or in the B-E junction of the affected transistor. If R17 changed value, it is obvious that the base and collector voltages of both X5 and X6 would be affected; but the voltage errors would be in the same proportion on both transistors.

In a push-pull output such as this, a complete loss of audio can be caused by R17 being open, a defective T1, a shorted C8, a bad speaker, or an open in the 4.5 volt line or ground return. Simply having one dead transistor will not cause a *complete* loss of audio—just weak, distorted audio.

Weak audio can also be caused by: Base voltages on the transistors rising; not enough drive voltage coming from T1; R15 or R16 opening; a bad speaker; an intermittent ground-return connection; or a leaky C8. Distortion would result from a bad transistor, speaker, or input transformer, or from changes in value of either R15, R16, or R17. Also, if C8 (which is used to provide a low-impedance path for the higher audio frequencies) develops leakage, it can partially short out the speaker voice coil and cause weak, distorted audio.

Single-Ended Output Stage

Fig. 3 shows another type of transistorized audio-output stage used in small pocket radios. Troubles that develop in this particular circuit are due primarily to either leaky coupling capacitors or the mechanical contacts of the earphone jack becoming dirty.

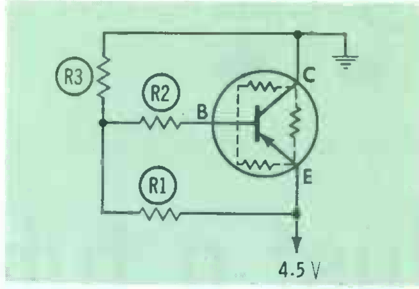


Fig. 2. Since a transistor is solid-state, it has resistance between electrodes.

In this single-ended stage, the base of the transistor is made 0.1 volt less negative than the emitter, thus establishing Class A bias for the circuit. If the base-emitter bias should increase for any reason, the stage would then operate as a Class AB or B amplifier; the output would still have adequate volume, but part of the audio waveform would be clipped, and severe distortion would occur. Therefore, bias voltage must be measured closely with a VTVM to discover the cause of distorted audio. Always check from electrode to electrode, as this is more accurate than using a ground reference. In Fig. 3, since both transistors are NPN, you would connect the negative lead of the meter to the emitter and the positive lead to the base.

On X4, the bias is developed as a result of electron flow from *CircuiTrace* Point 3, through the low-resistance, base-emitter junction of X4, and through R12 and R13. If R12 should change in value, both base and collector voltages could be upset. Should R13 change value, however, the collector voltage will be upset more than will the base voltage. In either case, if trouble is suspected, check voltages from the emitter to base. Further checks to determine if the base-collector junction is properly biased can be made by measuring the IR drop across R12.

• *Please turn to page 62*

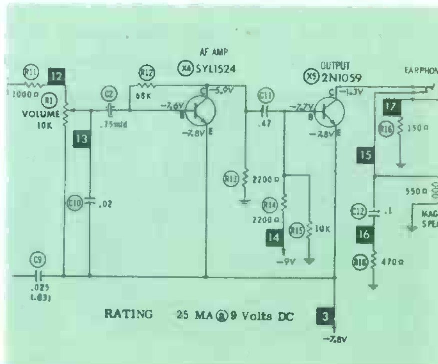
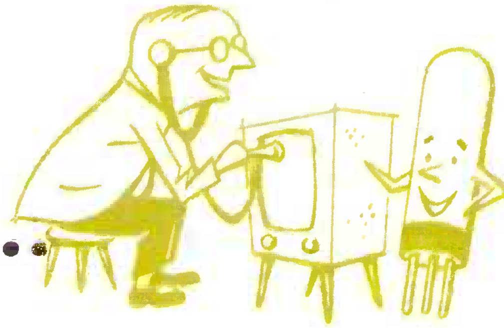


Fig. 3. This type of single-ended NPN driver and output circuit is widely used.

Shop Talk by Allan F. Kinckiner

Just a tube... after all



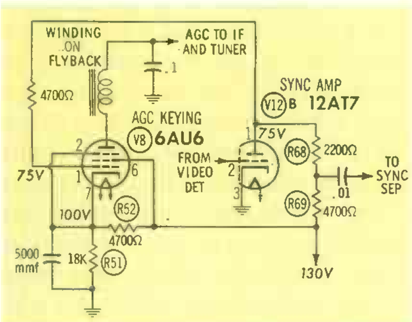


Fig. 1. Input to AGC tube in Westinghouse V-2313 is from a sync amplifier.

Nothing vexes a busy serviceman more than to bring a set into the shop for servicing, only to discover that its faults could have been corrected by replacing a tube in the customer's home. Many instances of this sort are, however, unavoidable—mainly because of unsuspected interactions between circuits.

Stacked B+ supply circuits are a prime origin of such problems. For instance, a positive voltage developed at the cathode of the audio amplifier is used in some receivers to supply screen voltage to the horizontal output amplifier; in this case, a weak audio amplifier will result in a low screen voltage on the horizontal tube, causing a narrow raster, low brightness, or blooming. There is an additional aspect to stacked B+ problems: In some designs, the audio amplifier is direct-coupled to the first audio stage, and a faulty tube in this first stage will cause the output stage to operate abnormally—thus affecting all stages involved in the stacked B+ system.

Stacked (cascaded) IF stages are similarly capable of creating odd conditions. If, for example, only one tube in a cascaded pair is replaced, the receiver may present what appears to be AGC trouble. In such receivers, it is almost mandatory to replace both tubes in cascaded IF stages if one needs replacing.

Unsuspected interaction is also common in receivers suffering from sync faults. Noise-pulse cancelling stages have considerable effect on the sync signal fed to the horizontal and vertical oscillators, and defective noise-canceller tubes can lead to strange intermittent rolling or erratic horizontal sync troubles (such as twisting or partial tearout).

The greatest source of hidden interaction is a keyed AGC circuit. This stage should never be considered by itself as a one-tube circuit, because the preceding tube that directly affects conduction of the keyed stage is just as important as the AGC tube. In sets using the conventional setup wherein the controlling tube is the video amplifier, the interaction is readily recognized; however, many models use some other tube for this function. Other purposes of the tube determine the name of the stage, and its job of controlling the keyed AGC is easily overlooked. In several Sylvania

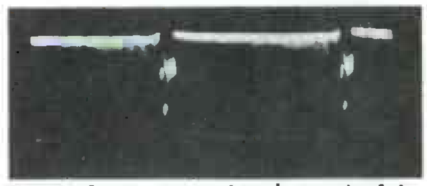


Fig. 2. Sync output signal was in fairly good shape, but showed some video.

models, for example, one triode stage—listed as the first sound IF and first sync amplifier—also controls conduction of the keyed AGC. Strangely, defects in this triode influence AGC action far more than either sound or sync operation. The tubes labelled as first sync stages in certain RCA and Westinghouse chassis are likewise used to control conduction of the keyed AGC stage.

It would be nice (and profitable) if the serviceman could be aware of all the possible interactions between stages in all receivers. But a serviceman who works on all makes and vintages of TV sets cannot possibly be aware of all interacting conditions; thus, a certain number of receivers will be shop-borne when only a tube is at fault. There is, at least, something good to be said for servicing these sets in the shop: With bench test equipment, particularly the scope, it is possible to make tests that assure the serviceman he has restored the receiver to first-class condition.

Bad Sync Stage—Weak Pix

One of our customers who oper-

(A) Video 50V p-p (B) Video 75V p-p (C) Video 100V p-p

Fig. 3. Visual effect on picture contrast as video signal amplitude varies.

ates his TV in a brightly lighted room complained of a weak picture on his Westinghouse Chassis V-2313. Our home-call serviceman replaced every tube in the picture-signal circuits, from the RF to the video amplifier, as well as a new 6AU6 in the keyed AGC circuit. Since tube replacement did not improve the picture one iota, the customer consented to having the set taken in for shop servicing.

The maximum amplitude of the video signal fed to the picture tube was only 50 volts, or about one half the output that three IF stages and a 12BY7 are normally capable of developing. My suspicions of trouble in the video amplifier were quickly overruled when I scoped less than two volts at the grid of the 12BY7—again only about half of normal. This last check tentatively pointed to trouble in the tuner or IF stages.

On one typical channel, I found an AGC bias of −7 volts being applied to the IF tubes—much more than usual for the existing signal conditions. This overabundance of AGC voltage led to checking the AGC circuit, a portion of which is presented in Fig. 1.

Cathode and bleeder resistors R51 and R52 were checked first, because I had previously seen cases in which the values of these resistors had changed considerably. In this particular set, these resistors were found to be normal, as was the keying pulse scoped at the plate of the tube.

Attention was next focused on the most critical voltage in any keyed AGC circuit—the difference voltage between grid and cathode. The smaller this bias voltage, the harder the AGC tube will conduct, and the more output will be developed. I actually did find less than normal bias, and in searching for the cause, I noted that the grid voltage of

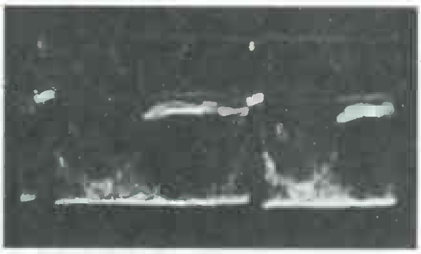


Fig. 5. White compression showed up plainly in waveform of video signal.

AGC tube V8 depended on the plate voltage of sync amplifier tube V12B. Both of these voltages were too high; this indicated less than normal voltage drop across plate resistors R68 and R69, and pointed to insufficient plate current in V12B. When this tube was replaced, the AGC settled down to normal, and the contrast level became high enough to satisfy the customer.

One puzzling aspect of the case was the fact that sync was unaffected by the weak V12B. When I returned the old tube to the set and checked the final sync signal, it scoped as shown in Fig. 2.

The effects of video signal amplitude on picture contrast in this set are shown in Fig. 3. Pattern A, the result of applying a 50 volt signal to the CRT, is pretty good, but it does appear rather "thin"—especially in the vertical wedges. Fig. 3B, obtained with a signal of 75 volts, shows an obvious improvement over 3A. Increasing the signal to 100 volts gives slightly too much contrast, as evidenced by the blocked-up small lettering. In the receiver from which these pictures were obtained, a video signal amplitude of 85 volts was just about right for most programs at the desired level of brightness.

White Compression

The owner of an older RCA set (a KCS78) was sure that his picture tube was at fault when the pictures showed flat, dull highlights, with a chalky white appearance in the brightest areas. The set had some other minor defects, like a noisy tuner, and the serviceman's past experience caused him to suspect an open plate resistor in the video amplifier as the reason for the picture trouble. (In many instances, this flat seven-watter has been responsible for similar complaints.) Therefore, the set was brought in for shop servicing.

I've tried to show the chalky-white condition in Fig. 4, although the camera makes the picture look better than it really was. Facial shadows that can be seen in the photo were virtually invisible on the picture tube. When I checked the suspected resistor, I was disappointed to find it a perfect 6750 ohms. I scoped the video output signal and saw the trace in Fig. 5, with its definite indications of white compression. Replacing the 6CL6 video amplifier tube removed the compression, and the pictures regained a full range of gray tones. The improvement was especially noticeable in people's faces, as in Fig. 6; note the more natural-looking highlights and shadows.

Video Amplifier Instigates Bad Sync

A Silvertone Model 528.50240 portable was brought in with the complaint that the picture would intermittently flip vertically, and the raster would sometimes break into jagged white lines. Both these complaints showed up after I ran the set for about ten minutes. The white-line symptom (Fig. 7) proved to be horizontal squegging; although this condition is common in *Synchroguide* horizontal oscillators, the pattern in this case was different from any other case of squegging I had ever seen. In the first place, squegging is not usually an intermit-

•*Please turn to page 60*

Fig. 4. Compressed video signal peaks gave white areas "chalky" texture.

Fig. 6. Faces looked more natural when the video compression was eliminated.

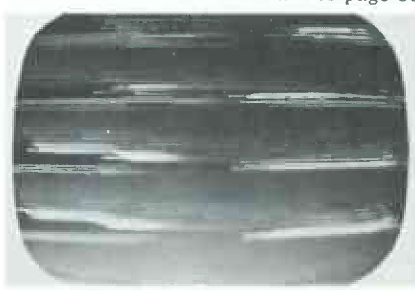


Fig. 7. Unusual form of horizontal squegging due to odd tube defects.

Servicing Industrial Electronics
by
Leo G. Sands

TROUBLESHOOTING in a small plant

Small manufacturing plants are among the major users of industrial electronic equipment. While their systems may not be nearly so complex as those used in large plants, it is in the small plant that the economic value of electronic equipment becomes quickly evident. Here, too, is a likely prospect for the service shop seeking industrial business, since the maintenance force is seldom qualified to service electronic equipment.

To Name A Few

Your local bottling works may have an electronic inspection machine that detects foreign particles in bottled liquids. A cosmetics or chemical plant might have an automatic batch-control system which feeds just the right amounts of chemicals into mixing machines, as directed by a punched card or taped program.

Magnetic tape machines control conveyor belts in warehouses and manufacturing plants. Punched-paper-tape readers feed information into computers, which in turn control machines. Electronic reading machines, known as OCR (optical character recognition) devices, can read numbers or words printed on cards, labels, etc.; the machine deciphers the printed characters and generates electrical signals that can be fed into a computer or used to control a conveyor operation.

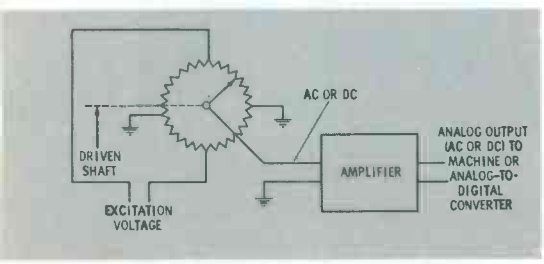


Fig. 1. Shaft-position indicator produces AC or DC analog output signals.

Your local supermarkets may soon use OCR for checking purchases automatically. Packaged foods are labeled with geometric symbols. As each package is moved past a light beam, each symbol is read and translated into signals that actuate an illuminated display, which shows the price. The information is stored, and the total bill is computed and presented.

Particle accelerators are used in wire plants and others that employ plastics and similar materials. In one small wire plant, an insulated wire is fed from a reel through a linear accelerator which irradiates the insulating material and transforms it chemically into a material that can withstand temperatures much higher than before. Food, also, may be processed this way in meat-packing plants, to make refrigeration unnecessary.

Ultrasonic cleaning systems have many uses: To clean components and assemblies, degrease bearings and gears while making repairs, or remove soldering flux from printed circuit boards after dip soldering. Liquid level is often measured and controlled by ultrasonic devices, particularly when the liquids are dangerous to handle.

Closed-circuit television is probably the leading type of industrial electronic equipment used in small plants; CCTV makes it possible to monitor operations where it is unsafe or uneconomic to send a man. Remote radio control systems are now being used to control overhead cranes from the plant floor, right at the scene of the action. In one factory, a bulldozer is controlled by radio as it pushes dangerous materials.

Taking the Plunge

While there are countless types of simple as well as exotic industrial control systems, they are all composed basically of simple subassemblies. Troubleshooting is simple, provided you are fully informed on system operation. This information should be contained in the instruction book which is normally supplied to the customer with the system.

The plant maintenance superintendent is usually the man to see. If his staff is unqualified to maintain the electronic devices under his charge, he is almost always empowered to get the work done outside. And he is generally the custodian of all instruction and main-

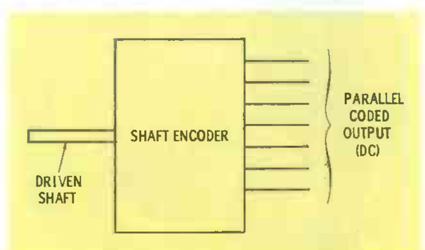


Fig. 2. Encoder unit develops digital information without analog converter.

