No. 894,233. PATENTED JULY 28, 1908.

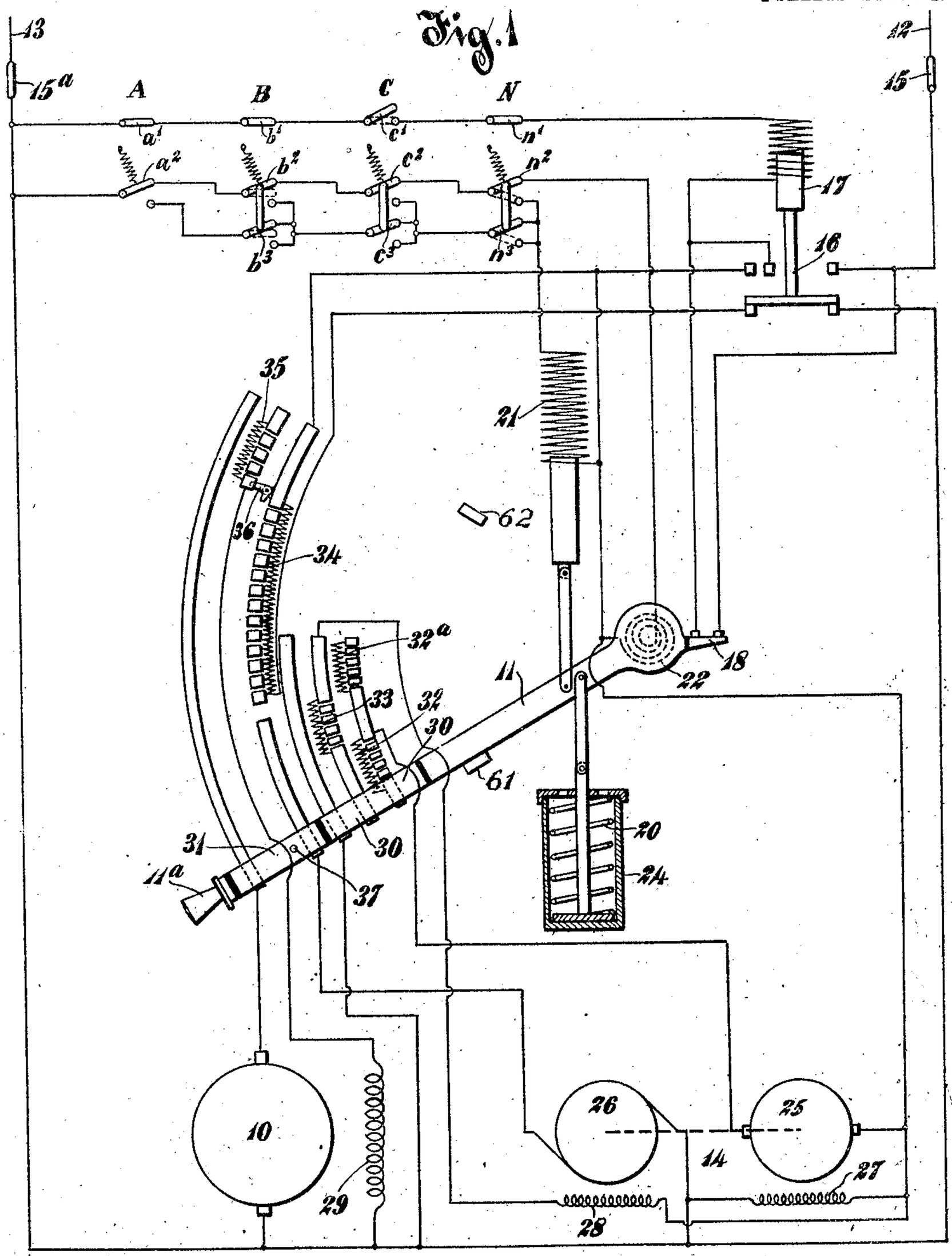
W. J. RICHARDS.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED JAN. 31, 1907.

2 SHEETS—SHEET 1.

Fig. 1



Witnesses

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2 SHEETS—SHEET 2.

