Oct. 18, 1966 NANAO TODA ETAL 3,280,371

IGNITION SYSTEM FOR ELECTRICAL DISCHARGE LAMPS

Filed Oct. 23, 1963

FIG. 1

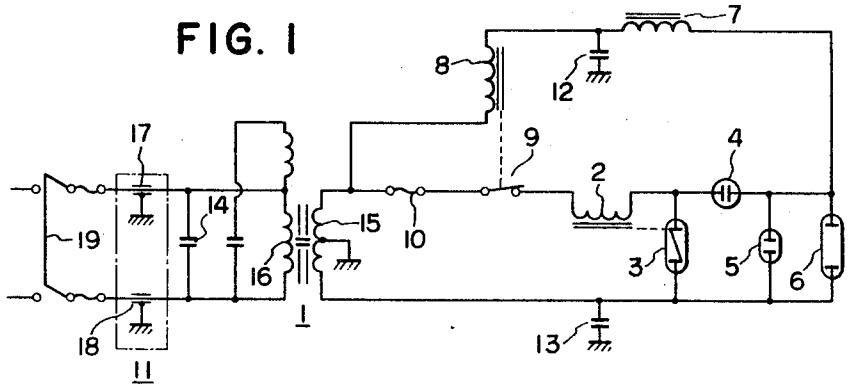


FIG. 2

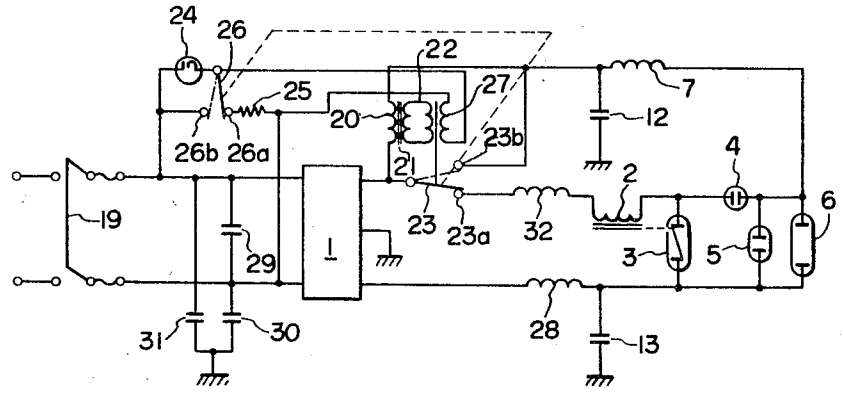
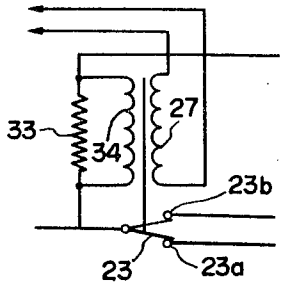


FIG. 3



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IGNITION SYSTEM FOR ELECTRICAL DISCHARGE LAMPS

Nanao Toda, Yoshishige Tokui, and Yoshio Kurokawa, Tokyo, Japan, assignors to Iwasaki Denki Kabushiki Kaisha, Tokyo, Japan

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9 Claims. (Cl. 315—290)

This invention relates to a lighting means for the instantaneously relighting of discharge lamps. Generally, for relighting a discharge lamp, such as a high voltage mercury lamp, soon after having once been extinguished, a lowering of gaseous atmospheric pressure due to temperature decrease of said discharge lamp has to be awaited. It requires several minutes or a few minutes above ten. Accordingly, as a means for relighting the discharge lamp after having once been extinguished, means for an instantaneously applying high voltage or pulses are usually adopted.

It is a first object of the present invention to provide a lighting apparatus for discharge lamps wherein a discharge lamp is instantaneously relighted by imparting a high voltage pulse generated in a pulse circuit to said discharge lamp.

A second object of the present invention is to perform a rapid and exact opening operation of a high voltage pulse circuit by connecting a stabilizing circuit to said high voltage pulse circuit, that is, once the lighting of the discharge lamp is effected, and immediately thereafter automatic change-over of the system to the stabilizing circuit is effected in order to perform the opening of the high voltage pulse circuit rapidly and exactly.

