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Eguchi

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[54] **CONTROL SYSTEM FOR A PLURALITY OF LOADS**

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[52] **U.S. Cl.** **307/41**, 317/139

[51] **Int. Cl.** **H02j 3/14**

[58] **Field of Search** 307/41, 38, 39, 40, 141, 307/141.4, 141.8; 317/123, 136, 139, 141

[56] **References Cited**

UNITED STATES PATENTS

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Attorney, Agent, or Firm—Waters, Roditi, Schwartz & Nissen

[57] **ABSTRACT**

In a control system wherein a plurality of loads are sequentially connected in parallel across supply conductors, each load is connected across the supply conductors through a switching circuit which is closed a predetermined interval after the application of an operating voltage, the loads in the second and succeeding stages are connected across the supply conductors through transfer switches which are operated in response to the operation of the loads in the preceding stages, a relay contact is connected in parallel with each transfer switch, and relay means is provided for each stage for opening the contact when the load and the switching circuit in that stage are energized, and for closing the contact after a predetermining interval. For the purpose of performing a conduction test of the whole system, the supply conductors are terminated with an impedance element, and a test voltage lower than the operating voltage is connected to the supply conductors at the time of the conduction test.

4 Claims, 4 Drawing Figures

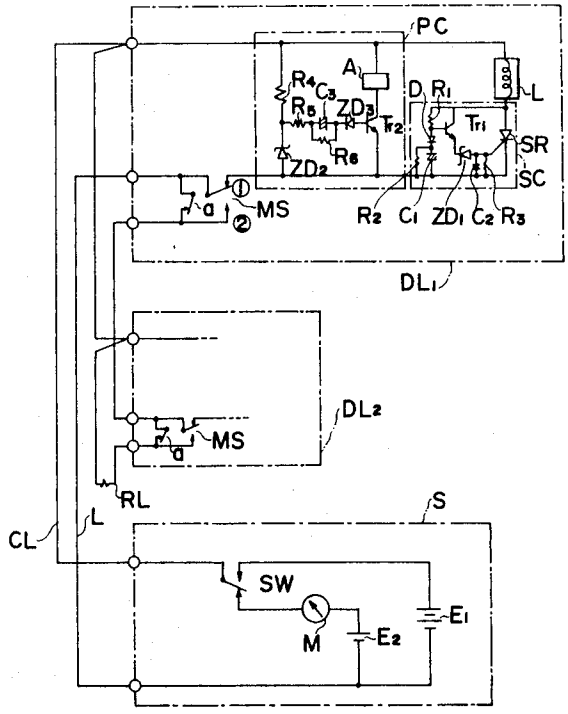


FIG.1 PRIOR ART

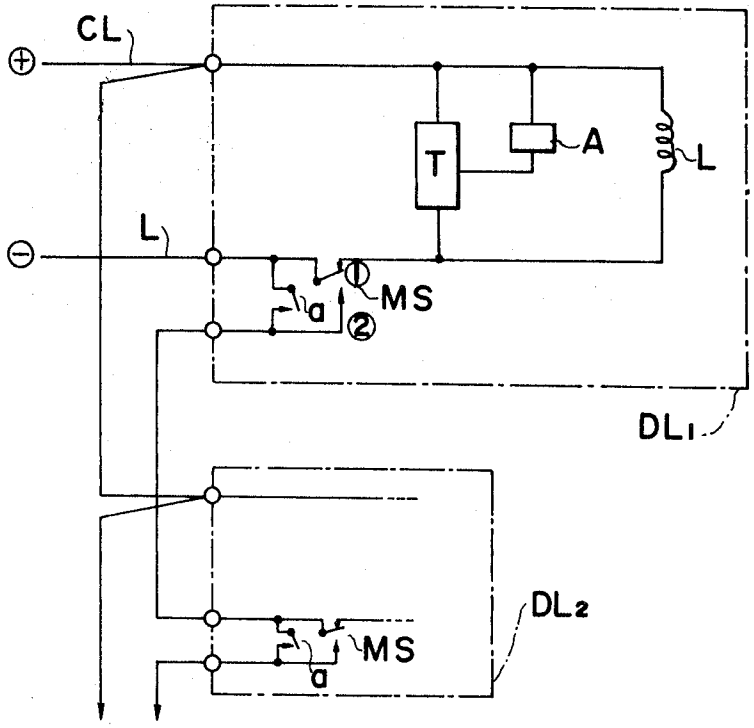


FIG.2 PRIOR ART

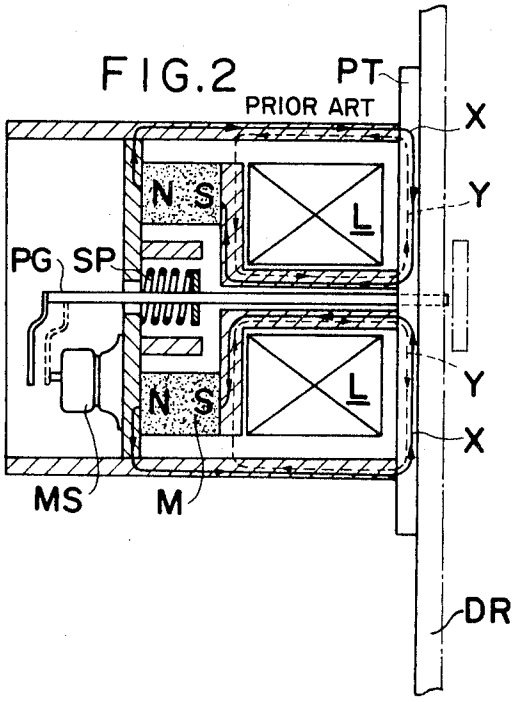
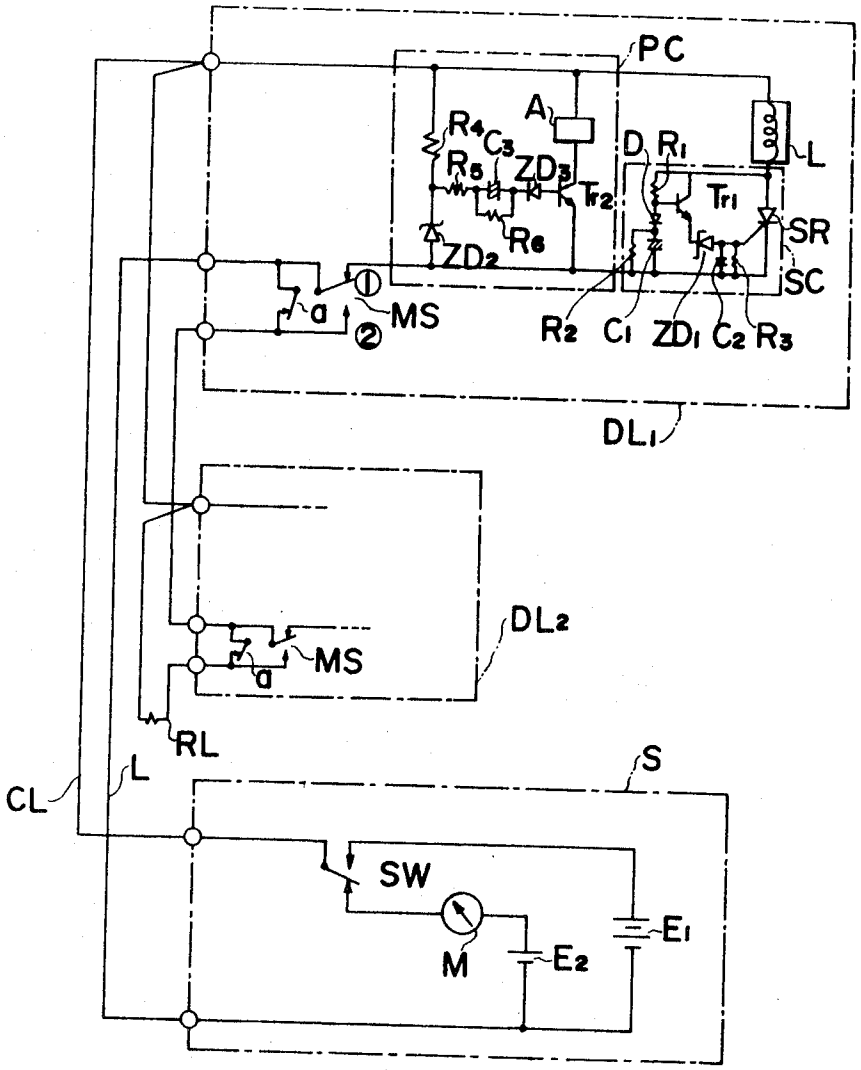