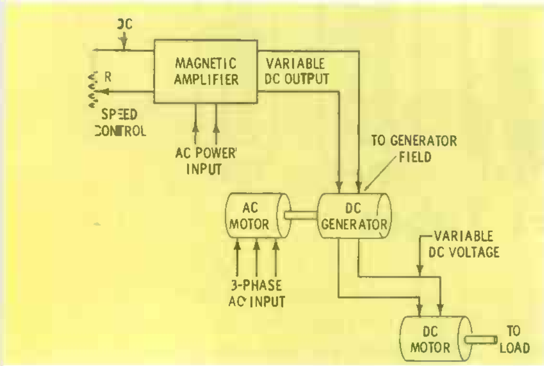


Fig. 3. An open-loop control system.

tenance manuals that are furnished with equipment when it is installed.

Having secured the order to take care of service needs of a small plant, you'll find the equipment a little bit different from television sets. But don't let that scare you; electronics is electronics. Let's go over the fundamentals of industrial gear, however, and make sure you understand the basic concepts.

Control Systems

In a control system, there is an input signal and an output signal, or perhaps more than one of each. The input signal may take the form of DC or AC, a pulse, or an open or closed switch. In the latter two instances, the opening or closing of a pair of contacts causes voltage, current, or phase to change within the control amplifier.

The actuating force may be easy to measure; on the other hand, field measurement may be impractical. The output signal is generally much larger than — and often different from — the input signal; it may be DC or AC, a pulse, or a coded combination of pulses.

Input Sources

The input signal may be derived from a switch, relay contacts, a potentiometer, or any of several types of transducers — such as a strain gauge. A potentiometer is shown as controlling the input in Fig. 1. In this case, the potentiometer is coupled to a rotating shaft. The input signal is determined by the position of the shaft, and may be used directly in an analog control system. Or, the analog input signal may be amplified and converted into a binary signal by an electronic analog-to-digital converter.

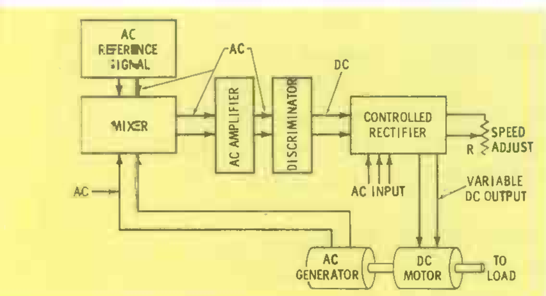


Fig. 4. A closed-loop control system.

Digital shaft encoders, such as shown in Fig. 2, are widely used to obtain a coded digital signal directly from the position of a shaft. The driving shaft may be part of a weighing scale or some other type of meter. A signal will appear only at certain of the output leads, depending upon contact closures within the instrument at various shaft positions.

Open-Loop System

In an open-loop system there is no feedback. The motor-speed system shown in Fig. 3 employs a magnetic amplifier to control the field voltage of a DC generator that is driven at constant speed by an AC motor. The DC motor which drives the load runs at a speed determined by the output voltage from the DC generator.

The input signal is a small variable DC voltage whose level is determined by adjustment of rheostat R. To troubleshoot this system, you'd measure the DC voltage applied to the DC motor (generator output signal), the DC output and AC input of the magnetic amplifier, and the small DC voltage across R. If varying R does not cause the amplifier's DC output to vary, either R or the magnetic amplifier is defective. You might even have to check the speed of the AC motor with a tachometer.

Closed-Loop System

In an open-loop system, the output signal is affected only by the input signal. But, in the closed-loop system shown in Fig. 4, a change in output voltage causes a corresponding change in input voltage. Here, the DC motor is powered by a variable-output rectifier, and drives both the load and a feedback generator.

When the motor drives the AC generator at the speed which makes the output frequency equal to that of the reference signal at the mixer, the discriminator output (DC) is zero — or the required reference

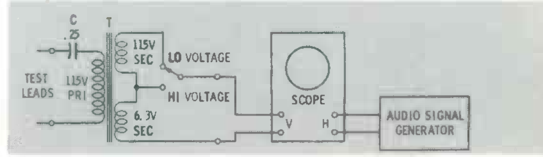


Fig. 5. This hookup results in a Lissajous figure for comparing frequencies.

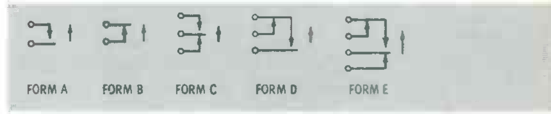


Fig. 6. Most common relay grouping.

level. If the motor speeds up or slows down, the generator frequency rises and the discriminator voltage affects the rectifier to return the motor speed to the desired rpm. The speed may be set manually by adjustment of R, which determines the DC reference level for the controlled rectifier.

Troubleshooting here is a matter of isolation. Check the DC output voltage and the level and frequency of both AC input voltages. A scope can be used for the latter purpose by employing an ordinary power transformer to isolate the scope's unbalanced input (one side grounded) from the balanced lines —as shown in Fig. 5. The switch arrangement makes it possible to reduce the signal voltage for convenient measurement on the scope. A comparison signal can be obtained from an accurate audio generator.

Relay Circuits

Relays are still the most popular type of electronically controlled switch, since their contacts can be isolated from the control circuit. You should be familiar with the basic contact assemblies shown in Fig. 6.

Control Components

Temperature-, light-, and time-controlled circuits are often packaged as complete subassemblies of a control system. A typical example is given in Fig. 7. The light-sensitive resistor (or photocell) or other transducer produces a small input

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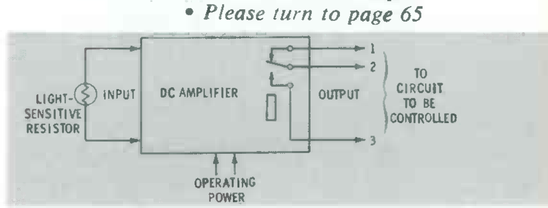
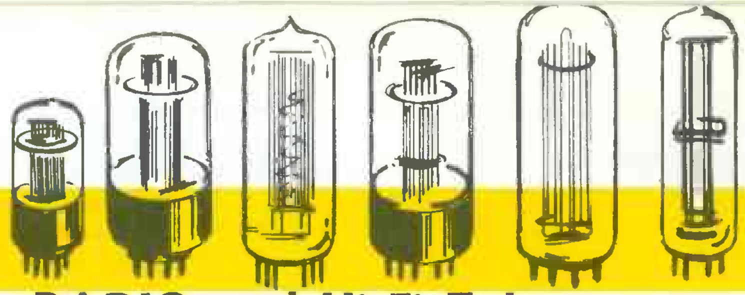


Fig. 7. Simple modular control circuit.

STOCK GUIDE for RADIO and Hi-Fi Tubes



The basic tube-stock requirements for home radio, phono, and tape-recorder servicing are much more modest than for TV, since the circuits are generally simpler and more standardized. In fact, the 30 types listed in the adjoining column will handle the great bulk of your replacement needs—now and for a long time to come. But the last five years have brought some important developments in the radio and hi-fi field that may require you to expand your tube inventory in the future.

Most of the demand for new tube types is due to the boom in FM radio. A product that was almost nonexistent during the middle 1950's is now being produced in quantity by nearly all radio and hi-fi manufacturers—with stereo multiplex circuits available in receivers at all price levels. Efforts to increase the operating efficiency of low-priced phono amplifiers and AM radios have also contributed to the list of new tube types on the market.

It's still too early to predict which of these new tubes will become the most popular, since some of them have been used in only a few of the latest-model sets. But keep an eye on the new types among those listed in the chart at the bottom of this page; they've appeared in enough different models to be worth keeping in stock, if you do a considerable volume of radio and audio servicing.

This chart also includes some older types, like the 6BJ6, that will be needed from time to time—although their applications are too specialized to rate a listing in the "top 30."

The last 12 tubes in the second chart are seldom used in American equipment, but are commonly found in AM-FM radios imported from Europe. An American substitute type is listed where possible; in many cases, exact replacements are widely available in this country, marked with either the European type number or the American-style number as an alternate.

Some tubes of European origin have become "naturalized citizens"; many of them are manufactured, as well as used, on both sides of the Atlantic. The most important of these types are listed in the charts according to the American type number, but European designations are also given as an aid in identifying the various types.

Several special classes of tubes have been omitted from these listings:

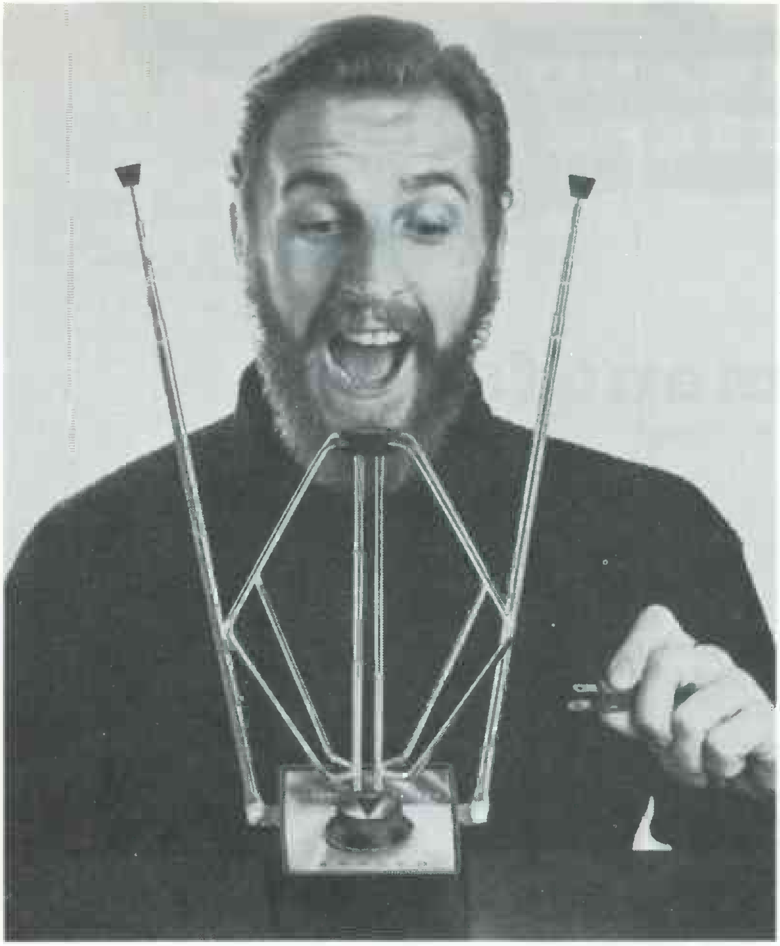
1. Obsolescent radio tubes, used mainly in sets more than 10 years old or in portables.
2. Common TV tubes that are used only occasionally in radio and hi-fi circuits; examples are the 6BN8, 6EW6, and 6EA8.
3. Tubes used exclusively in auto radios.
4. Tuning-eye indicator tubes. ▲

TYPES MOST OFTEN NEEDED

5Y3	rectifier
6AQ5	AF output
6AT6	AM detector-AF amplifier
6AU6	IF-AF amplifier
6AV6	AM detector-AF amplifier
6BA6	RF-IF amplifier
6BE6	AM converter
6BQ5/EL84	AF output
6L6	AF output
6V4/EZ80	rectifier
6V6	AF output
6X4/EZ90	rectifier
12AT6	AM detector-AF amplifier
12AT7/ECC81	AF amplifier
12AU6	IF-AF amplifier
12AU7/ECC82	AF amplifier
12AV6	AM detector-AF amplifier
12AX7/ECC83	AF preamp
12BA6	RF-IF amplifier
12BE6	AM converter
25C5	AF output
25EH5	AF output
25L6	AF output
35C5	AF output
35EH5	AF output
35L6	AF output
35W4	rectifier
50C5	AF output
50EH5	AF output
50L6	AF output

5AR4/GZ34	rectifier
6AB4	FM oscillator
6AQ8/ECC85	FM RF amplifier and converter
6BJ6	FM RF or IF amplifier
6BL8/ECF80	misc. multiplex
6BM8/ECL82	audio amplifier and output
6C9	FM RF amplifier and converter
6CA4/EZ81	rectifier
6EU7	AF preamp
6EZ8	FM mixer and oscillator
6GY8	FM mixer and oscillator
6JK8	FM RF amplifier and converter
12AL5	FM detector
12AQ5	AF output
12DT8	FM RF amplifier and converter
12EQ7	AM IF and detector
14GT8	FM detector and AF amplifier
17C9	FM RF amplifier and converter
17EW8/HCC85	FM RF amplifier and converter
18FW6	AM IF amplifier
18FX6	AM converter
18FY6	AM detector and AF amplifier
19T8	FM detector and AF amplifier
32ET5	AF output
34GD5	AF output
36AM3	rectifier
50DC4	rectifier
60FX5	AF output
7025	AF preamp
7189A	AF output
7199	AF amplifier
7247	AF amplifier
7355	AF output
7408	AF output
7591	AF output
7695	AF output
EAA91	replace with 6AL5
EABC80/6AK8	AM-FM detector, AF amplifier
EBF89/6DC8	AM-FM IF, AM detector
EC92	replace with 6AB4
ECH81/6AJ8	AM converter, FM IF
ECL86/6GW8	AF amplifier and output
EF85/6BY7	IF amplifier
EF86/6267	AF preamp
EF89/6DA6	IF amplifier
EF94	replace with 6AU6
EL90	replace with 6AQ5
EL95/6DL5	AF output

LOOK! ALL PROFIT AND NO WORK!



Transistor-Powered Apollo, model 3721

Transistor-Powered FM/Stereo, model 3731

A new TV indoor antenna guaranteed to work up to 45 miles clear out!

Bet you thought the "15-to-60 mile" reception area was the private preserve of outdoor antennas only; that nobody, but nobody, had yet conceived an indoor antenna powerful enough to break the suburban picture-and-sound barrier!

Well, Channel Master has! And it creates a brand-new market. We've combined the world's most advanced indoor TV antenna and a super-effective built-in hidden amplifier. Result? The Apollo!—a transistor-powered indoor antenna that, for sheer TV pull-in power, surpasses every other indoor antenna ever created. What other indoor antenna guarantees to bring in a picture clear, sharp, and ghost-free—from 15 to 50 miles out.

And talk about adaptability: the Apollo's "Miraclick" Switch gives the viewer exactly the right amount of power his area requires. The "Miraclick" electronically adjusts the antenna to weak or strong signal areas. And a built-in FM Trap cuts out FM overloading in strong signal areas. **Fair-traded at $29.95.**

A new FM/stereo indoor antenna guaranteed to work up to 60 miles clear out!

Channel Master's transistor-powered FM/Stereo indoor antenna alone does for FM what the Apollo does for TV. Works from 15 to 60 miles out. (And offsets signal loss inherent in the multiplex circuit). **Fair-traded at $19.95.**

You're in a new business! Both these powerhouse antennas are smart, modern showpieces. Eye-catchingly packaged for easy selling, too. Together, they push the indoor antenna market back to a brand-new frontier. Even if you don't know the first thing about antennas (of any kind)—and have never before cared to become involved with them—the high sales possibilities of these two should be enough to change your mind.

