

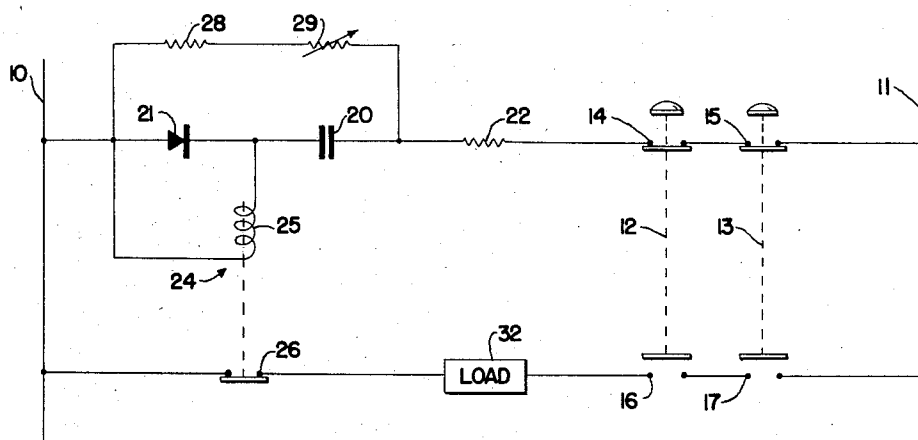
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SAFETY CONTROL SYSTEM

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SAFETY CONTROL SYSTEM

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The invention is directed to safety control systems in which a plurality of switches must be actuated within a predetermined time in order to energize a load circuit. Such systems find application in the control of punch presses and the like where it is desirable that both of the operator's hands must be used to initiate an operation and hence are out of the danger area.

It is desirable that the time interval during which all the control switches must be actuated in order to initiate an operating cycle be adjustable within a rather wide range to meet the requirements of various types of apparatus and the various jobs to be run on any particular apparatus. The optimum may vary from close to zero to as much as 4 seconds. Difficulty has been experienced in the past in obtaining very short timing in systems of this type, whereas in the system disclosed herein the time interval can be adjusted down to zero.

An object of the invention is to provide a safety control system in which the time interval during which a plurality of control switches must be operated is adjustable between zero and a selected maximum. This object is attained with a minimum number of components most of which are readily available commercially.

A further object is to provide a timing control of general application.

The single figure of the drawing shows one form the invention may take. Various additions can be made to this circuit to take care of the various requirements of different types of power operated machines as is well known in the art.

An alternating current source is indicated in the drawing by conductors 10 and 11. Manually operable switches 12 and 13 having normally closed contacts 14 and 15 and normally open contacts 16 and 17 serve to initiate a timing period and to complete a load circuit as will later appear. A charging circuit for a capacitor 20 includes the normally closed switch contacts 14 and 15 as well as a selenium rectifier 21 and a current limiting resistor 22. A direct current relay 24 has a coil 25 connected across the rectifier 21 and normally open contacts 26 connected in a load circuit as will be described later. A fixed resistor 28 and a variable resistor 29 are connected in series across the capacitor 20 and rectifier 21.

A load circuit is connected between conductors 10 and 11 and includes the normally open contacts 16 and 17 of switches 12 and 13, the normally open contacts 26 of relay 24 and a load 32. The load is herein represented diagrammatically but may be a solenoid, relay winding or the like. Obviously the load circuit could be energized from any current source and may be independent of the control circuit.

By way of example, the capacitor 20 may be 50 microfarad electrolytic; the relay coil 25 may have a direct current resistance of 8000 ohms; fixed resistor 28 may have a resistance of 27,000 ohms; and variable resistor 29 may be adjustable between zero and 100,000 ohms. The current limiting resistor 22 may be 10 ohms to limit the current through the rectifier to a safe value.

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In operation, the capacitor 20 is charged and the relay 24 is energized to close contacts 26 when the switches 12 and 13 are in normal position. If either or both of the switches are operated, the charge on the capacitor leaks off through the resistors 28 and 29 and the relay coil 25, holding in the relay until its drop-out voltage is reached. The load can be energized only if both switches are operated before the drop-out voltage is reached.

Assuming 115 volts alternating voltage on the conductors 10 and 11 and switch contacts 14 and 15 closed, the capacitor 20 will be charged to a maximum value of approximately 160 volts, but the potential may drop about 30 volts between alternating voltage peaks due to current flow through the relay coil 25 and resistors 28 and 29.

