Oct. 27, 1959 B. J. PATTON 2,910,337

METHOD FOR REJUVENATING FLUORESCENT LAMPS

Filed Nov. 2, 1954

Fig. 1

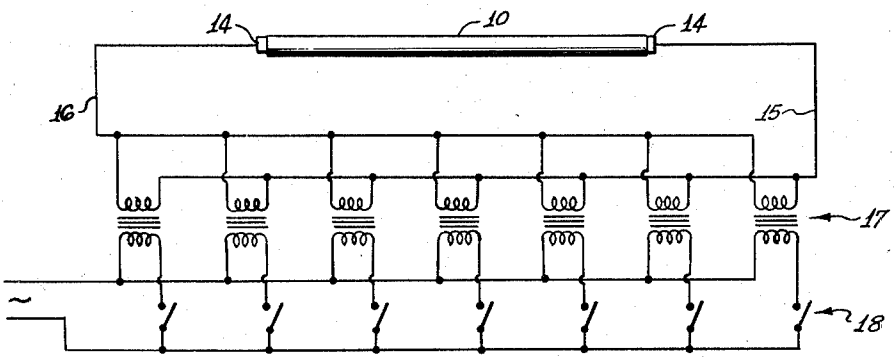


Fig. 2

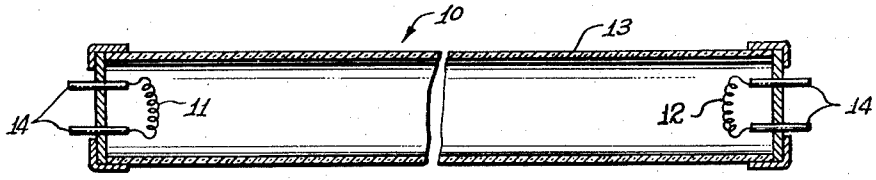
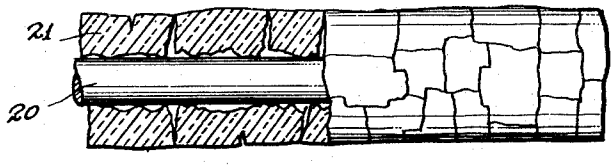


Fig. 3



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METHOD FOR REJUVENATING FLUORESCENT LAMPS

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3 Claims. (Cl. 316—2)

My invention relates generally to the rejuvenation of gaseous conduction light sources, and more particularly to the rejuvenation of such sources that are usually referred to as "fluorescent lamps."

The incandescent lamp, wherein a filament of metal or other material is heated to incandescence by a passtage of an electric current has long been known and used. More recently, a light source consisting of a pair of electrodes sealed in a tubular glass envelope containing a suitable gas through which an arc is established, has become popular. Such sources, known as "neon tubes," have been used for a number of years in displays and signs, and more recently the inside of the tube has been coated with a suitable phosphorescent material that is caused to glow by the production of both visible and ultra-violet light by the electrical arc or discharge. However, the so-called "neon tube" requires a relatively high voltage for its operation, usually in the neighborhood of several thousand volts, and such a voltage is not practical for use in homes. The fluorescent tube type of lamp, on the other hand, can be used at a relatively low voltage, but in order to accomplish this, the electrodes within the tube must be coated with some emissive material that will emit electrons readily so that an arc may be established. Usually the electrodes are coated with a metallic oxide, and are heated by an electric current to emit electrons.

After a considerable period of operation, a fluorescent tube lamp starts to flicker and provides a reduced light output, and until relatively recently, it was considered necessary to replace the tube when this occurred. However, by subjecting the tube to a relatively high voltage, it is possible to rejuvenate the tube and to restore it to substantially its original efficiency, and a device for accomplishing this is shown in the co-pending application of the present inventor, Serial No. 257,051, filed November 19, 1951, now Patent No. 2,733,973 issued February 7, 1956 and entitled "Fluorescent Tube Rejuvenator."

