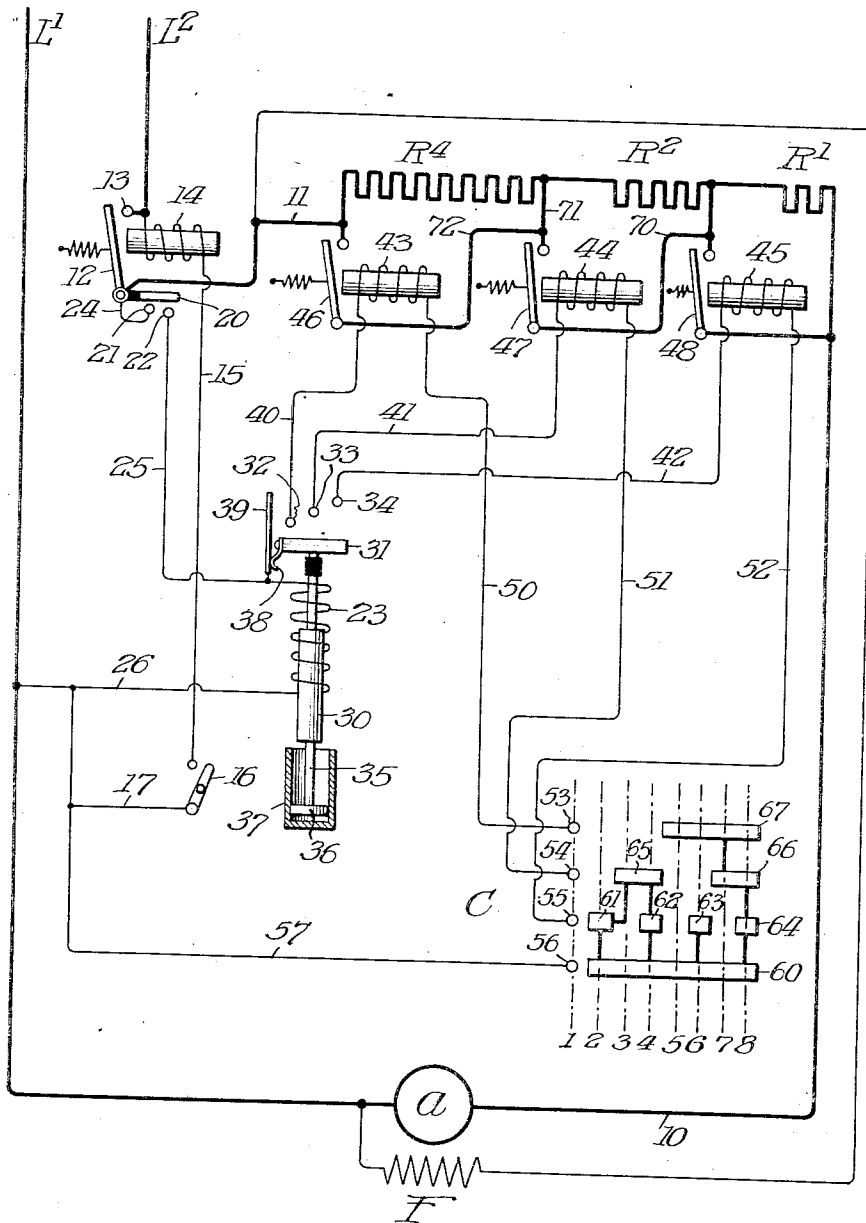


H. L. VAN VALKENBURG.
 CONTROLLER FOR ELECTRIC MOTORS.
 APPLICATION FILED NOV. 21, 1918.

1,373,846.

Patented Apr. 5, 1921.



Inventor
 Hermon L. Van Valkenburg
 By Chever & Cox attys

UNITED STATES PATENT OFFICE.

HERMON L. VAN VALKENBURG, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO INDUSTRIAL CONTROLLER COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

CONTROLLER FOR ELECTRIC MOTORS.

