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REGULATOR.

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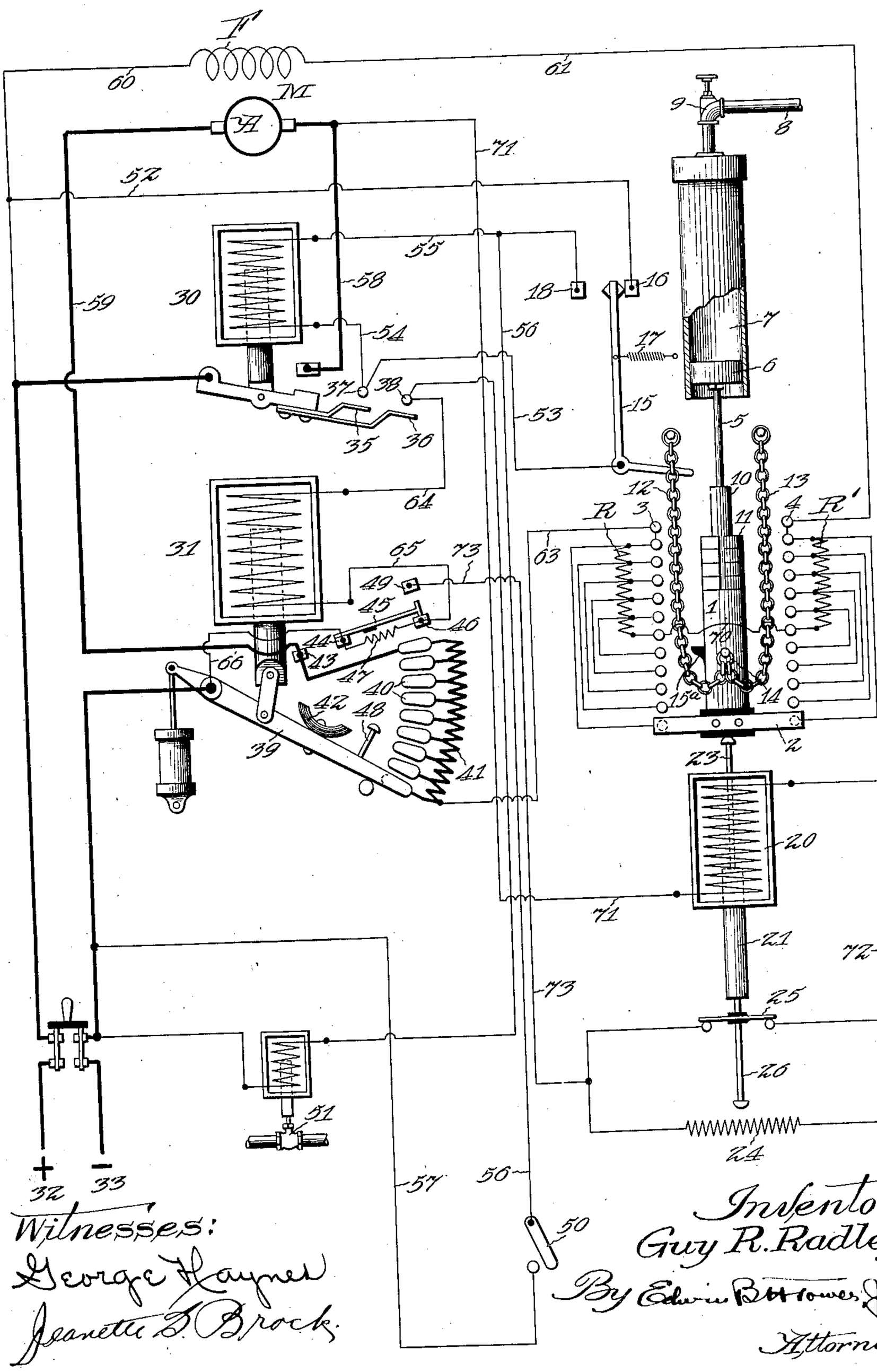
Patented Sept. 28, 1915.



