June 11, 1957 E. LEMMERS 2,795,692

FLUORESCENT LAMP FIXTURE AND CIRCUIT

Filed April 1, 1953

Fig. 1

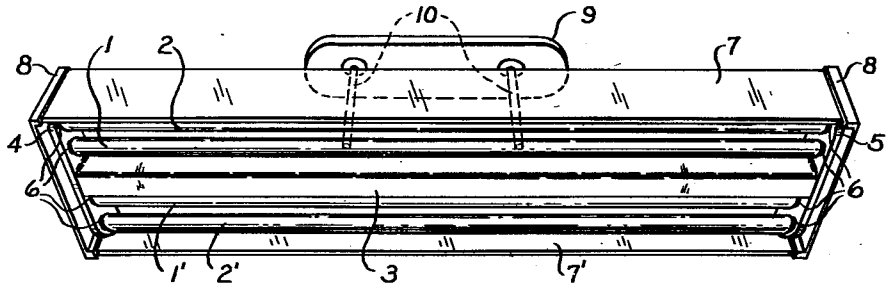


Fig. 2

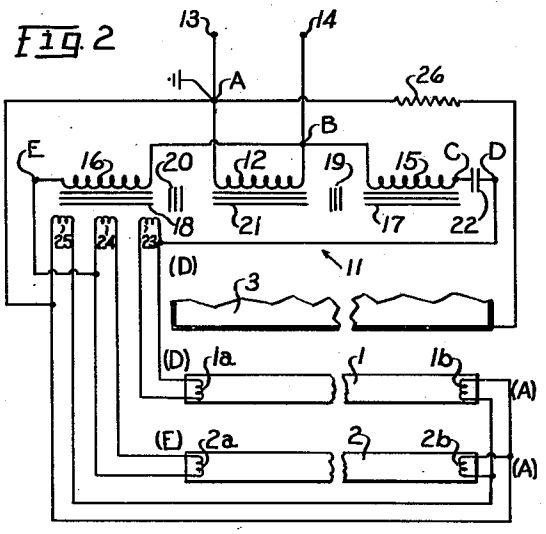
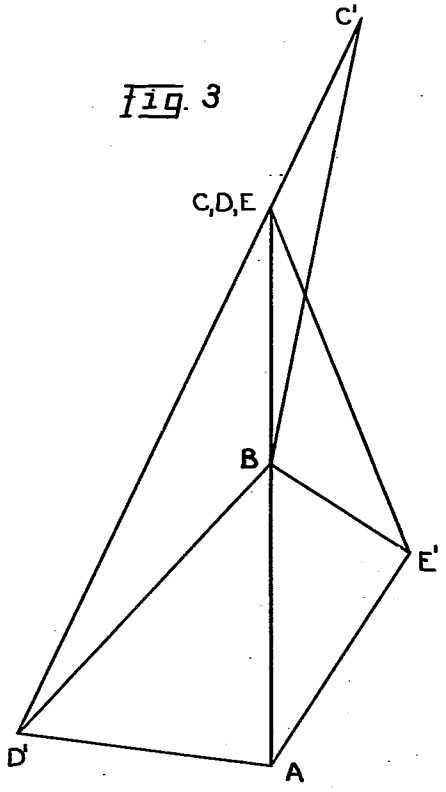


Fig. 3



Inventor:
Eugene Lemmers,
by Vernet C. Kauffman
His Attorney

United States Patent Office 2,795,692 Patented June 11, 1957

2,795,692

FLUORESCENT LAMP FIXTURE AND CIRCUIT

Eugene Lemmers, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York

Application April 1, 1953, Serial No. 346,230

1 Claim. (Cl. 240—51.11)

This invention relates to an operating circuit and fixture arrangement for elongated low pressure discharge devices such as fluorescent lamps. The arrangement is intended particularly for the new type of fluorescent lamp now generally known as "rapid-start," and described and claimed in my copending application Serial No. 250,106, filed October 6, 1951, entitled "Electric Discharge Device," and assigned to the same assignee as the present invention.

The rapid-start lamp is characterized by having filamentary activated electrodes of small size and some means extending the length of the lamp which facilitates the establishment of a potential gradient for starting the lamp at a low voltage. The means which have been adopted for this purpose in the commercial rapid-start lamp is a water-repellent coating which permits the lamp to be started reliably under substantially any atmospheric conditions. An operating circuit is provided which includes a conductive element located in close proximity to the lamp and extending substantially the length thereof, and having thereon a potential differing substantially from that applied to at least one of the electrodes of the lamp. In the case of the 40-watt rapid-start fluorescent lamp of 48-inch nominal length which is very widely used, the requirement of a conductive element extending the length of the lamp is generally economically fulfilled by the metal channel or housing of the fixture. The fixture is grounded whereby it is placed at a definite potential difference with respect to the "high" electrode of the lamp, that is, the electrode connected to the high voltage side of the operating circuit.