1,373,846.

Specification of Letters Patent.

Patented Apr. 5, 1921.

Application filed November 21, 1918. Serial No. 283,594.

To all whom it may concern:

Be it known that I, HERMON L. VAN VALKENBURG, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Controllers for Electric Motors, of which the following is a specification.

This invention relates to automatic controllers for starting and regulating the speed of motors. In controlling motors for operating printing presses, machine tools and similar apparatus it is frequently necessary to regulate the speed of the motor by means of resistance in series with the armature; and it is desirable in such cases to be able to preordain the speed at which the motor shall finally operate, and then in starting the motor supply it, initially, through protective or "starting" resistance and automatically and gradually bring the motor up to the preordained speed by cutting out the starting resistance. It is also desirable to always subject the motor to the same inrush of current regardless of the speed at which the motor is finally to operate. The general object of my invention is to provide simple and efficient apparatus for accomplishing these desirabilities. Heretofore, it has been usual to provide two sets of resistances—a starting resistance, which is used to protect the motor against excessive initial current, and a regulating resistance, a portion of which remains in circuit, the amount depending upon the ultimate speed at which it is desired to have the motor run. As a result of my invention it is possible to utilize a single set of resistances for both starting the motor and regulating its speed. My apparatus possesses great flexibility or range of regulation; for example, in the form illustrated it is possible to operate the motor at eight different speeds by employing but three sections of resistance—these sections, as above stated, also performing the function of starting resistance.

I accomplish my objects by the apparatus illustrated in the accompanying diagram.

Referring to the diagram, the current is supplied through the lines L^1 L^2 . The motor has an armature A and a shunt field F. The line L^1 is connected to one of the motor terminals, the other terminal being connected by a conductor 10 to three sections of re-

sistances R^1 , R^2 , R^4 . In the most developed form of my invention these resistances are graded, and in the preferred form they are so graded that the resistance R^2 will be twice as great as the resistance R^1 and the resistance R^4 will be four times as great as the resistance R^1 . These resistances are connected by a conductor 11 to a normally open main line switch or contactor 12. When closed said contactor engages a stationary contact 13 which is in electric connection with the line conductor L^2 . The main line contactor is controlled by a coil 14 connected at one end to the conductor L^2 and at the other end by a conductor 15 to a hand switch 16 which is connected by a conductor 17 to the line conductor L^1 . By closing this hand switch the main line contactor 12 will be closed, thus closing the auxiliary switch 20 which is adapted to bridge the contacts 21 and 22 for energizing the coil 23 of the accelerating device, hereinafter referred to. Contact 21 is connected to contactor 12 through a conductor 24 while contact 22 is connected to the said coil through the conductor 25. The other end of coil 23 is connected to the line L^1 through a conductor 26.

The accelerating device mentioned is here shown in the form of a time limit relay having a plunger 30 for operating a contactor 31 located in position to successively engage and thereafter maintain engagement with the contact fingers 32, 33, 34 in the order mentioned. The plunger has a stem to which is attached a piston 36 working in a dash pot 37, and so constructed as to permit the piston, plunger and contactor to descend rapidly but rise slowly. The contactor is kept in circuit by means of a finger 38 sliding upon a stationary conductor bar 39 permanently connected to the conductor 25. The fingers 32, 33, 34 are connected by conductors 40, 41, 42 respectively to coils 43, 44, 45 respectively for controlling the contactors 46, 47, 48 respectively. These contactors are normally open and govern the resistances R^4 , R^2 , and R^1 , respectively. The coils 43, 44, 45 are connected by conductors 50, 51, 52 respectively to contact points or fingers 53, 54, 55, respectively. A fourth contact point or finger 56 is connected by a conductor to the line conductor L^1 .

