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ELECTRIC DISCHARGE LAMP CIRCUIT

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INVENTOR

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WITNESSES:

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My invention relates, generally, to an operating circuit for electric discharge lamps, such as fluorescent lamps, and, more particularly, to a circuit for operating lamps of this character from a constant current series circuit or source where it is desired to maintain the power factor at a relatively high value.

Fluorescent lamps of the conventional type require that around 150 percent of normal operating current be passed through the filamentary electrodes or cathodes, for a short period in order to heat the cathodes prior to applying the starting voltage. This is for the purpose of reducing the starting voltage below the abnormally high value for starting the lamp with cold or insufficiently heated cathodes and to increase the life of the lamp. Furthermore, attempting to start the lamp with cold cathodes requires larger and more expensive auxiliary equipment.

When such lamps are to be operated from a constant current series circuit through isolating current transformers or safety coils, which isolates or insulates the lamp from the high voltage of the series circuit and provide the correct operating voltage for the lamp, it has been found that disadvantages result from attempting to use an isolating current transformer having a drooping characteristic with a constant primary current for the purpose of supplying the increased starting current required for starting the lamp. These disadvantages result from the fact that the primary power factor of such a transformer is low, being around 60 percent, which results in an increase in the size and cost of the constant current regulator required for the series circuit and also in a lower power factor on the primary feeder supplying this regulator.

The object of my invention is to provide for overcoming these disadvantages in a practical and economical manner whereby a fluorescent lamp may be efficiently operated on a constant current series circuit without shortening the normal life of the lamp and without requiring expensive auxiliary control equipment or lowering the power factor of the primary supply circuit.

A more specific object of my invention is to provide an operating circuit for a fluorescent lamp supplied with current from a constant current series circuit which shall function to supply the necessary increased starting current to the lamp and at the same time permit the use of an isolating current transformer having a high primary power factor.

A more specific object of my invention is to provide a circuit for operating a fluorescent lamp from a constant current series circuit which shall function to supply the necessary increased starting current for the lamp when connected to the series circuit through an isolating current transformer having such characteristics that its secondary current is so nearly the same under short circuit and normal operating conditions that it will not itself supply the necessary starting current for the lamp.

A further object of my invention is to provide for utilizing auto transformers in the operating circuit of a fluorescent lamp to provide the increased starting current required when the lamp is connected to a constant current series circuit through an isolating current transformer having a high primary power factor and a substantially constant secondary current.

These and other objects of my invention will become more apparent from the following detailed description when read in conjunction with the drawing in which the single figure is a diagrammatic view of a circuit embodying the principal features of my invention.

Referring to the drawing, the reference character 10 indicates a well known constant current series circuit supplied with current from a primary feeder circuit through a constant current regulator (not shown) such as is commonly used for street lighting systems. The lamp 9, is utilized to connect the cathodes of the lamp in series circuit relation for a short period of time, usually about...
one second, for the purpose of heating them to the required temperature prior to applying the normal operating voltage to the lamp.

One form of thermal relay suitable for such use is that disclosed by the patent to E. C. Dench No. 2,311,443, dated May 14, 1940, although any other suitable type may be used to open the cathode circuit and apply normal operating voltage to the lamp after a predetermined time. Some types of thermal relays have a normally closed contact element and others, such as the Dench type, have a normally open contact element which closes and then opens and remains open.

In order to provide for operating the lamp from the series circuit through an isolating current transformer 11 of the high power factor type, a pair of auto-transformers 21 and 22 are utilized to boost the cathode heating current during the starting period.

The windings of these transformers are connected in series across the secondary winding 13 of the isolating current transformer through the heater 18 and contact element 19 when the latter is closed. The cathodes 15 and 16 are connected across a portion of the windings of auto-transformers 21 and 22, respectively, so as to receive additional current to that which could be derived from the secondary voltage of the isolating current transformer alone.

