Video Display Devices

- Primary output device – Video Monitor
- Operation – Standard Cathode-ray tube (CRT) design
- Several other technologies exist now

Refresh Cathode-Ray Tubes

- Fig 2.2
- A beam of electrons (cathode rays), emitted by an electron gun, passes through focusing and deflection systems that direct the beam toward specified positions on the phosphor-coated screen
- The phosphor then emits a small spot of light at each position contacted by the electron beam
- Because the light emitted by the phosphor fades very rapidly, some method is needed for maintaining screen picture

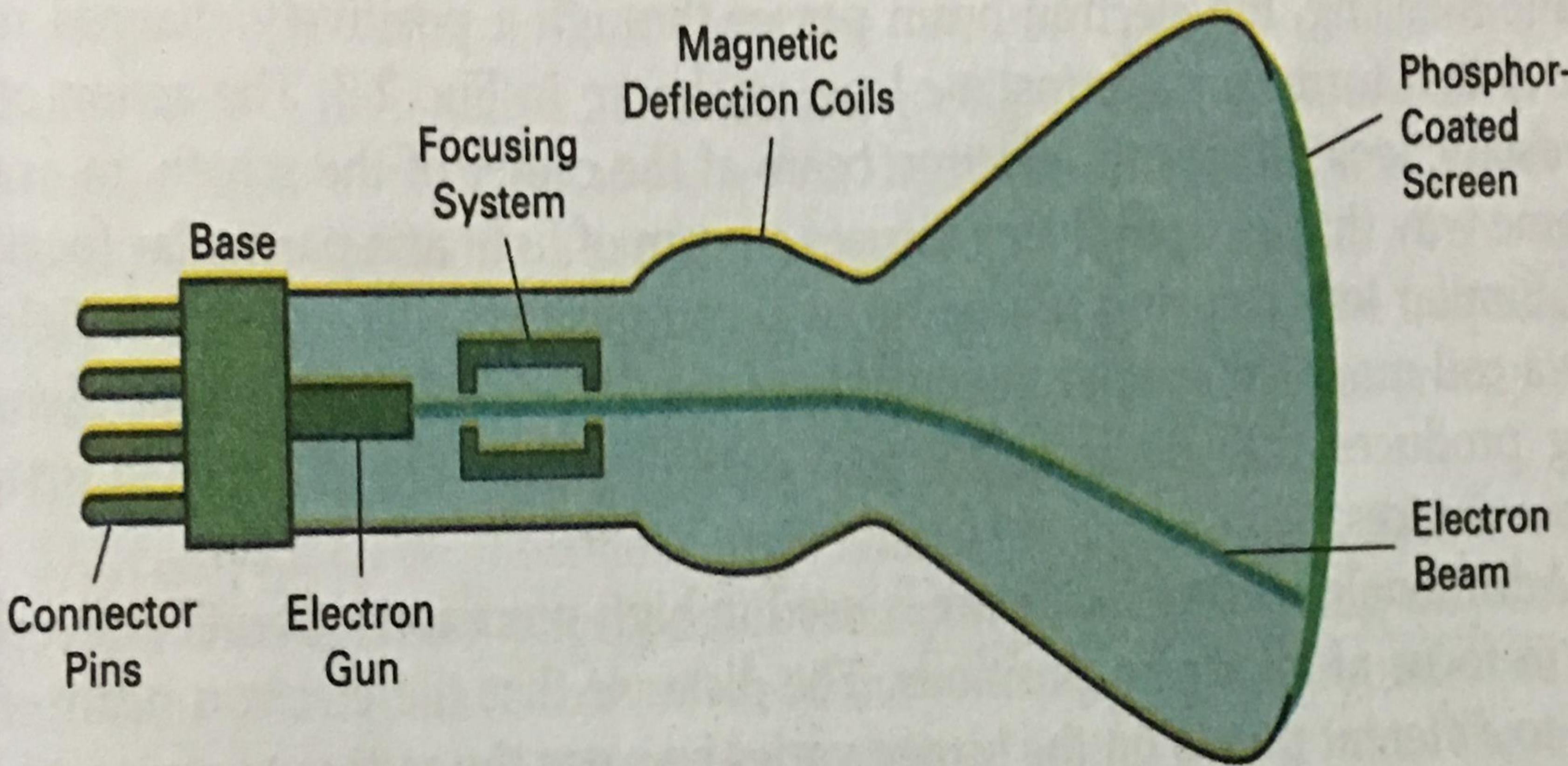

Figure 2-2
Basic design of a magnetic-deflection CRT.

- One way to keep the phosphor glowing is to redraw the picture repeatedly by quickly directing the electron beam back over the same points
- This type of display is called a refresh CRT
- The primary components of an electron gun in a CRT
  - The heated metal cathode
  - Control grid (fig 2.3)
- Heat is supplied to the cathode by directing a current through a coil of wire, called the filament, inside the cylindrical cathode structure
- This causes the electrons to be “boiled off” the hot cathode surface