The potential across the relay coil is pulsating direct voltage and is generally sinusoidal with the lower extremities of the curve flattened during the approximately 2.2 milliseconds the rectifier conducts to charge the capacitor. A voltage doubling effect is obtained whereby the peak voltage across the relay coil may be over 320 volts. Apparently the voltage across the capacitor is added to line voltage during the non-conducting half cycle to give double voltage across the relay coil. Advantage is taken of this effect in providing an available pull-in voltage for the relay that is sufficiently high to assure positive operation of the relay under all conditions.

The time necessary for the relay 25 to drop out after the capacitor charging circuit is broken depends, of course, on the time required for the voltage across the relay coil to reach the drop-out voltage. It is a function of the rate of discharge of the capacitor and the difference between the initial voltage across the coil and the drop-out voltage. By increasing the resistance in series with the relay coil, the initial voltage across the coil is decreased. This tends to decrease the drop-out time. Increasing the resistance also reduces the flow of current from the capacitor, tending to increase the drop-out time. As might be expected, increasing the resistance from a low value first increases the time delay to a maximum and then reduces the time delay until at some resistance value where the initial voltage on the coil equals the drop-out voltage the time delay is zero. Since the relay coil itself has appreciable resistance it is not possible to obtain very short timing by operating on the low resistance part of the curve. Hence, the fixed resistor 28 is selected to provide maximum timing when the adjustable resistor is set at zero resistance, and the adjustable resistor may be set to provide a total resistance sufficiently high so that the initial voltage across the relay coil is below the drop-out voltage to attain zero time delay. The desired time delay may be selected by setting the adjustable resistor at an intermediate point. In the illustrative embodiment the relay may drop out at 10 volts requiring a total of 120,000 ohms in series with the 8000 ohm relay coil to obtain zero time delay. If the system is to be installed to control a power operated machine of known timing requirements, a fixed resistor of proper value can be substituted for the fixed resistor 28 and variable resistor 29.

It will be noted that the load circuit is made by the manually operated switches rather than by the relay contacts and hence the possibility of the relay sticking in closed position is reduced to a minimum.

Additional control switches can be added to the circuit as well as the usual limit switches where single stroke operation must be assured. The invention is adapted for use as a timer of general utility. Also, an electrically operated device other than a relay may be substituted without departing from the basic concept. Other changes and additions can likewise be made without departing from the basic concept of the invention.

I claim as my invention:

1. A safety control system comprising, an alternating current line, a plurality of switches each having normally closed contacts connected in series with a capacitor and a rectifier across said line, a load control relay having its coil connected across said rectifier, and a time delay resistor connected across said rectifier and said capacitor to determine the drop-out time of said relay.

2. A timing control comprising, an alternating current source, a normally closed switch, a capacitor and a rectifier connected in series to said source, an adjustable resistor connected across said capacitor and said rectifier, and a relay having its coil connected across said rectifier.

3. A control system comprising, an alternating current source, a switch connected in series with a capacitor and a rectifier across said source, a resistor connected across said capacitor and said rectifier, and an electromagnetically operated device having a coil connected across said rectifier, said electromagnetically operated device being energized when said switch is closed and being deenergized at a predetermined time after said switch is opened.

4. A safety control system comprising, an alternating current source, a plurality of switches each having normally closed contacts connected in series with a capacitor and a rectifier to said source, a resistor connected across said capacitor and said rectifier, and a relay having its coil connected across said rectifier, said relay and said switches having normally open contacts connected in series in a line adapted to energize a load.

5. A safety control system comprising, an alternating current source, a plurality of switches each having normally closed contacts connected in series with a capacitor and a rectifier to said source, a resistor connected across said capacitor and said rectifier, and a relay having its coil connected across said rectifier, said relay and said

switches having normally open contacts connected in series in a line adapted to energize a load, said relay being energized when said switches are all in normal position and being deenergized a predetermined time after a switch is actuated.

6. A safety control system comprising, an alternating current source, a plurality of switches each having normally closed contacts connected in series with a capacitor and a rectifier to said source, a resistor connected across said capacitor and said rectifier, and a relay having its coil connected across said rectifier, said relay and said switches having normally open contacts connected in series in a line adapted to energize a load, said relay being energized when said switches are all in normal position and being deenergized a predetermined time after a switch is actuated, and said load circuit being completed only if all of said switches are actuated within said predetermined time.

7. A control system comprising, an alternating current source, a switch connected in series with a capacitor and a rectifier across said source, a resistor connected across said capacitor and said rectifier, and an electromagnetically operated device having a coil connected across said rectifier, said electromagnetically operated device being operatively energized by pulsating direct current when said switch is closed, and operatively energized by direct current from said capacitor through a series circuit including said resistor for a predetermined time after said switch is opened.

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