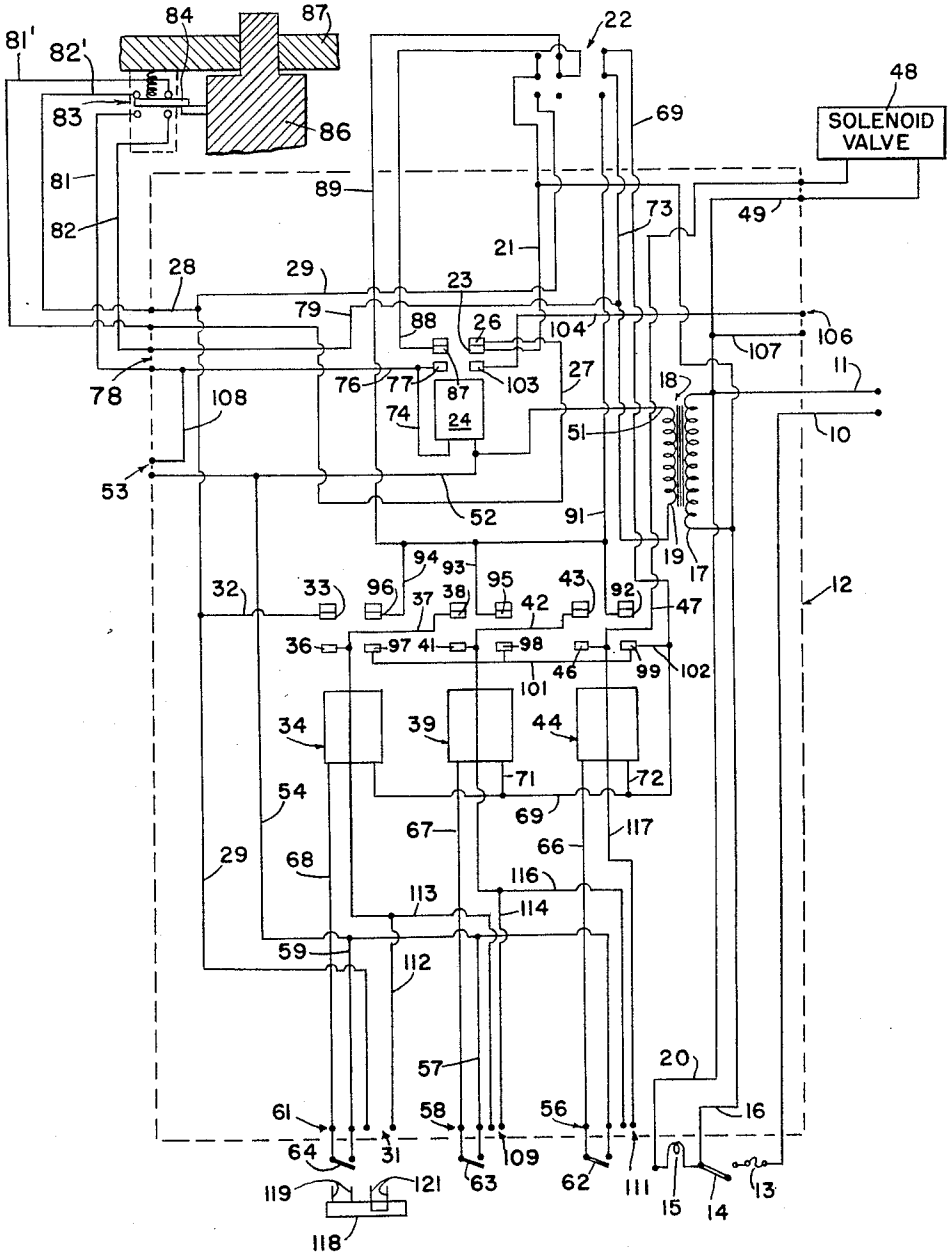
Dec. 1, 1959 A. J. SAMUELS ET AL 2,915,651

CONTROL APPARATUS

Filed Feb. 27, 1957



INVENTORS

ARNOLD J. SAMUELS &

IRVING YAMET

BY Raymond W. Cotton

ATTORNEY

United States Patent Office

2,915,651

Patented Dec. 1, 1959

2,915,651

CONTROL APPARATUS

Arnold J. Samuels, Forest Hills, and Irving Yamet, Riverdale, N.Y.