Fig. 2

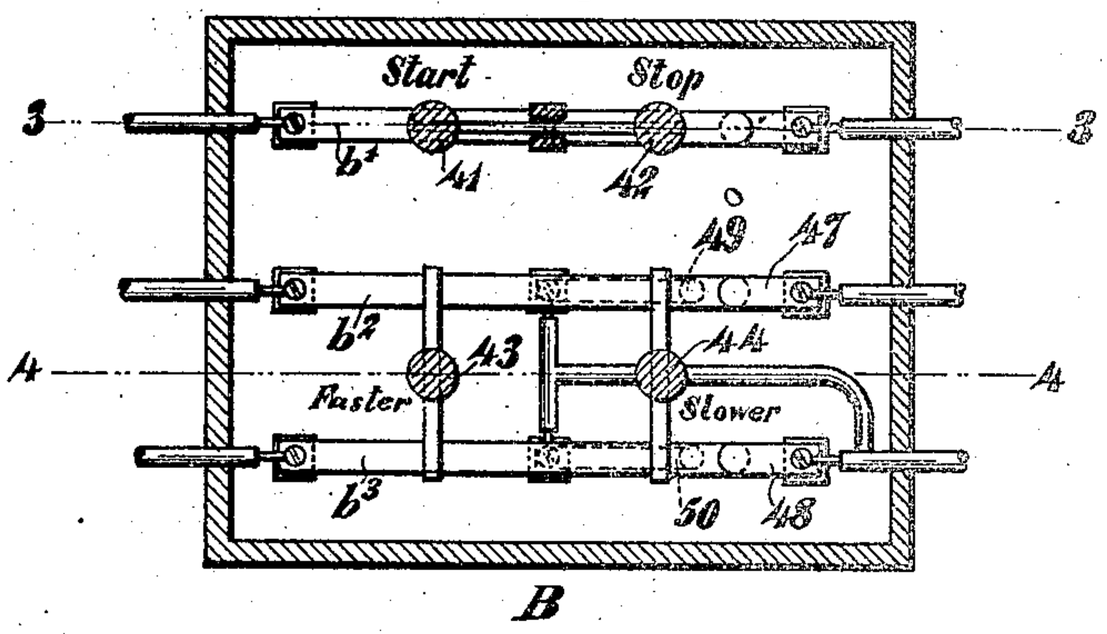


Fig. 3

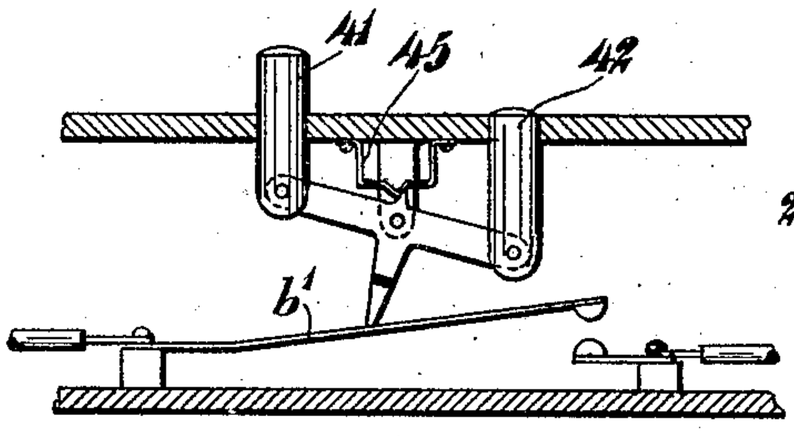


Fig. 4

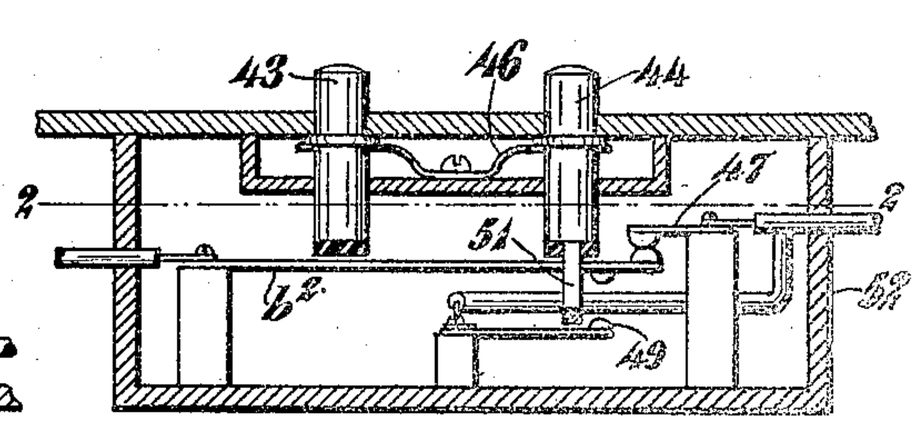
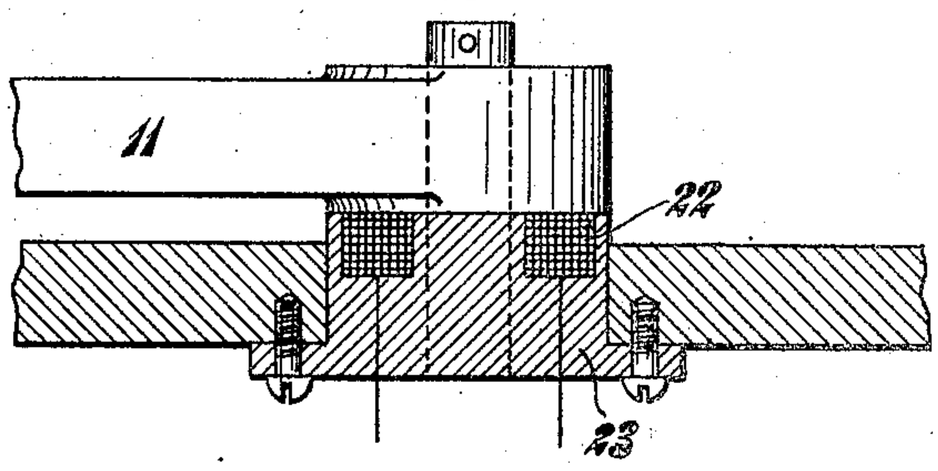


Fig. 5



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UNITED STATES PATENT OFFICE.

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SYSTEM OF MOTOR CONTROL.

No. 894,233. Specification of Letters Patent. Patented July 28, 1908.

Application filed January 31, 1907. Serial No. 355,163.

To all whom it may concern:

Be it known that I, WALTER J. RICHARDS, a citizen of the United States, residing at Norwood, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Systems of Motor Control, of which the following is a full, clear, and exact specification.

My invention relates to motor control systems, especially as applied to teaser systems of printing press control.

In operating certain kinds of machinery, such as perfecting printing presses, it is necessary that the starting and stopping be accomplished without shock. An admirable arrangement for accomplishing this is set forth in the patent to Burke No. 611,588, Sept. 27, 1898. It is often desirable, however, that machinery be controllable from a number of different points or stations about it. It is also desirable that in case conflicting operations are simultaneously sought, only the most conservative of the operations desired will be obtained; that is, in case it is simultaneously sought to go faster, to go slower, and to stop, a stopping will result, while a slower operation may be obtained regardless of attempts to obtain a faster operation. Also, a quick stop should be obtainable without shock. Moreover it is often advantageous to require no niceties of manipulation by the operator, so that in case of emergency the desired object will not be defeated by too much or too little movement or force on the part of the operator.

It is the object of my present invention to provide a motor control system in which all the advantages of the control system set forth in the Burke patent are combined with those above stated.

My invention therefore broadly comprises a system of motor control consisting of a motor to be controlled, a converter, means for connecting said motor to a source of current either directly or through the converter, and a push-button controlling system for said means.

