T. E. BARNUM.

MOTOR CONTROLLER.

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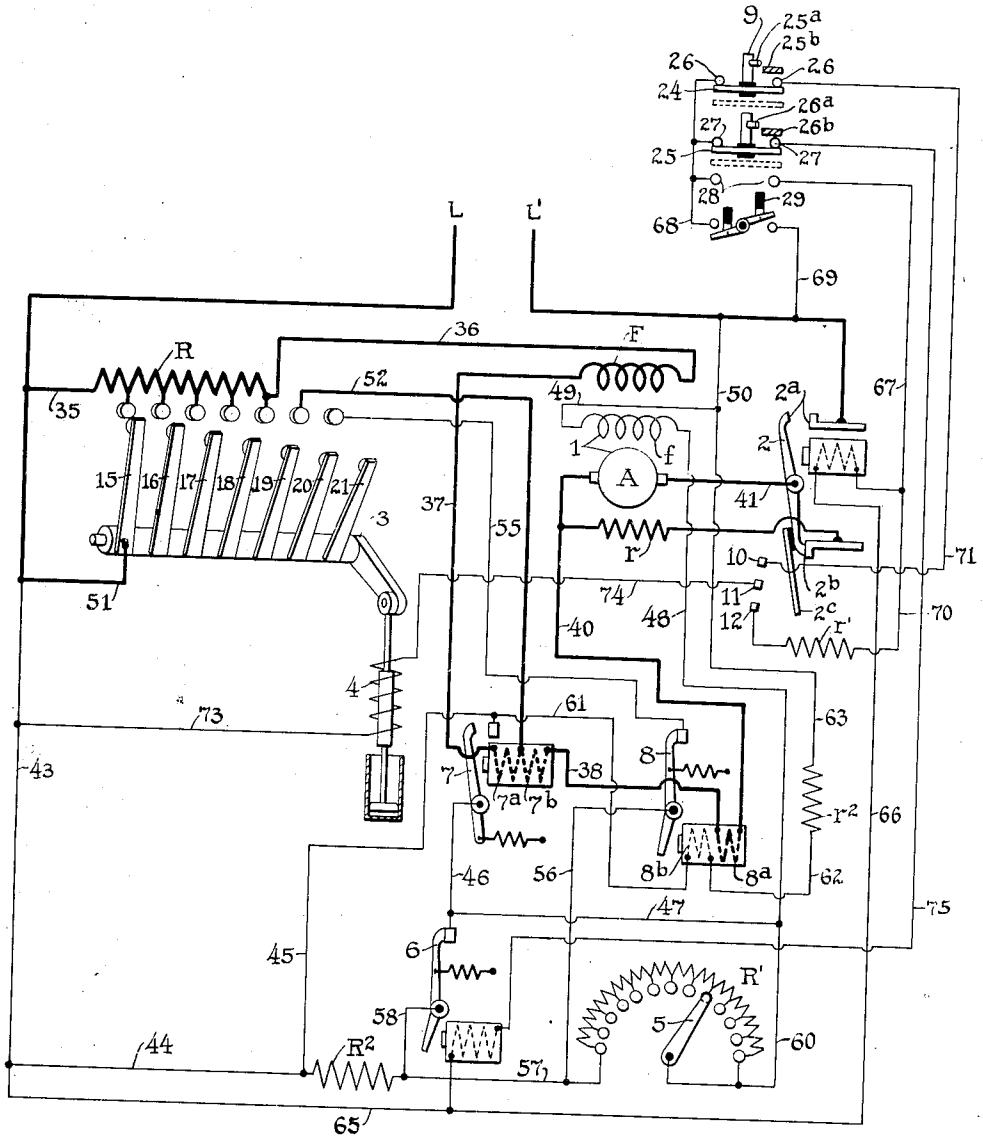

Inventor

Thomas E. Barnum

By Frank H. Hubbard

Attorney

UNITED STATES PATENT OFFICE.

THOMAS E. BARNUM, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MFG. CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

MOTOR-CONTROLLER.

1,237,454. Specification of Letters Patent. Patented Aug. 21, 1917.

Application filed May 24, 1915. Serial No. 30,047.

To all whom it may concern:

Be it known that I, THOMAS E. BARNUM, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Motor-Controllers, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

This invention relates to improvements in motor controllers.

More particularly the invention relates to controllers for motor driven printing presses although, as will be apparent, various features thereof may be advantageously employed in other relations.

