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2,466,053

STARTING RELAY FOR FLUORESCENT LAMPS

Filed April 30, 1945

2 Sheets-Sheet 1

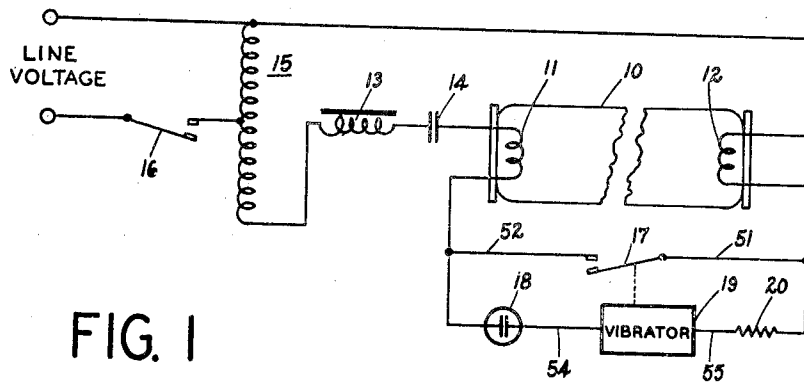


FIG. 1

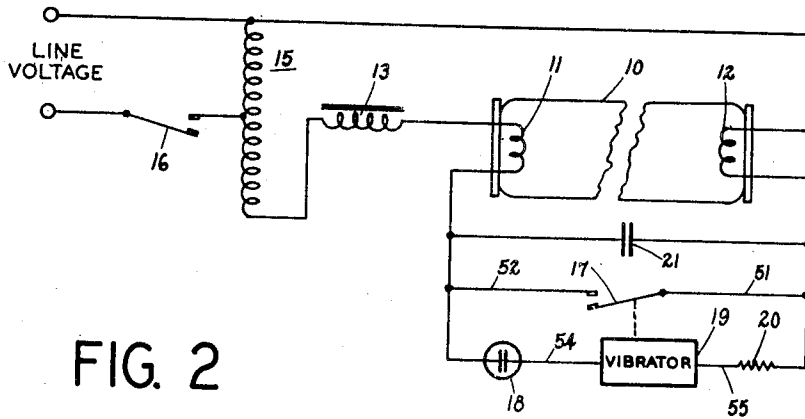


FIG. 2

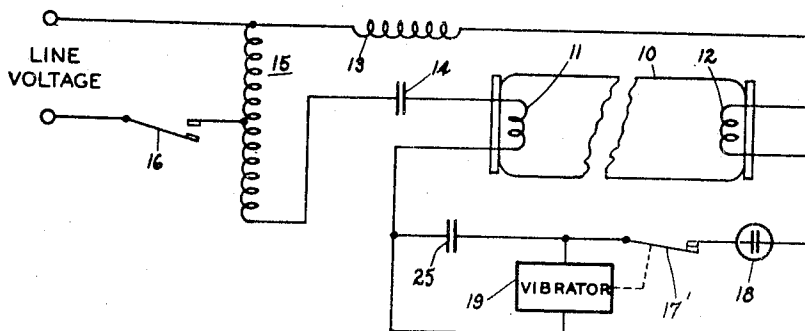


FIG. 3

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2 Sheets-Sheet 2

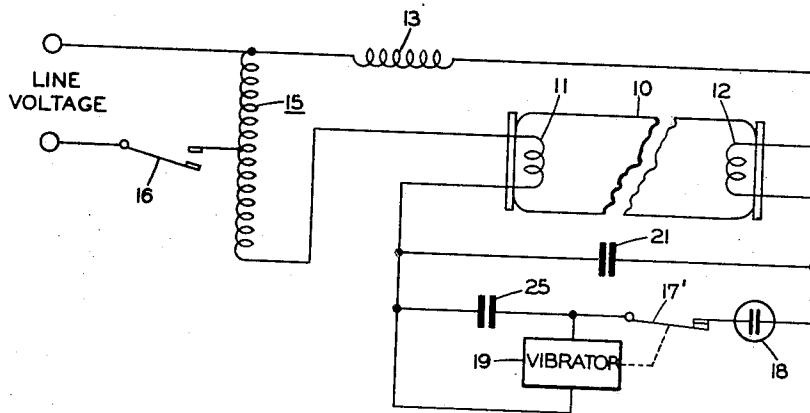


FIG. 4

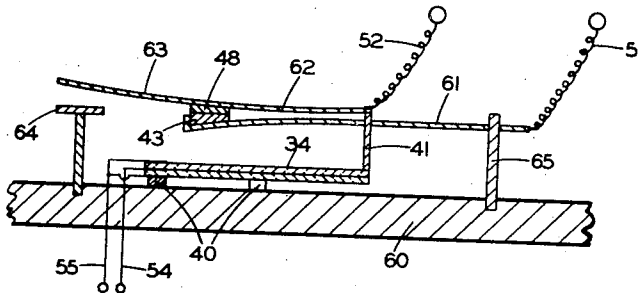


FIG. 5

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STARTING RELAY FOR FLUORESCENT LAMPS

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3 Claims. (Cl. 171-330)

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This invention relates to the control of electric discharge devices, and more particularly to the starting and operating of an electric discharge device such as a fluorescent lamp.

There has long been a need for a circuit and/or device for quickly starting a discharge device such as a fluorescent lamp after its switch is thrown, as one of the biggest drawbacks to fluorescent lamps is the time interval or lag between the instant a switch is thrown and the instant the lamp lights. This interval is often annoying and if the lamp is placed to illuminate stairs such as the basement stairs in a home it can be extremely dangerous.

Many of these lamps which exhibit objectionable lag provide a long time period after the switch is thrown to heat one or more of the filaments to an electron emissive temperature and then apply a voltage surge across the heated filaments to start the lamp.

Lamps have been made which are quick starting but they do not last long in service, due primarily to the fact that the quick starts tear too much of the activating material from the filaments of the lamp. These quick starting lamps may heat the filaments slightly and apply a moderately high voltage surge, or they may merely apply a very high voltage surge across cold filaments. The colder the filaments the higher the voltage surge should be, and the higher the voltage surge, the more the activating