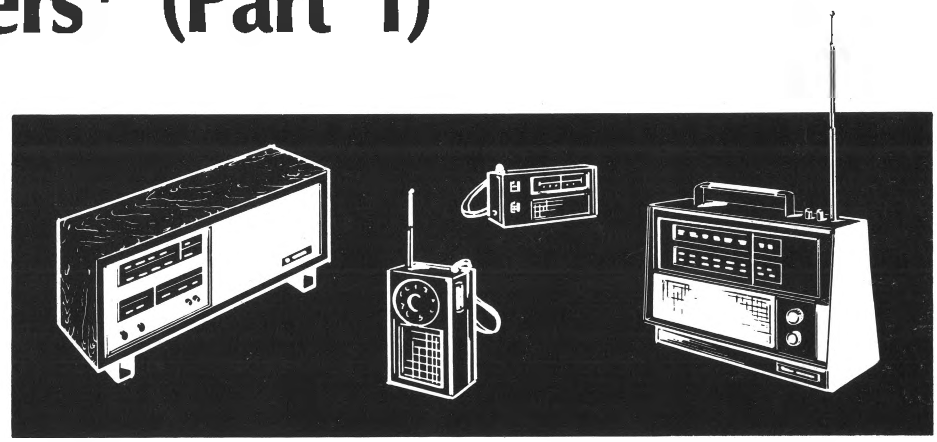
SYLVANIA NEWS
M.N. WILDEMANN: TECHNICAL EDITOR
TECHNICAL INFORMATION OF INTEREST TO THE INDEPENDENT RADIO/TV SERVICE TECHNICIAN

Profitable Servicing of Solid-State AM Receivers* (Part 1)



With the economies provided by present-day, solid-state technology, improved manufacturing techniques, and the advent of the "discount" store, AM receiver prices have been reduced to levels never before thought achievable. This has thrown a further burden on the service technician already struggling to operate a profitable service business in an increasingly inflationary era. Upon him falls the onus of making the decision—vital to himself and the customer—of whether or not to undertake diagnosis and repair of a given receiver. At what point can he be certain that servicing of the set will be both profitable for him and economical for the customer? In short, should the receiver be repaired or replaced?

Hard and fast rules are hard to come by. Of primary import to the service technician is his ability to estimate 1) the amount of service time likely required to diagnose and make the repair, and 2) the availability and cost of replacement parts. With adequate background knowledge and a thoroughly systematic approach to servicing, the technician is properly armed to make repair of all but the least expensive AM receivers a profitable part of his business.

To this end, this article (to be continued in the next issue) presents a logical approach to the servicing of solid-state AM receiver circuits so that the service technician can attack the problem in an organized manner and quickly recognize symptoms without being led astray by false indications. Worth brief mention at this point, too, is the contribution the Sylvania line of ECG replacement semiconductors can make to this part of the servicing business. The skill that permits the rapid isolation of a failed semiconductor leads to frustration and a dead end if a suitable replacement part is not easily available. Almost 90,000 foreign and domestic solid-state device types which are replaced by the ECG line of semiconductors are currently listed in the ECG literature.

Troubleshooting AM Receivers

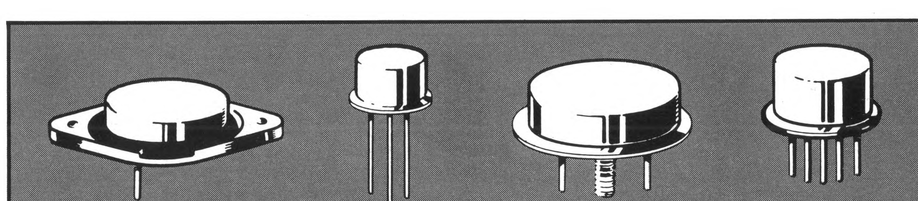
The servicing techniques applied to solid-state equipment are the same, in principle, as those employed in vacuum-tube circuitry; differences exist only in details. If these details are overlooked, however, much time can be wasted and needless damage to equipment may result.

In order to help familiarize you with logical diagnostic techniques, we'll begin the discussion on troubleshooting AM transistor radios, including portable types, with a common fault to which straightforward troubleshooting methods may be easily applied: a completely dead receiver.

Analyzing a "Dead" Receiver

Preliminary Checks—Many causes of complete failure may be localized with a few simple tests. The following tests can be made in a few minutes and do not require any measurements to be made other than those available at the dc power-supply terminals. These tests are:

1. visual inspection
2. battery voltage (if a battery-operated type)
3. total current drain
4. speaker-circuit click test
5. local-oscillator test
6. agc test



Visual Inspection—Many failures, particularly in portable types, follow accidental dropping of the radio. A visual inspection should be made to locate physical damage. Check the fine wires leading from the loopstick antenna for breaks at tuning capacitor or printed-circuit terminals. Inspect the loopstick for cracks and see if the tuning capacitor turns freely. Leads to the volume control, speaker, earphone jack, and battery should also be inspected for breaks. The printed-circuit board should be carefully inspected for cracks. Flex the board at several points by applying slight pressure with the eraser end of a pencil. Momentary return of sound indicates a crack in a printed circuit conductor or a poor connection to a component lead. Careful inspection in the sensitive area may locate the fault.

In portable sets, which employ a battery or several batteries, make sure the battery(s) have been inserted correctly. An instruction sheet is usually affixed near the battery case, or the ends of the case may have polarity marks. Reversing the battery polarity may result in burnout of transistors and electrolytic filter and decoupling capacitors.