In another light my invention comprises the combination of a motor, a main controller therefor, and a master controller for the main controller comprising a plurality of push-buttons for accomplishing different results, said push-buttons being so connected and arranged that in case a number of push-buttons are depressed to obtain conflicting results only that one of the depressed push-buttons which seeks the most conservative running of the motor will be effective.

Other features of my invention will appear from the following description and accompanying drawings and will be particularly pointed out in the claims.

Figure 1 is a diagrammatic view showing one embodiment of my invention; Fig. 2 is a section on the line 2—2 of Fig. 4, showing one arrangement of a controller station; Fig. 3 is a section on the line 3—3 of Fig. 2; Fig. 4 is a section on the line 4—4 of Fig. 2; and Fig. 5 is a sectional view showing the means for retaining the controller arm in any desired position.

The main motor 10 is arranged to be controlled by a movable arm 11, which in its different positions is arranged to connect the motor 10 to the mains 12 and 13 either directly or through a converter 14. In the mains 12 and 13 there may be manually operated switches 15 and 15^a if desired, while between the main 12 and the various circuits is a solenoid-operated switch 16. The solenoid 17 of the switch 16 is connected between the mains 12 and 13 through a switch 18 which is closed only when the arm 11 is in its lowest position, and through manual switches a', b', c', ... n'. These latter switches are placed at different stations A, B, C, ...N around the press or other controlled mechanism. There may be any number of these stations, which are the master controllers. When any one of the switches $a', b', c', \ldots n'$ is open the solenoid 17 is deënergized. When all of these switches are closed, and the arm 11 is in its lowest position to close switch 18, the solenoid 17 is energized to close the switch 16. The closing of the switch 16 not only completes the various controlled and controlling circuits, but also short-circuits the switch 18, so that when the switch 16 is closed the circuit of the solenoid 17 remains complete regardless of the position of the arm 11.