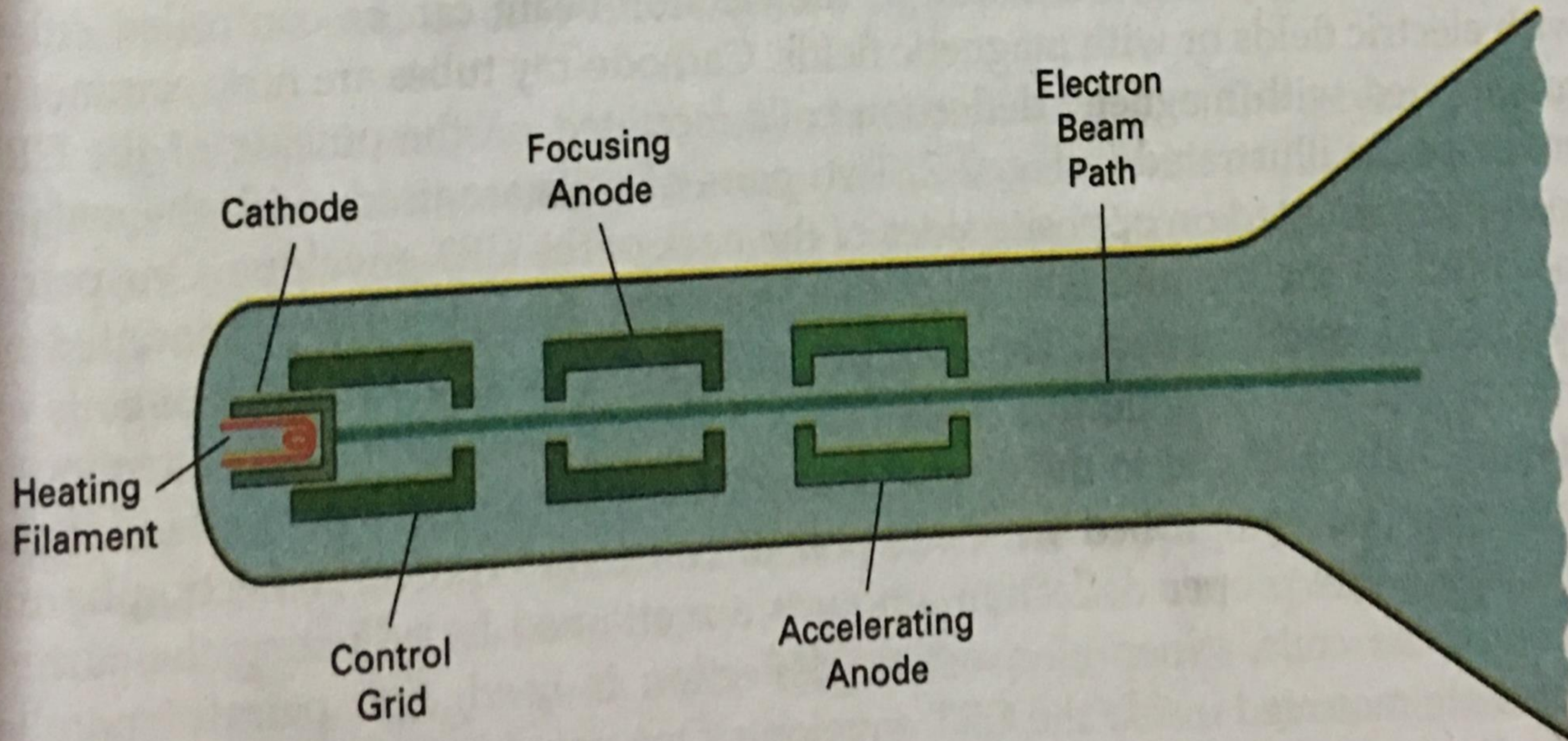

Figure 2-3
Operation of an electron gun with an accelerating anode.

- In the vacuum inside the CRT envelope, the free, negatively charged electrons are then accelerated toward the phosphor coating by a high positive voltage
- The accelerating voltage can be generated with a positively charged metal coating on the inside of the CRT envelope near the phosphor screen, or an accelerating anode can be used, as in Fig. 2-3.
- Sometimes the electron gun is built to contain the accelerating anode and focusing system within the same unit.

- Intensity of the electron beam is controlled by setting voltage levels on the control grid, which is a metal cylinder that fits over the cathode.
- **A high negative** voltage applied to the control grid will shut off the beam by repelling electrons and stopping them from passing through the small hole at the end of the control grid structure.
- **A smaller negative voltage on the control grid simply decreases** the number of electrons passing through.
- Since the amount of light emitted by the phosphor coating depends on the number of electrons striking the screen, we control the brightness of a display by varying the voltage on the control grid.

- We specify the intensity level for individual screen positions with graphics software commands
- The focusing system in a CRT is needed to force the electron beam to converge into a small spot as it strikes the phosphor.
- Otherwise, the electrons would repel each other, and the beam would spread out as it approaches the screen.
- Focusing is accomplished with either electric or magnetic fields

- Electrostatic focusing is commonly used in television and computer graphics monitors.
- With electrostatic focusing, the electron beam passes through a positively charged metal cylinder that forms an electrostatic lens, as shown in Fig. **2-3.**
- **The** electrostatic lens **focuses the electron beam at the center of the screen**
- Lens focusing effects can be accomplished with a magnetic field set up by a coil mounted around the outside of the CRT envelope.
- Magnetic lens **focusing** produces the smallest spot size on the screen and is used in special purpose devices

- Additional focusing hardware is used in high-precision systems to keep the beam in focus at all screen positions.
- The distance that the electron beam must travel to different points on the screen varies because the radius of curvature for most CRTs is greater than the distance from the focusing system to the screen center.
- Therefore, the electron beam will be focused properly only at the center of the screen.