There are some types of multiple fluorescent lamp fixtures however which do not lend themselves readily to locating the metal channel of the fixture or any elongated conductive member thereof in close proximity to at least some of the lamps included therein. For instance, one type of fixture in widespread use and which is designed to throw light both upwardly towards the ceiling and downwardly toward the floor but with a much lesser intensity at angles approaching the horizontal, is particularly subject to this difficulty. This fixture generally comprises a relatively narrow central metal channel supporting at its ends a pair of brackets to which are affixed the lampholders or sockets. In the case of a four-lamp fixture, two lamps are supported on each side of the channel, the inner lamps of each pair being located close to the channel and the outer lamps being located laterally beyond the inner lamps. The desired light distribution from the fixture is then achieved by locating a vertical translucent plate of glass or plastic laterally beyond each outer lamp and extending the length of the fixture. With this arrangement, there is no difficulty as regards providing a conductive element to serve as a capacitive starting aid for the inner or proximate lamps, the metal channel of the fixture being adequate for this purpose. However, there is no corresponding conductive element for the outer or remote lamps of the fixture. The difficulty is particularly noticeable where it is desired to operate the lamps on

lead-lag types of ballasts. The object of the invention is to provide a new and improved circuit and fixture arrangement particularly suitable for rapid-start fluorescent lamps.

A more specific object of the invention is to provide, in a fixture for a plurality of lamps each of which would normally require the presence of a conductive element in proximity thereto to serve as a starting aid, and wherein it is not feasible to provide such an element for some of the lamps, an improved circuit and lamp combination assuring reliable starting of all the lamps.

My present invention is based upon an observation made during my studies of the rapid-start lamps described in my earlier mentioned copending application, to the effect that in multiple lamp operation when lamps are in proximity to each other an operating lamp may operate as a starting aid for an adjacent lamp that is not yet started. Generally, this effect is mild and of no particular consequence. However, I have discovered that this effect can be greatly accentuated in a lead-lag type of ballast and used to considerable advantage in fixtures where some lamps are far removed from the metal channels of the fixture with other lamps intervening between such remote lamps and the channel. In such case, I place the lag lamps in the remote or outermost positions relative to the channels and the lead lamps in the proximate or innermost position. Under these conditions, reliable starting of the lead lamps is readily obtained by reason of their proximity to the channel of the fixture which serves as the capacitive starting aid. The lead lamps having started, the circuit voltages and waveforms are shifted with respect to the open circuit conditions. As a result, the lead lamp shows a potential difference with respect to the non-started lag lamp which is greater, when measured on a peak voltage basis, than the potential difference which exists between the same lag lamp and the metal fixture, likewise measured on a peak voltage basis. Thus each operating lead lamp becomes a very effective starting aid to the lag lamp adjacent to it, which lag lamp is thereby started without difficulty.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description of a preferred embodiment thereof taken in conjunction with the accompanying drawing. The features of the invention believed to be novel will be more fully pointed out in the appended claim.

In the drawings:

Fig. 1 is a pictorial view, somewhat diagrammatic in form, illustrating a fixture to which the invention is applicable.

Fig. 2 is a schematic diagram of a circuit arrangement in accordance with the invention, and applicable to the fixture arrangement of Fig. 1.

Fig. 3 is a vector diagram of the voltage relationships in the circuit of Fig. 2.

Referring to Fig. 1, there is shown a fixture designed to hold four fluorescent lamps 1, 2 and 1', 2' in a parallel arrangement in a substantially horizontal plane. The fixture proper comprises a central metal channel 3 in the form of a hollow box-like girder of sufficient rigidity to support the whole assembly. To the ends of the channel 3 are fastened transverse plates 4 and 5, and on the inner faces of the plates are fastened the sockets or lampholders 6 of the usual two terminal type, well known in the art, for receiving the bi-pin bases of fluorescent lamps. The lamps are shielded from direct viewing at angles close to the horizontal by translucent side panels 7, 7' which are supported laterally beyond the outer lamp 2, 2' by brackets 8 at each end supported in turn from the ends of the channel 3. The fixture may be installed in a room

at a height somewhat below the ceiling level and for this purpose there is provided a plate 9 which is intended to be secured to the ceiling and having pendant rods 10 which are fastened into the channel 3.

