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FLUORESCENT LAMP OPERATING CIRCUIT

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FIG. 1.

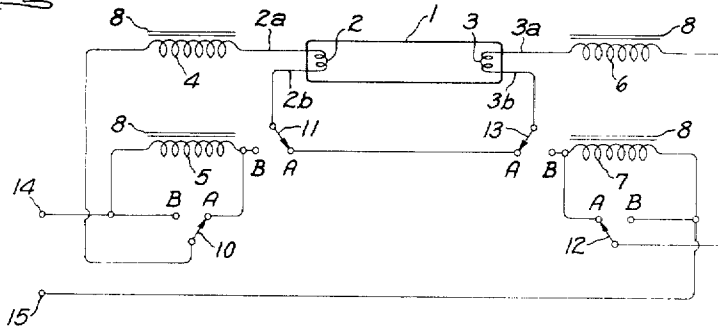
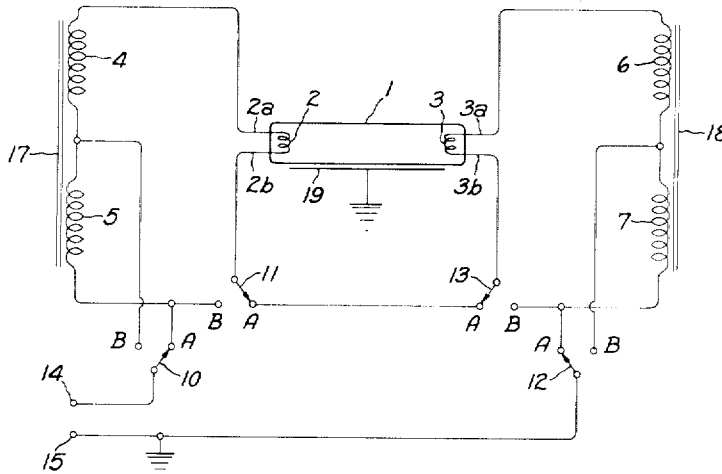


FIG. 2.



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FLUORESCENT LAMP OPERATING CIRCUIT
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This invention relates to a circuit for conveniently switching a fluorescent lamp from stand-by to high current operation.

In the usual fluorescent lamp utilizing filamentary type cathodes activated with alkaline earth oxides, the arc current proceeds primarily from a region of localized heating of the cathode, commonly known as the hot spot. In switch-start type circuits, one side of each cathode is connected to the supply voltage and a single hot spot develops on each cathode at the point of substantial electron emissivity closest to the line connection. In a rapid start type circuit wherein a low voltage heating winding is permanently connected across each cathode, a single hot spot occurs on the side which provides the greatest potential difference relative to the other cathode. As the arc current of the lamp is increased, the emitting hot spot increases in temperature to meet the demand for electrons. With either type of operation, the limitation on lamp operating current with a given cathode is the attainment by the hot spot of such a high temperature (incandescence) that cathode material is quickly vaporized, blackening the ends of the lamp.

The object of the invention is to provide a fluorescent lamp operating circuit which permits convenient switching of the lamp from stand-by to operation at much higher currents than would otherwise be possible, without excessive envelope darkening.

In a circuit embodying my invention, the current handling capacity of a fluorescent lamp having filamentary cathodes is increased by delivering the current to the cathodes through an external circuit comprising four chokes or reactors which divide the current equally between the inleads to each side of each cathode. This results in the formation of two hot spots on each cathode, one on each side. Each hot spot is substantially lower in temperature than would be a single one supporting the same total discharge current, so that envelope darkening is substantially reduced. In the stand-by condition, the four chokes are connected in series with the two filamentary cathodes across the supply voltage, thereby maintaining the cathodes hot and the lamp ready for immediate use.

Further objects and advantages of this invention will become apparent from the following description and the accompanying drawing. The features of novelty which characterize the invention will be pointed out with particularity in the appended claims.

In the drawing:

FIG. 1 is a schematic diagram of a fluorescent lamp operating circuit embodying the invention.

FIG. 2 is a schematic circuit diagram of a variant.

Referring to FIG. 1 of the drawing, the illustrated lamp comprises an elongated envelope 1 with cathodes 2, 3 sealed into opposite ends. Conventionally, the cathodes consist of a double or triple coiled tungsten filament coated with emissive material such as barium, strontium and calcium oxides and supported across a pair of inleads

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sealed through the end of the lamp. The envelope contains a filling of a starting gas such as argon at a few millimeters pressure plus some droplets of mercury which exert in operation a partial mercury vapor pressure of a few microns. The usual fluorescent coating on the internal surface of the envelope converts the ultraviolet radiation produced by the discharge into visible light.

