Feb. 14, 1950 T. W. FRECH 2,497,542

TIME DELAY MAGNETIC STARTER

Filed June 27, 1947

Fig. 1

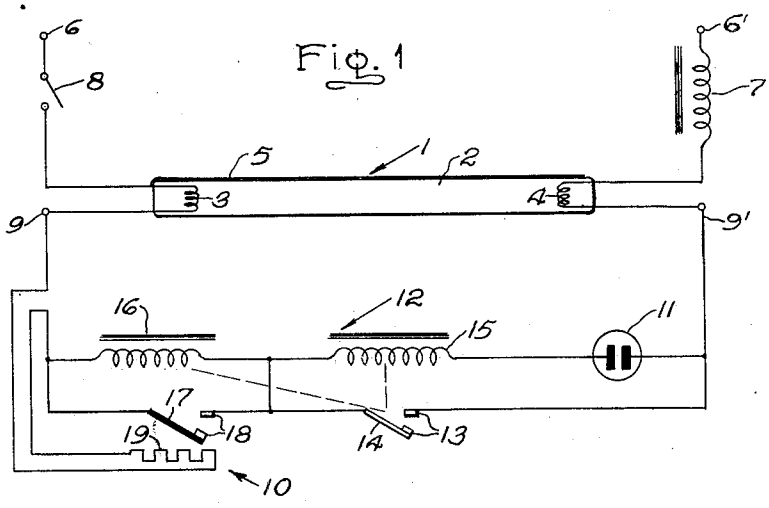


Fig. 2

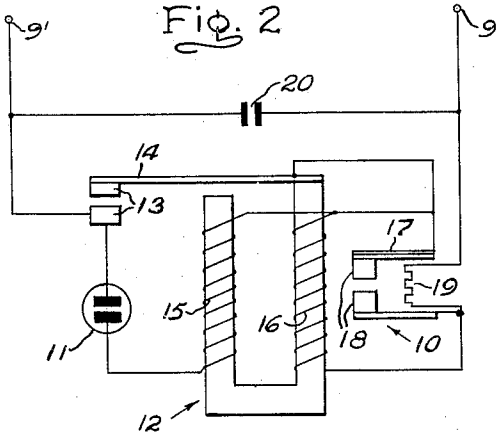


Fig. 4

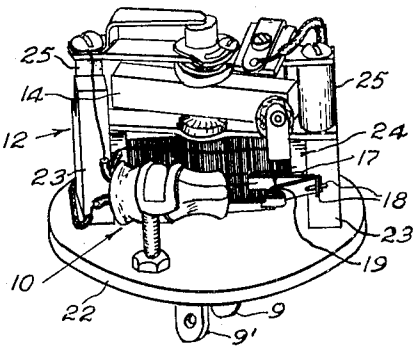


Fig. 3

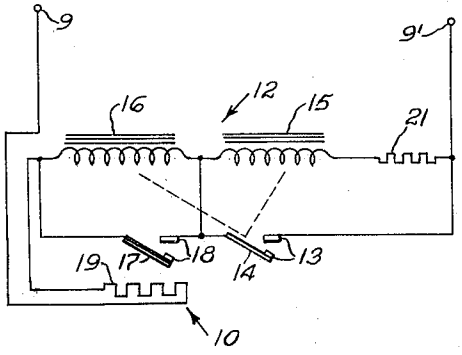
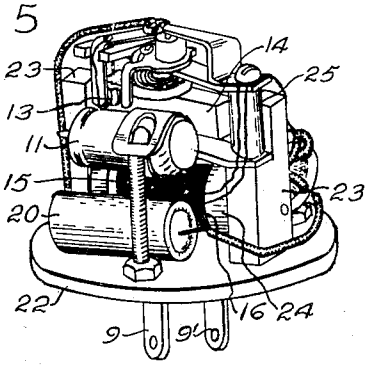


Fig. 5



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TIME DELAY MAGNETIC STARTER

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10 Claims. (Cl. 315—100)

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My invention relates to electric discharge devices of the type employing ionizable mediums such as gases or vapors, and more particularly to starting and operating devices and circuits therefore.

