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(54) **Starter circuit for a fluorescent tube lamp.**

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Description

This invention relates to a starter circuit for a fluorescent tube lamp and a lamp fitting incorporating the circuit.

Fluorescent tubes are lamps which produce light by means of an electrical discharge in a gas which excites a phosphor coating on the tube. When in operation, the impedance of the tube is negative and therefore requires an added series impedance so that the operation is stable. For AC circuits the series impedance is chosen to be inductive so as to reduce power losses and to produce the pulses for striking the tube.

Once the tube has been struck the "running" voltage is between 20 and 60 per cent of the nominal AC supply voltage, the remainder of that voltage being dropped across the added series impedance. The purpose of a starting circuit is to strike the discharge in the tube and the voltage required to achieve this is higher than the running voltage and depends on the age of the tube, its operational environment and the length of time for which striking voltage is applied. Tubes have heated cathodes which provide a source of ions and electrons for the discharge and reduce the magnitude of the voltage required to strike the tube. It is possible to strike a tube when the cathodes are cold but the striking voltage/time requirement is usually beyond the capability of conventional starting circuits; and, in any case, the cold striking of a tube with high voltage pulses tends to shorten its life. Moreover the high voltages required for the larger tube sizes would call for correspondingly high voltage components, so that cold striking is not normally used for such tubes. It is therefore a function of starting circuits to provide a period for which current is applied to the cathodes to heat them and a well-known circuit for achieving this includes a glow tube switch which is used to complete a series circuit including the ballast series impedance and the two cathode heaters, the switch itself being connected between the two cathode heaters. When power is first supplied to the circuit, the full AC supply voltage is applied to the glow tube in which a discharge is set up and the heat of this discharge heats up a bimetallic strip. When sufficiently hot, this strip closes some switch contacts which short-circuit the glow tube and cause the cathode heaters to be heated by the supply current. After a certain period of time the bimetallic strip cools allowing the switch to open again which interrupts the heater current and causes the ballast impedance, which is usually an inductor, to produce an e.m.f. in addition to the supply voltage which is usually sufficient to strike the tube. If the tube does not strike, the glow tube will repeat its attempt to strike it as described above. After the tube has struck insufficient voltage is applied to the glow tube for the discharge to be set up in it and the starter remains quiescent.

The main problems with the glow tube switch as described above are that the actual time of opening of the switch is random relative to the supply voltage so that the actual e.m.f. applied to the tube in an attempt to strike it is frequently insufficient so that the striking of the tube is delayed and it is preceded by an unpleasant series of flashes at intervals of about 1 second. Furthermore, the performances of the glow tube starters are very variable which can result in unreliable operation in some instances. In addition, the life expectancy of the glow tube switch is unpredictable. Moreover, the continued attempts to strike a faulty tube by such a switch can be very annoying.

In order to overcome the above disadvantages of a glow tube starter switch certain semiconductor solutions have been proposed, but in many instances the circuits operate in a similar manner to a glow tube switch and produce similar delays in striking the tubes and the preliminary flashes.

It is an object of the present invention to provide an improved form of electronic circuit for starting a fluorescent tube lamp.

According to the present invention there is provided a starter circuit for an AC energised fluorescent tube lamp having cathodes with heaters and an inductive ballast impedance connected in series with the lamp across an AC supply, and in which in use the starter circuit is connected between the cathodes of the lamp itself, wherein the starter circuit includes a switch and a control circuit for the switch which is responsive to the presence of voltage across the tube to cause the switch to execute a cycle of connecting together the cathodes of the tube through a low resistance path and then breaking the connection between them several times in each half cycle of the AC supply, whereby the starter circuit when in use causes the ballast impedance to apply a corresponding succession of voltage pulses to the lamp.

The circuit may include a full wave rectifier producing a DC supply for the other parts of the circuit from the alternating voltage across the lamp. The switch may include a thyristor constructed to require a high holding current to maintain conduction or otherwise being capable of being turned off by a signal applied to its gate and preferably also has a zener diode connected so as to limit the voltage of the pulses produced by the ballast impedance when the circuit is in use. The control circuit may be responsive to the current through the low resistance path to cause the switch to break the connection whenever the current reaches a particular value. Alternatively, the control circuit may include an oscillator producing a rectangular wave for controlling the switch and having a frequency and a mark to space ratio matched to the charge and discharge characteristics of an inductive ballast impedance with which the starter circuit is intended to be used.

The control circuit may include a circuit for delaying the start of the switching cycles for a period of time after switching on the supply to the lamp, and therefore to the starter circuit, to permit the cathodes of the lamp to be preheated before the pulses are applied to the lamp.

The control circuit may be responsive to a characteristic of the voltage across the lamp to detect when it strikes and then terminate the switching cycles for at least the remainder of the particular half cycle of the supply. A timing circuit may be provided to terminate the switching cycles if the lamp does not strike within a predetermined time of being switched on.

