

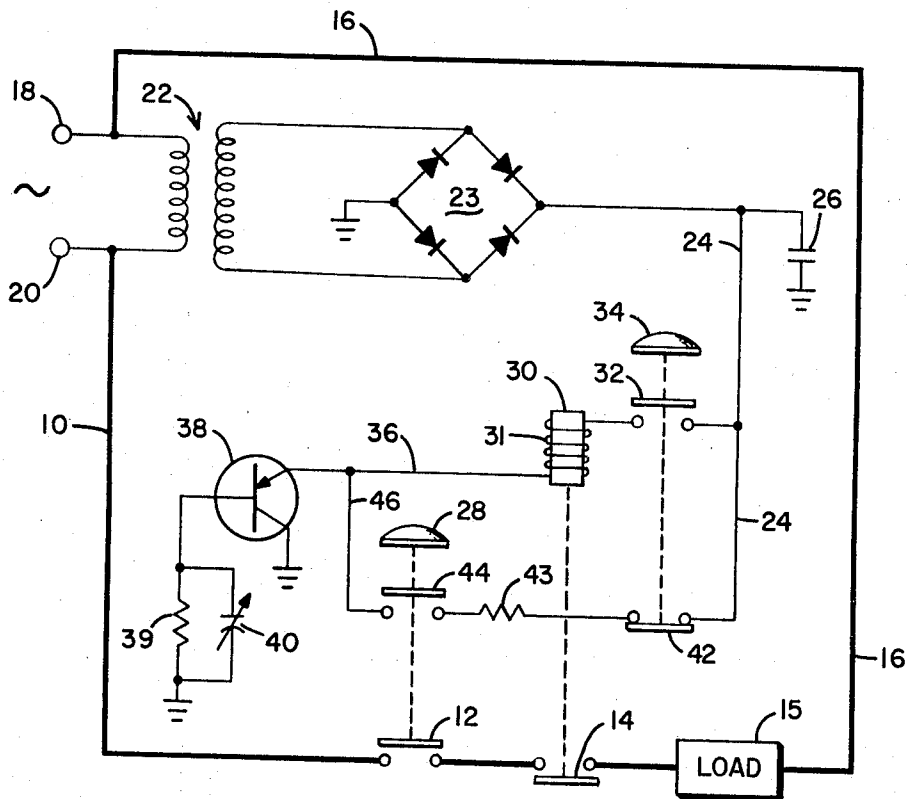
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SAFETY CONTROL SYSTEM

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SAFETY CONTROL SYSTEM
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This invention relates to a safety system for electrically operated machinery. More particularly, the invention relates to an electrical safety control system of the interlocked type, requiring the operation of two switches in substantially simultaneous manner in order to initiate the operation of a machine tool or the like.

In dangerous types of industrial machinery, such as punch presses, sheet metal shears, and the like, it is desirable that the control system thereof be designed in such a manner that both hands of the operator are required to initiate an operation and hence are out of the danger area. Since it is inherently impossible for a person to actuate two switches simultaneously, it is common practice in control systems of the present kind to provide a means for establishing a time interval during which the two switches must be actuated to initiate an operation.

It is, accordingly, one object of this invention to provide a safety control system in which two switches must be operated within a predetermined period of time in order to actuate means for energizing the load. In this regard, it is an aim of the invention to provide a circuit in which a precise time interval is established during which the two switches must be actuated, or the circuit will become inoperative.

It is another object of the invention to provide a control system of the character described which employs commercially available components, and in which the time interval during which the two switches must be actuated is controllably variable and adjustable in a precise manner.

Still another object of the invention is to provide a safety control system in which the components thereof are normally in an idle state, but are available for immediate operation whenever it is desired to operate the system. In this manner, the lifetime of the components is increased substantially.