Battery Voltage—The more frequent causes of failure in portable radios are weak batteries. The receiver should operate if the battery voltage is about 2/3 of its normal rating. At lower voltages the receiver may be weak and distorted or may motorboat. Complete loss of sound may also result due to failure of the local oscillator. Check the battery voltage under load by checking terminal voltage while the battery is connected to the receiver with the switch turned on. As an alternative, the battery may be checked by placing an external load resistor across its terminals. Choose a resistor to draw about 20 mA at the rated terminal voltage. If the battery shows a terminal voltage less than 2/3 of its rating under load, replace it with a fresh unit.

Total Current Drain—Many circuit failures alter the dc operating conditions of one or more stages. A failure which greatly alters the operating point of a single stage may be detected by measuring the total current drain of the receiver. This measurement is made by simply placing a milliammeter in series with the battery leads. Total current drain is given by some manufacturers in the service notes. The figure is usually given for no-signal conditions. A high reading indicates a shorted or leaky filter or decoupling capacitor, or a transistor stage which is conducting too heavily. A low reading is usually the result of an open transistor or a break in the dc circuit of a stage.

If the normal no-signal current drain is not known, it may be estimated roughly by allowing 0.5 mA to 1 mA for the converter stage; 1.5 mA for each IF and audio-driver stage, and 4 mA for a class-B push-pull stage. If a personal portable uses a single class-A output stage, allow about 4 mA for the output stage. The detector, whether a diode or a transistor, draws negligible current under no-signal condition. The currents given for each stage include the current drawn by the base-bias circuits. The current drain of a six-transistor or portable using a push-pull output stage and two if stages is estimated as follows:

converter	0.5 mA
if amplifiers (2)	3 mA
audio driver	1.5 mA
output stage	4 mA
Total	9.0 mA

If the measured current drain is zero, a break is indicated in the supply circuit. The small on-off switches employed in personal portables are a common cause of this fault.

A current reading which differs from the estimated no-signal current drain ±50 percent indicates either a radical change in the operating conditions of a stage or a shorted decoupling capacitor. Signal-tracing tests may then be dispensed with and the trouble localized by dc tests alone. Methods for measuring the current drain of individual stages are shown later. If current drain is about normal, the following preliminary checks may localize the fault. If not, more exhaustive checks must be applied.

Speaker-Circuit Click Test—This test localizes faults in the collector circuit of the output stage. Hold the speaker close to the ear and turn the power switch on and off. A definite click should be heard. The mechanical click of the control may mask the click in the speaker. If so, leave the switch on and make and break one of the battery connections. If no click is heard, an open exists either in the speaker, or the primary or secondary of the output transformer, or the connections to the earphone jack. As shown in Figure 1, a bent or broken, normally closed contact on the earphone jack, or a broken terminal connection on the jack is a common cause of trouble.

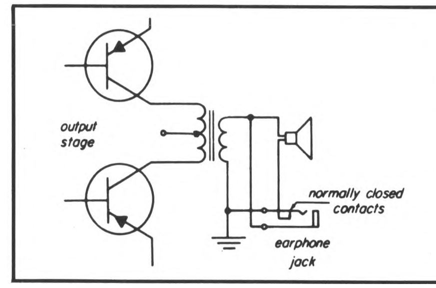


Figure 1. Speaker-Headphone Circuit in Typical Transistor Portables

Local-Oscillator Tests—A quick check of local-oscillator operation may be made without opening the case of the receiver. Tune another receiver to a station between 1000 KHz and 1500 kHz. Place the transistor receiver under test close by, and rotate the tuning dial slowly through the range of 545 kHz to 1045 kHz. If the oscillator is operating, it radiates signals in the 1000-kHz to 1500-kHz range. Oscillation is established when the radiated signal beats with the signal to which the auxiliary receiver is tuned. A loud whistle is heard in the speaker of the auxiliary receiver. If no zero beat can be heard, the trouble has been localized to the local oscillator.

AGC Test—The collector current of controlled if stages varies from one milliampere to a few tenths of a milliampere when signal conditions vary from very weak to very strong. This change in current can be detected by monitoring the total drain of the receiver. If a dip in total current drain is noted while slowly rotating the tuning dial, the converter, if amplifier, detector, and agc systems must be functioning. Trouble is therefore indicated in the audio section. This test may not be conclusive unless there is at least one strong local station. The receiver must be tuned carefully because the drop in total current is small and may be missed if the set is tuned too rapidly.

Note that an increase in total current drain when tuning in a station indicates audio drive to the class-B output stage. If a large increase in total drain is noted and no sound can be heard, the trouble is probably in the speaker circuit.

Localizing the Defective Stage—The preliminary checks should have eliminated the local oscillator and the collector circuit of the output stage as possible causes of trouble. The agc test might also have indicated whether the trouble precedes or follows the detector stage. To further localize the trouble to a single stage, the receiver chassis has to be removed from the case and signal-tracing or signal-injection methods applied.