In order that the present invention may be fully understood and readily carried into effect an example of it will now be described with reference to the accompanying drawings, of which:

FIGURE 1 is a block diagram of the complete energisation circuit for a fluorescent tube lamp incorporating a starter circuit according to the present invention;

FIGURES 2A to 2D represent waveforms occurring in parts of the circuits shown in Figure 1 which will be used to explain the operation of the circuit; and

FIGURE 3 is a detailed circuit diagram of a starter circuit according to the invention.

The present invention relates to a starter circuit for a fluorescent tube lamp and to a lamp incorporating such a circuit. Although the operation of the circuit could be described without reference to the other components used in the energisation circuit for the lamp, the point of the various functions of the starter circuit would only become apparent from a consideration of their effects in the overall energisation circuit with a lamp and therefore for convenience the entire energisation circuit and its manner of operation will be described.

Referring now to Figure 1, an alernating mains electricity supply is connected to terminals 1 and 2, the supply typically having a voltage of 240 volts. The terminal 1 is connected via an on/off switch 3 and a ballast inductance 4 to a cathode 5 of a fluorescent tube lamp 6. The lamp 6 has a second cathode 7 which is connected directly to the terminal 2. The cathodes 5 and 7 incorporate heaters and these take the form of electrical resistances through which current is caused to flow from the supply terminals 1 and 2 to the starter circuit 8 connected between the ends of the cathodes 5 and 7 remote from the terminals 1 and 2. A capacitor 9 is connected at nodes A and B in parallel with the starter circuit 8 for the purpose of suppressing radio frequency interference due to the action of the starter circuit in conjunction with the inductance 4.

The starter circuit 8 includes a full wave bridge rectifier 10 producing a DC supply across conductors 11 and 12. The conductors 11 and 12 are joined by a zener diode 13 and a controllable switch 14. A control circuit 15 also receives the DC supply and produces on a conductor 16 control signals for the switch 14. Although the switch 14 is shown as a mechanical switch, it would in practice either be a thyristor able to be turned off by a signal applied to its gate or a device known as a fluoractor as described in European Patent Application No. 0118309. In the case where switch 14 is a fluoractor, the zener diode 13 is incorporated into it. The control circuit 15 may include means connected in series with the switch 14 for responding to the current through it.

In the operation of the circuit shown in Figure 1, the control circuit 15 is arranged to open and close the switch 14 at about 300 to 400 times per second so that in each half cycle of the AC supply, assumed to be of 50 Hz, there are three to four pulses applied to the lamp 6 when the switch 14 is open-circuited and the energy stored in the inductance 4 is discharged to produce the pulses. The zener diode 13 operates to limit the voltage of the pulses produced by the inductance 4 and in doing so extends their duration, it having been found that a pulse of slightly lower voltage but of longer duration is more effective to cause a fluorescent tube lamp to strike.

Ignoring for the present the matter of providing a preheating time for cathodes of the lamp 6, since it has been found that a starter circuit according to the invention can strike a fluorescent tube lamp when its cathodes are cold without causing significant damage to the lamp, the circuit has the advantage that on switching on the lamp produces a progressively increasing amount of light without apparent flashing until the lamp strikes. If a preheating time is provided, for example by being built into the control circuit 15, then the progressive brightening of the lamp will follow after, say, half a second delay normally provided for the preheating of the cathodes.

Figure 2A represents the AC supply and Figure 2B is the supply after full wave rectification by the rectifier 10. Figure 2C represents the current pulses in the inductance 4 in each half cycle of the mains supply, the half cycles being marked by the lines 17. Figure 2D represents the voltage across the lamp 6. As shown in Figures 2C and 2D, in the first half cycle the switch 14 is opened three times and three pulses of voltage V determined by the zener diode 13 are applied to the lamp 6. It is assumed that the lamp does not strike during this half cycle, but the gas in the lamp will be heated and the lamp caused to produce a small amount of light output which will not, however, appear as flashing because the frequency of the pulsing is too high. During the second half cycle the lamp is assumed to strike on the second pulse which therefore appears shortened in Figure 2D, so that the voltage across the tube falls to V1 as determined by the conduction of the lamp. In this half cycle the lamp produces a greater amount of light because it is struck for about half the time. In the third half cycle the lamp is assumed to strike on the first pulse and produces even more light by having been struck for about three-quarters of the half cycle. After this the lamp will probably remain struck because the gas inside will have become sufficiently heated and the control circuit 15 is arranged not only to detect the striking of the lamp and to terminate the pulses in the rest of the half cycle in which the striking occurred but also to discontinue the application of pulses to the switch 14 after detecting the striking of the lamp on the first pulse in preceding half cycles or after a predetermined period of time.

The striking of the lamp can be detected in several ways, for example by measuring the duration of the voltage pulse across the lamp and noting when it is greatly reduced as a result of the striking of the lamp, measuring the voltage across the lamp and noting the rapid reduction in that voltage as a result of the lamp striking, or monitoring the current through the zener diode 13 and noting when it is interrupted. The ends of half cycles of the AC supply could be detected by a zero voltage condition between the conductors 11 and 12.

