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Vol. 8, No. 2

Electronic TUBES
Techni-talk
on AM, FM, TV Servicing

Color TV-X

Aperture Mask and Post Acceleration Type Picture Tubes

A considerable number of different types of color picture tubes have been developed and tried with varying degrees of success. At the present time, practically the only color picture tube that has been used in commercial receivers is the aperture mask type. General Electric's color television efforts are being concentrated on a "post acceleration" type color picture tube that gives many times more brightness than tubes in color sets now on the market. Both the aperture mask and "post acceleration" types will be described in this article.

It will be recalled that the NTSC system described in previous issues was based on a three-gun picture tube. Each gun actuated one of the three primary color phosphors (red, green and blue) deposited on the viewing screen. It has been shown that various mixtures of the light produced by these phosphors will produce a wide range of colors. Both the aperture mask tube and the "post acceleration" tube use three electron guns and have three color phosphors. The similarity ends here, however, since the two types differ considerably in appearance, construction, and operation.

THE APERTURE MASK TUBE

The basic construction of the aperture mask tube is shown in Fig. 1. The gun structure is carefully assembled with each gun tilted slightly toward the central axis of the tube so that the three beams converge at the aperture mask. The three guns are spaced 120 degrees apart with respect to each other. Each individual gun is similar in operation to the type used in an electrostatic focus, monochrome picture tube.

The aperture mask is made of thin metal (about .003 inch thick) perforated with as many as 357,000 precisely spaced holes. The phosphor dot screen contains three times as many phosphor dots as there are holes in the aperture mask. These phosphor dots are arranged so they form triangular groups called trios or triads. Each triad is composed of one green, one red, and one blue dot as shown in Fig. 2. When the aperture mask and the phosphor dot screen are mounted in the color picture tube, each phosphor dot triad is in front of a single aperture mask hole as shown in Fig. 3.

Each triad may be considered as a single picture element capable of blending the three colors to produce some specific color. Since the phosphor dots within each triad are very small, the eye only sees the color produced by the mixture. Each of the three guns produce independent pictures, one red, one green, and one blue. Due to the close spacing of the phosphor dots, the three pictures appear to be superimposed. When a monochrome picture is seen on a color picture tube, the light produced by each color presents a complete picture in the correct proportion to result in black and white. When a color picture is produced, the light produced by each color phosphor may *not* present a complete picture but only the proportion of that color present in the original scene. Colorimetry was covered in considerable detail in the Vol. 6, No. 1 through Vol. 6, No. 4 issues.

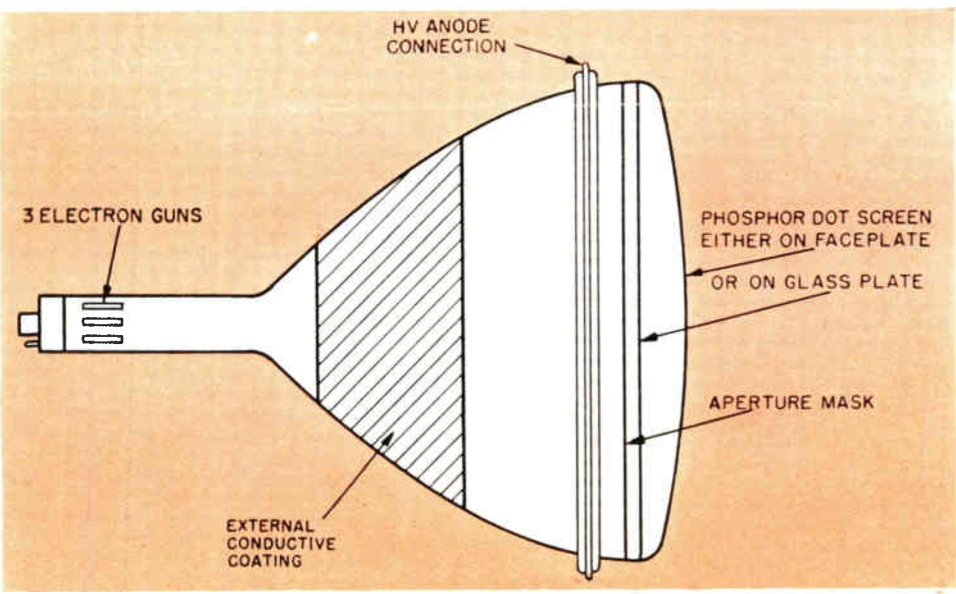


Fig. 1. Location of major elements in aperture mask color picture tube.

