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STREET LIGHTING APPARATUS

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Fig. 1.

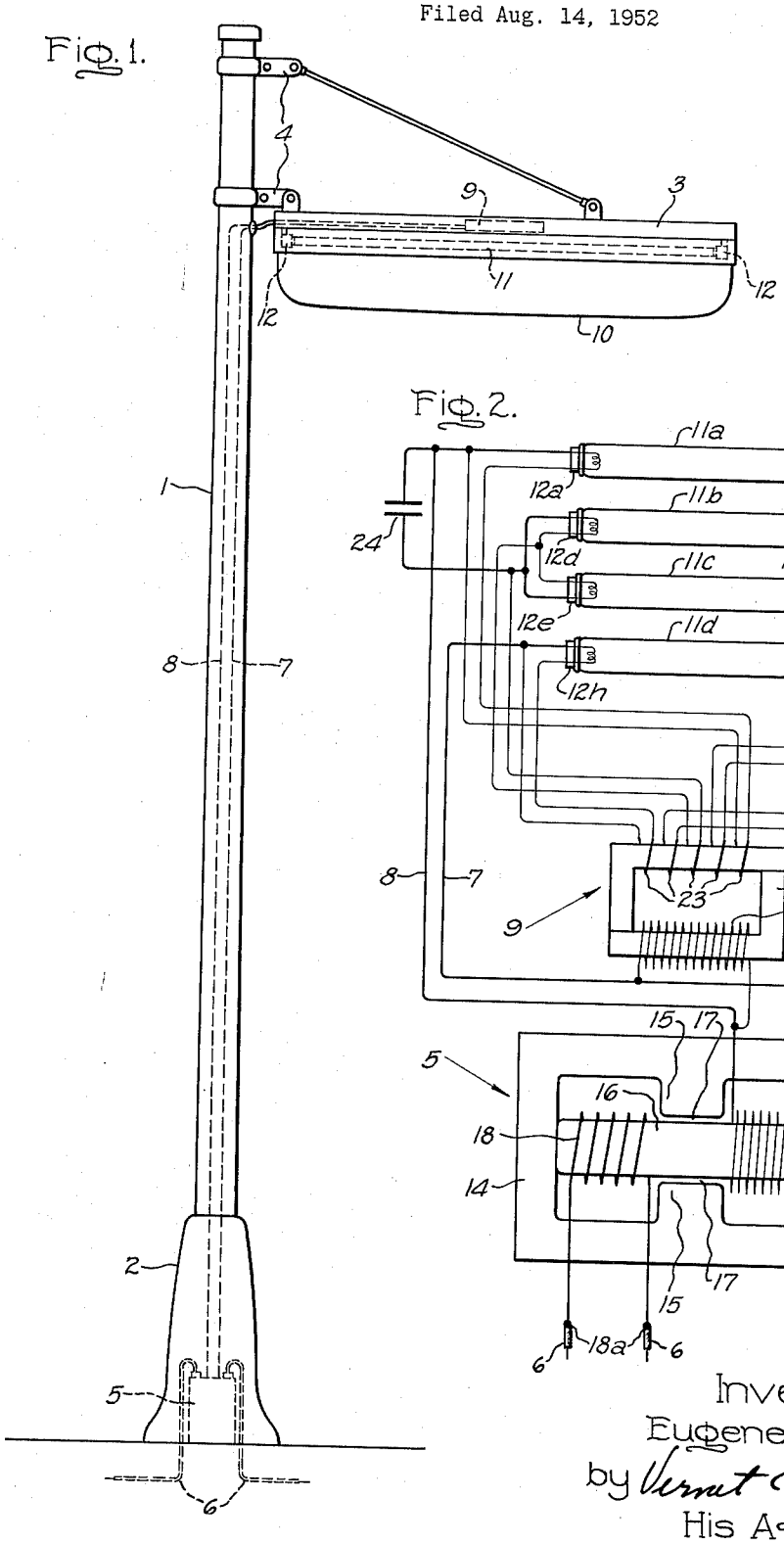


Fig. 2.

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STREET LIGHTING APPARATUS

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3 Claims. (Cl. 240—25)

This invention relates to fluorescent street lighting, and particularly to a fixture arrangement or apparatus utilizing elongated fluorescent lamps for street lighting purposes.

The invention is primarily intended for series street lighting installation and permits retention of the generally used and approved standards and practices relative to such installations. In the relatively common incandescent lamp series street lighting system, the lamps of a number of street lighting fixtures are connected in a continuous series loop in which the current is maintained constant, generally at 6.6 amperes.