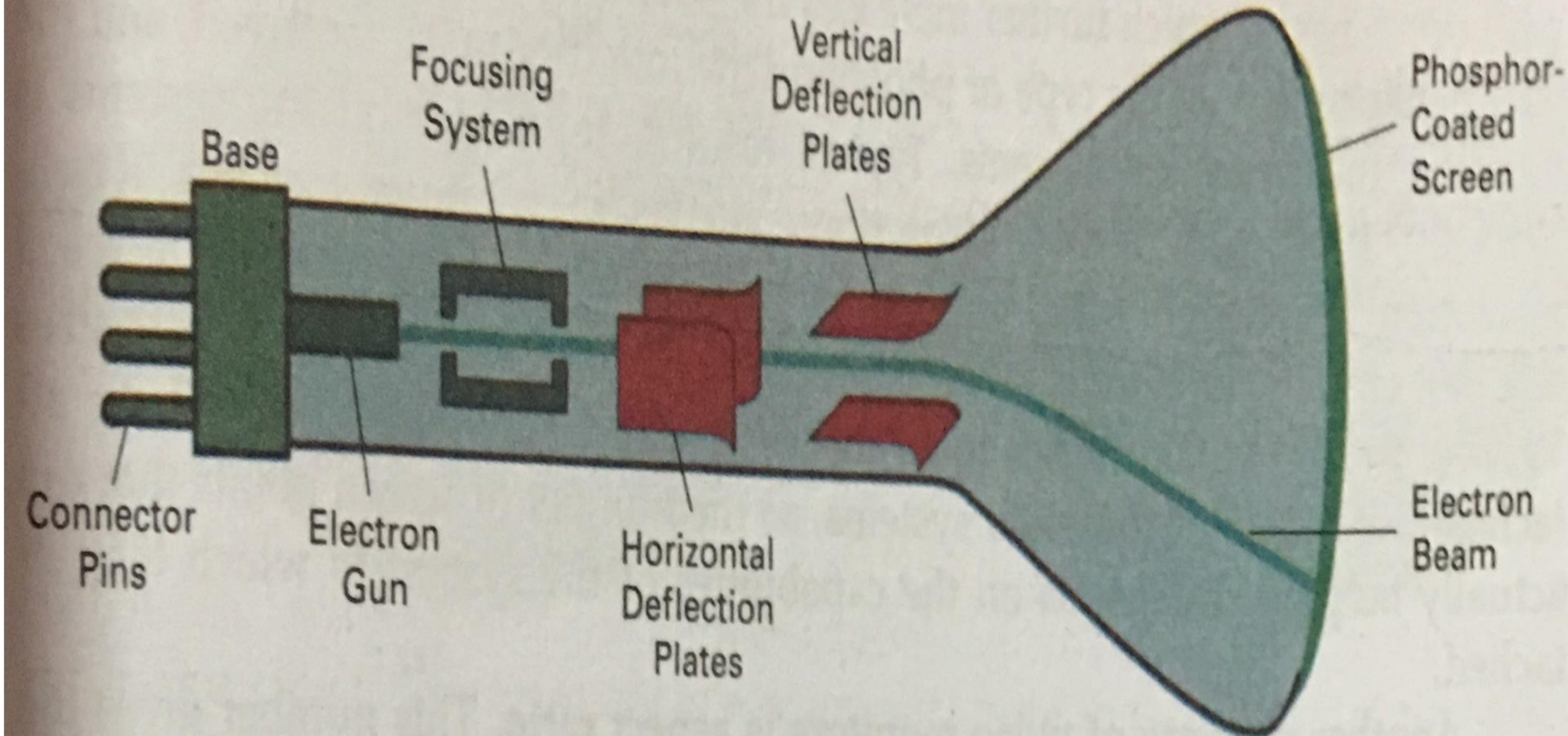

Figure 2-4
Electrostatic deflection of the electron beam in a CRT.

- As the beam moves to the outer edges of the screen, displayed images become blurred.
- To compensate for this, the system can adjust the focusing according to the screen position of the beam.
- Spots of light are produced on the screen by the transfer of the CRT beam energy to the phosphor.
- When the electrons in the beam collide with the phosphor coating, they are stopped and the kinetic energy is absorbed by the phosphor.
- Part of the beam energy is converted by friction into heat energy, and the remainder causes electrons in the phosphor atoms to move up to higher quantum-energy levels.

- After a short time, the "excited phosphor electrons begin dropping back to their stable ground state, giving up their extra energy as small quantums of light energy.
- What we **see on the screen is the combined effect of all** the electron light emissions: a glowing spot that quickly fades after all the excited phosphor electrons have returned to their ground energy level.
- The **frequency (or** color) of the light emitted by the phosphor is proportional to the energy difference between the excited quantum state and the ground state.