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The Aerovox Research Worker

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Television Receivers

PART 6

(*Conclusion*)

By the Engineering Department, Aerovox Corporation

THIS, the last in the series of articles on television receivers, deals with the picture tube, the power supply and general operating instructions.

THE PICTURE TUBE

Focusing of a cathode-ray beam can be done two ways: electrostatically and magnetically. Nearly all tubes used in this country are designed for electrostatic focusing. One may consider the focusing electrodes as a lens which forms an image of the cathode on the screen. Such an "electron lens" has properties similar to optical lens.

Remembering the theory of light and of lenses, most observations apply equally well to electron lenses if we replace the light source by a cathode, a light-ray by an electron path and the lens by two fields formed by conductors having different potentials. The two cases are illustrated in Figure 1.

In optics, a lens has its converging or diverging power because the speed of light in glass is different from that in air and because of the specially shaped surfaces. Similarly, an electron lens can be made if the electron beam

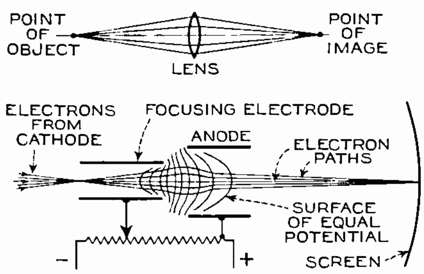

Figure 1

is to pass into a region where the speed changes and if the border of this region can be suitably shaped. The speed of the electron increases when it passes to a region of higher positive potential. The surface of the lens can be properly shaped by the design of the electrodes and the ratio of their potentials. In an electron lens the speed of the electrons changes gradually when passing from a low-potential to a high-potential region while a light-ray changes its speed suddenly at the surface of the glass. The electron lens can have its focal length changed by varying the potentials of the electrode. In this respect it is superior to the optical lens.

The focal length of an electron lens depends on the physical shape of the electrodes and the ratio of the electrode potentials, but does not depend on the potentials themselves. So, one may reduce all the electrode voltages in the same proportion and still obtain a small focused spot. In this case, however, the electrons strike the screen at a lower speed resulting in less brilliance. If all the voltages are increased in the same proportion, the spot will be more brilliant, but if the rating of the tube is exceeded the screen will be burnt.

In the picture tube, the grid and accelerating grid form a diverging lens causing an enlarged image of the cathode in space. This real image becomes a virtual object of a second converging lens consisting of the focusing anode and the anode, resulting in a small image on the screen. This is illustrated in Figure 2.

It will now be clear why the spot will generally be de-focused by a change in grid voltage. The surface of the screen should be a part of a sphere with the center at the deflection plates or coils, else the spot will go out of focus when deflected. The

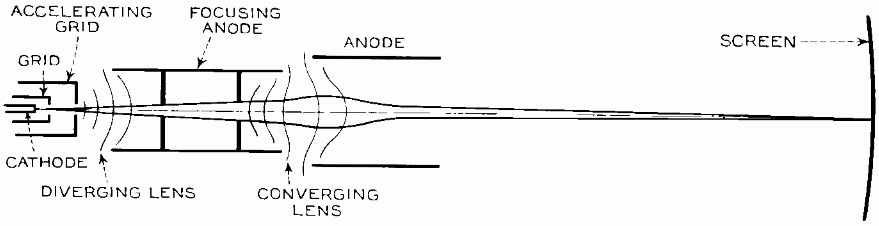

Figure 2

so-called "short" tube does not fulfill this requirement but the depth of focus is large enough to make the effect unnoticeable.

MAGNETIC FOCUSING

It is possible to focus the beam magnetically from the outside. The focusing anode is then unnecessary. A coil is wound around the neck of the tube and a current passed through it. Magnetic lines of force will then run lengthwise in the tube. Electrons will prefer to follow these lines, for, if they have a velocity at an angle with the field, they cut lines of force, which requires energy. They will then be forced back gradually in the direction of the field. The resulting electron path is a spiral becoming ever narrower. Focusing is done by varying the current in the coil. Figure 3 illustrates a tube with magnetic focusing.