Signal-injection methods are the same, in principle, to those employed in vacuum-tube circuits. The ground side of an audio generator is connected to either terminal of the battery. The test signal is then injected through a 0.1-µF capacitor to various points in the audio circuit. Starting at the collector terminal of the output stage, adjust the generator for an output signal that is just audible. The free end of the coupling capacitor is then moved back towards the volume control touching in sequence the points numbered in Figure 2. Note that a signal voltage is being injected. All transformers in the transistor radio have a voltage step-down ratio. Thus, when moving the injected signal from point 2 to 3, a definite drop in volume should be expected. When moving the probe from the collector to base (from point 3 to 4), a large increase in volume should be heard. Always reduce the attenuator setting of the signal generator to maintain a low output volume, or the effect of agc or signal overload may hide the true change in volume. Failure to produce an output at any point localizes the trouble between the point where the signal was last heard and the point where no output can be produced. DC voltage checks should then be made to localize the fault to a component.

If an audio output can be produced with a low-level signal applied at the volume control (about 3 millivolts), the audio section is eliminated, and trouble is indicated in or ahead of the detector. (A method for determining a 3-millivolt signal is given later.) Signal injection, using a modulated rf-signal generator tuned to 455 kHz, should continue as shown in Figure 3. A 0.005-µF or larger

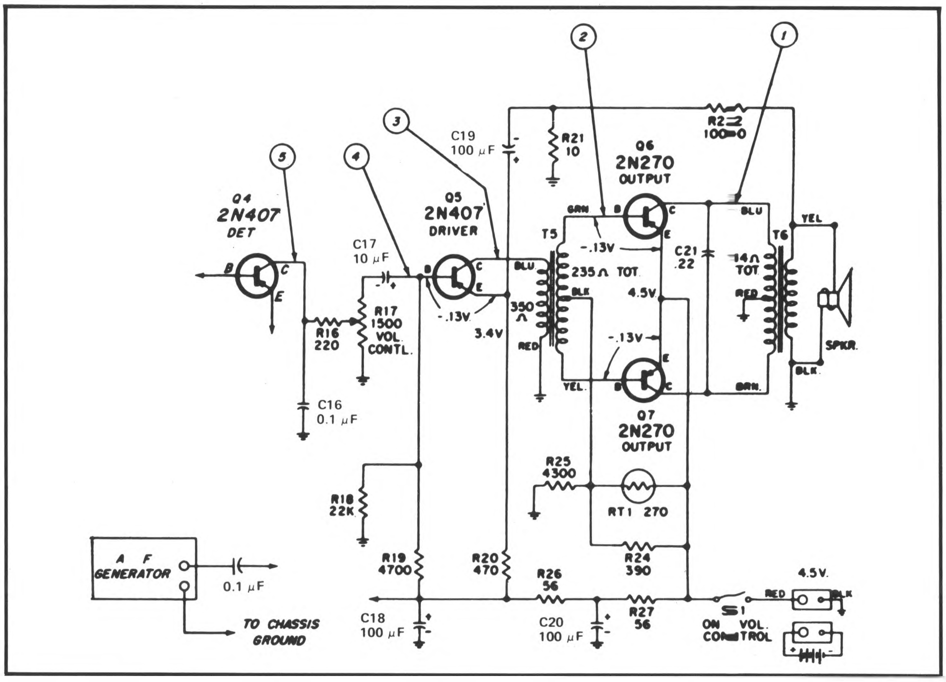


Figure 2. Signal Injection Points in Audio Circuits.