material is torn from the filaments with consequent shortening of lamp life. The hotter the filaments the easier the lamp will start, but heating requires time which is objectionable, and care must be exercised to keep the filaments from getting too hot as excess heating, both as to degree and duration, reduces lamp life.

It is an object of our invention to provide a lamp starting circuit and switch which will provide sufficient heating time and sufficient voltage in a surge to quickly start a discharge lamp yet which will allow good lamp life.

An object of the invention is to provide a new and improved circuit for starting an electric discharge device.

A further object of the invention is to provide a new and improved switch for use with circuits for starting an electric discharge device.

A further object of the invention is to provide equipment for starting fluorescent lamps which can readily be applied to existing fluorescent lamp installations.

Other objects and a fuller understanding of

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the invention will be had by referring to the following description and drawings wherein:

Figures 1 to 4 are diagrams of circuits for initiating discharge in electric devices, and Figure 5 illustrates a vibratile switch for use in the circuits of Figures 1 to 4.

In Figure 1 there is shown an electric discharge device 10 of the fluorescent tube type having coated filaments or cathodes 11, 12 at its ends, connected through ballast 13 and a condenser 14 to a source of voltage 15. This voltage source 15 may be line voltage for the smaller size lamps but for the larger sizes a transformer whose secondary output has a voltage on the order of twice line voltage is desirable. A normally open switch 16 of the manually operated type is provided between the source of line voltage and the transformer 15, and may be closed to light the lamp. Across the lamp electrodes 11, 12 there is connected a normally open switch 17, and in parallel with the switch there is a circuit including a glow tube 18 and a vibrator 19.