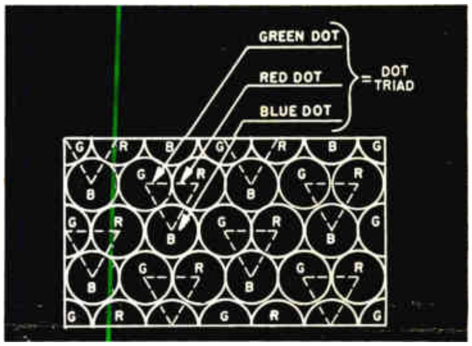


Fig. 2. Area of phosphor dot screen illustrating the arrangement of phosphor dot triads.

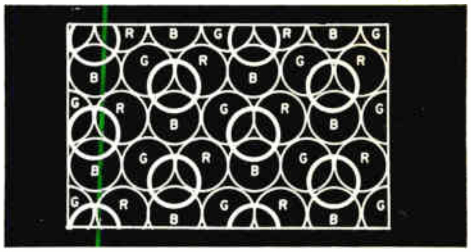


Fig. 3. Relative position of phosphor dot triads and aperture mask holes.

In order to obtain maximum light output, the phosphor dot screens used in all size color picture tubes have been aluminized. The aluminizing process also eliminates the necessity of one or more ion trap magnets.

The number of holes in the aperture mask and therefore the number of phosphor dots vary with the size of the picture tube. The 15-inch tube has about 195,000 holes, the 19-inch about 300,000, and the 21-inch about 357,000. Some 15-inch color tubes use a flat phosphor dot screen and aperture mask as shown in Fig. 1. Other 15-inch and most of the larger size tubes have the phosphor dot screen deposited on the faceplate as is also shown in Fig. 1. Those tubes with the phosphor dots on the faceplate have a curved aperture mask instead of the flat type. The reason for this is obvious since each triad must be positioned in front of an aperture mask hole.

The gun structure, aperture mask and phosphor dot screen are designed and positioned so that the electron beams from the red, green, and blue guns should converge at the aperture mask and hit only their respective color phosphor dots as shown in Fig. 4. Due to the angle of the beams after they converge and pass through the aperture mask, each gun

(Continued on page 2)

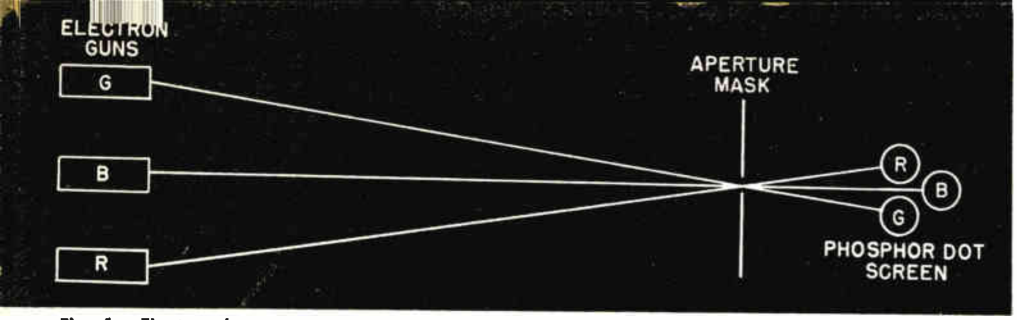


Fig. 4. Electron beams converge at aperture mask and strike respective phosphor dots.