The lamps are operated from lead-lag ballast; two such ballasts are provided, one for lamps 1, 2 and another for lamps 1', 2', both ballasts being normally housed within the channel 3. It will be appreciated that the operation of some lamps on leading current and other lamps on lagging current within a single fixture is advantageous from the point of view of reduction of flicker and stroboscopic effects.

Referring to Fig. 2, the circuit along with the ballast for operating lamps 1, 2 is schematically illustrated; that for operating lamps 1', 2' is identical and has not been illustrated. The lamps are of the rapid-start type each comprising a pair of filamentary activated electrodes 1*a* and 1*b* of a small size and which are heated to electron emission at voltages below the ionization voltage of the gas or vapor within the lamp. The electrodes are of the coiled coil type provided with an overwind holding a relatively large quantity of activated material comprising alkaline earth oxides. Each electrode may comprise a few major turns with relatively long extensions or legs of minor coiling, as described and claimed in my earlier mentioned copending application. The filling within the envelope comprises a starting gas such as argon at a pressure of a few millimeters of mercury and a small quantity of mercury. The envelopes of the lamps are coated exteriorly with a water-repellent coating which assures that, when the lamps are placed close to a conducting element, they will start reliably under any atmospheric conditions at relatively low values of voltage applied between the electrodes.

The ballast unit 11 provided for operating the lamps 1, 2 comprises a primary winding 12 which is supplied with 118 volts 60 cycle A. C. voltage from the usual commercial supply at input terminals 13, 14. Terminal 13 is connected to the low or grounded side of the line as indicated, whereas terminal 14 is connected to the high side of the line. The secondary windings 15 and 16 are of the high leakage reactance type, being wound on magnetic cores indicated schematically at 17 and 18 with magnetic shunt paths indicated at 19 and 20 relative to the primary winding core 21.

In accordance with the invention, lamp 1 which is proximate to the starting aid provided by the metal channel 3, is operated on leading current from the secondary winding 15, the circuit being completed through a series capacitor 22 connected between the high voltage end of winding 15 and electrode 1*a*. Lamp 2, which is remote from the channel, is operated on lagging current by means of a direct connection from the high voltage end of winding 16 to electrode 2*a*. The return circuit for both lamps through electrodes 1*b* and 2*b* is to the low side of primary winding 12, that is to the grounded side connected to input terminal 13.

For the operation of rapid-start fluorescent lamps, the electrodes are supplied with a preheating current which is supplied by low voltage secondary windings 23 for electrode 1*a*, 24 for electrode 2*a*, and 25 for electrodes 1*b* and 2*b* in parallel. The metal channel 3 is grounded at least indirectly with respect to the lamps, either by a connection to a suitable earth point, or by a connection to the low side of the line corresponding to terminal 13. Where the channel 3 is connected to the low side of the line, the connection is preferably made through a resistor 26 chosen to limit the current to a safe value in order to prevent shock hazard should the input terminals 13, 14 be accidently reversed when connected to the commercial supply.

With the application of the 118 volts to the primary 12 across input terminals 13, 14, the secondary windings 15, 16 are proportioned to generate approximately 100 volts on open circuit. Referring to the vector diagram in Fig. 3, these voltages are represented by AB for the primary voltage, BC for the voltage across secondary 15, and BE for the voltage across secondary 16. Before starting, since there is no current flowing through the lamp, the voltage drop across capacitor 22 is zero and accordingly point D coincides with point C and also of course with point E. Since the metal channel 3 is grounded, there is a difference of potential between it and electrode 1*a* which is equal to AD, approximately 218 volts.

Due to the proximity of the grounded channel 3, lamp 1 starts without difficulty. Having started, it draws a current which leads the voltage applied to the primary and produces across the lamp a voltage drop D'A, across the internal leakage reactance and resistance of secondary winding 15, a voltage drop BC', and across the capacitive reactance of capacitor 22, a voltage drop C'D'. The voltage at electrode 2*a* of lamp 2 is as yet the open circuit voltage of secondary winding 16 in series with the primary winding 12 and indicated by the vector AE. The root-mean-square (R. M. S.) value of voltage ED', which is the potential difference between electrode 2*a* of the lag lamp which has not yet started and electrode 1*a* of the lead lamp which is in operation, may be approximately 230 volts. Thus it will be seen that the started lead lamp 1 is now in a position to accentuate the potential gradient in the vicinity of electrode 2*a* of non-started lag lamp 2 in somewhat the same manner as metal channel 3 had previously accentuated the potential gradient in the vicinity of electrode 1*a* of lamp 1 to enable it to start.