Think of it! All profit (very high) and no work (no rooftop installation). You're really in business! Matter of fact, it's no trade secret that each antenna in Channel Master's complete indoor antenna line is the best in its category at its price.

Call your Channel Master distributor for full details on our indoor antenna **free premium** promotion!

Also available! Top quality non-amplified indoor antennas.

Model 3720. Model 3730. Model 3900, Model 3901. Model 3718.

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ELLENVILLE, N.Y.

Circle 13 on literature card

two way talk

MULTIBAND RECEIVERS

with alignment faults

by Patrick M. Craney

The cause of poor sensitivity or station crowding in a multiband communications receiver is often nothing more than a misaligned RF or IF stage. True, there sometimes are actual component faults—such as a bad IF tube or transformer—to account for such reception problems. But more likely than not, the frequency-selective RF and IF circuits just need peaking—to *compensate* for changes in tubes and other components. Over a period of time, the effects of heat, humidity, and age can cause coils, resistors, and capacitors to change value slightly. And then, there is another common possibility—inexperienced fingers fooling with alignment that is better left to the technician.

Alignment Troubles

Some customer complaints stemming from poor alignment are: failure to receive a particular station that previously came in loud and clear; poor volume (which can be caused by weak RF or IF stages, as well as audio faults); squeals and howls in the set.

Tracking

A lesser-heard complaint is that stations at one end of the dial are weak and off the normal dial reading, while those at the other end of the dial are normal. This is called "tracking error," and is commonly caused by the RF and oscillator frequencies not staying "in step" with each other as they are tuned across the band. For example, if the receiver IF is 455 kc, the oscillator must always operate precisely 455 kc above or below the frequency selected by the RF section of the tuning capacitor. If, however, the oscillator frequency is incorrect in some portion of the band, some stations will come in at points on the dial slightly removed from the correct settings; furthermore, this inaccuracy will mistune the RF section and cause the signal to be weak.

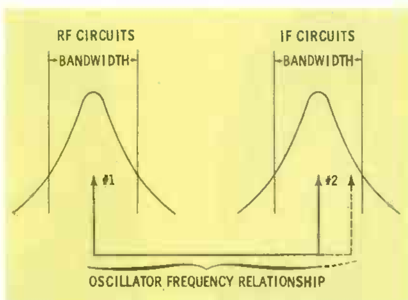

Fig. 1. Tracking is accurate only when oscillator-RF relationship is constant.

Fig. 1 shows a simple diagram of the RF and IF response curves in the gang-tuned front end of a receiver. The arrows point to the center of these curves, denoting maximum amplitude or gain in both circuits. The line joining the two arrows represents the frequency difference between the RF and oscillator circuits. So long as the length of this line remains constant, the IF arrow will always fall in the center (maximum amplitude) of the IF response curve. This condition will be met if the RF and oscillator tuning are tracking properly. But if the oscillator — for any reason — doesn't "keep step," a different IF frequency will be developed. The dotted arrow symbolizes the result: IF operation far from peak efficiency, and thus a weakening of reception in that portion of the radio dial.

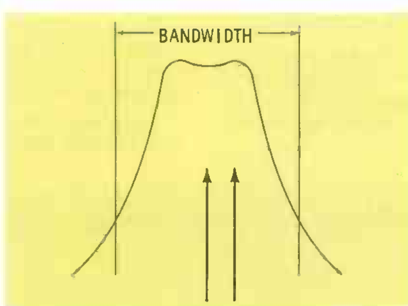

Fig. 2. Misalignment will widen bandwidth and ruin receiver selectivity.

Selectivity

Still another complaint is that of not being able to select weak stations without adjacent-channel interference (from stations on nearby frequencies). This is generally caused by improperly tuned IF circuits. If all the IF coils aren't peaked sharply, the excessive bandwidth will permit other signals to pass through to the detector unattenuated. Of course, these signals will reach the listener and be very annoying. The very broad IF response curve in Fig. 2 is characteristic of sets that have poor selectivity.

Causes and Cures

Not long ago, a shortwave receiver was brought to me for a not-uncommon compaint—it was very insensitive on the 40 meter band, but okay on all others. Since it was a four-band receiver, I realized that any trouble common to all bands could be ruled out. Therefore, only those circuits dealing strictly with the defective Band A could be at fault—which pinned the trouble to somewhere within the RF or oscillator sections.

A functional schematic of those

On target? Sure! But more than that—

This rotator alone has the power to turn the heaviest antenna array easily ... and the ruggedness to keep it "on course" in foulest weather.

Most any good rotator can hit the target in fair weather!

(Channel Master Tenn-A-Liner Rotators offer a degree of pinpoint accuracy pretty close to perfect).

But in installing a rotator, ask yourself this: How will it do in foul weather? Stand up -- or act up? Will it turn a heavy antenna load without trouble? And keep the antenna on the beam?

THE FACTS are as follows: Channel Master rotators (manual or automatic) have the greatest turning power of any TV-FM rotator in existence. Thanks to their built-in, friction-free, ball thrust bearing (nobody else has it), these rotators alone have the power to easily turn the heaviest fringe-area antennas. They've proved they can even "crack through" an ice-loaded antenna installation weighing over 329 pounds. Also, because higher voltage is delivered to the motor, you can use longer leads. And still maintain peak torque.

CHANNEL MASTER rotators, furthermore, are made to operate under a 70 mile gale wind. And to back up all this rugged, foolproof performance, only Channel Master Tenn-A-Liner Rotators give your customers a 90 day "Instant Replacement" Warranty. (After 90 days, parts or the complete unit can be replaced at extremely low pro-rated prices).

Priced to let you meet competition head-on, too. And to give you top profit as well. Do yourself, and your customers, a good turn. Install Channel Master Rotators next time.

CHANNEL MASTER Rotators

"More accurate by design ... more distinctive in design"

COMPASS TENN-A-LINER (Model 9520). Non-automatic. Fingertip control. Accurate repeatability. Continuous instant direction indication. Pushbutton Switch ends reception interference caused by wind vibration.

AUTOMATIC TENN-A-LINER (Model 9524). Most accurate in the world. Aims antenna within one degree of precise transmitter location. Increments are not limited to 10 to 15 degree segments.

NEW! GEMINI (Model 9527). World's first all-in-one Automatic Rotator with built-in amplifier. Combines Tenn-A-Liner with famous Telstar transistorized booster-coupler. Fast, profitable, 2-in-1 installation. Only 1 unit on mast -- 1 housing on set -- 1 transmission line. Built-in "FM Trap".

ROTATOR ALIGNMENT BEARING (Model 9523). Provides added rough-weather protection by stabilizing antenna on giant fringe-area antenna arrays.

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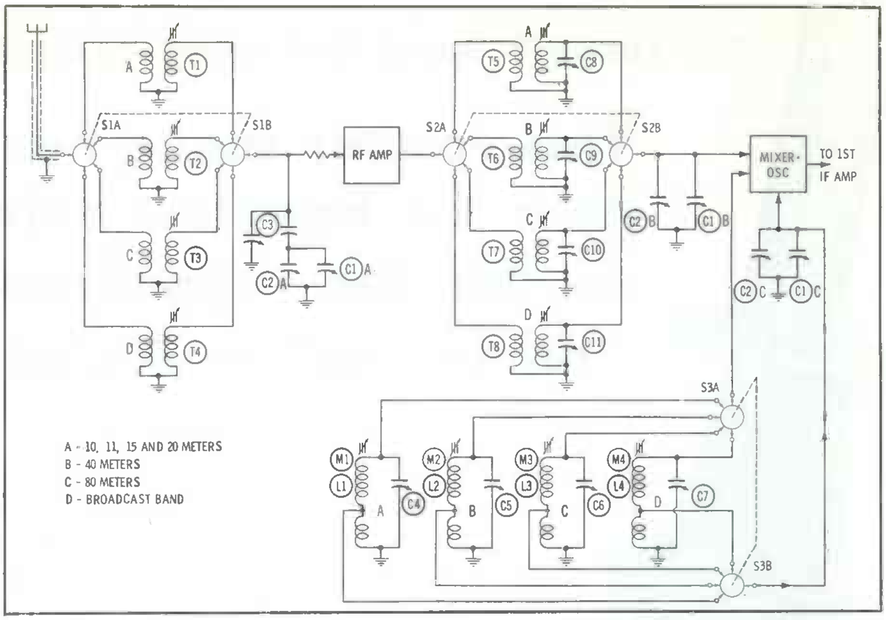


Fig. 3. Alignment points in typical four-band RF, and oscillator circuits.

sections of the set is shown in Fig. 3. Since T2 and T6 were logical culprits, I injected a signal into the set and adjusted T6. Although I obtained a peak on the S-meter by adjusting T6, the reading didn't increase much. So, apparently this wasn't the trouble. When I adjusted T2 just a hair, the S-meter reading rose sharply. Turning the slug for an exact peak increased the reading by a good 40%. This improved the reception of the 40 meter signals considerably. Thus, in less time than it takes to tell it, the immediate problem was "cured."

Although this "quick" method of alignment is fine for troubleshooting, it's not accurate enough for final peaking of the set's performance. By adjusting any one tuned circuit, you can throw overall tracking off somewhat. Therefore, I knew an overall alignment was in order to ensure a thorough job. Not only had the tracking been thrown slightly off by adjusting the 40-meter circuits, but a sensitivity test indicated the set probably hadn't been aligned for some time; all bands needed attention badly.

IF Alignment Procedures

Alignment of communications receivers can be divided into three steps: IF, oscillator, and RF-mixer alignment. The necessity for aligning the IF coils *first* stems from the fact that they determine to a great extent the overall sensitivity and selectivity of the receiver. Even though normal procedure calls merely for "peaking" the IF transformers, they have the highest Q (are most efficient) at only one frequency. Therefore, they must be tuned to their *exact* design frequency. If not, they will not have maximum response to the signal coming from the mixer.

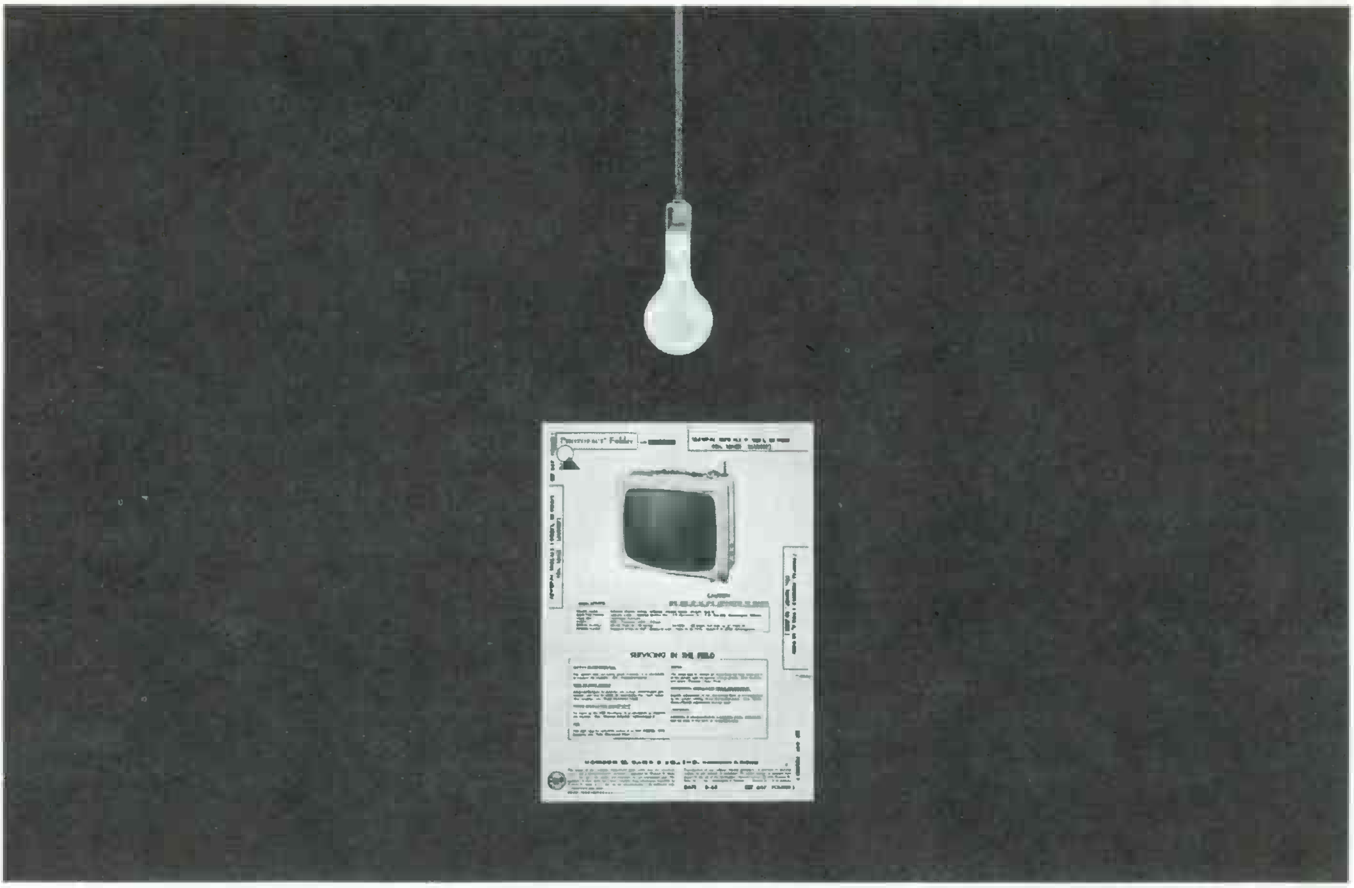
Preliminaries

For alignment, you'll need a signal generator of dependable accuracy, and a VTVM or VOM set to read AC volts across the speaker voice-coil leads. The IF signal can be injected via a .01 mfd capacitor. After a few minutes of warmup time, set the meter to its lowest voltage range, and the generator to the exact IF. Adjust the modulated generator output to achieve a reading on the meter. Do not increase the generator output much beyond this point, as it will tend to overload the receiver and make the adjustments less sensitive. It is also best to keep the meter indication on the lower third of the scale.

The RF and audio controls should be left at maximum, so sufficient audio voltage will reach the meter. If either control is intermittent or bad, it should be replaced before proceeding with alignment.

The IF Coils

Start IF alignment by quickly adjusting all the coil slugs or trimmers (Fig. 4) for peak readings on the meter. If the meter reading increases considerably, decrease the signal fed to the mixer, so the meter



"...like switching on the light in a pitch-dark room..."

Come to think of it, this is a pretty good way to describe PHOTOFACT. *We* didn't dream it up—it's part of a letter that came to us (unsolicited) from a PHOTOFACT user, a letter that goes like this:

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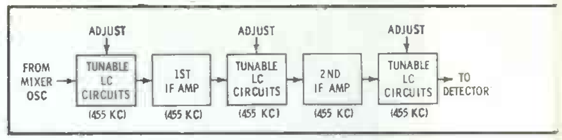


Fig. 4. Two IF tubes mean three adjustment points; three would indicate four.

will once again read in the lower third of its scale. Then, starting with the last IF and working backward to the mixer output, go back over the adjustments and carefully touch up each in turn for a precise peak. Run through them a third time, if necessary, to insure absolute maximum peaks; this time recheck the generator frequency to be sure it is correct.

