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[54] **ELECTRICAL SAFETY STRUCTURE**
4 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **317/135,** 317/154
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[50] **Field of Search** ..... 317/135, 154; 192/129—131

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ABSTRACT: An electrical safety structure designed to prevent injury to an operator of a machine. This safety structure includes a safety circuit and an operating circuit for operating a machine when this latter circuit is closed. A pair of series-connected normally closed switches are located in the safety circuit and a pair of series-connected normally open switches are located in the control circuit and are respectively coupled with the normally open switches to form with the latter a pair of switch units spaced from each other by a distance too great to be operated by one hand of the operator. A control switch means maintains part of the operating circuit closed as long as the normally closed switches of the safety circuit remain in their closed positions and operates to enable the operator to actuate both of the switch units simultaneously to provide for simultaneous closing of both normally open switches along with simultaneous opening of both normally closed switches so that the operating circuit will be closed by the pair of series-connected normally open switches only by simultaneous actuation of both switch units and not by separate actuation of either one of the switch units. Because the operator must use both hands for simultaneous operation of the switch units, the operator's hands cannot be located at a part of the machine where the operator can be injured when the machine is actuated by closing the operating circuit.

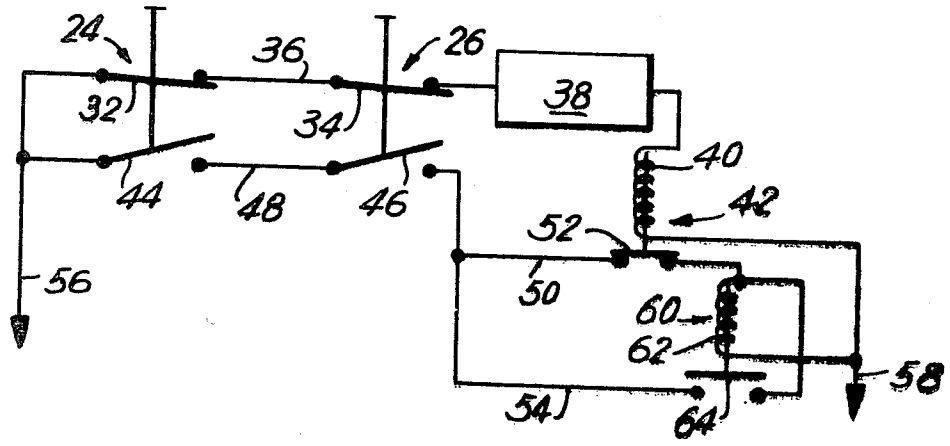
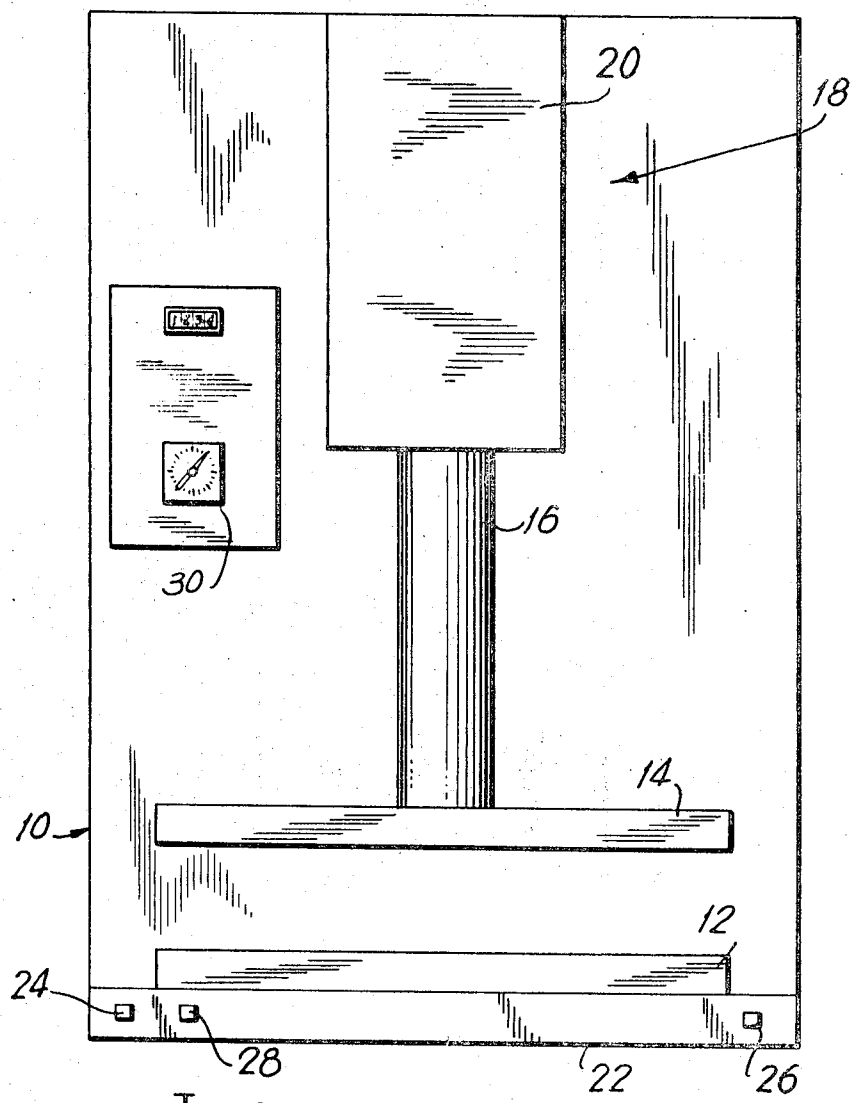