While it has been known that the device disclosed in the said co-pending application produces satisfactory results, the reason for these results has not been clearly understood. It is now thought that the physical effects involved and the reasons for the satisfactory operation are known, and the theory of operation permits better understanding of the action occurring.

It is therefore a major object of the invention to provide a method of rejuvenating or reactivating gaseous conduction light sources.

Another object of the invention is to provide such a method that is applicable to such light sources that make use of coated electrodes, whether these be of the so-called hot cathode or cold cathode type.

It is a further object of the invention to provide a method for rejuvenating light sources of this type that cannot cause harm to any lamp capable of operation, and in fact, improves the characteristics of a new lamp that supposedly does not need any treatment whatsoever.

Still another object of the invention is to provide

such a method that is easily and quickly operable by relatively unskilled persons so that a large number of light sources may be treated in a given time.

It is a still further object of this invention to provide such a method that requires only very simple and elementary equipment which is readily available and easily obtained at a relatively low cost.

These and other objects and advantages of the invention will become apparent from the following description of a preferred form, and from the drawings illustrating the invention in which:

Figure 1 is a schematic wiring diagram of a rejuvenating device of the type disclosed in the said copending application and adapted to practice the present invention;

Figure 2 is a somewhat schematic cross-sectional view of a fluorescent tube lamp; and

Figure 3 is a greatly magnified view of a portion of the coated electrode material, a portion of the figure being shown in cross-section and the remainder in elevation.

Referring now to the drawings, and particularly to Figure 1 thereof, the numeral **10** indicates generally a fluorescent tube lamp of the type having a pair of heated electrodes **11** and **12** located in opposite ends of a glass tubular envelope **13**. As indicated in Figure 2, the electrodes **11** and **12** are in the form of coils, which coils are usually formed of a helix of very fine wire, with the ends of the wires being separately connected to conductors or pins **14** that extend through suitable insulating caps on the ends of the tube **13**.

In operating such a fluorescent tube lamp, the electrodes **11** and **12** are generally connected in series with each other and to a source of power so that the electrodes are first heated. Thereafter, the series connection is broken and the full voltage of the power source is applied across the space between the electrodes **11** and **12** and an arc is established therebetween, through the gas that fills the tubular housing **13**. The tube and its normal method of operation form no part of the present invention except as they may cooperate with the present method to provide a new and patentable combination.

The circuit diagram shown in Figure 1 includes the tube **10** and shows the conductor pins **14** of the electrodes **11** and **12**, the pins for each electrode being shorted and connected through a suitable pair of buses **15** and **16** to the opposite terminals of a source of high potential electrical energy. In the form shown, the buses **15** and **16** are separately connected to the output terminals of a series of transformers **17**, the primary terminals of the transformers being connected by suitable switches **18** to a source of relatively low voltage alternating current (not shown). By way of example, the low voltage source of power may be approximately 115 volts, while the high voltage terminals of a transformer **17** may provide a voltage of approximately 15,000 volts. As the current drawn from the transformer **17** increases, the voltage appearing across the output terminals, and hence across the buses **15** and **16** tends to decrease, and consequently by providing a series of individually controlled transformers, the requisite high voltage may be maintained under varying load conditions.

To operate the rejuvenator shown in Figure 1, the particular transformers **17** that experience has shown to be necessary for the type of tube to be rejuvenated, are energized, and the tube is connected to the buses **15** and **16** in such a manner that the pins **14** of each of the electrodes **11** and **12** are shorted. The entire output of the buses **15** and **16** is thus applied across the space between the electrodes **11** and **12** and an arc is immediately established if the electrodes are still properly connected to the pin **14**. It will be realized, of course, that in some instances the

electrodes are no longer connected to the pins **14**, and under these conditions, the tubular light source cannot be rejuvenated. However, if the tube is one that can be rejuvenated, the arc is immediately formed, and thereafter, the entire tube **10** is removed from the buses **15** and **16**. Preferably, the means of connecting the buses **15** and **16** to the pins **14** is by metallic block or bars that are suitably located, the tube **10** being laid across the block or bars for ease and speed in treatment. During the removal of the tube **10** from the blocks connected to the buses **15** and **16**, an arc is often formed between the pins **14** and the blocks and while it is not known that this is greatly beneficial, at least it does no harm.