should "see" only its own respective color dots through the mask as illustrated in Fig. 5. Unfortunately, this is not entirely true due to manufacturing tolerances and difference in curvature between the convergence arc produced as the beams are swept over the screen and the arc formed by the phosphor dot screen as illustrated in Fig. 6. Some manufacturing tolerances in electron gun alignment are compensated for by individual, externally mounted, permanent magnets located over each electron gun. These magnets are adjusted to properly converge the three beams in the center area of the screen. The beam movement produced by these three magnets is shown in Fig. 7. Some tubes such as the 19-inch have an additional external permanent magnet which produces a horizontal movement of the blue beam as shown in Fig. 8. The adjustment of these magnets is known as

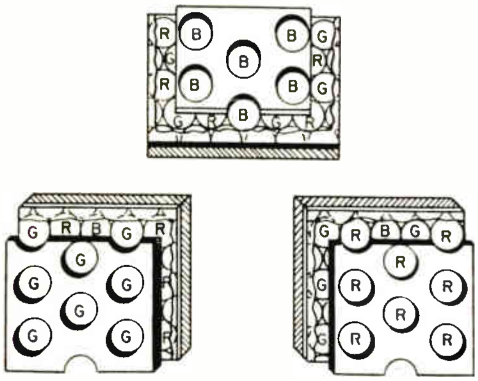


Fig. 5. Each electron gun "sees" only one color phosphor dot.

"static convergence correction." When properly adjusted, all three beams pass through the aperture mask holes exciting all three phosphors in the proportion necessary to produce a mixture accepted by the eye as white.

Since all three beams must converge (cross over) at the aperture mask in order to strike the proper phosphor dots, additional adjustments are necessary as the beams are deflected toward the top and bottom as well as each side of the screen. It can be seen in Fig. 6 that the distance between the deflection center and the aperture mask increases as the beams are swept toward the edges of the screen. The point of convergence would normally follow the arc shown in Fig. 6. Additional correction must be introduced and this is known as "dynamic convergence adjustment." A parabolic waveform is applied, either electrostatically to a convergence electrode or electromagnetically to external magnets, to correct for the condition shown at the top of Fig. 6. As a result of dynamic convergence adjustment, the beams cross over at the aperture mask as shown at the bottom of Fig. 6. The dynamic convergence waveforms are derived from the horizontal and vertical deflection circuits and will be described in detail in a later article on receiver circuits.

It was stated earlier that each electron gun is similar to that used in a monochrome electrostatic focus type tube. Since all three guns are within the same envelope and the characteristics of each gun as well as the color phosphors may not age uniformly, additional controls are used to vary the G_2 voltage on each gun. The three electrostatic focus (G_3) elements are connected together within the tube and have one common base pin and therefore a single control.

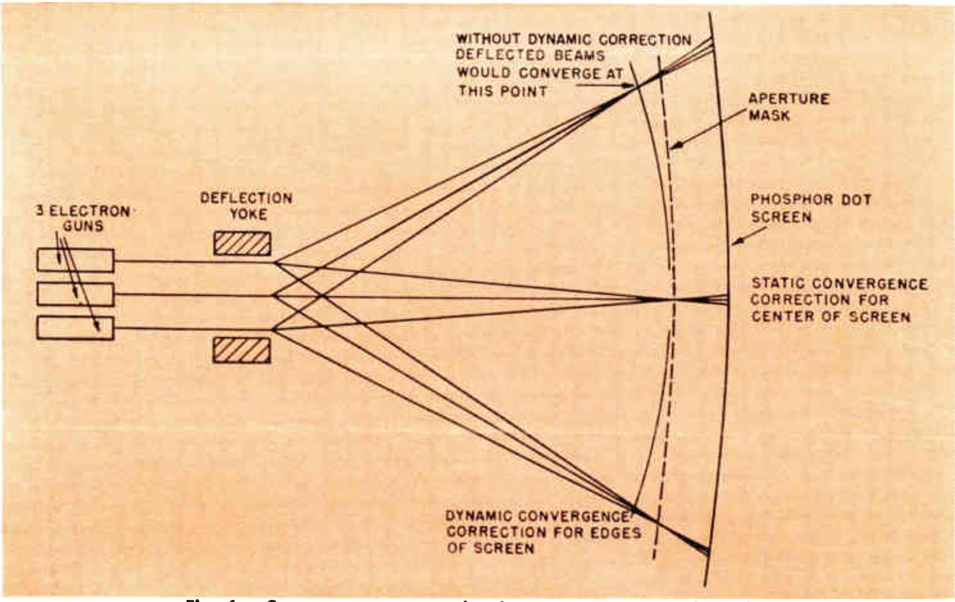


Fig. 6. Convergence correction in aperture mask color tube.