The objects of the invention are achieved by utilizing the accurate and consistent switching characteristics of a transistor. In a preferred embodiment of the invention, the control circuit is provided with a self-contained DC power supply, so that when desirable it may be connected directly into the customer's equipment and be operated from a commercial 60 cycle supply. The control circuit contains a transistor having a timing means in the base circuit thereof. The switches which are normally manually controlled by the operator are connected to the transistor so that operation of either of the switches will start charging a capacitor in the base circuit of the transistor. After a predetermined time interval, as determined by the rate of charge of the capacitor through its associated circuitry components, the transistor will be biased out of conduction. If the other of the switches has not been pressed prior to the time that the transistor is biased out of conduction, the actuation of the second switch will have no effect on the system. A resistor is placed in the charging circuit for controllably dissipating the charge on the capacitor.

Other objects, advantages and new features of the invention will become apparent from the following detailed description when read in conjunction with the accompanying drawing. The single figure of the drawing shows a preferred embodiment of the present control system.

As shown in the drawing, the invention consists of a main load circuit consisting of conductor 10, switch con-

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facts 12 and 14, load 15 and conductor 16. The load 15 is ordinarily a part of the machine to be controlled. In the case of a punch press, for example, the load 15 may be a solenoid winding which when energized, actuates a linkage to release a stop pin which allows the press to cycle mechanically. Electrical energy for operating the load 15 is derived from a pair of leads 18 and 20 connected to a suitable source of AC current.

Leads 18 and 20 are also connected to the primary of a transformer 22 which has its secondary coupled or connected to a rectifier network 23 for producing a DC control circuit voltage on lead 24. A smoothing capacitor 26 may also be employed in the DC power supply circuit, if desired.

Contacts 12 and 14 must be closed simultaneously in order to energize or actuate the load 15. Switch contacts 12 are controlled and closed by a manually operated switch 28 in the control circuit. Switch contacts 14 comprise a portion of a relay 30, the coil 31 of which is connected to lead 24 through the switch contacts 32 of a second manually operated switch 34.

The energizing circuit for the coil 31 of the relay 30 is completed to ground over lead 36 and through the emitter circuit of transistor 38, the arrangement being such that the relay 30 can be actuated only when the transistor 38 is in a conductive state. Connected in the base circuit of the transistor 38 is an R-C time constant circuit consisting of resistor 39 and variable capacitor 40. Resistor 39 can also be made variable if desired. Timing control is achieved by starting to charge the capacitor 40 at the time that either of the manually operated switches 28 or 34 is actuated. The charging circuit through switch 28 is from lead 24 through contacts 32 of switch 34, coil 31 of relay 30, and over lead 35 through the transistor 38 to ground. For the manually operated switch 28, the charging circuit extends from the lead 24 through a set of normally closed contacts 42 in the switch 34, a resistor 43, the value of which is substantially matched or equal to the impedance of the coil 31 to balance the circuit, contacts 44 on the manually actuated switch 28, and lead 46 connected to lead 26. The charging circuit is then completed through transistor 38 to ground.

The operation of the circuit should now be apparent. Assuming that switch 34 is pressed first, the contacts 32 thereof will be closed and the contacts 42 will be opened. Closure of contact 32 will complete the circuit through the coil 31 of the relay 30 and the transistor 38 to ground, so that the relay 30 will be actuated to close contacts 14. At the same time, capacitor 40 will start to charge. After the charge on the capacitor 40 rises to a predetermined value the time period required being determined by the charging rate of the capacitor 40 in its circuit arrangement, the voltage on the base of transistor 38 will be such that the transistor is biased out of conduction. At this point, the relay 30 will be deenergized and contacts 14 will be opened. Accordingly, if, prior to the time that the transistor stops conducting, the switch 28 has not been actuated a subsequent attempt to actuate the load by operation of the switch 28 will not be effective.

