

# THE TELEVISION PICTURE TUBE—II



# Techni-talk

## on AM, FM, TV Servicing

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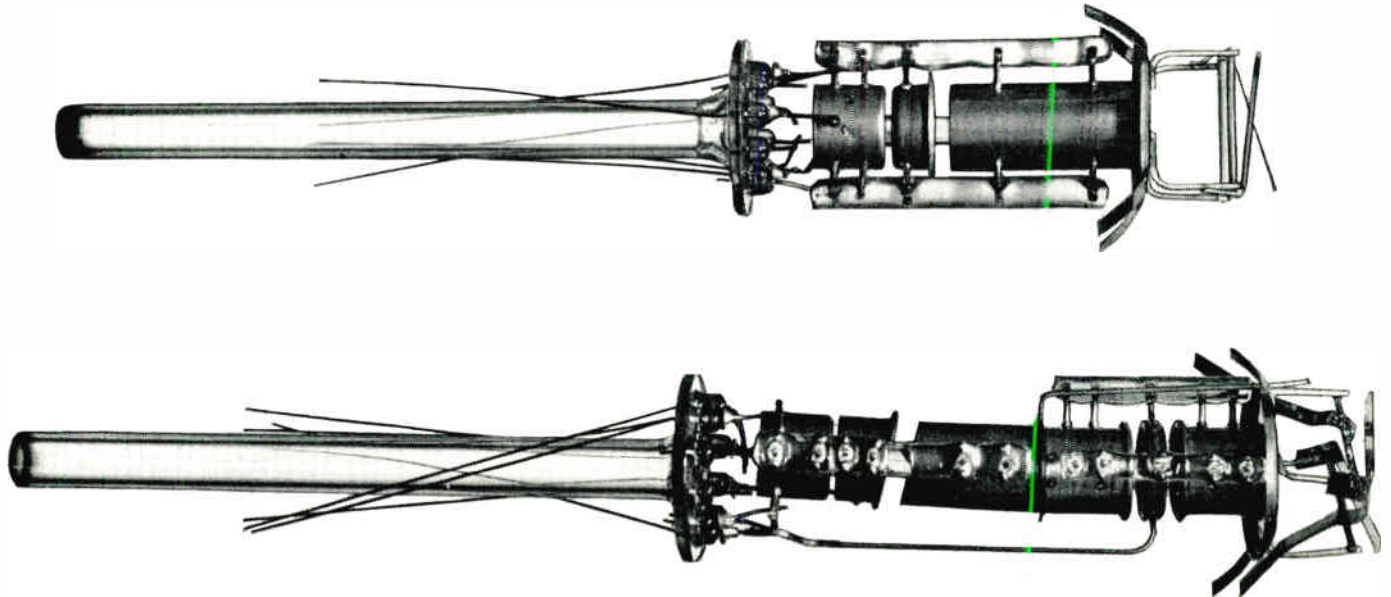


Fig. 1. Two types of electron guns used in TV picture tubes.

### THE TELEVISION PICTURE TUBE—II

In the last issue the different type Phosphors used in cathode-ray tubes were discussed in considerable detail. The inside and outside conductive coatings used on glass cathode-ray tubes were also described. In this issue the metal-cone type picture tube and the electron gun together with some of the defects which develop in this gun will be discussed.

### THE METAL-CONE PICTURE TUBE

Some picture tubes use metal instead of glass for the cone or bell portion of the bottle. This has some advantages such as (1) a reduction in the total weight and (2) less chance of an implosion due to the reduction in total glass area. The metal-cone type also has several disadvantages among which are (1) the shock hazard from the entire metal cone surface; (2) the possibility of the cone becoming partially magnetized which may cause picture distortion; (3) the necessity of a second HV capacitor to take the place of the capacitor formed by the graphite coatings previously described; (4) the possibility of high-voltage leakage from the metal cone to either the deflection yoke, the cabinet or the chassis. The service technician must exercise additional precautions when servicing receivers using metal-cone picture tubes primarily because of the shock hazard.