Circuits now in wide use with fluorescent lamps are provided with means for heating the filamentary electrodes and for impressing a high voltage for a short duration across the electrodes for starting an electrical discharge therebetween. Some of these arrangements are provided to delay the application of the high voltage until the electrodes have reached the desired electron emitting temperature. In prior art arrangements the delay means or switch provided relatively slow starting occasioned by lingering preheating periods, and varying or erratic operating characteristics with age.

An object of my invention is to provide a new and improved circuit for starting and operating electrical discharge devices employing filamentary electrodes.

Another object of my invention is to provide a new and improved means for impressing starting voltages across filamentary electrodes of an electric discharge device which after a predetermined inverval of time after the initiation of current flow through the electrodes impresses starting and operating voltages thereacross.

A further object of my invention is to provide a new and improved starting device for electric discharge devices which embodies a repetitive magnetic switch of the vibratory type accurately controlled by a thermal element.

In accordance with my invention I provide a new and improved starting device and system for fluorescent lamps wherein there is obtained an accurately determined and uniform period of electrode preheating which is reduced to a minimum or optimum value without sacrificing adequate preheating of the electrodes, thereby substantially avoiding the undesirable long waits in starting the lamps but without imposing severe operating conditions on the lamps.

Further features and advantages of my invention will appear from the following description of species thereof.

For a better understanding of my invention reference may be had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. Fig. 1 is a diagrammatic view of an electric discharge device and a starting and operating circuit therefore incorporating my invention. Fig. 2 illustrates schematically the time

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delay magnetic starter shown in the circuit of Fig.1. Fig. 3 illustrates a modification of the starting and operating circuit shown in Fig. 1. Figs. 3 and 4 illustrate a commercial embodiment of a starting device embodying certain aspects of my invention.

Referring to Fig. 1, I have there illustrated one embodiment of my invention as applied to an electric discharge device 1. The electric discharge device 1, such as a fluorescent lamp, therein illustrated comprises an elongated tubular or cylindrical envelope 2 having sealed into the ends thereof filamentary electrodes 3 and 4, each herein illustrated as comprising a coil, preferably in the form of a coiled coil of tungsten wire activated with oxides of alkaline earth metals, such as a mixture of barium and strontium oxides. The envelope 2 contains an ionizable atmosphere such as a rare gas-like neon, argon or mixtures thereof at a pressure of a few milimeters and a small quantity of mercury which, during the operation of the lamps, has a low pressure of the order of 10 microns. The device 1 may be a low pressure positive column lamp of the fluorescent type provided with a suitable phosphor or fluorescent coating. This fluorescent coating upon excitation by the radiation produced by an electric discharge between the electrodes, transforms a shorter wave radiation due to the discharge into longer wave radiation such as radiation within the visible range. For ease of starting, a stripe of strip 5 of conductive material which, for example, may be a metallic paint or graphite mixed with potassium silicate, may be applied to a surface of the envelope. The starting strip 5 may be connected to one or both of the electrodes.

In accordance with my invention the device 1 is connected across a suitable power supply circuit 6, 6' which for example may be a 115 volt, 60 cycle alternating current source, for supplying current to device 1 through the usual ballast 7 which serves as a starting inductance. A manual make and break control switch 8 may be used to connect device 1 to the power supply. A starting and operating circuit 9, 9' comprising a parallel circuit, including two branches in series with a thermal switch 10 and thermionic electrodes 3 and 4 of device 1, may include a voltage sensitive means 11 and a repetitive magnetic switch 12 comprising contact means 13, an armature 14, and a pair of high and low impedance winding means 15 and 16, respectively. The thermal switch 10 comprises a bi-metal strip 17, contacts 18 and a heater element 19 and may be, for example, a thermal switch such as that dis-