Application February 27, 1957, Serial No. 642,860

2 Claims. (Cl. 307—115)

The present invention relates to a control circuit primarily intended for use with power presses, brakes, shearing machines, and other automatic and semi-automatic equipment.

In the operation of presses, shears and other types of machines, there is considerable danger to the hands of the operator. There are known circuits and arrangements of parts which have been proposed to solve this problem wherein the cycle of the machine is initiated by the closure of two safety switches spaced apart sufficiently to preclude operation of both by one hand. Such prior art proposals have however, lacked the extreme versatility of the present invention.

There are also devices in the prior art embodying control circuits for valves or switches, for example, which in turn control the operation of the machine itself. Such control circuits may incorporate a switch, closed by movement of a machine part, to energize a holding circuit which in turn deenergizes a circuit containing the main control valve or switch. These devices however, are not of the "fail-safe" type, in that they do not provide for the interruption of the main control circuit should the switch itself be dislodged from the machine, or its normal functioning otherwise disrupted.

Another common deficiency of known equipment of this type is that it permits an operator to close the safety switches to initiate a cycle, then release them during the cycle, and finally reclose them near the end of the cycle to cause a second cycle to be commenced, thus exposing the work to damage and the operator himself to unnecessary danger.

It is among the objects of the present invention to provide a control circuit which may be readily installed on a conventional machine without requiring redesign or substantial modification; to provide a safety control circuit of the "fail-safe" type; and to provide a safety control circuit rendering it impossible for the operator to initiate a new cycle prior to the conclusion of an existing cycle.

A more complete understanding of the invention will follow from a description of the accompanying drawing wherein the single figure illustrates the circuit according to a preferred embodiment of the invention, together with a schematic showing of the mounting of the machine-actuated switch.

A pair of supply leads **10** and **11** may supply currents for an A.C. source to the control equipment arranged in a suitable housing **12** generally indicated by broken lines. One of these leads **10** is connected through a fuse **13** to one pole of a main switch **14** whose second pole is connected to a conductor **16** leading to one terminal of the primary winding **17** of a step-down transformer **18**, having a secondary winding **19**. A pilot lamp **15** is connected to the second pole of the main switch **14** and by a conductor **20** with supply lead **11** to indicate when the switch **14** is closed. The conductor **16** is also connected with a conductor **21** which interconnects a central terminal of three-pole double throw switch **22** and the right

hand movable contact **23** of a relay **24**. In the unenergized condition of the relay **24** as depicted, its contact **23** engages an upper right-hand contact **26**, which is connected through a conductor **27** to one terminal of a socket **78** mounted on a wall of the housing **12**. Another terminal of the socket **78** is connected by a conductor **28** to a conductor **29** which extends from a lower terminal of the switch **22** to a terminal of another socket **31** supported by one of the housing walls.

A conductor **32** connects the conductor **29** to the left-hand movable contact **33** of a relay **34**, depicted as unenergized. Upon energization of the relay **34**, the contact **33** will move downwardly into engagement with the lower left-hand contact **36**, which is connected by a conductor **37** to the left-hand movable contact **38** of a relay **39**, depicted as unenergized. Upon energization of the relay **39**, its contact **38** will engage the lower left-hand contact **41**, which is connected by a conductor **42** to the left-hand movable contact **43** of a relay **44**, likewise depicted as unenergized. Again, upon energization of the relay **44**, its contact **43** will engage the lower left-hand contact **46** which is connected by a conductor **47** to one side of the winding of a motor, such as an electromagnetic motor or solenoid valve **48** which energizes the machine, as by admitting fluid under pressure to an operating cylinder, or by some equivalent arrangement which will cause the machine to commence its cycle of operation. The other side of the winding of the motor **48** is connected by a conductor **49** to the supply lead **11**.