Aperture mask type tubes require what is known as a purity coil. This coil is located on the neck of the tube near the G_2 and G_3 grids and produces a uniform field perpendicular to the axis of the tube. The purity coil also corrects for manufacturing tolerances in that its action is to position the three beams so each beam strikes only its own color dot. The purity coil used on earlier model receivers was the electromagnetic type whereas most current model receivers use the permanent magnet type. The usual method of making the purity adjustment is to turn off the blue and green guns and then adjust for a pure red screen. Adjustment is usually made by changing the strength and the rotational position of the magnetic field produced by the purity coil. Since the position of the deflection yoke may also affect color purity, the manufacturers' instructions should be carefully followed.

Since any stray magnetic fields may affect color purity, particularly around the periphery of the picture tube, some method is usually used to neutralize them. Earlier receivers used a field neutralizing coil whereas recent models use a number of permanent magnets. In either case, the field neutralizing assembly is mounted around the front rim of the tube.

THE "POST ACCELERATION" TUBE

The General Electric "post acceleration" tube was announced a few months ago and created considerable interest and anticipation in the industry. This tube is not commercially available at the present time and, therefore, all details have not been finalized. A number of tubes have been produced and demonstrated at varying degrees of lighting. These tubes produced a very "seeable" picture in light comparable to a brightly lighted store.

The "post acceleration" tube is basically a three-gun type which uses direction selection at the front end to cause each of the three beams to strike the proper array of phosphors. The direction selection mechanism consists of an array of parallel wires located just in back of the phosphor screen and forms the color selection electrode. This color selection electrode or grille provides "electron optical" masking instead of aperture masking. The grille transparency is greater than 90%, which means that more than 90% of the electrons ejected from the gun strike the phosphor screen and contribute to picture brightness. This compares quite favorably with the aperture mask tube with its transparency of only 12–14%. In that case, more than 85% of the high-voltage power does nothing but heat up the aperture mask and does not contribute to brightness. For equal high-voltage power input, the "post acceleration" tube is theoretically more than six

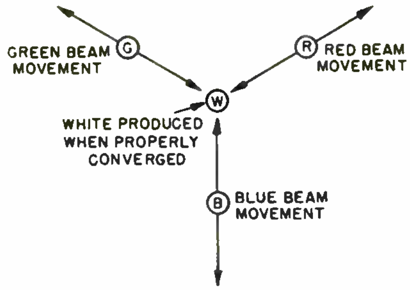


Fig. 7. Beam movement due to adjustment of beom positioning magnets.

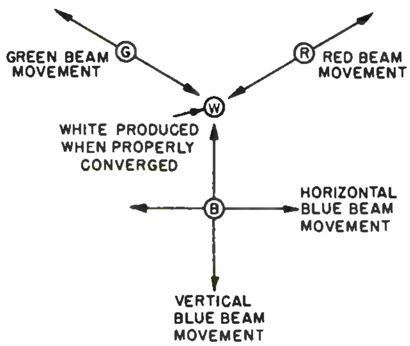


Fig. 8. Additional movement produced by horizontal blue positioning magnet.

times as bright as the aperture mask tube.

A sketch of the "post acceleration" tube is shown in Fig. 9. It can be seen that the three electrostatic guns lie in a plane instead of in a triangular array as in the aperture mask tube. This gun arrangement has very definite advantages which will be pointed out later. The grille consists of a parallel array of fine wire mounted within the tube envelope and in close proximity to the phosphor screen. This screen consists of vertical phosphor stripes deposited on the faceplate. Note that the bulb is rectangular in shape with a 22-inch diagonal measurement.

In normal operation, the final gun electrode potential and cone potential are held at about 6½ kv. The grille is held at a potential approximately 200 volts lower than the gun and cone potential, and the phosphor screen is run at approximately 25 kv.

