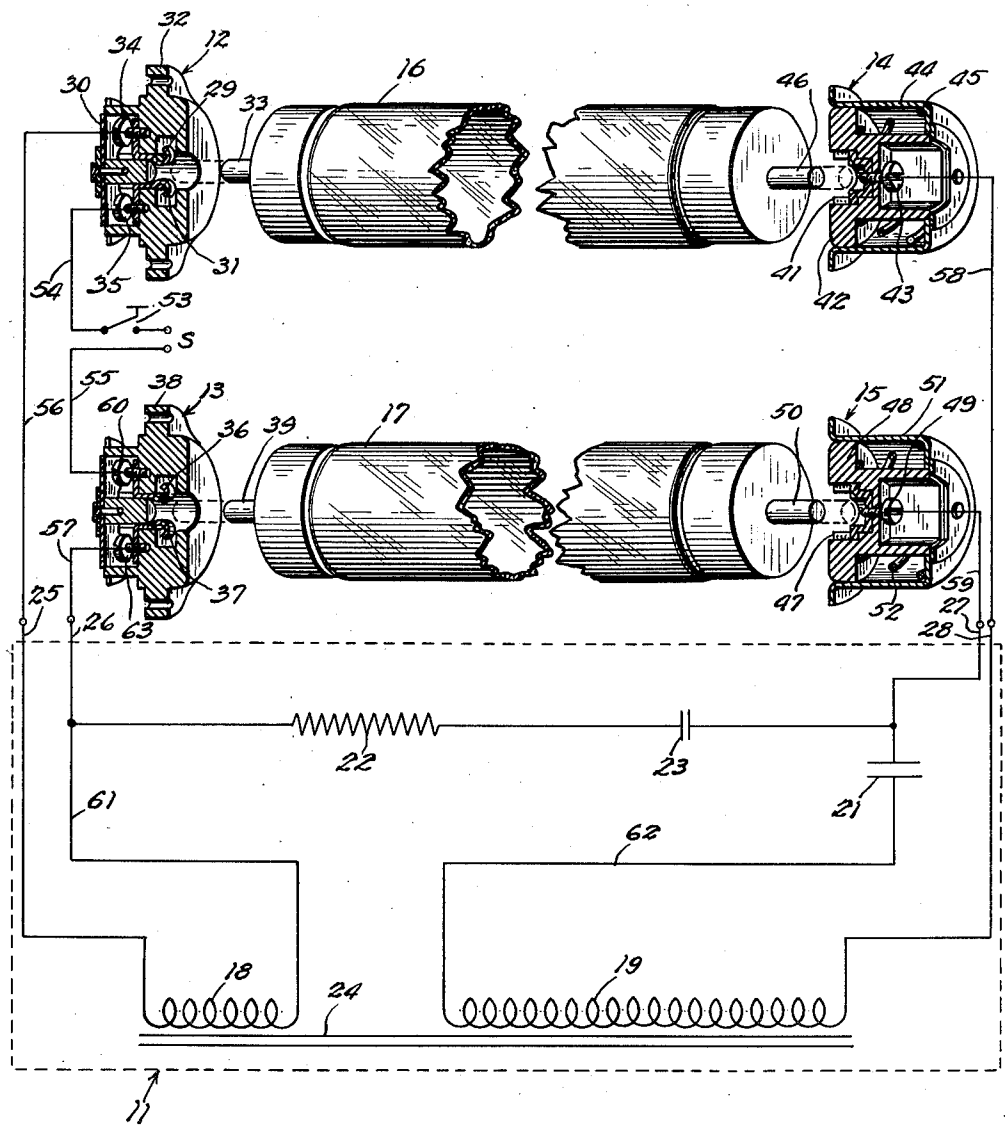
May 8, 1951 C. A. PETERSON 2,552,111

ENERGIZING CIRCUIT FOR FLUORESCENT LAMPS IN SERIES

Filed May 9, 1950



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Patented May 8, 1951

2,552,111

UNITED STATES PATENT OFFICE

2,552,111

ENERGIZING CIRCUIT FOR FLUORESCENT LAMPS IN SERIES

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Application May 9, 1950, Serial No. 160,867

5 Claims. (Cl. 315—100)

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This invention relates to autotransformer fluorescent lamp energizing circuits or apparatus for a plurality of lamps in series, more particularly to such a circuit or apparatus wherein the high voltages which exist in ordinary circuits across terminals receiving the lamps, when the lamps are removed therefrom, and while a source of energy is connected to appropriate terminals, are lacking, and it is an object of the invention to provide improved circuits or apparatus of this character.