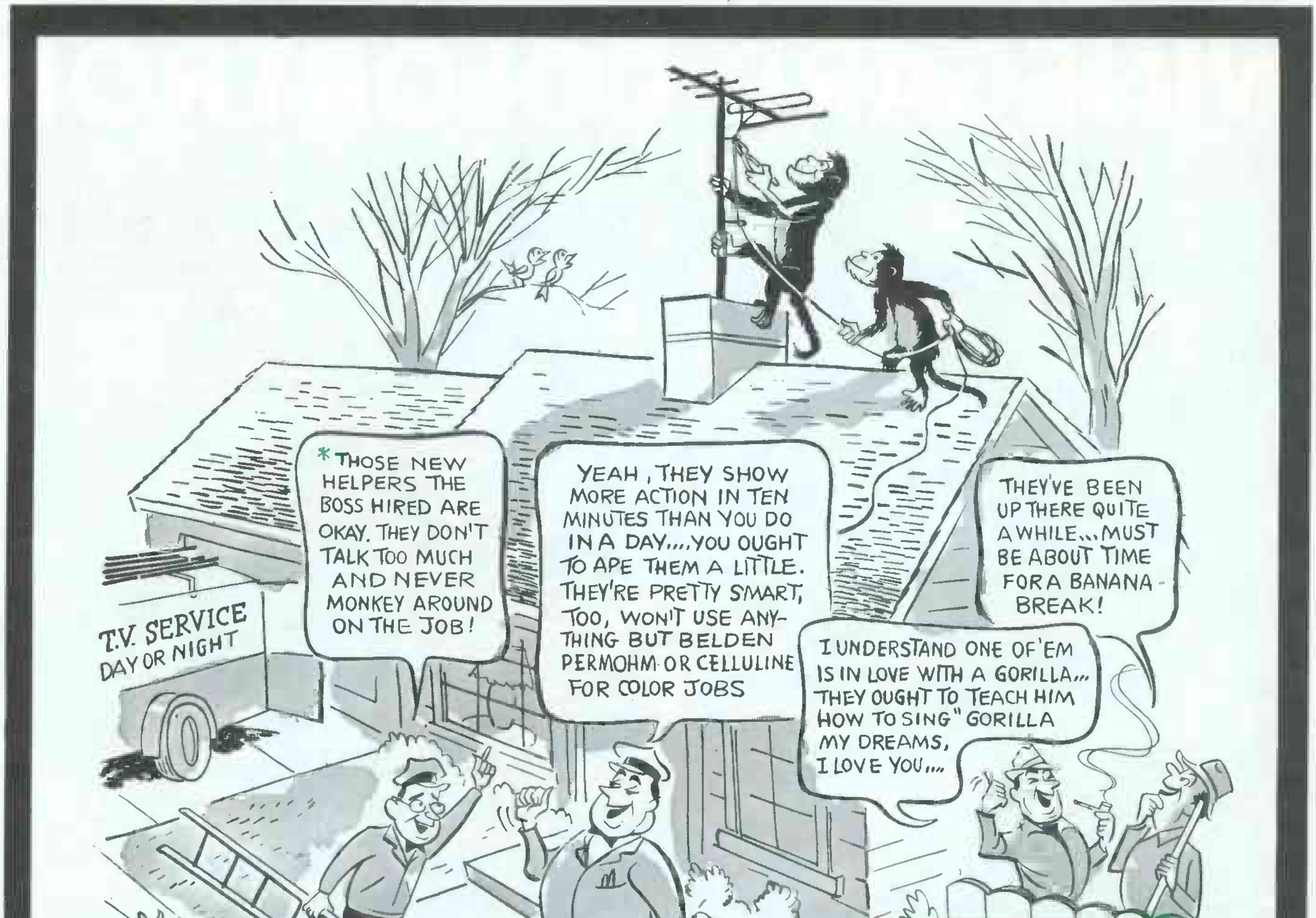
BFO Adjustment

Once the IF stages are peaked, you can use the same signal and input point to check the beat-frequency oscillator (BFO or CWO). Turn off the generator modulation and switch the receiver to generate the BFO signal. Adjust the pitch to midrange; then set the BFO adjustment (usually a slug-tuned inductance or a small tunable capacitor) to achieve a null (zero beat) in the speaker. This null should occur at approximately midposition of the pitch control, so a high-pitched whistle can be obtained at either end. The frequency of the generator must be critically set to the exact IF frequency for this adjustment—a ½ kc error can prevent the BFO circuit from operating properly.

If the coil or capacitor adjustment has a locking device to insure stability of the setting, carefully loosen the lock before making the adjustment. This lock, if used, is usually a collar—with a set screw—that tightens against the chassis. When done, be sure that tightening the lock hasn't altered the BFO adjustment.

Oscillator Alignment

Having successfully completed the IF and BFO alignment, disconnect the generator from the input of the first mixer, remove the capacitor, switch the modulation back on, and connect the generator output to the set's antenna terminals. If necessary, use a resistive pad to match the generator output impedance to the input impedance of the receiver. Keep the RF and AF gain controls at maximum, and turn off



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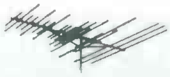

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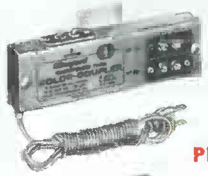

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the BFO. Set the station selector to the high-frequency end of the dial and the bandswitch to the highest-frequency band. If a bandspread dial is used, set the dial at zero or "set."

Finding the Signal

For an example, we'll consider a set like that diagrammed in Fig. 3. The highest frequency it will receive is 34 mc, on band A. Tune both the station selector and generator exactly to this frequency and adjust the modulated generator output to maximum. If the radio isn't picking up the generator signal, rock the dial setting to either side to find the signal. Make sure the output meter is switched to a higher scale to avoid pegging the needle. Once you've "found" the test signal, and obtained a meter indication, note in which direction the dial had to be turned — up-frequency or down. Then return the dial setting to exactly 34 mc. Now adjust the appropriate oscillator trimmer (C4 in Fig. 3) to bring in the 34 mc signal at the correct dial setting. If you had to move the dial "up-frequency" to find the signal originally, you'll have to adjust C4 counterclockwise to find it again. This is true of most sets although a few will be the opposite, depending on whether the oscillator operates above or below the RF signal. If you're in doubt, find the signal again by rocking the receiver dial; then move it slightly toward the correct 34 mc setting, but not far enough to lose the signal completely. Note which way you turn C4 to peak it again.

RF and Mixer

When you finally get a peak meter reading at the correct dial setting, do as before: reduce the generator output to keep the meter reading low. Then adjust RF and mixer capacitors C8 and C3 for a maximum meter reading. If necessary, align first one and then the other, moving back and forth a couple of times to obtain a precise peak.

Tracking

When the 34 mc signal comes in exactly at the 34 mc dial setting, and C8 and C3 are peaked, set the receiver dial to the lower end of Band A—say, 12 mc. Adjust the generator output to maximum and the meter to a higher range setting. Once again, adjust the oscillator to bring the signal in at the exact dial setting, *except* this time, adjust L1; do not touch C4. Once the 12 mc signal can be received at its correct dial point, reduce the generator output and meter range, and adjust T1 and T5 for a maximum meter indication.

Then, go back and repeat the high-end alignment. Afterward, go once again through the low-end alignment. You may have to repeat the oscillator adjustments several times. Always adjust the *trimmer* at the high end, and the *coil slug* at the low end of the band. This will insure a minimum of tracking error over the entire bands.

Other Bands

With Band A aligned properly, proceed with the same steps for other bands of the receiver. Following the same general procedures with Band B, adjust C5 to place the signal at the correct dial setting, and adjust C9 and C3 for a maximum meter indication. Then tune in a low-end signal and set the Band B coil slugs—L2, T2, and T6.

You may wonder why the high band was aligned before the lower

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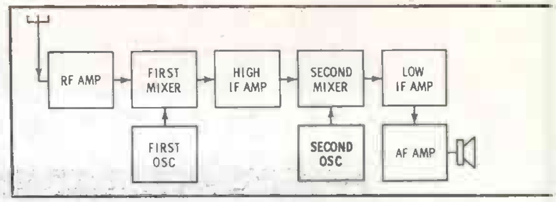


Fig. 5. Dual-conversion receiver is often called a double-superheterodyne.

ones. In some receivers, high-band adjustments affect the alignment of other bands. Thus, starting "at the top" is an excellent habit to form, although sometimes it won't be necessary to follow that order.

Dual-Conversion Receivers

Although dual-conversion (double-superheterodyne) receivers are less numerous than single-conversion sets, it is well to understand the small difference that exists between them. In a dual-conversion set, the RF and oscillator signals are mixed once to produce an IF; then that IF signal is heterodyned, or mixed, with a second oscillator signal to produce a lower-frequency second IF. This process, illustrated in Fig. 5, provides better selectivity and image-frequency rejection than single conversion.

The dual-conversion set is aligned in much the same manner as the single-conversion receiver. About the only difference lies in the extra frequency needed to align the low-frequency IF.

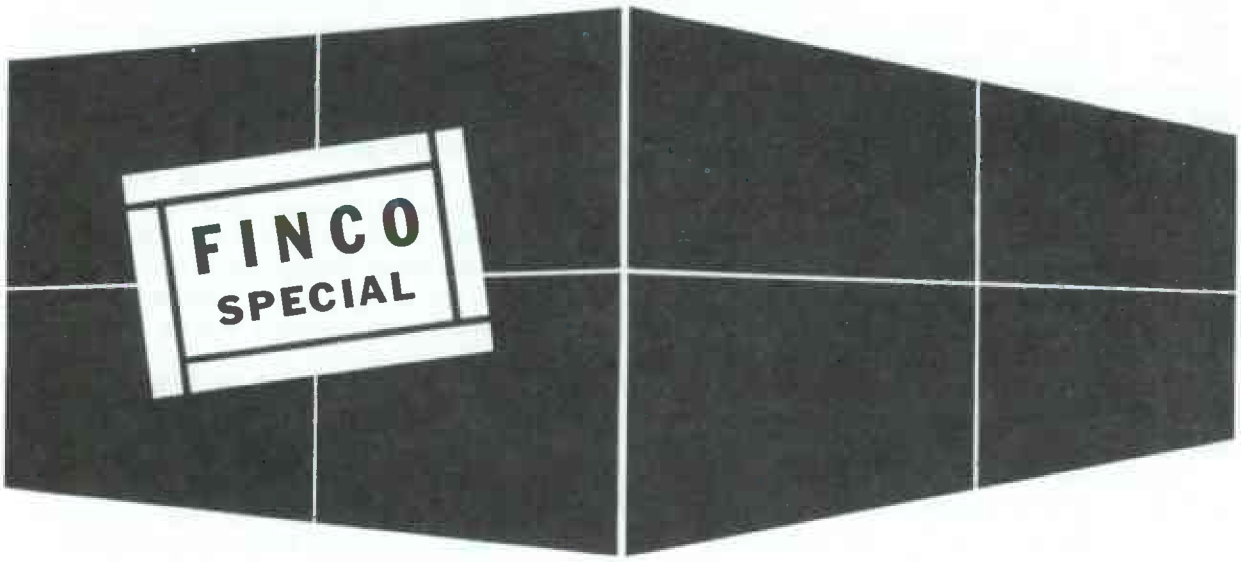
The alignment procedures in both types of receivers follow similar courses. First you align the second IF stages, then the first.

Oscillator alignment is the same, except that the second oscillator is fixed in frequency—usually by a crystal. Over a long period, however, the second oscillator may need adjustment to compensate for any slight drift due to age.

Customer Satisfaction

Usually, the communications-receiver listener is more demanding of his radio than a broadcast-receiver customer. This, of course, is because the communications receiver is meant to pick up weak, distant signals, whereas the broadcast receiver doesn't have to. Therefore, alignment of short-wave receivers is more critical and must be right up to snuff—otherwise, poor reception, and possibly a lost customer, will result. ▲

EVERYDAY
EVERYDAY
EVERYDAY



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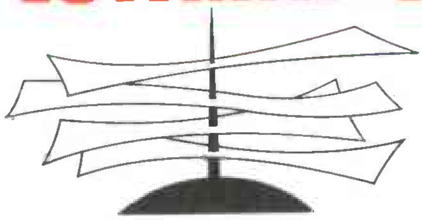
by Ernest Tricomi

ESTIMATES can be profitable



"I want my television set fixed; but I want to know how much you're going to charge, before you go ahead."

These can be discouraging words to a service technician—but words which are being repeated more and more often in today's buyers' market. As an increasing number of shops compete for service work, the customer finds herself in a position to "shop" for service and to compare prices before she places the order.

This trend puts the service shop owner in a bind. Should he send a service technician to the customer's home to make the estimate, absorbing the cost of the call if she decides not to buy? Or should he risk losing the business by informing the customer on the spot that there will be a charge for the estimate? Or is there some other solution to the problem . . . ?

Before you decide what to do, it would be best to examine as many phases of the question as possible. First, how is this problem handled in other types of service business?

Not so long ago, when your automobile was in need of body work for a dented fender, you simply made a tour of the body shops in your community, and requested an estimate. Each of the shops you visited cheerfully wrote out an estimate, itemizing parts and labor. Then, when you got home, all you had to do was weigh the lowest price against your impression of the shop's competence, get a few opinions from your neighbors, and award the job to the shop that came up with the best score.

Today, all that has changed. The body shop owners came to the collective realization that they were getting only a fraction of the jobs they were asked to bid on. Result: Today many body shops make a $5 to $10 charge for estimating—and they are thriving as never before!

Of course, the amount that was already paid for the estimate is deducted from the final bill if the customer decides to go ahead with the job. As an extra bonus, the very fact that a written estimate was furnished lessens or eliminates altogether any misunderstandings over the amount of the final bill.

This same pattern of change is found in other service fields as well. In some of the "chain" automobile repair garages, a "diagnostic service" is offered at a flat-rate charge. In a specially equipped bay, autos are given a thorough inspection with electronic testing equipment. Customers may avail themselves of this service, or they may elect to order some needed repair without going through the diagnostic bay. In the latter case, the garage does not guarantee that the defect reported by the customer will be corrected.

Table I—Labor Cost of Fruitless Estimates

	Example	Yours
(1) Annual Payroll (service calls only)	$10,000	$______
(2) Total Annual Calls	3,500	______
(3) Divide (1) by (2) for cost per call	$ 2.85	______
(4) Calls incomplete/estimate refused	150	______
(5) Multiply (4) by (3) for final cost	$427.50	______

Should I or Shouldn't I?

Here's one way to arrive at the information you need to support your answer to the question, "Should I or shouldn't I charge for estimates?"

First, make a study of your call reports as far back as your records go. Find the total number of calls made by your shop in one year. If you can identify them, extract the total number of incomplete calls—those for which you didn't charge—in the same period. If you have no record of incomplete calls, enlist the aid of your memory to arrive at an intelligent guess.

Divide the total number of calls into the number of incomplete calls to determine the percentage of the latter. Calculate the cost of labor involved in the incomplete calls as shown in Table I. In the example, an incomplete call is considered of the same duration as an average completed call, to simplify the figuring. The final figure tells how much it is costing you annually in labor to make fruitless estimates.

Whether the above figure is large or small, the real success of your estimate plan depends on how often you are asked to furnish an estimate, and how many of these you are able to convert into actual service orders—and profits. If, for example, most of your service calls are completed, in spite of the fact that you are frequently called upon for estimates, you are apparently converting a high percentage of estimates into actual service orders. This, then, means that you are not being hurt too badly by free estimating.

On the other hand, if more than two or three per cent of your service calls are incomplete, and you have a record of frequent estimate requests, you are converting fewer estimates into service orders. This means

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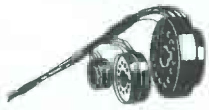
No adaptor sockets. One neat test cable with all six sockets for testing any CRT. No messy adaptors, reference charts or up-dating is required. The Sencore CR125 is the only tester with both color sockets. (Some have no color sockets, others have only the older type color socket.)