A conductor **51** connects one side of the transformer secondary **19** with the right-hand side of the winding of the relay **24**; the conductor **51** also joins a conductor **52** connected in parallel with one terminal of a socket **53** and a conductor **54** which leads to the fixed terminals of each of a plurality of sockets **56**, **58** and **61**, producing a parallel connection of these terminals with the aid of conductors **57** and **59**. Removable operating switches **62**, **63** and **64** of the plug-in type are depicted as received by the sockets **56**, **58** and **61**, respectively. Two of these operating switches may be safety switches of known types, positioned in spaced relationship so as to insure that an operator's hand is not in the path of any moving parts of the machine when it is operated. The third or any additional number of operating switches may serve as positioning switches controlled by the work to assure proper positioning relative to the operating parts of the machine, such as a press or shear. In applications not requiring the safety features, any or all of the operating switches can serve to facilitate production. For example, one or more such switches can be actuated by properly locating the work in a die. When this occurs and all other operating switches then in circuit are closed, one cycle of operation of the machine will occur. After all of the operating switches have been opened and again closed, a subsequent cycle of operation can be effected.

The second terminal of each of the sockets **56**, **58** and **61** is connected to the winding of its corresponding relay **44**, **39** and **34** by means of conductors **66**, **67** and **68**, respectively. The other sides of the windings of the relays **44**, **39** and **34** are connected in parallel by conductors **69**, **71** and **72** to the upper right-hand terminal of the switch **22**, engaging the central right-hand terminal, in the position shown, through switch **22** when in the position shown to conductor **73** and connected by means of the same conductor **73** to the other side of the transformer secondary **19**. The conductor **69** is also connected with the lower right-hand contact of the relay **44**.

The left-hand side of the winding of the relay **24** is connected by conductors **74** and **76** in parallel to the lower left-hand contact **77** of the relay **24** to the lowermost terminal of the socket **78** carried by the housing **12**. The next higher terminal of the socket **78** is con-

nected by a lead 79 to the conductor 73. These terminals of the socket 78 are connected by conductors 81 and 82 to a lower pair of terminals of a double make double break switch 83 whose movable contact is biased downwardly by means of a compression spring. The upper pair of terminals of the socket 78 are connected by means of leads 81' and 82' to the upper fixed contacts respectively of the switch 83. An operator 84 attached to the movable contact is disposed in the path of a movable part 86 of the machine to be controlled. The switch 83 is shown as mounted on a fixed part 87 of the machine. In the positions of these parts as depicted, the moving part 86 is in its uppermost position of travel, and upper contacts of the switch 83 are closed while its lower contacts are open. When the cycle of operation begins, the moving member 86 moves downwardly, whereupon the upper contacts of the switch 83 will open and its lower contacts will close. Similarly, should the switch 83 be dislodged from its position, its upper contacts will be opened and its lower ones will close, providing a safety feature not previously known in such an environment.

The relay 24 has a left-hand movable contact 87 which is connected by a conductor 88 to the central movable terminal of the switch 22, whose upper fixed terminal is connected by a conductor 89 in parallel with the central right-hand terminals 92, 95 and 96 of relays 44, 39, and 34, through leads 91, 93 and 94, all respectively. The relays 34, 39 and 44 have their lower right contacts 97, 98 and 99 respectively, connected in parallel by means of conductors 101 and 102 to the conductor 69.

The lower right-hand contact 103 of relay 24 is connected by a conductor 104 with one terminal of a housing supported socket 106, whose other terminal is connected to the supply lead 11 by means of a conductor 107. This socket 106 is intended to be connected with a counter. Similarly, the socket 53, whose second terminal is connected to the conductor 76 by a conductor 108 may also energize a counter.

Comparable with the socket 31 disposed adjacent to the socket 61, sockets 109 and 111 are provided adjacent to the sockets 58 and 56 respectively. As previously stated, the conductor 29 is connected to one terminal of the socket 31, its other terminal being connected by a conductor 112 to a conductor 113 which extends from one terminal of the socket 109 to the conductor 37 interconnecting contacts 36 and 38 of relays 34 and 39 respectively. The other terminal of the socket 109 is connected by a conductor 114 to a conductor 116 which connects one terminal of the socket 111 with the conductor 42 interconnecting contacts 41 and 43 of relays 39 and 44 respectively. The other terminal of the socket 111 is connected to the conductor 47 by means of a conductor 117.

Plugs 118 are provided for insertion into sockets 61, 31; 58, 109; and 56, 111; only one such plug having been illustrated. Each plug 118 has a first pair of prongs 119, insulated from one another, for reception by the sockets 61, 58, and 56; and a second pair of prongs 121, which are electrically interconnected, for shorting the terminals of the sockets 31, 109, and 111. When the plugs 118 are to be used, the terminals of the switches 62, 63, 64 must first be removed from the sockets.