Fluorescent lamps, as is well known in this art, require a high starting voltage, and for reasons of economy the windings of the transformer utilized in the energizing circuit commonly are connected in autotransformer relationship since in such case the voltage of the transformer primary winding, in addition to the voltage of the transformer secondary winding, is available for lamp starting. To limit the current through the lamps after starting, some form of ballast apparatus is used, the voltage across the lamp or lamps after starting being reduced thereby to a lower value. When a fluorescent lamp is removed from its sockets or terminals and the source of power remains connected to the transformer, the voltage needed for starting reappears across the terminals.

The Underwriters' Laboratories, for safety reasons, have fixed an upper liimt to the voltage which may be present across the terminals of a fluorescent lighting fixture when there is no lamp therein. This limit restricts sharply the number of fluorescent lamps which may be started in series and has restrained adoption of lamp circuits wherein a plurality of lamps are connected in series. The development of sequence starting and series operating lamp circuits has made it possible to reduce the total starting voltage required much below the sum of the starting voltages of the lamps connected in series, but it may still be sufficiently high to be above the Underwriters' Laboratories' limit, for example, for long or high voltage lamps. Accordingly, it is a further object of the invention to provide an improved autotransformer fluorescent lamp energizing circuit for series operation of two or more fluorescent lamps wherein, when any one of the lamps is absent or removed from its sockets or terminals, the voltage thereacross is prevented from rising above a predetermined limit.

It is a further object of the invention to provide an improved autotransformer fluorescent lamp energizing circuit for series operation of

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two or more fluorescent lamps wherein, when any one of the lamps is absent or removed from its socket or terminals, the voltage across the terminals of all the lamps is substantially removed.

It is a further object of the invention to provide an improved autotransformer fluorescent lamp energizing circuit for series operation of two or more fluorescent lamps wherein, when each one of the lamps is absent or removed from the lamp its socket or fixture, the circuit supplying voltage to the primary winding of the transformer is substantially interrupted.

It is a further object of the invention to provide an improved autotransformer fluorescent lamp energizing circuit of the character indicated which is simple in form, inexpensive to manufacture, and has relatively few parts.

It is a further object of the invention to provide an improved autotransformer fluorescent lamp energizing circuit of the character indicated without the use of separate switches insulated from the fluorescent lamp terminals.

In carrying out the invention in one form, an energizing circuit for a pair of fluorescent lamps in series is provided comprising, a primary winding and a secondary winding disposed on a common magnetic core and being connectible effectively in an additive autotransformer relation in series with the pair of fluorescent lamps, the windings having sufficient voltage when so connected to strike at least one of the lamps; a pair of double contact members each for engageably receiving the terminal of a fluorescent lamp between the contacts thereof, the double contacts of each one of the members defining an effective open circuit except when the terminal of a fluorescent lamp is therebetween, one contact of each one of the pair of members being connected to one of the ends, respectively, of the primary winding, the other contact of each one of the pair of members being connectible to a source of energy; and a pair of contacts each for engagement by the terminal of a fluorescent lamp, each of the last mentioned contacts being connected to one of the ends, respectively, of the secondary winding.

For a more complete understanding of the invention, reference should be had to the accompanying drawing in which the sole figure is a diagrammatic view, partially in perspective, of apparatus embodying the invention.

Referring to the drawing, the invention is shown embodied in an energizing circuit comprising a ballast 11 to which energy may be supplied from a source S of alternating voltage, a pair of

two contact circuit interrupting sockets 12 and 13 connected between the source S and the ballast, and a pair of single terminal sockets 14 and 15 also connected to the ballast, the sockets 12 and 14 being arranged to receive the terminals of one lamp 16, and the sockets 13 and 15 being arranged to receive the terminals of a second lamp 17. Lamps 16 and 17 are connected in series circuit with each other and with the windings of the ballast, as will be described subsequently in this specification.

