G. H. WHITTINGHAM.

APPARATUS FOR CONTROLLING ELECTRIC MOTORS.

APPLICATION FILED JUNE 7, 1909.

965,672. **Patented July 26, 1910.**

3 SHEETS—SHEET 1.

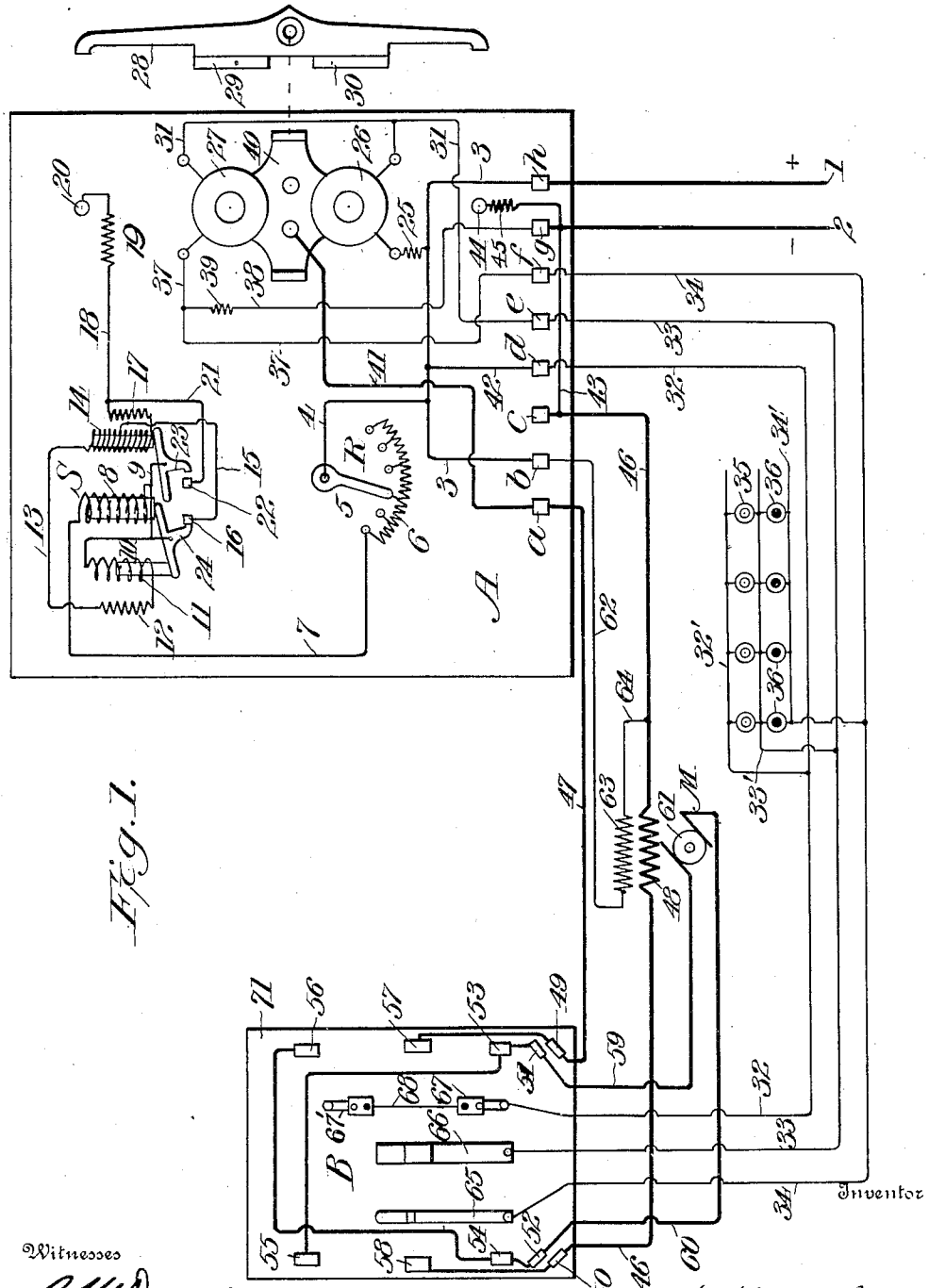

Fig. 1.

Witnesses

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3 SHEETS—SHEET 2.

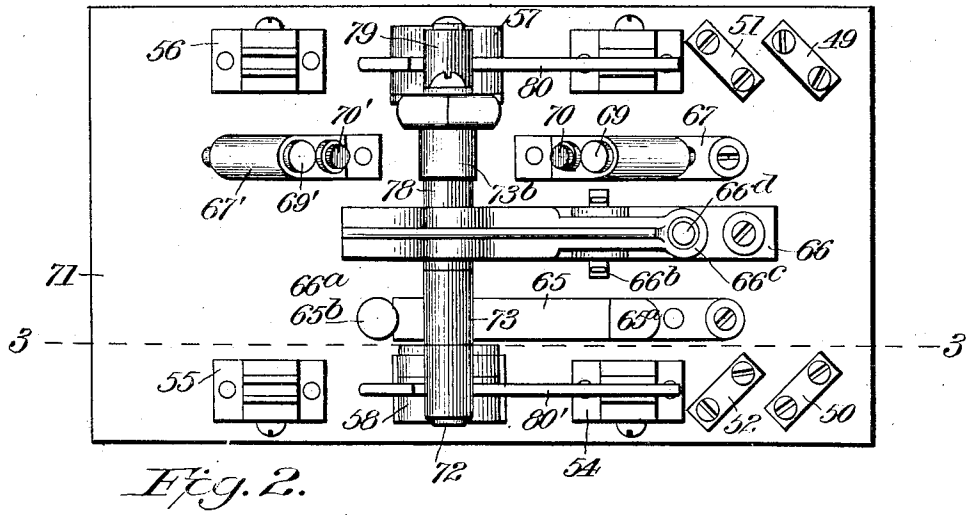

Fig. 2.