The metal-cone type picture tube goes through practically the same manufacturing processes as the all-glass picture tube. One exception is in the application of an exterior aquadag coating to the cone. Since the metal-cone cannot be used as a dielectric to form a capacitor, aquadag is only applied to the inside surface of the metal cone. This coating also extends into the glass neck and makes contact with the HV anode cylinder. The HV filter circuit in receivers using metal-cone picture tubes usually include a second HV capacitor to take the place of the

one ordinarily formed by the internal and external aquadag coatings.

### THE ELECTRON GUN

In the same way that the picture tube is the heart of the TV receiver, the heart of the picture tube is the gun structures shown in Figs. 1 and 2. These three types of guns are currently used in the manufacture of General Electric picture tubes. The straight gun type shown at the top of Fig. 1 is used in some of the smaller size aluminized picture tubes such as the 5TP4, 10FP4-A and 12KP4-A. A straight gun can be recognized by the straight adjacent edges of the number two grid cup and the HV anode cylinder. Tubes which use a straight gun do not require an ion-trap magnet.

The bent gun shown in Fig. 2 is by far the most popular type since it is used in the larger size aluminized picture tubes as well as many of the non-aluminized types. The bent gun can be recognized by the slanted adjacent edges of the number two grid cup and the HV anode cylinder. All picture tubes which use a bent gun require an ion-trap magnet.

The electron gun shown at the bottom of Fig. 1 is also a bent gun type but in addition, it has a focusing electrode which eliminates the use of an external focus coil or magnet. This type gun is used in electrostatic focus type tubes such as the 17EP4-A and the 21EP4-A. As previously mentioned all picture tubes which have a bent gun require an ion-trap magnet. All three types of guns shown in Figs. 1 and 2 contain the following parts each of which will be discussed in detail: (1) heater (2) cathode assembly (3) grid No. 1 (4) accelerating anode or grid No. 2 (5) HV anode.

### THE HEATER

The heater of a picture tube, shown inside the cathode sleeve in Fig. 2, serves the same

purpose as the heater in any other indirectly heated cathode type receiving tube which is to heat the cathode and maintain it at an emitting temperature level. The picture tube heater is composed of a tungsten wire wound to form a double helix and coated with an insulating material (aluminum oxide) to prevent inter-filament shorts and filament to cathode shorts.

The television picture tube, due to its principle of operation, must necessarily have a considerably higher vacuum than receiving tubes. This factor results in longer heater life since there is less vaporization of the tungsten filament when operated at the normal heater voltage. The heater in a picture tube may, during its useful life, develop certain defects. Some of these defects can be remedied by the service technician while others will make the picture tube practically useless.

### HEATER DEFECTS

Occasionally a picture tube will develop an open heater. This can be caused by any one of the following:

1. Severe physical shock which, due to the instantaneous strain, causes the filament to break. Very little can be done by the service technician to permanently remedy this type of defect. A temporary weld may be made either by sparking a high a-c voltage across the filament terminals or by discharging a capacitor (100 to 200 mfd 450 v.) across the filament terminals. This type of repair is not recommended since it usually lasts only a few hours at the longest.
2. Excessive heater voltage which causes the filament to melt in one or more places. When this happens the picture tube must be replaced.
3. Loss of vacuum will also cause the filament to vaporize and open in one or more places. The getter deposit which can ordinarily be

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seen through an open rectangular area in the aquadag coating on the neck of the tube will appear either black or milky in color instead of the usual silver appearance. Nothing can be done by the technician to remedy this condition since the picture tube would not operate on "air" regardless of the condition of the filament.

4. A defective contact at one of the picture tube heater base pins will also cause the heater to check as open. In every case where an open heater in the picture tube is indicated, the service technician should try resoldering the base pins. This type of repair is recommended since it returns the picture tube to a condition at least as good as it was before, and with very little chance that this same condition will reappear.

Unfortunately, the heater of a picture tube may develop a "short" as well as an "open." One type of short is the cathode-heater short. The heater usually touches the cathode sleeve in one or more places as shown in Fig. 2. This does not ordinarily cause a cathode-heater short because the portion of the heater inside the cathode sleeve is coated with an insulating material. If, however, any of this insulating material breaks off at a point of contact with the cathode sleeve, it may result in a cathode-heater short. If a cathode-heater short exists in the picture tube, it may ground the cathode through the heater winding. In this type of circuit, a separate 6.3-volt transformer can sometimes be used to extend the life of a picture tube. In most cases, this will only work satis-

factorily in receivers which have the signal fed into the grid and not the cathode.