The ballast 11, which commonly is a single unit, comprises a transformer having a primary or exciting winding 18 and a second winding 19, a consenser 21 in series with the secondary winding, and a series combination of a resistor 22 and a condenser 23 connected between windings 18 and 19. Windings 18 and 19 are wound on an iron core 24 and may be so wound and arranged relative to the core construction that the transformer has a high leakage reactance, as is well understood in this art. For example, the core may be made relatively long and narrow and the windings placed side by side, or a shorter core may be used and high reluctance shunts placed between the windings as is shown, for example, in Patent No. 2,346,621 to Joseph G. Sola entitled Alternating Current Supply System, and assigned to the same assignee as the present invention. The dotted line shown surrounding the ballast 11 may represent a case, for example, out of which extend the leads 25, 26, 27 and 28 to which the remaining apparatus is connected.

In one form of apparatus embodying the invention, the condenser 21 may combine with the leakage reactance of the transformer to form a series resonant circuit when the lamps are lit, as is described in the aforementioned patent of Joseph G. Sola. Other means for controlling the lamp current after the lamps strike may, of course, be used.

The windings 18 and 19 may have an appropriate number of turns, and the core 24 may be of a size determined by standards well known in the art. The ratio of turns of winding 19 to 18 is such that a sufficient voltage is developed across the secondary winding 19 which, when added to the voltage of winding 18 (the supply voltage of proper magnitude and frequency), a sufficient voltage is obtained for starting the lamps in sequence and operating them in series. The windings 18 and 19 connected to the lamps 16 and 17, as shown, are in autotransformer relationship and are connected in additive polarity since the voltages of the two windings add to each other. The series combination of resistor 22 and condenser 23 connected across the conductors 26 and 27 form a starting circuit in shunt with lamp 17 whereby the lamp 16 may be struck first followed by striking of the lamp 17. While the starting circuit shown is a preferred form thereof, either the resistor or the condenser may be omitted provided the value of the remaining member is changed slightly to compensate therefor.

The socket 12 includes a pair of contacts 29 and 31 held in an insulating support 32 which, for example, may be formed of Bakelite. The forward portions of contacts 29 and 31 are spaced apart from each other to form an open circuit and are spaced sufficiently close together so as to spread apart for receiving the single prong terminal 33 of lamp 16, and the rearward portion of contacts 29 and 31 are adapted to receive terminal screws 34 and 35 for attaching conductors to the contacts. The rearward portions of the contacts and the terminal screws are received in appropriately formed openings in the insulating support 32 and a fiber or other insulating washer 30 may be disposed over the terminal screws for insulating purposes. The socket 13 is substantially identical to socket 12 and includes a pair of spaced apart contacts 36 and 37 held in an insulating support 38. The forward portions of contacts 36 and 37 may spread apart to receive the terminal prong 39 of lamp 17. The rearward portions of contacts 36 and 37 are adapted to receive terminal screws 60 and 63.

The socket 14 may comprise a single contact 41 suitably held in an insulating support 42 and having a terminal screw 43. The insulating support 42 may be formed of any suitable material, such for example as Bakelite, and may be received in a metallic cup-shaped sheil 44, a spring 45 being disposed as shown for urging the insulator 42 and consequently the terminal 41 outwardly. The two sockets 12 and 14 may be held in a suitable fluorescent lamp fixture, not shown, and to insert the lamp 16 the single prong 46 is placed into the terminal 41 and sufficient force exerted to move terminal 41 against the force of spring 45 until sufficient displacement has occurred to permit the reception of single terminal 33 into the socket 12. Thereafter the prong 33 is urged between contacts 29 and 31 and the terminal 41 remains in contact with terminal 46 due to the presence of spring 45.

Socket 15 is substantially identical to socket 14 and includes a terminal 47 and a terminal screw 49 held in an insulating support 48. The insulator 48 is held in a metallic cup-shaped member 51 and a spring 52 is disposed to urge the insulator and the terminal outwardly as described in connection with socket 41. The sockets 13 and 15 may be held in the same fixture as sockets 12 and 14, and to insert lamp 17 the same procedure outlined for lamp 16 is followed. That is, the single prong 50 is first inserted into terminal 47 followed by insertion of prong 39 between contacts 36 and 37.

The sockets shown and described are a preferred form, but it will be understood that other forms of sockets or switches may be used, it being essential only that appropriate contacts or terminals be provided for completing the circuits to be described.