An example of a lamp and specific application in which the invention finds particular usefulness is a reflectorized 18" T8 (1" diameter) lamp which is used in photo reproducing equipment. In the photo reproduction equipment in which this lamp has been used up to the present, it is operated at currents of 0.8 to 0.9 amperes. It is now desired to operate the lamp at currents of 1.5 amperes without excessive blackening. One could of course redesign the lamp and provide heavier cathodes capable of withstanding higher currents. However such a lamp would not operate efficiently in the lower current range because the cathodes would be at too low a temperature resulting in sputtering and envelope darkening. It is much preferable to retain the original lamp design as a universal design so that only one lamp type need be stocked for both the present equipment using 0.8 to 0.9 amperes, and the prospective equipment using 1.5 amperes. My invention permits this preferred course to be followed by providing a circuit which will allow the original lamp type to be operated at 1.5 amperes without excessive darkening.

In photo reproducing equipment, it is desirable to hold the lamps in stand-by status with the cathodes heated so that the lamps may be switched to the operating mode without delay. In the prior photo reproducing equipment, in stand-by status, heating voltage was applied to the cathodes from separate transformer windings. In the lamp example given earlier, cathode heating current was approximately 0.42 amperes and cathode heating was switched off when the lamp was switched on to operating status.

In the circuit embodying my invention, the lamp current is caused to divide approximately equally between the two terminals or inleads for each cathode. The division of current is achieved by what may be referred to as divided current ballasting. An impedance, suitably a reactor, is connected in series with each cathode inlead. As illustrated in FIG. 1, reactors 4 and 5 are provided for inleads 2a and 2b of cathode 2, and reactors 6 and 7 are provided for inleads 3a and 3b of cathode 3. Each reactor may consist of a winding on an individual magnetic core as conventionally indicated at 8.

In accordance with the invention, a switching arrangement is provided which connects the four reactors and the two cathodes in series together in order to have only limited heating current through the cathodes during stand-by. For the operating mode, the switching arrangement places the reactors in parallel at each end of the lamp, one to each side of each cathode. The switching is effected by means of a four pole double-throw switch, the four sections 10 to 13 being mechanically interlocked so that all contacts are transferred simultaneously. In the drawing, the switch is shown in position A corresponding to stand-by status. Starting at line terminal 14, the circuit proceeds through reactor 5, switch pole 10, reactor 4, cathode 2, switch pole 11, switch pole 13, cathode 3, reactor 6, switch pole 12, reactor 7 to terminal 15. When

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the switch is thrown to position B, circuit continuity starting at terminal 14 proceeds through both reactors 4 and 5 in parallel to cathode 2, the circuit through reactor 4 being completed through switch pole 10, and that through reactor 5 being completed through switch pole 11. Similarly, starting at terminal 15, continuity through reactors 6 and 7 is completed through switch poles 12 and 13 respectively. An important feature of the circuit is the fact that current flow through all reactors continues in the same direction when the transition from stand-by to operating is made. This results in more reliable starting of the lamp than would be the case if the switching arrangement compelled reversal of current flow through any of the chokes.

In an operating circuit according to FIG. 1 actually constructed and tested, the design is based on 1.5 ampere operation at a lamp operating voltage of 36 volts. For proper ballasting under these conditions from a 118 volt, 60 cycle supply, a ballasting impedance of 71 ohms is required. This was brought about by designing four separate 71 ohm reactive impedances connected as per the circuit of FIG. 1. Under stand-by conditions, the cathode heating current is .405 ampere and the voltage drop across each reactor is 27.5 volts. Under operating conditions, lamp current is 1.5 amperes and two hot spots can be distinguished at each cathode, one on each side. As a result, neither hot spot achieves an excessively high temperature so that the rapid envelope darkening which would otherwise occur is avoided.