closed and claimed in United States Patent No. 2,236,697, granted April 1, 1941, on an application of L. R. Peters and assigned to the assignee of this application. The contact means 13 of the repetitive magnetic switch 12 shunts the voltage sensitive means 11 and the high impedance winding means 15, and the contacts 18 of the thermal switch 10 shunt the low impedance winding means 16. Heater element 19 of the thermal switch 10 is in series relationship to both the electrodes 3, 4 and the parallel branches of the starting circuit 9, 9'. The voltage sensitive means 11, for example, may be a glow discharge device having a critical or minimum break-down voltage or it may be a high resistance means. Preferably, such a glow discharge device has a critical breakdown voltage greater than the operating voltage of device 1 and less than the starting voltage produced by the change of current through the ballast 7. The repetitive magnetic switch 12, for example, may be an electromagnet ignition arrangement provided with normally open contact means 13. The thermal switch 10 is a time delay arrangement provided with a bi-metal strip 17, having normally open contacts 18. The heating element 19, positioned in heat transfer relation with the bi-metal strip 17, serves as an actuating means for the thermal switch.

One branch of the parallel circuit forming part of the starting and operating circuit 9, 9' contains the voltage sensitive means 11 in series with the high and low impedance windings 15 and 16, respectively, of the repetitive magnetic switch 12. The other parallel branch of circuit 9, 9' contains the contact means 13, an armature 14 of the repetitive magnetic switch 12 in series with the contacts 18 and the bi-metal strip 17 of the thermal switch 10.

When the entire installation is energized by closing switch 8, current flows through the ballast 7, thermionic electrode 4, voltage sensitive means 11, high impedance winding means 15, low impedance winding means 16, heater element 19, and filamentary electrode 3. The high impedance winding means 15 and the low impedance winding means 16 actuate the armature 14 substantially instantaneously so that the normally open contact means 13 engage each other and short circuit the voltage sensitive means 11 and the high impedance winding 15. Contact means 13, however, remain closed by reason of the magnetic attraction of the low impedance winding 16 for armature 14. Preheating current thus continues to flow through the ballast 7, electrode 4, contact means 13, armature 14, low impedance winding means 16, heater element 19, and electrode 3 until the heater element 19 actuates the bi-metal strip 17 which in turn closes the normally open contacts 18 of the thermal switch 10 and shunts the preheating current around the low impedance winding means 16. Upon de-energization of the low impedance winding means 16, armature 14 is released and the current flowing through the filamentary electrodes 3 and 4, and the ballast or inductance 7 is rapidly reduced. At this point the filamentary electrodes 3 and 4 are sufficiently heated to support an electrical discharge therebetween, and the induced voltage supplied by the inductance 7 initiates an arc discharge between the electrodes. When the discharge has taken place, the voltage between the electrodes 3 and 4 drops to an operating voltage, as for example 60 volts. The voltage sensitive means is so designed that its operating voltage is above this value and for all practical purposes the starting circuit is disconnected from the discharge circuit. The thermal switch 10 thereupon cools, its contacts 18 open, and the switch is ready for another cycle of starting operations.

If device 1 does not ignite at the first opening of the contact means 13 of the repetitive magnetic switch 12, current again flows through electrode 4, voltage sensitive means 11, high impedance winding means 15, contacts 18, bi-metal strip 17, heater element 19, and electrode 3. Contacts 18 at this point are still in engagement with each other because the design of the thermal switch is such that momentary interruptions of current through its heater element will not open its contacts. Upon the flow of current again through the high impedance winding means 15, armature 14 is actuated substantially instantaneously so that the normally open contact means 13 again engage each other and short circuit the voltage sensitive means 11 and the high impedance winding 15. Contact means 13 however, do not remain closed upon this second starting operation because the low impedance winding means 16 normally used for retaining the contact means 13 in engagement with each other is not energized, but short circuited by the thermal contacts 18. Thus, the electromagnet switch operates as a repetitive magnetic switch until the discharge device 1 ignites.

