This is the fourth and concluding article in a series on the television picture tube. In the last three issues, the physical structure, operation and a number of defects were described. Suggestions on how to eliminate some defects were also included. In this issue, the construction and operation of a picture tube tester will be described.

PICTURE TUBE TESTING

The testing of a picture tube has always been somewhat of a mystery to most service technicians. This has been due primarily to the fact that test equipment manufacturers have been slow to market good usable equipment of this type. The unit described in this article has been designed to provide the technician with a dependable low-cost picture tube tester. This unit incorporates a test for "shorts" which is practically identical to that used in the General Electric picture tube factory.

In the manufacture of picture tubes, a great many tests are made to insure good picture quality and long life. If we exclude tests for screen defects such as blemishes, color, etc., it is a fairly simple matter to determine whether a picture tube is good. The necessary tests are:

1. Check for shorted elements.
2. Check for open connections.
3. Check for leakage between elements.
4. Check for cathode emission.
5. Check condition of cathode.
6. Check for gassy tube.
7. Check for air leak.

The first four tests can be performed on the tester to be described. The fifth check on the condition of the cathode can be made by observation as described in the last issue. The last two tests for gassy tubes or air leaks can be performed with a commercial "sparker" unit. This unit will be described in the section on gas and air leak testers.

PICTURE TUBE TESTER

The unit shown in Fig. 1 can be assembled and wired in a few hours time. The parts required will in most localities cost about $27.00 if all the parts have to be purchased. However, you will probably find that a number of these parts can be found in your "junk" box. This tester will save you many hours time making voltage tests and substituting picture tubes to determine whether the tube or the circuit is defective. The circuit for this unit is shown in Fig. 2. The following is a list of the parts required.

PARTS LIST

1. Thordarson No. T22R01 transformer or equivalent. This type transformer has these voltage windings: 275 ± 0.275 v at 50 ma, 5 v at 2 amp, 6.3 v at 2.5 amp.
2. Mallory No. 1335L switch (this is a 3-gang, 6-pole, 5-position rotary switch).
3. 0.500 microammeter (preferred) or 0-1 milliammeter (3-in. or 3 1/2-in. case).
4. -20,000-ohm, 1-watt potentiometer.
5. 1/16-in. pointer type lar knobs.
6. Octal base tube socket.
8. 20-mfd 50-volt capacitor.
10. General Electric Type NE45 Neon bulbs.
11. Adjustable slide, candelabra base, pilot light sockets.
12. No. 40 pilot light.
light assembly with ½-in. jewel.

1—Picture tube socket with 541 cable. (Picture tube extension cable can be used.)

1—Rud No. CB792 7 in. D x 12 in. W x 3 in. H Metal Utility Cabinet.

1—8 ft a line cord.

1—35,000-ohm 5-watt resistor (1 20K and 1 15K used).

1—10,000-ohm 5-watt resistor.

1—20,000-ohm 5-watt resistor (2 10K used).

1—7,000-ohm 2-watt resistor.

1—1,500-ohm 1-watt resistor.

1—5,000-ohm 1-watt resistor.

1—6,000-ohm 1-watt resistor.

1—10,000-ohm 1-watt resistor.

1—100,000-ohm 1-watt resistor.

1—220,000-ohm 1-watt resistor.

These parts were mounted in a 7 in. x 12 in. x 3 in. Metal Utility box, but any similar type box could be used. A rear view of the completely assembled unit is shown in Fig. 3. The only problem that you may have will be in drilling the metal panel for the meter and neon lamps. A 2½-in. hole was required for the meter shown, and three ½-in. holes were needed for the neon lamps. Since the flange of the meter case usually covers at least ½ in. all around the hole, it can be cut out with a drill and a metal cutting saw.

Keep in mind when wiring the rotary switch that when looking at it from the rear, the terminal next to the rotor terminal is not used. Then come terminals No. 1, 2, 3 and 4 going counterclockwise. You will notice that the switch specified has 5 positions when only 4 positions are required. This type switch normally has a stop-set washer which should be set to limit the number of positions to 4. Since the rotary switch is a six-pole type, one of the front sections which would have been difficult to solder was left unused.