The heater of the picture tube is designed to operate at a certain voltage which in all current type picture tubes is 6.3 volts at 0.6 ampere. If for some reason this voltage is reduced, the cathode temperature will also be reduced, thereby affecting both the picture quality and brightness. Occasionally a receiver will be found where the heater voltage is too low. In this case the line voltage should be checked and if this is low, all voltages in the receiver will be low. If, however, the line voltage is normal, the circuit should be checked to see if some defect has caused this reduced voltage.

One example of this would be an increase in the resistance of the "glomar" resistor R154 in Fig. 3. If this resistor increases in value, the voltage drop across it will also increase, thereby decreasing the heater voltage on all tubes including the picture tube. The replacement of this resistor with a new "glomar" will correct this condition. Another example, which would result in a reduction of only the picture tube heater voltage, is one or more shorted turns in the picture tube heater (V8) in Fig. 3. This would decrease the resistance of the picture tube heater and therefore also decrease the voltage across it. The reduction in this heater voltage would depend on the number of turns shorted out. If the picture tube heater voltage is not reduced by more than ten or fifteen percent, it may operate normally at this reduced voltage. If necessary, a separate 6.3-volt transformer could be used to supply only the picture tube heater and in this way prolong the life of the picture tube. An emission test with the unit which will be described in the next issue would indicate whether or not the expense of adding a filament transformer would be justified. If the heater voltage is reduced by more than fifteen percent, indicating that more than fifteen percent is not operating, the picture tube should be replaced with a new tube.

There has recently appeared on the market a number of units which increase the heater voltage above normal and, thereby, claim to extend the useful life of a picture tube. If a picture

tube is operating at a lower than normal heater voltage, it is advisable to bring this voltage back to normal. This can be accomplished by using a separate transformer as suggested in the preceding paragraph as long as the filament voltage does not exceed 6.3 volts.

Practically all of these units operate the picture tube at a higher than normal heater voltage. This cannot be considered a recommended procedure to extend the life of a picture tube since the heater voltage must be considerably higher than the voltage at which the tube was originally designed to operate. As an example, the light output from a light bulb which has been in operation for several hundred hours will tend to decrease. This light output could be brought almost back to normal by increasing the filament voltage. If the filament voltage is increased, the conditions which caused the reduction of light output are greatly accelerated and the possibility that the filament will burn out prematurely is considerably increased. If this hypothetical light bulb were replaced with a new bulb and operated at the higher voltage, its life would only be a fraction of its normal expected life, and, in addition, its light output would decrease at an accelerated rate. Practically the same conditions are found in "Photoflood" lamps which are designed to produce a very bright light. This type of lamp has a very high filament temperature and is only expected to have a very limited life.

A similar result is obtained if the heater voltage on a picture tube is considerably increased. A picture tube which is on its "last legs" due to low emission can be given a "shot in the arm" by increasing the heater voltage. This increase in heater voltage, like a "shot in the arm," is only temporary and after a few weeks, at the most, a new picture tube will be required anyway. Another important consideration is that if this unit is left in the circuit when a new picture tube is installed, the life of the new tube will be considerably shortened. If a new tube fails during the manufacturer's warranty period and examination indicates that its failure was due to excessive heater voltage, credit will not be allowed.

