Jan. 8, 1952 A. F. KOEHLER 2,581,959

FLUORESCENT LAMP

Filed Nov. 13, 1950 2 SHEETS--SHEET 1

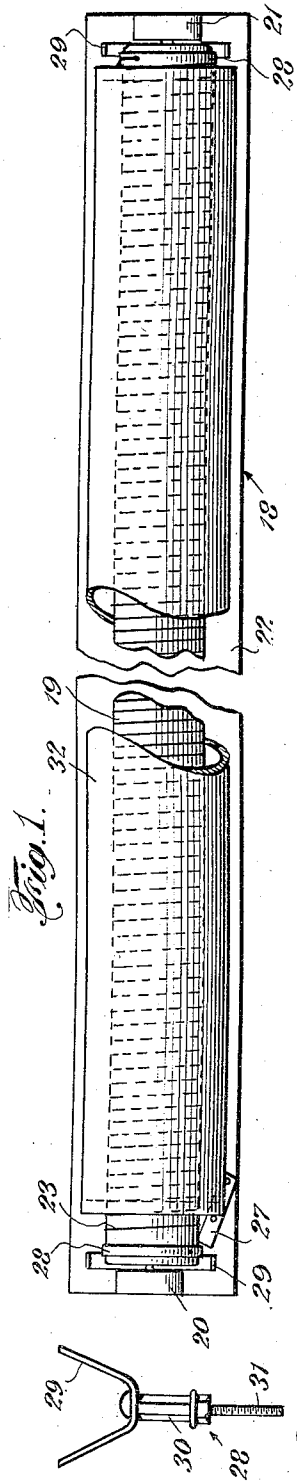


Fig. 1.

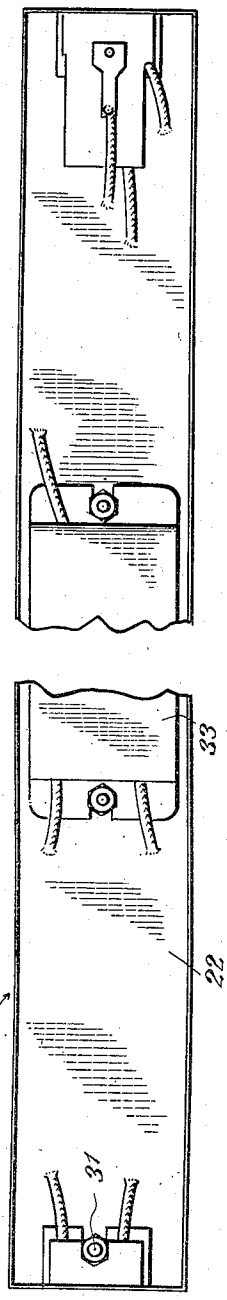


Fig. 2.

Fig. 5.

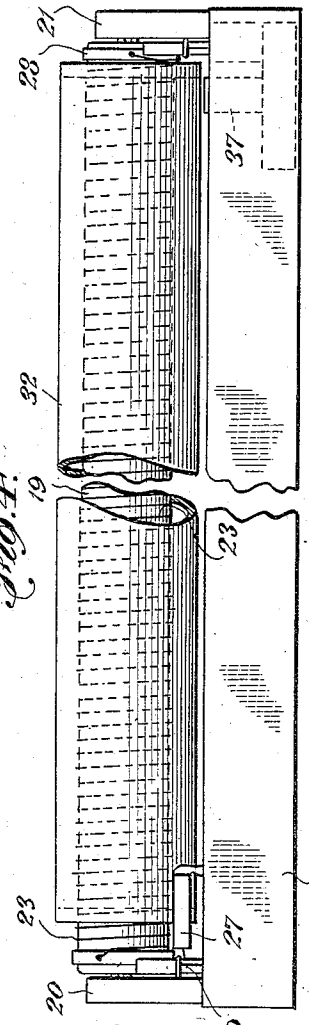


Fig. 4.