The generation of the pulses used to open-circuit the switch 14 may be achieved by monitoring the current through the switch which will be dependent on the current through the inductance 4 and when the current through the switch reaches a predetermined value corresponding to a required energy charge in the inductance 4, the switch 14 is open-circuited. This will result in the pulses applied to the lamp 6 being of substantially the same energy which can therefore be adjusted to provide optimum starting conditions for the lamp without causing damage to its cathodes. If preheating of the cathode is not employed, it is desirable to restrict the energy of the starting pulses so as to warm up the gas in the lamp without disrupting the material from the cathodes.

Figure 3 shows in detail the circuit diagram of the starter circuit 8 of Figure 1. The nodes A and B of the circuit of Figure 1 are marked in Figure 3 connected to the rectifier bridge 10 which produces a DC voltage across conductors 11 and 12. The switch 14 and the zener diode 13 are combined in a fluoractor 20 connected from the conductor 11 through a series of four diodes D5, D6, D7 and D8 to the conductor 12. The junction of the fluoractor 20 and the diode 5 is connected through a diode D9 to a conductor 21 on which a steady voltage is maintained relative to the conductor 12 smoothed by a capacitor C1. The voltage on the conductor 11 is not smoothed and retains the form shown in Figure 2B.

Initially, the fluoractor 20 is conducting as a result of the current through a resistor R2 from the conductor 11, the transistor TR1 being non-conducting at this time. The remaining parts of Figure 3 constitute the control circuit 15 of Figure 1 and will now be described. A comparator IC1A compares the voltage across a resistor R1 shunting the diode D8 with the steady voltage established at the junction of resistors R3 and R4 connected in series between conductor 21 and conductor 12, and the output of the comparator IC1A is applied to the set input of a D-type flip-flop IC2 which causes the Q-output of IC2 to go high when the voltage across the resistor R1 due to the current flowing through fluoractor 20 and down the diode chain reaches a predetermined value. This causes the transistor TR1 to become conducting which switches off the fluoractor causing a pulse to be applied to the lamp. If the lamp does not strike the decaying of the voltage pulse across the lamp 6 to below 400 volts will be detected by a comparator IC1C which compares a proportion of the voltage between conductors 11 and 12 determined by resistors R15 and R16 in series with a voltage at the junction of resistors R12 and R13 of the series chain R12, R13 and R14 connected from conductor 21 and conductor 12. The output of the comparator IC1C clocks the flip-flop IC2 which, as its D-input is low for reasons to be explained, causes its Q-output of IC2 to become low again switching off TR1 and allowing the fluoractor 20 to turn on again for another cycle as just described.

If the lamp does strike, the voltage pulse across it will be shortened and there will be a rapid decrease in the voltage of the pulse. This rapid decrease is detected by the transistor TR2 in conjunction with the differentiating circuit formed by capacitor C3 and resistor R11. This causes the collector of the transistor TR2 to go low which in turn via the comparator IC1B causes the D-input of the flip-flop IC2 to go high. This rapid decrease occurs before the pulse decays below 400 volts as mentioned above so that under these circumstances the D-input is high before the flip-flop IC2 is clocked by comparator IC1C. As a result the Q-output of the flip-flop IC2 remains high and the transistor TR1 is kept conducting so that the fluoractor 20 is maintained in the nonconducting condition and the lamp can continue its conduction, at least until the next half cycle. If the lamp does not strike the D-input of IC2 will remain low as mentioned above.

A comparator IC1D detects when the voltage on the conductor 11 falls below 30 volts positive with respect to conductor 12 and through the NAND-gate IC3 resets the flip-flop IC2, so that its Q-output becomes low again and the transistor TR1 is turned off so that the fluoractor 20 can be triggered into conduction at the beginning of the next half cycle. The NAND-gate IC3 serves to eliminate simultaneous application of a low condition to both the R and S inputs of the flip-flop IC2 because of the control of the NAND-gate IC3 by the Q-output of the flip-flop.

As thus far described, the circuit turns off the fluoractor 20 repeatedly in each half cycle until the lamp strikes when the fluoractor 20 is held in the off condition up to the end of the half cycle. In order to terminate the striking pulses once the tube has been struck, a timing circuit formed by resistor R19 and capacitor C5 produces a rising voltage which is applied to a comparator IC4A the output of which is connected through diode D11 to the set input of the flip-flop IC2 to prevent it being reset again until the mains supply is turned off and then on again.

When the mains supply is turned off, the ripple on the conductor 11 is no longer conveyed by capacitor C4 to the comparator IC4B which permits the capacitor C6 to be charged up by current through resistor R22 thereby turning on the transistor TR3 and discharging the capacitor C5 through it. Whilst the mains supply is maintained, negative-going pulses from the comparator IC4B keep the capacitor C6 discharged.