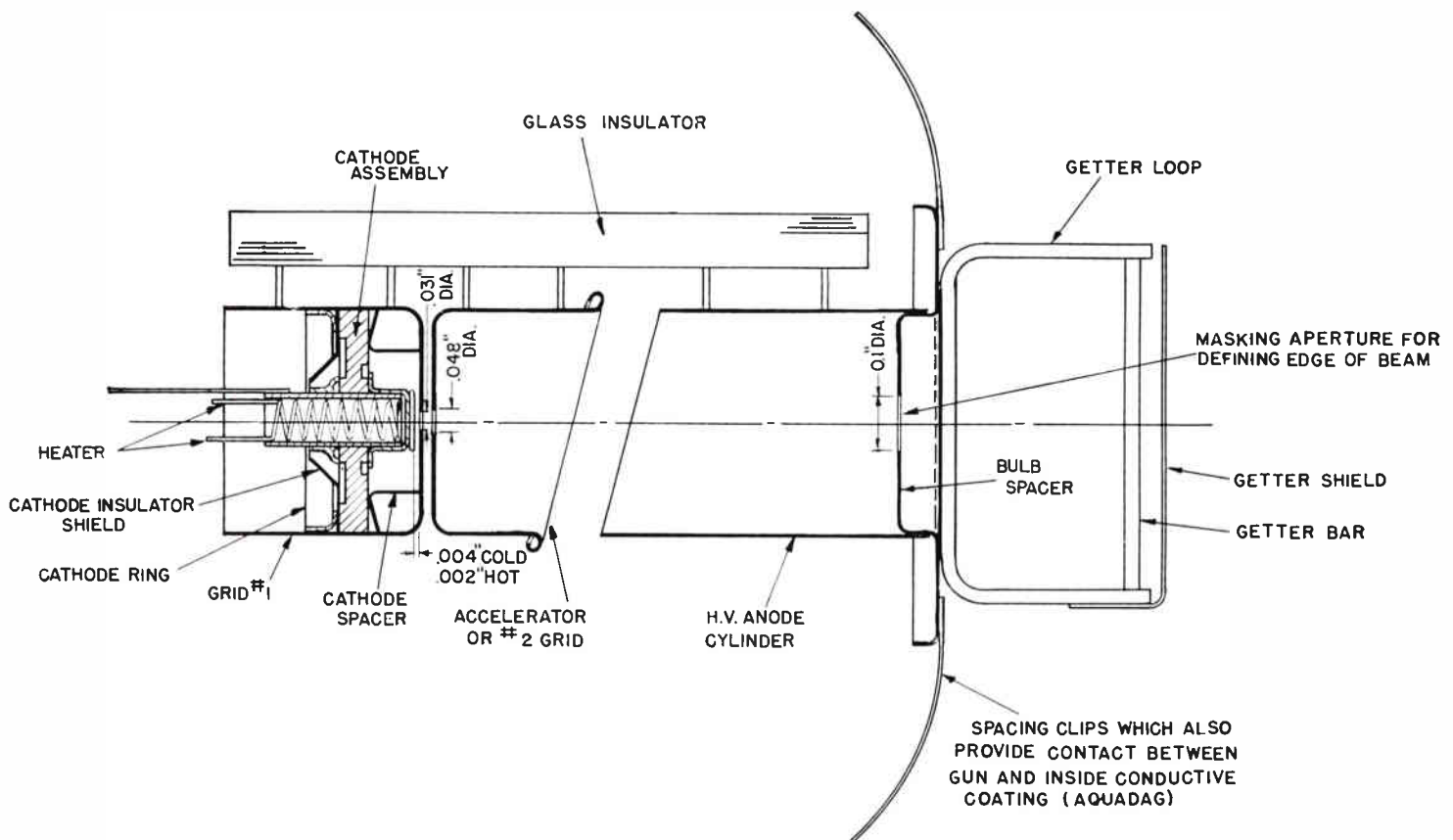


Fig. 2. Cut-away drawing of an electron gun.