All six sockets, including latest color socket, on one neat cable.



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Horizontal amplifier extended sweep range from 5 to 500 kc in five overlapping steps and frequency response from 10 CPS to 1 mc within 3 DB insures linear sweep and positive sync. External inputs for horizontal sweep and sync, intensity modulation, and smart two-toned case and "designer" styled controls brands the PS127 a truly professional oscilloscope.

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that to this degree you are giving away your services, and should consider charging for estimates.

Other factors to consider are the degree of competition, the income level of your market, and business practice in your own community.

For example, service shops in large cities would have tough sledding to try to institute a charge-for-estimates policy, because customers in large cities have a much wider choice of service shops. It would be easy for customers to switch their loyalties to another shop. The small-town shop would also have difficulty in taking a new approach to estimates, because people in small towns often resist change.

The suburban-area service shop would have the best chance of adopting such a policy, because residents in suburban areas are usually new householders who don't mind going along with change. The generally higher income level of surburban residents is certainly an important consideration as well.

Means To An End

There are several forms that a charge-for-estimates policy can take. Here are some of the more common ways it is done:

1. Make a nominal charge, to be paid if the work is not done, or to be added to the final bill if the work is done.
2. Same as 1, but charge a full minimum bench rate or a one-hour rate.
3. Charge a nominal or full-hour rate for the estimate, but deduct that charge from the final bill:
   a. If the customer gives the go-ahead while the serviceman is still on the customer's premises, or
   b. If the customer calls in within a specified length of time to have the job completed (this means another trip—be very sure this is what you want).
4. Cancel the estimate charge if the final bill for service work and parts exceeds a stated minimum.

How Much To Charge?

While you should do everything possible to make an estimate pay off in immediate cash, you can also reason that an opportunity to estimate is an invitation for more business. Therefore, you can tell yourself, the cost of estimating is an investment similar to the cost of advertising. Somewhere between this extreme and that of overcharging is the true answer to the question of how much *you* should charge.

Making It Pay

One important consideration that is commonly overlooked is how to make the estimate policy pay off—whether you decide to charge for estimates or to give them away free. If the policy doesn't result in profits for your shop, one way or another, it is not a satisfactory policy.

With estimates, the estimate itself seldom results in any clear-cut profit—no matter how much you charge. The profit comes from those estimates you convert into service jobs. Only if you can convert the estimate into a repair job will you (a) make money, (b) keep the customer, and (c) establish your reputation as a fair and sensible businessman. Here is the practice recom-

mended by one extremely successful shop owner.

Making the Estimate Charge

In no case should you offer an itemized estimate for less than your regular service charge. It just doesn't make sense, and it offers boundless temptation to the "chiseler" type of customer. If the estimate is to be made in the customer's home, you should charge for it separately or not at all; in either case, the service-call fee must be paid. (If you approach it from this angle, "free" estimates suddenly don't sound quite so costly, do they?)

Your customer should understand that a service call is entirely different from an estimate. You must collect your minimum charge, and endeavor to repair the set within the maximum time allotted for service calls.

If other repairs are needed, requiring bench work, the set is taken to the shop for complete analysis. (This shop owner allows no estimates or "guesstimates" to be given in the home.) The set owner is told that an estimate charge of $5.00 will be made if the repair isn't okayed, and the set will be returned. (Thus, the shop collects for their service call and for their analysis time.)

If the customer chooses to okay the estimate, repairs are completed at the estimated price—*exactly*—and the set returned. No special charge is made for the estimate; the customer pays for the initial service call and for the bench work.

At this shop, each customer gets exactly what he pays for—no more and no less. And, you'll note, he pays for what he gets! This description sounds a bit oversimplified, and it is. There is one more important ingredient that goes into every estimate undertaken by this service shop.

Selling the Job

You wouldn't expect a real-estate salesman to give you an estimate on how much a house would cost, and then simply walk away and let you "take it or leave it," would you? Well, you can bet he wouldn't do it that way! He'd spend some time telling you why that is a good price, pointing out some of the special advantages the house had to offer, explaining why you'd do

"—Then other times the picture looks like this."

best to buy from him, and listing many other points to make you want to buy. In other words, he tries to *sell* the house to you.

The same reasoning should apply to your service business. You must try to *sell* each job. And the estimate situation is one of the areas most needful of this type of selling—and the most often neglected.

You've no reason to be ashamed or apologetic for charging a reasonable price for work done. Instead, point out the many advantages of having your shop do the job—quicker service, higher-quality workmanship, special-rated components, technical capability, longer service guarantee, or any other special advantages. (Just be sure you can fulfill anything you promise.) Convince the customer that price really isn't a consideration at all. You have the equipment, technical knowledge, and facilities to do the job as well as or better than any other shop. And then, there's the fact that the customer has already invested in a service call (for which he'll be charged) and might as well have the job done right.

In this selling process, it is very important to make the estimate policy very clear. But *read* it to the customer, don't leave it to chance; be *sure* the customer understands fully. The printed wording may leave something open to misinterpretation, which in turn might lead to misunderstanding. Sell only the facts.

Putting It In Effect

If you have decided on a regular charge for estimates, the question then becomes, "How to go about establishing this policy?"

A vital consideration is to acquaint your customer with the policy as soon as the question of an estimate is brought up—usually on the telephone when the call is first received. If the customer asks what the job will cost, and hints that she wants a firm estimate before you proceed with the job, you can proceed something like:

"Mrs. Howard, we can't give you an estimate over the telephone, because we don't know enough about the trouble with your set until we examine it. However, we'll be glad to send a man to your home and examine your set thoroughly with our test equipment, so we'll know exactly what is wrong with it. Then we can give you a firm price in writing, itemizing all the parts you will need and the cost of the labor.

"We do charge for this service, because we simply cannot afford to send a man and a truck out to your home for nothing. However, if you decide to let us go ahead with the job right on the spot, we make no charge for the estimate.

"If you decide to wait, you can pay our man for the service call and then call us later if you decide to go ahead with the job. In this case, though, the cost of the estimate stands, and is not deducted from your bill.

"If you want my candid advice, Mrs. Howard, you can avoid the doubts by letting us simply go ahead and fix your set without an estimate. We're in business to stay, and we want you to call us back the next time you have trouble. I can assure you that we will do everything necessary to repair your set—and not one nickel's worth more."

"Reliability without innovation is just a fancy word for improving an old breed!"

William Dubilier, Mica Capacitor Inventor

D. C. Tubular Aluminum Electrolytic Capacitors

Preferred Replacements: *Three selected types, immediately available, cover all replacement needs.*

Reliability: *Typically high Cornell-Dubilier quality to protect your reputation and profits.*

The right replacement... when and where you want it. Immediately available from the CDE network of Authorized General Line Distributors, and especially selected to solve any under-chassis and sub-panel tubular electrolytic replacement problem. Each of the three D.C. aluminum electrolytics use highest quality materials, utilizing the latest, exclusive CDE processes—the result of CDE's 53 years of knowledge and experience in capacitors.

Type ECSP—for printed circuit and low voltage, transistorized equipment. The industry's only rectangular cased, miniature electrolytic. Pre-molded case, exclusive moisture resistant encapsulation, and guaranteed lead center dimensions. Available 3 to 75 volts DC working, 3 to 250 microfarads, operating temperature range—20 to 65C.

Type NLW—for transistorized and portable equipment, or other miniaturized applications. Ultra-miniature axial lead electrolytics, hermetically sealed in aluminum cases, and provided with plastic insulating sleeves. Available 3 to 150 volts D.C. working, 1 to 450 microfarads, operating temperature range—40 to 85C.

Type BR / BBR—the famous CDE "Blue Beaver"®, most popular and widely used of any tubular electrolytic. Hermetically sealed in compact aluminum cases and provided with cardboard insulating sleeves. Available 3 to 700 volts D.C. working, 1 to 5000 microfarads, operating temperature range—20 up to 85C. Also available BBRD (dual), BBRT (triple), and BBRQ (four section).

Order a supply of these preferred replacements from your CDE Distributor. For more information, ask him for Section 201 of the CDE REPLACEMENT COMPONENT SELECTOR, or write: Cornell-Dubilier Electronics, Division of Federal Pacific Electric Co., 50 Paris Street, Newark 1, New Jersey.

CDE CORNELL-DUBILIER

INNOVATION WITH RELIABILITY

Circle 33 on literature card

Answering Objections

There's no question about it—you will run into some resistance from some of your customers. This is to be expected. Here are answers to some of the objections you will get:

Question: "Suppose your estimate is so high that I simply can't afford it? Can't you tell me now about how much the job will run? After all, I don't want to buy a cat in the bag."

Answer: "Madam, if you can describe the way your set behaves, I can give you a rough idea on the telephone of what might be causing your trouble and roughly how much it will cost to fix it. But please don't forget I'm only guessing. It might go higher or lower."

Question: "Why should I pay you for making an estimate when Joe's Shop advertises 'no charge for estimates'?"

Answer: "Because I don't have to absorb the cost of free estimates, I can charge less for the actual work. I'm sure you'll find that your total bill from me will be no higher than his."

Question: "You mean to tell me you'll charge me for just *looking* at my set?"

Answer: "The charge covers a complete analysis of your set with our electronic testing equipment. We not only check operation of every tube, but we make many other tests to find any possible weak points in your set. As a result, we not only can repair the portion of the set that is causing your present trouble, but can detect early signs of future trouble and take steps now to correct them *before* they develop into another costly service call and repair bill. As you know, Mrs. Howard, one defect leads to another. Many parts in your television set are dependent on other parts. That's why a complete analysis of your set is so important."

Review Your Situation

First look at your own operation. Are you making too many estimates that are eating into your technicians' productive time and not being converted to service jobs?

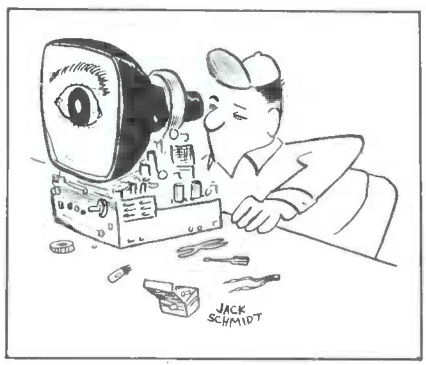
Is your competition so strong that you already feel the pinch, or are you fairly secure in the loyalty of your customers?

If you are in a small town, will your customers resent the charge simply because it's different from what they are accustomed to?

Can you look upon an estimate as an opportunity to gain more business, or do you want the estimate to pay off in hard cash?

Finally, have you considered every possible angle so that your technicians have a ready answer in a firm policy printed on the back of the work order?

Estimates, remember, can pay off even if you don't charge for them. We've outlined several very different ways of handling estimates; one should suit your particular situation. ▲



STOP! LOOK! SAVE!

A STANDARD COLOR BAR GENERATOR at 1/2 THE COST OF OTHERS

only $99^{50}

the all new SENCORE

CG126 STANDARD COLOR BAR GENERATOR

A standard color bar, white dot, crosshatch generator especially made for field service on color TV . . . and at a great savings to you.

Check these outstanding features and you will see why this generator belongs on the top of your list for color TV servicing.

All patterns crystal controlled offering "rock like" stability. You'll think the patterns are painted on the TV screen.

Simplified operation speeds up every servicing job. Just dial the standard keyed bars, white dots, crosshatch, vertical bars or horizontal bars and watch them "pop" on the screen. That's all there is to it.

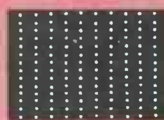
Exclusive adjustable dot size. The white dots can be adjusted to the size that satisfies your needs by a screwdriver adjustment on the rear. No need to argue about dot size anymore. Just select the size that you like to work with best.

Pretuned RF output to Channel 4. Other low channels can be selected if Channel 4 is being used in your area by simple slug adjustment. Patterns are injected directly into antenna terminals, simplifying operation and saving servicing time.

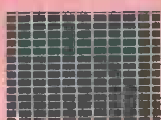
Reserved output on color bars for forcing signal through defective color circuits. The color output control is calibrated at 100 percent at the center of rotation, representing normal output. A reserve up to 200 percent is available on the remainder of rotation.

Smaller and more portable. With color receivers weighing much more than black and white TV, portable equipment becomes essential for home servicing. The CG126 weighs less than 10 pounds and measures only 11" x 8" x 6".

Ten standard keyed color bars (RCA type) that automatically provide all colors at specified NTSC phases . . . but without need of interpretation when servicing.



Stable white dots with new exclusive dot size adjustment in rear.



Stabilized crosshatch pattern for simplifying convergence adjustments.

10 thin white vertical lines for horizontal dynamic convergence adjustments . . . often missing on other generators.

14 thin horizontal lines for vertical dynamic convergence. Also missing on many high priced generators.

March into your local parts distributor and demand the CG126 Sencore color generator that sells at ½ the price of others. Don't let him switch you.

SENCORE

426 SO. WESTGATE DRIVE • ADDISON, ILL.

Circle 35 on literature card

Notes on Test Equipment

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

by Forest H. Belt

Modern TV Scope

The Model 677 *Wideband Oscilloscope* was introduced this year by Hickok Electrical Instrument Co. as an addition to their line of test equipment for color servicing. The unit (pictured in Fig. 1) offers features that make it a logical addition to any modern service shop—whether or not color sets are serviced.

The vertical amplifier is frequency compensated from unbalanced input to push-pull output. Peaking coils, regulated supply voltages, and large decoupling capacitors are incorporated to provide a vertical amplifier response that is within ±3 db of flat from 5 cps to 4.5 mc.

The vertical amplifier incorporates a three-step frequency compensated attenuator at its input, coupled to a cathode follower. Capacitive coupling is used throughout the instrument. The vertical gain control transfers signal voltage from the cathode follower to a triode-pentode amplifier. The overall gain of the vertical amplifier is sufficient for a sensitivity rating of 40 mv rms for 1" deflection.

The push-pull output stage is fed from the unbalanced amplifier stages by the usual device of grounding one of the push-pull grids for signal voltages. Fig. 2 shows in detail how this is done. Vertical positioning is accomplished by a balance control in the grid of the final amplifier, controlling the bias and thus the average plate voltage on the tubes. The final amplifier plates are directly coupled to the deflection plates of the CRT.

The cathode-ray tube itself is a 5UP1, and the chassis contains a provision for controlling the spot shape. A screwdriver adjustment, similar in function to the astigmatism control in some other scopes, is accessible at the rear of the instrument without disassembly. The CRT phosphor is the usual green (#1) with sufficient brightness for ordinary television servicing applications.

A 1V2 rectifier develops about 1200 volts negative DC for the CRT. The cathode is connected to high voltage through the intensity control, while the CRT deflection plates operate at slightly more than 300 volts. Thus, around 1500 volts DC is available for driving the CRT beam. Voltage for the focus anode is taken from a bleeder network connected across the high voltage supply.