In adapting a series street lighting system to fluorescent lamp operation, the problems encountered are relatively simple of solution so long as the lamps are of a type which does not require preheating of the electrodes, for instance, the instant-start type. In such case, it is merely necessary to provide, at a place relatively close to the luminaire, a suitable constant-current to high-voltage high-reactance transformer and to run a pair of conductors from its secondary terminals to the luminaire wherein a number of lamps are connected in series across them. It will be appreciated however that instant-start systems are relatively expensive, and less efficient from the point of view of ballast losses. However, when it is desired to use fluorescent lamps having electrodes of the preheatable two-terminal type, the problem becomes considerably more complicated by reason of the fact that it is neecssary to provide a separate pair of conductors to carry heating current to each electrode or group of electrodes operating at a different potential in the series. It will readily be appreciated that it is impractical to mount the large and heavy transformer in question here within the luminaire which is supported on a relatively light upright standard. Moreover it is inordinately expensive and cumbersome, when the transformer is located at the base of the upright or within the standard supporting it, to run the required number of high voltage conductors for preheating the lamp electrodes, from the transformer to the luminaire. It will be appreciated that even though the preheating voltage itself is low, the conductors carrying it must have high voltage insulation due to the high voltage from the electrodes to ground.

Accordingly the object of the invention is to provide a new and improved street lighting fixture arrangement for operating a plurality of fluorescent lamps of the two-terminal preheatable type, and which avoids the above-described undesirable features.

A more specific object of the invention is to provide a series street lighting fixture arrangement for fluorescent lamps of the two-terminal preheatable type wherein the relatively heavy main transformer of the constant-current to high-voltage type is located without the luminaire, and wherein a single pair of conductors, running from the main transformer to the luminaire, suffices for the arrangement.

In accordance with the invention, the above objects are

effected by means of a fixture arrangement including a main transformer of relatively large volt-ampere capacity which is mounted without the luminaire, preferably at the base of the standard supporting it, or within the pedestal of the standard. This main transformer supplies an open circuit voltage which is greater than its output voltage under normal operating current load. Within the luminaire, a number of lamps of the two-terminal preheatable electrode type, for instance four, are connected in a series circuit and a single pair of conductors lead from the secondary output terminals of the main transformer to the lamps within the luminaire. Also within the luminaire, there is provided a small auxiliary transformer having a volt-ampere capacity which is but a few percent of that of the main transformer. The auxiliary transformer has a primary winding which is connected across the pair of conductors previously mentioned, and a number of separate low voltage secondary windings which are connected to the electrodes of the lamps through two-terminal lampholders which may be of the usual bi-pin type.

The improved features and advantages of the invention will be better understood from the following description taken in conjunction with the accompanying drawing. The features of the invention believed to be patentable will be more particularly pointed out in the appended claims.

In the drawing:

Fig. 1 shows the general appearance and location of parts in a street lighting fixture arrangement embodying the invention.

Fig. 2 illustrates diagrammatically the circuit elements and connections.

Referring to the drawing and more particularly to Fig. 1, there is shown a street lighting fixture comprising an upright standard **1** which is supported on a heavy pedestal **2**, and which in turn supports at its upper end an elongated luminaire **3** by means of hanger straps or brackets **4**. The luminaire may be constructed of relatively light sheet metal, for instance aluminum, and may, if desired, be inclined at an angle to the horizontal in order to achieve a suitable light distribution onto the street or roadway.

At some point without the luminaire, for instance within the pedestal **2**, is located the main transformer **5** which converts the constant current flowing through conductors **6** into a suitably high secondary voltage which is conducted to the luminaire through the single pair of conductors **7**, **8**.

Within the luminaire, there is located an auxiliary filament heating transformer **9** whereof the primary is connected directly across the conductors **7**, **8** to receive the high voltage output of the secondary of transformer **5**. The fluorescent lamps **11**, which are of the two-terminal pre-heatable electrode type, and, if desired, four in number, are supported within the luminaire by means of two-terminal sockets **12** at either end, and are connected in a series or continuous loop across the conductors **7**, **8**. The sockets may be any one of the bi-pin type fluorescent lampholders commonly used in the art. The lamps are enclosed within the luminaire by a dished clear plastic lens or cover **10**.