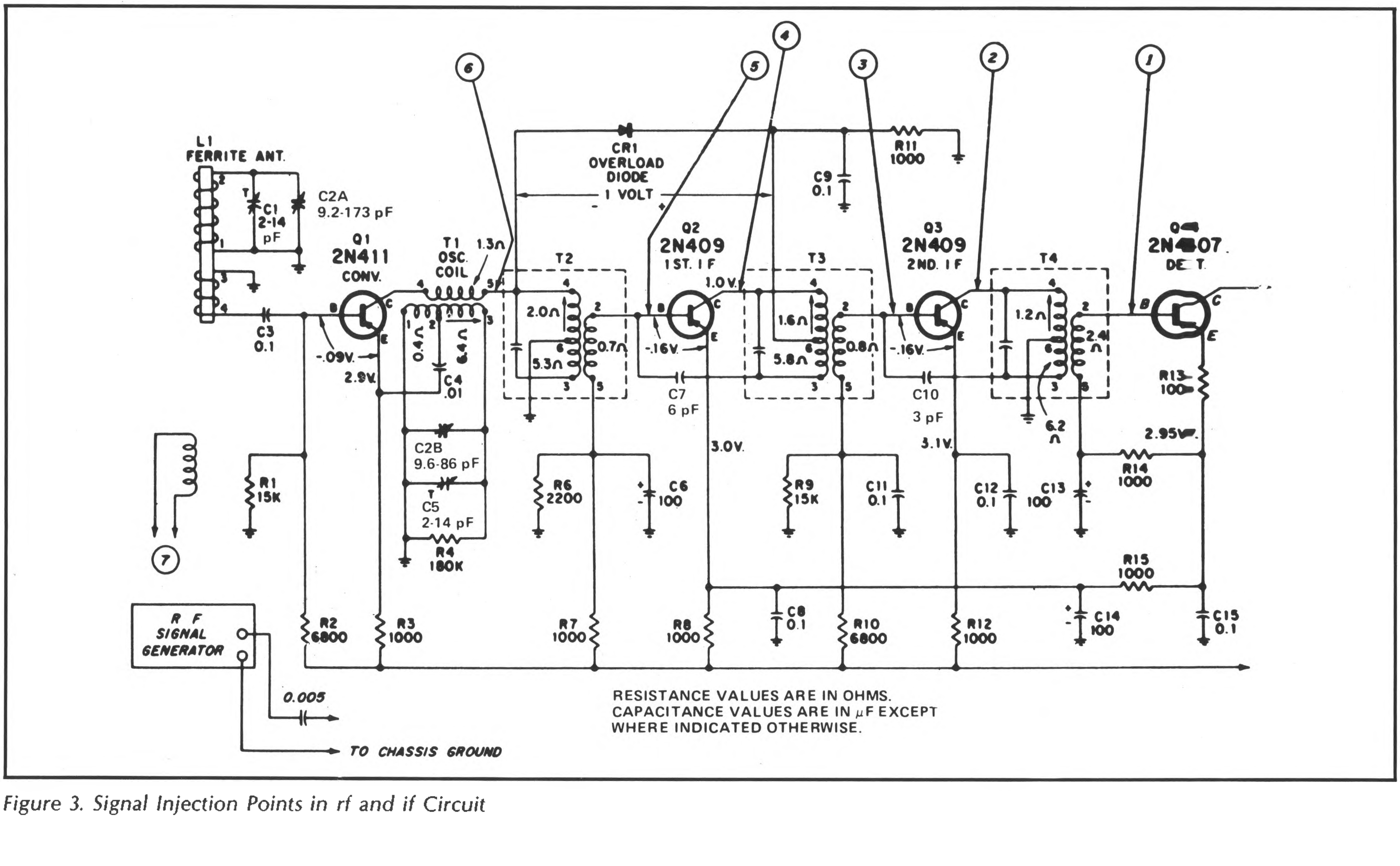


Figure 3. Signal Injection Points in rf and if Circuit

capacitor should be used for coupling the generator to these stages. The same procedure applies: a drop in volume should be noted when the probe is moved from the secondary of a transformer to the primary and a definite rise in volume should be noted when moving the injection probe from collector to base of a stage.

Trouble is indicated in the rf tuning section if a low-level (10 microvolt) signal applied to the base of the converter at 455 kHz produces an output. To check the rf tuning section, the rf signal should be injected in such a way that the output resistance of the signal generator does not load the resonant tank. A suitable coupling system can be made using a loopstick antenna or an air core coil. The latter may consist of 15 to 20 turns of hookup wire wound upon a two-inch coil form. The coil is connected across the output of the signal generator and is positioned about 6 inches to 12 inches away from the loopstick antenna in the receiver under test. The amount of coupling may be adjusted by varying the spacing. This coupling arrangement is also very useful for aligning the rf section of the receiver.

