

Dec. 2, 1958

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2,863,098

DEVICE FOR STARTING AND OPERATING GLOW DISCHARGE LAMP

Filed Oct. 26, 1954

2 Sheets-Sheet 1

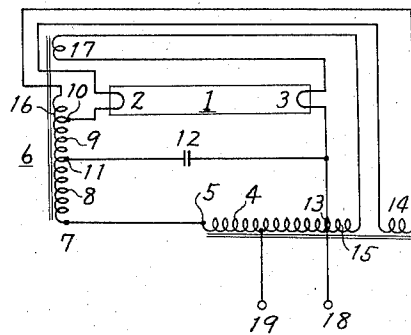


FIG. 1

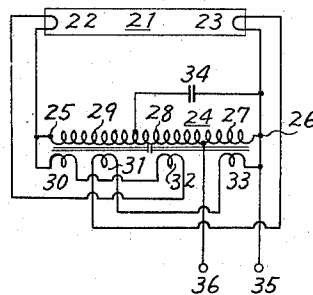


FIG. 2

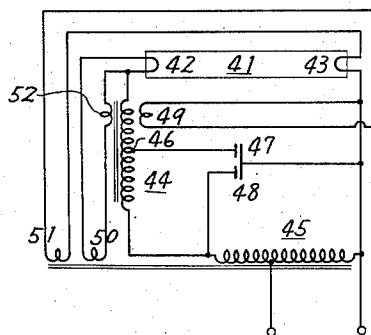


FIG. 3

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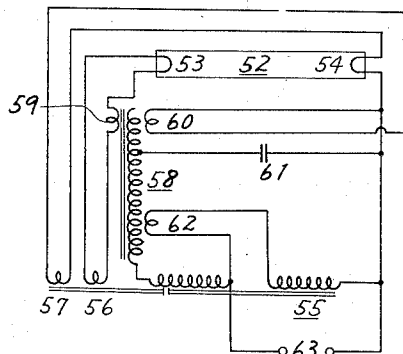


FIG. 4

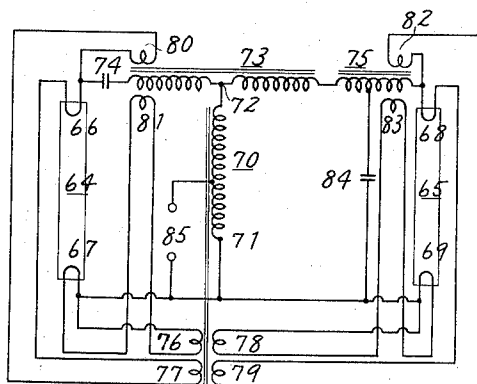


FIG. 5

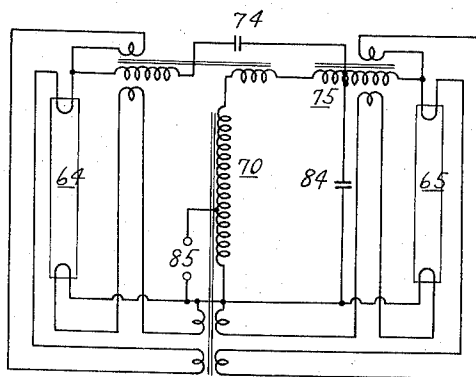


FIG. 6

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DEVICE FOR STARTING AND OPERATING GLOW DISCHARGE LAMP

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Application October 26, 1954, Serial No. 464,701

Claims priority, application Japan November 11, 1953

9 Claims. (Cl. 315—98)

This invention relates to a starting and operating device for glow discharge lamps, more especially to circuits for starting and operating hot cathode glow discharge lamps.

For lighting hot cathode glow discharge lamps, such as fluorescent lamps, it has hitherto been the practice to use thermo-responsive glow switches. However, a comparatively longer period of time is necessary for the lighting, and such switches, which are generally damaged within a short period of time, must be changed from time to time.

It is one object of the present invention to provide starting and operating circuits for glow discharge lamps by which the lighting thereof can be done much quicker and the cathode heating current can be decreased after lighting, without using glow switches.

Another object of the invention is to provide starting and operating circuits for glow discharge lamps by which a comparatively high voltage is impressed between the two cathodes at the same time as such cathodes are heated with a comparatively large current, prior to the starting of discharge, and also the cathode heating current as well as the voltage impressed on such glow discharge lamps can be decreased after lighting.

Another object of the invention is to provide starting and operating circuits for glow discharge lamps by which the lighting is done easily and quickly, and also the life of such glow discharge lamps can be made longer.

Still another object of the invention is to provide circuits for glow discharge lamps by which the variation of current flowing in the said lamps is made smaller in spite of the variation of frequency and voltage of the electric source.