Referring now to Fig. 2, the main transformer **5** comprises a magnetic core assembly including a laminated frame or yoke **14** having reentrant portions **15** which, in cooperation with the central winding leg **16**, define a pair of non-magnetic gaps **17**. The reentrant portions and the cooperating gaps form high reluctance magnetic shunt paths between the primary winding **18** wound on the left hand portion of the central leg as illustrated in the drawing, and the secondary winding **19** on the right hand portion of the same leg.

The illustrated embodiment of the invention is designed

to operate four fluorescent lamps **11***a* to **11***d* in series. These lamps may be elongated tubes approximately 6 feet in length corresponding in size and general appearance to the fluorescent lamp known commercially as 72–T-12. However, these lamps are of the two-terminal preheatable electrode type and preferably of the type now becoming generally known as "rapid-start" fluorescent lamps. Such lamps are described and claimed in my copending application Serial No. 250,106, filed October 6, 1951, and assigned to the same assignee as the present invention. They are characterized by having filamentary activated electrodes of a small size and which are heated to electron emission at voltages below the ionization voltage of the gas or vapor in the lamp, and by having some means extending the length of the lamp which facilitates establishment of a potential gradient for starting the lamp, for instance a water-repellent coating. The present lamps **11***a* to **11***d* are operated at a current of approximately 1 ampere, and the average voltage across each lamp during normal operation is approximately 110 volts, the wattage under these conditions being approximately 100 watts per lamp.

For an installation operating four lamps in series as described above, transformer **5** is proportioned such that when the standard series street lighting current of 6.6 amperes is flowing through the primary winding **18**, the open circuit voltage across the secondary winding **19** is approximately 900 volts R. M. S. The gaps **17**, in cooperation with the magnetic circuit, are proportioned so that the secondary voltage drops to approximately 440 volts when a current of approximately 1 ampere is drawn to operate the four lamps. In general, the open circuit voltage may be 1.5 to 2.5 times greater than the operating voltage under normal current load, such a ratio being in any case a requisite for good regulation independently of starting requirements.

It will be appreciated that the main transformer **5** by reason of its relatively large volt-ampere capacity, and also by reason of the fact that it must have high voltage insulation from ground, is of a relatively heavy construction so that it is not feasible to locate it within the relatively light luminaire **3**. Preferably it is located either within the pedestal **2** as illustrated, or within a suitable enclosure buried underground, and the secondary voltage is conducted to the luminaire by the single pair of conductors **7, 8**.

Within the fixture, conductors **7** and **8** are connected to the end lampholders **12***a* and **12***h*, the intermediate lampholders **12***b* to **12***g* being connected together in pairs such as **12***b*—**12***c* so as to include all the lamps in a continuous loop or series circuit. In addition, there is located within the luminaire a relatively small auxiliary transformer **9** comprising a magnetic core **21** forming a closed magnetic circuit, and supporting a high voltage primary winding **22** which is connected directly across the conductors **7, 8** to receive the full secondary voltage. The transformer comprises a plurality of secondary windings **23** which are connected across the lampholder terminals, these windings being one more in number than the number of lamps included in the system, namely five in the illustrated embodiment. The reason for this, as will appear upon inspection, is that the electrodes at the common point between contiguous lamps in the series may be connected in parallel so that only one winding is required for each pair of electrodes except the outermost electrodes in the series, each of which requires its own separate winding.

The wattage required for preheating the electrodes is relatively small with lamps of the "rapid-start" type, a total of three watts per electrode being generally sufficient for the particular size of lamp described. Moreover, since the auxiliary transformer **9** is connected across the secondary energizing circuit for the lamps, whereof the open circuit voltage drops by 30 to 50% as soon as normal operation has begun, the preheating wattage supplied to the electrodes is reduced accordingly and the auxiliary transformer need be designed, as regards its volt-ampere capacity, for the normal operating condition only. Thus a total capacity of 20 to 25 volt-amperes is adequate for auxiliary transformer **9**, and it will readily be appreciated that a transformer of this capacity need weigh but a few pounds and can, without difficulty, be mounted in the luminaire **3**. By contrast, main transformer **5** must have a capacity of 400 to 500 volt-amperes, and its weight and bulkiness are in proportion to its capacity.

In order to facilitate the starting of the lamps, a starting capacitor **24** of relatively small value is connected within the luminaire across a pair of electrically spaced lampholders, for instance **12***a* and **12***d*, so as to bridge two contiguous lamps of the series, the lamps being **11***a* and **11***b* in the drawing as illustrated. Capacitor **24** may have a value between .05 and .1 microfarad, which value is so small that no appreciable unbalance of the lamps occurs during normal operation.