Although, as mentioned above, it is not necessary to preheat the cathodes of the lamp before applying pulses to it, it may be desirable to do so to avoid any possibility of damage to the cathodes resulting from the application of the pulses to the lamp before the cathodes are heated. A preheating delay can be provided in the circuit by connecting a capacitor C2 in parallel with resistor R3 which thereby causes the voltage applied to the non-inverting input of the comparator IC1A to start substantially at the potential of the conductor 21 and to fall gradually to the normal operating value as the capacitor C2 is charged up by current through resistor R4. This means that the output of the comparator IC1A is prevented from going low in response to the voltage developed across the resistor R1 for a short period of time. This permits the cathodes of the lamp to heat up before fluoractor 20 is turned off for the first time and pulses start to be applied to the lamp.

From the above description, it will be appreciated that the circuit of Figure 3 includes certain of the alternatives mentioned above in the description of the control circuit 15. The circuit of Figure 3 could be modified in a number of ways. For example, a capacitor could be connected across the resistor R4 instead of resistor R3 with the result that the width of the pulses applied to the lamp would start at a low value and increase gradually to the normal value because the comparator IC1A would be caused to trigger the flip-flop IC2 at lower levels of current through the fluoractor 20 than normal. This latter feature could be combined with a preheating delay by the use of an additional comparator to block the start of the gradually increasing pulses until after the preheating delay, which would be useful for any lamps which are susceptible to "end blackening" when pulsed before the cathodes are sufficiently heated.

Instead of the circuit described for turning off the fluoractor 20 a fixed frequency oscillator could be provided having a frequency and mark to space ratio so chosen with reference to the inductance 4 to provide the most appropriate pulse energies for different lamps. Small fluorescent lamps require higher values of inductance, and if the triggering of the pulses is based on the current through the inductance as described above, then the smaller tubes would receive larger energy pulses which they do not require. With the time of the charging current applied to the inductance being fixed, the higher values of inductance will have a smaller current through them because of the lower rate of increase of current and thus smaller tubes would receive more appropriately sized striking pulses.

The analogue timing circuits used in Figure 3 could be replaced by a pulse generator and counters which would permit much of the circuit to be realised by a custom-built gate array which would avoid the need to design an integrated circuit specifically for it.

Claims

1. A starter circuit for an a.c. energised fluorescent tube lamp having cathodes with heaters and an inductive ballast impedance connected in series with the lamp across an a.c. supply, and in which in use the starter circuit is connected between the cathodes of the lamp itself, wherein the starter circuit includes a switch and a control circuit for the switch which is responsive to the presence of voltage across the lamp to cause the switch to execute a cycle of connecting together the cathodes of the lamp through a low resistance path and then breaking the connection between them

several times in a half cycle of the a.c. supply, whereby the starter circuit when in use causes the ballast impedance to apply a corresponding succession of voltage pulses to the lamp.

2. A circuit according to claim 1 including means responsive to the occurrence of a characteristic change in the voltage across the lamp indicative of the lamp striking to terminate the cycles of operation of the switch for at least the remainder of the particular half cycle of the a.c. supply in which the characteristic change in the voltage across the lamp occurs.

3. A circuit according to claim 2 wherein the control circuit includes means responsive to the voltage across the lamp not exceeding a preset value indicative of the lamp being struck to prevent the switch from closing the connection across the lamp.

4. A circuit according to claim 2 or 3 wherein the characteristic change in the voltage across the lamp is a rapid decrease in that voltage which occurs before the voltage falls below a threshold value.

5. A circuit according to claim 2 or 3 wherein the characteristic change in the voltage across the lamp is reduction in the duration of the voltage pulse across the lamp.

6. A circuit according to claim 5 including a zener diode connected in parallel with the switch for limiting the voltage of the pulses produced by the ballast impedance, wherein the characteristic change in the voltage across the lamp is detected by means responsive to the current through the zener diode.

7. A circuit according to any one of claims 1 to 5 including a rectifier through which the switch and the control circuit are connected to the cathodes of the tube, so that the a.c. voltage across the lamp is applied in rectified form to the switch and the control circuit.

8. A circuit according to claim 7 wherein the rectifier is a full wave rectifier.

9. A circuit according to claim 7 or 8 wherein the switch is a thyristor constructed to require a high holding current to maintain conduction or otherwise being capable of being turned off by a signal applied to its gate and the control circuit is connected to turn on and off a current fed to the gate of the thyristor.

10. A circuit according to claim 9 including a zener diode connected in parallel with the controlled current path of the thyristor to limit the voltage of the pulses produced by the ballast impedance when the thyristor is turned off.

11. A circuit according to claim 10 wherein the zener diode is incorporated into the thyristor.

12. A circuit according to any one preceding claim wherein the control circuit includes means responsive to the current applied to it through the ballast impedance tending to open-circuit the switch whenever that current reaches a particular value.

13. A circuit according to any one of claims 1 to 11 wherein the control circuit includes an oscillator producing a rectangular wave for controlling the conductivity of the switch, the rectangular wave having a frequency and a mark to-space ratio matched to the charge and discharge characteristics of an inductive ballast impedance with which the starter circuit is intended to be used.