The source S is connected to contact 31 through a switch 53, a conductor 54 and screw 35. Similarly, the source S is connected to contact 36 through a conductor 55 and screw 60. The contact 29 is connected to lead 25 of the ballast through a conductor 56 and terminal screw 34. Likewise, contact 37 is connected to lead 26 of the ballast through a conductor 57 and terminal screw 63. The terminal 41 is connected to lead 28 of the ballast through a conductor 58 and terminal screw 43, and terminal 47 may be connected to lead 27 of the ballast through a conductor 59 and terminal screw 49.

The circuit for energizing the primary winding 18 of the transformer may be traced as follows: From source S through conductors 55, contacts 36 and 37, conductor 57, lead 26, conductor 61, winding 18, lead 25, conductor 56, contacts 29 and 31, conductor 54 and switch 53 to source S. When the terminal prongs of either of lamps 16 and 17 are removed from sockets 12 and 13, respectively, a gap exists between the appropriate pairs of contacts 29, 31 and 36, 37 and no excitation can be supplied to winding 18. When, however, both lamps 16 and 17 are disposed with

terminal prongs 33 and 39 between the associated pairs of contacts, the circuit traced out for winding 18 is complete since terminal prongs 33 and 39 are conducting. The full voltage of the transformer is obtained across leads 25 and 26, and when operating the lamps 16 and 17 are connected in a series circuit therewith and consequently in series with the windings 18 and 19. This series circuit may be traced as follows: From lead 25 through conductor 56, contact 29, lamp 16 through terminal prongs 33 and 46, terminal 41, conductor 58, lead 26, winding 19, conductor 62, condenser 21, lead 27, conductor 59, terminal 47, lamp 17 through terminals 50 and 39, contact 37, conductor 57, lead 26, conductor 61, and winding 18 to lead 25.

The striking voltage of lamps 16 and 17 in series commonly is much greater than the combined voltages of windings 18 and 19. Accordingly, it is necessary to start the lamps in sequence and for this purpose the series combination of resistor 22 and condenser 23 is provided and is connected in shunt with one of the lamps, preferably lamp 17 when this lamp is in circuit. This shunt circuit may be traced from contact 37 through conductor 57, lead 26, resistor 22, condenser 23, lead 27 and conductor 59 to terminal 47.

The starting operation of the lamp may be understood by visualizing that switch 53 is closed and a source of suitable alternating voltage is thereby connected to winding 18. The full voltage of windings 18 and 19 is first applied to lamp 16 through the circuit which may be traced as follows: From winding 18 through lead 25, conductor 56, contact 29, lamp 16, terminal 41, conductor 58, lead 26, winding 19, conductor 62, condenser 21, condenser 23, resistor 22 and conductor 61 to winding 18. During the first instant of voltage application no current flows and thus the full voltage of the windings appears across lamp 16. The combined voltage of windings 18 and 19 is sufficient to strike lamp 16 whereupon ionizing current flows therethrough, the ionizing current being not sufficient to cause the lamp to reach full brilliance. The current is limited to this ionizing value due largely to the reactance value of condenser 23. The resistor 18 is relatively small in ohmic value compared to the reactance of condenser 23, but is utilized to improve the operation. The ionizing current flowing through the shunt circuit of resistor 22 and condenser 23 develops sufficient voltage thereacross to strike lamp 17, as is well understood in this art. As soon as lamp 17 strikes the voltage thereacross drops from the high striking value to the much lower operating value whereupon the current flow through the shunt circuit drops to a considerably lower value. After striking in sequence as just described, the lamps operate in series as is understood.