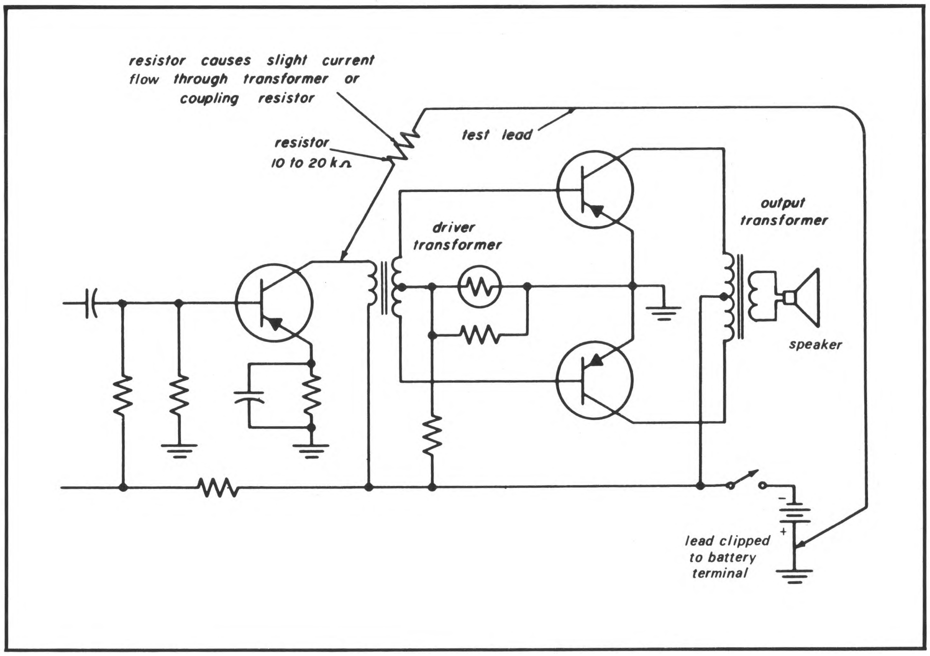


Figure 5. Making Click Tests Without Danger of Transistor Damage

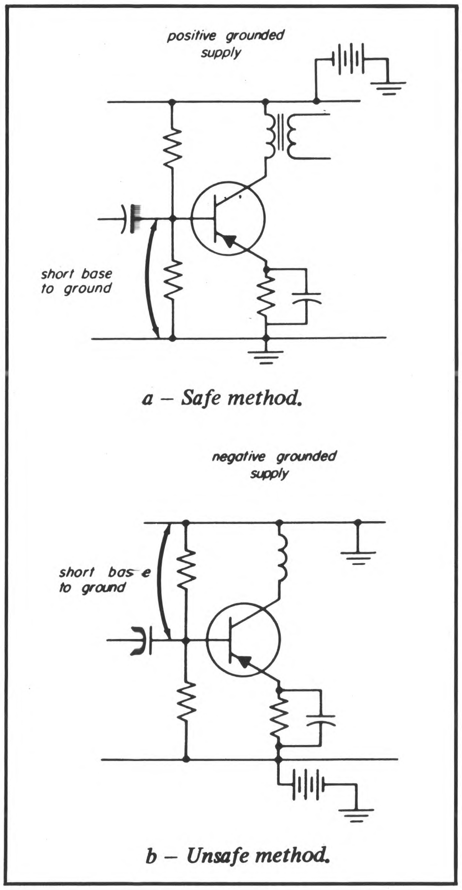


Figure 4. Click Tests

Some service technicians prefer signal-tracing. This method, using a high-gain amplifier preceded by a detector, traces the signal from the antenna to the speaker (reverse of signal injection). With this method an rf signal may be injected by means of the coupling coil. The signal-tracer probe is placed across the loopstick antenna in the receiver, and the volume control on the signal tracer is adjusted to obtain an output in the headphones. The probe is then moved from point to point towards the speaker in the reverse order from that shown in Figures 2 and 3. Here again, remember that the coupling transformers step down the voltage so that volume normally drops when going from primary to secondary.

Click Tests—Many service technicians are accustomed to injecting signals into vacuum tube audio circuits by the "finger" method. Placing the finger on the arm of the volume control in a vacuum-tube set, for example, produces a loud hum in the speaker. This method does not work at all in transistor circuits because of the very low impedance of the input circuit as compared to that of the vacuum tube's grid circuit.

A favorite service test is to inject a transient signal by momentarily shorting the grid of a tube to ground (chassis). This test may also be applied in transistor circuits but certain precautions must be observed or damage may result. To illustrate, consider the audio circuit shown in Figure 4a. Shorting the base to the chassis (or the ground conductor on the printed-circuit board) removes the forward bias applied to the transistor. A momentary removal of bias cannot damage the transistor and the disturbance produces an audible click in the speaker if this stage and the following stages are functioning. If the same test is applied in the circuit shown in Figure 4b, burn-out of the transistor is the likely result. In this case the short returns the base directly to the negative side of the battery, placing a high forward bias on the emitter junction. Many receivers are wired as shown in Figure 4b with the negative side of the battery returned to ground.

To insure safe click tests the setup shown in Figure 5 is recommended. A 10-kilohm to 20-kilohm resistor limits the current flowing in the test probe even if it is accidentally placed in the wrong spot. By returning the probe to the positive side of the battery, the base bias of a transistor is reduced when the base is touched. If n-p-n transistors are used, return the probe to the negative side of the battery.

The click test is used just as in signal injection by starting at the output stage and working towards the antenna. A break in the signal path is indicated when touching the base of a transistor does not produce a click in the speaker.

(To be continued in next issue)

What's New in Color Picture Tubes?

David L. Smith, Applications Engineering Laboratory, Electronic Tube Division

Since the advent of color television, many types of color tube systems have gained wide-spread acceptance. There are: delta guns, in-line guns; 36-mm (OD) necks, 29-mm (OD) necks; dot screens, line screens; aperture masks, slotted masks, grill masks; 70-degree, 90-degree, and 110-degree deflection angles; non-matrix (conventional) screens, positive guard band matrix screens, and negative guard band matrix screens (matrix-type screens was the subject of an article in a prior issue of *Sylvania News*); saddle yokes, toroidal yokes, and combination saddle/toroidal yokes. This listing is not meant to imply that all the possible permutations exist, for they do not. However, many more combinations could be made than are presently available.

Because of the increasing frequency with which the service technician can expect to encounter some of these new systems, this article will briefly survey the major new technologies to fill in some of the gaps that may exist in his knowledge.

Each of the color tube systems actually placed on the market has been selected by the receiver manufacturer for a variety of reasons, including consideration of such factors as cost, performance, manufacturability, evaluation of competitive product offerings, and, perhaps most important, the manufacturer's best judgment of potential consumer acceptance in the constantly changing market place.

Needless to say, in the development of a new color system, close co-operation is required at each step of the way between CRT manufacturer and receiver circuit designer. Of major concern to the CRT designer is the ultimate impact of the new design on the service technician—including such characteristics as reliability and accuracy and ease of tube setup.

Delta and In-Line Systems

One principle of a color system is to provide tri-color information to the color picture tube's gun and then separate this information as a tri-color visible display at the screen. A conventional delta system, as shown in Figure 1, has the three guns positioned in a triangular configuration and the phosphor dot trios similarly arranged in a triangular configuration. The beams converge at the shadow mask and then diverge sufficiently to provide visible red, green, and blue information at the screen. Figure 2 illustrates a Sylvania delta electron gun assembly.