The fingers 53 to 56 form part of a regulator C which is here shown in the form of a

drum controller, the drum whereof is capable of occupying eight different positions indicated by the dot and dash lines 1, 2, 3, 4, 5, 6, 7, 8. The drum has contacts arranged in four lines to engage the fingers 53 to 56, respectively. The contact 60 which is in line with finger 56 is adapted to engage therewith in all positions, except number 1 which is the position indicated in the diagram. This may be regarded as "off" position and when the controller is in this position all of the resistances will remain in circuit during the entire time the motor is running, regardless of the position of the contactor 31 of the accelerating device. In line with finger 55 are four contacts, 61, 62, 63 and 64. These are all electrically connected, permanently, to contact 60 and are located at positions 2, 4, 6 and 8. In line with finger 54 are contacts 65, 66 which are electrically connected, permanently, to contact 60, and are located at positions 3, 4, 7 and 8. In line with finger 53 is contact 67 which is electrically connected, permanently, to contact 60 and is located at positions 5, 6, 7 and 8.

Operation: Let it be assumed that the parts are in the prestarting position shown in the diagram, with all switches open and the regulator C in "off" position. When the attendant desires to start the motor he closes the hand switch 16 thereby energizing the coil 14 and closing the main line contactor 12. This closes the circuit through all of the resistance in series thus: from the main line L^1 through armature A, conductor 10 resistances R^1 , R^2 , R^4 , conductor 11, contactor 12, contact 13 to main line conductor L^2 . The motor thus starts with all the resistance in circuit. The closing of the main contactor 12 closes the auxiliary contactor 20 thus energizing the coil 23 of the retarding device and causing the contactor 31 to slowly rise and engage the fingers 32, 33, 34 one after the other. Engaging the finger 32 would energize the coil 43 through the conductor 40 if it were not for the fact that the conductor 50 leading from the other end of the coil is on open circuit because the regulator drum is in off position and hence the contact 53 is not engaged. For a similar reason the engaging of the fingers 33 and 34 fails to energize the coils 44 and 45 as the contacts 54 and 55 are unengaged. So the movement of the contactor of the accelerating device or time limit relay has no effect to cut resistance out of the motor circuit when the regulator is in off position.

But assume that the regulator drum is in second position corresponding to dot and dash line 2, in the diagram. In such case, the drum through its contacts 60 and 61 will connect the contacts 55, 56 and hence when the contactor 31 of the time limit relay reaches contact finger 34, the coil 45 will be

energized, thus closing the contactor 48 which short circuits the resistance R^1 . Consequently, under these conditions, when the contactor 31 reaches its final position it will cut out the smallest unit of resistance and a somewhat higher voltage will be supplied to the motor finally than initially. Assuming the regulator drum to be in third position corresponding to dot and dash line 3, the contact 54 will be connected to contact 56 through the drum contacts 65 and 60 and hence when the contactor 31 of the time limit relay reaches the finger 33 the coil 44 will be energized and close the contactor 47, thus eliminating the resistance R^2 . The motor will then be supplied as follows: from the line L^1 through the armature A, conductor 10, resistance R^1 , conductor 70, contactor 47, conductor 71, resistance R^4 , conductor 11, main line contactor 12, contact 13, to line conductor L^2 . Thus finally the current will be supplied through all of the resistances, in series, except resistance R^2 . As resistance R^2 is here shown as being greater than resistance R^1 , it will be observed that the voltage finally supplied the motor is somewhat higher than when the drum of the regulator is in second position, previously described.

By positioning the regulator drum in fourth position, corresponding to dot and dash line 4, the contacts 54 and 55 will both be connected to contact 60, and the resistances R^1 and R^2 will both finally be cut out by the energization of the coils 44 and 45 as explained. If resistance R^2 is twice as great as resistance R^1 this will cause the final elimination of three unit values of resistance from the motor circuit.

If the regulator drum occupies fifth position corresponding to dot and dash line 5, the resistance R^4 alone will be finally eliminated, the current flowing from the line L^1 , through armature A, conductor 10, resistances R^1 and R^2 , conductor 72, contactor 46, conductor 11, contactor 12, contact 13, to line conductor L^2 .

