

Feb. 1, 1944.

A. SLEPIAN'

2,340,348

FLUORESCENT TUBE CIRCUIT

Filed June 15, 1940

2 Sheets--Sheet 1

Fig. 1

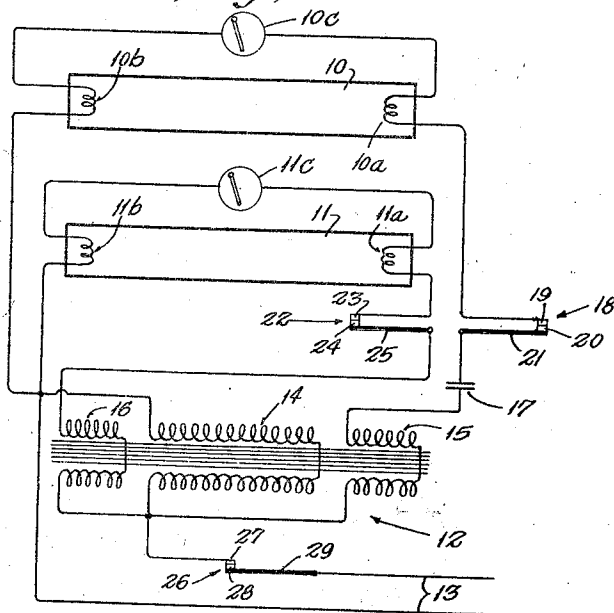
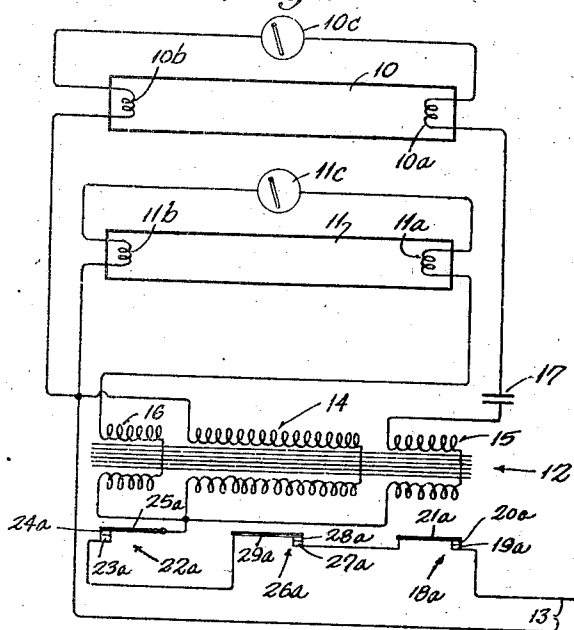


Fig. 2



INVENTOR
Arthur Slepian
BY
Johnson, Kane & Smyth
ATTORNEYS

Feb. 1, 1944.