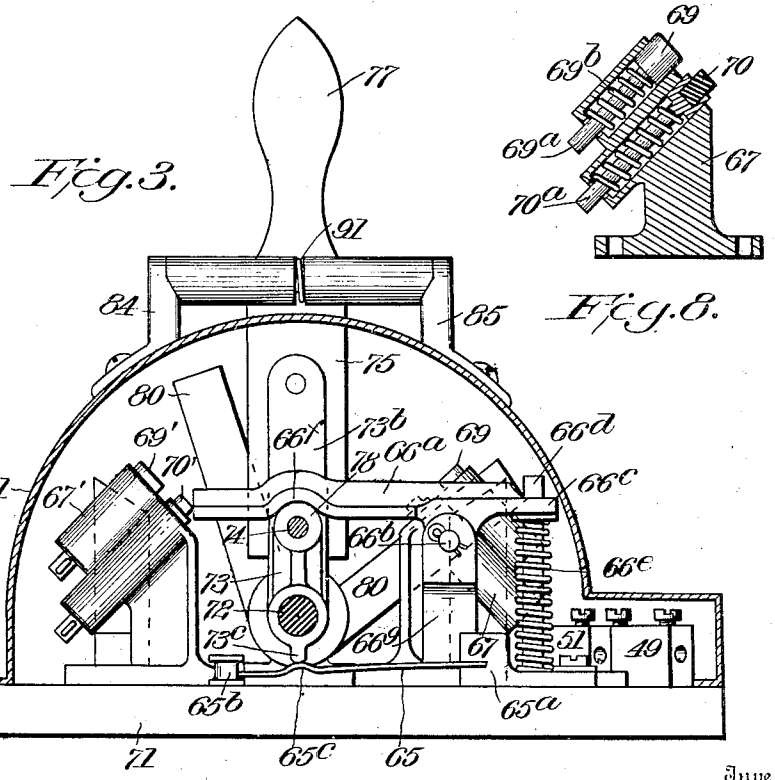

Fig. 3.

Fig. 8.

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3 SHEETS—SHEET 3.

Fig. 4.

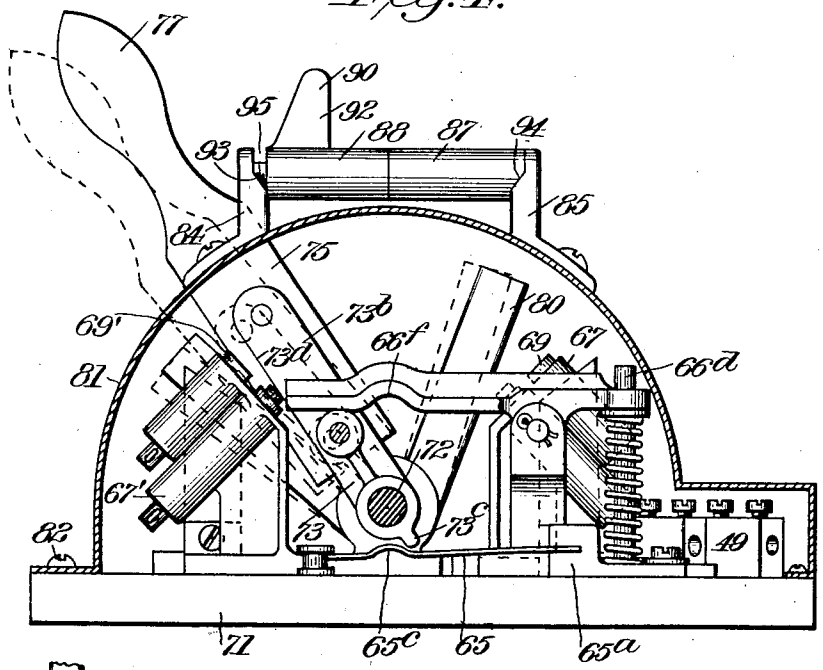


Fig. 5.

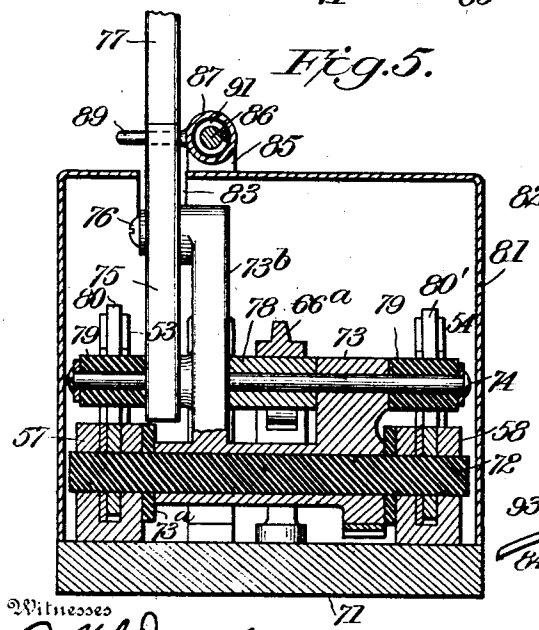
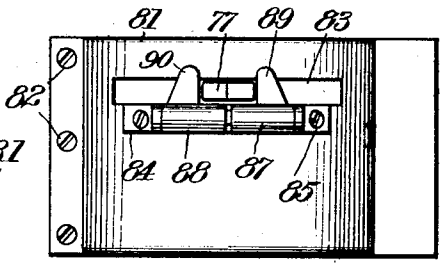