FIG. 3


PC
A
R4
C3
R5
ZD3
Tr2
D
R1
L
Tr1
SR
SC
ZD2
R6
①
a
MS
②
R2
C1
ZD1
C2
R3
DL1
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MS
a
RL
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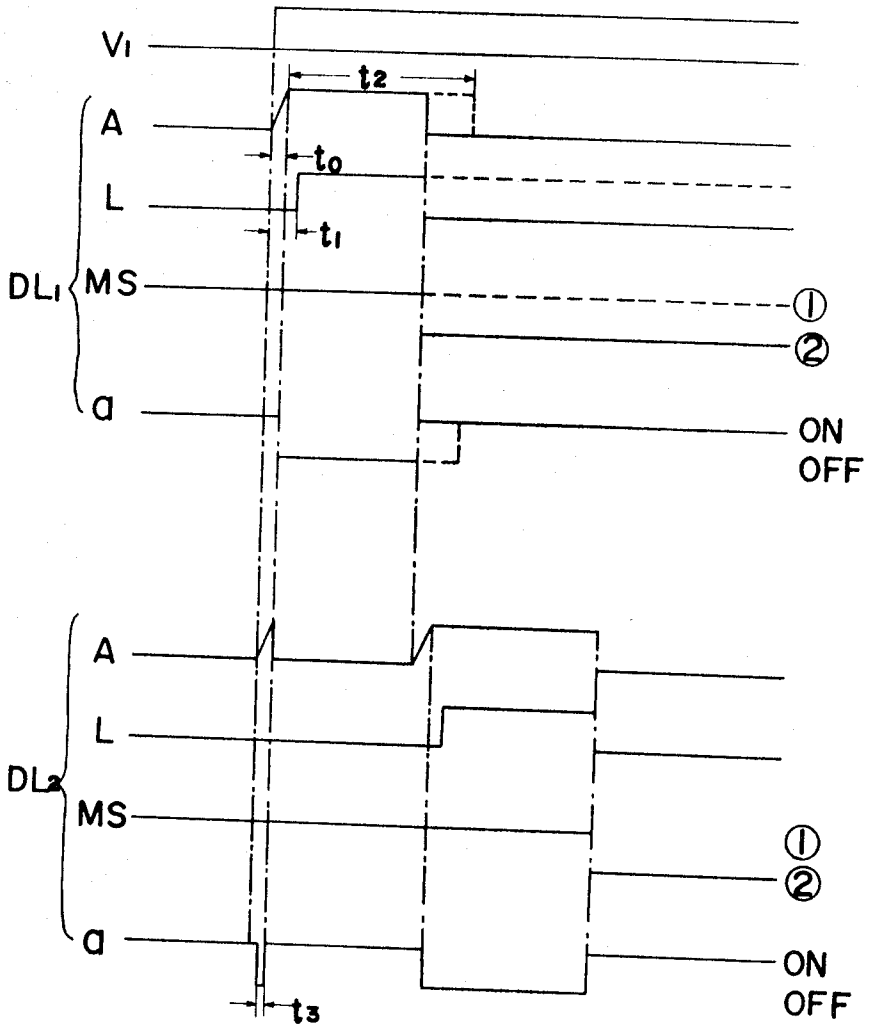
FIG.4



CONTROL SYSTEM FOR A PLURALITY OF LOADS

BACKGROUND OF THE INVENTION

This invention relates to a control system, and more particularly to a control system for sequentially operating a plurality of loads connected in parallel to a source of supply, for example, fire-preventing doors or shutters, unlocking means for emergency doors, smoke exhaust fans, automatic water sprinklers, alarms, etc., installed in buildings.