14. A circuit according to any one preceding claim wherein the control circuit includes means for delaying the start of the switching cycles for a period of time after switching on the a.c. supply, thereby to permit the cathodes of the lamp to be preheated before voltage pulses are applied to the lamp.

15. A circuit according to any one preceding claim wherein the control circuit includes a timing circuit responsive to the period of time for which the a.c. supply has been switched on, to terminate the switching cycles after a predetermined time period.

16. A circuit according to any one preceding claim constructed using electrical analogue circuit techniques.

17. A circuit according to any one of claims 1 to 15 constructed using digital circuit techniques.

Revendications

1. Circuit de starter destiné à un tube fluorescent alimenté en en courant alternatif et comportant des cathodes avec des filaments de chauffage et une impédance inductive de ballast branchés en série avec la lampe sur une alimentation en courant alternatif et dans lequel, lors de l'utilisation, le circuit de starter est branché

entre las cathodes de la lampe elle-même, dans lequel le circuit de starter comprend un interrupteur et un circuit de commande de l'interrupteur qui est sensible à la présence d'une tension aux bornes de la lampe pour commander l'exécution par l'interrupteur d'un cycle de liaisons des cathodes de la lampe entre-elles par l'intermédiaire d'un circuit à faible résistance et d'interruptions consécutives de cette liaison plusieurs fois pendant une demi-période de l'alimentation en courant alternatif, le circuit de starter, lorsqu'il est utilisé, causant l'application par l'impédance de ballast d'une succession correspondante d'impulsions de tension à la lampe.

2. Circuit selon la revendication 1, comportant des moyens sensibles à l'apparition d'un changement de cractéristique de la tension aux bornes de la lampe, qui est significatif de l'amorçage de la lampe afin de mettre fin aux cycles de fonctionnement de l'interrupteur pendant au moins le reste de la demi-période particulière de l'alimentation en courant alternatif pendant laquelle se produit le changement de caractéristique de la tension aux bornes de la lampe.

3. Circuit selon la revendication 2, dans lequel le circuit de commande comprend des moyens sensibles à la tension aux bornes de la lampe, n'excédant pas une valeur prédéterminée significative de ce que la lampe a été amorçée afin d'empêcher l'interrupteur de fermer la connexion aux bornes de la lampe.

4. Circuit selon la revendication 2 ou 3, dans lequel le changement de caractéristique aux bornes de la lampe est une diminuation rapide de cette tension qui se produit avant que la tension ne tombe en dessous d'une valeur de seuil.

5. Circuit selon la revendication 2 ou 3, dans lequel la variation de caractéristique dans la tension aux bornes de la lampe est une réduction de la durée de l'impulsion de tension aux bornes de la lampe.

6. Circuit selon la revendication 5, comportant une diode Zener branchée en parallèle avec l'interrupteur en vue de limiter la tension des impulsions produites par l'impédance ballast, dans lequel la modification de caractéristique de la tension aux bornes de la lampe est détectée par des moyens sensibles au courant traversant la diode Zener.

7. Circuit selon l'une quelconque des revendications 1 à 5, comportant un redresseur à travers lequel l'interrupteur et le circuit de commande sont reliés aux cathodes du tube de telle manière que la tension alternative aux bornes de la lampe est appliquée sous forme redressée à l'interrupteur et au circuit de commande.

8. Circuit selon la revendication 7, dans lequel le redresseur est un redresseur double alternance.

9. Circuit selon la revendication 7 ou 8, dans lequel l'interrupteur est un thyristor conçu de manière à nécessiter un courant de maintien élevé pour maintenir la conduction ou encore qui est capable d'être bloqué par un signal appliqué à sa porte et le circuit de commande est branché de manière à appliquer et interrompre un courant envoyé à la porte du thyristor.

10. Circuit selon la revendication 9, comportant une didode Zener branchée en parallèle sur le circuit de courant commandé du thyristor afin de limiter la tension des impulsions produites par l'impédance ballast lorsque le thyristor est bloqué.

11. Circuit selon la revendication 10, dans lequel la diode Zener est incorporée dans le thyristor.

12. Circuit selon l'une quelconque des revendications précédentes, dans lequel le circuit de commande comprend des moyens sensibles au courant qui lui est appliqué par l'intermédiaire de l'impédance ballast et susceptibles d'ouvrir le circuit de l'interrupteur chaque fois que ce courant atteind une valeur particulière.

13. Circuit selon l'une quelconque des revendications 1 à 11, dans lequel le circuit de commande comprend un oscillateur produisant une onde rectangulaire destinée à commander la conductibilité de l'interrupteur, cette onde rectangulaire ayant une fréquence et un taux d'impulsions adaptés à la charge et à la décharge caractéristique d'une impédance inductive de ballast avec laquelle on désire utiliser le circuit de starter.