FIG. 1



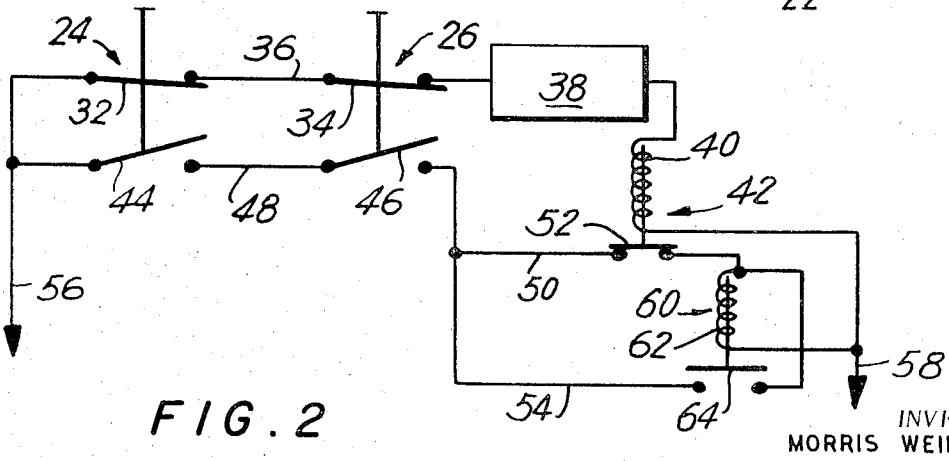
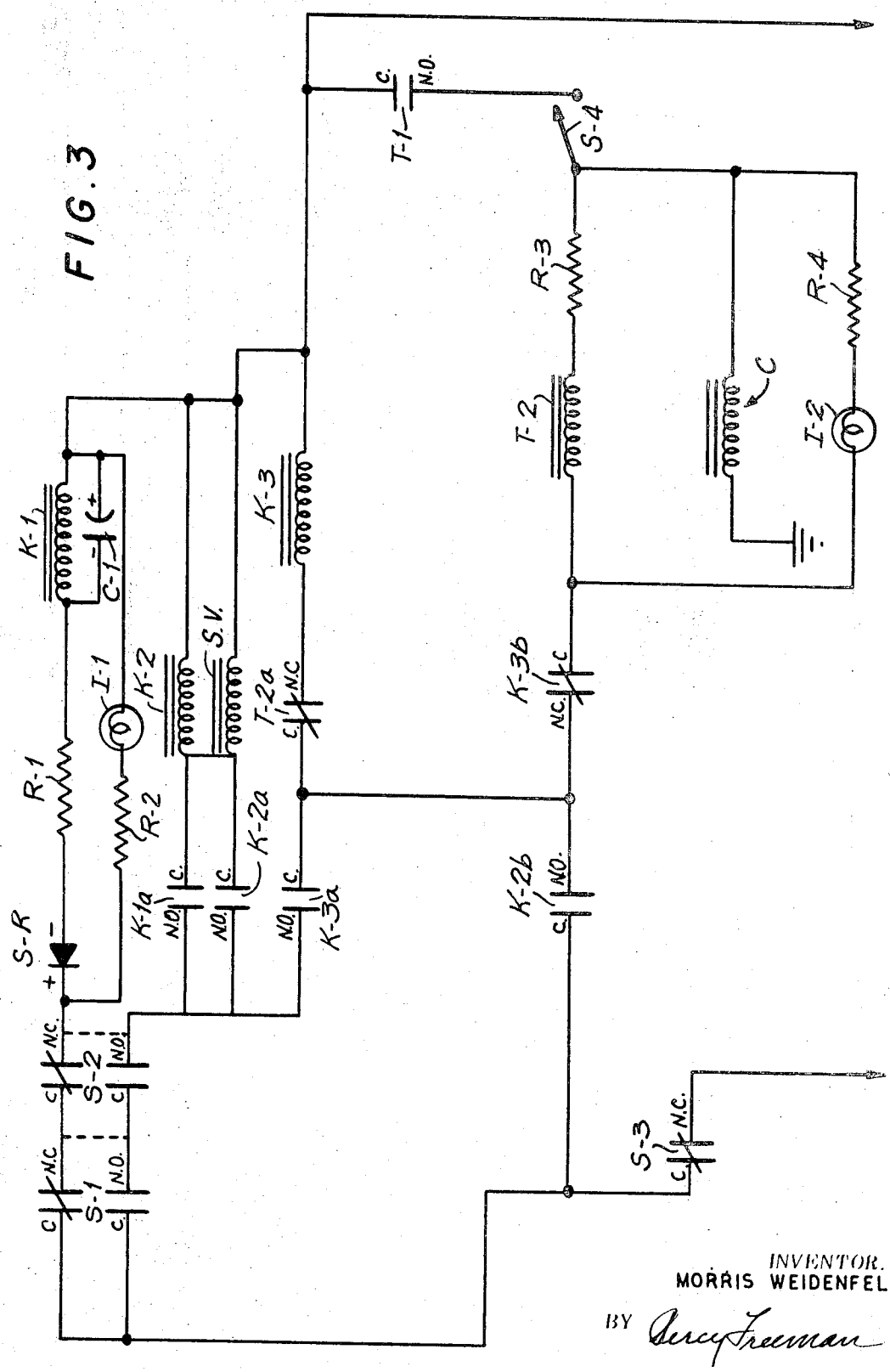