Further, a third object of the present invention is to prevent in advance the occurrence of pulse by opening the high voltage pulse circuit with a slight delay after an electric source being connected, so as to eliminate the effect of back flow of pulses upon a safety device and other devices on the side of the electric source, in case of the circuit being unable to start due to disturbance of the discharge lamp.

In the following, the present invention is described in detail in connection with the accompanying drawings, in which

FIG. 1 is a wiring diagram for the apparatus of the present invention adapted to open a high voltage pulse circuit by melting down a fuse in order to avoid disturbances from high voltage pulse when the discharge lamp is unable to be lighted;

FIG. 2 is a wiring diagram for the apparatus of the present invention adapted to automatically perform the opening of the high voltage pulse circuit of above-mentioned FIG. 1: and

FIG. 3 is a part of the modified relay wherein the primary coil of the relay in the apparatus illustrated in FIG. 2 is replaced by a decrease in voltage due to resistance.

Referring to FIG. 1 of the accompanying drawings, by **1** is meant a leakage transformer, namely a stabilizing device; **2** an induction coil; **3** a vacuum switch; **4** a gap; **5** a protection gap; **6** a discharge lamp; **7** a choke coil; **8** an exciting coil; **9** relay switch contacts; **10** a fuse; **11** an electromagnetic safety device; **12** and **13** condensers inserted in the secondary winding of stabilizing device **1**; **14** a condenser inserted in the primary winding of stabilizing device **1**; and a pulse circuit is consisted of the secondary winding **15**—fuse **10**—relay switch contacts **9**—induction coil **2**—vacuum switch **3**—the secondary winding **15** of stabilizing device **1**.

When a switch **19** for the electric source is closed, a voltage will be induced in the secondary winding **15** of stabilizing device (a leakage transformer) **1**, and an electric current will flow along a circuit path through the fuse metal (or low fusion point metal) **10**, switch **9**, induction coil **2**, vacuum switch **3**, stabilizing device **1**. In this case, the induction coil **2** acts as an exciting coil for the vacuum switch **3** to cut off and disconnect the current passing through above-mentioned circuit. A back electromotive force occurring then causes a spark discharge across the gap **4** resulting in a high voltage pulse between both terminals of discharge lamp **6**. Accordingly, the discharge lamp **6** commences to make an arc discharge, and then electric current begins to pass through a stable circuit traced from the secondary winding **15** of stabilizing device **1**, exciting coil **8**, choking coil **7**, discharge lamp **6**, and back to the secondary coil **15** of stabilizing device **1**. As a result, the exciting coil **8** is excited to open the switch **9** inserted in the pulse circuit and stop the occurrence of pulses. In such instance, the pulse circuit is opened in $\frac{1}{50}$ to $\frac{1}{20}$ second after current is passed.

The foregoing description relates to the case when the discharge lamp **6** is lighted normally. However, when the lamp **6** becomes unable to start for some cause, the pulse circuit should be opened quickly to stop the occurrence of pulses. In order to avoid bad effects of pulses upon other elements of apparatus during the time from the occurrence of pulses to the opening of the pulse circuit, the protection gap **5** is connected in parallel to the discharge lamp **6**. Even more, it is preferable that the occurrence of pulses be stopped even earlier. Therefore, according to the present invention, the pulse circuit is connected with the fuse metal **10** in series, and when the discharge lamp **6** does not start, the pulse circuit is adapted to be spontaneously opened after elapse of a predetermined interval of time.

Accordingly, a fuse-metal melting due to an electric current nearly equivalent to a short circuiting current for the pulse circuit is used, and fuse metal **10** is adapted to melt down with a time-difference of approximately $\frac{1}{3}$ to $\frac{1}{2}$ second after the electric source being connected thereto.

Furthermore, according to the present invention, the electromagnetic safety device **11** is provided to prevent reflected pulses from being fed back toward the electric source. Namely condensers **17** and **18** are connected to both lines of the primary winding **16** of the stabilizing device **1** to constitute the safety device **11** for by-passing the reflected pulse to a point of reference potential.