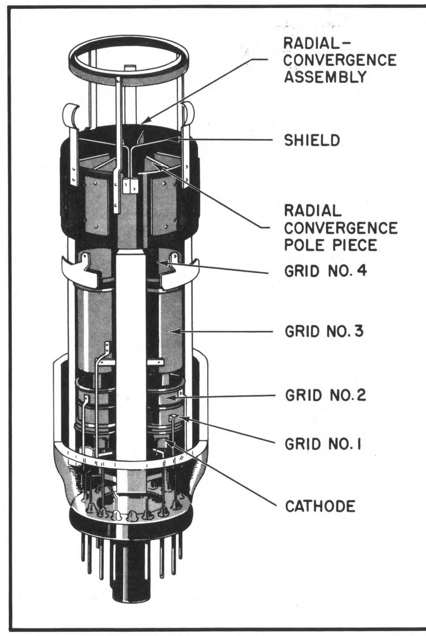


Figure 2. Sylvania Sharp-Focus Delta Electron Gun Assembly

A departure from the classical delta approach has gained considerable interest recently. This in-line system, as shown in Figure 3, provides three guns in a horizontal line and, of course, three beams in a similar configuration. These beams also approach a shadow mask, converge, and then diverge to separate the color information at the screen. This will be discussed at greater length later. Figure 4 illustrates a Sylvania in-line electron gun assembly.

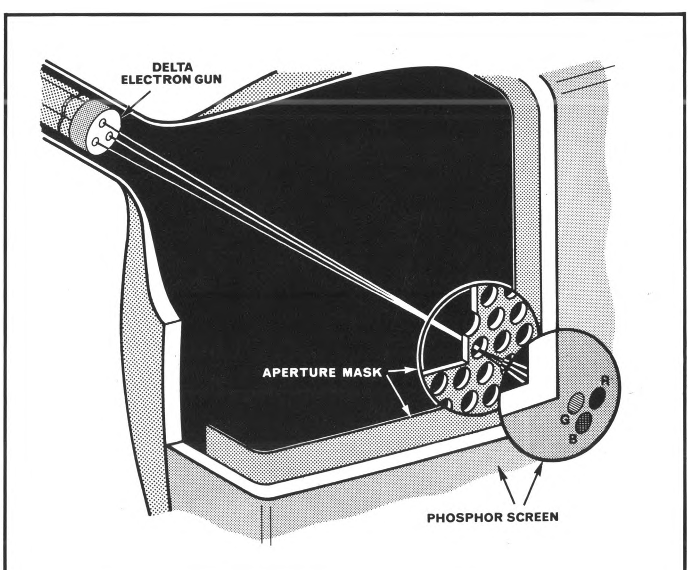


Figure 1. Conventional Delta Gun, Shadow Mask, and Tri-Dot Screen Arrangement.

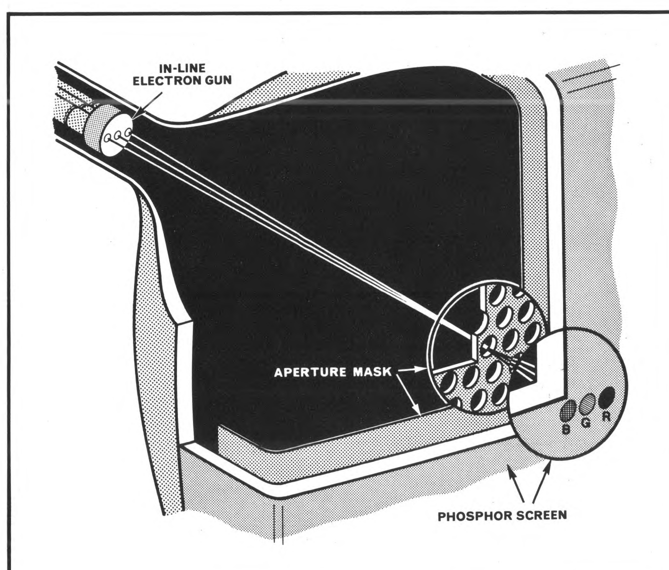


Figure 3. Large Neck, In-Line Gun Arrangement

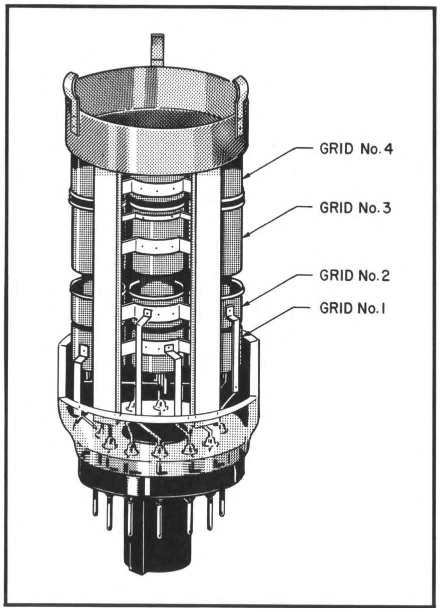


Figure 4. Sylvania Precision-Focus In-Line Electron Gun Assembly

The move to this in-line concept has reduced convergence complexity, shortened the tube, and allowed the use of a quadripole toroidal yoke. The quadripole toroidal yoke allows dynamic convergence to be achieved with only 4 controls compared to 12 or 13 on a similar delta system. The low-impedance characteristic of the toroidal concept is convenient for solid-state drive.

Up until now, in-line tubes have only partially benefited from the horizontal beam array. The next step—a line screen. The line screen consists of alternating vertical stripes of red, green, and blue phosphor, and as always, a method of separating the beams when they reach the screen. This can be done with openings in the mask running the full height of the screen (grill mask), or shorter, stronger slots with interconnecting "webs" (slotted mask) to add strength. The latter is most promising, especially with spherical faceplates and for the larger tube sizes. Current Japanese grill-mask constructions employ cylindrical rather than spherical faceplates; this results in a heavier tube which also suffers from a narrower viewing angle.