When the constant current circuit 10 becomes energized the series heating circuit is closed through the contact element 19 of the thermal switch. This circuit extends from one terminal of the secondary winding 13 thru conductor 24, heater 18, conductor 26, auto-transformer winding 22, conductor 27, contact element 19, conductor 28, auto-transformer winding 21, conductor 29 to the other terminal of the secondary winding 13.

Upon the establishment of this circuit, current not only flows through the windings of the auto-transformers 21 and 22 but also through the cathodes 15 and 16 which are connected across the output terminals of these transformers. Accordingly, it will be apparent that the cathodes will be subjected to a heating current larger than that which the isolating current transformer 11 supplies, due to the boosting of the current supplied by the auto-transformers 21 and 22.

Thus it is seen that the auto-transformers function to increase or boost the heating current to a value above the normal operating current which can be supplied by the isolating current transformer.

After a predetermined time delay as determined by the characteristics of the starting switch 17, its contact element 19 opens to interrupt the series heating circuit and effect the discharge of the lamp. When this circuit is open the auto-transformers are rendered ineffective and the lamp circuit operates in the normal manner, the isolating current transformer 11 functioning to supply the necessary current to maintain the discharge.

The heater or thermal element 18 of the starting switch 17 may be connected in the circuit in any other suitable position such, for example, in series with either one of the lamp cathodes.

While throughout the description specific reference has been made to auto-transformers for boosting the heating current it is to be understood that any other suitable device may be used for this purpose.

In view of the foregoing it will be apparent that the operating circuit disclosed makes it possible to operate an electric discharge device, such as a fluorescent lamp, from a constant current-series circuit or source of supply without attempting to start the lamp with its cathodes in a cold or insufficiently heated condition or without resorting to the use of an isolating current transformer having a deficiency such as would lower the power factor of the primary circuit feeding the series circuit. This means that a fluorescent lamp or a plurality of such lamps may be efficiently and successfully operated from a constant current series circuit having such characteristics as will maintain the power factor of the primary supply circuit at a relatively high value and not require the use of a constant current transformer of excessively large rating.

Although but one embodiment of the invention has been herein shown and described, it is to be understood that other modifications thereof may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim as my invention:

1. A circuit for operating an electric discharge lamp of the type requiring preheating of the electrodes prior to application of operating voltage from a constant current series supply circuit through an isolating current transformer having insufficient output current to heat the electrodes to the required temperature during starting comprising, a pair of auto-transformers connected in series to the output terminals of the isolating current transformer, a time-delay starting switch having its contact element interposed in the circuit between the transformers and operable to open said circuit a predetermined time after it is energized, and means for connecting the electrodes of the lamp to the output terminals of said auto-transformers, whereby said transformers supply the additional electrode heating current during starting.

2. The combination with an electric discharge lamp connected to a constant current source through an isolating current transformer and having a time delay starting switch for interrupting a series heating circuit through its electrodes, of an auto-transformer connected in said series heating circuit in parallel with each electrode for boosting the heating current during the starting period above the amount supplied through the isolating current transformer, thereby to permit the use of an isolating current transformer having a high primary power factor so as to maintain the power factor of the constant current source at a high value.

3. The combination with an isolating current transformer having its primary winding connected in a constant current series supply circuit, of an electric discharge device having electrodes adapted to be preheated prior to the application of operating voltage to the device, a pair of auto-transformers having their current terminals connected across the electrodes, means connecting one of the primary terminals of each auto-transformer to the terminals of the secondary winding of the isolating current transformer, and means including a time-delay starting switch connecting the other terminals of the auto-transformers together thereby to provide for boosting the heating current of the electrodes during the starting period of the
2,313,961