One of the objects of the invention is to provide means adapted to operate under the direction of a simple push-button station to afford an exceedingly flexible control of the motor, including starting and acceleration thereof to different predetermined degrees by different operations of a single push-button switch.

A further object is to provide means of the aforesaid character wherein a single push button switch will serve for starting and accelerating the motor to different speeds and also for decelerating the motor, at the will of the operator.

A still further object is to provide control means including field regulating means adapted to operate under the direction of a single switch to accelerate and decelerate the motor and also automatic means to protect the motor against injury by untimely operation of said field regulating means.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawing diagrammatically illustrates one embodiment of the invention and the same will now be described, it being understood that the invention may be embodied in other forms falling within the scope of the appended claims.

The controller is illustrated as governing a compound wound motor 1 having an armature A, a series field winding F and a shunt field winding *f*. The controller includes a main switch 2, an accelerating device 3 having an operating solenoid 4, a manual field rheostat 5, electro-responsive relays 6, 7 and 8 associated with said field rheostat and a push-button control station 9.

The main switch 2 has two sets of contacts 2^a and 2^b, the former to complete the motor circuit upon response of said switch and the latter to establish a dynamic braking circuit for the motor through a resistance *r* upon deënergization of said switch. Also, switch 2 is provided with an insulated contact 2^c adapted upon response of said switch to engage and bridge contacts 10, 11 and 12. The contact 10 is connected to one of the supply lines while contacts 11 and 12, when electrically connected with contact 10, respectively complete the energizing circuit of solenoid 4 and a maintaining circuit for the main switch 2 and solenoid 4. As will hereinafter appear, however, the continuity of the maintaining circuit just mentioned is dependent upon the setting of a switch of the control station.

The accelerating device 3 is of conventional form and includes a series of contact arms 15 to 21 to be moved successively into engagement with coöperating contacts upon energization of solenoid 4. The contact arms 15 to 19 inclusive control an armature resistance R for the motor and upon operation serve to exclude said resistance from circuit in steps. As will be hereinafter more specifically set forth, the arm 20 when moved to circuit closing position excludes from circuit the series field winding of the motor and also short-circuits a section of the operating winding of relay switch 7. Contact arm 21 upon movement to circuit-closing position completes a circuit between the supply line and the field rheostat 5 through the relay switch 8.

The field rheostat 5 is likewise of conventional form the same comprising an arm adjustable over a series of contacts to control a field resistance R′. The arrangement is such that the arm is movable to the right to increase the amount of field resistance and to the left to decrease the amount of said resistance included in circuit. The relay 6 associated with said rheostat is of the normally closed type and when closed completely short-circuits said rheostat. Upon energization of this switch the same opens to break said short-circuit. The relay 7 also controls a short-circuit around the field rheostat but this relay is normally open and of the vibratory type. Further, its winding comprises two sections 7^a and 7^b which are connected in series with the motor armature

and which act cumulatively. Both sections of the winding are included in circuit throughout the starting period of the motor and their combined pull is sufficient to insure closure of the switch to short-circuit the field rheostat throughout said period. On the other hand, after the device 3 has excluded all of the armature resistance to bring the motor up to normal speed the arm 20 of said device short-circuits the section 7^a of the winding of relay 7 whereby said relay is rendered free to vibrate upon fluctuation of the armature current. Thus if after the motor is brought up to normal speed the relay 6 be opened to include the field rheostat in circuit, the vibrating relay 7 will function in a well-known manner to intermittently exclude and reinclude said rheostat until the motor is accelerated to the speed predetermined by the setting of the rheostat arm.

The relay 8 is provided to function similarly to the relay 7 but for deceleration instead of acceleration. This relay is normally closed to complete circuit between the line and a point between the field regulator 5 and relay 6 in parallel with an auxiliary field resistance R^2. Thus upon response, relay 8 includes said auxiliary resistance in series with the shunt field to weaken the same. The relay has a winding 8^a in series with the motor armature and a winding 8^b connected across the supply circuit through a protective resistance r^2. The windings 8^a and 8^b oppose one another during acceleration of the motor and act cumulatively to open the switch 8 when the motor is slowed down so quickly as to cause it to generate a current exceeding the value at which said relay is set to respond. In consequence, if after acceleration the relay switch 6 is deënergized to short-circuit the field rheostat 5 and excessive current conditions result in the motor circuit, relay 8 will respond to include the auxiliary field resistance R^2 in circuit, thereby again weakening the motor field and in consequence reducing the generative action of the motor, and will thereafter vibrate until the motor is restored to the speed at which it is desired to operate under full field strength.

