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FLUORESCENT DISCHARGE TUBE

Original Filed July 14, 1941

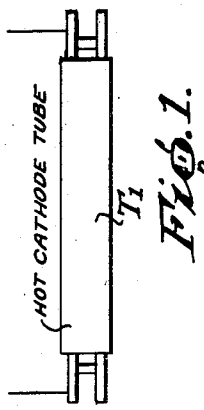


Fig. 1.

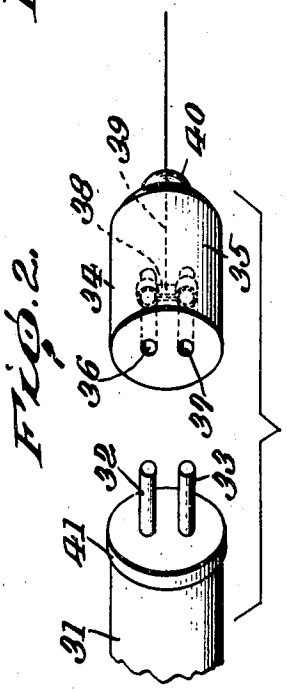


Fig. 2.

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FLUORESCENT DISCHARGE TUBE

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1 Claim. (Cl. 176—126)

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This application for patent is a division of our copending application Serial No. 402,412, filed July 14, 1941, entitled Luminescent tube system and apparatus now Patent 2,351,914 of June 20, 1944, and the invention relates to fluorescent tube lighting, and more particularly concerns a method and manner of operating the present-day hot cathode fluorescent gas discharge tubes, which are now widely available on the market, on cold-cathode operation.

The advantages which are attendant upon the operation of fluorescent gas discharge tubes on cold-cathode operation, with energy provided by high leakage reactance transformers which automatically provide the voltages required for satisfactory operation, including both the required high starting voltage and the lower operating voltage necessary once the arc is struck, have already been touched upon in our two co-pending applications, Serial No. 402,410, filed July 14, 1941, now Patent 2,352,073 of June 20, 1944, and Serial No. 402,411, filed July 14, 1941, now Patent 2,317,844 of April 27, 1943. Only casual mention is made there, however, as to the feasibility of the satisfactory use in such cold systems of tubes which are readily available on the market but which are initially designed for hot-cathode operation, and the consequent achievement of material saving in initial investment. No manner of connecting nor mode of operating the hot-cathode tubes is described in either said application.

An important object of our invention, therefore, is to provide for the satisfactory employment of hot-cathode fluorescent gas discharge tubes on cold-cathode operation. Another object is to produce a socket for the reception of a hot-cathode fluorescent gas discharge tube in such manner that the tube will perform satisfactorily on cold-cathode operation.

Other objects and advantages in part will be obvious and in part pointed out hereinafter.

In the drawing, Figure 1 is a perspective view showing a hot-cathode fluorescent tube adapted for cold-cathode operation in accordance with our invention, and Figure 2 is an exploded perspective view showing one form of socket which may be employed according to our invention, as well as the manner in which the same is associated with the terminals of a typical hot-

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cathode fluorescent gas discharge tube which can now be readily purchased on the market.

As conducive to a more thorough understanding of our invention, we may say at this time that the use of fluorescent gas discharge tube lighting has sprung into considerable prominence during the last few years in various industrial and commercial fields, as well as in household lighting. Such fluorescent tube lighting in fact shows evidence of substantially replacing the more conventional incandescent filament lighting in many fields of illumination.

The presence of the oxide-coated filamentary cathode relied upon in the operation of hot-cathode tubes to provide the electron emission necessary to prepare such tubes to support the arc discharge, and for aiding in the maintenance of the arc once it is struck, represents a source of weakness. As the tube ages, the electron-emitting properties of the coating diminishes, and the coating tends to volatilize off, or to chip off under ionic bombardment. Both starting and maintenance of the arc discharge at prevailing voltages becomes increasily difficult, and the arc becomes unstable in its characteristics. Blackening of the tube in the region of the electrodes is found to occur, due to the depositing thereon of the coated material violatilized from the cathodes.

Although the preliminary heating of the filamentary cathodes prepares the arc discharge path for striking an arc thereacross at comparatively low potential gradient between the electrodes, with consequent comparatively high power-factor and minimum sputtering of the cathode metal, it is apparent that once the arc strikes, the arc tends to follow the path of the maximum ionization and to settle on the hottest point of the filament. Since sputtering inevitably follows that phenomenon, the filament becomes thinner at this point, increasing in resistance. Because of the IR drop in the region of the filament, therefore, this point of weakness becomes the hottest point along the cathode. Repeated settling of the arc thereon eventually causes failure of the filament at that point. This of course ends the useful life of a tube where used on hot cathode operation. These filamentary cathodes are formed of small diameter tungsten wire, and consequently are somewhat fragile. Al-

though the tungsten metal possesses strong molecular cohesion at high temperatures, the positive ionization bombardment which takes place during arc discharge is such that after about 2500 hours of operation, the filament wire is broken through and the lamp becomes normally inoperative.