The three candelabra sockets were fastened to the front panel with ½-in. angles soldered to the adjustable slide bracket. This positioned the neon bulbs so they just came through the front panel.

**SHORT-OPEN-LEAKAGE TEST**

When the unit is completely assembled and wired, it is ready to be used. The picture tube socket should be placed on the picture tube which may be either separate or in a receiver. If the picture tube is in a receiver, be sure that the receiver is turned "off" to eliminate the possibility of the voltage on the HV anode cylinder arcing over to one of the other elements inside the tube.

The rotary switch should be turned from the "off" position to the "preheat" position, and left there for three minutes. The switch should then be switched to the "short and continuity" position. If the tube is good, one-half of the G1 and G2 neon bulbs will glow as shown at the top of Fig. 4. You will probably find that the lit half of the G1 and G2 neon bulbs are not in the position shown in Fig. 1. In some instances, the bulbs can be correctly positioned by turning them one way or the other on the sockets. In other cases, it may be necessary to build up the center contact on the bulb base with solder. The neon bulb on the left marked "HV" can be in any position since both sides glow when some element is shorted to the heater.

![Fig. 3. Rear view of Picture Tube Tester.](image)

**REJECTION CRITERION**

<table>
<thead>
<tr>
<th>H</th>
<th>G1</th>
<th>G2</th>
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<tbody>
<tr>
<td><img src="image" alt="Good Tube" /></td>
<td><img src="image" alt="Reject for Open G1" /></td>
<td><img src="image" alt="Reject for Open G2" /></td>
</tr>
<tr>
<td><img src="image" alt="Reject for Open Cathode" /></td>
<td><img src="image" alt="Reject for Heater-Cathode Short" /></td>
<td><img src="image" alt="Reject for Heater-G1 Short" /></td>
</tr>
<tr>
<td><img src="image" alt="Reject for Heater-G2 Short" /></td>
<td><img src="image" alt="Reject for G1 - Cathode Short" /></td>
<td><img src="image" alt="Reject for G2 - Cathode Short" /></td>
</tr>
<tr>
<td><img src="image" alt="Reject for G1 - G2 Short" /></td>
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![Fig. 4. List of neon glow lamp indications for tester shown in Fig. 1.](image)

The tube should be tapped on the glass area near the tube base to show up any intermittent shorts. A tap can be made in accordance with the drawing shown in Fig. 5. This is very simple to make since a pencil can be used as the dowel and a No. 15 cork can be obtained at most hardware stores. A hole should be drilled in the cork and the dowel or pencil cemented in place. The tap should be held between the thumb and forefinger and used with a wrist action only. Tap the tube several times at different points going around the neck.
The short and continuity test will indicate either an "open" or a "short" and in addition, it points out the tube elements which are defective. As mentioned in previous parts of this series, resoldering the base pins should always be tried whenever an "open" is indicated. If the neon lamps indicate that G3 is "open," resolder pin No. 2. If G6 is "open," resolder pin 10 and if cathode is "open," resolder pin 11. An "open" in the heater does not show on the indicator lamps since this defect can be detected by looking at the gun inside the picture tube. If a short or leakage is indicated on the tester, try using a "Sparker" to burn off the material causing this defect. A typical "sparker" is the Model 1110 manufactured by Electro Technique Products, 1602 Montrose Ave., Chicago 4, III. This unit, as mentioned in previous issues, has a list price of $12.10 and can be obtained from your tube and parts distributor or the manufacturer. Be sure to ground one of the shorted elements and then apply the sparker to the other shorted element. The heater and cathode should always be tied together unless the short exists between these two elements. Limit the application of the sparker to about 30 seconds. If this does not eliminate the short, try again for the same length of time. Do not use the "sparker" for any longer period of time than is necessary since prolonged sparking between heater and cathode or between cathode and G6 may permanently damage the picture tube.

A somewhat different method should be used when a "hot" G6 —cathode short occurs. This type of short occurs only after the tube has been in operation for a period of time, and is indicated by the complete loss of control over brightness. A short of this type can sometimes be eliminated by the application of about 150 volts d-c between G6 and cathode while the tube is hot. This voltage should be applied with the negative side connected to G6 and with a 500-ohm resistor placed in series with one of the leads.