Fig. 6



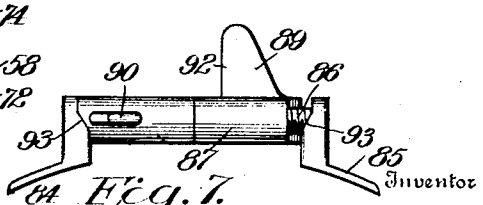


Fig. 7.

Witnesses

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UNITED STATES PATENT OFFICE.

GEORGE H. WHITTINGHAM, OF BALTIMORE, MARYLAND, ASSIGNOR TO MONITOR MANUFACTURING COMPANY OF BALTIMORE CITY, A CORPORATION OF MARYLAND.

APPARATUS FOR CONTROLLING ELECTRIC MOTORS.

965,672. Specification of Letters Patent. Patented July 26, 1910.

Application filed June 7, 1909. Serial No. 500,667.

To all whom it may concern:

Be it known that I, GEORGE H. WHITTINGHAM, a citizen of the United States, residing at Baltimore and State of Maryland, have invented certain new and useful Improvements in Apparatus for Controlling Electric Motors, of which the following is a specification.

My invention relates to apparatus for controlling electric motors, and more particularly to apparatus for use in connection with systems employing an electro-magnetically operated switch in the armature circuit, controlled from a distance by means of push buttons. Such systems of motor control are especially adapted to the operation of large printing presses and other machines, and it is the common practice to carry the controlling circuit to various points of the machine, and arrange push buttons in the same, so that the machine can be started and stopped by the operator from any one of a number of positions. In testing, adjusting and repairing motor driven machines of a complicated nature, however, trouble has been experienced owing to the fact that one workman may start the machine by pushing a button before another workman is ready, or without the authority of the foreman, and thus frequently cause accidents or loss of time.

The primary object of the present invention, therefore, is to provide a master controller for such a push button system, so arranged that when thrown to a certain position, it will be impossible for the motor to be started by manipulating the push buttons.

A further object of the invention is to provide such a controller, which, while it prevents the push buttons being used to start the motor permits of the motor being stopped by the buttons in the usual manner.

A further object is to so organize such a master controller that it may be itself used for both starting and stopping the motor, independent of the push buttons.

A further object is to combine in one device a master controller as above mentioned, and a reversing switch, and to provide a single lever for operating the same.

A still further object of the invention is to provide, in combination with a reversing switch, means for preventing its too rapid throw from one position to the other.

A still further object is to provide an improved arrangement of electro-magnetically operated switch and wiring system therefor, whereby the motor may be effectively controlled, and whereby a dynamic brake is brought into action when the armature circuit is broken.

With the above and other objects in view, and to improve generally upon the details of such apparatus, my invention consists in the construction and arrangement of parts hereinafter described, and illustrated in the accompanying drawings, in which:—

Figure 1 is a diagram of the wiring and apparatus employed in connection with my improved motor controlling apparatus; Fig. 2 is a plan view of the master controller with the cover removed; Fig. 3 is a longitudinal section through the controller complete, on the line 3—3 of Fig. 2, parts being shown in elevation; Fig. 4 is a similar view, the parts being shown in a different position; Fig. 5 is a central transverse section through the controller, parts being shown in elevation; Fig. 6 is a plan view, on a reduced scale, of the controller as shown in Figs. 3, 4 and 5; Fig. 7 is a side elevation of the locking device hereinafter described; and, Fig. 8 is a central vertical section through one of the contact devices hereinafter described.

Referring to the drawings in detail, and more particularly to Fig. 1 thereof, my improved system of motor control comprises what I will term a starting panel designated in its entirety by the character A, and a master controller panel designated by the character B. M indicates the motor for the control of which the apparatus is designed. On the starting panel is mounted a regulating rheostat R, a suitable type of automatic starter S, and an electro-magnetically controlled switch, hereinafter described. 1 and 2 designate the terminals of the supply circuit through which the current is supplied to the apparatus. The supply wires 1 and 2 are secured to binding posts *g* and *h*. Other binding posts, designated *a*, *b*, *c*, *d*, *e* and *f*, are also provided for the reception of the various wires. From the binding post *h* extends a conductor 3 to the binding post *b*, and a conductor 4 connects the conductor 3 with the arm 5 of the rheostat R. From the resistance 6 extends a wire 7 to the automatic starter. This starter may be of any