The operation of the arrangement, upon energization of the primary terminals **18***a* of the main transformer **5** is as follows. The secondary winding **19** provides a voltage of approximately 900 volts to the apparatus included within the luminaire. The auxiliary transformer **9** is energized and the filaments of the lamps **11***a* to **11***d* are rapidly heated to electron emission. Previous to the establishment of the arc discharges in the lamps, the capacitance of capacitor **24**, though small, is nevertheless much greater than the capacitance of the lamps **11***c* and **11***d* in series. Thus practically the full secondary voltage of 900 volts is supplied across lamps **11***c* and **11***d*. Thereupon a glow starts within these two lamps and the voltage drop across them is immediately very much reduced, so that the secondary voltage then becomes effective to initiate a starting glow in lamps **11***a* and **11***b*. The glows being initiated, the discharges rapidly build up within all the lamps and the transition into arcs occurs, the whole process requiring but a few seconds at most. The heating current to the electrodes continues during normal operation, at a somewhat reduced figure as previously pointed out, and the total wattage loss resulting therefrom is negligible and is disregarded for all practical purposes.

The invention thus provides a street lighting apparatus which allows the use of fluorescent lamps of the two-terminal preheatable electrode type without entailing the undesirable features previously had with such systems. The advantages offered by the invention from the point of view of permissible lightness of the luminaire and fixture resulting from the circuit arrangement make it a practical and economical system for street lighting.

While a certain specific embodiment of the invention has been shown and described, it will be obvious that various changes and modifications may be made therefrom without departing from the invention. Thus the number of lamps and their voltage ratings, and also the matter of the current supply rating from which the system is to be operated, are variables to which the present invention may readily be accommodated by suitable modifications within the skill of the designer. The appended claims are therefore intended to cover any changes and modifications 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:

1. Street lighting apparatus comprising a standard and a luminaire supported therefrom, a relatively large volt-ampere capacity transformer located without said luminaire and comprising a magnetic core, a primary winding, and a secondary winding, said transformer being proportioned to produce an open circuit voltage greater than its operating voltage at normal current load, socket means in said luminaire for receiving a plurality of elongated electric discharge devices of the type having two-

terminal preheatable electrodes and means connecting said socket means for including said lamps in a series operating circuit, a single pair of conductors joining the ends of said secondary winding to the outer ones of said socket means in said series circuit, and a filament heating transformer mounted in said luminaire and comprising a primary winding connected across said pair of conductors and a plurality of low voltage secondary windings having their ends connected across said socket means for supplying electrode preheating current to the discharge devices.

2. Street lighting apparatus comprising a standard and a luminaire supported therefrom, a relatively large volt-ampere capacity transformer located without said luminaire and comprising a magnetic core, a primary winding having terminals for receiving a primary current supply and a secondary winding proportioned to produce an open circuit voltage greater than its operating voltage at normal current load, a plurality of double contact lampholders mounted in said luminaire for receiving elongated electric discharge devices of the type having two-terminal preheatable electrodes, conductors joining said lampholders for operating said lamps in a continuous series circuit, a single pair of conductors joining the outermost lampholders of the series to the ends of said secondary winding, and a filament heating transformer of relatively small volt-ampere capacity mounted in said luminaire and comprising a primary winding connected across said pair of conductors and a plurality of low voltage secondary windings having their ends connected across the terminals of said lampholders.

3. A street lighting fixture arrangement comprising an upright standard and a luminaire supported thereon, a

main transformer of relatively large volt-ampere capacity located without said luminaire and comprising a primary winding having terminals for receiving a constant current supply, a secondary winding, and a magnetic core linking said windings and including a high reluctance magnetic shunt therebetween, said transformer being proportioned to produce an open circuit voltage of 1.5 to 2.5 times its operating voltage at normal current load, a plurality of double contact lampholders mounted in said luminaire for receiving elongated electric discharge devices of the type having two-terminal preheatable electrodes, conductors joining said lampholders in sequence for operating said lamps in a continuous series circuit, a single pair of conductors joining the outermost lampholders in the series to the ends of said secondary winding, a filament heating transformer of relatively small volt-ampere capacity mounted in said luminaire and comprising a primary winding connected across said pair of conductors and a plurality of low voltage secondary windings having their ends connected across the contacts of said lampholders, and a capacitor of relatively small value connected between a pair of electrically spaced lampholders in said series circuit for bridging at least one of said discharge devices at starting.

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