In operation, upon closing the switch 14, a circuit will be completed from the supply lead 10, through conductor 16, primary 17 of transformer 18 and to supply lead 11. A circuit will also be completed from the supply leads through the pilot lamp 15 and the conductor 20. Upon closing of the switches 62, 63 and 64, current will flow from the secondary 19 of transformer 18, through conductors 51, 52 and 54, and through conductors 66, 67, and 68, the windings of relays 44, 39, 34, conductor 69, through switch 22, and conductor 73 to the other side of the secondary winding 19. Under these conditions the central contacts of the relays 34, 39 and 44 will be shifted downwardly to separate from their upper contacts and engage the lower ones.

When relays 34, 39, 44 have been energized, a circuit is established from the supply lead 10 through the switch 14, conductors 16 and 21, the right movable contact 23 of the relay 24, the right upper contact 26, conductors 27, 81', the upper contacts of switch 83, conductors 82', 28, 29 and 32, contacts 33 and 36 of relay 34, conductor 37, contacts 38 and 41 of relay 39, conductor 42, contacts 43 and 46 of relay 44, conductor 47, the winding of solenoid valve 48, conductor 49 and supply lead 11.

It will thus be understood that only by closing all of the switches 62, 63, 64, the relays 34, 39 and 44 will be energized permitting current to be supplied to the winding of the solenoid valve 48. Energization of the winding of solenoid valve 48 causes the press or other machine to begin its cycle of movement, thus causing the movable machine part 86 to depart downwardly from the fixed machine part 87. This movement results in opening the upper contacts and closing the lower contacts of the switch 83 under the biasing action of its spring. Opening of the upper contacts of the switch 83 opens the circuit previously described and deenergizes the solenoid valve 48. Closure of the lower contacts of the switch 83 completes a circuit from the secondary 19 through conductors 51 and 52, the winding of relay 24, conductors 74, 76, 81, lower contacts of switch 83, and conductors 82, 79 and 73 back to the other side of the secondary 19. Since such energization of the relay 24 causes its movable right-hand contact 23 to separate from the contact 26, the circuit which initially included the winding of the solenoid valve 48 will be opened. A holding circuit is completed however, from the secondary 19, through conductor 51, the winding of relay 24, conductors 74, contacts 77 and 87, conductor 88, switch 22, conductor 89, and in parallel through conductors 91, 93 and 94, contacts 96—97, 95—98, and 92—99, conductors 101, 102, 69, switch 22, and conductor 73 to the other side of secondary 19. This holding circuit maintains relay 24 energized so long as any one of switches 62, 63 or 64 is closed, and hence keeps open the circuit which includes solenoid valve 48. This insures that each of switches 62, 63, 64 must be opened before a circuit may again be completed through solenoid valve 48.

Due to the fact that the upper contacts of the switch 83 are normally open and its lower contacts normally closed during an operating cycle of the machine and will be so positioned under the bias of its spring should the switch be dislodged from the machine, or its normal functioning otherwise disrupted, a "fail-safe" arrangement is provided. Such malfunctioning will cause the upper contacts to open the circuit of the solenoid valve 48 as already described. Closure of the lower contacts provides further assurance of safety in that such closure effects completion of a circuit through the winding of relay 24, and thus causes the main control circuit which includes the solenoid valve 48 to be open, as the contacts 23 and 26 of relay 24 will be separated. It will follow that should the cable containing conductors 81, 82, 81' and 82' become severed, as has been known to occur in practice, the effect would be the same as opening the circuit of the upper contacts of the switch 83.

It is extremely important in accordance with the present invention, that in normal operation, once the cycle has been initiated so that the upper contacts of the switch 83 have been opened and its lower contacts closed, it is not possible for an operator to initiate the new cycle of the machine prior to the completion of the existing cycle and return of the machine to its rest position depicted in the drawings.

Should it be desired to count the strokes of the machine, a counter may be plugged in at either socket 53 or 106 and receive a pulse each time the relay 24 is energized.