FIG. 2

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FIG. 3



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ELECTRICAL SAFETY STRUCTURE

BACKGROUND OF THE INVENTION

The present invention relates to safety devices. In particular, the present invention relates to electrical safety devices to be used in connection with machines which are operated electrically.

As is well known, certain electrically operated machines are capable of injuring the operator. Such machines may include, for example, a pair of members one of which moves toward the other in in order to carry out the work of the machine, and in the event that a hand of the operator is located between these members when the work is performed by the machine, the operator can become injured.

In order to avoid this latter drawback, it has already been proposed to provide machines of the above type with a pair of switch units to be operated simultaneously by the operator and located from each other by a distance too great to be operated by one hand, so that the operator's hands are necessarily situated at both of the switches simultaneously when the machine is actuated to carry out the required work. In this way it was proposed to maintain the hands of the operator reliably away from the space between the work performing members of the machine. Thus, in the case where work is supported by a platen and a ram drives a working member downwardly toward the platen to engage work thereon, with such a machine it was considered advisable to provide a safety structure of the above type so as to maintain the hands of the operator away from the space between the platen and the descending work performing member actuated by the ram.

However, it has been found that in practice the desired safety is not achieved with constructions of this type. For example, certain operators will maintain one of the switch units of the above type in a permanently closed position, as by stretching a piece of adhesive tape of the like across one of the switch units in a position maintaining the operating button thereof depressed, so that in this way one of the switch units is always maintained closed, and with such an expedient an operator can have one free so that he still can become injured.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide a construction which will avoid the above drawbacks.

It is an object of the invention to provide a safety structure which includes a pair of switch units which must be operated simultaneously in order for the operating circuit of a machine to be closed to actuate the machine. In other words, it is an object of the invention to provide a structure which is incapable of closing the operating circuit of the machine if one of the switch units is operated separately from the other switch unit.