When lamps 16 and 17 are properly disposed in their sockets and switch 53 is closed to connect a source of voltage to the apparatus, the high voltage developed by the transformer is applied to the first lamp 16 for starting, the circuit to the primary winding being completed by means of the prong 33 forming a complete circuit between terminals 29 and 31, and the prong 39 forming a complete circuit between terminals 36 and 37. During operation, the voltage existing between prongs 33 and 46 of lamp 16 and prongs 39 and 50 of lamp 17 are much lower, being limited thereto by the ballast. If either of the lamps 16 and 17 should burn out, thereby in effect opening the circuit between the respective terminal prongs of the lamps, the relatively high voltage needed for striking the lamps would reappear thereacross. If either of the lamps 16 and 17, however, is removed from its socket, whether or not the lamp is burned out, the circuit to the primary winding is opened by the gaps existing between contacts 29, 31 and 36, 37. Consequently, the transformer windings become de-energized and no voltage exists across the socket contacts and terminals which receive the lamp terminal prongs. The voltage of the source may still be applied to contacts 31 and 36, but this voltage does not appear anywhere else in the circuit. Accordingly, the energizing circuit for the lamps is safe at all times since when a workman removes a lamp, the high voltage in the circuit disappears and it cannot reappear until the lamp is placed into proper position.

While a particular embodiment of the invention has been shown, it will be understood, of course, that the invention is not limited thereto since many modifications may be made, and it is, therefore, contemplated by the appended claims to cover any such modifications as fall within the true spirit and scope of the invention.

The invention having thus been described, what is claimed and desired to be secured by Letters Patent is:

1. An energizing circuit for two gaseous discharge lamps each lamp having two terminals comprising, transforming means energizable to provide voltages for starting and operating said lamps including a primary winding for connection to a voltage source having a certain magnitude and frequency and a secondary winding disposed on a common magnetic core, two pairs of spaced contact means each pair of which is adapted for conductively engaging the terminals of one of such lamps, the first contact means of each pair including two normally spaced-apart contacts capable of receiving one of the terminals of one of such lamps so as to electrically connect it with both the contacts, one of the normally spaced-apart contacts of each of said first contact means being connected to a separate end of said primary winding, the other of said normally spaced-apart contacts of each of said first contact means being connectible to a separate terminal of such source, the second contact means of each pair including a lamp terminal engaging contact operatively connected to a separate end of said secondary winding in such manner that when such lamps are disposed in such energizing circuit they are connected in series with each other and said windings are effectively connected in series relationship.

2. An energizing circuit for two gaseous discharge lamps each lamp having two terminals comprising, transforming means energizable to provide voltages for starting and operating said lamps including a primary winding for connection to a voltage source having a certain magnitude and frequency and a secondary winding disposed on a common magnetic core, two pairs of spaced contact means each pair of which is adapted for conductively engaging the terminals of one of such lamps, the first contact means of each pair including two normally spaced-apart contacts capable of contacting one of the terminals of one of such lamps so as to electrically connect it with both the contacts, one of the normally spaced-apart contacts of each of said first contact means being connected to a separate end of said primary winding, the other of said normally spaced-

apart contacts of each of said first contact means being connectible to a separate terminal of such source, the second contact means of each pair including a lamp terminal engaging contact operatively connected to a separate end of said secondary winding in such manner that when such lamps are disposed in such energizing circuit they are connected in series with each other and said windings are effectively connected in series relationship.

3. An energizing circuit for two gaseous discharge lamps each lamp having two terminals according to claim 1, characterized in that the primary and the secondary windings are effectively connected in autotransformer relationship in additive polarity.

4. An energizing circuit for two gaseous discharge lamps each lamp having two terminals according to claim 1, characterized in that the core and the primary and secondary windings are so constructed and arranged as to produce a high magnetic leakage reactance effect, a shunt circuit comprising a resistor and a condenser is connected in circuit between the windings and a condenser is connected in circuit with the secondary winding.

5. An energizing circuit for a plurality of gaseouse discharge lamps each lamp having two terminals comprising, transforming means energizable to provide voltages for starting and operating said lamps including a primary winding for connection to a voltage source having a certain magnitude and frequency and a secondary winding disposed on a common magnetic core, two pairs of spaced contact means each pair of which is adapted for conductively engaging the terminals of one of such lamps, the first contact means of each pair including two normally spaced-apart contacts capable of receiving one of the terminals of one of such lamps so as to electrically connect it with both the contacts, one of the normally spaced-apart contacts of each of said first contact means being connected to a separate end of said primary winding, the other of said normally spaced-apart contacts of each of said first contact means being connectible to a separate terminal of such source, the second contact means of each pair including a lamp terminal engaging contact operatively connected to a separate end of said second winding in such manner that when such plurality of lamps are disposed in such energizing circuit they are connected in series with each other and said windings are effectively connected in series relationship.

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