A. SLEPIAN

2,340,348

FLUORESCENT TUBE CIRCUIT

Filed June 15, 1940

2 Sheets-Sheet 2

Fig. 3

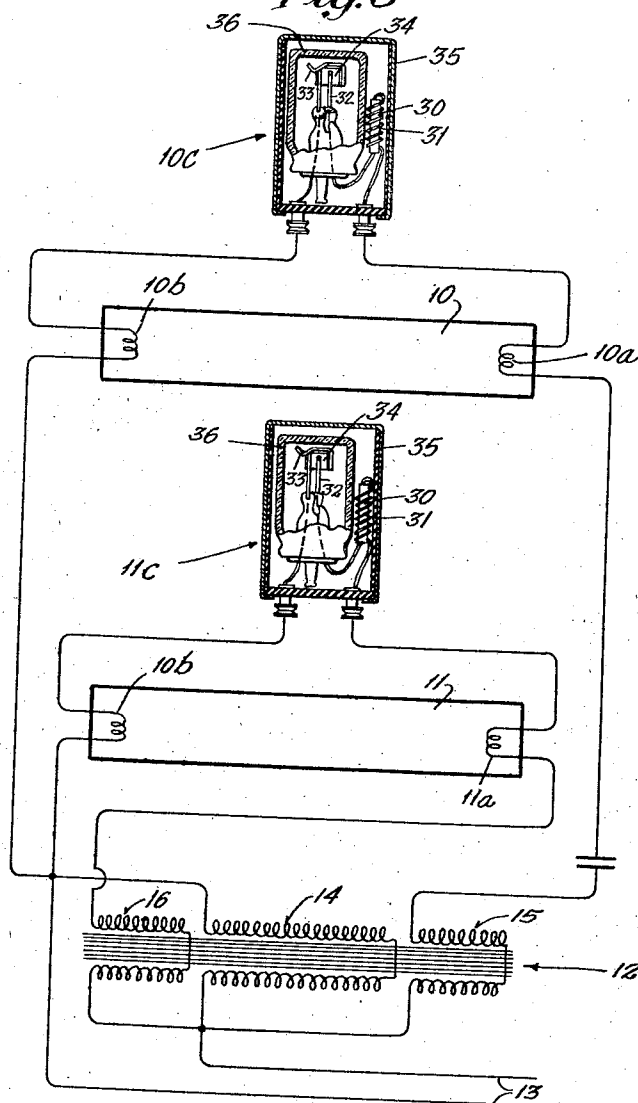


Fig. 4

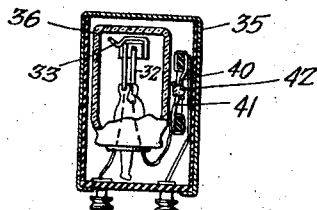


Fig. 5

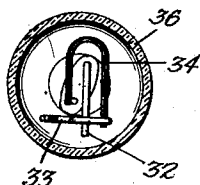
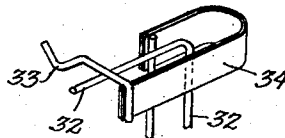


Fig. 6



INVENTOR
Arthur Slepian
BY Johnson, Klue and Smith
ATTORNEYS

UNITED STATES PATENT OFFICE

2,340,348

FLUORESCENT TUBE CIRCUIT

Arthur Slepian, Trumbull, Conn., assignor, by
mesne assignments, to The Wheeler Insulated
Wire Company, Incorporated, Bridgeport,
Conn., a corporation of Delaware

Application June 15, 1940, Serial No. 340,701

4 Claims. (Cl. 176-124)

The present invention relates to fluorescent tube circuits, and, more particularly, to a control means therefor.

In fluorescent tube circuits, especially of the type wherein an automatic starter is employed to close the filament circuit during the heating period thereof to cause said heated filaments to produce an ionized condition in the tube which will arc over upon a proper potential being impressed thereon, difficulty had been encountered because of the automatic switch failing to open the heating circuit for the tube after the heating period which results in a prolonged flow of high current in the filaments, which current causes the filaments to burn out readily.

Also, when the starter fails to open the heating circuit, the abnormal current demand places an additional load on the transformer or other energy supplying means which results in a large amount of heat being generated in said transformer or supply means causing the potting compound or other filling material therein to be softened and the unit otherwise damaged.

In some circuits having capacitance therein, the tube will arc over even though the switch has not opened.

It is practically impossible, after the tubes have arced over, to determine from the appearance of the tube whether or not the automatic switch means has opened the heater circuit and thus the damaging effects of such a condition will not be apparent until after the damage has been done.

According to the present invention, I have provided in the lighting circuit a means for opening said circuit, should the automatic switch fail to properly operate or should some other portion of the circuit fail. This may take the form of a current-responsive circuit opener or a heat-responsive circuit opener, or both of said circuit openers may be included in the same circuit.

In one form of the invention, I have illustrated a plurality of tube circuits and have provided a current-responsive switch in each of these tube circuits. Each circuit is connected to a secondary of the operating transformer. I have also placed a current-responsive switch in the line circuit for the primary of the transformer. With this arrangement, only that circuit need be cut out which is in trouble, since the current-responsive switch in the circuit which is in trouble will be caused to open and cut off a supply of energy to the tube. However, should an unusual condition exist which would not affect the current-responsive means sufficiently to open the tube cir-

uits but which, acting in conjunction with the operation of the other tube in the circuit, would cause undue load on the transformer, then the current-responsive switch means in the primary circuit would function to open the circuit to said transformer and prevent a supply of energy to the whole system. It is to be understood that preferably these current-responsive means shall have sufficient time delay so that they will not be operated by the starting current in the tube but which will operate on a prolonged high current demand.

In another form of the invention I have provided heat-responsive switches which are inserted in the circuit and are heated by the transformer or other operating means, upon becoming overheated due to failure of the lighting circuits to properly function. In the preferred form of the invention I have applied three heat-responsive switches, one located adjacent each of the secondaries connected to each of the tubes and another adjacent the primary. Thus it will be seen that if one of the tube circuits should fail the secondary connected with said tube would become greatly overheated and would cause the heat-responsive switch controlled by that circuit to open the supply of current to the tube. Also, should a condition exist in which the temperature in the secondaries is not sufficient to operate either of the heat-responsive switches controlled thereby, but, when combined, will produce a temperature in the primary which may cause damage, then, the heat-responsive switch located adjacent the primary will function to cut off the source of supply. These heat-responsive switches can be connected in tube circuits for individual control of said circuits, or may be connected in series with the supply line so that operation of any one of the heat-responsive switches will interrupt the entire supply circuit.