The control station 9 includes two push-button switches 24 and 25 of the general type disclosed in the Horton Patent No. 1,122,931, of Dec. 29, 1914. The switch 24 is provided with a single set of coöperating contacts 26. It is biased to engage and bridge said contacts and is lockable by a pin 25^a and stop 25^b in dotted line position to interrupt circuit between the same. The switch 25 has a set of up contacts 27 and a set of down contacts 28. It is biased to engage and bridge contacts 27 and depressible to engage and bridge contacts 28 while it is provided with a pin 26^a and stop 26^b to limit its upward movement to the dotted line position. Under such conditions the switch 25 is movable between its dotted line position and its down position to make and break circuit between contacts 28. The control station also includes a push button switch 29, preferably of the snap type, which may be set in either open or closed position. This switch controls the line connection of both of the push button switches 24 and 25 while the latter switches control the main switch 2, the accelerating device 3 and the field relay switch 6.

By different settings and operations of the push button switches of the control station the motor may be controlled in various different ways. For example, it may be started and stopped for inching by depression and release of push button switch 25. Again, it may be started for continuous operation and automatically accelerated to normal speed by depression of the same push button and thereafter increased to a speed determined by the setting of the rheostat by release of said button. Again, after the motor is accelerated through the medium of the field rheostat it may be restored to normal speed by depression of push button 25 for either a temporary or prolonged period, as desired, and whenever the motor is started for continuous operation it may be stopped at will by depression of push button 24. Moreover, as will be apparent from the foregoing description of the controller the acceleration and deceleration of the motor through the medium of the field resistance will be automatically governed to protect the motor against excessive current conditions. The flexibility, convenience, reliability and safety of the control thus provided will thus be at once apparent.

Considering now the circuit connections, the power circuits may be traced as follows: With the switch 2 energized the armature circuit is completed from line L by conductor 35 through the starting resistance R, by conductor 36 through the series field winding F, by conductor 37 through the windings 7^a and 7^b of relay 7, by conductor 38 through the winding 8^a of relay 8, by conductor 40 through the motor armature A, by conductor 41 through the switch 2, to line L′. The shunt field winding is normally connected across lines L and L′ through resistance R^2 and relay 6 but as above set forth, the relay 7 closes immediately upon initial completion of the motor circuit and under such conditions the shunt field is connected directly across said lines. This circuit may be traced from line L by conductors 43, 44 and 45 through said relay by conductors 46, 47 and 48 through the shunt field winding, by conductors 49 and 50 to line L′. In consequence, the motor is insured full field strength in starting. When the device 3 is

operated the starting resistance is excluded from circuit and upon closure of circuit by the arm 20 of said device the armature circuit is traceable from line L by conductor 51 through the device 3 and said arm 20, by conductor 52 through the coil 7^b of switch 7 and thence through the coil 8^a of relay 8 and the motor armature A, as already described. This it will be observed excludes the field winding F and the winding 7^a of relay 7. The relay 7 is thereupon free to open, assuming normal current conditions to exist in the armature circuit. Opening of the relay opens the short-circuit around the field resistance, but if the relay switch 6 remains closed a second short-circuit is at once established by the arm 21 of the accelerating device through said relay 6 and the normally closed relay 8. This short-circuit may be traced from line L by conductor 51 through the device 3 and its arm 21, by conductor 55 through relay 8, by conductors 56 and 57 and 58 through relay switch 6, by conductors 47 and 48 to the field winding. Thus relay switch 7 insures short-circuiting of the field rheostat throughout the starting period and functions entirely independently of the relays 6 and 8. On the other hand, the accelerating device and the other two relays function to insure continued short-circuiting of the field rheostat independently of the relay 7 but subject to the manual control of relay switch 6. If relay switch 6 is opened prior to acceleration of the motor to normal speed then when the relay 7 is rendered free to open, and does open, the field rheostat will be immediately included in circuit. The field circuit established then extends through the accelerating device and relay 8 as already traced to conductor 56 and thence through the portion of the field resistance R′ to the left of the arm, by conductors 60 and 48 to and through the field shunt winding. Then should the relay 6 be reclosed the field resistance R′ would be again short-circuited, thereby effecting deceleration of the motor. Under such conditions, if the removal of the field resistance should cause an excessive current in the armature circuit then the relay 8 would open, forcing the field current to take the path through auxiliary field resistance R^2. In other words, the field current would then flow from line L by conductors 43 and 44 through resistance R^2, to conductor 58 and thence directly through relay switch 6 to the shunt field, these connections being the same as those established upon stopping the motor. In this connection, as the relay switch 7 when closed parallels the resistance R^2, it should be noted that the adjustment of said switch is such that it will not close during deceleration and in consequence will not in any wise interfere with the aforesaid regulation by the decelerating relay 8. Considering the circuit of the winding 8^b of decelerating relay 8, the same may be traced from line L by conductors 43, 44, 45 and 61 through said winding, by conductor 62 through protective resistance r^2, by conductors 63 and 50 to line L′.