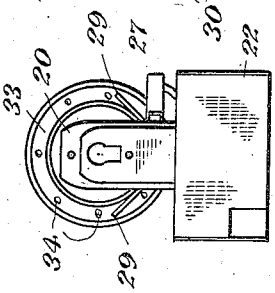


Fig. 3.

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Fig. 6.

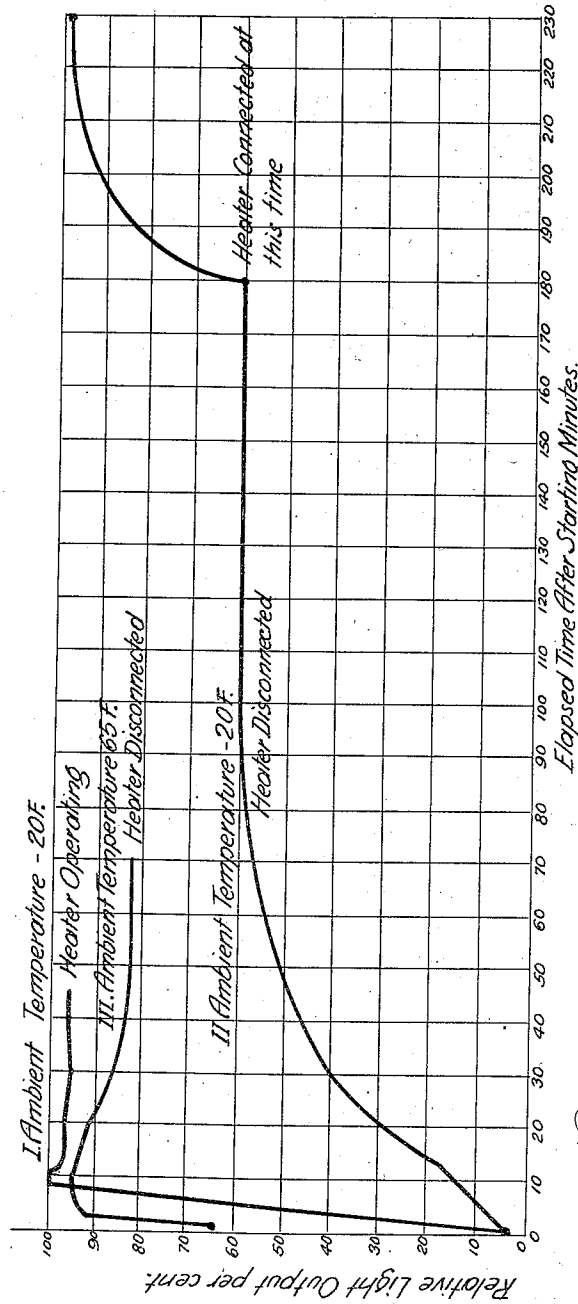


Fig. 7.

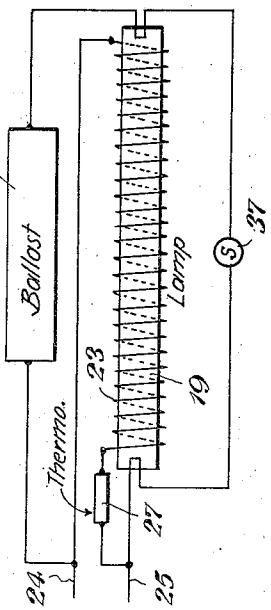
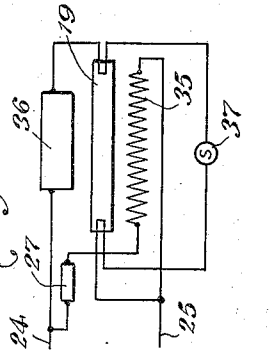


Fig. 8.



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FLUORESCENT LAMP

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9 Claims. (Cl. 315—100)

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This invention relates to an improvement in the operation of the ordinary fluorescent lamp whereby such a lamp may be started at low temperatures and quickly brought to substantially its normal high light intensity and so maintained for the time of its illumination even with surrounding temperatures existing between minus 50° F. and approximately plus 50° F.