The theoretical operation of the grille and screen area is shown in Fig. 10. It should be pointed out that several artistic liberties were taken in preparing Fig. 10 to best show the important features of tube operation.

Here we see electron beams entering the grille with a slight angular separation. The angle is exaggerated since in the actual tube it is less than 1°. As the electron beam enters the grille region two effects occur. First, the central ray of a particular beam no longer travels in a straight line but assumes a parabolic path exactly as occurs when one throws a ball which is then acted upon by the earth's gravitational field. In this case, the strong electrostatic field between the screen and the grille causes the path to be parabolic and obviously accelerates the electrons to the high screen potential.

A second and most important action which occurs as the beam enters the grille region is a focusing phenomenon. With properly applied potentials, each pair of grille wires forms an excellent electron optical cylindrical lens. This lens reduces the size of the beam in the horizontal dimension from its initial diameter of

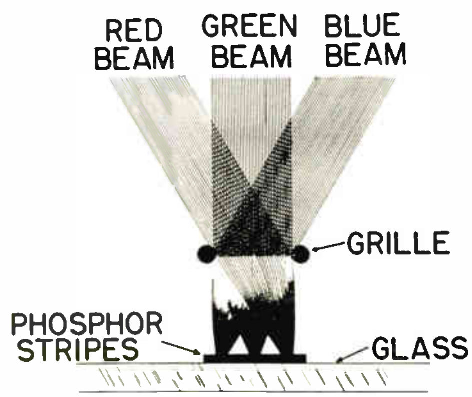


Fig. 10. This illustrates the focusing action which occurs at the grille of the "post acceleration" tube. The angular separation is greatly exaggerated in this sketch since it is less than one degree.

let's say 35 mils down to only 5 mils. This is illustrated in Fig. 10 and immediately points out another decided advantage of the "post acceleration" tube; namely, one of tolerances. Because the beam width is so small in comparison with the phosphor stripe width, a guard band is formed on either side of the beam landing area allowing the beam to move about on a particular stripe without striking an adjacent stripe and hence, affecting color purity. This wide guard band allows considerably larger mechanical tolerances in manufacture, and electrical tolerances in operation.

The electron trajectories between grille and screen are shown in Fig. 11. This

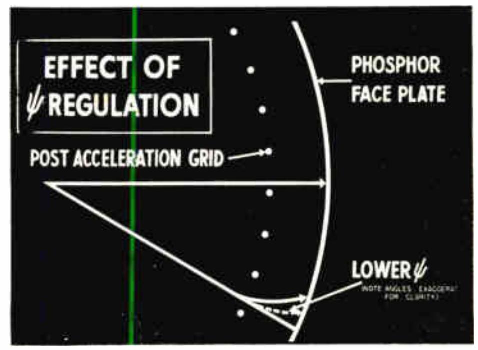


Fig. 11. This shows the effect of grille voltage regulation. The electron trajectories change as the ratio of screen voltage to grille voltage changes.

points out one of the first circuit requirements of this tube which is different than with the aperture mask tube. Not only high voltage is required but also a lower voltage must be applied to the grille. This voltage is not difficult to come by since the grille draws little current. There is, however, an important requirement associated with the ratio of the screen voltage to the grille voltage. It must be regulated. The electron trajectories between grille and screen and also the properties of the cylindrical lenses mentioned earlier are dependent on this ratio. The absolute magnitude of these voltages is not of consequence as long as the ratio is correct. A tube and a relatively simple circuit have been developed for this purpose.

As pointed out earlier, a gun assembly which places three beams in essentially the same plane—in this case the horizontal plane—has decided theoretical and practical advantages as far as convergence is concerned. It is, of course, necessary to apply convergence dynamically at both the horizontal and vertical rates, but a complete separation of functions is possible with the one plane construction.

Another advantage is that the deflection requirements are relaxed. Because post acceleration is fundamental to its operation, this tube requires deflection of only a 6½-kv beam instead of the much higher voltage used in other type tubes—for instance 27 kv in the aperture mask type tube. A considerable saving in deflection power results.

