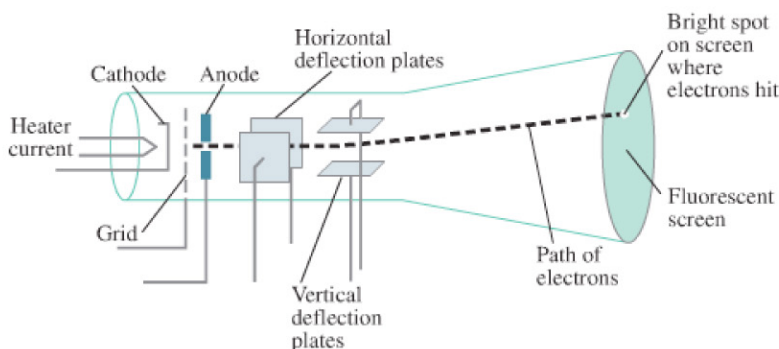


FIGURE 17–20 A cathode-ray tube. Magnetic deflection coils are often used in place of the electric deflection plates shown here. The relative positions of the elements have been exaggerated for clarity.



PHYSICS APPLIED
CRT

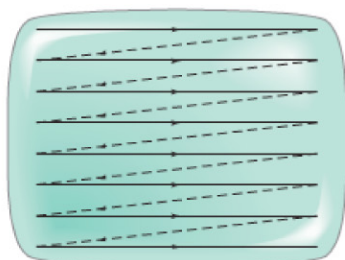


FIGURE 17–21 Electron beam sweeps across a television screen in a succession of horizontal lines. Each horizontal sweep is made by varying the voltage on the horizontal deflection plates. Then the electron beam is moved down a short distance by a change in voltage on the vertical deflection plates, and the process is repeated.

PHYSICS APPLIED
TV and computer monitors

PHYSICS APPLIED
Oscilloscope

The **cathode ray tube (CRT)** derives its name from the fact that inside an evacuated glass tube, a beam of cathode rays (electrons) is directed to various parts of a screen to produce a “picture.” A simple CRT is diagrammed in Fig. 17–20. Electrons emitted by the heated cathode are accelerated by a high voltage (5000–50,000 V) applied between the anode and cathode. The electrons pass out of this “electron gun” through a small hole in the anode. The inside of the tube face is coated with a fluorescent material that glows when struck by electrons. A tiny bright spot is thus visible where the electron beam strikes the screen. Two horizontal and two vertical plates can deflect the beam of electrons when a voltage is applied to them. The electrons are deflected toward whichever plate is positive. By varying the voltage on the deflection plates, the bright spot can be placed at any point on the screen. Many CRTs use magnetic deflection coils (Chapter 20) instead of electric plates.

In the picture tube or monitor for a computer or television set, the electron beam is made to sweep over the screen in the manner shown in Fig. 17–21 by changing voltages applied to the deflection plates. For standard television in the United States, 525 lines constitutes a complete sweep in $\frac{1}{30}$ s, over the entire screen. High-definition TV provides more than double this number of lines, giving greater picture sharpness. We see a picture because the image is retained by the fluorescent screen and by our eyes for about $\frac{1}{20}$ s. The picture we see consists of the varied brightness of the spots on the screen, controlled by the grid (a “porous” electrode, such as a wire grid, that allows passage of electrons). The grid limits the flow of electrons by means of the voltage (the “video signal”) applied to it: the more negative this voltage, the more electrons are repelled and the fewer pass through. This video signal sent out by the TV station, and received by the TV set, is accompanied by signals that synchronize the grid voltage to the horizontal and vertical sweeps.

An **oscilloscope** is a device for amplifying, measuring, and visually observing an electrical signal (a “signal” is usually a time-varying voltage) on the screen of a CRT. The electron beam is swept horizontally at a uniform rate in time by the horizontal deflection plates. The signal to be displayed is applied (after amplification) to the vertical deflection plates. The visible “trace” on the screen, which could be an electrocardiogram (Fig. 17–22), or a signal from an experiment on nerve conduction, is a plot of the signal voltage (vertically) versus time (horizontally).

FIGURE 17–22 An electrocardiogram (ECG) trace displayed on a CRT.