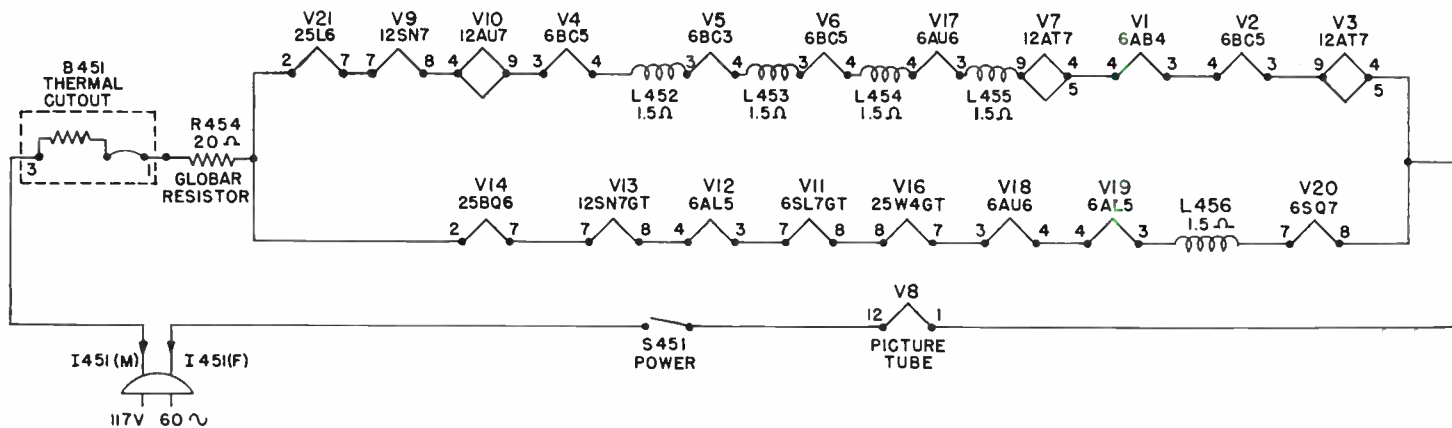


Fig. 3. Typical filament supply circuit used in many General Electric TV receivers.

These facts should be kept in mind whenever a unit is installed which abnormally increases the heater voltage. Remember that in many cases, one dissatisfied customer will more than offset a great many satisfied customers.

### THE CATHODE

The cathode of a picture tube is composed of several parts as shown in Fig. 4. The structure of the complete cathode assembly cannot ordinarily be seen since it is welded into the G1 cup as shown in Fig. 2. The cathode is a small metal cylinder with a cap on one end. Only the top of this cap is coated with an emitting material. The other end of the cathode cylinder is open so the filament can be inserted. The picture tube cathode differs somewhat from the cathode found in the ordinary receiving tube, in that the emitting area in the ordinary tube is the outside area of the complete cathode sleeve, whereas the emitting area in a picture tube is only the top of the cathode sleeve cap. A ceramic spacer is placed in back of this cap and held in place by a metal collar which is spot-welded to the cathode sleeve. A metal spacer is first inserted into the G1 cup which prevents the cathode emitting material from contacting G1. The space between these two surfaces is between four and five thousandths of an inch. As the cathode heats up it reduces this spacing to between two and three thousandths of an inch. A cathode insulator shield plus a ring which is spot-welded to the inside of the G1 cup completes the cathode-G1 assembly. All of the parts of this assembly can be seen in Figs. 2 and 4. Obviously, all of these parts as well as the thickness of the cathode emitting surface must be precision made.

### CATHODE DEFECTS

The close spacing of the cathode and G1 cup increases the possibility of a short developing between these two elements. Occasionally this type of short as well as a short between other elements can be eliminated by the application of a high-voltage spark. This can be obtained from a "sparker" or high-frequency tester such as the model BD10 manufactured by the Electro Technic Products, 4602 W. Montrose Ave., Chicago 4, Ill. This unit has a list price of \$12.10 and may be obtained by your tube and parts distributor from the manufacturer. This type unit develops a spark which will jump across a one-inch air gap and can also be used to detect a "gassy" picture tube. This application will be described under the section on gas in picture tubes. Another source of a high-voltage spark is that produced by the high-voltage supply in the TV receiver. There are several disadvantages in using this source, such as the possibility of shock as well as increasing the resistance of the filter resistor or burning it out completely. This is the resistor which is connected between the HV rectifier filament and the picture tube anode cap. Since this resistor ordinarily passes

only the HV anode current which is somewhat less than 200 microamperes, a short to ground, even of very short duration, may cause it to heat up and change value. An increase in its resistance will cause the picture to "bloom" whenever the brightness is increased.