In accordance with one feature of the invention, the device comprises a glow discharge lamp or lamps having hot cathode filaments, a choke coil with iron core, which has an intermediate tap and is connected between one of the above filaments and the energy supplying transformer, a condenser connected between the said intermediate tap and the other of the above filaments, transformer windings for cathode-heating, and coils which are connected between the said transformer windings and the hot cathode filaments and wound on the same core as that of the said choke coil.

In accordance with another feature of the invention, at the starting of the glow discharge lamps, a leading current flows in a part of the said choke coil through the said condenser, a voltage substantially in phase with that of the voltage source is induced, by the above leading current, to the other part of the said choke coil and the coils in the cathode filament heating circuits, whereby the voltage impressed on the discharge lamps and the cathode heating current are increased and therefore the starting of the glow discharge lamps can be done easily and quickly. After the discharge lamps are lighted, a lagging current flows in a part of the choke coil, a voltage substantially in counter-phase to that of the voltage

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source is induced in the said choke coil and the coils in the cathode heating circuits, whereby the voltage impressed on the discharge lamps and the cathode heating current are decreased and therefore, the electric power can be economized and the life of the discharge lamps can be made longer.

In accordance with another feature of the invention, the variation of the electric current flowing through the discharge lamps may be made smaller with regard to the variation of the frequency and voltage of the energy supplying source.

Other objects and features of the present invention can be made clear by the following description of embodiments given with reference to the accompanying drawings.

In the drawings, Fig. 1 shows a circuit diagram of one embodiment of the invention. Figs. 2, 3 and 4 show other embodiments which are modifications of the embodiment shown in Fig. 1. Fig. 5 shows still another embodiment in which two glow discharge lamps are used. Fig. 6 shows a modification of Fig. 5.

In Fig. 1, a gas filled glow discharge lamp such as a fluorescent lamp is shown at 1, which has hot cathode filaments 2 and 3. A transformer to be connected to the energy supplying source is shown at 4. One terminal 5 of the secondary winding of the said transformer is connected to one terminal of the hot cathode filament 2 through the terminal 7 of the choke coil 6, windings 8 and 9 which are the two parts forming the said choke coil and the terminal 10. The other terminal of the said secondary winding is connected to one terminal of the other hot cathode filament 3. The choke coil 6 is divided into two parts 8 and 9 at the intermediate terminal 11. The parts 8 and 9 are wound on the same core, and the said terminal 11 is connected to the junction point 13 of the cathode 3 and the secondary winding of the transformer 4 through the condenser 12. The windings 14 and 15 which are wound on the same core as that of the transformer 4, are connected respectively to the terminals of the hot cathodes 2 and 3 through the windings 16 and 17 which are wound on the same core as that of the choke coil 6.

The capacity of the condenser 12 is so selected as the leading current flows therein, overcoming the effect of the coil 8, in case the current does not flow in the glow discharge lamp 1.

Hereunder, we shall explain the operation of the device in accordance with the present invention. When the input terminals 18 and 19 of the transformer 4 are connected to the power source, the current flows through the output terminal 5 of the transformer 4, the choke coil 6, the intermediate terminal 11 and the condenser 12, to the other output terminal 13 of the transformer 4. The leading current, therefore, flows in the choke coil 8, and the electromotive force in phase with that of the terminal voltage of the coil 8 is induced in the coil 9 which is wound on the same core as that of the choke coil 8. And the electromotive force induced in the coil 9 is superposed to the output voltage of the transformer 4 and the terminal voltage of the coil 8 which is induced by the leading current, and therefore, a voltage higher than that of the source voltage is impressed between the terminals 10 and 13, namely between the cathodes 2 and 3.

On the other hand, a part of the source voltage is impressed on the cathode filaments 2 and 3 from the coils 14 and 15 which are wound on the same core as that of the transformer 4. Also, the secondary voltage induced in the coils 16 and 17 which is caused by the leading current passing through the choke coil 8 is added to the voltage of the said coils 14 and 15. This secondary volt-

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age is substantially in phase with the induced voltage of the coils 14 and 15, and flows through the hot cathode filaments 2 and 3. The cathodes 2 and 3 are rapidly heated and therefore the glow discharge lamp 1 is also rapidly lighted.

Once the glow discharge lamp is lighted, the current flows from one output terminal 5 of the transformer 4, through the choke coils 8 and 9, the cathode 2, the glow discharge lamp 1 and the cathode 3 to the other terminal 13 of the transformer 4. Since this current is a lagging current, the voltages induced across the choke coils 8 and 9 are in the counter-direction to the voltages which had been induced in the same part before lighting, and the voltage appearing between the terminals 10 and 13, namely the voltage impressed to the glow discharge lamp 1 is lowered down. At the same time, the vector of the voltage induced in the coils 16 and 17 is in the counter-direction to that before lighting, and the voltages applied to each of the cathodes 2 and 3 become the differences of the voltages induced in the coils 14 and 15 and the voltages induced in the coils 16 and 17, whereby the voltages applied to each of the filaments 2 and 3 are lowered down and the cathode current decreases.

