May 4, 1948. M. PENNYBACKER 2,440,832

GAS DISCHARGE LAMP

Filed May 29, 1945

Fig. 1.

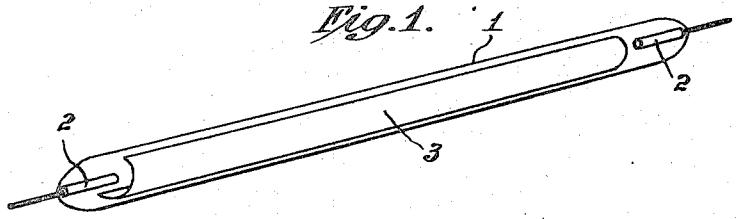
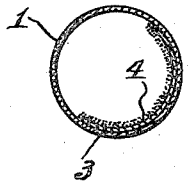


Fig. 3.

Fig. 2A.



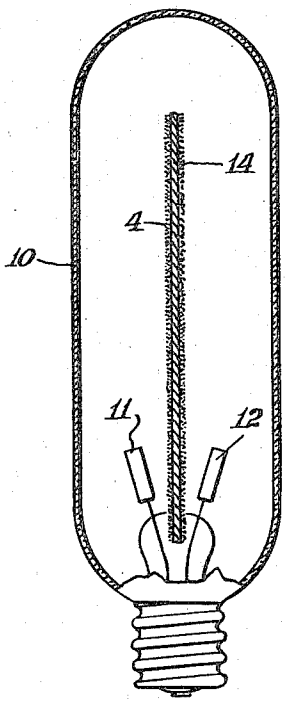


Fig. 2B.

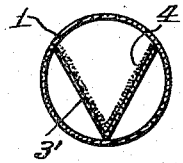
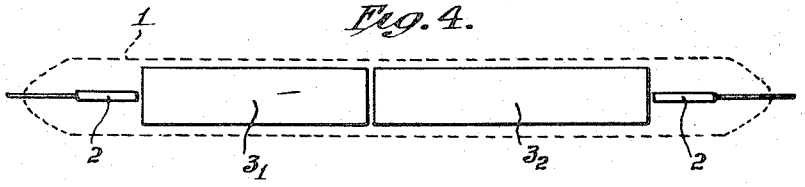


Fig. 4.



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GAS DISCHARGE LAMP

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Application May 29, 1945, Serial No. 596,560

4 Claims. (Cl. 176—122)

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This invention relates to electrical lamps of the gaseous discharge type, employing a positive column gas discharge.

This invention includes certain elements and features of the lamp described in my co-pending application Serial #569,488, filed December 23, 1944.

Positive column gas discharge lamps are usually constructed in the form of a relatively long and narrow cylinder of glass, quartz or other suitable transparent or translucent material, provided with suitable electrodes at both ends thereof. In one widely used form, the internal surface of the transparent envelope is coated with a phosphor, which acts to transform luminous energy from one portion of the spectrum, such as ultra violet, to another portion of the spectrum better suited for general illuminating purposes.

For most purposes, it is desired that the light from a lamp be emitted over an arc of not exceeding 180 degrees. Accordingly, when a cylindrically-shaped lamp is employed, it is usually found necessary, or at least highly desirable, to employ a reflector which will render available a portion of the light otherwise wasted by reason of the fact that it is emitted in an undesired direction.

One object of this invention is to provide a novel form of elongated cylindrical lamp from which the externally available light is emitted substantially wholly along one longitudinal half of the cylinder, thus causing the luminous output of the lamp to be completely available without the need of employing an external reflector.

Another purpose of this invention is to provide a tubular lamp with an internal reflector, in the form of an element not closely connected, either mechanically or chemically, with the internal wall of the tube, in distinction from reflecting elements which have hitherto been formed as metallic deposits, or the like, upon such internal wall, and which reflector may also act as a support for a fluorescent coating.

A still further purpose of this invention is to provide a tubular lamp in which the reflector can be manufactured independently of the tube and only inserted therein when the tube is ready to be sealed. This discrete construction is well adapted to economical large scale production, in contrast to certain hitherto employed methods of constructing an internal reflector, in situ, within the tube itself.

An advantage of one form of this invention is that there is provided a fluorescent lamp in

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which optical efficiency is increased by causing the useful light to proceed directly from the surface of the phosphor which is acted upon by radiations coming from the positive column discharge, and causing this light to pass directly to the exterior of the tube, without having to pass through any other layers of phosphor, or through other semi-opaque material.

Other purposes and advantages of this invention will be apparent to those skilled in the art from the following description of several embodiments thereof.

Reference is now made to the drawings hereunto attached, where—

Fig. 1 is a perspective view of a tube embodying one form of this invention,

Fig. 2A is a cross-sectional view of the tube of Fig. 1,

Fig. 2B is a cross-sectional view of a tube embodying another form of this invention,

Fig. 3 is a single-end connected tube showing another form of this invention, and

Fig. 4 shows, partly schematically, an alternative form of this invention, using a divided reflector strip.