The invention further relates to an improved structure of lamp of the fluorescent type whereby the lamp when subjected to temperatures about minus 40° F. may be brought, after starting, to substantial full luminosity within twenty minutes. The tube of this fluorescent lamp is preferably of the elongated type with electrodes at each end and pins connected to each of said electrodes and projecting from the ends thereof. The pins normally engage spaced sockets carried by the lamp structure. Also, this fluorescent type of lamp usually has the tube thereof of the low pressure mercury vapor discharge type.

The invention also pertains to improvements in signs of the fluorescent type which are constructed to operate under cold conditions, between about minus 40° F. and plus 50° F. whether inside a building or outside a building, or cabinets, or other structures, and to maintain substantially full luminosity during the time they are lighted.

One of the features of this improved invention is to provide a novel structure of the gaseous type lamp that will burn with high intensity, and usually without flickering, while being operated under cold weather conditions.

Another feature of the invention is to provide improved means for intermittently heating the ordinary fluorescent tube of a fluorescent light to maintain it at a fairly uniform temperature and to provide a suitable heating means so that it is not observable when the lamp is burning.

A further feature of the invention is to provide an improved means for heating a fluorescent light and for maintaining the heat in close relation to one or more parts of the lamp so that substantially full illumination is given by the lamp even though the temperature normally surrounding the lamp varies from a minus to a plus Fahrenheit condition. Also, the improvement for so maintaining the lamp in substantially good warmth and full illumination is made automatic and allows for proper ventilation so that the lamp neither gets too hot or too cold. This advantageous heating is able to be provided at almost negligible cost.

Another feature of this invention is the provision of an improved accessory apparatus for attachment to a fluorescent lamp that in its functioning will reduce and substantially eliminate the flickering of the lamp even when starting at temperature below 0° F. temperatures, and the reduction of such flickering acts to give a much longer life of the lamp.

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Another feature of the invention is the provision, as additions to the ordinary fluorescent lamp, for heating the tube of the lamp in a novel manner to maintain effective and efficient burning of the lamp. Such means is unobservable when the lamp is lighted, and which means may also function to have a cold lamp brought to its substantially normal full illumination within the matter of a few minutes. This additional means has proven itself to be most satisfactory and effective in extending the life of the lamp to a minimum life of substantially 7200 hours.

A further feature of this invention in its preferred form is that of providing a resistance heating element or wire of very small gauge that will heat the tube of the lamp, preferably intermittently, and automatically, and substantially uniformly over its majority length, and have the wire not noticeable when the lamp is burning.

Still another feature of this improved device is to provide at least another, or a third and fourth, contacts carried by the tube so as to have the heater element automatically connected to the lighting circuit when the tube is normally assembled in its support and thereby have the heater connected to the regular lighting circuit, subject, of course, to the heater's regulating thermostat.

Another feature of the invention is to provide a satisfactory means for maintaining most of the heat developed from the resistance wire close to the lamp tube and to have that heat maintaining means preferably of transparent material and extending a major portion of the length of the tube of the lamp, thus obtaining practically equal distribution of the generated heat over at least a major portion of the length of the tube.

In providing improved means for maintaining the lamp in proper temperature for efficient lighting in cold atmospheres, it is also a feature to provide suitable ventilation so that the lamp tube will not become too hot in one place and too cold in another, but to maintain a substantially uniform temperature throughout its length, thereby eliminating excessive temperatures and conditions at different places which cause this type of lamp tube to burn out. This ventilation may be obtained in several ways, one is to provide

ventilating holes in desired positions in washers installed at the ends of the surrounding transparent means or shield, or at different positions in the surrounding shield. Usually, it is desirable to maintain the tube of the lamp at a temperature between 110° F. and 125° F. while the lamp is burning.