Considering now the control circuits it will be first assumed that it is desired to inch the motor. This requires closure of switch 29, the setting of switch 24 in dotted line position and depression of switch 25 to bridge contacts 28. Circuit may then be traced through the operating winding of main switch 2 from line L by conductors 43, 65 and 66 through said winding to conductor 67 and thence through contacts 28 of switch 25, by conductor 68 through switch 29, by conductor 69 to line L′. Switch 2 is thereupon closed to complete the motor circuit but subject to deënergization immediately upon release of switch 25. During inching the device 3 remains inert whereby the motor will be restricted to a slow speed. As will hereinafter appear, the auxiliary contacts of the main switch serve to complete the circuit of device 3 but under inching conditions the setting of the switch 25 insures against closure of said circuit while the resistance r' insures against energization of said device by the parallel circuit including said resistance. On the other hand, if it is desired to start the motor for continued operation, switch 24 is set in closed position and under these conditions when switch 2 responds to depression of switch 25 as just described, said switch 2 will establish for itself a maintaining circuit through push button switch 24. This circuit may be traced from line L′ to and through the winding as already described and thence by conductor 70 through resistance r', and contacts 12 and 10 associated with switch 2, by conductor 71 to and through push button switch 25 to conductor 68 and thence through switch 29 to line L′ as already traced. Also, with the switch 24 set in the position illustrated, circuit will be closed through the operating solenoid 4 of the accelerating device upon response of main switch 2. This circuit may be traced from line L by conductors 43 and 73 through said solenoid, by conductor 74 through contacts 11 and 10 associated with main switch 2 to conductor 71 and thence through switches 24 and 29 to line L′, as already traced. The rheostat is thereby set in operation to exclude the starting resistance and subsequently excludes the series field winding and coil 7^a of relay 7, as above set forth. This provides for acceleration of the motor to normal speed and to continue the operation at this speed the push button switch 25 must be set to limit its return movement to the dotted line position; or in other words,

to prevent its reëngagement with contacts 27. On the other hand, if it is desired to further accelerate the motor by field regulation then the switch 25 is permitted to return to engagement with contacts 27. This completes the energizing circuit of relay 6, said circuit extending from line L, by conductors 43 and 65 through the winding of said relay, by conductor 75 through contacts 27 of switch 25 and thence through switch 29 to line L'. Energization of this relay throws the rheostat 5 in circuit with the shunt field winding, as above described. After acceleration to maximum speed or that determined by the adjustment of field R' it will be apparent that the motor may be decelerated by depression of switch 25 to deenergize relay 6 and that the motor may be stopped at any time by depression of switch 24 to interrupt the maintaining circuit of switch 2.

Thus, briefly reviewing the functions of the controller, it will be observed that the very simple push button station illustrated provides for inching, for continuous operation at either normal speed or at a higher speed determined by the field rheostat, for change of speed at will, and for stopping at will. Also, it will be noted that when the motor is stopped the device 3, by disengagement of its arm 21 from its coöperating contact, will open the short-circuit extending around resistance R^2 through relay 8 thereby utilizing said resistance to protect the shunt field while its motor is idle.

What I claim as new and desire to secure by Letters Patent is:

1. In a motor controller, in combination, electro-responsive starting and accelerating means for the motor and a push button switch therefor operable to effect starting and acceleration of the motor thereby to any one of a plurality of predetermined speeds determined by the position of said switch.

2. In a motor controller, in combination, electro-responsive starting and accelerating means for the motor and a push button control switch therefor depressible to effect starting and acceleration of the motor to one speed and returnable to a predetermined position to effect an increase in the speed of the motor.

3. In a motor controller, in combination, electro-responsive starting and accelerating means for the motor, and a push button control switch therefor depressible to effect starting and acceleration of the motor to one speed, returnable to a predetermined position to effect an increase in the speed of the motor and thereafter depressible to decelerate the motor.

4. In a motor controller, in combination, electro-responsive starting and accelerating means, other electro-responsive accelerating means for an increased speed and a push button control switch common to said means to effect selective operation of the former means alone or progressive operation of both means.