14. Circuit selon l'une quelconque des revendications précédentes, dans lequel le circuit de commande comprend des moyens pour retarder le début des cycles de commutation pendant une période de temps suivant le branchement de l'alimentation en courant alternatif, de manière à permettre de préchauffer les cathodes de la lampe avant que les impulsions de tension ne soient appliquées à la lampe.

15. Circuit selon l'une quelconque des revendications précédentes, dans lequel le circuit de commande comprend un circuit de temporisation sensible à la période de temps pendant laquelle l'alimentation en courant alternatif a été branchée afin de faire cesser les cycles de commutation après une période de temps prédéterminée.

16. Circuit selon l'une quelconque des revendications précédentes, construit en utilisant des techniques des circuits électriques analogiques.

17. Circuit selon l'une quelconque des revendications 1 à 15, construit en utilisant des techniques des circuits numériques.

Ansprüche

1. Zündschaltung für eine wechselstromgespeiste Leuchtstofflampe, die mit Heizelementen versehene Katoden und eine induktive Ballastimpedanz in Serie zu der Lampe an der Wechselstromversorgung aufweist, wobei im Betrieb die Zündschaltung zwischen den Katoden der Lampe liegt und wobei die Zündschaltung einen Schalter und eine Steuerschaltung für den Schalter enthält, der abhängig von der Anwesenheit einer Spannung an der Lampe den Schalter veranlaßt, einen Zyklus auszuführen, bei dem die Katoden der Lampe über einen niederohmigen Weg verbunden werden und daraufhin die Verbindung zwischen ihnen mehrmals in einem halben Zyklus der Wechselstromversorgung unterbrochen wird, wodurch die Zündschaltung im Betrieb die Ballastimpedanz veranlaßt, eine entsprechende Folge von Spannungsimpulsen an die Lampe anzulegen.

2. Schaltung nach Anspruch 1, mit einem Mittel, das abhängig vom Auftreten einer charakteristischen Änderung der Spannung an der Lampe, die das Ansprechen der Lampe anzeigt, die Betriebszyklen des Schalters für zumindest den Rest des betroffenen Halbzyklus der Wechselstromversorgung beendet, in dem die charakteristische Änderung der Spannung an der Lampe auftritt.

3. Schaltung nach Anspruch 2, bei welcher die Steuerschaltung ein Mittel enthält, das abhängig davon, daß die Spannung an der Lampe einen voreingestellten Wert nicht übersteigt, der anzeigt, daß die Lampe angesprochen hat, den Schalter daran hindert, die Verbindung parallel zur Lampe zu schließen.

4. Schaltung nach Anspruch 2 oder 3, bei welcher die charakteristische Änderung der Spannung an der Lampe ein schneller Spannungsabfall ist, der eintritt, bevor die Spannung unter einen Schwellenwert absinkt.

5. Schaltung nach Anspruch 2 oder 3, bei welcher die charakteristische Änderung der Spannung an der Lampe eine Reduzierung der Dauer der Spannungsimpulse an der Lampe ist.

6. Schaltung nach Anspruch 5, mit einer Zenerdiode, die parallel zu dem Schalter zur Begrenzung der Spannung der Impulse liegt, die von der Ballastimpedanz erzeugt werden, wobei die charakteristische Änderung der Spannung an der Lampe durch ein Mittel festgestellt wird, das auf den Strom durch die Zenerdiode anspricht.

7. Schaltung nach einem der Ansprüche 1 bis 5, mit einem Gleichrichter, durch den der Schalter und die Steuerschaltung mit den Katoden der Lampe verbunden sind, so daß die Wechselspannung an der Lampe in gleichgerichteter Form an den Schalter und die Steuerschaltung angelegt wird.

8. Schaltung nach Anspruch 7, bei welcher der Gleichrichter ein Vollweggleichrichter ist.

9. Schaltung nach Anspruch 7 oder 8, bei welcher der Schalter ein Thyristor ist, der so aufgebaut ist, daß er zur Aufrechterhaltung seines Leitungszustandes einen hohen Haltestrom erfordert oder auf andere Weise die Fähigkeit hat, durch ein an seinen Steueranschluß angelegtes Signal abgeschaltet zu werden, wobei die Steuerschaltung so angeschlossen ist, daß sie einen dem Steueranschluß des Thyristors zugeführten Strom ein- und ausschaltet.

10. Schaltung nach Anspruch 9 mit einer Zenerdiode, die parallel zum gesteuerten Stromweg des Thyristors geschaltet ist, damit die Spannung der von der Ballastimpedanz erzeugten Impulse begrenzt wird, wenn der Thyristor gesperrt ist.

11. Schaltung nach Anspruch 10, bei welcher die Zenerdiode in den Thyristor eingebaut ist.

12. Schaltung nach einem der vorhergehenden Ansprüche, bei welcher die Steuerschaltung ein Mittel enthält, das abhängig von dem ihr über die Ballastimpedanz zugeführten Strom das Öffnen des Schalters anstrebt, wenn der Strom einen bestimmten Wert erreicht.

