

**Stabilisers.**

The characteristics of the electrical discharge in an inert gas have been made use of in stabilising circuits for maintaining constant voltage in electronic apparatus. The familiar neon lamp is an example of such a stabiliser, the voltage drop across the lamp remaining constant within wide limits of variation in current through the lamp. When such lamps are used for stabilising, a resistance must be connected in series with them to limit the current on starting. An interesting development of the neon discharge tube is the Stabilovolt, made by the Marconi W.T. Co. In this tube, a number of auxiliary electrodes are mounted between the main electrodes (Fig. 12), and the total voltage applied to the tube may be subdivided by tapping off one or other of the electrodes as shown. The stabilising action of this tube is such that the output voltage alters by only 0.1 per cent for a 10 per cent change in applied voltage.

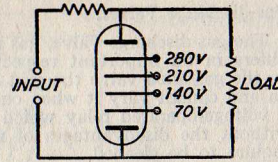


FIG. 12.—MARCONI "STABILOVOLT" GAS DISCHARGE VOLTAGE STABILISER.

**Photo-cells**

The photo-electric cell provides the link between light and electrical energy and for this reason is an essential basis of accurate quantitative measurements of light intensity, colour comparison, and other optical properties.

It is well-known that the human eye is unreliable in the estimation of brightness, as it is influenced by surroundings and other varied factors, but a photo-cell having the same characteristics as the human eye can be relied on to give accurate and repeatable results. See also page 79.

**Types of Photo-Cells.**

There are three main types of photo-cells, and the choice of a suitable cell for work is governed by the characteristics of each type.

The first is the PHOTO-CONDUCTIVE cell, in which the resistance of the material is affected by light falling on it. This was one of the earliest forms of photo-cell, and is usually made of selenium. Modern manufacturing processes have made it a reliable and economical cell for simple relay work, but there is an appreciable time-lag in the change in resistance which makes the cell unsuitable for rapidly fluctuating illumination. The cell requires to be connected in series with a source of e.m.f., the difference between the "dark" and "light" resistance being about 25:1, depending on the illumination. One of the advantages of the selenium cell is its response to low values of illumination.

THE PHOTO-VOLTAIC, or Photronic cell also makes use of selenium, but the action is entirely different. A thin film of selenium is deposited on a base plate of steel (Fig. 13), and the surface of the selenium is covered with a thin film of transparent metal to which contact is made to form one pole of the cell, the other being the baseplate. When light passes through the transparent metal and falls on the selenium, electrons are liberated which pass across a "barrier-layer" above the selenium and accumulate a negative charge on the top metal surface. This charge is sufficient to yield a current of several microamperes in an external circuit, a current of 600 microamperes being obtained from one type of cell with 100 ft.-candles illumination. One of the smallest cells manufactured by specialists in this work will deliver a current of 30 micro-amps. through an external resistance of 3,000 ohms. Special barrier-layer cells are manufactured having a resistance of some six

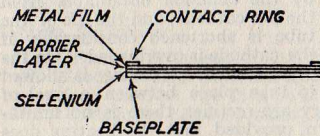


FIG. 13.—SECTION THROUGH A SELENIUM PHOTO-VOLTAIC CELL.

to eight megohms and suitable for use on the grid of any normal power-amplifying valve. These cells have a very wide field of application, and long life unlimited.

THE PHOTO-EMISSIVE cell contains a specially prepared surface of alkali metal enclosed in an evacuated glass bulb. A collecting electrode, or anode, is sealed in the bulb in the form of a thin ring or wire. When light falls on the metal surface, electrons are liberated, and these pass to the anode if a positive potential is applied between it and the emissive surface.

This photo-electric current is similar to the thermionic emission produced from a heated cathode, but in the case of the photo-cell it is caused by the action of light. The emission is directly proportional to the intensity of illumination of the surface. By choosing the metal for the light sensitive surface the cell can be adapted to give maximum response to light of a particular wavelength. For example, potassium is sensitive to blue and violet light, caesium oxide-silver is sensitive to red and infra-red. By

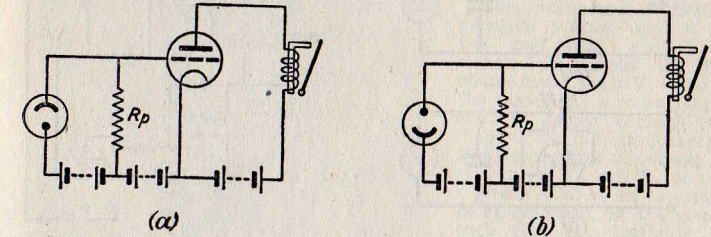


FIG. 14.—TWO CIRCUITS SHOWING THE CONNECTION OF A PHOTO-CELL TO AN AMPLIFYING VALVE.

choosing suitable filters, the response of the cell may be made the same as that of the human eye, which is of great importance in comparison of colours, etc.

Instead of evacuating the bulb thoroughly, it is sometimes of advantage to leave a trace of inert gas in the bulb, producing the so-called "gas-filled" cell. The electrons emitted from the light-sensitive cathode ionise the gas molecules and increase the electrons collected by the anode. By this means it is possible to increase the emission current tenfold. The amount of ionisation increases very rapidly with an increase in the anode voltage, until a point is reached at which the gas breaks down into a glow discharge, which will damage the emitting surface. Gas-filled cells should always be operated at low values of anode voltage and with due safety precautions against glow.

The current produced by the photo-emissive cells is very low, and it is usually necessary to amplify it by one or more stages of valve amplification. The connection of the cell to a valve is shown in the diagram of Fig. 14.

**Electronic Measuring Instruments**

The use of thermionic valves in instruments allows a much wider range of measurement to be undertaken than is possible with instruments of the usual type. The amplifying properties of the valve enable the sensitivity of a delicate galvanometer to be obtained with a robust type of pointer instrument with the additional advantage that the power required to deflect the pointer is not derived from the circuit under test.

The frequency range of thermionic instruments is very wide—in special cases up to several million cycles per second—and this property permits their being calibrated on mains frequency and subsequently used on higher frequencies without loss of accuracy.

A criticism that has been made of valve-operated measuring instruments is that the calibration is liable to be affected by variations in the supply