

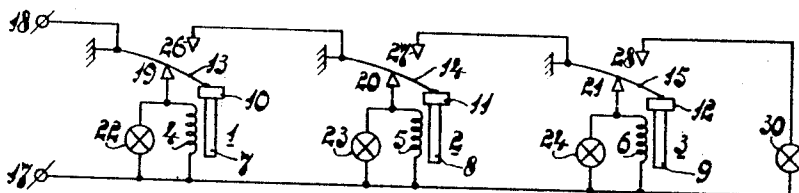
March 5, 1957

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2,784,355

TIME-LAG RELAY CIRCUIT

Filed Sept. 23, 1953



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TIME-LAG RELAY CIRCUIT

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Application September 23, 1953, Serial No. 381,928

Claims priority, application Netherlands October 3, 1952

3 Claims. (Cl. 317—133)

The invention relates to a relay circuit comprising the chain of two or more time-lag relays. A "time-lag relay" is to be understood to mean herein a relay, the switching mechanism of which becomes operative some time after the energizing condition of the relay has been changed. The term "chain" is to be understood to mean that the switching circuit of one relay is connected to the energizing circuit of the next-following relay, so that the change-over of the first relay varies the energizing condition of the last-mentioned relay.

The invention has for its object to utilize particularly the time interval between the instant when a switching cycle of the chain is initiated by a variation of the energizing condition of the first relay of the chain, produced by an independent excitation, i. e. an excitation not associated with the mechanism of the chain circuit, and the instant when the last relay of the chain changes over, for example, in order to derive a variation of the energizing condition of, for instance, a signalling apparatus from this change-over. It is particularly suitable for household purposes, in which after a predetermined time after a load, for example, an electric washing machine, has been switched in, a signal, for instance, an alarm signal is produced and/or the load is switched out.

The problem arises that, if a variation in the energizing condition of the relay of a chain has taken place and the initial condition is restored, the relay requires some time to function again under the initial conditions. In the case of thermal relays, for example, in which the time lag is obtained from the period required for heating a temperature-sensitive element of the relay, a certain "restoring" time is, of course, required to cool the element to its initial temperature after the heating circuit of such a relay has been interrupted. This "restoring" time is frequently longer than the time lag.

For the present purpose this property is undesirable, since it should be possible to initiate a new switching cycle at any instant and hence, if required, even immediately after a switching cycle has been completed. However, a new switching cycle should not be initiated without an independent excitation.

According to the invention use is made of time-lag relays of single switching operation, in which the switching cycle of the chain is initiated by varying the energizing condition of at least the first relay of the chain by excitation from without, the initial energizing condition of this relay being restored automatically, simultaneously with, or before the occurrence of, the variation of the energizing condition of the last relay of the chain produced by the mechanism of the chain.

The term "single switching operation" is to be understood to mean herein that after the variation in the energizing condition of the relay, the switching circuit changes over, but that after the initial energizing condition has been restored it does not return into its initial position.

In accordance with another feature of the invention use is made of thermal relays of a type comprising a ferromagnetic core, in which in known manner, when the Curie temperature of the core is exceeded, an armature falls off and moves to such a distance from the core that it is no longer lifted when the core returns to the initial temperature.

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In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawing, wherein the figure is a schematic diagram of a preferred embodiment of the present invention.

In the figure three thermal relays 1, 2 and 3, comprise heating windings 4, 5 and 6 and ferromagnetic cores 7, 8 and 9, which cooperate with armatures 10, 11 and 12 of permanent magnetic material, supported by springs 13, 14 and 15. The lower terminals of the heating windings 4, 5 and 6 are connected to one terminal 17 of a source of voltage and the spring 13 of the first relay is connected to the other terminal 18 of said source.

During operation a switching cycle is initiated, for example, simultaneously with the actuation of a load, by hand or by another independent operation, since the armatures 10, 11 and 12 are simultaneously urged against the cores 7, 8 and 9, where they remain, due to the retentivity of said armatures. The springs 13, 14 and 15 thus engage contacts 19, 20 and 21, connected to the upper terminals of the heating windings 4, 5 and 6. Thus from the moment when the armature 10 is urged against the core 7, a current from the supply source 17, 18 flows by way of the spring 13 and the contact 19 through the heating winding 4. This condition may, if desired, be indicated by a signalling lamp 22. After some time, referred to above as the "time lag," the core 7 assumes such a temperature, owing to the heating winding 4, that the Curie temperature of the core material is exceeded, so that it becomes non-magnetic and the armature 10 no longer engages the core 7. The spring 13 then engages a contact 26, connected to the spring 14, so that the heating winding 5 of the next following relay 2 is energized from the source 17, 18 via the switching elements 13, 26, 14, 20. The energization may, if desired, be indicated by a signalling lamp 23. In accordance with the invention, the heating winding 4 of the relay 1 is switched off simultaneously, since the spring 13 and the contact 19 are disengaged, while the spring force of the spring 13 and the switching path of the armature 10 are chosen to be such that, after cooling of the core 7, which thus regains its ferromagnetism, the armature 10 remains too far from the core 7 to be attracted automatically, which means that the relay 1 and also the relays 2 and 3 exhibit a single switching operation.

In a manner similar to that described with reference to relay 1, the relay 2 falls off after a certain time lag, which need, of course, not be equal to that of relay 1. The spring 14 engages a contact 27, connected to the spring 15, so that the heating winding of relay 3 is energized. This energization may be indicated by means of a signalling lamp 24. If finally also the armature 12 of relay 3 falls off after a certain time lag, an alarm device, for example, a clock or a signalling lamp 30, is energized through a contact 28, to mark the end of the switching cycle. Instead of the alarm device 30 a relay may be energized, with the aid of which the load switched in simultaneously with the initiation of the switching cycle may be switched off. This relay may, if desired, be economized by providing the relay 3 with a second interruptor (not shown), through which said load is switched off.