The large cathode-ray tube is dangerous to handle. Due to the vacuum inside, the glass is subject to considerable strain. Care must be taken not to subject the tube to pressure, especially around the rim. A breaking tube may injure the operator. The precautions recommended by the manufacturer should be followed. When the yoke is placed around the neck it should not exert pressure on the tube.

THE POWER SUPPLY

The television receiver has two power supplies, one is to furnish the plate voltage to the tubes in the receiver proper; the other to the picture tube. They may or may not be run from the same transformer.

The power supply for the receiver is of conventional design. It is generally a rather large one since there are many tubes to be supplied. Thus it will be equipped with a 5Z3 or similar rectifier while the filter condensers will be of large capacity and the chokes small. A heavy current would cause too much voltage drop and consequent bad regulation with a heavy drain. A large input condenser, 40 mfd., can be employed with a 5Z3 rectifier or a similar wide-spaced tube. They are not to be recommended with a close-spaced rectifier such as the 83V. In that case it is best to have the first condenser small, (1 mfd. maximum), and to use large condensers at the other locations in the filter.

A separate power source for the cathode-ray tube or "picture tube" delivers from 2000 volts to 7500 volts depending on the size of the tube. This part of the receiver also con-

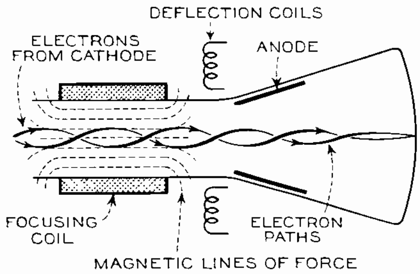

Figure 3

tains several controls such as the focusing control, brilliance control and the two centering controls. Some or all of these are at a high potential which calls for unusual care in the design, construction and servicing of the receiver.

Contrary to oscillograph practice, the filament of the picture tube is usually at a low potential and the anode at a high potential in order to bring the grid of the picture tube to the same voltage as the plate of the last video stage. The deflection plates, if any, are at the same potential as the anode which calls for high-voltage blocking condensers to drive them and also complicates the centering controls.

Since there are essential differences in power supplies for electrostatic and magnetic deflection tubes, they will here be considered separately.

ELECTROSTATIC DEFLECTION

Figure 4 shows a power supply for a receiver employing an electrostatic deflection tube such as the 1802 or the 1805 or a Dumont tube. Since the current drain on the high-voltage supply is very low, it is easy to filter even with a half-wave rectifier. Suitable tubes are described in the May 1939 issue of the Research Worker.

The ripple filter consists of but one condenser in the circuit of Figure 4. If more filtering is required, the filter may consist of two condensers with a resistance instead of a choke. Such an arrangement is shown in Figure 6.

The filter condensers used for the high-voltage supply must, of course, be of the high-voltage paper-dielectric type. The voltage rating varies from 2000 volts for the 5-inch tube to 7500 volts for the 12-inch tube. The capacity values employed are between .1 mfd. and .5 mfd.

Some experimenters will undoubtedly want to connect several low-voltage condensers in series. If this is done, the voltage divides itself across the condensers in proportion to their insulation resistances. Since these may easily vary greatly between different samples of the same type, one condenser with a very high insulation resistance would be subjected to the greatest strain and probably would break down. Resistors across the condensers, as in Figure 5, will equalize