To reiterate, the "post acceleration" tube will use less deflection power, simplified convergence circuitry, and simplified components in the neck of the tube. It will require the ratio regulation mentioned earlier. It is felt, however, that the over-all combination of these features will permit easier servicing plus a reduction in price of receivers using "post acceleration" picture tubes.

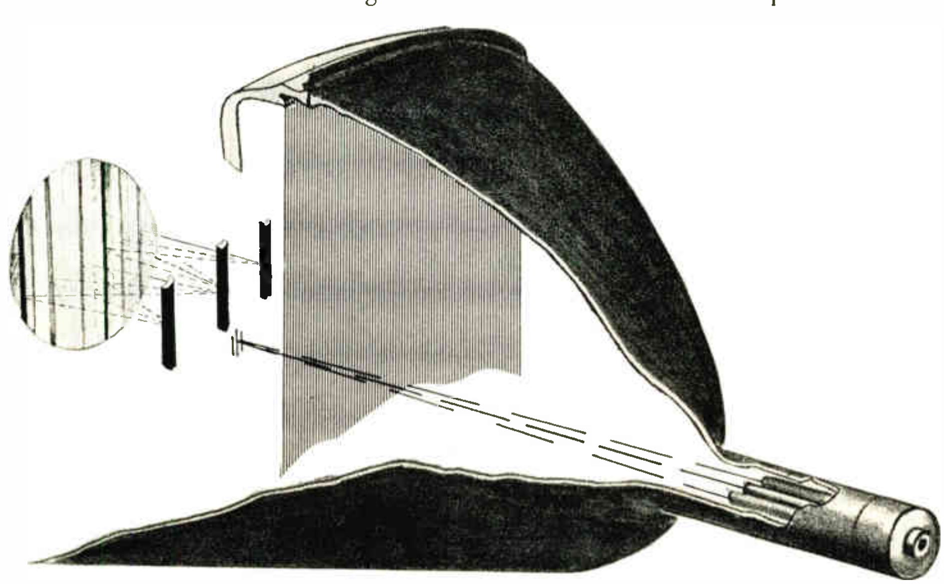


Fig. 9. Sketch showing location of major elements in the "post acceleration" tube.

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, New York.

VERTICAL STRETCHING

In our television service shop we serviced a General Electric Model 21C107 N-line (1956). There was leakage across C175 400 mmf 1000 V vertical blanking capacitor of 4 megohms.

The result was that the top of the picture was being stretched, which could not be corrected with the height or vertical linearity controls. The vertical hold control would not synchronize except in clockwise position.

After C175 had been replaced, all the controls, vertical linearity, vertical height and vertical hold responded properly.

Nikolaus Sanftleben
c/o Carl W. Liss
Radio Sales and Service
417 Smith Street
Schenectady, New York

REINFORCING TUNER CONTACTS

On Standard Coil tuners—To reinforce contact springs, cut and insert a length of right size spaghetti insulation so one piece extends through all the contact spring loops on the oscillator section. Another piece should also be inserted in the input section. The barrel should be removed to make this insertion. Use the type of spaghetti which is flexible but still holds its shape. Insert through oscillator alignment holes and then through the spring loops. This reinforces each spring by the adjoining spring.

Mrs. Louis F. Polzin
Polzin's Radio & TV Service
141 North Grant
Canby, Oregon

SPACE SAVER

In pursuing television service work I have found the tube caddy-toolbox to be an item subject to great strain at the seams with never enough room for anything. To help this situation I have eliminated all but one cord in my tool box. This was accomplished by cutting the cord on my Ungar soldering iron down to 1-in. and attaching a male interlock socket. We gave the same treatment to the large size cheater plug and also to the picture tube checker we have in the tool box. Now we have only one cheater cord to worry about winding up and getting in the way when we lean on the caddy cover in the process of getting it closed.

Dwight A. Nelson
Melody Lane TV
5327 Lyndale Avenue South
Minneapolis 19, Minn.

INTERMITTENT UHF

Mallory Converter Model TV-101

Trouble

Loss of picture. Wiggle that 6AF4 in socket—picture comes back. Then goes out. Do it again and again. Same thing. Intermittent 6AF4? No! Bad socket? No! But that's what it looks like. I've had a good number of them.