Since the relays exhibit a single switching operation and switch themselves out, adequate time is available for cooling the core 7 before the end of the switching cycle. Thus the device is immediately suitable for re-actuation; it does not start a new switching cycle spontaneously. Since the cooling time frequently exceeds the heating time, use is preferably made, in the case of relays of the said type, of at least three relays, so that the core of relay 1 may be cooled when relays 2 and 3 are not yet actuated. This applies particularly to the case

in which the final temperature which the core would assume by way of the heating winding, if it were not switched out, materially exceeds the Curie temperature. In general the cooling of relay 1 must start at the latest at the instant when the heating circuit of relay 3 is switched in.

The invention is not confined to the use of the magnetic relays shown in the drawing, although these relays are particularly suitable for the desired purpose. As an alternative, use may be made of other relays of single switching operation for example, the relays in which the time-lag is obtained by the delayed displacement of, for example, a liquid column, in conjunction with the use of a snap switch or those relays operating on the thermal expansion of a bi-metal, in conjunction also with the use of a snap switch. As a snap switch use may be made of a ferromagnetic relay comprising a magnet coil and an armature having a comparatively large switching path. In general, in such a relay a variation in the energizing condition will provide a delayed operation thereof, and the restoring of the initial energizing condition requires a period of time before the relay can again operate under the initial conditions.

While the invention has been described by means of a specific example and in a specific embodiment, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A relay system comprising a chain of interconnected relay circuits each including a thermal relay of a type having predetermined energization and deenergization operational time lags and comprising a heater element, a core of magnetic material in operative relation to said heater element and a switching element adapted to switch from one operative condition to another under the influence of the temperature of said heater element, each said switching element being adapted to switch from said one operative condition to said other operative condition when the temperature of its associated heater element exceeds a predetermined value and subsequent to said predetermined energization time lag and to remain at said other operative condition for at least said predetermined deenergization time lag when the temperature of its associated heater element is below said predetermined value, said predetermined temperature value of each said heater element being the Curie temperature of its associated core, means for applying a supply voltage between the first switching element and the first heater element of said relay circuits, means actuated by said first switching element in said one operative condition for applying said supply voltage to said first heater element thereby to energize said first heater element, and means actuated by said first switching element in said other operative condition for applying said supply voltage to the next succeeding heater element thereby to energize said next succeeding heater element, said means actuated by said first switching element in said one operative condition being deactuated upon the actuation of said last-mentioned means whereby said first heater element is permitted to cool by the time the heater element of the last of said relay circuits is energized.

2. A relay system comprising a chain of interconnected relay circuits each including a thermal relay of a type having predetermined energization and deenergization operational time lags and comprising a heater element, a core of magnetic material in operative relation to said heater element and a switching element adapted to switch from one operative condition to another under the influence of the temperature of said heater element and comprising an armature of permanent magnetic material in cooperative relation with its associated core, each said switching element being adapted to switch from said one operative condition to said other operative condition when the temperature of its associated heater ele-

ment exceeds a predetermined value and subsequent to said predetermined energization time lag and to remain at said other operative condition for at least said predetermined deenergization time lag when the temperature of its associated heater element is below said predetermined value, said predetermined temperature value of each said heater element being the Curie temperature of its associated core, means for applying a supply voltage between the first switching element and the first heater element of said relay circuits, means actuated by said first switching element in said one operative condition for applying said supply voltage to said first heater element thereby to energize said first heater element, and means actuated by said first switching element in said other operative condition for applying said supply voltage to the next succeeding heater element thereby to energize said next succeeding heater element, said last-mentioned means being actuated when its associated armature loses its magnetic attraction to its associated core due to the temperature of said core exceeding said predetermined value, said means actuated by said first switching element in said one operative condition being deactuated upon the actuation of said last-mentioned means whereby said first heater element is permitted to cool by the time the heater element of the last of said relay circuits is energized.

3. A relay system comprising a chain of three interconnected relay circuits each including a thermal relay of a type having predetermined energization and deenergization operational time lags and comprising a heater element, a core of magnetic material in operative relation to said heater element and a switching element adapted to switch from one operative condition to another under the influence of the temperature of said heater element and comprising an armature of permanent magnetic material in cooperative relation with its associated core, each said switching element being adapted to switch from said one operative condition to said other operative condition when the temperature of its associated heater element exceeds a predetermined value and subsequent to said predetermined energization time lag and to remain at said other operative condition for at least said predetermined deenergization time lag when the temperature of its associated heater element is below said predetermined value, said predetermined temperature value of each said heater element being the Curie temperature of its associated core, means for applying a supply voltage between the first switching element and the first heater element of said relay circuits, means actuated by said first switching element in said one operative condition for applying said supply voltage to said first heater element thereby to energize said first heater element, and means actuated by said first switching element in said other operative condition for applying said supply voltage to the next succeeding heater element thereby to energize said next succeeding heater element, said last-mentioned means being actuated when its associated armature loses its magnetic attraction to its associated core due to the temperature of said core exceeding said predetermined value, said means actuated by said first switching element in said one operative condition being deactuated upon the actuation of said last-mentioned means whereby said first heater element is permitted to cool by the time the heater element of the third of said relay circuits is energized.

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