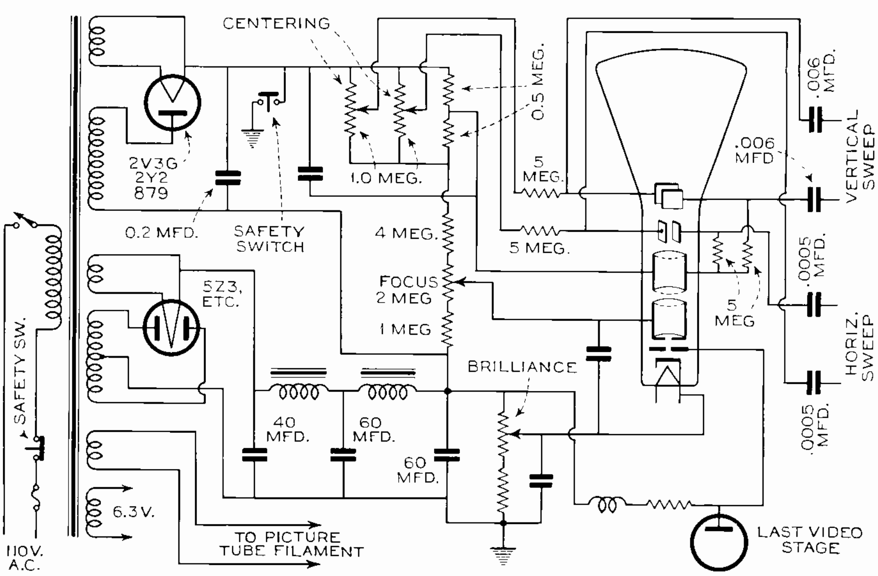

Figure 4

the voltages across the condensers. The values of the resistors must be small compared to the insulation resistances. A good value would be between 1 megohm and 10 megohms.

If electrolytic condensers are connected in the same way, the resistors should be of a much lower value since the insulation resistance of this type is so much lower. It is also well to remember that the capacity of condensers in series is smaller than the smallest according to the well-known laws. Five 1 mfd. condensers in series will result in a .2 mfd. condenser.

Returning now to Figure 4, the two power supplies are in series in order to bring the grid of the picture tube to the potential of the plate in the last video stage. This will then permit direct coupling and may do away with the d.c. restorer in some cases. The initial bias is adjusted with a potentiometer, labeled "brightness control".

The voltage drop in the plate load of the last video stage must be large enough to make the grid negative with respect to the cathode. In this connection one should note that a failure of the last video stage may result in damage to the picture tube. If the last video stage fails to draw

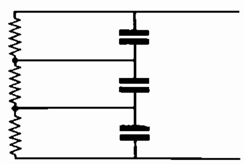

Figure 5

current, the picture tube grid becomes positive with respect to the cathode. Therefore, the placing of the grid at ground potential is perhaps preferable as illustrated in Figure 6. This arrangement is, of course, equally possible with electrostatic and magnetic deflection circuits.

The focusing control is connected as in conventional oscillograph design. The centering controls require some special attention. The deflecting plates are returned to the anode through grid leaks. However, one plate of each pair is "biased" by means of the potentiometers or "centering controls" at the positive side of the high-voltage supply.

Since the deflection plates are at high potential, they must be driven through blocking condensers which must be able to stand the high voltage plus the low voltage plus the signal voltage in the circuit of Figure 4. Mica condensers are best for this service while paper condensers would be second choice. The sizes depend on the lowest frequency to be transmitted. Those indicated in Figure 4 are typical.

SAFETY FIRST

The centering controls, the focusing control and the brilliance control, are at various voltages above the chassis.

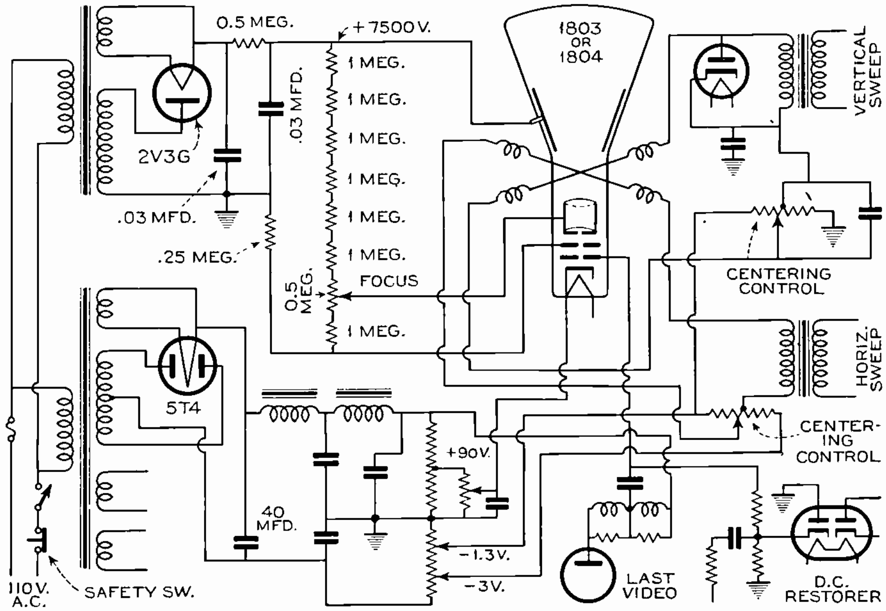

Figure 6

The high voltages employed in television receivers are dangerous. Precaution must be taken to prevent contact with the high potentials on the part of the "looker-in" as well as the serviceman. Even when the power is "off" danger exists, for, if the bleeder were open, the high-voltage condenser would retain its charge. The following measures are recommended:

1. Include an automatic switch, operated when the cabinet is opened, which opens the power line and shorts the high-voltage condensers.
2. The focusing, centering and brilliance controls should be mounted on insulating material away from the front panel and operated by means of long, insulated shafts.
3. High-voltage parts should be so located as to make accidental contact unlikely.

Servicemen and experimenters will have to operate the receiver with the cabinet open on occasion. They should then be especially careful. The old rules of one hand in the pocket and standing on insulating material might be followed.

MAGNETIC DEFLECTION

Figure 6 illustrates a somewhat simplified diagram of the TRK12* power supply. Magnetic deflection has the advantage of eliminating the high voltage at the deflecting circuits. Consequently, the centering controls can be at low potential.

The grid of the picture tube is at chassis potential which brings the brilliance control also within safe voltages. However, this requires that the grid be driven through a blocking condenser and the grid leak must therefore be connected to the d.c. restorer.

The centering controls are of interest here. The adjustment is accomplished by passing some direct current through the deflecting coils and the secondary of the output transformer. The power is taken from the low-voltage power supply. The potentiometers are connected across a portion of the negative part of the voltage divider because this part is drawing a heavy current and can more easily supply the deflecting circuits.

Note that in both the deflecting circuits one side is connected to a tap on the potentiometer which makes it possible to run the current through the coil in either direction.

OPERATION

The identifying chart employed by television stations is designed to facilitate proper adjustment of the receiver. The focusing and brilliance control might be adjusted with no signal coming in. If the brilliance control is advanced the raster becomes visible. The return traces in particular permit accurate focusing. The brilliance control can then be turned back until the raster just disappears.

Next, tune in the station when it is transmitting its identifying chart. Adjust the centering controls and the size controls (volume controls of sweep circuits) so that the picture fills the correct space and is in the center. Next, the contrast control and brilliance control can be set so as to get all the shades of gray transmitted. Focusing may be touched up by watching the detail at the converging lines. Egg-shapes and similar distortion can be corrected with the "horizontal peaking control."

* *By permission, R.C.A.*

MAX. 525v. SURGE
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12	15/16 x 1-11/16	.75
16	15/16 x 2-3/16	.90
20	1-1/16 x 2-3/16	1.00

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12	11/16 x 1-11/16	.50
16	11/16 x 1-11/16	.55
24	11/16 x 2-3/16	.60
30	13/16 x 1-11/16	.65
40	13/16 x 2-3/16	.70

MAX. 75v. SURGE
50v. D.C. Working
Type PRS-50—Single Section

10	9/16 x 1-11/16	.45
25	11/16 x 1-11/16	.55
50	13/16 x 1-11/16	.80
100	13/16 x 2-3/16	1.00

MAX. 40v. SURGE
25v. D.C. Working
Type PRS-25—Single Section

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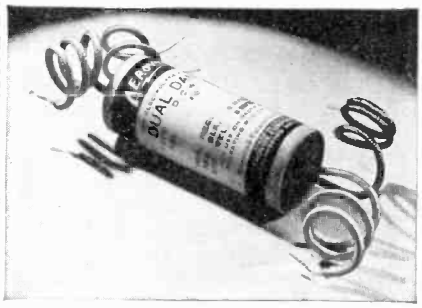
25	9/16 x 1-11/16	.50
50	11/16 x 1-11/16	.60
100	13/16 x 1-11/16	.90



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PRS-A	200	8-16	13/16 x 2-5/16"	1.00
PRS-A	200	16-16	7/8 x 2-5/16"	1.15
PRS-A	150	8-8	11/16 x 2-3/16"	.80
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