

Oct. 16, 1945.

A. SLEPIAN

2,386,914

FLUORESCENT TUBE CIRCUIT

Original Filed June 15, 1940

Fig. 2

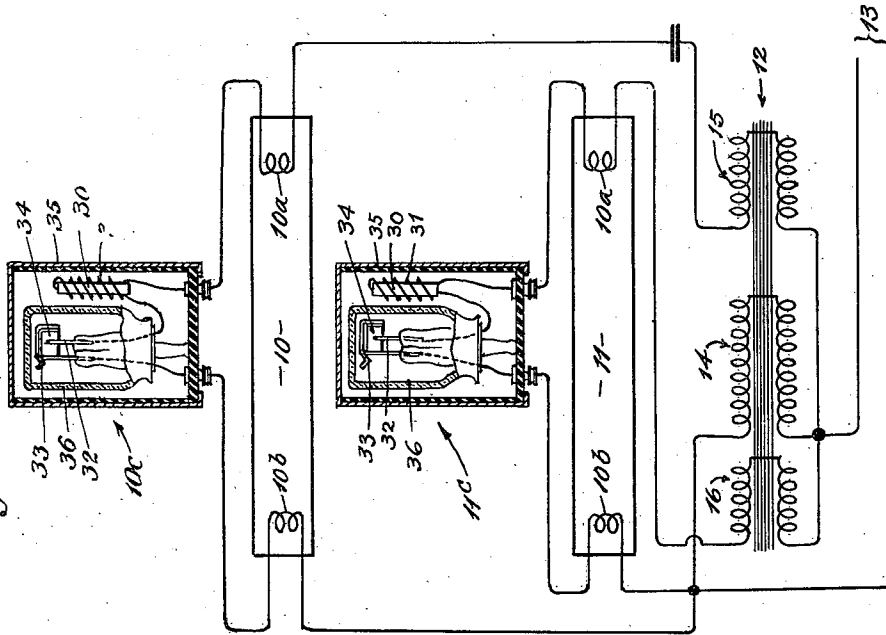


Fig. 1

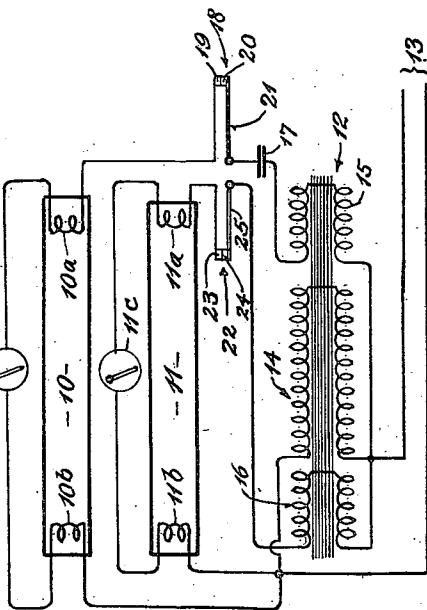


Fig. 3

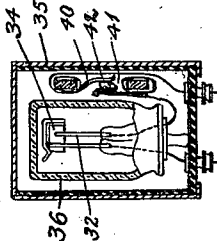


Fig. 4

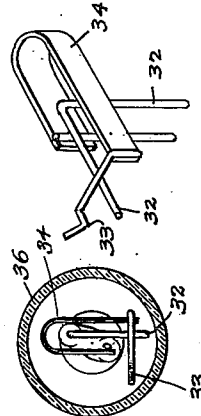
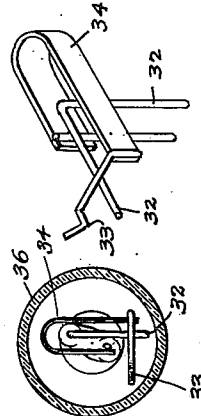


Fig. 5



INVENTOR
Arthur Slepian,
BY Johnson and Kline
ATTORNEYS

UNITED STATES PATENT OFFICE

2,386,914

FLUORESCENT TUBE CIRCUIT

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

Original application June 15, 1940, Serial No.
340,701, now Patent No. 2,340,348, dated Febru-
ary 1, 1944. Divided and this application March
4, 1943, Serial No. 477,932

5 Claims. (Cl. 315—100)

The present invention relates to fluorescent tube circuits, and, more particularly, to a control means for opening the circuit upon failure of the starter to cause the tube to arc over.

This application is a division of my copending application, Serial No. 340,701, filed June 15, 1940, now Patent No. 2,340,348, granted February 1, 1944.

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 supply 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. 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.

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.

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 preferably have 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 drawing, in which:

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

Fig. 2 is a diagrammatic view of the circuit showing one form of the starter can in section.

Fig. 3 shows another form of control for the starter can.

Fig. 4 is a sectional view of the thermo-responsive switch.

Fig. 5 is a detail of the contact structure of the thermal switch.

The drawing shows 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 automatic 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 open.

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 arched 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 arched 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 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.

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.

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.

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. 2, 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 therethrough 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. 3, the starter can 35 has mounted therein a pair of spring 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 gaseous discharge fluorescent tube having filaments therein; automatically operated switch means in said circuit for periodically closing a heating circuit between said filaments when the tube is non-conducting to heat the filaments to cause said tube to be operative; and heat-responsive means including contacts in the heating circuit for opening the heating circuit upon overheating of the starting means caused by repeated operations of said switch upon the tube failing to become operative.

2. A gaseous discharge lamp; a starting circuit for said lamp; starting means including contacts for closing and opening said starting circuit and adapted upon the application of voltage to said lamp to cause current flow through the lamp electrodes to effect heating thereof when the contacts are engaged and upon separation of the contacts to cause the application of voltage across the electrodes sufficient to light the lamp; and protective means having contacts in said starting circuit and operable to open said starting circuit in the event the lamp does not light in response to the operation of said starting means.

3. A fluorescent lamp; a starting circuit in parallel with said lamp; a starting switch in said starting circuit operable when the lamp is out and voltage is applied thereto to effect repeated opening and closing of said starting circuit until the lamp lights; a ballast in series with said lamp operable each time said starting circuit is

broken to induce a relatively high voltage across said lamp for lighting the lamp; and a normally closed protective switch connected in said starting circuit operable to effect the opening of said starting circuit in the event the continued operation of said starting switch fails to start said lamp in operation within a predetermined time interval after the initial operation thereof.

4. A protected starter unit to be used in the filament circuit of a fluorescent tube comprising a housing, an automatic starter switch means enclosed therein to be connected in the filament circuit of the fluorescent tube for temporarily closing said circuit to heat the filaments and cause said tube to become conductive and to repeat said operation until said tube becomes conductive, and a protective means connected in said circuit and mounted within the housing, said protective means including a destructible member and a heater resistor therefor connected in the said circuit to destroy said destructible member and permanently open the circuit upon repeated operations of the starter switch means or change from a normal condition in the starter means.

5. A protected starter unit to be used in the filament circuit of a fluorescent tube comprising a housing, an automatic starter switch means enclosed therein to be connected in the filament circuit of the fluorescent tube for temporarily closing said circuit to heat the filaments and cause said tube to become conductive and to repeat said operation until said tube becomes conductive, and a protective switch mounted in the housing, said last-named switch including a pair of contacts connected in the filament heating circuit and normally urged to open-circuit position and heat-responsive means for holding said contacts in closed-circuit position and for releasing said contacts to permanently open the circuit upon repeated operations of the starter switch means or change from a normal condition in the starter means.

ARTHUR SLEPIAN.