

ing about it, Fig. 10. In a normal atom, negative electrical charges of electrons equal positive charges on the protons in the nucleus, so the atom is electrically neutral.

When an electron emitted from the cathode at high velocity collides with a gas atom the impact knocks one or more electrons out of the atom, Fig. 11. In a gas-filled electron tube that is in operation, a tremendous number of gas atoms are being bombarded by the electrons shot out into space by the hot cathode. As a result the number of free electrons is greatly increased in the space between cathode and anode.

Atoms that lose one or more electrons become positively charged, because the negative charge of their electrons is less than the positive charge of their nucleus. These positively charged atoms are called ions and the process of forming them is ionization.

The positive charge on the ions neutralizes most of the negative space-charge effects existing in a high-vacuum tube, and permits more electrons to reach the anode. This effect, combined with a large increase in free electrons, previously mentioned, results in a large increase in current flow through the tube compared to a high-vacuum tube under similar conditions.

In Fig. 9, the symbol for a gas-filled tube is the same as for the high-vacuum tube in Fig. 7 except that it contains a large dot. This dot represents inert gas, or a drop of mercury that partly vaporizes when the tube operates.

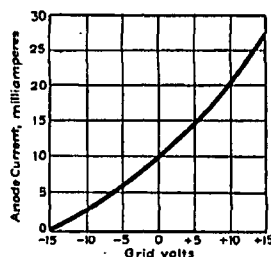
All electron tubes are essentially rectifiers; that is, they let current flow through them in one direction only. This characteristic permits using them to change alternating to direct current, which will be explained in later articles.

A simple diode, 2-element electron tube, has no means of controlling current flow through it except by external means, as explained. To make it possible for electron tubes to control current flow through them a third element, or grid, is added, Fig. 12. Such a tube is called a triode and its grid is placed between cathode and anode as shown. In Fig. 12, the grid connects to a terminal in the tube base. In other designs, this connection is placed in the side of the tube. Grids differ in both form and material (Fig. 25 to 29, *Power*, June, pp 98, 100) depending on tube design, size and application.

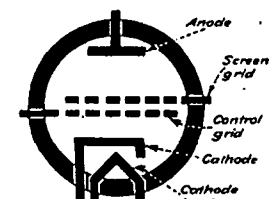
Fig. 13 shows the symbol for a grid-controlled high-vacuum tube with a directly heated cathode, and Fig. 14 for a grid-controlled gas-filled tube with an indirectly heated cathode. Fig. 15

(Continued on page 142)

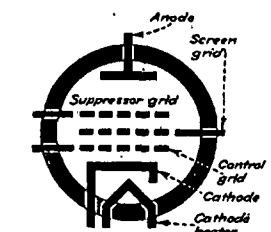
Hot and Cold Cathodes



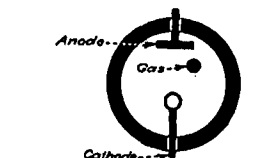
16 Current change made by adjusting potential on grid of vacuum tube



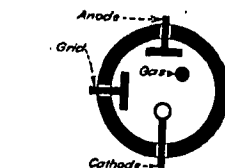
17 The symbol of a high-vacuum tube with both control and screen grid



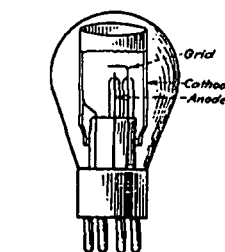
18 Symbol of a five-element tube with cathode that is indirectly heated



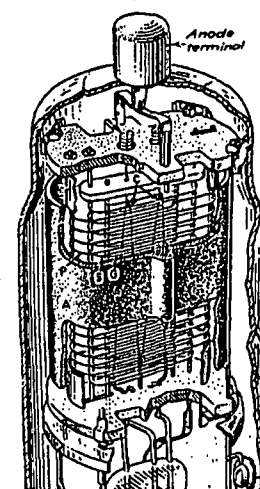
19 Symbol of a gas-filled two-element electron tube of cold-cathode type



20 The symbol of a grid-controlled gas-filled cold-cathode electron tube



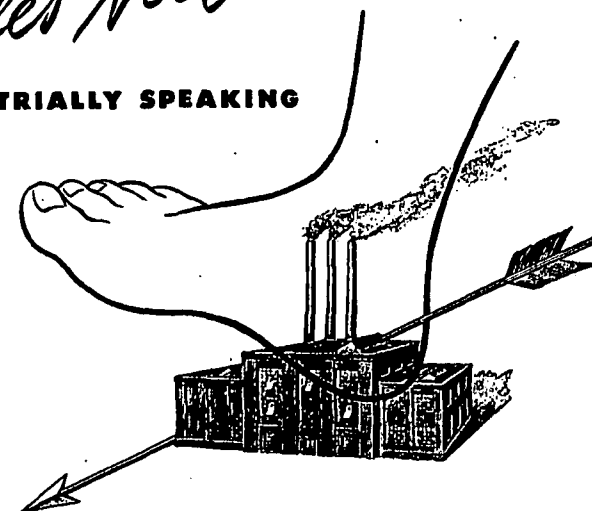
21 One design of cold-cathode electron tube that is controlled by a grid



22 Arrangement of the elements in one design of tube having five elements

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