Other features and advantages of this improved fluorescent lamp and its structure will become apparent in reading the detailed description below taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a top plan view of the improved fluorescent lamp with an outer shield or sleeve partly broken away to show a heating element;

Fig. 2 is an underside view of the base or support or channel of the fluorescent lamp;

Fig. 3 is an end elevational view of the improved lamp structure;

Fig. 4 is a side elevational view of the improved fluorescent lamp;

Fig. 5 is an elevational view of one of the electrical contacts provided for connecting the electrical light circuit to the heater element of the improved fluorescent lamp;

Fig. 6 is a series of curves illustrating the beneficial use of the improved heater cooperating with the tube of the lamp;

Fig. 7 is a wiring diagram of the fluorescent lamp and illustrating the additional heating element; and

Fig. 8 is another wiring diagram illustrating a modified type of heating arrangement.

Referring now to these drawings, a fluorescent lamp 18 is illustrated in Figs. 1, 2, 3 and 4, as being provided with tube 19 mounted in lamp holders or sockets 20 and 21 carried on a base or support or channel 22. There are electrical contacts in each of these lamp holders that connect the extending contacts or pins of the tube to the lighting circuit.

In carrying out one of the main features of this invention, it is desirable to maintain the tube 19 in a condition of substantially uniform temperature, preferably somewhere between 115° F. and 125° F. for any use at any temperature. In outside temperatures which range from minus 50° F. to approximately 60° F. there is an additional means for keeping the tube when lighted somewhere between the temperatures of 115° F. and 125° F. The present known most applicable means for this purpose is a suitable heater. One form of providing a substantially uniform temperature of the tube 19 under relatively cold temperatures is illustrated herein as a suitable resistance heating element or wire 23 wound on tube 19, preferably spirally, and having the ends of the wire 23 connected to the lighting circuit represented by wires 24 and 25—Fig. 7—through a suitable thermostat 27. It is preferred to solder the ends of the wire 23 to electrical conducting terminals or bands 28—Fig. 1—and it is preferred that these bands be annular so that they will engage with contacts or U-shaped saddle pieces 29. These pieces 29 have post portions 30 and screw threaded shafts 31 which extend through the base or channel 22 and tightened in position, as shown in Fig. 2 and are connected to the electrical circuit. Thus, it will be observed that when tube 19 is mounted in the holders 20 and 21 for properly connecting it to the lighting circuit for energizing the tube 19, the bands 28 will automatically engage the saddle pieces 29 which are herein noted as being the third and fourth contacts for the improved lamp and the preferred

type of heater for maintaining the tube in desired temperature when the exterior atmosphere is colder than 60° F. When desired, the bands 28 may be substituted by other construction of contacts that will give the proper connection of the resistance heating element terminals to the lighting circuit, and such substitute contacts may be short extending contacts to which wire 23 is soldered and which readily engage saddle pieces 28.

Now referring to Fig. 8, there is illustrated another form of heating unit by having the heater positioned in proximity to the tube 19, or by being a single strip of resistance wire positioned near the tube and preferably throughout its length. If desired a wire of proper resistance may be affixed to the tube 19 in a suitable manner to obtain substantially uniform heat distribution throughout the length of the tube, and as noted above, the element or wire 23 is spiralled on the tube, and accomplishes the desired purposes. Other types of heating means, electrical or not, may be employed so long as the results are accomplished. The wire 23 is preferred to be small in gauge and, therefore, is not observable when the lamp 18 is burning.

In the preferred construction of the improved lamp illustrated in Figs. 1, 3 and 4, there is shown a suitable shield or jacket for maintaining the temperature of the tube 19 at a desirable figure. The preferred shield herein takes the form of a cylindrical shield or casing or sleeve 32 and is positioned to surround the tube 19 for most of its length and to be held so that it is about ⅛" from the tube 19 at any point, or expressed in another manner, the shield 32 is greater in diameter than tube 19 by ¼" to $\frac{5}{16}$". This figure may vary, as desired, under varying circumstances.