While many types of current-responsive switches and heat-responsive switches may be inserted in these circuits, in the preferred form of the invention I employ a bimetallic strip element as the operator in either of these types of switches. In the current-responsive switch, the bimetallic element will be heated by the current passing therethrough and the normal current of the circuit will not be sufficient to heat the element to cause it to flex to open-circuit position, but an abnormal flow of current will cause it to become overheated and flexed to open position. A switch of this type will provide a time lag, if necessary, to allow for the normal operations of the devices as before mentioned.

In the heat-responsive switch, the bimetallic element will be located adjacent to parts of the circuit which are adapted to become overheated due to shorts or other disturbances in the circuit so that they will be heated by radiation, convection or conduction from said parts and operate to open the circuit.

Both of these switches will again close the circuit after they have cooled off, and, in the case where the short circuit or other change in the circuit is temporary, will again cause the lights to function normally. However, should the trouble be of a permanent nature, the switch will protect the device until the trouble has been detected and corrected.

During the deactivating process of the tube, at which time the tube will fail to arc over, the automatic starter will be periodically operated. While the current therein is not excessive to cause the current-responsive switch to fail, the heating of the starter by the repeated operations thereof tends to destroy the starter and causes an unnecessary load to be placed on the transformer.

Accordingly, I have provided a heat-responsive switch in the starter circuit and placed it within the can or adjacent thereto to be operated in accordance with the heating of the starter. In one form of the invention, there has been provided a fusible element which is melted by the temperature within the starter can. In another form of the invention, I have provided a heater operated by the current in the starting circuit for destroying the fusible element upon predetermined overheating due to the operation of the starter circuit. In this connection, it must be pointed out that a sufficient time lag should be present in these circuit breakers to prevent them from operating during the normal use of the lights.

Other features and advantages will be apparent from the specification and claims when considered in connection with the drawings, in which—

Figure 1 shows one form of the invention employing the current-responsive switch means.

Fig. 2 shows another form of the invention employing the heat-responsive switch means.

Fig. 3 is a diagrammatic view of the circuit showing one form of starter can in section.

Fig. 4 shows another form of control for the starter can.

Fig. 5 is a sectional view of the thermo-responsive switch.

Fig. 6 is a detail of the contact structure of the thermal switch.

The drawings show the present invention as applied to a lighting system having two fluorescent tubes 10 and 11 therein operated by a power supply 12 connected across lines 13.

In the illustrated form of the invention, the power supply comprises an autotransformer having a primary 14 and a pair of secondaries 15 and 16 spaced at opposite ends thereof supported by the core of the transformer. The fluorescent tube 10 has its filament 10a connected to the secondary 15 and its filament 10b connected to one side of the power line and a starter switch 10c, preferably of the automatic type, positioned in the conductor connecting the filaments 10a and 10b.

The tube 11 has its filament 11a connected to the secondary 16 and its filament 11b connected to the line and a switch 11c, preferably an auto-

matic starter switch, in the circuit connecting the filaments.

One of the tube circuits is provided with a condenser 17 to provide a leading current for power factor compensation as is required by the utility companies supplying current for these devices.

The starter switches per se which are diagrammatically illustrated at 10c and 11c do not form a part of the present invention. These switches may be of the type sold as "can" switches FS-2 or FS-4, or of the type disclosed in Patent No. 2,200,443 to Dench, granted May 14, 1940; and which function to open the heating circuit for the filaments after they have been heated sufficiently to render said tubes conductive. If the FS-2 or FS-4 are used, the condenser 17 need not be included in the circuit as a condenser is incorporated in the unit.

Many difficulties have arisen in fluorescent tube circuits. One of the chief sources of trouble resides in the operation of the starter switch which is closed to heat the filaments and cause ionization of the gas in the tube to permit an arcing over or discharge between the filaments upon proper voltage being applied to the filaments where the heating circuit is opened.

It will be apparent, therefore, that the heating circuit must be automatically opened as soon as the filaments have been heated to reduce the current demand in said circuits. However, in many instances, especially where automatic starter switches have been employed, the starting circuit has failed to open and has caused a heavy current to continue to pass through the filaments of the tube, which quickly causes these filaments to burn out and the tube to become useless.

Also, the heavy load caused by this abnormal demand for current causes the transformer or choke coil or other energy-supply means to become overheated to such an extent that the potting or filling material for the transformer or the like becomes melted and runs therefrom causing damage to the transformer or the like and causing disagreeable effects as a result of the dripping of the potting material from the transformer.