It is furthermore an object of the present invention to provide a construction of this type which is exceedingly simple and fully reliable in operation.

Also, it is an object of the invention to provide a construction which is capable of being connected to a single source of current, such as readily available alternating current, in order to achieve the objects of the invention.

Also, it is an object of the invention to utilize for the safety structure readily available electrical components which are assembled together to provide the circuitry of the invention, so that the structure of the invention can be provided at a relatively low cost.

Also, it is an object of the invention to provide a structure of this type which can be readily added to existing machines, without any great effort or cost, so as to enable such existing machines to have the safety structure of the invention.

In accordance with the invention there is a safety circuit and an operating circuit, the latter circuit being adapted, when closed to operate a given machine. The safety circuit includes a pair of series-connected normally closed switches, while the operating circuit includes a pair of series-connected normally open switches, and the latter switches are respectively coupled with the normally closed switches to form therewith a pair of switch units. Thus, when each switch unit is operated the normally closed switch thereof will be opened simultaneously with the closing of the normally open switch thereof. A control switch means is connected between both of these circuits for maintaining part of the operating circuit closed as long as the safety circuit is closed by the series-connected normally closed switches, and this control switch means operates with a time lag sufficiently great to enable the operator to simultaneously close both of the normally open switches during actuation of the pair of switch units when the normally closed switches are simultaneously opened. These switch units are, of course, spaced from each other by a distance too great to permit them to be operated simultaneously by one hand. Therefore, it is possible for the operator to simultaneously close the normally open switches of the operating circuit before the control switch opens, and the part of the operating circuit which is closed by the control switch means is bypassed by a bypass portion of the operating circuit, so that when the control switch means opens an instant after simultaneous closing of both of the normally open switches, the operating circuit can be maintained closed.

BRIEF DESCRIPTION OF DRAWINGS

The invention as illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic representation of a machine which can be controlled by the circuit structure of the invention.

FIG. 2 is a schematic representation of a circuit which illustrates the principle of the present invention.

FIG. 3 is a wiring diagram of one possible practical circuit which may be used to operate a machine such as that schematically shown in FIG. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1, there is schematically illustrated therein a machine **10** which has, for example, a stationary lower platen member **12** which is adapted to carry any work on its upper surface. Situated over the platen **12** is a work member **14** which is to be displaced downwardly toward the member **12** in order to carry out the work of the machine **10**. For example, a pair of sheets which are to be heat-sealed to each other can be situated on the platen **12** to be exposed to pressure and heat derived from the member **14** when the latter is displaced downwardly toward the member **12**. In the illustrated example the work member **14** is carried by a ram **16** forming part of a piston assembly of a fluid-pressure moving means **18** which includes a cylinder **20**. In any suitable way this means **18**, which may be pneumatically operated, for example, is controlled by a solenoid-operated valve, for example, so that when the latter valve opens upon energizing of its solenoid air under pressure will be delivered to the cylinder **20** in order to drive the ram **16** and the work member **14** downwardly therewith to carry out the work of the machine.

Situated at the front of the machine, just below the platen **12**, for example, on a suitable panel **22**, for example, are a pair of switch units **24** and **26** which are spaced from each other by distance small enough to be operated by two hands but too great to permit the switch units to be operated by one hand of the operator. Between these units there is, for example, an emergency switch **28** which can be actuated for turning off the entire machine Also, suitable control units can be located in a control box **30**, these control units being of a type referred to below in connection with FIG. 3.

Thus, with this structure of FIG. 1 as long as both hands of the operator are required for simultaneous actuation of the switch units **24** and **26**, the hands of the operator cannot be located between the members **14** and **22** when the member **14** is driven downwardly to carry out the work which is to be performed by the machine **10**. In this way injury to the hands of the operator is reliably avoided.

Referring now to FIG. 2, the switch units 24 and 26 are schematically illustrated therein. These switch units include a pair of normally closed third and fourth switches 32 and 34 which are located in a safety circuit 36 which is provided with a rectifying means 38 and which includes a first relay coil 40 of a control switch means 42.