In some instances, it may be desirable to utilize less than all of the switches **62, 63, 64.** Under such conditions, the switch or switches to be eliminated will be disconnected from their respective sockets and replaced by a plug or plugs **118.** Since the prongs **119** of the plug **118** are not electrically connected, the circuit formerly completed through a switch **62, 63,** or **64** and the winding of its relay is not completed and the relay will not be energized. However, since the prongs **121** of each plug **118** are electrically connected, assuming a plug **118** has been inserted in the sockets **61—31,** a circuit is completed from supply lead **10,** switch **14,** conductors **16** and **21,** contacts **23** and **26** of relay **24,** conductors **27, 28, 29,** socket **31,** prongs **121,** conductors **112, 113** and **37,** left movable contact **38** of relay **39** so as to supply current to the contact **41** upon energization of the relay **39.** Hence, although relay **34** will not be energized, closing of switches **63** and **62** will energize relays **39, 44** to permit current flow through the relay contacts, to the winding of the solenoid valve **48,** and back to the supply lead **11.** Insertion of a plug **118** into sockets **59—109** and/or **56—111** may also be effected.

Where it is desired that the machine operate continuously rather than by single strokes, the switch **22** is thrown to its other position. This will complete a circuit from the supply lead **10,** through switch **14,** conductors **16, 21,** switch **22,** conductor **29,** prongs **121** in socket **31,** conductor **113,** prongs **121** in socket **109,** conductors **114** and **116,** prongs **121** in socket **111,** conductors **117,** and **47,** winding of solenoid valve **48,** and conductor **49,** to supply lead **11.** Thus, there will be no interruption of current supplied to the winding of the solenoid valve **48,** as in the other position of the switch. Under these conditions however, relay **24** will continue to operate and supply pulses to sockets **106** and **53** for actuating counters or auxiliary equipment if desired.

It will be understood that within the scope of the appended claims variations from the form of the invention described will not depart from the spirit of the invention.

What is claimed is:

1. In a control for a cyclically operable machine, an electromagnet energizable to activate said machine, an energizing circuit for said electromagnet comprising switch means, electromotive means for opening said switch means upon energization thereof, energizing circuit means for said electromotive means including spring biased normally closed switch means, means operable by the machine during the last part of its cycle to open said normally closed switch means, a plurality of electromotive means connected in parallel with each other and with said first mentioned electromotive means, switch means in series with each of said plurality of electromotive

means, a plurality of normally open switches each operable by one of said plurality of electromotive means, a socket, said plurality of normally open switches being connected in series in said energizing circuit, and a bypass circuit for at least one of said plurality of normally open energizing circuit switches comprising a conductor leading from a part of said energizing circuit to one terminal of said socket, a second conductor leading from the other terminal of said socket to the conductor connecting one of said normally open energizing circuit switches with the next, and a plug adapted to be inserted in said socket and connect said conductors.

2. In a control for a cyclically operable device having a member movable in a work cycle: a first circuit having one winding of a transformer therein; a second circuit in parallel with said first circuit comprising a pair of normally closed contacts and a plurality of pairs of normally open contacts, said contacts being in series, and an electromagnet in series with said contacts; a third circuit comprising another winding of said transformer, a relay a spring biased normally closed switch means operable by the machine during the last part of its cycle to open said normally closed switch; a fourth circuit in parallel with said third circuit comprising a plurality of relays connected in parallel and each having a switch in series therewith; said relays of said fourth circuit each carrying a pair of the normally open contacts of said second circuit and said relay of said third circuit carrying said pair of normally closed contacts of said second circuit; a fifth circuit in series with the relay of said third circuit and comprising a pair of normally open contacts carried by said last mentioned relay and a plurality of pairs of normally open contacts in parallel with each other and in series with said last mentioned pair of contacts, each of said plurality of pairs of normally open contacts of said fifth circuit being carried by one of the relays of said fourth circuit; and sixth and seventh circuits in series with one another and each of which is in parallel with a pair of said normally open contacts of said second circuit, each of said sixth and seventh circuits comprising a socket adapted to receive a plug to close said sixth and seventh circuits.

References Cited in the file of this patent

UNITED STATES PATENTS

2,302,838	Bundy	Nov. 24, 1942
2,404,980	Munschauer	July 30, 1946
2,473,683	Hines	June 21, 1949
2,496,574	Boger	Feb. 7, 1950
2,802,154	Bonn et al.	Aug. 6, 1957