suitable form, but, as shown, comprises three solenoids indicated by the characters 8, 11 and 14. The wire 7 extends first to the winding of the solenoid 8, thence through wire 10, to and through solenoid 11, thence through a resistance 12 and wire 13 to solenoid 14. The solenoid 14 has approximately double the number of turns of solenoid 11, and from the lower end of the solenoid 14 a conductor extends to and through a resistance 17, from which leads a wire 18 to and through a resistance 19, to a fixed contact 20. A conductor 21 taps the wire 18 and extends to a fixed contact 22, while a conductor 15 taps the solenoid 14 at its middle and extends to a contact 16. Pivoted levers 23 and 24 are arranged to coöperate with the fixed contacts 22 and 16, and are governed in their movements by the three solenoids. The lever 23 is connected by the wire 9 to the wire 10, and the wire 10 is also connected to the lever 24. A high resistance wire 25 connects the conductor 3 with one side of an electro-magnet coil 26, the other side of which is connected with a wire 31 which extends to binding post *e*. This wire 31 also connects with a second electro-magnet coil 27, the other terminal of which is connected by means of a wire 37 with the binding post *f*. The two electro-magnet coils 26 and 27 are preferably arranged on a core or yoke 40 so as to constitute a double electro-magnet. A switch arm 28 is pivoted at its middle to the yoke 40, and carries a pair of armatures 29 and 30 coöperating with the coils 27 and 26 respectively. One end of the arm 28 is adapted to engage the fixed contact 20, while the other end of the arm coöperates with a second fixed contact 44. This contact 44 is connected by means of a conductor 43 with the binding post *c* and also with the binding post *g*, thereby making connection with one of the supply wires 2. A suitable resistance 45 is preferably placed in this wire 43 adjacent the contact 44 for the purpose hereinafter described. A wire 38 taps the wire 37 and also extends to the binding post *g*, there being a high resistance 39 also included in this wire. A conductor 41 extends from the yoke 40 to binding post *a*, and a conductor 42 connects the wire 3 with binding post *d*. Wires 32, 33 and 34 extend from the binding posts *d*, *e* and *f*, respectively, to the master controller hereinafter described, and between these wires or else between branch wires 32′, 33′, 34′, are arranged a series of "stop" and "start" push buttons 35, 36. From the binding posts *a* and *c* extend conductors 46 and 47 to the master controller B, and these wires constitute the main motor circuit. The wires 47 and 46 are attached to binding posts 49 and 50, respectively, carried in the master controller panel 71, and these binding posts are connected with blocks 57 and 58, respectively, in which the blades of the reversing switch are pivoted. Coöperating with the blades of this switch are the usual cross-connected contacts 53, 55, 54, 56, which, in turn, are connected with binding posts 51 and 52, respectively. From the binding posts 51 and 52 extend conductors 59 and 60 to the armature 61 of the motor M. The motor is shown as being of the compound wound type, the series field 48 of which is included in the conductor 46, while the shunt field 63 is connected at one end by means of a wire 62 with binding post *b*, and at the other end by means of a wire 64 with the conductor 46. The wires 32, 33 and 34 are connected to contact members 67, 66 and 65, the contact member 67 being connected by means of a wire 68 with a similar member 67′ at the other side of the switch.

Referring now more particularly to Figs. 2 to 5, inclusive, the details of construction of the master controller will be explained. The reference characters employed in Fig. 2 are, of course, the same as those shown in Fig. 1 and the identification of the various parts will, therefore, be easy. A shaft 72, preferably formed of insulating material, is journaled in the blocks 57 and 58, and extends across the controller base 71. On this shaft is mounted a frame 73, such frame being separated from the blocks 57 and 58 by means of insulating washers 73^a, as clearly shown in Fig. 5. A rod or bolt 74 extends through the upper part of the frame 73 parallel with the shaft 72, and near the middle of the bolt is journaled a sleeve 78, while at its ends are mounted sleeves or bushings 79, of insulating material. An arm 73^b, preferably formed integral with the frame 73, extends upwardly therefrom and a lever 75 is secured to the upper end of the arm 73^b as by means of a screw 76, the rod 74 passing through the lower end of the lever and thus serving to form a rigid connection. The lever terminates at its upper end in a handle 77, by means of which the controller is operated. 80 and 80′ designate the blades of the reversing switch, which blades are journaled on the shaft 72 in the blocks 57 and 58, and are preferably of substantial V-shape and so arranged that they may be thrown into engagement with either of the fixed contacts 53, 54 or 55, 56, as is well understood. In connection with the frame 73 and associated lever 75, I provide a centering device which may consist of a lever 66^a, pivoted at 66^b upon a fixed support 66^c, and having a concave seat 66^d formed near its free end, adapted to engage the sleeve 78 carried by the frame 73. At the opposite end 66^e of the lever 66^a is a spring 66^g, confined between the base 71 and the inside of the lever in such a manner as to normally force the free end of the lever into engagement with the sleeve

78. In order to maintain the spring in position and properly guide the movement of the parts, I provide a post or pin 66^d around which the spring is coiled, and the upper end of which projects through an opening in the end 66^c of the lever. It is apparent, therefore, that the lower cam surface of this lever coöperating with the roller 78 has a tendency to yieldingly maintain the lever 78 in its central position, as shown in Fig. 3. Projecting from the frame 73 below the shaft 72 is a lug 73^c, which lug, when the parts are in position shown in Fig. 3, is adapted to engage a hump 65^c in a contact spring 65 which is rigidly secured at one end to a block 65^a and at the other end, plays between the upper and lower limits of a stop 65^b.