Fig. 2 shows another embodiment of the invention, which is an improvement of that shown in Fig. 1. The only difference is that a single leakage transformer is used instead of the transformer 4 and choke coil 6 of Fig. 1. In Fig. 2, one end each of the hot cathode filaments 22 and 23 of the glow discharge lamp 21 is connected to the terminal 25 or 26 of the leakage transformer 24, and the leakage transformer 24 has the primary coil 27, the coil 28 forming the secondary winding coupled with the primary coil 27 and the choke coil 29. The transformer 24 also has the coils 30 and 31 which are coupled with the coil 29 and the coils 32 and 33 which are coupled with the coil 27. The coils 30 and 32, and the coils 31 and 33 are respectively connected in series with the hot cathode filaments 22 and 23. The condenser 34 is connected between the secondary windings of the leakage transformer 24. Input terminals 35 and 36 of the transformer 34 are connected to the power source.

The operation of the circuit shown in Fig. 2 is quite the same as that shown in Fig. 1. The construction is much simplified by the use of the leakage transformer.

Fig. 3 shows another embodiment, which is the same as that of Fig. 1, except the addition of a condenser across the transformer winding in order to improve the power-factor.

In Fig. 3, 41 shows a glow discharge lamp having hot cathode filaments 42 and 43. One end of the filament 42 is connected to one of the secondary terminals of the transformer 45 through a choke coil 44, and one end of the other filament 43 is connected to the other of the secondary terminals of the transformer 45. The said choke coil 44 has an intermediate tap 46. A condenser 47 is connected between the tap 46 and the terminal of the hot cathode filament 43. A condenser 48 is connected across the secondary terminals of the transformer 45. Preferably, the condensers 47 and 48 have one common electrode.

The filaments 42 and 43 are connected in series with the coils 48 and 49 coupled with the choke coil 44 and also with the coils 50 and 51 wound on the transformer 45.

The operation of the circuit shown in Fig. 3 is almost the same as that of Fig. 1, except that the power-factor is improved by the condenser 48, and that the condenser 48 coacts with the leakage inductance of the transformer 45 at the moment of lighting of the glow discharge lamp, whereby the secondary voltage of the transformer can be raised.

If the core of the transformer 45 is used at its somewhat saturated state, the variation of the magnetic flux density can be decreased with regard to the variation of

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the source voltage, whereby a substantially definite voltage is induced in the coils 50 and 51 of the filament heating transformer, and the lighting is made with stability with regard to the variation of the source voltage.

Fig. 4 is another improvement of the circuit which is shown in Fig. 1. Preferably, the hot cathode filaments 53 and 54 are connected in series with the coils 56 and 57 of the leakage transformer 55 and the coils 59 and 60 which are wound on the choke coil 58. A condenser 61 is connected between the intermediate tap of the choke coil 58 and the filament 54. The primary winding of the transformer 55 is connected in series with the coil 62 which is wound on the same core as that of the choke coil 58. Since the magnetic core of the transformer is saturated in this case, the primary current wave becomes steep at the crest of the alternating current wave, whereby a magnetic flux having a peak value is produced in the iron core of the choke and the starting of the glow discharge lamp is made easier.

Fig. 5 shows another embodiment of the invention. The two glow discharge lamps 64 and 65 have each hot electrodes 66 and 67 or 68 and 69. 71, one of the secondary terminals of the transformer 70 is connected to the hot cathode filament on one side of the glow discharge lamps 64 and 65. Other secondary terminal of the transformer 70 is connected through a first and third choke coil 73 and the condenser 74 to another hot cathode filament 66 of one glow discharge lamp 64 and is connected to the hot cathode filament 68 of the other glow discharge lamp 65 through a second choke coil 75. The filaments 66, 67, 68 and 69 of the glow discharge lamps 64 and 65 are connected in series with the coils 76, 77, 78 and 79 of the transformer 70 and the pairs of coils 80, 81, and 82 and 83 of the choke coils 73 and 75. The condenser 84 is connected between the intermediate tap of the choke coil 75 and the filaments 67 and 69 of the glow discharge lamps 64 and 65.

In case the input terminal 85 of the transformer 70 is connected to the power source, the glow discharge lamp 65 and then the glow discharge lamp 64 are lighted in the similar manner as that explained in connection with the Fig. 1. In this embodiment, however, the glow discharge lamps 64 and 65 are lighted alternatively, whereby the flickering of the light can be decreased.