As soon as the treated tube is removed, another tube may be placed on the block, and subjected to the same treatment. After such treatment, the tube is checked to make sure that it is in operating condition, since not all tubes, because of their condition, may be rejuvenated. If the tube is found to operate satisfactorily, it can be replaced in service and reasonably expected to last substantially as long as a new tube.

As previously indicated, the reason for the successful operation of the previously mentioned method and device is not clearly known. However, it is known that satisfactory results are achieved, and it is thought that the successful operation may be related to the re-forming of the electron-emissive surface of the electrodes. Thus, as previously mentioned, the electrodes **11** and **12** are formed of a very fine wire that is coated with an electron-emissive material such as barium oxide, etc. As indicated in Figure 3, the central wire **20** is suitably covered with an emitting material **21**, such as the barium oxide previously mentioned, the coating taking the form of a generally cylindrical housing surrounding the wire **20**. When first applied, the coating **21** has a more homogeneous nature, and touches and adheres to the central wire **20** substantially uniformly along its length. However, the coefficient of expansion of the metal forming the wire **20** is different from that of the material forming the emissive coating **21**, and after repeated heating and cooling, the coating becomes cracked and tends to separate from the wire, occasionally even falling off. When this occurs, emissivity of the electrode is greatly reduced.

The electric wire **20** is heated by the passage of an electric current through it, and this heat is transferred to the coating **21** by radiation and conduction. As the coating **21** separates from the wire **20**, the area of the coating that is in contact with the wire is reduced, and hence the heat transfer from the wire to the coating is likewise reduced. At a lower temperature, the amount of electron emission that is provided by the coating **21** is reduced, and hence the flow of current through the tube will be reduced, thereby impairing the efficiency.

In a simliar manner, the breaking away of the coating **21** from the wire **20** also tends to increase the resistance to the flow of current from the wire through the coating, through the gas, and then to the other electrode. When this increased resistance to the flow of electrical current is combined with the decreased electron-emissive action of the coating **21**, it can readily be seen that operation of the tube becomes more difficult and less certain.

It seems, though it has not definitely been established, that the previously described method of rejuvenating fluorescent tube lights causes the fusion of the coating **21** to form a substantially one-piece tubular-enclosing member in better contact with the wire **21**. When this is done, the heat from the wire **20** is more efficiently transferred to the coating **21** so that a greater electron emission is secured, and additionally, the electrical resistance is simultaneously decreased. While there has been no definite proof that the method of treatment heretofore described actually causes the fusion of the coating **21** into a single homogeneous member, it seems likely that this is the principal effect of the treatment. This theory also explains why new lamps, in original factory-sealed cartons work better after this treatment than other new lamps without the treatment. It will be appreciated, of course, that the process of manufacturing fluorescent tube lamps involves the heating and cooling of the electrodes during manufacture, and once the coating is applied, successive heatings and coolings cause the cracking and breaking, as mentioned above. Consequently, even a new lamp has a certain amount of cracking in the coating **21**, and the rejuvenation treatment tends to fuse this coating into a single mass, as previously described.