The contact devices 67 and 67′ are symmetrically arranged at each side of the shaft 72 and are identical in construction. By reference to Fig. 8, it will be seen that each comprises a base or pedestal, and a pair of spring pressed plungers arranged parallel with each other and mounted diagonally in the upper part of the pedestal. One of these plungers has a metallic head or button 69 and a shaft 69^a around which is arranged a coiled spring 69^b, while the other plunger carries a head or button 70 of insulating material, and has a shaft 70^a, also surrounded by a spring. It will be noted that the button 70 projects somewhat farther than the button 69, so that the button 70 will act as a stop to prevent the arm 73^b coming into contact with the button 69. By reference to Fig. 2, it will be seen that the two contact devices 67 and 67′ are arranged in the same longitudinal plane as the arm 73^b and are symmetrically disposed in regard thereto, in such a manner that when the lever 75 is thrown to the position indicated by dotted lines in Fig. 4, the face 73^d of the arm 73^b is brought into contact with the button 69 (or 69′ as the case may be). It will be further and particularly noted, however, that after the lever has been thrown to the position shown in dotted lines and then released, the plunger 70 will serve to throw the lever back to the position shown in full lines, thus breaking contact between the button 69 and arm 73. In other words this contact can be maintained only so long as the lever 75 is manually held in its dotted line position.

The entire mechanism of the master controller is inclosed by a casing 81, substantially semi-cylindrical in shape, secured to the base 71 by means of screws 82. Such casing is provided with a slot 83 through which the operating handle 77 of the lever 75 projects. Secured to the casing adjacent the slot 83 is a locking device for engaging the lever and preventing it from being rapidly thrown from one position to the other. This locking device is clearly shown in Figs. 4, 5, 6 and 7, and comprises a pair of brackets 84, 85, having curved bases adapted to be secured to the upper surface of the cylindrical casing 81. Between the brackets 84, 85, extends a rod 86 on which is journaled a pair of sleeves 87, 88, from which project lugs or detents 89, 90, respectively. Surrounding the shaft 86 and lying within the sleeves 87, 88, is a coiled spring 91 (see Fig. 3) which abuts against internally formed shoulders in the sleeves, and normally tends to urge them apart so as to cause each sleeve to abut against its respective bracket 84, 85, as shown in Fig. 3. It will be now particularly noted that each bracket has formed on the inside thereof a beveled face 93, forming a cam surface of an inclination of substantially 45°, such cam surface being symmetrically disposed with regard to the axis of the rod 86. The end of each of the sleeves 87, 88, is cut to conform exactly with the shape of the corresponding brackets, and hence the end of each sleeve comprises a portion extending at right angles to the axis of the sleeve and an inclined or cam portion extending at approximately 45° thereto, and of such shape and size that the ends of the sleeves snugly fit the brackets, as shown in Figs. 3 and 6. When in this position, it will be observed that the two locking lugs or detents 89 and 90 project horizontally across the slot 83 into the path of the lever 77, and are adapted to receive this lever between them. When now it is desired to move the lever in either direction from its central position, one of the detents is swung upwardly on its pivot as shown in Fig. 4 or 7, according to which way the lever is moved.

We will suppose that the lever is in the position indicated by full lines in Fig. 4 and that it is desired to throw the same to its full reverse position. In attempting to move the lever over, however, it will encounter the detent 89 and be stopped thereby. By reference to Fig. 4, it will be observed that when the sleeve 88 was rotated so as to bring the detent 90 to an inoperative position, such rotation, by reason of the coacting cam surfaces 93 and 94, caused the sleeve 88 to travel longitudinally of the rod 86 so as to leave a space 95 between its square end and the bracket 84. In other words, it will be observed that when in their normal position, as indicated in Fig. 3, the combined length of the two sleeves is less than the distance between the brackets so that there is a space between their adjacent ends. When, however, the parts are moved to the position shown in Fig. 4, the sleeve 88 has been shifted toward the sleeve 87 until it practically abuts thereagainst and it is held in this position by reason of the square portion of its outer end engaging the square

inside face of the bracket 84. It will thus be seen that with the parts in this position, it is impossible for the sleeve 87 to be rotated since no endwise movement is permitted. When, therefore, the lever has been moved from the position shown in Fig. 4 to its middle position so as to strike the detent 89 it is necessary to first swing the detent 90 back to its normal position before the detent 89 can be swung up out of the path of the lever, in order to permit the lever to be thrown to its full reverse position. In other words, the two pivoted detents 89 and 90 are so related that either one may be swung out of the path of the lever as desired but both cannot be moved at the same time for the reason that when one is shifted it serves to rigidly lock the other in position. By this means a certain interval of time is consumed by the operator in turning back one of the detents and turning up the other before he can complete the stroke of the lever and in this way the movement of the lever is temporarily arrested at its intermediate position and a too rapid throwing thereof from one extreme position to the other is prevented. In this connection it will be observed that should, with the lever in the position shown in Fig. 4, the detent 90 become accidentally thrown down to its operative position it will not interfere with the lever being quickly thrown to its intermediate position. This is due to the fact that the outer edge of the detents 89 and 90 are formed sloping or beveled so that when the lever contacts therewith they will be thereby automatically shifted so as to allow the lever to pass. The inner face of the detents, however, are square as shown in Fig. 6, so that the lever may be firmly held between them.

The operation of the system as a whole will now be explained.