The normally closed switches 32 and 34 are respectively coupled with normally open first and second switches 44 and 46 which are connected in series in an operating circuit 48. The normally closed switches 32 and 34 are respectively coupled with the normally open switches 34 and 46 to form the pair of switch units 24 and 26, and when these units are simultaneously operated the normally closed switches 32 and 34 will be opened while the normally open switches 44 and 46 will be closed.

The operating circuit 48 has a portion 50 which is closed by the fifth switch 52 of the control switch means 42 as long as the relay 40 thereof is energized. When the relay 40 is not energized the normally open switch 52 assumes its open position opening part 50 of the operating circuit 48. This circuit 48 also includes a bypass portion 54 which bypasses the part 50 of the circuit and which is closed and opened by switch 64 of a second control switch means 60, which has a second holding relay coil 62 connected to circuit part 50 for closing bypass 54 when coil 62 is energized. The operating circuit 48 has a pair of lines 56 and 58 which are adapted to be connected to any source of alternating current such as that which is available at any wall outlet and which is supplied by a public utility.

With this construction of FIG. 2, as long as the operator does not actuate the switches 24 and 26, the parts will remain in a position shown in FIG. 2 where the operating circuit 48 is open and the safety circuit 36 is closed although both circuits are connected to a common source of alternating current, the rectifying means 38 provides a direct current for the control switch means 42. This control switch means 42 will operate with a time lag which is sufficiently great to enable the operator without difficulty to simultaneously close the switches 44 and 46 while opening the switches 32 and 34. In other words, the coil 40 does not become deenergized with a speed sufficiently great to enable a spring which acts on the switch 52 to retract the latter to its open position before the switches 44 and 46 are simultaneously closed by the operator. When the coil 40 is energized, it maintains, the switch 52 closed in opposition to the spring which maintains it in its normally open position. Thus, this time lag resulting from deenergizing of the coil 40 and responding of the spring to retract the switch 52 to its open position is sufficiently great to provide at least that fraction of a second which is necessary for any operator of normal coordination capabilities to close simultaneously both of the switches 44 and 46 while simultaneously opening both of the switches 32 and 34.

As is apparent for the structure of FIG. 2, the holding relay means 60 includes a coil 62 and a normally open sixth switch 64 for closing the bypass circuit portion 54. The coil 62 of the holding relay means 60 cannot be energized for displacing the switch 64 to its closed position unless both of the switches 44 and 46 are simultaneously closed with the switch 52. The holding relay 60 is designed so that it has a smaller time lag than the control switch means 42 and thus before the switch 52 becomes displaced to its open position, the energized coil 62 has displaced the switch member 64 to its closed position, thus closing the switch 64 and maintaining it closed even after the switch switch 52 opens. Now current can flow through both of the switches 44 and 46 and the bypass circuit portion 54 so that the entire operating circuit 48 will remain operative while the switches 32, 34 and 52 are all open. If only one of the switches 44 and 46 is closed, then the coil 62 remains unenergized and the switch 52 opens so that if thereafter the second switch of the series-connected switches 44 and 46 is closed, the coil 62 will remain unenergized. Thus, it is apparent that with this construction it is essential for the operator to simultaneously close both the switches 44 and 46 in order to enable the operating circuit 48 to close.

Referring now to FIG. 3, an actual circuit to be used with a machine is illustrated therein. The switch units S-1 and S-2 respectively correspond to the switch units 24 and 26. The rectifier means includes the selenium rectifier S-R, as well as a pair of resistors R-1 and R-2, and in this circuit is located the relay coil K-1 which corresponds to the coil 40. Connected across this coil K-1 is an electrolytic condenser C-1, and the circuit includes an indicating lamp I-1. The latter components are located in the direct current circuit portion of FIG. 3 corresponding to the circuit 36 of FIG. 2.

The alternating current operating circuit which includes the series-connected normally open switches of the units S-1 and S-2 include the normally open switch K-1*a* controlled by the relay coil K-1 and corresponding to the switch 52, and the relay coil K-2 is connected in series with this normally open relay switch K-1*a*. This relay coil K-2 corresponds to the coil 62 of FIG. 2 and controls the switch K-2*a* which is normally open, this latter switch becoming closed only upon energizing of the coil K-2 when both of the series connected normally open switches of the units S-1 and S-2 are closed, as was described above in connection with the embodiment of FIG. 2.