The ignition or starting devices and circuits may be adjusted to the discharge device 1 in such a manner that if the device 1 is faulty or non-operative the repetitive magnetic switch 12 will cease to operate after a predetermined number of starting attempts. This is commonly known as the "lock-out" arrangements in the prior art. Although the "lock-out" arrangement is not herein shown or described it may be applied to this circuit.

Fig. 2 incorporates the same corresponding parts shown in Fig. 1, but illustrates more in detail the component parts thereof. A condenser 20 shunts the starting devices of the starting circuit 9, 9'.

Fig. 3 illustrates a modification of the starting circuit shown in Fig. 1 and incorporates the same described corresponding parts thereof except the voltage sensitive means 11 therein illustrated as a glow lamp is replaced by a high resistance element 21. If desired, instead of using a glow lamp or a separate resistance element, the winding means 15 and 16 may be designed to afford sufficient resistance or impedance in themselves for connection in the circuit.

Figs. 4 and 5 illustrate a commercial embodiment of my invention.

In accordance with my invention, I provide a starting and operating device and circuit which will after a predetermined interval of time after the initiation of current flow through the electrodes impress an operating voltage thereacross. Accordingly, I provide a repetitive magnetic switch of the vibratory type accurately controlled by a thermal element.

Generally speaking I provide a starting device which will ignite an electric discharge device one second after the initiation of current flow through the electrodes thereof. As indicated in Figs. 4 and 5, I have therein illustrated a commercial embodiment of my invention comprising an insulating disc or member 22, a core structure supported by disc 22 and comprising a pair of

vertical magnetic members 23 and a horizontal magnetic member 24 bridging vertical members 23 of the magnetic switch 12, a horizontal rotatable armature 14 supported by a non-magnetic structure 25 mounted on vertical members 23 and supporting at one end thereof the movable portion of contact means 13, stationary contact means 13, and actuating winding means 15 and 16 wound about horizontal member 24. Contact means 13 comprising the stationary contact and the movable contact are actuated by armature 14 and are connected across winding means 15 and glow switch 11. Glow discharge device 11 has a critical breakdown voltage and is designed to establish closure of contact means 13 during an accurately determined interval of time. Contacts 18 of thermal switch 10 are connected across actuating winding means 16 for controlling the time delay between the time of energization of winding means 15 and 16 and the time of initiation of vibratory operation of armature 14. Condenser 20 is supported on member 22 and shunts the complete starting circuit 9, 9 incorporating my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a starting device for electric discharge devices having at least one filamentary electrode, the combination comprising a repetitive magnetic switch comprising normally open contact means, an armature and actuating winding means, said contact means being connected across a portion of said actuating winding means, and a thermal switch comprising normally open contacts connected across a different part of said actuating winding means and a heater element located to actuate said contacts to closed position when heated and connected in series with said part of said actuating winding means to establish closure of said contact means during an accurately determined interval of time.

2. In a starting device for an electric discharge device of the type employing a filamentary electrode, the combination comprising a repetitive magnetic switch of the vibratory type having contact means connected in series relation with said electrode, actuating winding means and an armature for actuating said contact means, a voltage sensitive device connected in series relation with said actuating winding means and having a critical breakdown voltage greater than the normal operating voltage of said discharge device, said contact means being connected across a portion of said winding means and the said voltage sensitive device, and a thermal means comprising contacts connected across a different part of said actuating winding means and a heater element connected in series relation with said part of said actuating winding means for short-circuiting said part of said actuating winding means a predetermined interval of time after the initiation of current flow through said electrode to cause said magnetic switch to open, said voltage sensitive element effecting subsequent energizations of the first-mentioned portion of said actuating winding means to cause repetitive closures of said magnetic switch irrespective of the condition of said thermal element when said discharge device fails to conduct initially.