The other embodiment of the present invention illustrated in FIG. 2 is arranged to use a time-limit opening device for the purpose of opening the pulse circuit when the discharge lamp 6 does not start. An exciting coil **20** corresponding to the exciting coil **8** shown in FIG. 1 is designed to constitute the primary winding of a transformer **21**, of which secondary winding **22** constitutes a relay coil for operating a change-over switch **23** between the pulse circuit and the stabilizing circuit. In addition, a winding **27** operated with above-mentioned secondary winding **22** is connected with the electric source, in series with a glow lamp **24**, and a resistance **25** is connected to the winding **27** in a parallel. When this resistance **25** is disconnected from the circuit a switch **26** is operated to short circuit the glow lamp **24**; such disconnection occurs because the switch **26** is interlocked with said switch **23**.

Now, on the occasion of close-circuiting the switch **19** to the electric source, a high voltage pulse is generated by a circuit for the stabilizing device **1** passing through the stabilizing device **1**, change-over switch **23**, contact **23***a*, induction coil **2**, vacuum switch **3**, stabilizing device

1; whereupon the high voltage pulse is applied to the discharge lamp 6 to start arc discharge and consequently letting a stable current begin to flow through the stabilizer 1, primary winding (induction coil) 20, choking coil 7 and discharge lamp 6. Thus the change-over switch 23 is changed from the contact point 23*a* over to contact point 23*b* by means of the secondary winding 22 of transformer 21, that is, the stabilizing device circuit is closed by disconnecting the high voltage circuit of pulse.

Through the primary winding 20 is short-circuited by the changing-over of change-over switch 23 to a contact point 23*b*, and in this instance, the switch 26 interlocked with switch 23 also changes from a normal position of contact point 26*a* over to a contact point 26*b*, the winding 27 remains connected to the electric source, maintaining the closing circuit of change-over switch 23 to the contact point 23*b* and, accordingly, maintaining the lighting condition of discharge lamp 6.

In case of an accident of discharge lamp 6 or other disturbances at above-mentioned starting, an electric discharge begins to take place across the protection gap 5 which is connected in parallel to the discharge lamp 6, protecting the circuit from high voltage pulses. The starting voltage of protection gap 5 should be higher than that of discharge lamps 6. In consequence, since it is necessary to open the pulse circuit after a certain time limit as similarly as in the case of the fuse 10 being melted down, the change-over switch 23 does not change over to contact point 23*b*, unless the stable current passes through winding 20 and of course, the switch 26 does not change over to contact point 26*b*. Therefore, a voltage is applied to the glow lamp 24 through resistance 25, and the glow lamp 24 commences to discharge. At first, the electric current passing through the winding 27 is minute and insufficient to operate the switch 23. Thereafter, when the inside contact point of the glow lamp 24 is closed after a predetermined time interval, for instance, 0.3 to 1 second delay, a heavy current will flow through the winding 27. The change-over switch 23 is operated by such current to open the pulse circuit, and simultaneously the switch 26 is transferred to the contact point 26*b*; therefrom the glow lamp 24 is short-circuited to open, which condition is maintained until the circuit of electric source switch is opened. Thus, bad influences due to high voltage pulse can be avoided.

The pulse circuit is protected from electric current of the stabilizer device passing through the pulse circuit, by by connecting the gap 4 in series to discharge lamp 6. Furthermore, the entrance of the electric current from the stabilizing device side into the pulse circuit is disturbed by means of lower filtering devices (7, 12, 13, 28). Even if a high voltage should occur in the primary winding side of stablizing device 1, there would occur almost no hinderances to affect other parts, since condensers 29, 30 and 31 are inserted for prevention.

In some cases, in addition to the induction coils 2, an exciting coil of the vacuum switch 3 may be provided separately. Instead of the primary winding 20 of the relay transformer 21 of FIG. 2, a resistance 33 of FIG. 3 may be used, thereby the change-over switch 23 being acutated by change of magnetic fluxes 34 due to lowering of the voltage.

