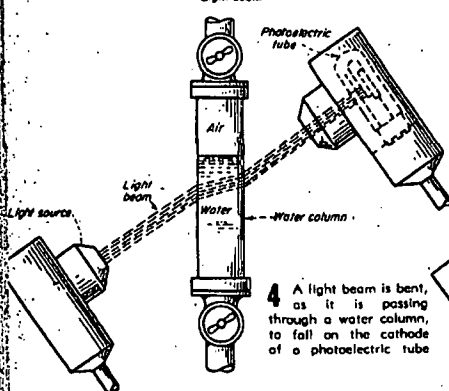
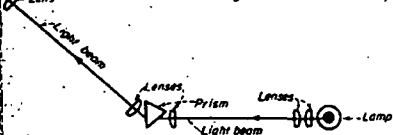
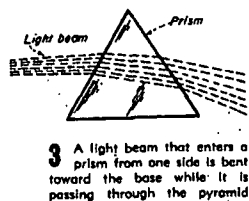
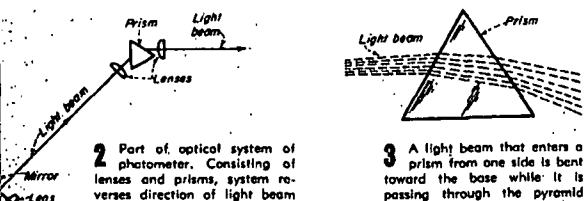
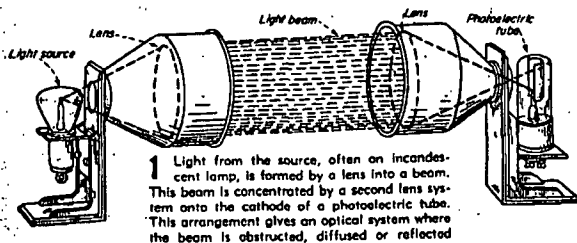


ELECTRONICS FOR THE POWER ENGINEER

By F A ANNETT, Associate Editor

5—Photoelectric Tubes

Optical Systems for Photoelectric Tubes



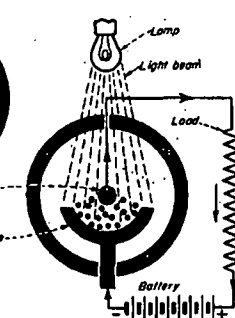
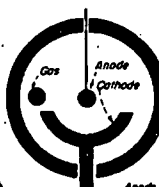
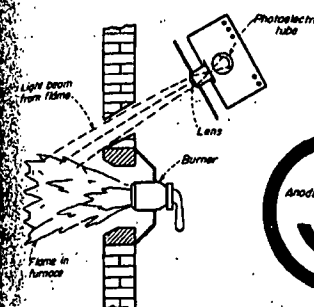
PHOTOELECTRIC-TUBE CATHODES have comparatively small areas, usually $1/2$ to 2 sq in. So even with intense illumination we have less than one lumen on the cathode. To concentrate maximum light flux on a cathode, some form of optical system is used.

For example, if the light in a room or an incandescent object actuates the tube, a single lens system, like that on the right, Fig. 1, concentrates this light. Same principle applies as when a magnifying glass concentrates the sun's rays to burn a hole in a piece of paper. But in our photoelectric-tube application, the light has only a small fraction of the intensity of the sun's rays.

Often an incandescent lamp is the light source and is directed as a beam across a space onto the photoelectric tube's cathode. For these applications two lenses are used, Fig. 1. One at the light source forms a beam that is directed across space to a second lens that concentrates the beam onto the tube's cathode. This arrangement provides an effective optical system in many applications where the beam is obstructed, diffused, reflected, refracted or deflected.

Obstruction. As an example of obstruction, a light beam is thrown across an elevator's entrance. While a passenger, getting off or on the car, is in the beam, a relay remains open to break the door-closing circuit and the door

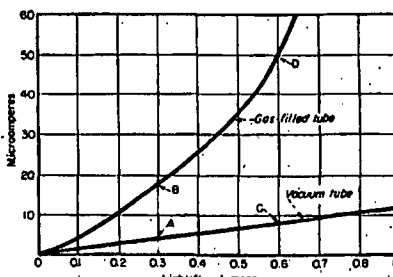
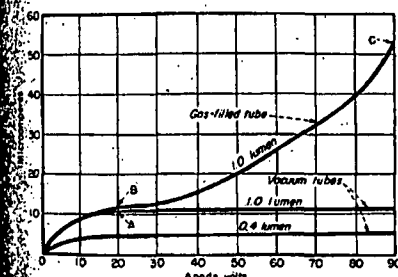
Photoelectric-Tube Symbols and Characteristic Curves



A photoelectric scanning system focuses the light from a flame through a lens on the cathode of the tube.

The symbol for a vacuum photoelectric tube with a curved coated-metal cathode and a vertical wire anode.

The symbol for photoelectric tube that is gas-filled. Dot indicates gas as in a hot-cathode tube.



cannot close as long as beam is broken. In the reverse of this application, the light beam is directed across a door opening. When a person walks across the beam a relay closes to energize the opener to open the door. A timing relay holds it open a given period to let the person pass; then the relay functions to let it close.

In another application a factory truck, approaching an electric-elevator door, interrupts a light beam. This actuates a photo-electric relay that starts the elevator machine to bring the car to the floor when the doors open for the truck.

Objects on a conveyor are counted automatically as they move through a light beam. Obstructing this beam actuates a photoelectric relay that causes a counter to function.

Diffusion. Applications where the light beam is diffused include smoke-density indicators. Here, as the density changes, the amount of light reaching the photoelectric tube also changes. This causes the smoke-density indicator to function accordingly, and generally to sound an alarm if a specified density is exceeded. A similar use is found in detecting turbidity in liquids.

Reflection. A mirror may reflect the light beam much as tilting a mirror makes a light beam race across a wall. Reflection is used to measure speed of fast-running shafts. A light beam reflected by a tiny mirror on the shaft's end acting through a photo-electric relay gives accurate speed indication.

A photoelectric recorder is another reflection application. Weak input signals cause the movement of a tiny

mirror. Reflected light from it controls a photoelectric-tube follow-up system that makes a permanent record of the weak electrical-input signal.

A prism provides another method of reflecting or bending a light beam toward a photoelectric tube. In its simplest form a prism is merely a glass pyramid. Light entering the pyramid from one side is bent toward the base as it passes through the glass, Fig. 3.

Deflection. Fig. 2, which diagrams part of the optical system of a photometer, gives a good illustration of how prisms and mirrors bend light beams in electronic metering devices. Light from the lamp is focused into a beam and directed to the left to a prism. Here the beam first passes through a lens and into the prism where it is deflected and passes through another lens toward a