The circuit of Fig. 5 can be modified as in Fig. 6. In this case, the circuit arrangement is the same as that of Fig. 5, except that the voltage is applied to 64, one of the glow discharge lamps, from the secondary of the transformer 70 through the intermediate terminal of a first choke coil 75 and the condenser 74.

Both in Figs. 5 and 6, the choke coils 73 and 75 can be wound on the same core.

While the principles of the invention have been described in connection with specific embodiments thereof, it is to be clearly understood that this description is made only by way of examples and not as a limitation of the scope of the invention.

I claim:

1. A starting and operating device for glow discharge lamps comprising two hot filament electrodes, a source transformer, a choke coil wound on an iron core and having an intermediate tap and being connected between one of the said electrodes and one terminal of the secondary of said source transformer, the other of said electrodes being connected to the other terminal of said source transformer, a condenser connected between the said intermediate tap and the other of said electrodes, coils for heating of said electrodes wound on the core of the said transformer, and coils for each of said electrodes wound on the iron core of the said choke coil, one of the said coils wound on the core of said transformer and one of said coils wound on the core of said choke coil being connected in series with each of the said hot filament electrodes.

2. A device as in claim 1, in which another condenser

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is connected between said one terminal of the secondary of the said transformer and the said condenser and having one electrode common with the said condenser which is connected between the intermediate tap of the choke coil and one of the hot filament electrodes.

3. A device as in claim 1, in which the transformer is a leakage transformer.

4. A device as in claim 1, in which the primary winding of the transformer is connected in series with another winding, the said another winding being wound on the same core as that of the choke coil.

5. A starting and operating device for glow discharge lamps comprising two hot filament electrodes, a leakage transformer having an intermediate tap, the output terminals of which are connected respectively to the said electrodes, two coils for heating the electrodes wound on the same core as the primary winding of the said leakage transformer, two coils wound on the same core as the other winding of the said leakage transformer, one of the coils on the same core as the primary winding and one of the coils on the same core as the other winding connected in series with one of the said hot electrodes, and a condenser connected between the intermediate tap of the said leakage transformer and one of the said hot electrodes.

6. A device as in claim 5, in which another condenser is connected between one terminal of the secondary of the said transformer and the said condenser and having one electrode common with the said condenser which is connected between the intermediate tap of the choke coil and one of the hot filament electrodes of the lamp.

7. A device as in claim 5, in which the primary winding of the transformer is connected in series with another winding, the said another winding being wound on the same core as that of the other winding of said leakage transformer.

8. A starting and operating device for a plurality of glow discharge lamps comprising at least four hot filament electrodes, two electrodes for each lamp, a source transformer, a first choke coil wound on an iron core, a second choke coil having an intermediate tap and wound on a second iron core, both of said choke coils being connected in series between one terminal of the secondary winding of said source transformer and one hot electrode of one of the said glow discharge lamps, the other terminal of said secondary winding being connected to the other hot electrode of the said one of said lamps, a condenser connected between the said intermediate tap and the other hot electrode of the said one

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of said lamps, a plurality of coils wound on the core of said transformer for heating said hot filament electrodes, a pair of coils wound on the core of the said second choke coil, each one of said pair of coils and one of said coils on the core of the transformer connected in series with one of the hot filament electrodes of said one of said lamps, a condenser and a third choke coil wound on an iron core connected in series between the said one terminal of the secondary winding of the source transformer and one electrode of another glow discharge lamp, and a pair of coils wound on the core of said third choke coil, each one of said pair of coils and one of the said coils on the core of said transformer connected in series with one of the hot filament electrodes of the said other glow discharge lamp.

9. A starting and operating device for a plurality of glow discharge lamps comprising at least four hot filament electrodes, two for each lamp, a source transformer, a first choke coil wound on an iron core and having an intermediate tap, said choke coil being connected between one terminal of the secondary winding of the source transformer and one hot electrode of one of the said glow discharge lamps, the other terminal of the secondary winding being connected to the other hot electrode of the said one of said glow discharge lamps, a condenser connected between the said intermediate tap and the other hot electrode of said one of said lamps, a plurality of coils wound on the transformer core for heating the hot filament electrodes, a pair of coils wound on the core of the said first choke coil, each one of said pair of coils on the core of the transformer connected in series with one of the hot filament electrodes of the said one lamp, a condenser and a second choke coil wound on an iron core connected in series between the said intermediate tap of the said first choke coil and one electrode of another glow discharge lamp, and a pair of coils wound on the core of the said second choke coil, each one of said pair of coils and one of the coils on the core of the said transformer connected in series with one of the hot filament electrodes of the said another glow discharge lamp.

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