The function of the picture tube cathode is to emit a sufficient number of electrons to produce adequate fluorescence of the picture tube screen. The cathode of a picture tube like the cathode of a receiving tube is ordinarily the only part which "wears out." When the cathode no longer emits a sufficient number of electrons, the brightness falls off and the tube has low emission. A reduction of the emitting qualities can be caused by several different conditions. One, and by far the most common, is the gradual depletion of the active cathode material resulting in *low emission*. When this happens, very little if anything, can be done to restore the emission to normal for a very long period of time. There have recently appeared on the market a number of "reactivators," or "rejuvenators" for TV picture tubes. Many service technicians will recall that a similar type unit was used on receiving tubes. Other methods were also used, such as placing receiving tubes in an oven at a certain temperature for so many minutes or hours. It was found that these tubes were temporarily renewed and tested perfect on a tube tester. It was also found that these tubes did not stand up in actual use. Repeated service calls to rejuvenate or replace the same tube are rather difficult for a reputable technician to explain. In view of this, reactivating receiving

tubes is seldom heard of today. A similar condition has also existed during receiving tube shortages when open filaments were welded together by sparking a high a-c voltage across the filament terminals. This was usually successful, but the weld just didn't last, and again it was found that temporary repairs do not make satisfied customers or prosperous technicians.

A somewhat different condition, aside from the depletion or the wearing out of the cathode emitting material, is present when for one reason or another the grid is driven positive with respect to the cathode. This may be due to a leaky coupling capacitor in the picture tube grid circuit, a change in resistance values or poor receiver design. A check for this is to connect a VTVM between the picture tube grid and cathode with the picture tube in operation. This connection can be made by using an extension cable between the receiver socket and the base of the picture tube. Remove only enough insulation from the G1 and cathode wires to make contact with the VTVM leads. These extension cables can be obtained from your General Electric Tube and Parts Distributor. If at any setting of the brightness or contrast controls the grid goes positive by more than a few volts, the circuit should be checked.

In the next issue, information on how to observe an enlarged image of the cathode as it can be made to appear on any picture tube screen will be included. The other elements in the electron gun and their affect on the electron beam will also be described.

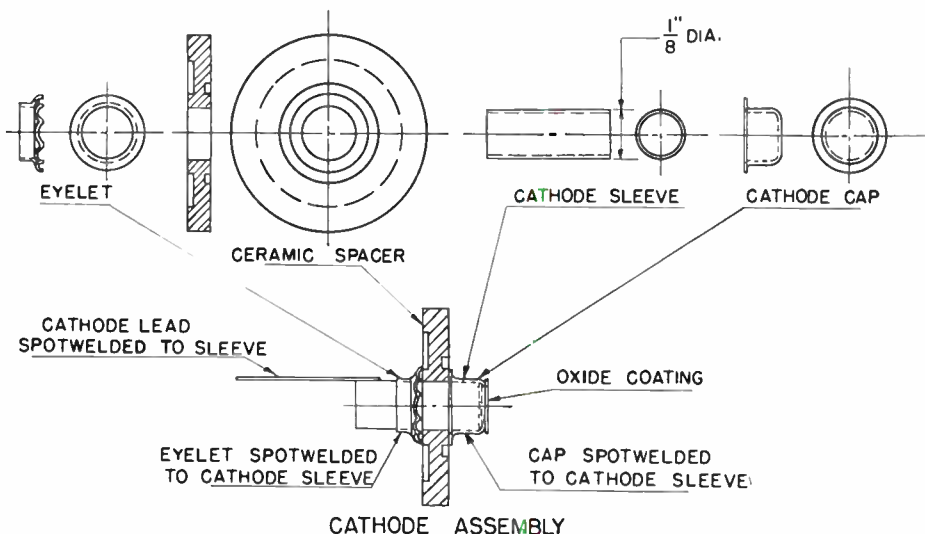


Fig. 4. Drawing of cathode assembly showing the different parts and their location when assembled.

# 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 event of duplicate 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, N. Y.

## EXTENDING BATTERY LIFE

I have a very simple and timely dealer sales idea which I find really saves money as well as increases my sales.

There are many small and various sized batteries, as we know, which have a relatively short shelf life. This, of course, discourages dealers from stocking an adequate assortment of batteries and packs. Thus, both he and the distributor lose potential profits.

The solution is very simple and effective. Place the batteries in a deep freezer, or the top freezer of a G-E refrigerator. The below freezing temperature prevents the batteries from discharging and they can be kept almost indefinitely.

Herbert F. Taylor  
904 Enfield St.  
Thompsonville, Conn.