The shield 32 may be properly held in relation to tube 19 by any suitable means such, for instance, as washers 33—Fig. 3—or may have its ends squeezed in at points so as to engage the tube at predetermined points but preferably allowing ventilating openings. These washers 33 are preferably provided with openings 34 so as to allow ventilation under the shield 32 and along tube 19. The number of holes in the washers for different diameters of the shield 32 may vary so that proper ventilation is obtained for the purpose of keeping the tube 19 at its desired temperature. When not employing washers 33, the ends of the shield 32 are squeezed or bent inwardly to engage the tube 19 at desired places and openings are thus provided in the ends of the shield as bent or provided along the shield or jacket at proper places so that ventilation may be satisfactorily obtained. Usually, the holes in the washers 33 are approximately $\frac{1}{32}$" in diameter and it has been found that about six or eight of them in each washer provides the means for preventing the tube 19 from becoming too hot while the lamp is burning and while being mounted in one or more cold atmospheric temperatures. In some instances it may be desirable to include perforations in the tube at desirable places, thus, providing proper ventilation so that the tube while lighted may be maintained at a temperature within the desired range.

As a matter of practicality, the resistance wire 23 may be wound on the tube 19, and when desired fastened in position by providing a suitable holding at a few points along its length. For instance, a globule of glass may be used or a drop of cement, or the like. At each end of the tube

the wire may be wound around the tube adjacent the annular contacts 23 and then soldered in position on those contacts. Thus, the wire 23 will be readily mechanically held in position so as to give a substantially uniform heating of the tube while in a cold atmosphere.

For the purpose of readily appreciating the value of any heating means, preferably electrical as above described, to maintain the tube at desirable temperatures, reference is made to the curves in Fig. 6. One of the ordinates is labeled for elapsed time after the starting seconds, and the other ordinate is for the relative light output percent using 100 as the usual rated lumens of light given by the lamp when burning normally. The time of starting any of these types of lamps is about five seconds. Reference to curve III is made as it shows the starting of a lamp of this nature at substantially room temperature and shows that within about three to five minutes the lamp has reached its substantial maximum output of lumens, and then as time goes on it drops off slightly. This curve shows the normal operation of many of these types of lamps. The lamp which was subjected to several tests and from which data these curves were made, was one which is represented in Figs. 1 to 4, inclusive. The heating wire 23 was in position but was not connected to the lighting circuit during the time of taking the data forming curve III.

Particular attention is now called to curve I which has to do with the tests made on this lamp while the lamp was held cold at approximately minus 20° F. It will be noted that within ten minutes, approximately eight minutes, the lamp was brought to full lumen output and then it dropped off to some extent and then continued substantially at approximately 96% of full lumens even though the outside temperature was continued at substantially minus 20° F. Thus, by use of the improved and preferred heating arrangement herein shown, a cold lamp is quickly brought to full illumination and maintained there without flickering and without trouble, and it has been found that such operations permit the life of the lamp to be increased to a large number of hours which have shown to be at least 7200 hours.

Referring now to the curve II which is included for the purpose of contrast to curve I, the starting of the lamp at minus 20° F. will be noted as being very gradual and that it never got up to more than 60% of its full lumens for three hours. For the purpose of making a further contrast, the heater was started after the three hour period, and the right hand portion of the curve is shown as increasing the lumens very quickly and fully, and inside of fifty minutes thereafter the lumen output was brought up to substantially 98% of its normal even through the surrounding temperature was maintained at the minus 20° F. temperature.

From these curves it will readily be noted that there is a very material value in having the tube of the lamp heated in some manner, and when heated to have a substantially uniform temperature, the lumens output is obtained very quickly and retained as long as the lamp is burning. In the preferred construction herein the heating arrangement only operates now and again due to a control by thermostat 27 which requires that the wire 23 be heated at different intervals so as to maintain the tube 19 at a temperature between 115° F. and 125° F. during its burning period. This thermostat is of the heat responsive type and may be positioned at any suitable

place near the tube 19 or its exposed ends, or near the cylindrical shield or jacket or sleeve 32, so that it responds to changes of temperatures for both the on and off position, thereby to cooperate with the resistance element or wire 23 to maintain the tube 19 at a temperature within the desired range for producing the most effectual illumination while the lamp itself is positioned in a cold atmosphere. The curves in Fig. 6 readily show the value of the improved device for properly heating the tube 19.