In the event that switch 28 is the first that is closed, the capacitor 40 will also start charging at that time. If the switch 34 is actuated before the expiration of the time established by the time constant of the capacitor circuit, the transistor will still be in its conductive state and the relay 30 will be actuated to close switch 14. In the event that the time that the switch 34 is actuated is after the predetermined time interval, however, transistor 38 will have again been biased out of conduction and operation of the switch 34 will have no effect on the relay 30.

It will be apparent that the time interval in which both of the switches 28 and 34 must be actuated in order to successfully actuate the load may be readily adjusted by

varying the capacitance of the capacitor 40 or the resistance value of resistor 39, or both. Thus, the time interval is adjustable over relatively wide limits in order to adapt the circuit to different control applications. As applied to a punch press, the desired time interval is typically on the order of 0.7 second.

The circuit is highly sensitive due to the fact that the transistor is inherently sensitive to being switched on and off since it possesses consistent switching characteristics. Accordingly, the relay 30 is operated quickly and little or no chattering of the contacts thereof results. Thus, the circuit is highly reliable in operation.

It will be noted in addition that during the time that the circuit is idle, that is prior to actuation of either of the switches 28 and 34, no current flows in the control circuit. Because of the high speed of operation of the transistor, however, the circuit is capable of responding immediately, accurately and consistently upon actuation of either of the manually operated switches.

It is to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as herein specifically described.

I claim:

1. A safety control system comprising
a main circuit and a control circuit therefor,
switch means in said main circuit for actuating a load,
said switch means including a first manually operated
switch and a control relay having its coil connected
in said control circuit,
a second manually operated switch in said control
circuit for energizing said control relay,
a transistor connected in series with the coil of said
control relay to permit current to flow therein when
said transistor conducts, and
means for biasing said transistor to conduct upon
actuation of either of said manually operated
switches and for biasing said transistor out of con-
duction upon the expiration of a predetermined time
interval thereafter.
2. A safety control system as defined in claim 1, said
biasing means comprising
an R-C time-constant circuit connected to the base of
said transistor.
3. A safety control system comprising
a main circuit and a control circuit,
switch means in said main circuit for actuating a load,
said switch means comprising a control relay having
a set of contacts in said main circuit and having its
coil connected in said control circuit, and a first
manually actuated switch having a set of contacts in
a series with said relay contacts,
a second manually operated switch in said control cir-
cuit for energizing said control relay,
a transistor in series with the coil of said control relay

and operative to permit current to flow in said coil when said transistor conducts,
means responsive to actuation of either of said manually operated switches to bias said transistor to conduction and operable after a predetermined time delay thereafter to bias said transistor out of conduction,

whereby said control relay cannot be operated after said predetermined time delay.

4. A control system as defined in claim 3, said biasing means comprising a resistor and a capacitor connected in parallel to the base circuit of said transistor.

5. A safety control circuit comprising
a main circuit and a control circuit therefor,
switch means in said main circuit for actuating a load,
said switch means including a control relay having a set of contacts in said main circuit and having its coil connected in said control circuit, and a first manually actuated switch having a set of contacts in series with said relay contacts in said main circuit,
a second manually operated switch, having a set of contacts in series with said relay coil,
a transistor connected in series with said relay coil, whereby closure of said second manually operated switch and conduction of said transistor will permit current to flow in said coil to actuate said relay,
an R-C time-constant network in the base circuit of said transistor, said R-C network being responsive to current flow through said transistor to bias said transistor out of conduction after a predetermined time,
a branch line in said control circuit connected in parallel with said relay coil and said second manually operated switch, said branch line including an impedance equal to the impedance of said coil and a set of contacts actuated by said first manually actuated switch,
whereby operation of either of said manually actuated switches will cause current to flow through said transistor to operate said R-C network, operation of the other of said manually operated switches after the time interval of said R-C network being inoperative to actuate said load.

6. A safety control circuit as recited in claim 5 wherein said main circuit is adapted to be connected to a source of AC current,
said control circuit having self-contained DC power supply adapted to be operated from said AC source.

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