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REGULATOR.

1,154,725. Specification of Letters Patent. Patented Sept. 28, 1915.

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To all whom it may concern:

Be it known that I, GUY R. RADLEY, 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 Regulators, 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.

My invention relates to improvements in regulators. It is particularly applicable to vacuum cleaning systems and other systems where it is desired to maintain a practically constant vacuum or pressure or at least within predetermined limits. It should be understood, however, that my invention is not limited to such an application thereof but may be used in various other relations for the accomplishment of various different results.

The various objects and advantages of my invention will be hereinafter set forth.

For the purpose of disclosing the nature and characteristic features of my invention I shall describe the embodiment thereof illustrated in the accompanying drawing. My invention however, is not limited to the specific embodiment thereof selected for the purpose of illustration.

The regulator illustrated is particularly adapted to use in a vacuum cleaning system. Its function is to automatically control the vacuum supplying means upon variations in the demand on the system to maintain the vacuum within predetermined limits. The regulator shown is adapted to accomplish the desired results through the control of electric circuits in a manner hereinafter set forth.

The regulator includes a longitudinally movable member 1 having secured to the lower end thereof and insulated therefrom a cross bar contact member 2. The contact member 2 is provided with two series of coöperating contact buttons 3 and 4 over which it is adapted to be moved upon longitudinal movement of said member 1. The member 1 is connected by a rod 5 to the piston 6 of a vacuum cylinder 7 which forms the operating means therefor. The piston 6 raises the member 1 upon an increase in vacuum and allows the member 1 to descend upon a decrease in vacuum. This results in moving the contact member 2 upwardly or downwardly over the contact buttons 3 and 4 in accordance with the vacuum conditions in the cylinder 7. It should of course be understood that any other form of controller might be substituted for the contact member 2 and series of contact buttons 3 and 4, and that any other suitable operating device, as for example a pressure cylinder or bellows might be substituted for the vacuum cylinder 7 according to the results desired.

For regulating at will the effectiveness of the vacuum cylinder I have provided in the pipe 8 adapted to connect the same with the main vacuum chamber a valve 9. Also I have provided the member 1 with a portion 10 of reduced diameter upon which is adapted to be placed weights 11 to give the member 1 the desired constant weight. In addition I have provided means for varying the weight of the member 1 in accordance with the direction and degree of its movement. This means comprises chains 12 and 13 secured at their upper ends to stationary supports and at their lower ends to a ring 14 secured to the member 1. Obviously with such an arrangement when the member 1 is in its lowermost position it assumes the weight of but a few links of the chains. On the other hand as it is raised it assumes the weight of more links of the chains in accordance with the degree of its movement and as it again descends is gradually relieved of this assumed weight. The object and function of these chains will at once be obvious to those skilled in the art. Without the provision of these chains or an equivalent thereof any degree of vacuum sufficient to move the member 1 at all would be sufficient to move the same throughout its entire range The provision of the chains however, as before stated, adds weight to the member 1 as it is raised, thereby permitting only a limited movement thereof with a given vacuum and necessitating an increase in vacuum to cause further movement. In other words the provision of the chains insures movement of the member 1 by stages proportional to the variations in vacuum. In addition to actuating the contact member 2, the member 1 may also be made to actuate at the upper limit of its movement a suitable auxiliary control device such as the switch 15. The purpose and function of this switch will be later explained. It is normally held in engagement

with a contact 16 by a spring 17 and is adapted to be actuated by a projection 15ª on the member 1 to disengage contact 16 and engage a second contact 18.