In some instances, where there is a condenser in the circuit, the tube has arced over even though the starter switch has not opened the heater circuit. When this occurs, the failure of the automatic switch to open the heating circuit after the tube has arced over and become fluorescent is not apparent and the trouble is not detected until damage to the equipment has occurred.

According to the present invention, I have provided current-responsive switch means in each of the tube circuits and also in the transformer circuit, which will open the circuit upon an abnormal current flowing in the circuit.

As shown in Fig. 1, a current-responsive switch 18 having a fixed contact 19 and a movable contact 20 carried by bimetallic arm 21 is connected in the circuit for the fluorescent tube 10, while a similar switch 22 having a fixed contact 23 and a movable contact 24 carried by a bimetallic arm 25 is connected in the circuit for tube 11.

Another current-responsive switch 26 having a fixed contact 27 and a contact 28 carried by a bimetallic arm 29 is connected in the line leading to the source of energy.

Should the starter means in either of the tube circuits fail to operate properly, the current demand will be sufficient to heat the bimetallic arms 21 or 25 and cause the arms to flex and move

contacts 24, 20 and open the circuit to either one or the other of the tubes. Heater coils for heating the arms 21 and 25 may be used if desired.

In the event that the current demand in the circuits for the tubes 11 and 12 is not sufficiently in excess to open the switches 18 and 22, but still places the undue load on the circuit, the switch 26 will be affected thereby and will open the circuit to the transformer thus preventing damage thereto.

While current-responsive switches of various types may be used in the circuit, I prefer that type employing the bimetallic arm inasmuch as the heating of the bimetallic arm provides a sufficient time lag in the circuit to permit the flow of the high starting current present in the normal operation of the tube.

In the form of the invention shown in Fig. 2, the circuits for the tubes are the same as described in connection with Fig. 1. However, in this form of the invention, I have employed heat-responsive switches which are placed adjacent portions of the circuit which become heated upon overload and which switches are heated by radiation, conduction or convection from said overheated part to open the circuit before permanent damages result.

In the illustrated form of the invention, I have provided three heat-responsive switches 18a, 22a, 26a located one each adjacent one of the secondaries and one adjacent the primary to be heated thereby. While these switches can be connected in the circuits for the tubes in the manner similar to that in Fig. 1, I have illustrated them as being connected in series in the line so that operation of any one of the switches will open the circuit to the transformer and render both of the lamps inoperative.

As is shown in Fig. 2, a heat-responsive switch 18a is disposed adjacent the secondary 15 which is connected to the tube 10 and has a fixed contact 19a and a movable contact 20a in the line circuit. The contact 20a is carried by a bimetallic arm 21a for operation thereby.

A similar switch 22a is disposed adjacent the secondary 16 which is connected to the tube 11 and has a fixed contact 23a and a movable contact 24a connected in the line circuit with the contact 24a secured to a bimetallic arm 25a for operation thereby.

A third switch 26a having a fixed contact 27a and a movable contact 28a carried by the bimetallic arm 29a is placed adjacent the primary coil so as to be heated thereby.

With the heat-responsive switch means positioned in this manner, it will be apparent that should a short circuit or other failure occur in the circuit for tube 10, the secondary 15 will become heated and will heat the switch 18a and cause it to flex and open the circuit. Similarly, if a short circuit or other failure occurs in the tube 11, the secondary 16 will be heated abnormally and will heat the switch 22a and cause it to open the circuit.

Either of these switches, which are connected in the line circuit, will open the circuit to the source of energy for the two lamps and prevent damage to the device.

In the event that the current in the two tube circuits is above normal, but not sufficient to cause the switches 18a or 22a to become heated to the point of opening the circuit but which current demand in both circuits acting together is sufficient to overheat the primary, then the switch 26a will be heated and open the circuit.

While I have described the heat-responsive switches as bimetallic arms, it is to be understood that there may be other types, such as expansible chambers or fusible elements, which will permanently open the circuit.

By the use of the bimetallic arm in both the current-responsive switch and the heat-responsive switch, I have provided a means which will open the circuit upon an abnormal condition existing and which, upon cooling, will again close the circuit.

If the short circuit or other disturbance is of a temporary nature, then when the circuit is again closed by the current-responsive or heat-responsive switch means cooling off, the tubes will again function in their normal manner. On the other hand, if the trouble is of a permanent nature, the switch means will operate to protect the apparatus until the permanent trouble has been located.

It is to be understood that a single current-responsive switch or heat-responsive switch can be employed in the circuit, or a combination of these switches can be connected in the same circuit if the demand requires it.

