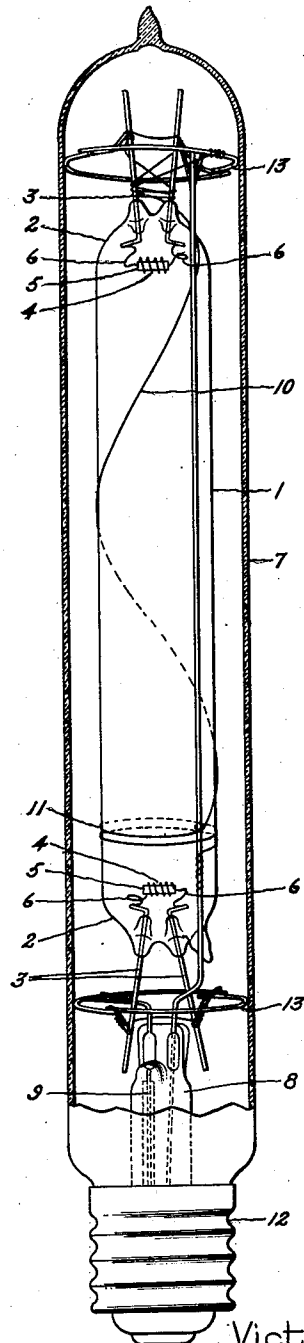


Feb. 20, 1934.

V. J. FRANCIS ET AL
LUMINOUS ELECTRIC DISCHARGE TUBE

1,948,261

Filed July 11, 1933



Inventors:
Victor James Francis,
John Walter Ryde,
by *Harry E. Dunham*
Their Attorney

UNITED STATES PATENT OFFICE

1,948,261

LUMINOUS ELECTRIC DISCHARGE TUBE

Victor James Francis, Wembley, and John Walter Ryde, London, England, assignors to General Electric Company, a corporation of New York

Application July 11, 1933, Serial No. 679,922, and in Great Britain July 1, 1932

6 Claims. (Cl. 176—122)

This invention relates to luminous electric discharge tubes of the recently developed high-pressure metal vapour type. Such tubes have a filling of metal vapour, usually mixed with rare gas to facilitate starting, furnished by an included body of metal that does not form part of either the anode or the cathode, but is heated by the discharge to a temperature greatly exceeding atmospheric. In order that the advantage of the type may be secured, it is necessary, according to present information, that, if the metal is mercury, the vapour pressure of the metal during operation should be not less than about 25 mm., it is preferably higher and may be greater than 1 atmosphere. If less volatile metals are used, the pressure may be correspondingly lower, but, if the vessel is to be of the type specified, it must be at least of the order of a millimetre. The tubes have thermionic electrodes and are adapted to be run at current densities large compared with those used in discharge lamps (other than arcs) previously known.

In order that the necessary high temperature may be reached during operation, the tube is usually insulated thermally by enclosing it in an evacuated outer glass envelope. A temperature distribution more uniform over the surface of the discharge tube and more independent of changes in the ambient temperature is thereby attained. Moreover the outer envelope or jacket provides a convenient method of housing and feeding the lamp. The discharge tube is supported within the jacket by the leads to the electrodes, which pass through a pinch in the end of the jacket and then through the end of the discharge tube. Further the tube may be capped by an ordinary cap or caps attached to the jacket; to cap the naked discharge tube would be almost impossible, because the capping cement would have to stand an excessively high temperature.

But we have found that, in spite of the use of the insulating jacket, difficulties arise in the construction of discharge tubes of the type specified, when the electrodes are mounted in electrode chambers or otherwise leave dead spaces behind them, that is to say, between the electrode and the wall of the tube on the side of it remote from the other electrode. These spaces tend to be at a lower temperature than the rest of the tube containing the positive column of the discharge; since the vapour pressure of the metal is determined by the temperature of the coolest part of the tube, they thus restrict the vapour pressure that can be attained at a given current density; in order to attain a sufficiently high vapour pres-

sure a current density has to be used so high that the main part of the tube becomes dangerously hot.

According to the invention, in luminous discharge tubes of the type specified, this disadvantage is overcome by making the tube without electrode pockets or other dead spaces behind the electrodes, the electrodes being arranged in the body of the tube, preferably close to the ends, so that heat may be readily transferred to the ends of the tube by radiation or by conduction through the gas and along the supports of the electrode.

In this way, by the avoidance of dead spaces, the pressure, luminous output at given current density, and the efficiency may be substantially increased as compared with previously known forms of tube.

But while it is desirable that the end of the tube should receive some heat by conduction along the supports of the electrode, it is undesirable that it should receive too much. For the heating of the end by this means is very local, and may crack or otherwise damage the glass. If the electrode is supported on its leads, and if these leads are straight and proceed by the shortest path from the electrode to the wall of the tube, it may be difficult to bring the electrode so near to the wall that radiation from it may play a sufficient part in heating the wall without running into this danger. It cannot be always avoided by making the leads thinner; for then they become insufficiently stiff to support the electrode. It could be avoided by making them longer; for the main part of the heat generated in the electrode arises from the discharge and not, as in a filamentary cathode of a high vacuum device, from current passing along the leads. But if the leads are to be straight and proceed to the nearest part of the wall, the electrode must then be placed further from the wall, and the heating by radiation is reduced.