By following out the remaining positions it will be evident that eight ultimate values of resistance in the motor circuit may be obtained as may be expressed by the following table.

Regulator in position—	Resistance finally in circuit.	
No. 1.....	All	=7 units.
No. 2.....	R^4 plus R^2	=6 units.
No. 3.....	R^4 plus R^1	=5 units.
No. 4.....	R^4	=4 units.
No. 5.....	R^2 plus R^1	=3 units.
No. 6.....	R^2	=2 units.
No. 7.....	R^1	=1 unit.
No. 8.....	0	=full line current.

The apparatus may be employed as a hand starter if desired: To illustrate, sup-

pose the attendant closes the switch 16 while the regulator or controller drum is in off or first position shown in the diagram. All of the resistance will remain in circuit

5 regardless of the movement to final position of the contactor 31 of the time limit relay. If the attendant now moves the drum to second position, corresponding to dot and dash line 2 he will thereby cut the resistance R^1 out of the motor circuit. If he
10 then moves it to third position he will thereby reinsert the resistance R^1 but eliminate the resistance R^2 thus reducing by one more unit the amount of resistance finally in circuit. By thus proceeding he can cut out the
15 resistance unit by unit until he has moved the regulator drum to eighth position, whereupon all the resistance will be cut out of the motor circuit.

20 From the foregoing it will be seen that the apparatus possesses great flexibility and range of operation. By setting the regulator drum at any given position the motor may be started and stopped as often as may
25 be desired, and when restarted will always return to the same speed. This ultimate speed may be varied either while the motor is running or before starting; and as above pointed out, if desired, the device may
30 be used as a hand operated controller. It will be noted that in the form described and shown the values of the resistance are graded in geometric progression. It will also be noted that the circuits of each of the
35 controlling coils 43, 44, 45 have what may be regarded as two switches in series with each other, one switch being a part of the accelerating device or time limit relay, and the other a part of the regulator or drum
40 controller, and a final effect upon any one of the coils will depend upon both of these factors. It will also be noted that, regardless of the position of the regulator drum the initial inrush of current will be the
45 same, for at the beginning the motor will be supplied with current which traverses all of the sections of resistance. A further characteristic of the apparatus is that the same resistance is used both as starting and regulating resistances. This is an advantageous
50 distinction to certain known types of apparatus in which two sets of resistances are employed, one for starting the motor and the other for regulating its speed.

55 It is evident that the contactor 31 of the time limit or accelerating device may properly be termed a starting switch.

Having thus described my invention what I claim as new and desire to secure by Letters Patent, is:—

60 1. A motor controller having a plurality of sections of resistance in series in the motor circuit, a regulator adapted at will to vary the sequence in which said sections
65 shall be cut out of circuit, and a time con-

trolled starting switch adapted as it advances to cut out the sections in the sequence previously determined by the regulator.

2. A motor controller having a set of resistances of different values in series with the motor, each of said resistances having a control circuit, a regulator switch adapted to be set in different positions to partially control different combinations of said circuits in groups of two at a time, and a
75 starting switch adapted, as it advances to complete the control solely of the circuits preselected by the regulator switch.

3. A motor controller having a set of at least two resistances of different values in series in the motor circuit, a control circuit for each of said resistances, a regulator switch adapted to be preset and having at least three positions in one of which both
85 sections of resistance will remain in circuit and in another of which the smaller of said resistances will remain in circuit and the larger will be cut out, and in the third position the larger of said resistances will remain in circuit and the smaller will be cut
90 out; and a starting switch adapted to travel along a definite path and in doing so to cut out the resistance or resistances preselected for the purpose by the regulator
95 switch.

4. A motor controller having a set of at least three resistances of different values in series with the motor, each of said resistances having a separate control circuit, a
100 regulator switch adapted to be set in more than three different positions to preliminarily and partially control different combinations of said circuits, and starting switch mechanism having a movable contactor and
105 adapted as the contactor advances to complete the control of those circuits preordained by the regulator switch.