What we claim:

1. A starting and operating system for a discharge lamp adapted to be operated from a transformer having a primary and secondary winding in which said primary winding is coupled to a power source, comprising in combination:

a starting circuit coupled to said discharge lamp by means of said secondary winding and including a first set of relay contact means having a normally open and a normally closed pair of contacts, an induction coil coupled in series to said aforementioned normally closed pair of contacts between said secondary winding and said discharge lamp, and a normally closed vacuum switch responsive to the energised state of said induction coil, being coupled in parallel with said discharge lamp and becoming non-conductive in response to the energized state of said induction coil to produce an electrical starting siginal for energising said discharge lamp;

an operating circuit coupling said secondary winding to said discharge lamp comprising first relay coil means and ballast means connected in series between said secondary winding and said discharge lamp, said first relay coil means being operative to open said aforementioned normally closed pair of contacts to provide an open circuit in said starting circuit when said operating circuit is energizing said discharge lamp;

and protective circuitry for said system in the event said starting circuit fails to operate comprising, second relay coil means for opening said aforementioned normally closed pair of contacts, an electrical timing device having a predetermined time delay coupled to said second relay coil means for energizing said second relay coil means after said predetermined time delay, circuit means coupling said timing device and said second relay coil means across said power source, and a second set of relay contact means simultaneously operable with said first set of relay contact means and having a normally open and normally closed pair of contacts, said second set of relay contact means coupled across said timing device whereby said open pair of contacts will short said timing device thereby rendering said timing device inoperative when said second relay coil means becomes energized.

2. Apparatus as defined by claim 1, wherein said protective circuitry includes a third relay coil magnetically coupling said first and said second relay coil means.

3. Apparatus as defined by claim 1, wherein said timing device comprises a glow lamp.

4. Apparatus as defined by claim 3, wherein said protective circuitry additionally includes resistance means coupled in parallel across said second relay coil means by means of said normally closed contacts of said second set of relay contact means.

5. A starting and operating system for a discharge lamp powered from an electric source comprising in combination:

transformer means having a primary and a secondary winding including means for coupling said primary winding to said electric source;

a starting circuit including said discharge lamp coupled across said secondary winding comprising, a pair of normally closed relay switch contacts, vacuum switch energization means connected in series to said normally closed relay switch contacts, gap means connected in series between said vacuum switch energization means and said discharge lamp, a vacuum switch adapted to be operated by said vacuum switch energization means and being coupled across said gap means and said discharge lamp, becoming non-conductive in response to the operation of said energization means to provide an open circuit thereacross, thereby causing an arc discharge to occur across said gap means to start said discharge lamp;

an operating circuit for said discharge lamp after starting comprising, a relay coil for actuating said pair of normally closed relay switch contacts in said starting circuit, circuit means coupling said relay coil to said secondary winding, ballast means coupled in series between said relay coil and said discharge lamp, said relay coil being operable to open said normally closed relay switch contacts to render said starting circuit inoperative when said discharge lamp has been started.

6. Apparatus as defined by claim 5, and including a protective circuit for said system in the event said starting circuit fails to operate comprising, another relay coil for

actuating said normally closed relay switch contacts, an electrical timing device having a predetermined time delay coupled to said another relay coil for energizing said relay coil after said predetermined time delay, circuit means coupling said timing device and said another relay coil across said power source, a pair of normally open relay contacts adapted to be actuated by both said relay coils, being connected across said timing device for rendering said timing device non-conductive when said second relay coil becomes energized.

7. Apparatus as defined by claim 6, wherein said timing device comprises a glow lamp.

8. Apparatus as defined by claim 6, wherein said timing device comprises a glow lamp having a predetermined time delay greater than the time necessary to start said discharge lamp by means of said starting circuit.

9. Apparatus as defined by claim 6, wherein said protective circuit additionally includes another pair of normally closed relay contacts adapted to be actuated by both

said relay coils and resistance means coupled in parallel across said another relay coil by means of said another pair of normally closed relay contacts.

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JOHN W. HUCKERT, *Primary Examiner.*

A. M. LESNIAK, *Assistant Examiner.*