To fully understand the registration advantages of a line screen, consider that the beam landings of a conventional hole mask tube move in or out, with respect to the center, as the yoke is moved forward and backward along the neck of the tube. This is shown in Figure 5. Bear in mind that the beam landings of all three electron guns are affected equally. Also, the "rotational" effect of the component of the earth's magnetic field parallel to the tube neck moves the beam landings tangentially when the receiver is facing magnetic North or South as shown in Figure 6.

Since any dot screen array (delta or in-line) can produce registration errors in two directions (and their vector sums at the corners) due to shifts in beam landings, a line screen is of interest since it eliminates concern for errors in a vertical direction. This is illustrated in Figure 7.

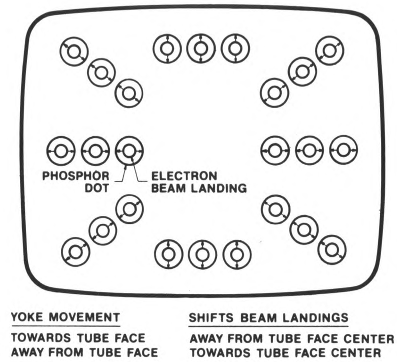


Figure 5. Effect of Yoke Movement on Registration (In-Line Beams with Hole Mask)

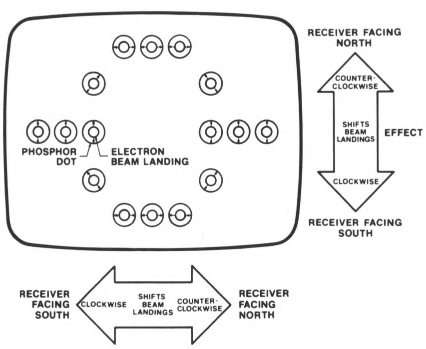


Figure 6. Effect on Edge Beam Landing by Horizontal Component of Earth's Magnetic Field (In-Line Beams with Hole Mask)

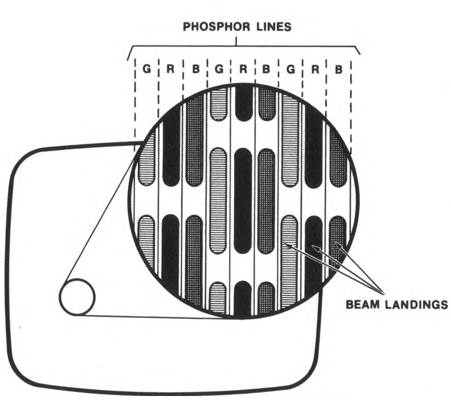


Figure 7. Representative Line Screen

Integral Tube and Components Assembly (ITC)

All systems discussed so far are similar in that the yoke must be adjusted on the neck for purity, static convergence and purity must be set, and dynamic convergence must be adjusted by the receiver maker or service technician.

The Sylvania integral tube and components assembly (ITC) approach shown in Figure 8 requires none of this, from the user's standpoint. The ITC tube is supplied with yoke, static converger, and purity magnets preset. There are no dynamic convergence controls. This tube combines an in-line gun, 29-mm neck, slotted mask, and a line screen.

The basis of this system is a yoke permanently fastened to the tube. Before the yoke is cemented in place, it is adjusted axially along the neck of the tube to optimize registration both vertically and horizontally with respect to the tube axis to optimize dynamic convergence.

The effect of the yoke positioning is explained in the following:

1. Moving the yoke left and right with respect to the neck's axis increases the size of the raster of the gun nearest the yoke (blue or green) with respect to the center gun (red). This effectively converges the horizontal lines at the top and bottom and the vertical lines at the sides.
2. Moving the yoke in an up or down motion tends to "rotate" the lines of the outside guns (blue and green) with respect to the line of the center gun (red). This converges the vertical lines at the top and bottom and the horizontal lines at the sides.

Since no service adjustment of the yoke will be required, the full details of setup are of only passing interest.

It is obvious that the appeal of a self-converging system will gain widespread acceptance. Because of this, it is not unreasonable to expect a system to be developed where the yoke can be positioned in the field to obtain optimum convergence. The ITC approach encompasses 15V-90° non-matrix, 17V-90° matrix, and 19V-90° matrix versions.

The service advantages of ITC are apparent:

1. *No setup required* (except, perhaps, for a slight touch-up of static convergence and purity).
2. Simple tube/yoke assembly replacement—no more complex than monochrome.
3. Less shop time—replacement could be done in the home, even without a crosshatch generator in most cases.

The extreme precision of the ITC electron gun is achieved in part by the use of common G_1's (control grids) and common G_2's (screen grids). In the case of the G_1's and G_2's, the grids are formed in one piece, thereby minimizing any spacing errors to very small errors in tooling. Of course with common G_1's and G_2's, the cathodes must be independent of each other.

In the case of conventional color tubes, each element is individually controllable (cathodes, G_1's and G_2's), making tracking quite straightforward. The ITC, however, requires a modified procedure. Only one screen (cathode-to G_2 bias) control and one drive (cathode-to-G_1 bias) control are available. Luminance and chrominance matrixing must take place in circuitry before the ITC tube, instead of within the tube, which has been the more conventional way. One set of three additional controls provides control of the bias of the video drivers.