Referring now to Figs. 7 and 8 the arrangement of supplying heat to the lamp tube is readily shown in the wiring diagrams. In Fig. 7 the wire 23 is shown in series with thermostat 27 and this thermostat and the wire 23 circuit is in shunt with the electrical supply to the lamp. The usual ballast 36 and the various connections to the electrical leads 24 and 25 are shown in Fig. 2 which illustrate the underside of the base or channel 22. The wiring of the lamp and the ballast and the usual starting element 37 are shown in Fig. 7. In the wiring diagram illustrated in Fig. 8, there is the showing of heater 35 which is positioned in proximity to the tube 19 and which may give sufficient heat in its position so that the tube 19 may be satisfactorily heated throughout its length by conduction through the glass of the tube 19. However, the more practical means of heating the tube is by the small wire 23 which is unobservable when the lamp is burning. When thus using this spiral winding of resistance wire 23, it is found to be more satisfactory to obtain a substantially uniform heating of the tube and, therefore, obtain a better efficiency of the operation of the lamp.

From the foregoing detailed description, it will be noted that a very satisfactory device has been provided and employed in specific positions for quickly obtaining the normal operating illumination of a fluorescent lamp when the lamp itself is exposed to low temperatures. Also, it will be noted that the fluorescent lamp structure includes a low pressure mercury vapor discharge tube, which is of the elongated type with an electrode in each end and is provided with pins which project from the ends of the tube. These pins are engageable with the contacts in the spaced sockets when the tube has been assembled therein for energizing. It will be further noted that the improved heating means requires only a very small electrical consumption in properly operating the lamp at its normal temperature by providing a thermostat controlled heating means that preferably is in shunt with the electrical supply line to the lamp and which operates intermittently and may be set or regulated to close or complete a circuit at a desired temperature. The temperature for closing its circuit may be 50° F., or 25° F., or some other temperature that is satisfactory for the purpose. It will further be noted that a satisfactory jacket or shield, or tube or sleeve may be employed for assisting in maintaining the tube of the fluorescent lamp at its normal efficient operating temperature. Also the actual construction of the apparatus preferably provides the added third and fourth contacts 28 and the yoke saddle pieces 29 for automatically cooperating with contact pins on the ends of the tube when the tube is mounted in its holders 20 and 21, thereby giving a very satisfactory and firm and automatic means of making sure that the lamp will be properly heated during its burning period. It is preferred that the jacket or shield shall be highly transparent and may be made of glass, plastic, or the

like. It is also desirable that the washers 33 shall be flexible and non-inflammable and non-conductors of electricity. The resistance heating element or wire 23 may be of any suitable material such as nickel-chrome or German silver, or any other satisfactory alloy, and it is desired that the wire 23 shall have an ohm resistance of between 300 and 750 for its length and size to satisfactorily maintain the tube at desirable temperatures when the lamp is mounted or held in low temperatures.

It will be understood that various modifications and changes may be made in the preferred form of the invention herein, and such modifications and changes are to be understood as part of this invention, as outlined in the following claims.

The invention claimed is:

1. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a surrounding transparent jacket carried by said tube and spaced therefrom, a resistance heating element surrounding said tube and positioned within said jacket, and terminals for said resistance heating element, said terminals being so positioned as to be electrically engaged with an electrical supply line when said tube is in said spaced sockets for energizing said tube.

2. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a transparent jacket surrounding said tube and spaced therefrom, a resistance heating element surrounding said tube and positioned within said jacket, terminals for said resistance heating element, said terminals being so positioned as to be electrically engaged with an electrical supply line when said tube is in said spaced sockets for energizing said tube, and a thermostat connected in series with said resistance heating element and responsive to the heat of said lamp.

3. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a surrounding transparent jacket carried by said tube and spaced therefrom, a resistance heating element surrounding said tube substantially uniformly and for substantially the length of said tube and positioned within said jacket, terminals for said resistance heating element, said terminals being so positioned as to be electrically engaged with an electrical supply line when said tube is in said spaced sockets for energizing said tube, and a thermostat carried by said lamp structure and being responsive to the temperature of said lamp, said resistance heating element and said thermostat being connected together in series and connected in shunt across said electrical supply line.

4. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a surrounding transparent jacket carried by said tube and spaced therefrom, a resistance heating element surrounding said tube and positioned within said jacket, terminals for said resistance heating element, contacts carried by said lamp structure and being positioned to engage said terminals when said tube is assembled in said spaced sockets, said contacts being connected with an electrical supply line.

5. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a transparent jacket surrounding said tube for at least a major part of the length of said tube, means for holding said jacket away from said tube and allowing ventiliation between said tube and said jacket, a resistance heating element spirally wound around said tube for at least a major part of the length of said tube, said element being positioned within said jacket, terminals for said resistance heating element, electrical contacts carried by said lamp structure and positioned to be automatically engaged by said terminals when said tube is mounted in said spaced sockets for energizing said tube, and a thermostat connected in series through one of said terminals with said resistance element, said thermostat and said resistance element as so connected then being connected in shunt to an electrical supply line, said thermostat operating at intervals when said lamp is below 30° F. to maintain said tube heated to a temperature that permits said tube to give substantially its maximum lumens.

6. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a transparent jacket surrounding said tube and spaced therefrom, a resistance heating element surrounding said tube and positioned within said jacket, terminals for said resistance heating element, said terminals being so positioned as to be electrically engaged with an electrical supply line when said tube is in said spaced sockets for energizing said tube, said resistance heating element creating heat within said tube to bring said tube to a temperature that allows said tube to attain its maximum lumens within ten minutes after starting, and a thermostat connected in series with said resistance element to temporarily connect and disconnect said resistance element with said supply line to maintain the temperature of said tube substantially within the range of 115° F. and 128° F.

7. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube

being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a transparent jacket surrounding said tube and spaced therefrom, an electrical contact carried by said lamp structure, a thermostat responsive to the heat of said tube connected between one side of the electrical supply line and said contact, a resistance heating element surrounding said tube and positioned within said jacket, and a terminal for said resistance heating element for engaging said contact carried by said lamp structure, the other end of said resistance element being connected to the other side of said electrical supply line.

8. In an electrical fluorescent lamp structure, the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to each of said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a surrounding transparent jacket carried by said tube and spaced therefrom, a resistance heating wire of between 300 and 750 ohms positioned within said jacket, terminals for said resistance heating wire, a thermostat connected in series with said resistance wire, said wire and said thermostat being connected in shunt across an electrical supply, said terminals being so positioned as to be automatically electrically engaged with said electrical supply when said tube is in said spaced sockets for energizing said tube, said tube being subjected to temperatures below 30° F., said thermostat acting intermittently to maintain said tube at a normal temperature between 115° F. and 125° F. thereby giving said tube a minimum life of 7200 hours.

9. In an electrical fluorescent lamp structure for maintaining said lamp at efficient substantially maximum lumens while burning and when

the surrounding atmosphere is below 30° F., the combination of a low pressure mercury vapor discharge tube adapted to be received in spaced sockets carried by said lamp structure, said tube being of the elongated type with an electrode in each end, pins connected to said electrodes and projecting from said ends, said pins being engageable with contacts in said sockets, a transparent jacket surrounding said tube, perforated washers for holding said jacket away from said tube, a resistance heating wire surrounding said tube for substantially the full length of said tube, terminals for said heating wire and being positioned outside said jacket, post contacts mounted in said lamp structure for engaging said terminals and being connected to an electrical supply circuit, said post contacts electrically engaging said terminals when said tube is in said spaced sockets for energizing said tube, a thermostat connected in series with one of said post contacts and with one side of said electrical supply circuit, the other post contact being connected to the other side of said electrical supply circuit, said thermostat acting to intermittently cause said tube to be heated by said resistance wire to maintain said tube at a temperature between 115° F. and 125° F. while said lamp is burning.

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