The arm 11 is biased toward its lowest position, either by gravity or a spring 20 or both, while it may be moved upward by a solenoid 21. If desired, a handle 11^a may be provided for manual operation of the arm 11. A coil 22 is wound in the support 23 of the arm 11 and when energized acts as a magnetic

clutch to hold the arm 11 in any position in which it may happen to be. This structure is best indicated in Fig. 5. A dash-pot 24 is arranged to retard both the upward and the downward movement of the arm 11. Stops 61 and 62 limit the movement of the arm 11.

At the stations A, B, C, ...N, are other switches a^2, b^2, c^2, ...n^2 respectively, and also, except at station A, switches b^3, c^3, ... n^3 respectively. Each of these switches cooperates with two fixed contacts as shown. The switches b^2 and b^3, c^2 and c^3, ...n^2 and n^3 are mechanically connected to move together and are biased to the positions in which they are shown in full lines. Hereafter when it is stated that any of the switches b^2, c^2, ...n^2 are moved to a certain position it is to be understood that their respective associated switches b^3, c^3, ...n^3 are correspondingly moved. When the switches a^2, b^2, c^2, ...n^2 are in their normal position, and the switch 16 is closed, the circuit of the coil 22 is completed, and said coil holds the arm 11 in whatever position it may happen to be. When any switch a^2, b^2, c^2, ...n^2 is in its lowest position, as shown in dotted lines at station N, the coil 22 is deënergized, and, except in certain cases hereinafter described, the solenoid 21 is energized, thus causing the arm 11 to move upward. When any switch a^2, b^2, c^2, ...n^2 is in its middle position, as indicated in dotted lines at station B, both the coil 22 and the solenoid 21 are deënergized and the spring 20 moves the arm 11 downward.

The converter 14 is here shown as a teaser or step-down motor-generator, comprising a motor-armature 25 and a generator armature 26 together with their respective field windings 27 and 28. Any other desired form of converter may be used. In the lower part of its movement the arm 11 connects the motor armature 10 to the teaser generator armature 26 and varies the voltage of said teaser generator by varying its speed and field strength successively. Farther up in its movement the arm 11 connects the motor armature 10 to the mains 12 and 13 and varies the resistance in circuit with said motor armature. The field winding 29 of the main motor is always supplied directly from the mains 12 and 13 whenever the switch 16 is closed, but the resistance of its circuit is varied during the operation of the arm 11. To accomplish these results, the arm 11 has two electrically distinct parts 30 and 31 preferably insulated from the rest of the arm. The part 30 controls resistance 32 and 32^a in the circuit of the teaser motor armature 25, and a resistance 33 in the circuit of the teaser generator field winding 28. The contacts of the resistances 32 and 32^a may be cross-connected if desired and only one resistance used. The part 31 connects the armature 10 to the teaser generator 26, and to the mains 12 and 13 through a resistance 34 and varies said resistance. Near the upper end of the movement of the arm 11 the part 31 also varies a resistance 35 in the circuit of the field winding 29 of the main motor. In order to accomplish this latter result, a switch 36, which normally connects the field winding 29 between the mains 12 and 13 without the intervention of any resistance, is opened by a pin 37 in the arm 11 in its upward movement as said arm reaches the lowest contact associated with the resistance 35, and is closed by said pin as said arm in its downward movement is about to leave said lowest contact.

The operation of the system is as follows:— The switches 15 and 15^a being closed, the motor 10 is started when the last of the switches a', b', c', ...n' is closed. The closure of this switch, as c', provided the arm 11 is in its lowest position to close the switch 18, energizes the solenoid 17 to close the switch 16. The closure of the switch 16 completes the circuits of the main motor field winding 29, the teaser motor field winding 27, the teaser motor armature 25 through the entire resistance 32, and the teaser generator field winding 28 through the entire resistance 33. It also short-circuits the switch 18 so that the circuit of solenoid 17 is not broken when the arm 11 begins to move upward. Moreover, it puts the circuits of the coils 21 and 22 under the control of the proper switches at the various stations such as switches b^2 and b^3 at station B. Unless some of these switches have been moved from their normal positions, the circuit of coil 22 is completed by the closure of the switch 16, but this coil serves no purpose at this particular point in the operation, because the arm 11 is held against further downward movement by the stop 61. The motor armature 10 is connected across the teaser generator armature 26 by means of the part 31 of the arm 11. Thus at this time the motor armature 10 is connected to the mains 12 and 13 through the converter 14.

