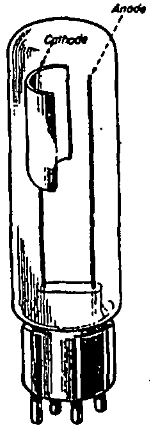
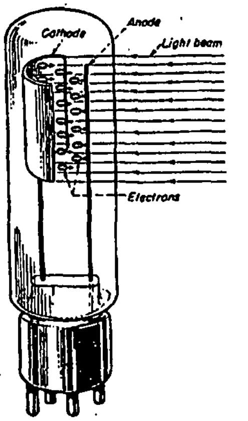
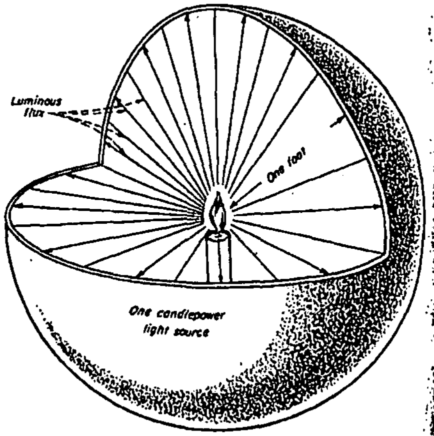
Photoelectric Tubes and Unit Light Source







2 Photoelectric tube has a cathode and an anode

3 Beam on cathode causes electron flow to anode

4 A unit light source is an equal distance from all the points on a sphere so that the intensity of the light can be measured

calcium and their oxides—and metals—such as tantalum, titanium and thorium—are used for cathodes of special-purpose photoelectric tubes. Sodium might be used as the light-sensitive element in a tube sensitive to the ultraviolet end of the spectrum. But an ultraviolet-sensitive photoelectric tube, *not sensitive to visible light*, would have a tantalum-, titanium- or thorium-coated cathode.

Light Flux. When we discussed hot-cathode tubes we learned that with other conditions constant, electron flow through the tubes varied as the current flow through the cathodes. In other words, for a given anode voltage, electron flow through the tube increased or decreased as the cathode's temperature was increased or decreased between limits.

Similarly, in a photoelectric tube for a given anode voltage, electron flow through these tubes is determined largely by the amount of light reaching the cathode. Light is a medium of energy transmission just as an electric current in a circuit is. But we do not speak of light flow as we do of an electric current; we call *it light flux* or light quantity.

Since light is one of the most important factors when dealing with photoelectric tubes, we should have some idea how it is measured. The three most commonly used units are candlepower, foot-candle and lumen. A candlepower is the unit of luminous intensity or unit source of light. It is *approximately equal to the light from a* ⅞-in. sperm candle, burning at a rate of 120 grams, or 0.274 oz per hour.

Light is given off from the source in all directions. To have the light source an equal distance from all points on a surface so its intensity can be measured at a given distance, the source is placed in a sphere as in Fig. 4. The standard sphere has a 1-ft radius or 2-ft diameter, as indicated. Then, all points on the sphere's inner surface are 1 ft away from the light source. Under this condition the luminous-flux density on each square foot of surface is called a foot-candle.

In other words, a one-candlepower light source will emit one foot-candle to each square foot of surface one foot away. A luminous-flux density of one foot-candle is a lumen per square foot. Since a sphere *2 ft in diameter* has 12.57 sq ft area, a one-candlepower light source emits a total light flux of 12.57 lumens.

Assume we put the one-candlepower light into a 4-ft sphere. We would still have the same quantity of light flux, 12.57 lumens, *from* the light source but it would be dispersed over four times the area. Now the luminous-flux density will be only ¼ foot-candle. From this we see that while the total light flux from a source remains constant, flux density per square foot, foot-candles, varies inversely as the square of the distance from the source—that is, if we double the distance the light intensity decreases to one quarter per unit area.

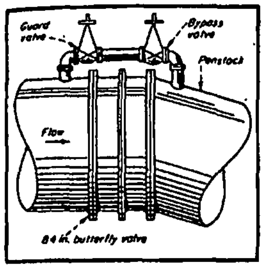
Electric-Lamp Application. How does all this apply to an electric lamp? A 75-watt tungsten gas-filled lamp with frosted bulb is rated 1100 lumens. Assuming such a light source at the center of a sphere 2 ft in diameter, the amount of luminous flux on each square-foot area would be 1100 + 12.57, or about 88. Foot-candles equal lumens per square foot; therefore, we have a *luminous-flux density* per square foot of 88 foot-candles.