With the particular construction shown in FIG. 3, the closing of the switch K-2*a* by energizing of the holding relay coil K-2 upon simultaneously closing of both of the normally open switches of the operating circuit will result in energizing of the third solenoid valve or relay S.V. connected in series with the switch K-2*a*, so that in this way the machine 10 of FIG. 1 will be actuated.

In the illustrated example, the energizing of the coil K-2 also serves to close a second normally open relay switch K-2*b* which serves through normally closed switch K-3*b* to actuate a timer T-2, which 52 a delay timer relay having coil T-2 and normally closed switch T-2*a*. It will be noted that once this switch K-2*b* is closed, the circuit will remain complete for a period of time determined by the timer T-2 even if the switches S-1 and S-2 are released by the operator, so that in this way the heat sealing operations, for example, will be carried out. The switch K-3*b* controlled by the relay coil K-3 is normally closed and opens when the relay coil K-3 is energized, so that this switch does not open until expiration of the time determined by the timer T-2. In this way, a certain delay will be achieved by the coil T-2 and the heat sealing timer T-1 becomes energized upon closing the switch S-4 so that this timer T-1 will provide a heat sealing operation of predetermined duration. There is also connected into the circuit suitable resistors R-3 and R-4 as well as counter C and various indicating lamps such as the lamp I-1 in the rectifier circuit and the lamp I-2 in the delay circuit.

Thus, with the direct current relay K-1 and the alternating current relays K-2 and K-3, it is possible with a circuit as described above, to bring about the desired operations in connection with heat-sealing of sheets to each other, for example, and at the same time the hands of the operator are reliable maintained from the space between the working components of the machine. FIG. 3 also shows at the lower left, the normally closed switch S-3 corresponding to the switch 28 and capable of being opened at any time by the operator in order to open the complete circuit and prevent the operations from continuing, so that this switch S-3 is an emergency switch which is normally closed but which can be opened whenever desired in order to terminate the operation of the machine.

Controls of this type referred to above in connection with FIG. 3 are housed within the control box 30 indicated schematically in FIG. 1.

Thus, it will be seen that by way of the simple structure described above and having the features of FIG. 2, it is possible to control any machine, such as that of the type shown in FIGS. 1 and 3, and this safety structure of FIG. 2 can be easily added to any existing machine at relatively low cost.

I claim:

1. An electrical apparatus, a safety assembly comprising and operating circuit and a safety circuit, said operating circuit having a first and second series-connected normally open

switches and said safety circuit having a third and fourth series-connected normally closed switches respectively coupled with said first and second normally open switches to form a pair of switch units to be manually actuated by opening said normally closed switches simultaneously with the closing of said normally open switches, one side of said first switch connected to one side of a third switch and to one side of a source of alternating current, said switch units being spaced apart from each other by a distance small enough to be operated by two hands but too great to be operated by one hand of the operator, one side of a first relay coil connected to one side of said fourth switch, the other side of said first relay coil connected to the other side of said source of alternating current, a fifth switch controlled by said first relay coil in a closed position when said first relay coil is energized, said fifth switch connected to one side of said second switch and to one side of a second relay coil and to one side of a third coil, the second side of said second relay coil and the third coil being connected to said other side of said source of said alternating current, a sixth switch, said second relay coil controlling said sixth switch, said first relay coil when deenergized operating to open said fifth switch with a time lag sufficiently great to enable the operator to simultaneously close both of said normally open switches and open both of said normally closed switches

to close said sixth switch by means of a current passing through said second relay coil, said operating circuit having a bypass circuit portion which includes said sixth switch connected in parallel with said fifth switch, said bypass circuit portion being energized when said time lag lapses, said third coil controlling said electrical apparatus and being directly energized when said second relay coil is energized.

2. The combination of claim 1 and wherein said safety circuit is a direct current circuit while said operating circuit is an alternating current circuit.

3. The combination of claim 1 and wherein the electrical apparatus includes a machine and in said operating circuit a plurality of electrically operable control units for controlling said machine so that the latter cannot be operated unless both said switch units are simultaneously actuated by the operator.

4. The combination of claim 3 and wherein the machine has a moving means and a pair of members one of which is movable by said moving means toward the other for carrying out the work of the machine, said members defining between themselves a space beyond which the operator must keep his hands in order not to be injured, and one of said control units being operatively connected with said moving means to actuate the latter when said one control unit is energized.