In modern large buildings, a large number of emergency apparatus of the type described above and consuming a relatively large power are installed. Accordingly, if such a large number of emergency apparatus are operated simultaneously upon occurence of an emergency such as a fire hazard a large electric power would be consumed thereby causing overload of the source of supply and a large voltage drop of the feeder. Accordingly, it has been proposed to sequentially start such emergency apparatus one after one or group after group.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide an improved control system for a plurality of loads connected in parallel across common supply conductors, according to which it is possible not only to sequentially start the plurality of loads, thereby preventing the source from overloading, but also to perform a conduction test of the whole system.

Briefly stated, according to this invention the loads are connected to the supply conductors through respective switch circuits which are closed a predetermined interval after the application of an operating voltage under the control of suitable time delay means, such as timers. Loads in the second and succeeding stages are connected to the supply conductors through transfer switches which are operated when the loads in the preceding stages are operated. Relay contacts are closed when the operating voltage is impressed upon the loads and the switching circuits in respectively preceding stages, and are opened a predetermined interval thereafter. The relay contacts are connected in parallel with the transfer switches, and an impedance is connected across the ends of the supply conductors.

On the supply ends of the supply conductors there are provided a first source to supply the operating voltage, a second source for supplying a test voltage which is lower than the operating voltage, switch means for selectively connecting the supply conductors to either one of the first and the second sources, and a meter for measuring the current flowing through the supply conductors and the terminal impedance when the second source is connected to the supply conductors.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a connection diagram of a prior-art control system for sequentially operating a plurality of loads, for example door unlocking circuits;

FIG. 2 shows a sectional view of a door unlocking device utilized in the circuit shown in FIG. 1;

FIG. 3 shows a connection diagram of the novel control system embodying the present invention; and

FIG. 4 shows voltage and current waveforms of the various elements utilized in the circuit shown in FIG. 3.

FIG. 1 of the accompanying drawing illustrates a typical connection diagram of a prior-art control system in which the loads are shown as a plurality of door unlocking devices DL_1, DL_2 ..... connected in parallel across supply conductors CL and L. Each of the door unlocking device comprises an operating coil L for unlocking a door, not shown, a time delay circuit T which are connected in parallel across supply conductors CL and L, a relay A including a contact *a* and connected in parallel with the time delay circuit T, and a transfer switch MS connected in parallel with contact *a*.

As shown in FIG. 2, the operating coil L comprises the coil of an electromagnet for operating a door unlocking device. More particularly, in the example shown in FIG. 2, a fire preventing door DR is provided with an armature PT secured thereto, and a permanent magnet M. The magnetic flux produced by the permanent magnet M flows through a magnetic circuit including a yoke for the permanent magnet M and the electromagnet and the armature as shown by solid line arrows X whereby the armature PT is attracted by the magnet assembly to lock the door in the closed position.

When a current flows through the coil L, the magnetic flux produced thereby flows in a direction indicated by dotted line arrows Y thus cancelling the flux produced by the permanent magnet M. Consequently, the armature PT will be released and the door DR will be biassed to the open position by the action of springs mounted on the door hinges (not shown). As the door is opened in this manner, a plunger PG is pushed outwardly to the position indicated by dotted lines by the action of a spring SP so that the inner end of the plunger PG actuates the transfer switch MS.

As can be readily noted from FIG. 1, when the transfer switch MS is operated in this manner, that is transferred from the upper contact to the lower contact, the door unlocking circuit DL_1 is deenergized and the next door unlocking circuit DL_2 is energized. In this manner, a plurality of door unlocking circuits are energized sequentially.