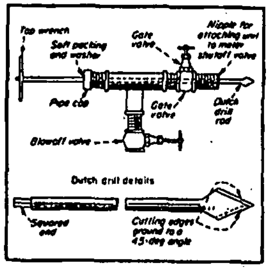
At 10 ft from the lamp, we have the same total *luminous flux, as at one-foot* distance, but it is spread over 10x10 = 100 times the area. Consequently the luminous-flux density equals 88 + 100 = 0.88 foot-candle or 0.88 lumen per square foot. We therefore do not have to get very far away from an ordinary light source before the intensity drops to a low value.

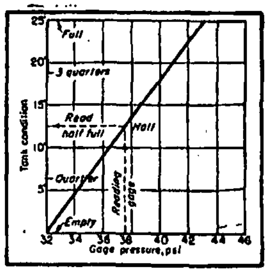
The next article will show how light from an electric lamp is concentrated into a beam, how this beam is manipulated to cause photoelectric tubes to perform many services.

POWER ENGINEERS' NOTEBOOK

PLANT-TESTED IDEAS TO SOLVE PROBLEMS OF DESIGN, OPERATION AND MAINTENANCE







Extra Valve Improves Maintenance Procedure

Hydraulic turbines served by single penstocks usually have butterfly valves at the spiral-casing inlet. Whenever the turbine is down for repairs, this valve shuts off the water without unwatering the penstock. Standard practice provides a bypass with a single shutoff valve around the butterfly valve. Before starting up the turbine this bypass permits filling the spiral casing with water, thereby equalizing the pressure on both sides of the butterfly wicket for greater ease in opening.

For an installation with 84-in. butterfly valves under 413-ft head with very long penstocks, it was realized that considerable advantage could be gained by providing duplicate guard valve in bypass. Extra gate valve, upstream of conventional gate valve, is normally open.

With both guard valve and butterfly valve closed, however, the regular bypass gate valve can be removed readily for inspection and repair. Without the guard valve, the regular valve could be removed only after unwatering the entire penstock, often leading to neglect of minor repairs.

Edward Uehling *Milwaukee, Wis.*

Clean Out Nipples Without Shutting Down the Main

A number of our steam-flow meters were indicating incorrectly because the meter nipples in the steam main had scaled up. We designed the tool shown above, which has permitted reaming out these nipples without taking the steam main out of service. The unit is built around a ½-in. tee. At one end of the straight run attach a short nipple with a cap drilled to accommodate the dutch-drill rod. At the back end of the cap place a soft ring of packing with a steel washer to prevent leakage. At the other end of the tee, attach the gate valve and nipples as shown. To the tee branch fix a nipple and blowoff valve.

Pull the drill back behind the gate valve and close both valves. Uncouple meter line from shutoff valve on meter nipple and attach unit. Open both gate and meter valves and operate drill rod with tap wrench or suitable tool. As *reaming progresses* the blowoff valve can be cracked to remove scale particles. All items are standard except the dutch drill, which can be made easily *from any piece of standard drill rod.*

E Podmayer *Palisades Park, N. J.*

Read Tank-Water Level From Pressure Gage

Hydrostatics, when properly applied, can give a convenient means of indicating the water level of an elevated tank for water storage. At one plant a standard elevated tank was erected so that its bottom stood 75 ft above the ground. Its top was 100 ft above the ground.

On this installation an ordinary water-pressure gage was piped into the existing system and placed at the base of the tank. Then a curve chart was made up so the operator could tell tank level by pressure readings. Here is how it works.

When the tank was full, water level reached the top of the tank and hence stood 100 ft above the ground. Knowing that a pressure of 1.0 psi is *required to support a column of water* 2.31 ft high, all that need be done is to calculate the gage pressure for a 100-ft column, or 100 ft divided by 2.31 ft gives 43.31 psi—say 43. At the empty position, the gage pressure figures 75 divided by 2.31, and is 32.4 psi or 32.

The curve chart that is shown above translates the pressure reading to the tank level. You can go still one step farther. With the total tank capacity known (10,000 gal) capacity per ft of a partially filled tank can be figured out. In this case 10,000 gal divided by 25 ft gives 400 gal per foot of tank.

J D Constance *Cliffside Park, N. J.*

(*Continued on page* 110)

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