One branch of the low voltage power supply is regulated by the 6C4 regulator circuit shown in Fig. 3. A 6X4 furnishes approximately 400 volts DC for several of the scope circuits. Series resistors R1, R2, and R3 conduct the B+ voltage to the plate of V1, the regulator tube. R4

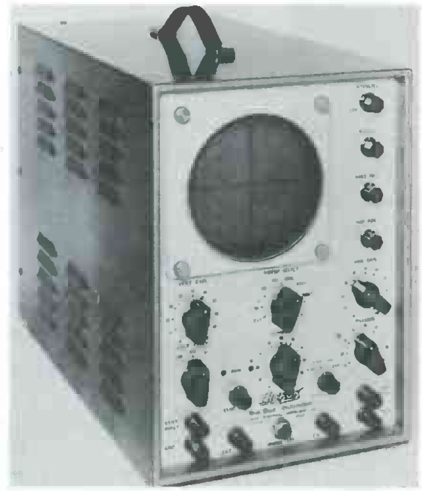


Fig. 1. Wideband scope includes frequency compensated vertical amplifier.

connects the grid of V1 to the high voltage bleeder chain, setting the average conduction point of the 6C4. Sudden voltage shifts or transient pulses appearing on the B+ line—whether they originate with the supply or from the load connected to the "150 V REG" point—are coupled to the grid of V1 by capacitor C2. This action controls the conduction of the tube, thus dropping across R2 and R3 only enough voltage to maintain 150 volts at the plate. This regulated B+ is used in critical stages such as the input amplifiers and the sweep generator.

The horizontal amplifier consists of a cathode follower, one stage of amplification, and a push-pull output circuit that is coupled directly to the CRT deflection plates. Sensitivity of the horizontal amplifier is 250 mv (¼ volt) rms for 1" deflection. Push-pull coupling, and beam positioning, are handled the same as in the vertical amplifier.

The sweep generator in this scope covers the range from 10 cps to 500 kc. This permits examining even some

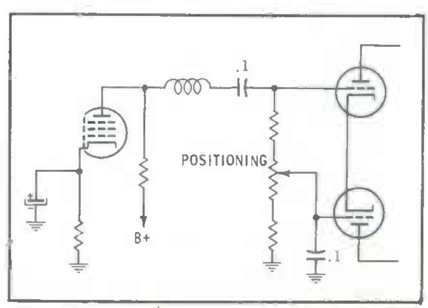


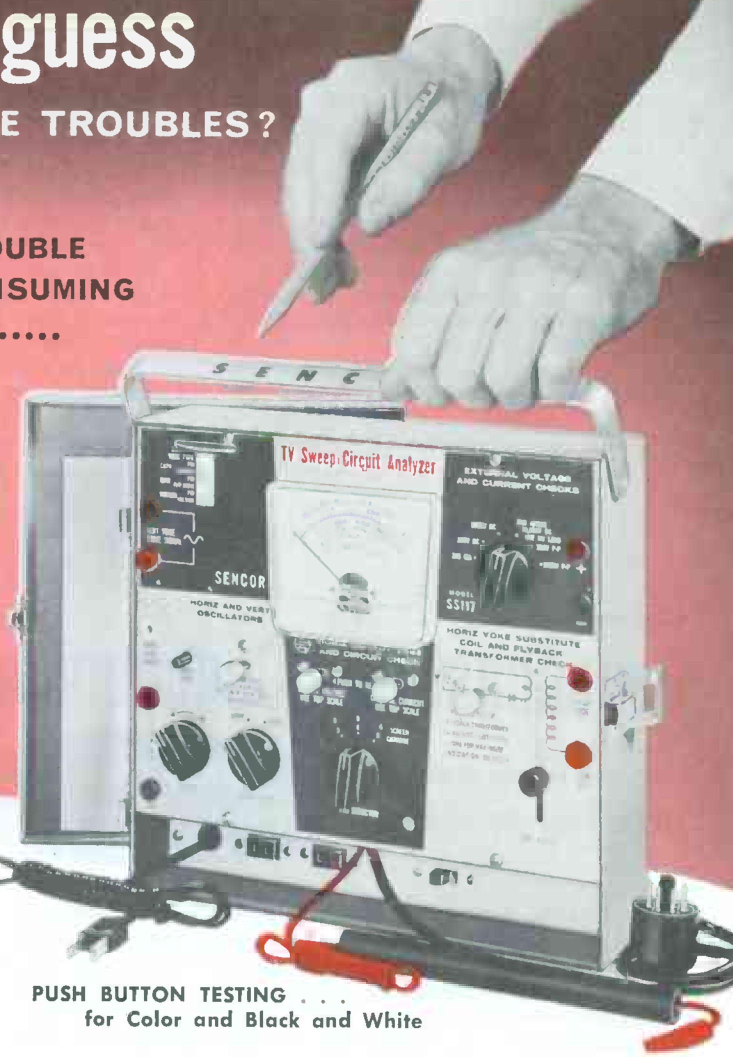
Fig. 2. Control in grid circuit of push-pull output adjusts trace positioning.

Can you afford to guess

AT SWEEP, SYNC OR HIGH VOLTAGE TROUBLES?

WHEN IT'S SO EASY TO WALK THE TROUBLE RIGHT OUT OF THESE TIME CONSUMING CIRCUITS..... STEP BY STEP.....

SYNC. CIR. & H. SYNC. DISCRIM.	VERT. OSC.	VERT. OUTPUT	VERT. OUTPUT XFORMER	VERT. DEFLEC. YOKE
HORIZ. OSC.	HORIZ. OUTPUT	HORIZ. FLYBACK XFORMER	2nd ANODE VOLTAGE CIRCUIT	HORIZ. DEFLEC. YOKE



NEW, IMPROVED SENCORE
SWEEP CIRCUIT ANALYZER
MODEL SS117

PUSH BUTTON TESTING . . . for Color and Black and White

How many times do you ask, "Why do I take so long finding that sweep trouble?" How often have you wondered whether weak horizontal sync was caused by defective sync circuit, horizontal oscillator, or sync discriminator? Can you quickly isolate inadequate width or low 2nd anode voltage to the oscillator, output, flyback transformer, or yoke? How many times have you changed a good yoke by mistake?

The SS117 will pinpoint troubles like these in minutes with tried and proven signal injection, plus yoke substitution for dynamic in-circuit tests. Error proof push button testing enables you to make all tests from the top of the chassis without removal from cabinet for maximum speed and profit on every job.

Here are the checks the SS117 makes . . .

- Horizontal Oscillator: Checked by substituting 15,750 variable output universal oscillator from SS117. Signal can be injected at any spot from horizontal output grid to horizontal oscillator to determine defective component.
- Horizontal Output Stage: Checked by reliable cathode current and screen voltage checks made with adapter socket and two push buttons,
- Horizontal Output Transformer: Checked for power transfer in circuit and read as good or bad on meter.
- Horizontal Deflection Yoke: Checked by direct substitution with adjustable universal yoke on SS117.
- Vertical Oscillator: Checked by substituting 60 cycle synchronized oscillator.
- Vertical Output Transformer: By simple signal injection for full height on picture tube.
- Vertical Deflection Yoke: By signal substitution for full height on picture tube.
- Sync Stages: Checked by synchronizing triggered horizontal SS117 oscillator from any stage. If oscillator synchronizes, sync is O.K.
- 2nd Anode Voltage: A new dynamic check using simulated picture tube load. C.R.T. does not need to be operating for current tests. No interpretations—read direct from 0 to 30 KV.
- External Circuit Measurements: By applying from 0 to 1000 volts AC or DC to external meter jacks. Meter will read DC or peak-to-peak volts. 0 to 300 milliamp scale also provided for measuring horizontal fuse current.
- New features include: Large 0 to 300 microamp meter for minimum circuit loading; all-steel carrying case with full mirror in adjustable cover; two 115 volt AC outlets in cable compartment.

Size: 10¼" x 9¼" x 3½". Wt. 10 lbs.

Model SS117 Dealer Net $89.50

Sencore Sam says . . . How can you miss . . .

EACH PACKAGED UNIT CONTAINS:
- An Easy to Follow Instruction Book Especially Prepared and Edited by H. W. Sams.
- A complete 33 RPM, 10 inch Permanent Record on "How to Simplify Sweep Circuit Trouble Shooting."

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Circle 37 on literature card

SENCORE
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RF signal waveforms. For example, we found in the lab that we could display 10 cycles of the 3.58 mc output from the chroma reference oscillator in a color set. Trace intensity is sufficient for easy viewing, even at these high sweep rates. However, the retrace blanking of the scope isn't fast enough to blank the entire retrace; consequently, a few "stretched-out" cycles of the 3.58 mc signal were partially visible in the background. By advancing the horizontal gain control, we could examine individual cycles of the signal.

The sweep generator has a familiar basic configuration; if you'll temporarily ignore the connection to the suppressor of V1, you'll recognize the cross-coupled multivibrator (Fig. 4) used in many modern scopes. However, this one uses an interesting innovation that combines a portion of the multivibrator with the sync circuit.

Frequency is controlled in the cathode circuit of the second multivibrator section. The SWEEP SELECTOR switch picks a capacitor combination that causes the multivibrator to operate at the desired frequency; the potentiometer is the vernier or fine frequency control. There are also two preset positions of the horizontal SWEEP SELECTOR switch, for

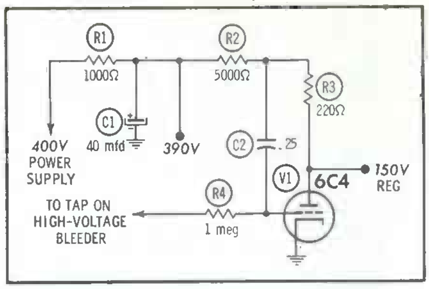


Fig. 3. Power supply includes 6C4 for voltage regulation of 150 volt line.

horizontal and vertical TV waveforms. Each is separately adjustable by screwdriver controls accessible through the front panel. We found the most useful display shows two complete cycles of each waveform.

As in many modern scopes, sync is automatic—although in this scope it is adjustable, as well. Waveforms can be synchronized on either the positive or negative excursion, whichever affords the more solid locking action. You'll find that complex waveforms usually lock best on the excursion that has the sharpest leading edge.

What is unusual about this sync system is the manner of coupling sync to the sweep generator. The first half of the multivibrator is a sharp-cutoff pentode—the 6DT6. Utilizing the special control characteristics of the suppressor grid in this tube, the sync signal (or sample) is electron-coupled directly into the electron stream within the tube, offering exceptionally strong sync action.

A sample of the signal waveform being measured by the scope is taken from a peaking coil in the plate circuit of either push-pull output stage, coupled through the sync switch, and applied to the 6DT6 through a SYNC AMPLITUDE control. Polarity of sync depends on which side of the output stage furnishes the synchronizing pulse. A small (47 mmf) capacitor connected across a portion of the control differentiates the sync sample, sharpening it for positive action. A slight bias coupled to the suppressor grid from the vertical-output circuit helps stabilize the sync portion of sweep generator operation.

The sync switch can choose external or line sync in place of internal sync; either one must go through slight differentiation before being applied to the 6DT6. All sync signals are controlled by the SYNC AMPLITUDE control.

The front panel of the Model 677 is laid out in four "sections," each with a

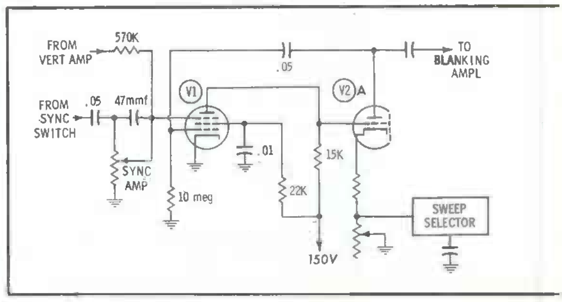


Fig. 4. Sync is injected into sweep multivibrator via suppressor of V1.

specific grouping of operating controls (Fig. 1). Along the right-hand edge, to the right of the graticule, are controls that affect the operation of the CRT—INTENSITY, FOCUS, VERT POS, HOR POS. Vertical input controls are grouped in the left-hand third of the lower panel —VERT GAIN, VERT ATTEN, and the two VERT INPUT terminals. Horizontal amplifier controls are grouped similarly in the right-hand third of the lower panel—HOR GAIN, PHASING, and the HOR INPUT terminals. The PHASING control affects the phase of line voltage fed to the horizontal amplifier when the SWEEP SELECTOR switch is set for "Line." With this arrangement, the scope trace can be synchronized with a sweep alignment generator even though the latter hasn't a special output signal for the scope; both instruments are locked to the frequency of the common line voltage that powers them.

Grouped beneath the graticule, and centered in the lower half of the panel, you'll find the sweep and sync controls —SWEEP SELECTOR, VERNIER, SYNC AMP, SYNC SEL. And along the bottom edge, in the same grouping, are the EXT SYNC and 1 V P-P jacks, and the pilot lamp.

The SWEEP SELECTOR includes a position for feeding 60-cps line voltage to the horizontal amplifier, one for coupling the HOR INPUT signal to the amplifier, and several to cover the frequency ranges described earlier. The SYNC SEL chooses positive or negative internal sync, line sync, or whatever signal is applied to the EXT SYNC input terminal. The SYNC AMP knob controls the amount of sync signal applied to the 6DT6 suppressor grid, and affects the sync in any of the four positions of the SYNC SEL switch.

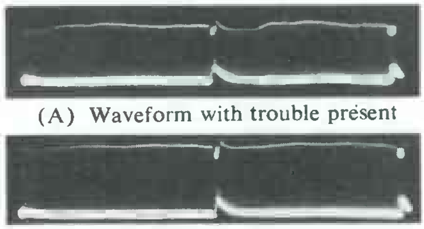
The 1 V P-P terminal furnishes a 1 volt sine wave that can be used to calibrate the vertical input amplifiers for measuring signal amplitudes. We found the Model 677 easy to calibrate, as follows: We clipped a jumper from the 1 V P-P terminal to the VERT INPUT terminal, set the VERT ATTEN for "xl," and adjusted the VERT GAIN until the trace just filled the section marked "1" on the graticule. At that setting, any signal from .1 volt to 3 volts peak to peak could be read by noting how many small spaces its display covered on the graticule's vertical grid. With the VERT GAIN setting untouched, the VERT ATTEN switch could be moved to "x10" to measure up to 30 volts peak to peak, and to "x100" to measure up to 300 volts.

To calibrate for readings smaller than .1 volt peak to peak, we set the VERT ATTEN to "x10" and adjusted the 1 volt signal to cover 5 tiny divisions on the graticule; thus, each represented .2 volt. With the VERT ATTEN switched to "x1," each division represented .02 volts or 20 mv; at "x100," each represented 2 volts. Since at least 30 tiny divisions are conveniently readable, the instrument—calibrated for sensitive readings —can dependably indicate signal levels from 20 mv to 60 volts peak to peak. ▲

For further information, Circle 38 on literature card.

Just a Tube . . .

(Continued from page 29)



(A) Waveform with trouble present

(B) After trouble was corrected

Fig. 8. Tips of horizontal pulses in the sync output waveform were irregular.

tent condition; once it starts, it ordinarily continues until the set is readjusted. In this instance, it would appear for about a second or two, and then the raster would straighten up into a perfectly normal picture. Another unusual feature of this symptom was the only three to six "bundles" of bright lines appeared instead of a completely random pattern. On further watching, I noted the squegging habitually occurred during camera breaks.

Wondering if a sync trouble were at fault, I scoped the output of the final sync stage. Even when the squegging was absent, I found a possible clue—a minor irregularity in the level of the horizontal sync-pulse tips, as shown in Fig. 8A. The slight dip following each vertical pulse can best be noted by comparison with the sync signal obtained after the trouble was corrected (Fig. 8B).

Before troubleshooting the sync circuits, I decided to scope the video amplifier's output signal—see Fig. 9. Note the very irregular horizontal sync trace and the extremely sloped back porch of the vertical sync pulse. While it is altogether normal for the sync-pulse bases and tips to show some minor irregularities due to variations in the contents of the picture signal, variations as severe as those in Fig. 9 are abnormal. Merely replacing the 6BH8 video amplifier flattened out the sync levels, cleared up the unstable sync, and resulted in the neat sync trace shown in Fig. 8B.