**EMISSION TEST**

If the short and continuity test indicates that the tube is good, turn the rotary switch to the "emission check" position. Then turn the right hand knob to the point where the meter reads 10 microamperes. This current reading is important and requires careful adjustment particularly if an 0–1 milliammeter is used. The 10 microampere point on the meter shown in Fig. 1 would be midway between 0 and the first mark on the scale. The 10 μa point would be much easier to locate on a 0–500 microammeter and it is for this reason that a 0–500 microammeter is preferred. After the meter is set at the correct point, press the push-button switch below the "HI" neon lamp. The meter should read between 350 and 550 microamperes if the emission is normal. If the emission reads between 250 and 350 microamperes, it is questionable and below 250 it should be replaced. In most cases, it will be found that tubes below the 300 microampere reading will have large dead areas on the cathode surface. The method of observing an enlarged image of the cathode surface was given in the last issue.

The limits indicated above are based on a line voltage of 115 v a-c. If the line voltage is low, the limits should be decreased by 10 μa for each volt below 115 v. If the line voltage is high, the limits should be increased by 10 μa for each volt above 115 v. These readings are, like all tube tester readings, subject to exceptions due to tolerance variables and "cut-off" characteristics. It will, however, provide the service technician with a reasonably accurate and reliable indication of the condition of a picture tube.

**GASY TUBES AND AIR LEAKERS**

Another defect which develops in a picture tube is that it becomes "gassy." The sparker previously mentioned can be used to detect gas by placing its tip on the glass near the base of the picture tube as shown in Fig. 6. If the tube is gassy, the area near and in the electron gun will have a pink glow. A similar condition will be noticed if the tube is an "air leak" except that sparks may jump through the glass to the gun and between the elements in the gun. Another indication is the milky appearance of the getter on the neck of the picture tube. This milky area will appear on the clear glass window sometimes left in the inside graphite coating near the position of the getter bar and shield as shown on page 2 of the Vol. 4 No. 5 issue. There is nothing the technician can do to correct either a gassy tube or an air leak except to replace the picture tube.

It might be well to point out here that when using the tester described above, a tube very low in emission may show as an open cathode. This is to be expected because it is the current flow between the cathode and the G1 and G2 elements in the picture tube which raises the neon bulbs to glow. If the cathode is not emitting a sufficient number of electrons, these two lamps may not light up.

This tester will not check electrostatic deflection type picture tubes or those with triode guns. It may be used, however, to indicate a "short" or "open" in tubes with triode guns. Obviously the G6 bulb will not operate on tubes of this type.

The picture tube tester described in this issue can be used effectively to increase your picture tube business. A good practice would be to test the picture tube on every receiver serviced. A notation could be written on the customer's bill as well as the job record. In this way the customer is aware of the condition of the picture tube and the job of selling a new tube either at the present time or some time in the near future should be easier.
BENCH NOTES

Contributions to this column are solicited. For each question, short-cut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the case of suspected or similar items, selection will be made by the editor and his decision will be final. The Company shall have the right without obligation beyond the above to publish and use any suggestion submitted to this column. Send contributions to The Editor, Techni-talk, Tube Department, General Electric Company, Schenectady 5, New York.

TV INTERFERENCE

I had a call one day last month on an interference problem which had the appearance of 32-volt Truck Electric System interference. Since there wasn't a major highway within 3 miles, that cause was ruled out. I checked all the electrical apparatus throughout the home but found nothing to remedy it. In desperation, I started checking the neighbors' homes in the immediate area. In the first four homes checked, I found the same condition on their TV sets. In the fifth home, I found an immersion heater for a fish tank which had been recently purchased. It operated off of 110 volts a.c. I had my doubts whether this was the answer. But after disconnecting it from the power source, all interference disappeared. I traced this heater with a lead shield which eliminated all signs of this interference.

Robert M. Davis
3802 Coolidge Ave.
Baltimore 29, Md.