13. Schaltung nach einem der Ansprüche 1 bis 11, bei welcher die Steuerschaltung einen Oszillator enthält, der zur Steuerung der Leitfähigkeit des Schalters eine Rechteckwelle erzeugt, deren Frequenz und Tastverhältnis an die Lade- und Entladecharakteristiken einer induktiven Ballastimpedanz angepaßt sind, mit der die Zündschaltung benutzt werden soll.

14. Schaltung nach einem der vorhergehenden Ansprüche, bei welcher die Steuerschaltung ein Mittel zum Verzögern des Beginns der Schaltzyklen für eine Zeitperiode nach dem Einschalten der Wechselstromversorgung enthält, wodurch sich die Katoden der Lampe vorheizen können, bevor Spannungsimpulse an die Lampe angelegt werden.

15. Schaltung nach einem der vorhergehenden Ansprüche, bei welcher die Steuerschaltung eine Zeitgeberschaltung enthält, die abhängig von der Zeitperiode, für deren Dauer die Wechselstromversorgung eingeschaltet worden ist, die Schaltzyklen nach einer vorbestimmten Zeitperiode beendet.

16. Schaltung nach einem der vorhergehenden Ansprüche mit einem Aufbau unter Anwendung der elektrischen Analogschaltungstechnik.

17. Schaltung nach einem der Ansprüche 1 bis 15 mit einem Aufbau unter Verwendung der digitalen Schaltungstechnik.

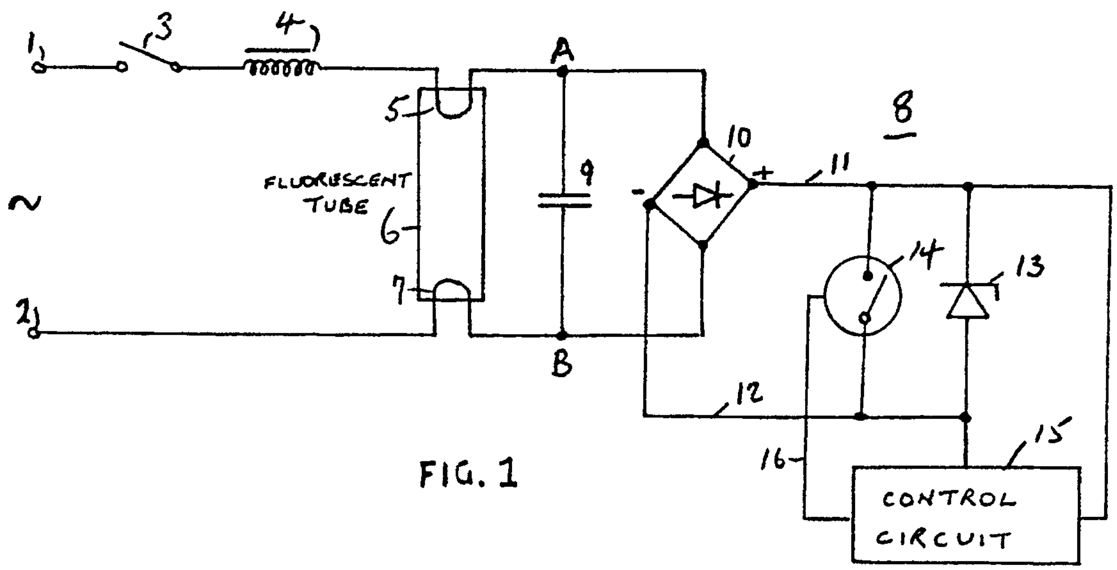
1
3
4
A
5
FLUORESCENT
TUBE
6
7
2
B
9
10
8
+
11
-
14
13
12
15
16
CONTROL
CIRCUIT

FIG. 1

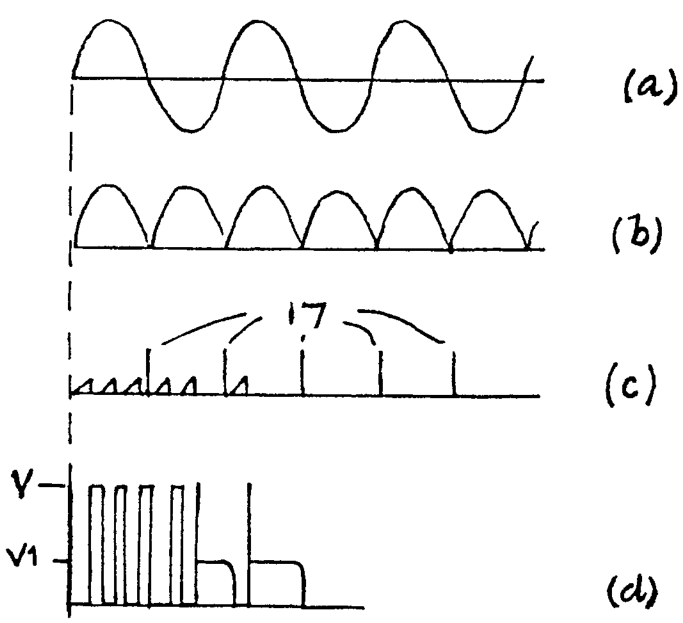
(a)
(b)
17
(c)
V
V1
(d)