Another difficulty occurs in the circuit when during the deactivating process of the tube, at which time the tube fails to arc over between the filaments thereof upon the opening of the starter circuit, the starter switch is caused to repeatedly operate in an effort to start the energization of the tube. This continued operation causes the automatic starter to become overheated and also places an unnecessary load on the circuit. Accordingly, I have provided a heat-responsive switch to be operated in accordance with the temperature of the starting means.

One form of this invention is shown in Fig. 3, wherein a fusible element 30 is located within the can 35 and is connected in series with one of the contacts of the starter switch and is provided with a heating coil 31 connected in the circuit.

When the light circuit is closed, the starter switch will arc over between contacts 32 and 33 enclosed in tube 36 and the current passing there-through will cause a bimetallic arm 34 carrying contact 33 to flex and move the contacts and extinguish the arc, causing the starter circuit to be opened and the tube to arc over. However, upon the failure of the tube to arc over, the voltage will still be impressed on the starter circuit to cause it to again arc over and again go through the operation necessary to start the fluorescent tube. This continued operation will cause the starter means to heat up.

In order to insure that the starting circuit will be opened upon overheating therein, the fusible element in this form of the invention is positioned closely adjacent the starter switch and the heating coil is so arranged with respect thereto as to insure destruction of the fusible element, only after a predetermined interval of time sufficient to cause the starter to become abnormally heated and open the circuit. Care must be taken to prevent the material of the fusible element from shorting the turns of the heater coil.

In the form of the invention shown in Fig. 4, the starter can 35 has mounted therein a pair of contacts 40, 41, connected in the heater circuit, which are normally biased into open-circuit position. The contacts, however, are held together by a fusible member 42 disposed adjacent the starter switch. Upon the heating of the fusible member, through increased operation of the

starter switch, the fusible element will become destroyed and the contacts will separate and open the circuit.

Also, if the contacts 32, 33 of the switch means should become permanently shorted so that the heat-responsive member cannot return them to their normal positions after extinguishing the arc, then the starter means will also heat up and the increased temperature will operate the heat-responsive means.

It is to be understood that the heat-responsive switch means can be placed in various types of automatic starting means to be operated by overheating of the same.

In the broader aspects of my invention, I have provided a means for protecting the tubes, which operate on critical voltages and currents, against abnormal currents which may be due to short circuits or the like in the lamp circuits.

Variations and modifications may be made within the scope of this invention and portions of the improvements may be used without others.

I claim:

1. In a fluorescent tube circuit, a fluorescent tube; automatic starter means in the filament circuit of the tube for temporarily closing said circuit to heat the filaments and to cause the tube to become conductive; means for supplying a proper voltage to the tube to maintain the tube conductive, said means being abnormally heated upon improper operation of said tube circuit; and means disposed in heat-receiving relation with and responsive to the temperature of said last-named means for disconnecting the means for supplying voltage to the tube.

2. In a fluorescent tube circuit, a fluorescent tube; switch means for temporarily closing the heating circuit for the filaments of said tube to cause the tube to become conductive and for thereafter opening the heating circuit; means having a supply circuit for supplying a proper

voltage to the tube to maintain said tube conductive; and bimetallic switch means in said supply circuit adjacent and in heat-receiving relation with said means for supplying a proper voltage to be heated thereby to open the circuit thereto upon an overload of said means by the failure of said switch means to properly open said heating circuit.

3. In a fluorescent lamp circuit, a plurality of fluorescent tubes; automatically operated switch means in each tube circuit for temporarily closing the heating circuit for the filaments of said tube to cause the tube to become conductive and for thereafter opening the heating circuit; a transformer connected to a power supply for supplying power to operate the tubes and maintain the tubes conductive; and heat-responsive switch means disposed in the power supply circuit and responsive to the temperature of the transformer upon overload of the circuit thereof by the failure of the automatically operated switch means to properly open the filament circuit for disconnecting said tubes from the power supply.

4. In a fluorescent lamp circuit, a plurality of fluorescent tubes; automatically operated switch means in each tube circuit for temporarily closing the heating circuit for the filaments of said tube to cause the tube to become conductive and for thereafter opening the heating circuit; a transformer connected to a power source having a primary and a plurality of secondaries, one each connected to a tube circuit for supplying power to operate the tube and maintain the tube conductive; and a heat-responsive switch disposed adjacent each of the secondaries and the primary in heat-receiving relation therewith for independently opening the circuit between said power source and said transformer upon either of the secondaries or primary becoming overheated due to an overload in said lamp circuit.

ARTHUR SLEPIAN.