A Real Deceiver

After replacing a multisection filter can in a Sylvania Chassis 1-532-3, I placed the set on the cooking rack for a while, because the customer had complained the raster would intermittently black out. I had a notion the filters had been the cause of this defect, and was surprised when the set did black out after running about two hours. The scope indicated that the horizontal oscillator was kicking up a good-sized sawtooth signal, so it appeared that the horizontal output amplifier was quitting. On noting that a 25DN6 was used in this set, I was slightly annoyed, because I didn't have one of these tubes in stock. At that time, however, I did happen to have a Philco 7E11 portable awaiting service and was able to borrow a 25DN6 from it for further testing of the Sylvania. When that set ran for a full day without trouble, I installed a new 25DN6 in it and returned it to its owner.

The complaint card on the Philco listed the trouble as "horizontal twist." As I replaced the original 25DN6 in the set, I mused that the trouble certainly wouldn't be this tube, for the Sylvania had played perfectly while using it. After running awhile, the Philco developed the slight twist shown in Fig. 10. Replacing the horizontal oscillator tube was no cure, so I scoped the sync output signal—but the resultant trace at 30 cps (Fig. 11A) showed no hum. Suspecting a freakish action of the AFC dual diode led me to replace that item, but again there was no cure. Next, scoping the signals on the AFC diode, I found some hum on the center terminal, and more (Fig. 11B) on the terminal to which the sweep-sample signal is applied. Against what I thought was my better judgment, I installed a new 25DN6, and

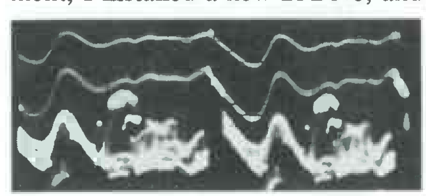
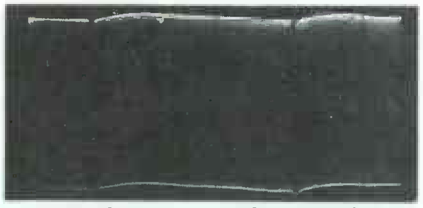
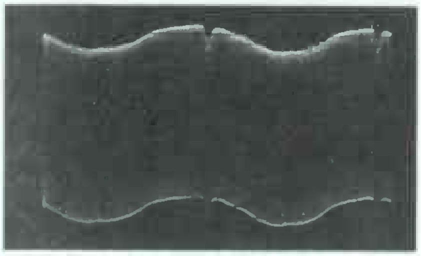


Fig. 9. Much worse distortion was apparent in video output plate waveform.

Fig. 10. Decentering the raster made it easier to examine twist in picture.



(A) Clean output of sync section



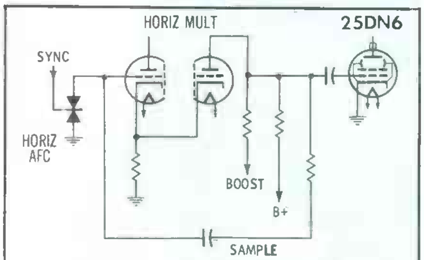
(B) Hum in AFC sample signal

Fig. 11. Sync waveforms in Philco 7E11 when faulty 25DN6 was installed.

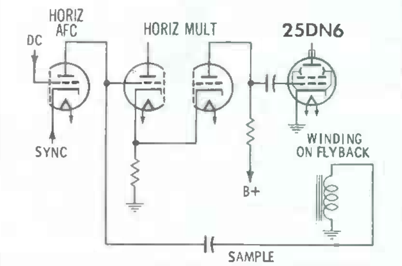
the horizontal twist was a thing of the past.

Why did the tube cause trouble in the Philco receiver, and not in the Sylvania? Some clues are provided in the skeletonized schematics of Fig. 12, which reveal several important differences between the horizontal circuits of the two receivers. Take special note of the different sources for the sample signal fed back to the AFC stage. If the 25DN6 has a grid-circuit fault that causes 60-cps hum to be picked up by the grid, the hum will be readily coupled back to the AFC in the Philco—but a slight hum is more likely to be eliminated in the more roundabout AFC feedback path in the Sylvania.

For my part, I was satisfied with the knowledge that the trouble source was just a tube, after all. ▲



(A) Philco Chassis 7E11



(B) Sylvania Chassis 1-532-3

Fig. 12. Twist was caused by bad 25DN6 in circuit A, but not in circuit B.

Circle 44 on literature card

Transistor Outputs

(Continued from page 27)

The bias for X5 is developed along two separate paths. Base voltage is a result of divider action between R14 and R15. The former drops 1.3 volts, and the latter, 7.7 volts; thus the base is 7.7 volts below ground. Collector voltage is the result of current flow through the high resistance of the transistor and the speaker voice coil. The internal resistance of the transistor is dropping 6.5 volts; the 550-ohm speaker drops the additional 1.3 volts.

Upon careful inspection, you can see that each component performs much the same purpose as the comparable part in Fig. 1 (although perhaps situated differently). Therefore, the same causes for the troubles in Fig. 1 generally hold true for Fig. 3.

Transformerless Push-Pull Output

The circuit in Fig. 4 is perhaps the most elaborate transistorized output stage you will encounter in portable radios. The voltages are so dependent on each other that a change in component value in one part of the circuit can upset both the driver and output stages. For this reason, the transformerless push-pull output is the most difficult to troubleshoot.

Rather than try to memorize the exact symptoms involved when a particular component goes bad, it is best to understand a little of the DC circuitry. As you will see, the overall driver-output circuitry consists of three parallel DC paths—each able to affect the others.

Ignoring all other paths of the DC circuit, consider the circuit which establishes the collector-emitter operating voltages for both X5 and X4. This path consists of the C-E resistance of X5, resistors R14 and R12, and the C-E resistance of X4. Next, consider the circuit which parallels R12 and the resistance of X4. This circuit, establishing base bias for X3, consists of R13, R9, and R8. The remaining biasing circuit consists of current flow from the 9-volt source through SP1, the earphone-jack contacts, R11, R10, and the C-E resistance of X3.

As you can see, X5 and X4 emitter voltages are the result of divider action in the series resist-

Circle 45 on literature card

Circle 46 on literature card

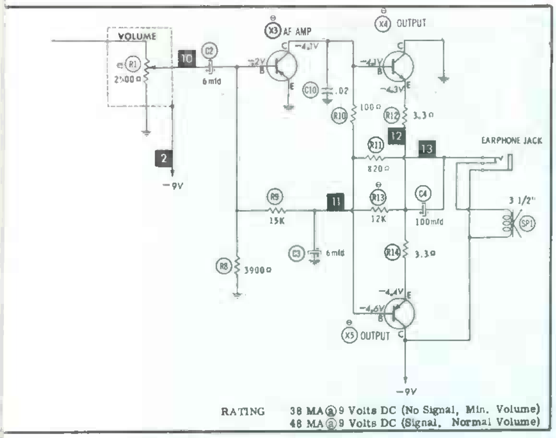


Fig. 4. Common-collector outputs use this hookup to obtain operating bias.

ances extending from the 9-volt source to ground (X4 collector). Likewise, X4 and X5 base voltages are the result of divider action. (Notice that the collector of X3 and the base of X4 are DC coupled. This is possible because X3 is a PNP and X4 is an NPN.)

The most common trouble sources in this type of circuit are audio coupling capacitor C4, and the earphone jack. As you can see, both X4 and X5 feed the speaker through C4. Should this capacitor develop leakage, open, or short out, the audio would be directly affected. Shorts or leakage would badly upset the voltages on all three transistors —causing distortion. If C4 were open, of course, no audio would get to the speaker.

Another source of trouble in circuits like this is C3, a capacitor used to prevent feedback to the base of the driver. If it should open, audio would not be bypassed to ground from the emitters of the output transistors; instead, it would appear at the base of X3 and cause motorboating.

Notice in Fig. 3 that bypass capacitor C12 (across the speaker) is used to provide a low-impedance path for high frequencies, and thus help to avoid the "tinny" sound so often associated with small speakers. In Fig. 4, C10 has a similar function. If either capacitor should open, little effect will be noticed—except for a slight distortion at high frequencies.

Troubleshooting the audio section of broadcast receivers, whether they be transistorized or tube type, is easier than servicing the RF's or IF's. For this reason alone, you should have little difficulty in finding and fixing audio troubles in most sets. Of course, there are bound to be a few "dogs" crossing your bench. But if you fully understand the circuit you are working on, troubleshooting will be largely a matter of mindwork, rather than guesswork.

A Third Hand

Seldom does a day go by that the technician doesn't wish for another hand. This is especially true when he's making a prolonged series of involved tests—such as equipment adjustments that require the use of test instruments as indicators.

One way to alleviate this problem is to find a convenient means of firmly attaching the test probes to various wires and terminals in the equipment. "Convenient" implies an ability to change connections without turning off the power. This calls for probes with insulated finger grips—like the *Gator-Probes* shown in the photo (manufactured by Gator-Probe Corp., Hollister, Calif.). The swivel-jawed clips that terminate the test leads are of the spring-return type and exert a pressure approximately equivalent to that of a standard alligator clip.

Besides being useful as in-circuit meter clips to leave the technician's hands free for adjustments, *Gator-Probes* can also be used as regular test prods, utilizing retractable metal tips that can be extended ⅝" from the nose of the plastic clip.

At the other end of the leads, the tips that plug into the measuring instrument are convertible to fit either banana or pin jacks. This feature allows the *Gator-Probe* to be used on a variety of instruments. With the probe tip extended, each lead measures 4½' long. ▲

For further information, Circle 56 on literature card.

Troubleshooting in a Plant

(Continued from page 31)

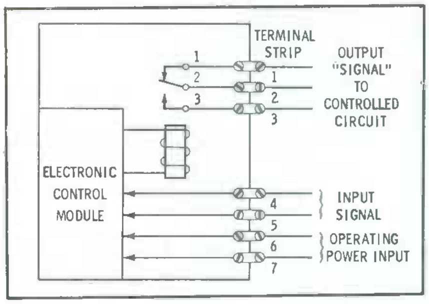


Fig. 8. Terminal strip simplifies the troubleshooting of this control device.

signal which is amplified to make it energize a relay. The output signal consists of two states: contacts 1-2 closed and 2-3 open, or contacts 1-2 open and 2-3 closed. (The circuit is effectively an SPDT switch.)

Fig. 8 shows the wiring of a typical control module employing a barrier-type terminal strip. Troubleshooting is easy. The first step is to measure the supply voltage across terminals 6-7, then the input signal across terminals 4-5. If the relay opens and closes as the input signal is applied and removed, as evidenced by a click, check for continuity across 1-2 when the relay is de-energized and across 2-3 when it is energized. If the results are incorrect, the trouble is in the relay contacts.

Never sandpaper or file relay contacts. Use only a relay-burnishing tool, and be careful not to bend the contact springs. It's better yet to replace an ailing relay; industrial electronic equipment wastes money if it is not reliable.

In some modules, the output signal is a voltage instead of a contact closure. The output voltage should change as the input signal is applied and removed. In the case of a light-sensitive transducer, a penlight can be used to check its functioning.

Ultrasonic Equipment

Perhaps the most widely used electronic device used in a small plant is an ultrasonic cleaning sys-

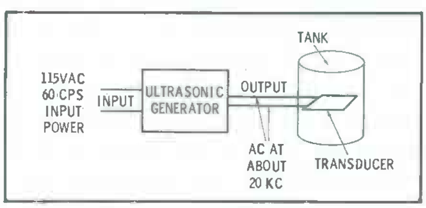


Fig. 9. Ultrasonic cleaning system is also common in watch-repair shops.

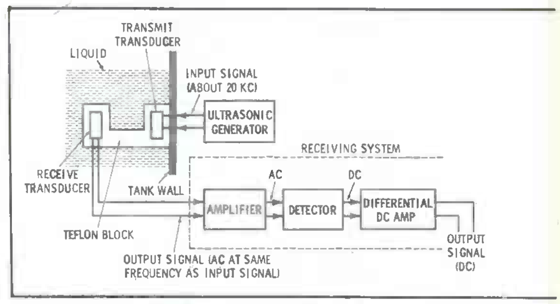


Fig. 10. Liquid-level detection system utilizes ultrasonics in special unit.

tem. It is a simple device, as shown in Fig. 9. A high-frequency AC signal (at about 24-40 kc) is generated by an electronic oscillator. Its output signal is fed to a transducer in the bottom of the cleaning tank which agitates the cleaning liquid. An AC voltmeter or an oscilloscope can be used to check the output signal. If the signal is strong, chances are the transducer is defective.

Ultrasonic liquid-level controls are used to actuate an overflow alarm or to close an intake valve. The system shown in Fig. 10 employes a sensing device made of *Teflon* in which are imbedded two transducers. Ultrasonic waves are transmitted from one transducer to the other through the open gap. When the gap is immersed in liquid there is less opposition to the transfer of ultrasonic energy than where there is air in the gap.

To check out this system, measure the generator output signal and then the amplifier input signal. If both exist, the trouble is in the receiving or detecting system. Use a scope or AC voltmeter to pinpoint the faulty unit.

Basic Procedures

Since most modern industrial electronic systems are of modular design, the basic troubleshooting chore is isolating the ailing module. This is done most readily by checking input and output signals, and by using substitution signals. If spare modules are available, they will minimize "down time."

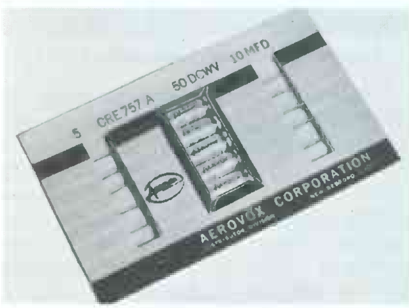
Repairs to modules can best be made on the bench, not in the field. Analysis of the function to be performed by each will turn up means for troubleshooting them. Industrial servicing is for advanced technicians, who can use advanced techniques—and develop their own, if need be. ▲

Product Report

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

Home Entertainment Outlet System (128)

This new RF-AF outlet system by **Winegard** connects a rooftop antenna to outlets throughout the house. A TV or FM set can be plugged into any outlet, and its speaker output coupled back into the same system via a special "Audio-Pix" coupler. Since all lines are connected through the "Audio-Pix," the system can also be used for piped music from a central source. Only one pair of wires is used, but both AF and RF are carried simultaneously without interference. The kit includes the coupler, an attachment for hi-fi or FM set, a portable extension speaker, 4 outlets, and 100′ of 300 ohm twin lead. The Model APK-360 is packaged in a display-type, carry-home carton and lists at $49.95. A transistorized version for weak-signal areas, the Model APK-360A, lists at $64.95.



Cradled Capacitors (129)

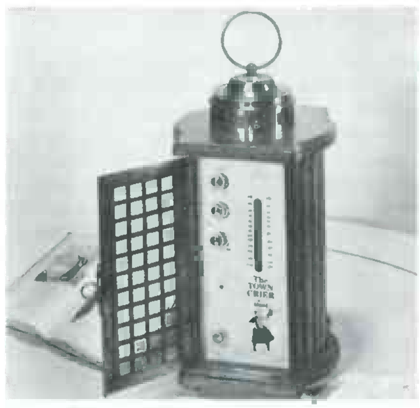
The "Cradle-Pak" is a new **Aerovox** design for shipping and storing tubular axial-lead capacitors. Special die-cut openings into the pack permit quick testing without removing the capacitors. Now available in the 3″ x 5″ Cradle-Pak is the Type CRE 85° C tubular aluminum-cased electrolytic capacitor featuring ratings from 3 to 150 volts DC.