Cure

Check the 10 mmfd. tubular ceramic capacitor in the plate circuit of the 6AF4. One end goes to the plate of the 6AF4, the other to the inductuner. Then check the center, which is grounded. Take a good look at the solder connection. It may not look bad. But don't strain your eyes. Just re-solder. Make sure to solder it good, but don't use too much heat. It's a bad spot so be careful. Your troubles are then over in this case.

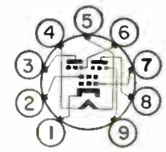
I have encountered this trouble in about 25 tuners and have heard similar complaints from other servicemen.

Chester Gloski
Franklin Radio & TV Co.
5 Pratt Street
Millers Falls, Mass.

What's new!

6BU8—3BU8 TWIN PENTODE

The 6BU8 is a miniature multisection tube which incorporates separate plates and number 3 grids for the two sections together with a common screen, number 1 grid, and cathode. The tube is intended for use as a combined sync-AGC tube in television receivers. In this service, when used in conjunction with suitable circuitry, one section of the 6BU8 functions as sync separator and sync clipper, while the other section is used to generate the automatic-gain-control voltage. In addition, by utilizing the common number 1 grid, noise pulses can be suppressed from both synchronizing and automatic-gain-control circuits. Except for heater ratings, the 3BU8 is identical to the 6BU8.



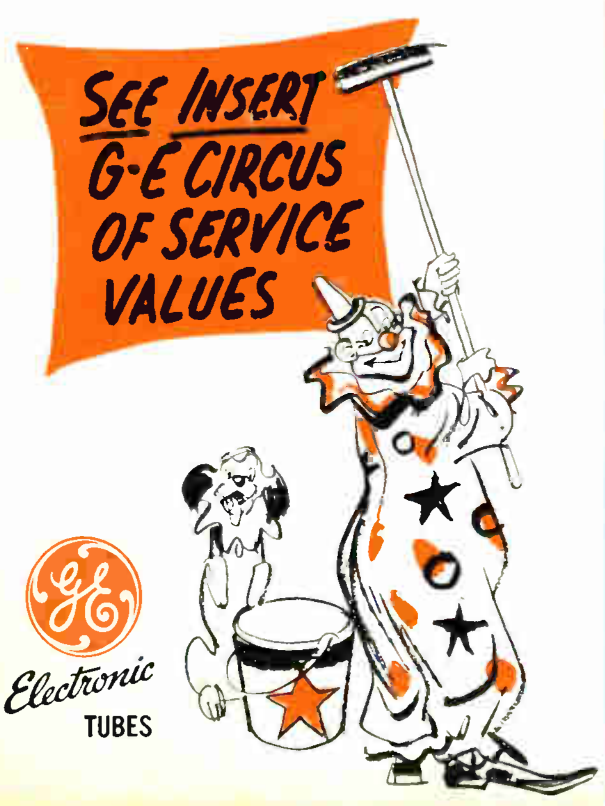
6BU8—3BU8
TWIN PENTODE

	3BU8	6BU8
Heater Voltage, AC or DC	3.15	6.3 Volts
Heater Current	0.6	0.3 Amperes
Heater Warm-up Time	11	... Seconds
CHARACTERISTICS AND TYPICAL OPERATION		
Average Characteristics, Both Sections Operating		
Plate Voltage, Each Section	100	100 Volts
Screen Voltage	67.5	67.5 Volts
Grid-Number 3 Voltage, Each Section	−10	0 Volts
Grid-Number 1 Voltage	‡	‡
Plate Current, Each Section		2.2 Milliamperes
Screen Current	6.5	3.3 Milliamperes
Cathode Current	6.6	7.8 Milliamperes

‡ With grid current adjusted for 100 microamperes d-c.

CORRECTION

Unfortunately, some errors appeared in Fig. 6 on page 5 of the Vol. 8, No. 1 issue. The battery in Fig. 6C should be 3.0 V instead of 360 V. The 22 K resistor on the right of Fig. 6E should be 2.2 K and the point where the line from the switch to the volume control crosses ground should be joined.



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