An important object of our invention therefore is to remove in large measure the difficulties and disadvantages set forth in the foregoing, and to produce a system for operating known fluorescent gas discharge tubes on cold-cathode operation, in which the tubes have stable operating characteristics over a useful life span substantially in excess of that hitherto possible of achievement.

One of the few disadvantages of the present-day fluorescent lighting as compared to the conventional incandescent filament bulbs, is that while the filamentary bulbs emit useful light as soon as they are energized, it requires at a minimum, some 6 or 7 seconds in which to strike an arc across hot cathode tubes in fluorescent lighting systems. This represents an appreciable time lag, and in many installations and uses is found to be a highly objectionable source of annoyance. Further, because such hot-cathode as are currently in use are designed to operate on low voltage input, it is impossible to reduce the impressed voltage to any material extent or to start or operate the tubes satisfactorily on what may be termed dimmer operation.

A further object of our invention, therefore, is to produce a system of operating hot-cathode tubes on cold-cathode operation in such manner that they have extremely satisfactory starting characteristics and are susceptible to satisfactory performance under dimmer operation, and in which system the occurrence of a broken filament in the fluorescent tube interposes no problem. A still further important object of our invention is to produce a fluorescent light system employing in satisfactory cold-cathode operation, the known hot-cathode tubes readily available on the market, and in which system, the size and physical shape of the electrodes of the tube are unimportant.

Referring now more specifically to Figures 1 and 2, wherein is disclosed a preferred embodiment of our invention.

The tube T_1, T_2 is of the hot-cathode type, having filamentary electrodes led out to pairs of exteriorly extending terminals, which terminals are short-circuited for our desired cold-cathode operation. The tube is lined with suitable fluorescent salts, to give rise to the desired secondary visible radiation.

Accordingly, we have evolved an ingenious method of operating these known hot-cathode tubes on cold-cathode operation, which will now be elaborated upon, having reference to Figure 2. Here the tube consists of a glass cylinder **31** interiorly lined with a suitable fluorescent salt. Filamentary electrodes, not shown, are disposed one at each end of the tube, and these electrodes are each connected at their ends to a pair of terminals **32**, **33** which extend exteriorly through a base **41**. This base, usually of metal, may be formed of suitable plastic, hard rubber, or the like.

The socket for receiving these terminals may follow any one of a variety of possible constructional embodiments. The essential point to be realized, however, is the short-circuiting of these filaments.

To illustrate, the socket may be somewhat of

the bayonet type, in which the lamp terminals and base are inserted into the socket and are locked in place by a slight rotary twist. The socket in such case is designed to short-circuit the terminals of the lamp. The design may be such that at the same time, a connection of the primary coil across the source of energy is established. This last feature is developed in our co-pending application Serial No. 402,413, filed July 14, 1941, now Patent 2,351,915 of June 20, 1944, and will not be enlarged upon here. A special jumper may be designed for dropping into the base of the ordinary socket, and is held in place, short-circuiting the tube terminals, by the base of the tube when the latter is positioned in the socket.

For purposes of illustration, however, we disclose a socket indicated generally at **34** and comprising a shell **35** of metal or suitable plastic. Within this shell and disposed in insulated relation thereto are metallic conduits **36**, **37** for receiving the prongs **32**, **33**, respectively, of the tube **31**. A metal jumper **38** is disposed within the shell, electrically connecting together the conduits **36**, **37**, and thereby short-circuiting them. A lead **39** to the associated secondary coil extends from the unit consisting of the two conduits and the jumper to the exterior through a cap **40** on the shell **35**. In this manner the unit consisting of the prongs **32**, **33** and the filamentary electrodes are electrically connected together and form a single electrode. The base **41** of the tube may consist either of metal or suitable plastic, just as the tube is found on the market. Since, however, this base is insulated from the prongs **32**, **33**, the question of whether it is formed of metal or of a plastic is a matter of but small moment. Short-circuiting the terminals adapts the tube for cold-cathode operation, and permits obtaining the manifold advantages referred to hereinbefore.

It will be readily appreciated that the invention described herein gives rise to many practical advantages not hitherto possible of achievement with the equipment at hand. Our invention makes it possible to adapt tubes already available on the market for service in our new electrical system, with increased tube life, much quicker starting characteristics, and with highly stable arc discharge, even with prevailing cold weather.

We find that, especially under steady operating conditions, the tubes employed in accordance with our present teachings, give a much larger saving in power demand in the tubes, for the same light output. For example, we find that under similar conditions, and with the same brilliance in light output, our system requires only 380 milliamperes, whereas the known hot-cathode tube systems require 420 milliamperes.

We claim:

In combination, a fluorescent gas discharge tube having at each end thereof a filamentary cathode and a pair of projecting prongs connected thereto for insertion in a supporting and energizing socket, and a pair of metal jumpers one abutting and interconnecting one pair of said projecting prongs and the other abutting and interconnecting the other pair, for short-circuiting the same and adapting the tube for initial and continued cold-cathode operation.

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