Referring now to Figs. 1 and 2A, there is here shown an elongated tube 1, of suitable gas-confining material such as glass. This material is chosen to be transparent to radiations having such wave lengths as are to be utilized externally. For example, the tube may be constructed of ultra violet transmitting glass or of quartz, if the radiations lie in the ultra violet portion of the spectrum. Suitable electrodes of the cold cathode type, 2, are shown at each end of the tube, but hot cathodes may optionally be used. Extending longitudinally of the tube, but preferably terminating short of each electrode is a reflecting strip 3. As shown in Fig. 2A, it is preferred that this strip extend for approximately 180 degrees around the internal periphery of the tube. However, strips extending over a greater or lesser angle may be employed without departure from this invention. Strip 3 may be formed of any suitable reflective material which will withstand the temperature and treatment incidental to the manufacture and operation of the tube. Such material should be capable of ready de-gasification and should not evolve gases during operation of the tube. For reasons hereinafter to be explained in detail, I prefer to make this strip of comparatively thin metal or alloy, possessing some degree of elasticity. Suitable materials include iron, nickel-plated iron, magnesium and aluminium, but this invention is not

confined to the employment of these particular metals. The strip may be sprung into a semi-cylindrical form, as it is being inserted into the tube, or prior to such insertion therein. The elasticity of the strip will then cause it to be pressed more or less firmly against the portion of the tube wall covered thereby. It is, however, possible to use a relatively less elastic material for the strip and to provide a coating of adhesive material between the strip and the tube wall, in order that the strip shall remain in the proper position, or it is possible to mount or fasten the strip in place by any other means.

In Fig. 2B there is shown a variant form 3' which the strip just described may assume. In this particular form, the apex of the V and extremities of the two arms of the V constitute three points of contact extending longitudinally along the tube wall. The tendency of the V to expand laterally may be used to hold the strip in place.

Evidently the surface of the reflecting strip should be chosen of a nature to act as an efficient reflector for the particular wave lengths which are to be emitted from the tube.

For confining the positive column discharge to the proper path thereof, it has been found desirable but not essential that the surface of a conducting reflecting strip which faces this path within the tube be covered with a layer of insulating material 4. If the material constituting the surface of the reflector strip be metallic in nature, it may be desirable to place over it an outside layer of some material which is relatively transparent or reflecting, but which is also non-conducting. Many white materials such as aluminum oxide, magnesium oxide, or other metallic oxides, and the like, function both as a suitable reflecting surface and as a suitable insulator. A material such as aluminum oxide also functions well in cases where reflection of ultra violet radiations, as well as visible, is desired. Such insulating materials act simultaneously as reflectors and as insulators to prevent or at least to minimize passage of any substantial amount of current through the reflector strip, when this strip is formed of a conductive material such as a metal.

In the case of gas discharge tubes of the fluorescent type, the visible light proceeds from a material which is usually non-conducting and only somewhat transparent. Such phosphors may be used to cover the surface of the reflecting strip, in which case the material functions not only as a light emitter, but also to a certain extent as a light reflector.

Another method of limiting undesired current flow through a conductive reflector is to form the reflector as a series of separate sections, electrically insulated from one another, so that the total voltage which would be required to supply the sum of the cathode-fall voltages as each such section is greater than the maximum voltage of the corresponding length of the positive discharge column, during normal starting or running. This arrangement will be hereinafter described in greater detail.

In certain embodiments of this invention, the longitudinal wall of the tube opposite such a strip coated with a reflective phosphor is relatively transparent, and inversely related to the arc covered by the relatively opaque reflecting strip. As the reflecting strip is made to extend more than 180 degrees, the light will be emitted throughout an arc correspondingly less than 180 degrees.

This arrangement will in many cases eliminate the need for external reflectors. By my use of a separate reflector strip bearing the phosphor, such type of lamp may be manufactured very simply, whereas it has been found very difficult to coat the internal wall of a tube over only a portion of the periphery thereof.

In the particular form of construction just described, employing a fluorescent coating, it is evident that the luminous efficiency of the lamp will be increased, at least as far as light emission in a desired direction is concerned, in comparison with a fluorescent lamp having the interior surface completely coated with the phosphor. Furthermore, it is possible with this invention, to apply the phosphor in a relatively thick coating to the reflector strip without thereby bringing about loss of efficiency, for reasons which have previously been mentioned. The possibility, thus secured, of using a relatively thick coating of phosphor leads to ease in manufacture, since such coating may be applied with a considerable factor of safety above the minimum thickness required to cover the strip.

Measurements made upon a fluorescent type tube employing a reflecting strip covering approximately 180 degrees, and covered with a phosphor, showed a luminous output, over approximately 180 degrees, of 33 units in comparison with 23 units from a similar tube, drawing the same amount of electrical energy, but employing a phosphor distributed over the entire inner surface of the tube, according to the hitherto prevailing practice in the art.