A typical gray-scale tracking procedure would be:

1. Collapse vertical scan with service switch.
2. Adjust drive control fully clockwise, and the bias controls and screen control fully counterclockwise.
3. Adjust the screen control until a line is just barely visible.
4. Adjust the bias controls to produce three barely visible lines of equal brightness.
5. Restore vertical scan by returning service switch to normal.
6. If desired white screen color is not obtained, turn down drive control of unwanted color.

While the names of some of the controls are different, this procedure is not really much different from the procedure used on conventional receivers without service switches.

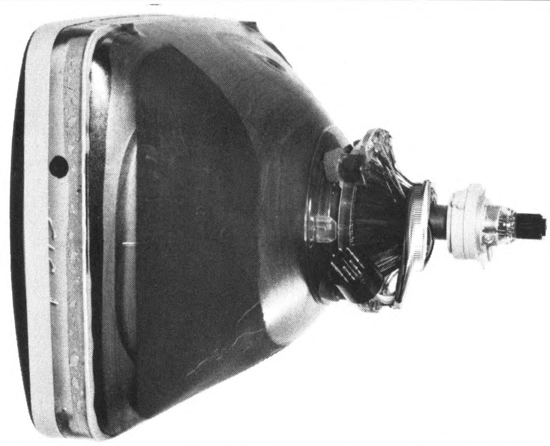


Figure 8. Sylvania Integral Tube and Components Assembly (ITC)

The ITC approach has gained rapid acceptance among TV set manufacturers. Not only does it present benefits to the manufacturer, but the service technician and customer are certain to benefit as well.

Foreign Constructions

While 18V-110° and 19V-110° deflection systems are not unknown in the United States, various foreign tubes of these types are being manufactured and have already become available here. The following listing is not meant to be all inclusive, but merely indicative of the wide variety of color tubes available from Japan:

1. Sharp Linytron
   - 13V-90°
   - 19V-110°

In-line gun, slotted mask, line screen, narrow neck, saddle/toroidal yoke.

2. Toshiba Blackstripe
   - 13V-90°

In-line gun, slotted mask, line screen positive guard band vertically and negative guard band horizontally, narrow neck.

3. Sony Trinitron
   - 17V-90°
   - 17V-114°
   - 19V-114°

In-line gun, grill mask (full-length slots), line screen, common focus, saddle/toroidal yoke, cylindrical faceplate.

4. Toshiba Rectangular In-line System (RIS)
   - 19V-110°

In-line gun, large neck but with power efficiencies of narrow neck because of rectangular yoke and funnel section, saddle/toroidal yoke.

30-kV Operation

Considerable activity recently has involved an industry shift to operation at higher anode voltage (30 kV or higher from the present 25 or 26-kV levels used for the larger tube sizes). The advantages of such a change can be in improved sharpness or improved brightness, or both. Testing has shown that at equal picture tube current, a change from 25-kV to 30-kV operation results in a 10-percent improvement in spot size and a 20-percent improvement in brightness.

Of course since brightness is of great concern in the market place, brightness could be emphasized. If the current is increased on a tube operated at 30 kV, sharpness can be brought down to a 25-kV level. In this case of equal sharpness, the resultant brightness improvement could be 30 percent due to the extra current; this plus the 20-percent increase which results from the higher anode voltage itself results in over a 50-percent brightness gain without going below the 25-kV level of spot quality!

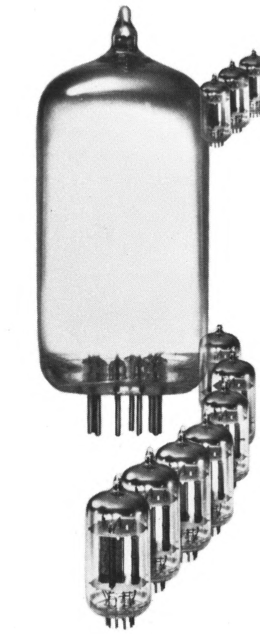
Of course other tradeoffs would be possible, but these two examples indicate some of the possibilities. Higher anode voltage operation can be used with all screen sizes, all deflection angles, and all screen types. More deflection power would be required.

From an X-radiation standpoint, new glass formulations are presently available to meet the federal government limit of 0.5 milliroentgen per hour. Since CRT's designed to operate at increased anode voltage employ these newer types of glass, for continued protection it is now even more important than ever that color picture tubes be replaced with only exact types.

Latest Receiving Tube Types

Listed below are the most recent additions to the Sylvania full line of quality receiving tubes—the line you can trust for your replacement needs.

See your Sylvania distributor for the ones that provide maximum domestic and foreign type coverage with minimum inventory requirements.



Type	Description
1BH2A	High voltage rectifier used in color TV receivers. Replaces type 1BH2.
3BM2A	High voltage rectifier used in both black & white and color TV receivers. Used by Zenith.
3CZ3A	High voltage rectifier used in color TV. Replaces type 3CZ3.
6DL5/EL95	Power output pentode used in audio amplifiers. Used in imported sets.
6DU3	Damper used in color TV receivers. Used by Zenith.
25HX5	A pentode used as vertical deflection amplifier in color TV receivers. Used in imported sets.
36KD6/40KD6	A beam power pentode used as horizontal deflection amplifier in color TV. Replaces types 36KD and 40KD6.

IN THIS ISSUE

Sylvania News is sent free of charge. Each issue contains information of value to the independent radio/TV service technician. Helpful servicing techniques, new processes, and the latest products are described. Sylvania thus offers its readers an important means of keeping tabs on some of the ever-changing complexities of the electronic servicing industry.

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