In fact however the arrangement just described makes for an even greater accentuation of the potential gradient about electrode 2*a* of the lag lamp 2 than is indicated by mere reference to the R. M. S. values of the voltages existing in the circuit. This is due to the fact the current flowing through lamp 1 is regulated in the main by a capacitive reactance. Capacitor 22 is preferably chosen such that the leading current through lamp 1 leads the voltage by a greater angle than the lag current through lamp 2 lags the line voltage. The leading current is of peaked waveform and produces a peaked voltage drop across the circuit elements. Thus, whereas the R. M. S. value of voltage ED' is 230 volts, the peak value of this voltage is 420 volts. The peak value if the waveform were sinusoidal would be only 325 volts. Thus the fact that the waveform is peaked makes it more effective in producing ionization in the vicinity of electrode 2*a* of lamp 2. As a result, lag lamp 2 is caused to start and thereupon draws a lagging current. Vector BE' indicates the voltage drop across the combined resistance and leakage reactance of secondary winding 16, and vector E'A represents the voltage drop across lamp 2.

It will be appreciated that if the lag lamp 2 with its connections were placed in the position proximate to the metal channel 3 and the lead lamp 1 were placed in the remote position, that is if the lamps 1 and 2 were interchanged in position but with each lamp retaining its circuit connections, the lag lamp would start first due to its proximity to the metal fixture 3. However, the lag lamp having started, the potential difference which would be effective between the running lamp and the one not yet started and which can be represented by the vector DE', has an R. M. S. value of 146 volts and a peak value of only 230 volts. The peak value is 190 volts less than that obtained with the arrangement in accordance with my invention.

It will be observed in Fig. 2 that the auxiliary heater windings 23, 24 and 25 are coupled to the lag extension portion 18 of the magnetic core of the ballast 11. After lag lamp 2 has started, the lagging current drawn by this lamp causes a change of magnetic flux distribution in the core which reduces somewhat, for instance to the extent of 20%, the voltage generated in the auxiliary

windings 23 to 25. It will be appreciated that this feature is desirable because it assists in reducing the wattage loss in the electrodes during normal operation, even though no provision is required in the case of rapid-start lamps for removing the electrode heating current during operation. With the present arrangement in accordance with the invention, it will be observed that the heating current supplied to the electrodes of the lamps by the auxiliary windings 23 to 25 is not reduced in any way until the lag lamp has started, and of course the lag lamp only starts after the lead lamp has already started. Thus the reduction does not occur until both lamps are in operation, whereas if the lag lamp were placed next to the fixture, the undesirable result would be had that the electrode heating current would be reduced before the lead lamp had started. Such a condition of course would be undesirable since it would make starting of the remaining lamp even harder, and would reduce the life of that lamp if it did succeed in starting at all.

While a certain specific embodiment of the invention has been shown and described it will be understood that the same has been done for illustrative purposes only. In general, the invention is applicable to any type of fixture wherein a plurality of lamps are received, some in proximity to a conductive member of the fixture and some remote from such a member. In such a fixture, whenever it is desired to operate rapid-start lamps requiring the presence of a capacitive starting member in close proximity to the lamps, the principles underlying my invention, namely the placing of the lead lamp next to the fixture in the proximate position and of the lag lamp in the remote position, may be made use of to advantage. The appended claim is therefore intended to cover any such modification coming 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:

In a four-lamp fixture and circuit arrangement for

elongated discharge lamps, the combination of an elongated central metal channel enclosing voltage transforming means, and provided at each end with brackets supporting spaced pairs of sockets on either side of the channel, four lamps of the type having low voltage preheatable electrodes at either end and requiring at starting the aid of a conducting element in close proximity to and extending the length of the lamp, a pair of lamps being received in said sockets on either side of the channel and substantially parallel therewith, each pair consisting of a proximate lamp located next to the channel and a remote lamp having the proximate lamp intervening between it and the channel, said voltage transforming means comprising a primary winding and, for each lamp, a high reactance secondary winding having one end connected to one side of said primary winding, said secondary windings generating substantially equal open circuit voltages, connections from the other side of said primary winding to one electrode in each lamp and, at least indirectly, to said channel, means including a series capacitor connecting the other end of two of said secondary windings to the other electrode of the proximate lamps, a connection from the other end of the other two secondary windings to the other electrode of the remote lamps, and heating windings in said transforming means connected across the electrodes of the lamps for supplying heating current thereto, whereby the lamps proximate to the fixture are energized by leading current and serve as starting aids for the remote lamps energized by lagging current.

References Cited in the file of this patent

UNITED STATES PATENTS

2,291,493	Naysmith	July 28, 1942
2,336,414	Mitchell	Dec. 7, 1943
2,505,288	Hall	Apr. 25, 1950
2,644,107	Keiffer et al.	June 30, 1953