In the second door unlocking circuit DL_2, relay A is actuated after a predetermined time determined by the delay circuit T associated therewith thereby closing a contact *a* in parallel with the transfer switch MS of the second door unlocking circuit DL_2. For this reason, even if the transfer switch M of the preceding door unlocking circuit DL_1 were not operated due to a fault or the like cause, the second door would be positively unlocked after a predetermined interval.

Although the control system described above is advantageous in that a plurality of loads or door unlocking circuits are operated sequentially and that succeeding door unlocking circuits are caused to operate sequentially even when a preceding door unlocking circuit fails to operate, since the door unlocking circuits are opened prior to their operation, it is impossible to test their conduction.

Even if a test contact is connected in parallel with the contact *a* of relay A and the transfer switch MS, because of the low impedance of coil L, it is impossible to determine the value of a terminal resistor connected at the end of the supply conductors from their supply

ends. Thus, it is impossible to perform a conduction test of the whole system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 3, there is shown a preferred embodiment of the control system constructed according to the teaching of this invention, which comprises a source E_1 for driving the loads, a source E_2 for performing a conduction test, an ammeter (or ohmmeter) M, and a transfer switch SW between sources E_1 and E_2. Although in this example door unlocking circuits DL_1 and DL_2 are shown as the loads it should be understood that various emergency apparatus of the type described above are used in practical applications.

In accordance with this invention, a switching circuit SC is connected in series with each door unlocking circuit. The switching circuit SC comprises a silicon controlled rectifier SR connected in series with the coil L, a control transistor Tr_1 for the silicon controlled transistor, resistors R_1, R_2 and R_3, capacitors C_1 and C_2, a diode D, and a Zener diode ZD which are connected as shown.

Further, in accordance with this invention, a protective circuit PC is connected in series with said serially connected coil L and switching circuit SC. The protective circuit PC comprises a relay A, a control transistor Tr_2 connected in series therewith, resistors R_4, R_5 and R_6, a capacitor C_3, and Zener diodes ZD_2 and ZD_3 which are connected as shown. A plurality of door unlocking circuits DL_1, DL_2...., each having a construction as above described, are connected in parallel across supply conductors CL and L.

Each of the second and succeeding door unlocking circuits DL_2, DL_3.... is connected to the supply conductors CL and L through the transfer switch MS shown in FIG. 1 or other suitable switch which is switched when the preceding load is operated, and the contact *a* of the relay A of the preceding load. The ends of the supply conductors are terminated by a terminal impedance element RL such as a resistor or a Zener diode.

The operation of the inventive control system shown in FIG. 3 will now be described with reference to the wave forms shown in FIG. 4. When the transfer switch SW of the source device S is thrown to the upper side, source E_1 having a voltage V_1 will be connected across the supply conductors CL and L. When impressed with this voltage V_1, Zener diodes ZD_1, ZD_2 and ZD_3 conduct, and transistor Tr_2 becomes ON to operate relay A after a short interval t_o to open its contact *a*. Consequently, the succeeding door unlocking circuits will not be actuated because they are energized only a short interval.

For this reason, even if one of the relays A in the second and following stages may be operated as shown by the contact *a* of the door unlocking circuit DL_2 shown in the lower portion of FIG. 4, due to the difference in the operating time of the relays of these stages, such relay will be reset after an extremely short time t_3.

In the first door unlocking circuit DL_1, the charging of capacitor C_1 is commenced and after a predetermined interval t_1 determined by the time constant C_1R_1, the terminal voltage across capacitor C_1 reaches a predetermined value thereby rendering conductive Zener diode ZD_1 and hence silicon controlled rectifier SR.

It is desirable that the interval t_1 is longer than t_o for the purpose of preventing the control system from misoperating. Capacitor C_2 functions as a bypass capacitor to maintain a sufficiently large gate voltage enough to render ON the silicon controlled rectifier even when the voltage of source E_1 fluctuates. When the silicon controlled rectifier SR is rendered conductive, coil L is energized, thus unlocking the door shown in FIG. 2.