3. In combination, an alternating current supply circuit, an electric discharge device comprising at least one filamentary electrode and employing an ionizable medium, an inductive ballast in series with said device, and a starting device

connected across said electric discharge device in series with said filamentary electrode and comprising a repetitive magnetic switch including normally open contact means, an armature and actuating winding means, said contact means being connected across a portion of said winding means, and a thermal switch comprising normally open contacts across a different part of said actuating winding means and a heater element in series with said part of said actuating winding means to open said contact means at the end of a predetermined interval of time and to produce a transient starting voltage by the change of current through said ballast.

4. In a starting device for electric discharge devices having at least one filamentary electrode, the combination comprising a repetitive magnetic switch comprising normally open contact means, an armature and actuating winding means, a glow discharge device in series with said actuating winding means and having a critical breakdown voltage greater than the normal operating voltage of said discharge device, said contact means being connected across a part of said actuating winding means and said glow discharge device, and a thermal switch comprising normally open contacts connected across a different part of said actuating winding means and a heater element in series with said magnetic switch and said glow discharge device to establish closure of said contact means during an accurately determined interval of time.

5. In combination with a gaseous electric discharge device comprising at least one filamentary electrode, a main discharge circuit connected to said electrodes, and means for preheating said electrodes comprising a starting circuit connected across said main discharge circuit through said electrodes, means for interrupting said starting circuit and imposing a starting voltage across said discharge device comprising a high resistance means in said starting circuit, a high impedance winding and a low impedance winding of a magnetic closing means in series with said high resistance means, and a low resistance means of a normally open thermal switch in series with said high resistance means and said high and low impedance windings, contact means actuated by said high and low impedance windings shunting said high resistance means and said high impedance winding, and normally open thermal means shunting said low impedance means.

6. A vibratory magnetic switch comprising an insulating member, a magnetic core structure supported by said member, an armature, actuating winding means and normally open contact means actuated by said armature, said contact means being connected across at least a part of said winding means, and a thermal switch including a heating element connected in series with said winding means and having normally open contacts actuated to closed position by said heating element upon heating thereof and connected across a different part of said winding means for controlling the time delay between the instant of energization of said winding means and the time of initiation of vibratory operation of said armature.

7. A vibratory magnetic switch comprising an insulating member, a magnetic core structure supported by said member, an armature, actuating winding means and normally open contact means actuated by said armature and connected across a part of said winding means, and a

thermal switch including normally open contacts connected across the remainder of said winding means for controlling the time delay between the time of energization of said winding means and the time of initiation of vibratory operation of said armature.

8. A voltage sensitive vibratory magnetic switch comprising an insulating member, a magnetic core structure supported by said member, an armature, actuating winding means and normally open contact means actuated by said armature and connected across at least a part of said winding means, a glow discharge device connected in series with said actuating winding means and having a critical breakdown voltage to establish closure of said contact means during an accurately determinable interval of time, and a thermal switch including normally open contacts connected across a different part of said winding means for controlling the time delay between the instant of energization of said winding means and the time of initiation of vibratory operation of said armature.

9. A starter comprising the combination of a magnetic relay including a high impedance actuating winding and a low impedance holding winding, an armature and a pair of normally open contacts actuated by said armature and connected in multiple with the high impedance winding and in series with the low impedance winding, and a thermal switch including a heater element connected in series with the relay windings and having normally open contacts actuated by said

heater element and connected in multiple with the said low impedance winding.

10. A starter comprising the combination of a voltage sensitive device, a magnetic relay including respectively high and low impedance actuating and holding windings in series with said voltage sensitive device, and a pair of normally open contacts actuated by said armature and connected in multiple with both the high impedance winding and the said voltage sensitive device, and a thermal switch including a heater element connected in series with the relay windings and the voltage sensitive device and having normally open contacts actuated by said heater element and connected in multiple with the said low impedance winding.

THEODORE W. FRECH.

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