FIG. 2

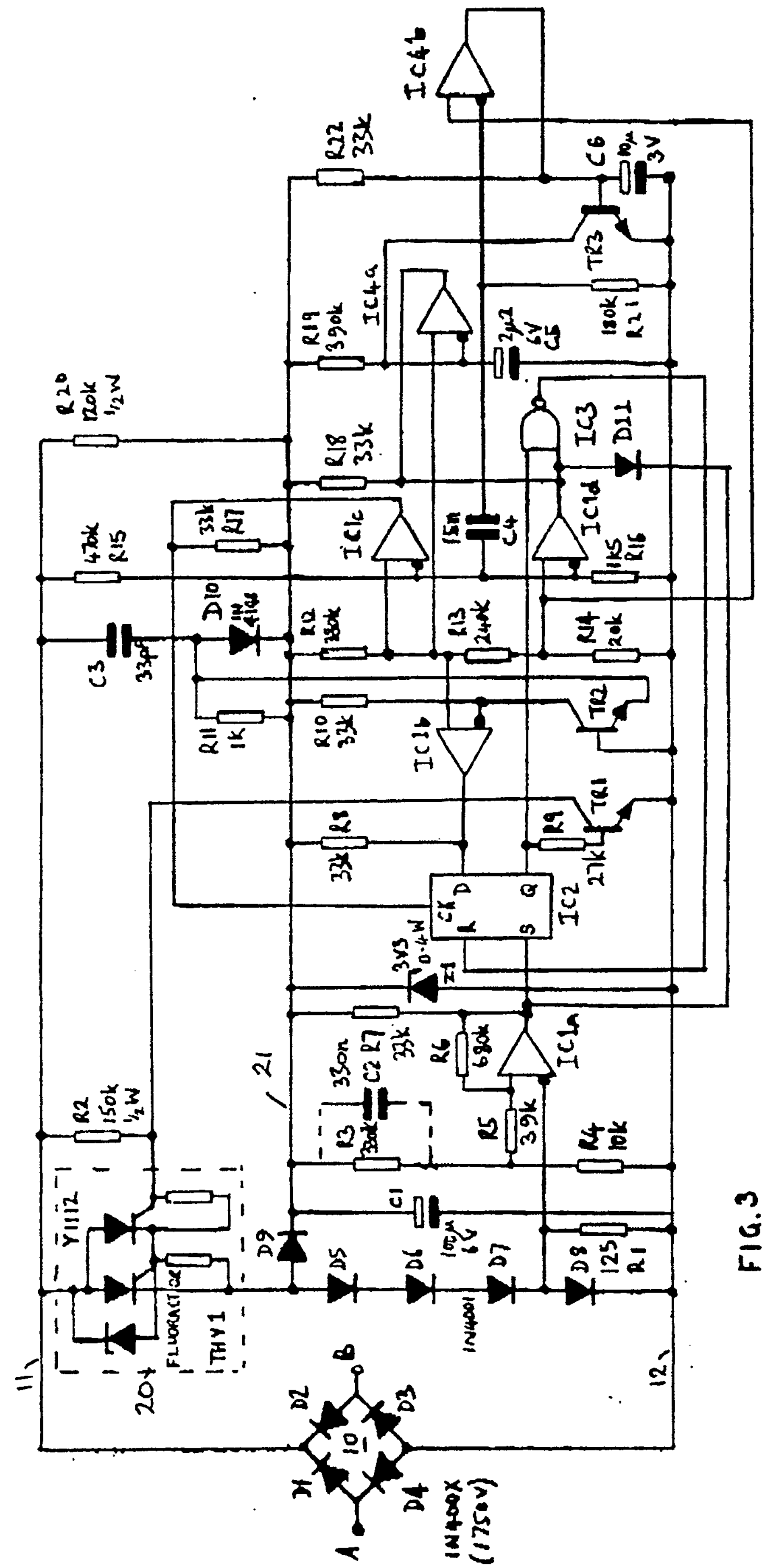
IC4b
R22 33k
C6
3V
TR3
IC4a
R19 390k
C5
R21 180k
R20 120k 1/2W
R18 33k
IC3
D11
R17 33k
IC1c
C4
IC1d
R15 470k
R16 1k5
D10
R12
R13
R14 20k
C3
TR2
R11 1k
R10 33k
IC1b
TR1
R8 33k
R9 27k
IC2
CK
D
Q
R
S
Z1
IC1a
R6 680k
21
C2
R7 33k
R3
R5 3.9k
R4 10k
R2 150k 1/2W
C1
D9
D5
D6
D7
D8
R1 125
1N4001
Y1112
FLUORACTOR
THY1
11
12
204
D1
D2
D3
D4
10
A
B
1N400X

FIG.3