In many cases, and particularly in the case of the form of strip of Fig. 2B, it is preferred that an insulating coating cover the rear of the reflector strip also. The rear side of the strip may be coated with a less permeable or impervious insulation, such as porcelain enamel, in order to minimize unwanted discharge on this side of the strip.

It will be evident that for ease in replacement, it will be desirable that the reflector strip be placed within the tube at a predetermined angular relationship to the contact-making pins usually provided in pairs, at both ends of the tube. This will ensure that, when a fixture or other device mounting the two sockets in which the tube is to be placed has once been put in position, the reflecting strip will be found in the desired position relative to the direction in which the useful light output is to be radiated. In the case of direct lighting, this direction usually will be downward and no external reflector will be needed. In the case of indirect lighting, the direction will usually be upward or sideward, but no shield between the light source and the eye will be needed because of the opaque strip in the lamp. In either case, the strip serves as a reflecting surface or secondary light source which cannot be reached by dust and dirt.

Referring now to Fig. 3, there is here shown a bulb 10, provided at one end with a conventional type of screw base. The electrodes 11 and 12 pass through the press 13 and connect to the terminals of the base. A partition or strip 14 extends from the press upwardly to a point near the other end of the bulb. This partition is shaped and sized to meet the internal walls of the bulb, so that the bulb is divided into two discrete compartments, open to one another only at the upper end of the bulb, and may be formed either of metal, as shown, or of insulating reflective materials. The sides of this strip, if

formed of conductive material, are preferably coated with a suitable reflective and insulating material 4, such as previously described, so that the latter will tend to minimize unwanted current flow through the strip.

The discharge extends upwardly in one chamber, crosses the upper end of the bulb, and descends in the other chamber.

In Fig. 4 there is shown a tube of the same general type as that shown in Fig. 1, the strip preferably being formed as shown in Fig. 2A or 2B. In this case the reflector strip is divided, at or near the center, so that there are really two strips, discrete from one another, and operating effectively in series with one another. The general method of operation of this bulb is similar to that already described in connection with Fig. 1. However, the two reflector strips, 3_1 and 3_2, present, together with the two electrodes, a total of three gaps, over which the cathode glow discharge must be initiated, before any appreciable current will flow through the reflector system.

With the multiple reflector strip employed in this particular form of structure of this invention, the total voltage drop across the gaps of the reflector strips and electrodes will be raised to a point where the positive column will present less resistance to the current discharge than will the reflector system. In this form, bare metallic surfaces may be used, as there is no need for any insulating coating to prevent undesired current flow through the multiple reflector strip.

Among the novel advantages of that form of this invention which embodies a separable strip is the fact that the actual application of the insulating or fluorescent material does not have to take place within the relatively narrow confines of the glass tube. The strip is preferably coated before insertion in the tube, thus making possible coating methods not so readily applicable to coating the inside of glass tubes. These methods permit the use of fluorescent powder or pigments which do not have to be subjected to the prolonged grinding or ball-milling now customary in making suspensions for coating the inner surfaces of fluorescent lamps.

The less the grinding of the fluorescent particles, the more efficient they are. Likewise, less care will be needed in applying this coating than is needed in applying it to an ordinary fluorescent lamp, since excess thickness upon any portion of the strip will not give rise to uneven illumination of the bulb. I have found that coatings made from the usual fluorescent silicates may be as much as several thousandths of an inch in thickness.

It is often advantageous to combine in one element a reflector and a starting strip. This embodiment of my invention is described in the above-identified co-pending application.

While there have been described certain non-limiting forms of this invention, other forms will

be apparent to those skilled in the art, and the scope of this invention is limited only by the hereunto appended claims.

What is claimed is:

1. A gas discharge lamp, including an envelope, means for establishing a positive column discharge within said envelope, a plurality of metallic reflectors insulated from one another and substantially coextensive with the path of said discharge and means for substantially preventing discharge via said reflectors, said discharge preventing means including the plurality of insulating gaps separating said reflectors into electrically discrete sections and presenting a total series cathode fall of potential in excess of the potential required for establishing said positive column discharge co-extensively with said reflectors.

2. A device according to claim 1, also including a coating of discrete non-conductive particles substantially completely covering the illuminated surfaces of said reflectors.

3. A device according to claim 2, in which said coating is formed of a fluorescent material.

4. In a gas discharge lamp, a gas-containing tube, a reflector situated longitudinally along a substantial portion of the path of gas discharge and comprising a plurality of metallic reflective elements, electrically separated from one another and from the tube electrodes and sufficient in number so that the total cathode fall of potential required to establish a discharge via said series of reflective elements exceeds the potential established along said portion of said gas discharge path, whereby electrical discharges via said reflector are prevented, said reflective elements being made of resilient metal strips, each having a normal width greater than the internal diameter of said tube, each element being deformed from a single plane, whereby the expansive tendency of the elements retains said elements in position within said tube.

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