When it is desired that the lamp 10 be lit the switch 16 is closed, applying line voltage to the transformer 15. The transformer generates a voltage in the neighborhood of 200 to 250 volts. At this voltage the glow tube 18 is conducting making a circuit through the inductor 13, condenser 14, electrode 11, glow tube 18, vibrator 19 and electrode 12. This causes the vibrator 19 to vibrate and close the normally open switch 17 whose contacts remain closed for a sufficient length of time that current flowing through the switch circuit will heat at least one of the filaments 11, 12. The vibrator then opens the switch 17 and a voltage surge due to the inductance in the supply circuit, particularly from the transformer 15 and the ballast 13, is applied across the filaments 11, 12. This starts a continuous discharge in the tube 10 which maintains voltage drop across the filaments on the order of 108 volts which is insufficient to keep the glow tube 18 conducting. When the glow tube extinguishes breaking its circuit, the vibrator 19 stops vibrating and the switch 17 returns to and remains at its normally open position. If, for any reason, the voltage surge applied across filaments fails to initiate a steady discharge, the glow tube 18 will continue to be conducting and the vibrator 19 will close and reopen the switch 17 again. This operation will continue so long as the switch 16 is closed and the tube 10 fails to light.

If the vibrator 19 is of a type which may be damaged by a high voltage surge, such, for example, as a piezoelectric crystal, a resistor 20 may

3 be put in the vibrator circuit. This limits the voltage on the vibrator to a safe value.

The circuit of Figure 1 is utilized with a leading lamp and the circuit of Figure 2 is used with a lagging lamp. The circuits are practically the same except that for the lagging lamp the condenser 14 is omitted, but the operation of the two circuits is substantially identical.

The circuit for the lagging lamp includes a condenser 21 of from about .05 to .5 microfarad connected across the filaments 11, 12 in parallel with the switch 17. This tunes the inductor 13 at a frequency which is high with respect to the line frequency, for example 600 cycles per second if line frequency is about 60 cycles per second, thereby increasing the voltage of the surge and improving the starting characteristics of the lagging lamp to an extent such that it is easier to start then the leading lamp.

The contacts of the switch 17 carry most of the current which passes through the filaments and should be made of silver or tungsten to prevent sticking, and the contact break apart should be done quickly to reduce arcing and to increase the voltage of the surge across the filaments 11, 12. The vibrator and switch shown in detail in Figure 5 and described later is designed to maintain the contacts of switch 17 closed sufficiently long to obtain proper filament heating and to then quickly open the contacts to get a quick substantially sparkless contact break.

Figure 3 illustrates a circuit for use with a leading lamp. An advantage in this circuit is that the switch 17 is normally closed. Accordingly, practically instantaneously with the closing of switch 16 the lamp filament means begin to heat and by the time the vibrator 19 vibrates with sufficient amplitude to break the contacts of switch 17 apart the filament temperature has risen, and upon the voltage surge being applied across the filaments the lamp will light and maintain the discharge. In this circuit a condenser 25 is connected across the vibrator 19 and in series with the switch 17 and glow tube 18 for providing sufficient voltage to operate the vibrator and to limit the flow of current through the glow tube 18 to a value which will not destroy the glow tube 18. This circuit depends primarily upon a high voltage surge to light the lamp but the slight heating of the filaments is beneficial.

Figure 4 illustrates a circuit somewhat like the circuit of Figure 3 but adapted for a lagging lamp. The condenser 14 of Figure 3 is not utilized and a condenser 21 is connected across the filaments 11, 12 for tuning the inductor 13 to a frequency high with respect to the line frequency, as has been explained in connection with Figure 2.

Figure 5 illustrates the details of a switch for a lamp starting circuit of the type shown in Figure 3 wherein the switch 17 is normally closed.