4. The combination with a constant current series supply circuit, of an electric discharge lamp adapted to be energized from said circuit, said lamp having a pair of electrodes adapted to be preheated prior to the application of operating voltage to the lamp by a heating current exceeding the normal operating current of the lamp, an isolating current transformer having primary and secondary windings for connecting the lamp to the supply circuit, said transformer having a high primary power factor and an output characteristic such that its starting or short circuit current is nearly the same as its operating current, means connecting one primary terminal of each of the auto-transformer windings and one terminal of each of the electrodes to the secondary winding terminals of the isolating current transformer, means connecting the other primary terminals of the auto-transformer to the secondary terminals, said connecting means including a time-delay control switch having its contact element connected so as to interrupt the said connection between the primary terminals a predetermined time after energization, and means connecting the other terminals of the electrodes to an output terminal of the auto-transformers, whereby said auto-transformers function during the starting period of the lamp to increase the starting current flowing in the electrodes above the amount which could be supplied by the isolating current transformer alone.

5. In combination, a constant current source of alternating current supply, a current transformer having primary and secondary windings, said primary winding being connected to the current source, an electric discharge device having electrodes adapted to be preheated, one terminal of each of said electrodes being connected to the secondary winding of the current transformer, a pair of auto-transformers each having one terminal of its winding connected to the secondary winding with the said one terminals of the electrodes, means including a time-delay control switch connecting the other terminals of the windings of the auto-transformers together, and means connecting the other terminal of each of the electrodes to an output terminal of the auto-transformers, whereby the voltages of said auto-transformers supplements the current derived from the supply through the current transformer at starting.

6. A circuit for operating electric discharge lamps of the type having electron emitting electrodes which are preheated from a constant current series circuit comprising, a high power factor isolating current transformer having a primary winding adapted to be connected in the series circuit and a secondary winding, a pair of auto-transformers having one terminal of each of their windings connected to the secondary winding of the isolating current transformer, means including a time-delay control switch connecting the other terminals of the auto-transformer windings together so that said windings are connected in series across the secondary winding of the isolating current transformer, and means connecting the electrode terminals of the discharge device across the auto-transformers, whereby said electrodes are supplied with additional heating current by said auto-transformers during the starting period when the control switch is closed.

7. A circuit for operating an electric discharge lamp from a constant current source including a current transformer comprising, a pair of auto-transformers having their windings connected in series circuit relation for connection to the current transformer, a control switch having a contact element connected in said circuit between the transformers operable to open said circuit a predetermined time after energization thereof, and an electric discharge device having a pair of electrodes each of which are connected across the auto-transformers, whereby said auto-transformers function to supply heating current to the electrodes during the time the series circuit is closed by the control switch.

8. In combination, a constant current source of alternating current, an electric discharge device having electrodes and a pair of terminals at each end thereof, a current transformer having a primary winding connected to the current source and a secondary winding connected to the terminals of the discharge device, a pair of auto-transformers each having one terminal of their windings connected with said one terminal of the electrodes to the secondary winding of the current transformer, means connecting the other terminals of the electrodes to the auto-transformer windings, and means including a control switch connecting the other terminals of the auto-transformers together in series circuit relation, said control switch being operable to open the series circuit a predetermined time after energization, whereby during the time the control switch is closed the electrodes are supplied with an additional amount of heating current over that which could be supplied by the controlling current transformer alone.

9. In combination, a constant current series circuit, an isolating current transformer having primary and secondary windings, said primary winding being connected in the series circuit, a discharge device having electron emitting electrodes connected to the secondary winding of the isolating current transformer, a pair of auto-transformers having one terminal of each of their windings connected to the secondary winding of the isolating current transformer, and their other terminals connected together through a control switch, said electrodes being connected across the auto-transformers, whereby said auto-transformers function to supply additional heating current for heating the electrodes when said control switch is closed to start the discharge device.

10. A circuit for operating a discharge device having electron emitting electrodes from a constant current series circuit including an isolating current transformer comprising, circuit means including a pair of auto-transformers connected in series to the secondary winding of the isolating transformer, means connecting the electrodes of the discharge device across said auto-transformers, and a control switch connected in said series circuit between the auto-transformers for interrupting the series circuit a predetermined time after the application of voltage thereto, said auto-transformers functioning to supply additional heating current to the electrodes during the time said control switch is closed to complete the series circuit.

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