TV HEADACHES

(1) ADMIRAL, 20B1 TV Chassis. This set came in shop with no video, audio apparently normal. All tubes and voltages checked good, except that AGC was very low. Checking video on the scope indicated good signal up to video output grid, but dropping to zero at all. Analysis of pulsed AGC circuit used in this model showed that plate of 6AU6 AGC tube operates during positive pulse from winding on width coil. Pulse was there, but not of amplitude indicated (200 v p-p). Secondary of width coil was found to be open, causing insufficient peak pulses on plate to conduct and rectify, thus no AGC. The reason the 6AG7 video amplifier did not function was that the grid was blocked due to overriding signal.

Upon installing new width coil, it was discovered that the primary to secondary phase relationship had to be correct, otherwise, negative pulses would result on 6AU6 plate. Reversing primary connections corrected this and set worked in normal manner again.

(2) STROMBERG-CARLSON TV-125. Owner had complained of poor vertical hold as long as we had been servicing the set. The hold did seem critical, but we found no tubes bad or other obvious causes. When set did finally get to the shop, tracing down the vertical and sync circuits with scope and VTM still showed no fault. However, the video signal on the scope did show a definite depression at the 60-cycle point where the vertical sync pulse was. Finally, a check of the AGC voltage with a scope showed a pinch at the 60-cycle portion of the sweep, which of course would be impossible with the normal AGC filtering circuits used. In this case, the .25 mfd AGC filter condenser had been left out in manufacture, but of course any decrease in AGC filtering action on any set might result in the same symptoms, for the AGC naturally tends to follow the video, which peaks at the vertical sync pulse and thus reduces gain for that portion of the signal, if not properly filtered.

Louis Eisen
Schenectady TV Serv.
10917 S. Central Park
Chicago 43, Ill.

VERTICAL ROLL

The complaint was a continuous vertical roll on Channels 4 and 7 only. The set was a Dumont "Tarrytown." I checked the antenna lead from roof down to the set and continued to check through the vertical circuit without success. I then tried changing the 6J6 in the tuner and the trouble was corrected.

Alfred Weid
60 Thayer Street
New York 34, N. Y.

21ZP4-A

The 21ZP4-A is a magnetic-focus and magnetic-deflection, direct-view all-glass picture tube for television applications. It provides a 19½ by 14½-inch picture and has an electron gun which is used with an external single-field ion-trap magnet. Other features of this tube include a high quality gray facer which increases picture contrast and detail under high ambient light conditions, and a space-saving rectangular face shape. An external conductive coating serves as a filter capacitor when grounded.

Deflection Angle, approximate

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<table>
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<td>Horizontal</td>
<td>67 Degrees</td>
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<tr>
<td>Diagonal</td>
<td>70 Degrees</td>
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Greatest Buff Dimensions

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<tbody>
<tr>
<td>Vertical</td>
<td>25 1/8 x ¼ inches</td>
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<tr>
<td>Height</td>
<td>12 1/8 x ¼ inches</td>
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</tbody>
</table>

RECOMMENDED OPERATING CONDITIONS

Ammeter Voltage: 10000 Volts
Grid No. 2 Voltage: 500 Volts
Grid No. 1 Voltage: +75 to —77 Volts
Focusing Coil Current, approximate (RTMA Coil No. 100 at 34 1/2 inches): 18 Milliamperes
Ion-Trap Field Intensity, approximate (single field ion-trap magnet): 40 G measures

6AX4-GT

The 6AX4-GT is a heater-cathode-type diode suitable for application as a damping diode in television sweep circuits or as a half-wave rectifier. Two of these tubes may be used in a full-wave rectifier circuit.

Heater Voltage (Vac or D.C.): 6.3 Volts
MAXIMUM RATINGS, Design-Center Values
Peak Inverse Plate Voltage: 10000 max. volts
Peak Plate Current: 100 max. man
Hot-cathode Transient Plate Current: 145 max.

For duration of 0.2 second maximum, 3.0 max. amp
De-Plate Current: 145 max.
Peak Heater—Cathode Voltage: Heater negative with respect to cathode, 10000 max. volts
Heater positive with respect to cathode: 100 max. volts

The rating applies only to television damping applications where the duty cycle of the voltage pulse does not exceed 12.5% of one scanning cycle and the duration of the pulse is limited to 10 microseconds.

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