FIG. 2 illustrates a variant of the invention which is particularly useful where a higher ratio of normal lamp operating current to stand-by cathode heating current is desired than in the circuit of FIG. 1. In other words, the circuit of FIG. 2 is suitable where it is desired to reduce the cathode heating current to a lower value than is achieved by the circuit of FIG. 1. This result is achieved by winding reactors 4 and 5 as one pair on a common magnetic core 17, and similarly, reactors 6 and 7 as another pair on a common core 18. The switching arrangement is similar though not identical to that of FIG. 1. In this configuration, the pair of windings 4 and 5 have self-inductance (leakage reactance) as before, and in addition mutual inductance. In the stand-by condition, the cathode heating current is effectively limited by the self-inductance of windings 4 and 5 in series, plus their mutual inductance. The same applies to reactors 6 and 7. However when the circuit is switched to the operating condition, the mutual inductance of reactors 4 and 5 in the first pair, and 6 and 7 in the second pair is self-cancelling. Only the self-inductance of each winding is effective to limit the lamp operating current. Thus by suitably proportioning the self-inductance to the mutual inductance in windings 4 and 5, and 6 and 7, any desired ratio of stand-by heating current to lamp operating current may be achieved.

It will be observed that if one side of the line supply (terminal 15 in FIG. 2) is assumed to be grounded, then under normal operating conditions the lamp is so to speak floating at a potential above ground. Upon transition from stand-by to operating, there is reversal of current flow in chokes 5 and 7; this may inhibit starting. Under these conditions, starting reliability may be improved by the use of a grounding strip placed close to the lamp and returned to the low or ground side of the line, as indicated at 19 in FIG. 2.

The particular embodiments of the invention which have been illustrated and described in detail are intended as exemplary and not in order to limit the invention thereto. Various modifications will readily occur to those skilled in the art and it is intended by the appended claims to cover any such falling within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A circuit for an electric discharge lamp of the kind

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having a filamentary electrode at each end with a pair of inleads leading to opposite sides of each electrode comprising:

two pairs of reactances;

and switching means having two positions, one for standby and the other for normal operation of said lamp;

said switching means in said standby position connecting one pair of reactances in series between an alternating current supply terminal and one side of one electrode, and the other pair of reactances in series between another alternating current supply terminal and one side of the other electrode, and further connecting the other sides of the two electrodes together;

said switching means in said operating position connecting the reactances of one pair from one alternating current supply terminal to opposite sides of one electrode, and the reactances of the other pair from the other alternating current supply terminal to opposite sides of the other electrode.

2. A circuit for an electric discharge lamp of the kind having a filamentary electrode at each end with a pair of inleads to opposite sides of each electrode, comprising: four reactances;

a four-pole, two-position switch, one position being for stand-by and the other for operating;

said reactances and switch poles being interconnected between alternating current supply terminals and the lamp electrodes such that in stand-by position, beginning at one line terminal, the circuit proceeds through the second reactance, the first switch pole, the first reactance, through one electrode of the lamp, the second switch pole, the third switch pole, through the other electrode of the lamp, the third reactance, the fourth switch pole, and the fourth reactance, to the other line terminal;

and in the operating position, beginning at said one line terminal, the circuit proceeds through the first switch pole and the first reactance to one side of said one electrode, and in parallel therewith through the second reactance and the second switch pole to the other side of said one electrode;

and beginning at the other line terminal, the circuit proceeds through the fourth switch pole and the third reactance to one side of said other electrode, and in parallel therewith through the fourth reactance and the third switch pole to the other side of said other electrode.

3. A circuit as defined in claim 2 wherein said four reactances are inductive and all substantially equal in electrical characteristics.

4. A circuit for an electric discharge lamp of the kind having a filamentary electrode at each end with a pair of inleads to opposite sides of each electrode, comprising:

two pairs of inductive reactances of substantially similar electrical characteristics, the reactances in each pair having both self and mutual inductance;

a four-pole, two-position switch, one position being for stand-by and the other for operating;

said reactances and switch poles being interconnected between alternating current supply terminals and the lamp electrodes such that in stand-by position, beginning at one line terminal, the circuit proceeds through the first switch pole, the second reactance of one pair, the first reactance of said one pair, through one electrode of the lamp, the second switch pole, the third switch pole, through the other electrode of the lamp, the first reactance of said other pair, the second reactance of said other pair and the fourth switch pole, to the other line terminal;

and in the operating position, beginning at said one line terminal, the circuit proceeds through the first switch pole, and the first reactance of said one pair to one side of said one electrode, and in parallel

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therewith through the first switch pole, the second reactance of said one pair and the second switch pole to the other side of said one electrode; and beginning at the other line terminal through the fourth switch pole, and the first reactance of said other pair to one side of said other electrode, and in parallel therewith through the fourth switch pole, the second reactance of said other pair, and the third switch pole to the other side of said other electrode.

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References Cited by the Examiner

UNITED STATES PATENTS

2,806,981 9/58 Asano ----- 315—100

FOREIGN PATENTS

650,992 3/51 Great Britain.

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