5. In a motor controller, in combination, electro-responsive starting and accelerating means, other electro-responsive means for an increased speed and a push button control switch common to said means to effect operation of the former alone or of both means and for subsequently effecting reverse operation of said latter means independently of said former means.

6. In a motor controller, in combination, electro-responsive starting and accelerating means, electro-responsive field regulating means and a push button control switch therefor depressible to effect starting and acceleration of the motor to normal speed and returnable to initial position to effect field regulation to further increase the speed of the motor.

7. In a motor controller, in combination, electro-responsive starting and accelerating means, electro-responsive field regulating means and a push button control switch therefor depressible to effect starting and acceleration of the motor to normal speed and returnable to initial position to effect field regulation to further increase the speed of the motor, said switch being also subsequently depressible to effect deceleration of the motor but solely by field regulation.

8. In a motor controller, in combination, electro-responsive starting and accelerating means for the motor, a control device for effecting response of said means to start and accelerate the motor, said means when energized being independent of said control device and field regulating means for the motor under the control of said device for decreasing and increasing the field strength of the motor at will.

9. In a motor controller, in combination, electro-responsive starting means for the motor, electro-responsive accelerating means controlled by said former means, electro-responsive field regulating means, and a push button switch for said means movable to one position to effect response of said first mentioned means and in consequence response of said second-mentioned means and movable to and from another position to effect energization and deënergization of said field regulating means without effecting said first two mentioned means.

10. The combination with a motor, of electro-responsive starting and accelerating means therefor, electro-responsive field regulating means for said motor, and a push button control switch for both of said means depressible to effect starting and acceleration of the motor and adapted upon release to effect field weakening but only after acceleration of the motor to normal speed.

11. The combination with a motor, of electro-responsive starting and accelerating means, electro-responsive field regulating means, a push button control switch for said means depressible to effect starting and acceleration of the motor and tending upon release to effect field weakening to further accelerate the motor and a means associated with said field regulating means and subject to the control of said first mentioned means to insure full field strength until the motor is accelerated to normal speed.

12. The combination with a motor, of electro-responsive starting and accelerating means, electro-responsive field regulating means including protective means responsive to the motor current and a push button control switch common to the aforesaid means to effect starting, acceleration and deceleration of the motor thereby at will.

13. The combination with a motor, of electro-responsive starting and accelerating means, field regulating means including a relay controlled by said former means to insure full field strength during acceleration of the motor by said former means and thereafter responsive to the motor current to protect the motor during acceleration by field weakening and a push button control switch common to the aforesaid means to effect starting, acceleration and deceleration of the motor at will.

14. The combination with a motor, of electro-responsive starting and accelerating means, field regulating means including an accelerating relay and a decelerating relay and a push button control switch common to the aforesaid means to effect starting, acceleration and deceleration of the motor at will.

15. The combination with a motor, of a field resistance therefor, an electro-responsive switch normally completing a short-circuit around said resistance and responsive to open such short-circuit, accelerating and decelerating relays associated with said switch and means to control said short-circuiting switch at will to decrease and increase the field strength of the motor subject to the action of said relays.

16. The combination with a motor of starting, accelerating and decelerating means therefor, means to weaken the motor field when the motor is idle and automatic means controlling said field weakening means to render the same ineffective when the motor is started and to subsequently render the same effective under abnormal decelerating conditions.

17. The combination with a motor and starting means therefor, of field regulating means to accelerate and decelerate the motor and auxiliary field regulating means to weaken the motor field when the motor is idle and under abnormal decelerating conditions.

18. The combination with a motor and starting means therefor, of a field rheostat for accelerating and decelerating the motor, an auxiliary field resistance, means including an accelerating field relay to insure the exclusion of both of said resistances from circuit upon starting of the motor and means including a decelerating field relay to effect inclusion of said auxiliary resistance in circuit under abnormal decelerating conditions and when the motor is stopped.

19. In a motor controller, in combination, starting means, push button control switches for said means and accelerating means jointly controlled by said starting means and said switches whereby with a predetermined setting of said switches said accelerating means will be rendered effective immediately upon operation of said starting means and with another setting of said switches will remain inert upon operation of said starting means.

20. In a motor controller, in combination, electro-responsive starting means, electro-responsive accelerating means controlled by said former means and push button control switches to effect response of said starting means and by their setting to selectively render said starting means effective or ineffective to energize said accelerating means.

In witness whereof, I have hereunto subscribed my name.

THOMAS E. BARNUM.