Referring first to Fig. 1, it will be noted that the magnet coils 26 and 27 are both in a normally closed series circuit. This circuit may be traced as follows: From the positive terminal 1, through wire 3, resistance 25, coil 26, wire 31, coil 27, wire 37, resistance 39, wire 38, binding post *g*, back to the negative terminal 2. It will, therefore, be apparent that the switch member 28 will remain in either position to which it may be thrown since the armatures 29 and 30 will cling to either magnet pole with which they are brought into contact. Furthermore, it will be understood that if the particular magnet with which one of the armatures is in contact be deënergized, the switch member 28 will be immediately shifted to its other position, owing to the attraction of the other magnet. The energization of the magnet coils 26 and 27 so as to operate the switch member 28, is controlled by means of the three controlling wires 32, 33 and 34 which extend, as above explained, from the starting panel to the master controller. The "start" and "stop" push buttons 35 and 36, located between these controlling wires or between branches thereof, constitute the normal means for controlling the operation of the electromagnetically actuated switch member 28. We will suppose that the switch member 28 is in its "open" position, that is, out of engagement with the contact 20, and we will assume that it is desired to start the motor. To do this, one of the buttons 35 is depressed, and this closes a circuit between the wires 32 and 33. The result of closing this circuit is to establish a short circuit shunt around magnet 26, for the current coming in on wire 3, instead of going through high resistance 25 and coil 26, to wire 31, goes directly through wire 42, wire 32, push button 35, wire 33 to wire 31, and thus continues to flow through the magnet coil 27, but is entirely shunted from the coil 26. The coil 26, is, therefore, deënergized and, under the influence of the magnet 27, the switch member 28 is moved into engagement with the contact 20. When, now, it is desired to stop the motor, one of the buttons 36 is depressed and a circuit thus closed between the wires 33 and 34. This results in short circuiting magnet coil 27 for, the current, after passing through coil 26, instead of going up through wire 31 and coil 27, passes down through wire 31, wire 33, push button 36, wire 34, wires 37 and 38, back to binding post *g* and thence to the negative terminal. Thus, the magnet 27 is deënergized, and the switch member 28 moves in response to magnet 26 so as to open the circuit at contact 20, and bring its other end into engagement with the contact 44. The term push-button, as used herein, is intended to apply to any manually operated switch suitable for temporarily closing a circuit.

The automatic starter S, shown on the panel A, is connected directly to the contact 20. When the switch member 28 is in engagement with this contact, current flows from the positive terminal 1, through wires 3 and 4, through the regulating resistance or rheostat R, wire 7, to and around winding of solenoid 8, thence to wire 9, conductor 10, lever 24, contact 16, wire 15, the lower half of solenoid 14, resistance 17, conductor 18, contact 20, switch member 28, magnet frame 40, conductor 41, binding post *a*, conductor 47, to and through the master controller and motor, whence it returns by way of conductor 46, wire 43 to negative terminal 2.

As shown in Fig. 1, the parts of the automatic starter are in the position they assume after the circuit has been closed and the motor running for a few moments. Normally,

when the circuit is open, the weight of the core of solenoid 8 resting on the inner ends of the levers 23 and 24 serves to maintain these levers out of contact with their respective contacts 22 and 16, and to maintain the cores of the solenoids 11 and 14 in their elevated position. When the circuit is first closed the current flows through wire 7, solenoid 8, wires 9 and 10, solenoid 11, resistance 12, wire 13, all of solenoid 14, resistance 17 and out wire 18, thus simultaneously energizing the three solenoids, and lifting the core of the solenoid 8 out of engagement with the ends of the levers. But owing to the fact that the current is heavy on starting, the solenoids 10 and 11 also hold their cores in their elevated positions so long as the current remains above a certain predetermined value. When, however, the motor has gained sufficient speed to cut the current down to this predetermined value, the solenoid 11 releases its core and swings the lever 24 into engagement with the contact 16, as shown in the drawing, with the result that the circuits may be traced in the manner first described. This has the effect of cutting out the solenoid 11 and resistance 12, as well as half of the solenoid 14, but the increased current flowing through the lower half of the solenoid 14 still serves to maintain its core in its elevated position. Finally, however, when the current has again fallen to a predetermined amount as the motor approaches normal speed, the solenoid 14 releases its core and thereby swings the lever 23 into engagement with the contact 22, thus short-circuiting all of the solenoids 14 and resistance 17, so that the current flows direct from wire 9 through lever 23, contact 22, wire 21, to wire 18 and out to the motor. If the regulating resistance, R, is all primarily included in series with the starter, for running at low speed, the current flowing through the starter will be reduced so that the starter will, with any given load, cut out the starting resistance more quickly than if less of the regulating resistance were included in the circuit. It will be understood, however, that in many of its aspects, the present invention is equally as well adapted for use in connection with any other suitable form of automatic starter.

The motor circuit, coming from the starting panel over the conductor 47, enters the master controller through binding post 49, whence it passes to pivot block 57 and thence through the reversing switch and motor armature to pivot block 58, binding post 50, and conductor 46, through the series field of the motor. The shunt field of the motor is permanently connected across the line, and the circuit may be traced from binding post *h*, through conductor 3, to binding post *b*, wire 62, field 63, wire 64, conductor 46, wire 43, back to the negative terminal.