5. A motor controller having a set of at least three resistances of different values in series with the motor, each of said resistances having a separate control circuit, a
110 regulator switch adapted to be set in six different positions to preliminarily and partially control any one of said circuits and any two of said circuits in groups of two,
115 and all three of said circuits as a group, and starting switch mechanism having a movable contactor and adapted, as the contactor advances, to complete the control of those circuits preselected by the regulator switch.
120

6. A motor controller having a plurality of sections of resistance in series in the motor circuit, an electromagnetic switch for governing each of said sections, a control
125 circuit for each of said switches, a hand regulated switch, and an accelerating switch, the last mentioned two switches being arranged in series in each of said control circuits.
130

7. A motor controller having a plurality of sections of resistance permanently connected all in series in the motor circuit, an electromagnetic switch for governing each of said sections, a control circuit for each of said switches, a hand regulated switch, and an accelerating switch, the last mentioned two switches being arranged in series in each of said control circuits.

10 8. A motor controller having a set of resistances of different values in series with the motor, each of said resistances having a control circuit, a hand adjustable regulator adapted to combine said circuits in groups
15 of any one at a time and any two at a time, and a time controlled switch adapted to control, one after the other, the individual circuits previously grouped by the regulator.

20 9. A motor controller having a set of at least three resistances of different values in series with the motor, each of said resistances having a control circuit and said control circuits having their terminals distributed, a hand adjustable regulator adapted
25 to combine said circuits in a group of three and in groups of any one at a time and any two at a time, and a time controlled switch adapted to engage said terminals successively to control, one after the other, the
30 individual circuits previously grouped by the regulator.

35 10. A motor controller having a set of at least three resistances of different values in series with the motor, each of said resistances having a control circuit and said control circuits having their terminals distributed, a hand adjustable regulator adapted to be preadjusted to different positions to combine said circuits in a group of three and
40 in groups of any one at a time and any two at a time, a starting switch adapted to engage said terminals successively as it advances, to control, one after the other, the individual circuits previously grouped by
45 the regulator, an electromagnetic winding for urging said starting switch to advance, and means for retarding the advance of the starting switch.

50 11. A motor controller having graded resistances, electromagnetic switches for governing said resistances, control circuits individual to said switches, a hand controller

having a greater number of positions than the number of resistances, and a time limit relay cooperating with said controller for
55 determining which of said resistances shall ultimately remain in the motor circuit, each position of the controller, except the off position placing a different combination of said resistances on closed circuit. 60

12. A controller for electric motors having a plurality of resistances, magnetic contactors for governing said resistances, said contactors having electromagnetic coils for
65 controlling them, a speed regulator adapted to be preset in different positions depending upon the ultimate speed desired, said regulator being adapted to put the individual coils on closed circuit according to its position, and an accelerating device for energizing successively the coils thus put on closed
70 circuit by said regulator.

13. A controller for electric motors having a plurality of resistances in the motor circuit, contactors for bridging said resistances, coils for controlling said contactors,
75 each coil having two terminals, one being a regulator terminal and the other an accelerating terminal, a regulator adapted to occupy different positions to connect different regulator terminals to one side of the supply
80 line, and an accelerating device for connecting the accelerating terminals successively to the other side of the supply line.

14. A motor controller having at least
85 three sections of resistance in series in the motor circuit, said resistances being of different values, a manually operated regulator adapted to be set in different positions to partially control said resistances, and adapted
90 to preordain both the sequence in which said resistances shall be cut out of circuit and the total number which shall be cut out of circuit, and the controller, if one section
95 is to be cut out of circuit, being adapted to control different groups of two to preordain what groups of two shall be cut out of circuit, and a starting switch adapted as it advances to cut out the sections preordained by
100 the regulator.

In witness whereof, I have hereunto subscribed my name.

HERMON L. VAN VALKENBURG.