A piezoelectric crystal element 34 of the multiple flexing type is mounted on a base 60 by means of mounting pads 40. A detailed description of the multiple flexing element may be had by referring to Sawyer, Re. 20,213 and Re. 20,680. The element preferably is of the "twister" type and is connected at three of its four corners of the base 60. If a "bender" crystal is used it may be preferable to use a somewhat oblong or trapezoidal shaped crystal instead of the square shape which is preferred in the "twister" crystal. A drive rod 41 is connected to the fourth or vibratile corner of the crystal 34 and is in driving engagement with an intermediate portion of the

spring contact arm 61. One end of the arm 61 is connected to the base 60 by the support 65 and the other end carries a contact 43. Thus the contact 43 will move with greater amplitude than the vibratile portion of the crystal 34. A second spring contact arm 62 carries a contact 48 which is positioned immediately above and in engagement with the contact 43. The arm 62 is connected at one end of the drive rod 41 and the other or free end 63 which extends beyond the contact 48 is positioned near a stop 64. The leads 51, 52 are connected, respectively, to the spring arms 61, 62 and the free ends of the leads are adapted to be connected to the lamp electrodes. In operation when the crystal 34 vibrates in accordance with an alternating signal between the leads 54, 55 both of the contact arms are vibrated. The upper spring system, which preferably has a resonant frequency equal to or greater than the resonant frequency of the lower spring system, follows the lower system thereby keeping the contacts 43, 48 in engagement with each other. During this time interval the current flowing through the contacts heats the lamp filaments 11, 12. When the amplitude of motion of the two contacts 43, 48 builds up sufficiently the arm extension 63 strikes the stop 64 thereby quickly breaking the contact engagement to establish the required voltage surge. If the lamp fails to light, the contacts 43, 48 will reengage for a fraction of a second and will then break apart again. This operation will continue until the lamp lights.

In operation the crystal element 34 vibrates at the line frequency, say 60 cycles per second, and the element preferably has a resonant frequency at or close to the line frequency so that maximum amplitude of motion of the drive wire 41 is obtained.

The best time to break the circuit is when the voltage across the filaments is near its maximum and when the current is also near its maximum. However, even then the voltage surge due to breaking the current might be negative with respect to the voltage across the filaments, resulting in a low voltage surge. This is an added reason for increasing the rapidity at which the switch contacts break in order to obtain a contact break when the voltage due to breaking the current is high and of the same polarity as the voltage across the filaments which should be near its maximum.

For the lagging lamp, a condenser 21 is connected across the lamp filaments tuning the choke 13 to a frequency which is high compared to the line frequency, say, for example, 600 cycles per second. This increases the probability of the lagging lamp starting as it establishes a large number of voltage surges in each cycle as the circuit is broken. These voltage surges are added to the voltages due to breaking the current and to the voltage across the lamp, resulting in an extremely high surge if the circuit conditions are such that they are all near their maximum in one direction. If the circuit conditions are not ideal upon the first break but the switch makes and breaks rapidly, perhaps 60 times per second, then a break will soon occur when the circuit conditions are good enough to ignite the lamp.

While we have described our invention with a certain degree of particularity it is to be understood that the illustrated means are by way of example, and that changes may be made in the construction and arrangement of parts without

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departing from the spirit and scope of our invention.

We claim as our invention:

1. A starting relay comprising, in combination, a base, a first spring arm connected at one of its ends to said base, first electrical contact means connected to said first arm at a location spaced from said connected end, the said first arm and said first electrical contact means constituting a first spring system having a given resonant frequency, electromechanical transducer means connected to said base, a second spring arm connected at one of its ends to said electromechanical transducer and adapted to be driven thereby, second electrical contact means connected to said second arm and normally in electrical engagement with said first electrical contact means, said second arm and said second electrical contact means constituting a second spring system having a resonant frequency greater than the resonant frequency of said first spring system, driving means connecting said transducer to said first spring system, and means for limiting the amplitude of motion of one of said spring systems without limiting the amplitude of motion of the other spring system.

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2. The invention set forth in claim 1 further characterized by said amplitude limiting means limiting the amplitude of motion of said second spring system.

3. The invention set forth in claim 1, further characterized by said driving means connecting said transducer to said first spring system at a point between said first contact means and the end of said first spring arm which is connected to said base.

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