Circle 54 on literature card

Solid State Amplifier (130)

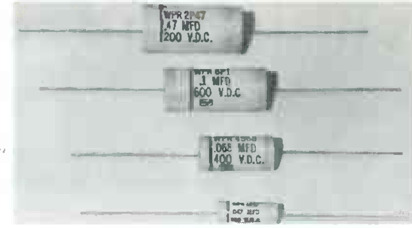
The "Award A700," a 70-watt integrated stereophonic amplifier, is a new product of **Harman-Kardon, Inc.** The unit contains a solid-state power supply plus output transformers that permit it to achieve a frequency response within ±1 db from 12 to 70,000 cps.

Features are: a stereo headphone receptacle, an illuminated push button on-off switch, a "blend" control, and blend and indicator lights. The A700 is also equipped with a switch for monitoring tapes while recording, separate bass and treble controls for each channel, a zero-to-infinity balance control, and a "stereo contour" control to boost bass energies at low listening levels. The unit, with separate high and low filters, is priced at $199.95.



"Hear Ye, Hear Ye!" (131)

The "Town Crier," an AM-FM radio styled in an Early American lantern case, is a new product from **Guild Radio & TV Corp.** This 8-tube AC/DC set features a solid maple cabinet and solid brass antique-finished fittings. A hand-made wrought-iron bracket is available for wall mounting.



High-Q Caps (132)

Tubular polystyrene capacitors having very high insulation resistances and Q values have been developed by **Cornell-Dubilier.** These capacitors (Type WPR) come in values from .001 to 1 mfd ±20%, and have voltage ratings of 100, 200, 400, and 600 volts DC. They are supplied with a polyester film case and epoxy end seals to provide protection from moisture. Sizes range from .200" in diameter by .9375" in length, to 1.025" by 2.375".

Tuner Cleaner-Lubricant (133)

This new cleaner-lubricant spray for TV tuners will not affect the plastic discs used for channel holders. "Super 100" is manufactured by the **Injectorall Mfg. Co.,** and contains an extra ingredient which keeps tuner contacts clean by preventing oxidation. Each 8-oz. can, equipped with a 6" steel injection needle, sells for $2.95 and is listed as part number 100-8.

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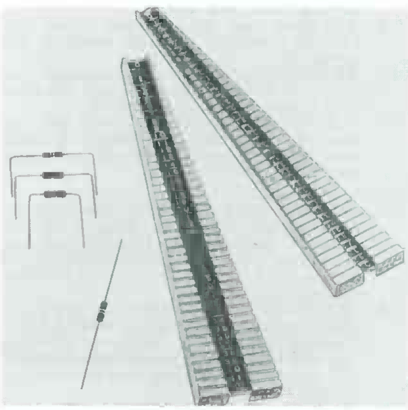
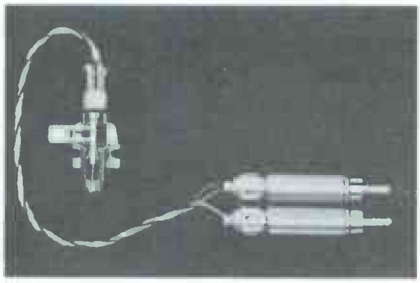


Lead Bending Tool (140)

A hand tool designed to aid in fast, accurate mounting of components on printed-circuit boards, the **Hunter** Lead Bending Gauge eliminates the need for bending and twisting component leads when trying to mount them in hard-to-get-at places. Component leads can be bent to precise measurements, and at any angle desired.

Versatile Two-Way Radio (137)

A battery-operated, portable two-way radio has been introduced by **General Electric.** This unit can be operated from AC line voltage while its batteries are being recharged. Named the "Voice Commander," this 1.5 watt, VHF-FM unit can be used for personal business communications indoors as well as out.



Ceramic Phono Cartridge (138)

A ceramic cartridge which features excellent compliance, channel separation of 30 db, and tracking force of only 1.5 to 3 grams for professional arms and 3 to 4 grams for changers, has been developed by **Sonotone Corp.** The "Mark IV" provides hum-free response over the entire audible range. Unaffected by heat, cold, or humidity, the unit boasts an exact RIAA response characteristic, and can replace existing magnetic cartridges. Equipped with a universal terminal plug for easy replacement and service, the Mark IV also features the breakproof "Sono-Flex" needle.

Ultra-Thin Speaker System (139)

Measuring only 1¾" thick, the **University Loudspeakers** "Tri-Planar" speaker radiates sound from both sides. Contained within this ultra-thin enclosure is a complete three-way system with an unusually large woofer area—264 square inches. With a frequency response of 45 to 18,000 cps, this system is rated at 20 watts. The entire unit measures 15" x 23" x 1¾", and is priced at $79.95. ▲

FREE Catalog and Literature Service

**Check "Index to Advertisers" for further information from these companies.*

ANTENNAS & ACCESSORIES

60. *ANTENNACRAFT*—Catalog sheet, illustrated in color, with information on connecting a UHF and a VHF antenna together using intercoupler G1483W.*
61. *BLONDER-TONGUE*—Home-products catalog describing full line of antenna signal amplifiers, couplers, and converters.
62. *FINNEY CO.* — Brochure describing *Finco* 3000 Series set couplers, traps, filters, and transformers for antenna installations.*
63. *GC ELECTRONICS*—Brochure C-120 describing *Colormagic* fringe antenna.*
64. *JERROLD ELECTRONICS* — Three short-form catalogs describing TV-FM distribution - system equipment, *Taco* TV-FM antennas, and *Powermate* TV-FM antenna preamplifiers for indoor-outdoor applications.
65. *JFD*—Specifications and operating information on *Transis-tenna* and newly designed, long-range LPV log-periodic TV antennas. Illustrated brochure showing entire line of indoor antennas and accessories for TV and FM. Data sheets on UHF antennas.
66. *MOSLEY ELECTRONICS*—Illustrated catalog giving specifications and features on large line of antennas for Citizens band and amateur applications.
67. *WINEGARD*—Informative catalog describing new UHF mast-mounted amplifier Model UHF-110, for regular or translator UHF band.*
68. *ZENITH*—Informative bulletin on new line of log-periodic vee-type antennas for FM, and monochrome and color TV.

AUDIO & HI-FI

69. *AMERICAN MICROPHONE* — New 1964 product directory listing complete line of microphones for home entertainment and professional equipment.
70. *ASTATIC*—Catalogs and brochures describing line of cartridges, needles, and microphones; includes booklet describing *Astatiphone* headphones for use in teaching labs.
71. *ATLAS SOUND, Div. of American Trading and Production Corp.*—New illustrated catalog 563, containing specifications of microphone stands and loudspeakers for use in public address, commercial, or industrial installations.
72. *BENJAMIN ELECTRONIC SOUND*—Illustrated product sheet on *Truvox* Model PD-100, four-track stereo tape deck, with transistorized monitoring preamplifier.
73. *BRITISH INDUSTRIES* — Four comparator guide booklets containing information on *Garrard* automatic changers, *Wharfedale* speaker systems, *Gold Lion* vacuum tubes, and *Multicore* solder.
74. *GIBBS SPECIAL PRODUCTS*—Product bulletin describing *Stereo-Verb* reverberation units for automobiles. Also includes catalog pages, envelope stuffers, cuts, and ad mats for dealer promotions.
75. *JENSEN MFG.*—24-page, 2-color catalog describing stereo and monaural hi-fi loudspeakers, headphones, speaker components, and speaker systems.
76. *MINNEAPOLIS SPEAKER*—Descriptive catalog with illustrations of new weatherproof Music *Mini-Speaker* for indoor or outdoor hi-fi reproduction; also includes information on new 8" speaker.
77. *NUTONE*—Two full-color booklets illustrating built-in stereo music systems and intercom-radio systems. Includes specifications, installation ideas, and prices.
78. *QUAM-NICHOLS*—New hi-fi catalog listing specifications and responses of coaxial, extended-range, low-frequency woofer, and tweeter speakers.
79. *OAKTRON*—"The Blueprint to Better Sound," an 8-page catalog of loudspeakers and baffles giving detailed specifications and list prices.
80. *ROBINS INDUSTRIES* — Condensed catalog listing all types of tape splicers and other tape recording accessories; includes pricing list.
81. *SONOTONE*—4-page brochure containing information on *Velocitone Mark IV* stereo cartridge.
82. *SWITCHCRAFT*—Product bulletin No. 134, describing stereo *Littel-Jax* 14B, for cutting out speakers when using stereo headphones, or for use in three-wire input circuits.*
83. *UTAH* — New data sheet describing speakers for commercial applications.
84. *VIKING OF MINNEAPOLIS*—Group of catalogs on audiophile tape recorders, professional tape transports, tape cartridge handlers, and tape cartridges.
85. *WATERS CONLEY*—Booklet "Selective Guide to Hi-Fi" and product sheet listing line of *Phonola* equipment.

COMMUNICATIONS

86. *CADRE*—New booklet "Businessman's Guide to Citizens Band 2-Way Radio" answers questions, and explains uses for two-way in commercial operations.*
87. *E. F. JOHNSON*—Booklet 838, entitled "All About Two-Way Radio for Business or Personal Use."
88. *PEARCE SIMPSON*—Informative product sheet describing *Escort* Citizens band transceiver for base or mobile operation.
89. *POCKETRONICS* — Brochures describing line of portable paging equipment: receivers, rechargers, encoders, adapters, and leather cases.

COMPONENTS

90. *BUSSMANN*—Bulletin SBCU on Buss Fustat Box Cover Units offers simple, low-cost way to protect workbench tools, soldering irons, drills, and the like against damage and burnout. Units fit standard outlet or switch boxes; have fuseholder, plus a plug-in receptacle, switch, and pilot light.*
91. *GENERAL ELECTRIC* — Abstracts of application notes on semiconductor rectifiers, silicon controlled rectifiers, and gate turn-off switches. Literature on general applications, circuit designs, and test circuits is described.
92. *JENSEN INDUSTRIES*—Replacement-cartridge catalog, listing complete line of snap-ins and standard types, including cross reference charts.
93. *MERIT*—General catalog and replacement guide, listing manufacturers' part numbers, with cross reference to replacements.*
94. *SEMITRONICS* — Product catalog of semiconductors, including transistors; rectifiers; germanium, silicon, and selenium diodes.
95. *SPRAGUE*—Latest catalog C-615 with complete listings of all stock parts for TV and radio replacement use, as well as *Transfarad* and *Tel-Ohmike* capacitor analyzers.*
96. *TRIAD* — Informative engineering bulletin on transformers for applications in transistorized power supplies.

SERVICE AIDS

97. *ADMIRAL*—Brochures describing 1964 line of radios, stereo hi-fi, color television, and black-and-white television.*
98. *CASTLE* — How to get fast overhaul service on all makes and models of television tuners is described in leaflet, which also contains a comprehensive list of universal and original - equipment tuners. Shipping instructions, labels, and tags are also included.*
99. *OELRICH PUBLICATIONS*—32-page catalog of TV service order forms, salesbooks, file systems, message minders, job tickets, and other related business items.
100. *SETCHELL-CARLSON*—Large product booklet illustrating new line of *Unit-Ized* TV chassis, including color TV; also lists other types of home entertainment equipment.
101. *STANDARD KOLLSMAN* — Tuner replacement guide, covering all TV sets from 1947 through 1962, with replacement parts listings.*
102. *WORKMAN*—Literature describing new transistorized auto ignition system, with switch to allow either transistor or standard operation.*
103. *YEATS*—The new "back-saving" appliance dolly Model 7 is featured in a four-page booklet describing featherweight aluminum construction.

SPECIAL EQUIPMENT

104. *ACME ELECTRIC* — Complete specifications and applications for control-type magnetic amplifiers with capacities from 5-1000 watts and voltage ranges from 24-160 volts.*
105. *AMPROBE INSTRUMENT*—Literature describing new AC wattmeter, miniature strip chart recorder Model LAW 50, and other types of electronic recording units and accessories.
106. *GATOR-PROBE CORP.* — Literature describing new test probe that features interchangeable tips and adjustable length, permitting one pair of tests leads to serve for several jobs.
107. *GREYHOUND*—The complete story of the speed, convenience, and special service provided by the Greyhound Package Express method of shipping, with rates and routes.*
108. *PHILMORE*—Bulletin describes code oscillator with variable tone control; operates with built-in speaker or earphone.
109. *VOLKSWAGEN*—Large, 60-page illustrated booklet "The Owner's Viewpoint" describes how various VW trucks can be used to save time and money in business enterprises; includes complete specifications on line of trucks.

TECHNICAL PUBLICATIONS

110. *CLEVELAND INSTITUTE OF ELECTRONICS*—"Pocket Electronics Data Guides" with handy conversion factors, formulas, tables, and color codes. Additional folder, "Choose Your Career in Electronics," describes home-study electronics training programs, including preparation for FCC-license exam.
111. *MOTOROLA TRAINING INSTITUTE*—Brochure describing 38-lesson home study course on servicing two-way radio, including section on transistors.
112. *RCA INSTITUTES* — 64-page book "Your Career in Electronics" detailing home study courses in TV servicing, communications, automation, drafting, and computer programming; for beginners and experienced technicians.*
113. *HOWARD W. SAMS*—Literature describing popular and informative publications on radio and TV servicing, communications, audio, hi-fi, and industrial electronics; including special new 1963 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

114. *B & K*—Catalog AP-21R describing uses for and specifications of new Model 1074 Television Analyst, Model 1076 Television Analyst, Model 850 Color Generator, Model 960 Transistor Radio Analyst, new Model 445 CRT Tester-Rejuvenator, new Model 250 Substitution Master, Model 375 *Dynamatic* VTVM, Model 360 *V-O-Matic VOM*, Models 700 and 600 *Dyna-Quik* Tube Testers, and Model 1070 *Dyna-Sweep* Circuit Analyzer.*
115. *EICO*—1964 test equipment catalog and catalog sheets on new Model 430 small general-purpose oscilloscope with 3" screen, and on Model 902 IM-Harmonic Distortion Meter and AC VTVM.*
116. *HICKOK* — Complete descriptive and operating information on Model 661 *Chrom-Aligner* standard NTSC color-bar generator.
117. *JACKSON*—Complete catalog describing all types of electronic test equipment for servicing and other applications.
118. *MAGNAVOX* — Descriptive sheet on Model 480 Stereo FM generator kit, for alignment of multiplex translators; includes information on other types of service aids and tools.
119. *SECO*—8-page bulletin describing company's complete line of modern tube testers.*
120. *SENCORE*—Question-and-answer bulletin on CA122 *Color Circuit Analyzer* and CG126 Color Generator.*
121. *SIMPSON*—Latest series of VOM's are described in test - equipment bulletin; also information on line of automotive test equipment.*

TOOLS

122. *BERNS*—Data on unique 3-in-1 picture-tube repair tools, on *Audio Pin-Plug Crimper* that enables technician to make solderless plug and ground connections, and on new-style *ION* adjustable "beam bender" for CRT's.*
123. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering techniques for speeding up and simplifying operations on PC boards.*
124. *HUNTER TOOLS*—Short-form catalog listing all types of special tools for electronic applications, including alignment tools, pliers, wire strippers, etc.
125. *PORTABLE ELECTRIC TOOLS, INC.*—*Shopmate* catalog and price bulletin, and catalog sheets illustrating entire line of *Shop-Craft* power tools.

TUBES & TRANSISTORS

126. *AMPEREX* — Catalog specifically devoted to extensive line of silicon planar epitaxial transistors. Describes applications for different types, with their basic specifications.
127. *GRODEN INC.*—New, condensed semiconductor catalog listing complete line of components.

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