According to a further feature of the invention, this dilemma can be overcome either by taking straight leads to some more distant part of the wall or by curving the leads, so that the length of the leads is greater than the least distance between the electrode and the nearest part of the wall. The latter alternative is usually greatly preferable; for, as has been explained, it is convenient to bring the leads through the end of the wall of the tube immediately adjacent to the end of the jacket.

An envelope which is of such configuration that pockets or other dead spaces which are partially shielded from being heated by radiation or other-

wise from the main discharge path in the tube, will be hereinafter generally referred to, for brevity, as being "of smooth conformation". Moreover, it is to be understood that the thermionic electrodes must themselves be so arranged and of such type that either they do not appreciably shield the space behind them from the heat of the tube, or else they must assume such a temperature, when in operation, that they themselves heat the spaces behind them to a temperature not substantially lower than that of the body of the tube.

A suitable known form of thermionic electrode for tubes of the type specified is a tungsten spiral surrounding a refractory rod of alkaline earth oxides, the spiral being spot-welded to the supporting leads. In this case the lengthening of the leads by curvature, according to the invention, may be effected conveniently by inserting between the leads and the part of the spiral that is in contact with the refractory rod (which forms the thermionic electrode) a few turns of the spiral not in contact with the rod. But this part of the invention can be applied to any other form of cathode in which the thermionically active electrode is clearly distinguished from the leads.

The principle of the invention is independent of the nature of the filling, so long as it satisfies the conditions of the type specified. But the metallic vapour will usually be mainly mercury, mixed possibly with such other metals as cadmium or sodium. The rare gas to facilitate starting is not absolutely necessary, but is usually convenient; the same effect may be attained by providing a separate heater which generates the necessary pressure of metallic vapour at starting.

One arrangement in accordance with the invention will now be described with reference to the accompanying drawing.

In the drawing the luminous tube comprises internal envelope of glass 1 having approximately spherical ends 2 into which are sealed the leading-in wires 3. To these leads are spot-welded the thermionic electrodes each consisting of a short refractory rod 5 composed of a mixture of calcium and barium oxides surrounded by a tungsten spiral 4; two turns 6 of the spiral, free of the rod, are used as the curved part of the leads for preventing the conduction of excessive heat to the seals. The electrodes are mounted very close to the spherical ends of the tube, being not more than 10 mm. from the wall. In order further to promote the heating of the ends of the tube, these may be covered with caps of thin metal foil.

The internal envelope 1 is arranged within an outer envelope 7 (shown as partly cut away in the drawing) having a foot-tube 8 and a standard form of lamp cap 12 at one end. The leads 9 for the discharge tube are brought through the foot-tube in the ordinary way, and connected to the leads 3 sealed into the inner envelope; these leads 9 may conveniently carry wire rings 13 which bear against the inside of the outer envelope and serve as supports for the inner envelope. The outer envelope is exhausted after assembly and sealed off.

The internal envelope contains enough mercury to give a pressure of about 1 atmosphere when operating on a current of from 2½ to 3 amperes—in the case of a tube about 17 cm. long by 3 cm. diameter, for example, about 0.2 to 0.25 gm. of mercury are adequate—together with a few mm. of argon to facilitate starting. Furthermore, to render the tube self-striking, a

wire 10 is carried from one of the leads along the outside of the inner envelope to a point near the other electrode of the tube and there wound round the outside of the inner envelope to form a conductive ring 11. Alternatively an auxiliary electrode may be put inside the tube, near one of the main electrodes and connected to another main electrode in a known manner by a high resistance. The use of the outer envelope with these forms of starting arrangement is particularly convenient, for it permits live conductors to be run along the outside of the discharge tube proper, without any danger that they may be accidentally touched.

We claim:—

1. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes, and electrode support wires distorted along the length thereof so as to bring said electrodes close to the end walls of said envelope.

2. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes, and electrode support wires distorted along the length thereof so as to bring said electrodes close to said ends of said envelope and said support wires extending through the wall of said envelope at a part other than that least distant from said electrodes.

3. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes comprising a rod of refractory electron emitting material surrounded by a spiral of refractory metal, and electrode support wires comprising in part at least one turn of said spiral not in contact with said rod.

4. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes, electrode support wires distorted along the length thereof, a thermally insulating jacket enclosing said envelope, and means for supporting said envelope from said jacket.

5. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes, electrode support wires distorted along the length thereof and a heat storing cap on an end of said envelope.

6. A luminous electric discharge tube provided with a filling including a metal vapour and operating with a "high pressure" discharge comprising a cylindrical envelope with substantially hemispherical ends, thermionic electrodes, electrode support wires distorted along the length thereof and means for facilitating the starting of the discharge comprising a conducting member arranged along and around the exterior of said envelope and connected to one electrode.

VICTOR JAMES FRANCIS.
JOHN WALTER RYDE.