The closing of the switch 16 causes the teaser motor 25 to start and to drive the teaser generator armature 26 to supply the motor armature 10 with current at a low voltage. This causes the motor 10 to start gradually. If it is desired to go faster one of the switches a^2, b^2, c^2, ...n^2 is moved into its lowest position, as shown in dotted lines at station N, and deënergizes the retaining coil 22 and energizes the solenoid 21. The latter begins to move the arm 11 slowly upward, but continues to do so only so long as the switch n^2 or its analogue is held in its lowest position. Upon the release of the switch n^2 by the operator, this switch returns to its normal or upper position, and deënergizes solenoid 21 and energizes retaining coil 22 to hold the arm 11 in whatever position it has reached.

As the arm 11 is moved upward, the resistance 32 is gradually cut out to increase the speed of the teaser motor 25 and consequently the voltage impressed upon the motor armature 10 by the teaser generator 26. After the resistance 32 has been entirely cut out to bring the motor 25 up to full speed, the resistance 33 is gradually cut out of circuit with the teaser generator field winding 28, thus further increasing the voltage impressed upon the motor armature 10 by the teaser generator armature 26.

When the resistance 33 has been fully cut out, the voltage of the teaser generator is at its maximum. Continued upward movement of the arm 11 beyond this point causes the part 31 of said arm to connect the armature 10 to the mains 12 and 13 through the entire resistance 34, this resistance also serving to reduce the voltage impressed on the motor armature 10 by the main source of current to that of the teaser generator 26. Shortly after the armature 10 has been connected to the mains through the resistance 34, the part 31 of the arm 11 disconnects it from the armature 26. Continued upward movement of the arm 11 from this point cuts the resistance 34 out of circuit with the armature 10, thus increasing the voltage impressed thereon and gradually increasing its speed. This movement also inserts the resistance 32^a in the circuit of the motor armature 25 to slow it down and finally disconnects the converter or teaser 14.

When the entire resistance 34 has been cut out the full voltage of the mains 12 and 13 is impressed upon the motor armature 10, and further movement of the arm 11 beyond this point causes the pin 37 to open the switch 36 and the part 31 of said arm to cut the resistance 35 gradually into circuit with the field coil 29 to further increase the speed of the main motor.

When the arm 11 is caused to move downward by moving one of the switches a^2, b^2, c^2, ... n^2 to its middle position, as shown in dotted lines at station B, and holding it there, the reverse of the actions above described takes place. Thus the motor 10 is slowed down by first increasing its field strength, the switch 36 being closed by the pin 37 when the entire resistance 35 has been cut out, then cutting the resistance 34 into circuit to decrease the potential impressed on its armature, then starting up the teaser 14 and connecting the motor armature 10 to the teaser generator armature and disconnecting it from the mains, and finally diminishing first the teaser generator field strength and then the speed of said teaser. This downward movement may be stopped at any point by releasing the switch b^2 or its analogue. The above is the slowing down operation under normal conditions. But if an emergency switch, as c', is opened, the coil 17 is deënergized and the switch 16 opened to interrupt all circuits supplied by the mains 12 and 13, and, if the motor armature 10 was connected to said mains, to close the circuit of said armature upon itself through so much of the resistance 34 as was not in circuit as the switch 16 opened. This causes the armature 10 to act as a generator armature to excite its own field winding 29, and to slow down rapidly, by reason of the braking effect thus produced. As the motor slows down and the arm 11 descends, the resistance 34 which was in the closed circuit of the armature 10 is gradually cut out, so that as the electromotive force generated by the armature decreases the resistance in the circuit is also decreased to maintain the braking current more nearly constant. The switch 16, once opened because of the opening of an emergency switch, as c', cannot be closed again until the arm 11 has reached its lowermost position and closed the switch 18.