## PICTURE SMEAR

In servicing a Tele King 12½-inch set Model 410 I found the following:

After 30 or 40 minutes the screen would turn very bright and the fine features in the picture, such as, the eyes, nose, mouth would have a one or two inch smear across picture for a few seconds and then go back to normal.

Diagnosis: poor frequency response.

Found trouble to be an intermittent open in the peaking coil. I resoldered both leads of the peaking coil which was wound on a resistor.

I assume the wax must have softened after the set was on for awhile and allowed a poor solder

connection to open the lead from the peaking coil to the resistor. Vibration in the room would make it go on and off.

Melvin Finburg  
357 3/4 So. Detroit St.  
Los Angeles 36, Calif.

## HV ARCING

Recently I repaired a TV Receiver with an HV arcing which was very difficult to locate. After spending many hours searching, looking, checking and dopping the hi-voltage supply, I finally replaced every part from the grid of the 6BG6-G to the picture tube HV lead. Still the same arcing caused streaks all across the picture. I then decided to remove the rubber cap from the end of the HV anode lead. Then I discovered that the arcing was between the anode terminal on the picture tube and the inside graphite coating. A new picture tube finally corrected the trouble.

I hope this will help some other service man, as it is something I have never seen before.

James C. Houston  
1538 Mardell Blvd.  
San Antonio 1, Texas

## BETTER CONTACT CLEANER

I read with interest the Bench Note in Techni-talk for April-May 1952, referring to the use of an eraser for cleaning contacts on tuners.

Am enclosing a sample of eraser, impregnated with diamond dust, which has served very well. It burnishes tuner contacts, tube prongs, socket prongs, removes rust from tools, and can be fashioned into various shapes for numerous applications.

I use it in an old aligning tool to reach difficult spots.

It is sold under the trade name of "Brite Boy" and can be obtained from most watch supply houses for about 40 or 50 cents. Size is about 1 x 2 inches.

Arthur H. Lawrence  
443 E. 142 Street  
Bronx 54, New York City

What's new!

## 27EP4

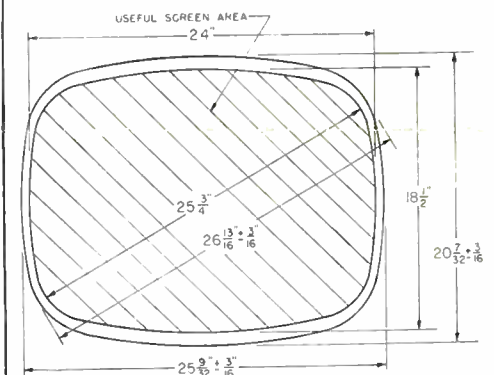
The 27EP4 is a magnetic-focus and magnetic-deflection, direct-view all-glass picture tube for television applications. It provides a 24 by 18½-inch picture and has an electron gun which is used with an external single-field ion-trap magnet. Other features of this tube include a high-quality gray faceplate which increases picture contrast and detail under high ambient light conditions, a reflective metal-backed screen to increase light output, and a space-saving rectangular face shape.

Heater Voltage.....	6.3 Volts
Heater Current.....	0.6 ± 10% Amperes
Deflection Angle, approximate	
Horizontal.....	85 Degrees
Diagonal.....	90 Degrees
Over-all Length.....	25 1/16 ± 3/16 Inches
Greatest Bulb Dimensions	
Diagonal.....	26 13/16 ± 3/16 Inches
Width.....	25 9/32 ± 3/16 Inches
Height.....	20 7/32 ± 3/16 Inches

## RECOMMENDED OPERATING CONDITIONS

Anode Voltage.....	16,000 Volts
Anode Current, average.....	.95 Microamperes
Grid-No. 2 Voltage.....	.300 Volts
Grid-No. 1 Voltage§.....	-33 to -77 Volts
Focusing-coil Current¶.....	.118 Milliamperes
Ion-Trap Field Intensity†.....	.38 Gauss

§ For visual extinction of undeflected focused spot.  
¶ RTMA Coil No. 109 at 3¾ inches from yoke reference line.  
† Single-field ion-trap magnet adjusted to optimum position.



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