When the switch member 28 is thrown to the "stop" position so that it engages the contact 44, the motor armature circuit is closed through the resistance 45, so as to constitute a dynamic brake and quickly bring the armature to a stop. The circuit may be traced as follows, supposing the reversing switch to be thrown into engagement with the contacts 55, 56; beginning at armature lead 59, current flows through binding post 51, to contact 55, thence through the reversing switch to pivot block 58, binding post 50, and through conductor 46, series field 48, wire 43, resistance 45, to contact 44. From here the circuit passes through switch member 28, magnet frame 40, conductor 41, binding post *a*, conductor 47, binding post 49, pivot block 57, through reversing switch to contact 56, and thence through binding post 52 to the other armature terminal 60. It will thus be seen that the armature is connected on itself in a closed circuit including the series field 48, regardless of the position of the reversing switch, so that a proper field excitation may be maintained in order to produce the necessary magnetic drag upon the armature.

While the push buttons 35 and 36 are to be located at convenient points around the machine which is being driven, so as to be readily accessible to the operators, the controlling panel B is located at a distance from the machine and preferably in such position as to be accessible only to the foreman or other person in charge of the work.

Referring to Fig. 3, it will be seen that when the lever 75 is in its intermediate or stop position, the lug 73^c on the frame 73 makes contact with the spring 65, and the wires 33 and 34 are thus connected through spring 65, frame 73, and lever 66^a and associated parts. The effect of this on the controlling system is, it will be understood, the same as maintaining one of the "stop" buttons, 36, depressed. In other words, as long as the lever 75 remains in its vertical position the magnet 27 is short circuited through the wires 33 and 34, the spring 65, and frame 73, and the switch member 28 thus maintained in its opened position by means of magnet 26. It will be also observed that with the controlling lever in this position it is impossible for the switch 28 to be closed by means of the "start" buttons 35, for the reason that the magnet 27 is completely short circuited, and no matter if the magnet 26 should be momentarily short circuited also by the depression of one of the buttons, 35, the armature 30 will still remain in contact therewith because there is no force exerted by the magnet 27 to pull it away. It will thus be seen that by leaving the lever

75 in its vertical position, the foreman assumes absolute control of the system and deprives the push buttons 35 of their normal function. We will assume now that the foreman himself wishes to start the machinery. To do this he throws the lever 75 into one or the other of its full reverse positions, as indicated in dotted lines in Fig. 4. In moving to this position the contact between the spring 65 and the lug 73^c is broken, and the short circuit around magnet 27 thus removed. Therefore, when the face 73^d of the arm 73^b is brought into contact with the contact button 69′, the circuit between wires 32 and 33 is closed through the contact device 67′ and the lever 66^a and frame 73. This has the same effect as depressing one of the buttons 35, and hence the switch member 28 is thrown into engagement with the contact 20 and the motor started. Immediately upon releasing the lever 75, it is thrown by means of the spring pressed insulated plunger 70′ into the position shown in full lines in Fig. 4. In this position the contact between spring 65 and lug 73^c is still broken, and both controlling circuits between the three wires 32, 33 and 34 are open, and the motor running. The motor now may be stopped by means of the buttons 36 in the usual manner. It may also be started by means of the buttons 35, so long as the lever remains in the position shown in Fig. 4, but as soon as it is thrown to the position shown in Fig. 3 the control of the motor is taken from the buttons 35 and vested solely in the master controller. It will also be understood that the lever 75 may be thrown from the position shown in Fig. 4 to that shown in Fig. 3 as many times as desired to start and stop the motor, without changing its direction. When, however, it is desired to reverse the motor, the lever is thrown from its central position to the opposite side of the axis from that shown in Fig. 4, and in so doing moves the reversing switch blades 80 and 80′ from the position shown in Fig. 4 to that shown in Fig. 3. This is accomplished by the engagement of the bushings 79 with the blades 80 and 80′. The lever 75, of course, is capable of exercising the same controlling functions as regards the wires 32, 33 and 34, regardless of the position of the reversing switch, and regardless of which side of the axis the lever may be. It will be observed that the controlling lever 75, in passing from its intermediate position to either of its extreme positions, serves to throw the reversing switch, and that while, when in its intermediate position, it deprives the push buttons of their normal controlling function, it is capable of itself performing the functions of the push buttons when swung to either of its extreme positions.

It will thus be seen that I have provided a system of motor control embodying a number of desirable features, and have associated them with a master controller which will enable a shop foreman to exercise complete control over the machines in charge of which he has been placed, and it is thought the great simplicity and many advantages of my invention will be readily appreciated by those skilled in the art.

What I claim is:

1. The combination with an electro-magnetically operated switch, of a pair of circuits extending therefrom, a push button in each circuit, serving, when actuated, to open or close said switch, and a master controller, adapted, when in one position to close the circuit in which one of said buttons is located, and thus render the other of said buttons ineffective.

2. The combination with a switch, of electro-magnetic means for positively moving it to both open and closed position, a pair of normally open push buttons connected with said electro-magnetic means, and serving, when actuated, to open or close said switch, and a master controller adapted, when in one position, to render one of said buttons ineffective.

3. In a motor controlling apparatus, the combination with a switch for stopping and starting the motor, electromagnetic means for operating the switch, "start" and "stop" push buttons for controlling said means, and a master controller comprising a member adapted, when in one position, to render said start button ineffective to close the switch, and when in another position to assume the function of said start push button.