The arrangement of switches at the various stations A, B, C, ...N is such that if there is a conflict of opinion between different operators as to the proper thing to be done, the most conservative operation desired will be obtained. Thus if one operator desires an immediate stop he may obtain it by opening his emergency switch a', b', c', ...or n', as the case may be, thereby causing the opening of the switch 16 to deprive all the operating circuits of currents so that it matters not whether or not any of the other operators have moved their switches for a faster or a slower movement. If different operators respectively desire to go faster and slower, the one who desires to go slower, say at station B, will prevail, because by moving his switches b^2 and b^3 to their intermediate positions, as shown in dotted lines, he not only interrupts the circuit of the retaining coil 22 to allow the arm 11 to descend, but also renders it impossible for the circu it of either solenoid 21 or retaining coil 22 to be completed at any of the other stations A, C, ...N. If two or more operators desire to go slower and move their switches, say b^2 and n^2, to intermediate positions, the circuit of coil 22 will be broken and additional breaks made in the circuit of solenoid 21, and the arm 11 will descend to cause a slowing down of the motor 10. If a number of operators should all desire to go faster, and move their switches, say b^2 and n^2, to their lowest positions, as indicated at station N in dotted lines, the circuit of coil 22 will be broken at two points and the circuit of coil 21 will be completed through the switches n^3 and b^2 in their lowest positions and c^3 and a^2 in their uppermost positions, and the arm 11 will be moved upward to cause a speeding up of the motor 10. Thus it is seen that with my system conservative running of the press is favored, while control may be obtained from any desired number of points.

With the arrangement set forth in Fig. 1,

it might sometimes happen that an operator in his excitement would move one of the controlling switches which has several operative positions either too far or not far enough. Thus for instance the switch b^2 might be moved only to middle position when the operator intended to move it to its lowest position, or vice versa. To avoid this liability of confusion, I have devised the arrangement shown in Figs. 2, 3 and 4, in which one of the stations, here taken as B, has the same three switches b', b^2 and b^3 as shown at station B in Fig. 1. The switches in Figs. 2, 3 and 4 are intended to be operated by various push-buttons 41, 42, 43 and 44. The switch b^2 is arranged to be closed by pushing in the "starting" push-button 41 and to be opened by pushing in the "stop" push-button 42. A spring 45 is provided for giving this switch a snap action. The two push-buttons 43 and 44 are arranged to be held in their outer position by a double leaf-spring 46, but either of them when depressed will move both switches b^2 and b^3 downward, the movement of the switches caused by depressing the button 43 being greater than that caused by depressing the button 44 because of the different distances of these push-buttons from the pivotal or supporting points of the switches b^2 and b^3. By depressing push-button 43, the switches b^2 and b^3 are moved out of engagement with their upper contacts 47 and 48 respectively, toward which they are biased, and into engagement with their lower contacts 49 and 50 respectively, this being equivalent to moving the switches b^2 and b^3 in Fig. 1 to their lowest positions. By depressing push-button 44, the two switches b^2 and b^3 are moved away from their upper contacts 47 and 48 respectively, but are not moved far enough to engage the contacts 49 and 50 respectively. Moreover by means of an extension 51 of the push-button 44, the contacts 49 and 50 are depressed so that they cannot be engaged by the switches b^2 and b^3 even though the push-button 43 is also depressed. This is still further to insure conservative running of the press. In case an operator in his excitement pushes in the two buttons 43 and 44, the circuits of both coil 22 and solenoid 21 will be broken to cause the motor 10 to slow down. Should the push-button 42 be depressed at the same time as either or both of the push-buttons 43 and 44, the switch 16 will be caused to open to obtain an emergency stop of the motor and only the push-button 42 will be effective. It is impossible to simultaneously depress push-buttons 41 and 42. Should push-buttons 41 and 43 be simultaneously depressed with the arm 11 in its lowest position, the switch 16 will be closed and the arm 11 caused to move slowly upward to increase the speed of the motor. These two push-buttons are not conflicting. Should the push-button 41 be depressed at the same time as the push-button 44 or both 43 and 44, with the arm 11 in its lowest position, the motor will start but the arm 11 will not move, the push-button 43, if depressed, being rendered ineffective because the push-button 44 is depressed and the push-button 44 being ineffective because the arm 11 is already in its lowest position. However, it would hardly ever happen that the "starting" push-button 41 would be pushed in by mistake, because when the motor 10 is operating and there is liable to be confusion this push-button is always depressed. The push-buttons 41, 42, 43 and 44 together with the switches which they control are preferably arranged in a single box or housing 52, though this is not necessary.

Terms which indicate position or direction, such as "lowest", "upward", "downward", etc., refer to the drawing only and are not intended to limit the actual structure. The different parts may be placed in any desired position and moved in any desired direction.

Many modifications may be made in the precise arrangements herein shown and described and all such which do not depart from the spirit and scope of my invention I aim to cover in the following claims.