Since the method of rejuvenation also works satisfactorily for so-called cathode lights in which the electrode is coated with an electron-emissive material, the explanation above seems logical. However, it is also possible that the deterioration of the light output and efficiency of the tubular light is caused by a surface contamination of the coating **21**, such as might be caused by chemical combinations of the gases within the tubular housing **13** with the material forming the coating **21**. Such chemical combination and resulting contamination could be hastened by the elevated temperature by which the electrodes **11** and **12** are normally operated. Presumably, when contamination has proceeded far enough the electron-emissive characteristics of the coating **21** are impaired, and the operation of the lamp **10** becomes faulty. By subjecting the lamp **10** to a materially higher voltage, in the general neighborhood of 10,000 volts, the electron and ion bombardment of the electrodes can break-up and remove the contaminating coating so that the lamp is thereafter capable of normal efficient operation.

It is quite possible that the gradual loss in efficiency of lamps operated under normal conditions is a result of both of the conditions specified, viz., the breaking and cracking of the coating **21**, and the contamination of the surface thereof. In any event, it appears that the aplication of the high voltage re-forms the surface of the coating **21** so that the lamp is thereafter enabled to function in a normal manner. The re-forming may consist in the fusion of the various pieces in the coating **21** to form a more uniform and homogeneous structure so that the cracked areas are, in effect, fused together, or the re-forming may take the form of removing the surface impurities or contaminants or possibly a combination of the two.

The principal effects of the high voltage method of treatment seems to be restricted to the coating **21**, with relatively little or no effects on the wire or conductor **20**. Since the heating or other effect is restricted to the coating, the wire is not caused to melt, as might be the case if a higher voltage were applied to the pins **14** of one of the electrodes **11** or **12**. Thus, if the coating **21** makes only a point contact with the wire **20**, a high resistance is found at this point, and a relatively low current will cause a fusion of the coating, while the wire **20**, because of its relatively low resistance will not be appreciably affected. If surface contamination is the cause of the poor action of the lamp, the surface of the coating **21** will be bombarded and cleaned, while the wire **20** will remain relatively unaffected.

From the foregoing, it will be recognized that the re-forming of the coating **21** is the same as that mentioned in the previously referred to application of the present inventor. While one form of apparatus for practicing this method has been disclosed, it is apparent that other forms of apparatus may be used, and the method itself is capable of modification. Consequently, while there has been shown and disclosed a preferred form of method, the invention is not to be restricted to the particular form or arrangement of parts or steps disclosed except as limited by the following claims.

I claim:

1. The method of rejuvenating fluorescent lamps of the class described, otherwise near the end of their useful life, which includes the steps of: applying a high A.-C. voltage of the order of 10,000 volts, between the

symmetrically located similar electrodes of the lamp, each electrode being at a substantially uniform voltage throughout its area, thereby to establish a high voltage discharge between said electrodes, and through the gas contained in said lamp, said electrodes being heated solely by said discharge; and maintaining said discharge while the electron-emissive surfaces of both said electrodes are re-formed thereby, said discharge being maintained for a period of at least several seconds.

2. The method of rejuvenating fluorescent lamps of the class described, otherwise near the end of their useful life, which includes the steps of: short-circuiting the terminals leading to each of the similar electrodes of the symmetrical lamp; establishing a high A.-C. voltage discharge between the electrodes of the lamp and through the gas contained in the lamp, each of said electrodes being maintained at a substantially uniform voltage throughout its length, and the potential difference between electrodes being of the order of 10,000 volts; and maintaining said discharge while the electron-emissive surfaces of both said electrodes are re-formed thereby, said discharge being maintained for a period of at least several seconds.

3. The method of rejuvenating a used fluorescent lamp

of the class described having similar electrodes at opposite ends to provide a symmetrical structure which is otherwise near the end of its useful life, which includes the steps of: applying a high A.-C. voltage between an electrode having an electron emissive coating and located at one end of said lamp and another electrode having an electron emissive coating and located at the other end of said lamp to establish a cold cathode high voltage discharge between said electrode and through the gas contained in said lamp, the entire surface of each electrode being maintained at substantially the same voltage; and maintaining said discharge for a period of time sufficient for said discharge to reform the electron emissive material on both said electrodes.

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