4. In a motor controlling apparatus, the combination with a switch for stopping and starting the motor, electromagnetic means for operating the switch, "start" and "stop" push buttons for controlling said means, a master controller comprising a member adapted, when in one position, to render said start button ineffective to close the switch, and when in another position to assume the function of said start push button, and means for automatically moving said member away from the latter position.

5. A controlling device for electric motors comprising a hand operated member, means associated therewith for closing a circuit to stop the motor in one position of the member and for closing a circuit to start the motor in another position of the member, and means for automatically returning said member from the start position to a position between the start and stop positions.

6. The combination with a switch, electro-magnetic means for operating the same, conductors connected with said electro-magnetic means and push buttons located between said conductors and serving to control the operation of said electro-magnetic means so

as to close or open said switch, of means for short-circuiting, when desired, such of said buttons as serve to close said switch, and thus render them ineffective.

7. The combination with an electric motor, of an electro-magnetically operated switch in the armature circuit thereof, a controller for preventing, at times, the closing of said switch, a reversing switch also in said motor circuit, and a single lever for operating both said controller and reversing switch.

8. The combination with a motor, of a switch in the armature circuit thereof, electromagnetic means for opening and closing said switch, circuits governing said electromagnetic means, a controlling device comprising a lever, means connected therewith for closing said switch-closing circuit when moved to either of its extreme positions, and means for closing said switch-opening circuit when in its intermediate position.

9. The combination of a motor, a switch in the armature circuit thereof, electromagnetic means for opening and closing said switch, circuits governing said electromagnetic means, a controlling device comprising a lever, means connected therewith for closing said switch-closing circuit when moved to either of its extreme positions, means for closing said switch-opening circuit when in its intermediate position and a reversing switch adapted to be operated by said lever in passing from its intermediate to either of its extreme positions.

10. A controlling device comprising a pivoted lever constituting one terminal of a circuit, a fixed terminal against which said lever is adapted to abut at the limit of its movement to close the circuit, and a spring pressed plunger for automatically moving said lever out of engagement with said fixed terminal, when released.

11. A controlling device comprising a lever, means associated therewith for closing a circuit when in its intermediate or either extreme position, and means for automatically returning said lever from its extreme position to a position between such position and its intermediate position.

12. A controlling device comprising a lever, means associated therewith for closing a circuit when in its intermediate or either extreme position, means for resiliently holding said lever in its intermediate position, and additional means for preventing said lever remaining in either extreme position.

13. A controlling device comprising a lever having a contact surface forming one terminal of a circuit, a fixed rigid abutment in the path of said lever, a coöperating contact resiliently carried by said abutment and forming the other terminal of the circuit, means for forcing said terminals into engagement and means carried by said abutment for automatically separating said terminals.

14. The combination with an electric motor, of an electro-magnetically operated switch in the circuit thereof, "start" and "stop" circuits controlling said switch, and a controlling device for governing said circuits, said device having means for momentarily closing said "start" circuit, and additional means for permanently closing said "stop" circuit.

15. The combination with an electric motor, of an electro-magnetically operated switch in the circuit thereof, "start" and "stop" circuits controlling said switch, a controlling device for governing said circuits, such device comprising a lever, means for holding said lever in position to close said "stop" circuit, and additional means for preventing said lever remaining in position to close said "start" circuit.

16. The combination of a reversing lever having two operative positions, of means for temporarily arresting the movement of such lever at a point between such positions as it is thrown from one to the other, such means comprising a pair of detents pivoted on an axis parallel with the plane of movement of such lever, and rotatable into and out of the path of the lever, said detents having cam shoulders so arranged as to permit one only of said detents to be turned out of the path of the lever at any one time.

17. The combination with a reversing switch, of a pivoted lever for operating the same, and a pair of pivoted detents arranged in the path of said lever, said detents having means whereby when one of them is swung out of the path of said lever the other is locked in position in such path.

18. The combination with a reversing switch, of a pivoted lever for operating the same, and a pair of pivoted detents arranged in the path of said lever, and adapted to receive said lever between them, either of said detents being movable at will to release said lever, and means whereby, when one detent is swung out of the path of the lever, the other is locked rigidly in position.

19. The combination with an electric motor having a series field, of a reversing switch for said motor, and a controlling switch therefor separate from said reversing switch, such controlling switch comprising a pivoted arm and a pair of contacts coöperating therewith, one of said contacts being connected directly to one side of said series field, and connections whereby, when the arm is in engagement with said contact, the motor armature is short-circuited upon itself through said field, in either position of said reversing switch.

20. The combination with an electric motor, of a switch for controlling the same,

such switch comprising a pivoted arm and a pair of fixed contacts coöperating therewith, an automatic starting device and a rheostat connected in series with one of said contacts and with the supply circuit, a series field for said motor connected to the other of said contacts, said arm itself being connected with the armature circuit of said motor, a reversing switch also in said armature circuit, and means for operating said switch arm, the arrangement being such that, when said arm is in engagement with one contact, the supply circuit is closed through said motor, rheostat and starting device, but when in engagement with the other contact, the motor armature is short-circuited on itself, including only the series field, regardless of the position of said reversing switch.

In testimony whereof I affix my signature, in presence of two witnesses.

GEORGE H. WHITTINGHAM.

Witnesses:

ROBERT WATSON,

C. ROLLINS ROGERS.