What I claim as new is:—

1. In combination, a motor, a source of current supply, a converter, a main controller arranged to connect said motor to the source of supply either directly or through the converter, and a plurality of electrically interlocked push buttons for controlling said main controller.

2. In combination, an electric motor, a supply circuit, a converter, a main controller for connecting the motor with the supply circuit either directly or through the converter, and a plurality of master controllers for said main controller, each of said master controllers comprising a plurality of switches.

3. The combination with an electric motor, of a supply circuit, a converter, means for connecting the motor with the supply circuit, means for breaking the converter circuit at an intermediate speed of the motor, and a push button system of control for both of said means.

4. The combination with an electric motor, of a supply circuit, means for connecting the motor with the supply circuit, a controlling rheostat in said supply circuit, a converter in circuit with the motor and with said supply circuit, means for breaking the converter circuit at an intermediate speed of the motor, and a push button system of control for both of said means and said rheostat.

5. The combination with an electric motor, of a supply circuit, means for connecting the motor with the supply circuit, a controlling rheostat in said circuit, a converter, means for interposing said converter between said

circuit and the motor and for withdrawing said converter from circuit, and a plurality of push buttons for controlling said rheostat and said means.

6. The combination with an electric motor, of a supply circuit, means for connecting the motor with the supply circuit, a converter in circuit with the motor and with the supply circuit, means for varying the out-put of the converter and for cutting the converter out of circuit at an intermediate speed of the motor, and a plurality of master controllers for said means, each of said master controllers comprising a plurality of switches.

7. The combination with an electric motor, of a supply circuit, a converter, means for connecting the motor with the supply circuit either directly or through the converter and for varying the voltage impressed on the motor with either connection, and a plurality of master controllers for said means, each of said master controllers comprising a plurality of push-button switches.

8. In combination, an electric motor, two sources of current supply, means for connecting said motor to either of said sources separately or in parallel, and a push-button system of control for said means.

9. In combination, an electric motor, a plurality of sources of current, means for connecting said motor to any of said sources and for varying the potential impressed upon the motor by any of said sources, and a plurality of push buttons for controlling said means.

10. In combination, a motor, a source of supply, a converter, means for connecting the motor to the source of supply either directly or through the converter, a plurality of push-buttons for controlling said means, and connections whereby in case more than one push-button is operated at a time, that one which is operated to obtain most conservative running of the motor will prevail.

11. In combination, a motor, a main controller therefor, a plurality of push-buttons for controlling said main controller, and connections whereby in case more than one push-button is depressed at any one time, the push-button which normally causes the most conservative operation of the motor will prevail.

12. In combination, a motor, a source of supply, a converter, a main controller for connecting said motor to said source of supply either directly or through the converter, a plurality of master controllers for the main controller, and connections whereby in case more than one master controller is operated at a time that one which is operated to obtain most conservative running of the motor will prevail.

13. In combination, a motor, a supply circuit, a converter, a main controller for connecting the motor to the supply circuit either directly or through the converter and for varying the voltage impressed upon the motor with either set of connections, a plurality of master controllers for the main controller, and connections whereby in case different master controllers are operated to obtain conflicting results the most conservative results sought for will be obtained.

14. In combination, a motor, a main controller therefor, a master controller for the main controller, said master controller comprising a plurality of push-buttons for obtaining different results, and said push buttons being so connected and arranged that in case conflicting push-buttons are simultaneously depressed only that one of the depressed push-buttons which calls for the most conservative running of the motor will be effective.

15. In combination, a motor, a main controller therefor, a master controller for the main controller, said master controller having "slower" and "faster" push buttons, and means whereby when the "slower" push button is depressed the "faster" push button is rendered ineffective.

16. In combination, a motor, a main controller therefor, a plurality of master controllers for the main controller, each of said master controllers having "slower" and "faster" push buttons, said push buttons being so connected and arranged that when any "slower" push button is depressed, the "faster" push buttons are all rendered ineffective.

17. In combination, a motor, a main controller therefor, a master controller for the main controller, said master controller having "slower", "faster", and "stop" push buttons, and means whereby when the "stop" push button is depressed, the other push buttons are rendered ineffective.

18. In combination, a motor, a main controller therefor, a plurality of master controllers for the main controller, each of said master controllers having "slower", "faster", and "stop" push buttons, said push buttons being so connected and arranged that when any "stop" push button is depressed, all the "faster" and "slower" push buttons are rendered ineffective.