When the door is opened, transfer switch MS will be thrown to the lower contact thereby deenergizing the circuit DL_1 in the first stage and energizing the door unlocking circuit DL_2. In this manner, the loads or the door unlocking circuits are operated sequentially.

Because the capacitor C_3 is included in the control circuit for transistor Tr_2 of the protective circuit PC, after a predetermined interval t_2 determined by a time constant C_3R_5, the control current is decreased to turn OFF transistor Tr_2, thus deenergizing relay A. As a result, contact *a* is reclosed. Under normal condition, since the transfer switch MS is operated prior to the elapse of interval t_o, the reclosure of contact *a* does not cause any action, but when the transfer switch MS fails to transfer, the reclosure of contact *a* causes sequential operation of the succeeding door unlocking circuits DL_2, DL_3... .

To perform a conduction test of the system, switch SW of source device S is thrown to the lower contact to impress voltage V_2 of source E_2 across supply conductors CL and L. Since voltage V_2 is lower than the operating voltage V_1, Zener diodes ZD_1, ZD_2 and ZD_3 are not turned ON. Accordingly, the switching circuit SC is in its OFF condition to isolate coil L from supply conductors CL and L. Thus, the protective circuit PC is also in the inoperative condition which is important.

Accordingly, if there is no fault on supply conductors CL and L, it may be considered that the supply conductors CL and L are terminated with resistance RL. Accordingly, it is possible to perform the conduction test over the entire length of conductors CL and L by reading the current flowing through these conductors with ammeter M. If either one of the conductors CL and L is interrupted, the ammeter M will show a resistance value higher than RL.

As can be noted from the foregoing description, the invention provides a new and improved control system capable of effecting not only sequential operation of a plurality of loads such as emergency machines and apparatus but also the conduction test of supply conductors for the loads.

What is claimed is:

1. A control system for sequentially operating a plurality of loads connected in parallel across supply conductors, said control system comprising a plurality of switching circuits for respective loads, each one of said switching circuits being closed a predetermined interval after the application of the operating voltage for connecting the associated load to said supply conductors, a plurality of transfer switches for connecting the loads to said supply conductors in the second and succeeding stages, means responsive to the operation of the load in the preceding stage for operating the transfer switch of the succeeding stage to connect the load of said succeeding stage across said supply conductors, a plurality of relay contacts respectively connected in parallel with said transfer switches, relay means connected in preceding stages for opening said contacts when the loads and said switching circuits in the pre-

ceding stages are energized, and for closing said contacts after a predetermined interval, and a terminal impedance element connected across the end terminals of said supply conductors.

2. The control system according to claim 1, which further comprises a first source for supplying a normal operating voltage for said loads, a second source having a test voltage lower than said normal operating voltage, a transfer switch for selectively connecting said supply conductors across either one of said first and second said sources, and a meter for measuring the current flowing through said supply conductors when said second source is connected thereto.

3. The control system according to claim 2 wherein, each one of said respective switching circuits comprises a silicon controlled rectifier connected in series with one load, a Zener diode connected to supply a gate voltage to said silicon controlled rectifier, a CR time constant circuit for applying a driving voltage for said Zener diode a predetermined interval after energization of the switching circuit, said Zener diode not becoming conductive when supplied with said test voltage.

4. The control system according to claim 3 which, further comprises a plurality of protective circuits, each connected in parallel with the serially connected one load and one switching circuit and comprising a relay coil for operating said contact, a transistor connected in series with said relay coil, and a CR time constant circuit and a Zener diode which are connected in series for applying a control current to said transistor, said last-named Zener diode becoming conductive when applied with said operating voltage for rendering conductive said transistor within the delay time of said switching circuit, said Zener diode becoming not conductive when applied with said test voltage which is lower than said operating voltage, and said last-named CR time constant circuit having a time constant which is predetermined such that said control current for said transistor is maintained for a interval somewhat longer than the operating time of said load and is then decreased to a value sufficient to interrupt said transistor.

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