19. In combination, a motor, a main controller therefor biased toward movement in one direction, an electromagnet for moving said controller steadily in the other direction, a second electromagnet for holding the controller in any position against movement in either direction, and a master controller for controlling said two electromagnets, said master controller comprising a plurality of push buttons.

20. In combination, a motor, a main controller therefor biased to move in one direction, an electromagnet for moving said controller in the other direction, a second electromagnet for holding said controller in any

position, and a master controller for energizing either of said magnets separately but not simultaneously or for deënergizing them both, said master controller comprising a plurality of push buttons.

21. In combination, a motor, a main controller therefor biased to move in one direction, an electromagnet for moving said controller uninterruptedly in the other direction, a second electromagnet for holding said controller in any position, and a plurality of master controllers for said electromagnets, each of said master controllers comprising a plurality of push buttons.

22. In combination, a motor, a main controller therefor biased to move in one direction, an electromagnet for moving said controller in the other direction, a second electromagnet for holding said controller in any position, and a plurality of master controllers each comprising a plurality of push buttons, said master controllers being connected to energize either of said electromagnets separately or to deënergize them both.

23. In combination, a motor, a variable resistance in the armature circuit thereof, a controller arm for varying said resistance, said controller arm being biased toward movement in one direction, an electromagnet for moving said arm in the other direction, a second electromagnet for holding said arm in any position, and a master controller for energizing either of said magnets separately but not both at once or for deenergizing them both and for controlling the motor circuit, said master controller consisting of a plurality of push buttons.

24. In combination, a motor, a main controller therefor biased in one direction, an electromagnet for moving said controller in another direction, a second electromagnet for holding said controller in any position, and a plurality of push buttons for controlling said electromagnets, said push buttons being so connected and arranged that when one of them interrupts the circuits of both electromagnets none of the others will be able to complete either of said circuits.

25. In combination, a motor, a controller therefor biased in one direction, an electromagnet for moving said controller steadily in the other direction, a second electromagnet for holding said controller in any position against movement in either direction, and push buttons for controlling said electromagnets.

26. In combination, a main controller, and a master controller therefor comprising a switch arm, a contact with which said arm is normally in engagement, a second contact with which said arm can be moved into engagement, a push button for moving said arm away from said first contact and into engagement with said second contact, and a second push button for moving said arm away from said first contact and also moving said second contact so that the first push button can not cause said arm to engage it.

27. In combination, an electric motor, a supply circuit, a converter, a main controller for connecting the motor with the supply circuit either directly or through the converter, and a plurality of master controllers for said main controller, from any one of which any desired operation of the main controller may be obtained at any time unless a more conservative operation is sought at another of said motor controllers.

28. In combination, a motor, a source of supply, a converter, a main controller arranged to connect said motor to the source of supply either directly or through the converter and for varying the resistance of the motor armature circuit when such connection is direct, and a plurality of master controllers for said main controller, any one of said motor controllers being capable of causing any desired operation of the main controller except when a more conservative operation thereof is also sought.

29. In combination, a motor, a source of supply, a converter, a main controller arranged to connect said motor to the source of supply either directly or through the converter and for varying the resistance of the motor armature circuit when such connection is direct, and a push-button system of control for said main controller.

30. In combination, a motor, a source of supply, a converter, a main controller arranged to connect said motor to the source of supply either directly or through the converter and to vary the resistance of the motor armature circuit when the connection is direct and the voltage of the converter secondary when such connection is through the converter, and a plurality of master controllers for said main controller, any one of said master controllers being capable of causing any desired operation of the main controller except when a more conservative operation is simultaneously sought.

31. In combination, a motor, a source of supply, a converter, a main controller arranged to connect said motor to the source of supply either directly or through the converter and to vary the resistance of the motor armature circuit when the connection is direct and the voltage of the converter secondary when such connection is through the converter, and a push-button system of control for said main controller.

32. In combination, a motor, a source of electromotive force, a converter, a main controller arranged to disconnect said motor or to connect it to said source either directly or through the converter, and a push-button system of control for said main controller.

33. In combination, an electric motor, two sources of electromotive force, means for dis-

connecting said motor or for connecting it to either of said sources, and a push-button system of control for said means.

34. In combination, an electric motor, a plurality of sources of electromotive force, means for disconnecting said motor or for connecting it to any of said sources and varying the potential impressed upon the motor thereby, and a push-button system of control for said means.

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

WALTER J. RICHARDS.

Witnesses:

GEO. B. SCHLEY,

FRED J. KINSEY.