As will later be explained it is desired under certain conditions to limit the downward movement of the regulator. On the other hand under other conditions it is desired to have the regulator dropped to its lowermost limit. A solenoid device 20 performs this function, said device preferably being controlled to check and release the regulator automatically under the desired conditions. The solenoid 20 is provided with a plunger 21 carrying an upwardly extending tail rod 23 in line with the member 1. The solenoid 20 is preferably so designed as to be incapable of lifting the member 1 but of sufficient strength to hold the member 1 against descent when the same strikes the end of the rod 23. For protecting the solenoid 20 after the same has fully responded a resistance 24 is provided to be inserted in series therewith. The resistance 24 is controlled by a switch 25 loosely mounted upon a downwardly extending tail rod 26 on the plunger 21 and having a lost motion connection therewith whereby it is not opened until the solenoid has fully responded.

The regulator is illustrated as controlling an electric motor M which it may be assumed operates a vacuum pump to supply a vacuum to a chamber to which the cylinder 7 is connected. The motor M is illustrated as of the shunt wound type, being provided with an armature A and a shunt field winding F. The function of the regulator is to vary the field strength of the motor, thus varying its speed and in consequence varying the vacuum produced by the pump operated thereby. More specifically, it controls two variable resistance sections R and R′ in series with the field winding. It should be understood that other types of motors might be employed and that the regulator might be used to control the motor in other ways than by field regulation. The regulator also functions to insure full field strength of the motor when started. For starting the motor and bringing the same up to normal speed, I have provided an electroresponsive main switch 30 and an electroresponsive rheostat 31. The main switch 30 is adapted to connect the motor to supply lines 32 and 33 through the rheostat 31. For a purpose hereinafter set forth the main switch is provided with auxiliary contacts 35 and 36 adapted to engage cooperating contacts 37 and 38 respectively. The rheostat illustrated is of a conventional type including a pivoted arm 39 movable over a series of contacts 40 to regulate a variable resistance 41 in the armature circuit of the motor. Mounted on the arm 39 is a double ended laminated contact 42 adapted to bridge contacts 43 and 44 when all of the resistance 41 is removed from circuit. Also the rheostat is provided with an auxiliary switch 45 normally engaging a contact 46 to short circuit a protecting resistance 47 for its operating winding. The switch 45 is adapted to be actuated by a pin 48 on the arm 39 to disengage contact 46 and engage a contact 49 when the rheostat arm reaches its uppermost position. When the switch 45 is thrown into engagement with contact 49 it energizes the solenoid 20 of the regulator as will be later described. In practice various refinements as for example an interlock between the main switch and rheostat would be provided but it has been deemed unnecessary to illustrate such refinements herein. For controlling the main switch to start the motor, I have provided a single pole control switch 50. In vacuum cleaning systems it is customary to provide in conjunction with the motor controller an electromagnetically operated valve 51 for controlling the flushing stream.

I shall now describe the operation of the controller, including the regulator, at the same time clearly setting forth the functions of the various parts and the circuit connections.

Assuming that it is desired to start the motor to set the vacuum system in operation, the manual control switch 50 is first closed. This completes a circuit from main line 32 by conductor 52, switch 15 of the regulator by conductors 53 and 54 through the operating winding of the main switch by conductors 55 and 56 through control switch 50 and thence by conductor 57 to main line 33. The main switch thereupon responds closing the motor circuit from main line 32 through said main switch by conductor 58 through the motor armature by conductor 59 through resistance 41 of the rheostat, thence through the arm 39 to main line 33. The shunt field winding of the motor is permanently connected across the supply lines. This circuit may be traced from main line 32 by conductor 60, thence through the field winding by conductor 61 to the uppermost of the contact buttons 4, thence by a cross connection to lowermost contact button 4 and across contact member 2 and the lowermost contact button 3 by a cross connection to the upper two contacts 3 by conductor 63 through the rheostat arm 39 to the negative line. The motor is thus set in operation but operates at a slow speed owing to the insertion of the resistance 41 in its armature circuit. When, however, the main switch closes it completes the circuit of the operating winding of the rheostat through its auxiliary contact 36. This circuit may be traced from said main switch through its auxiliary contact by conductor

64 through the operating winding of the rheostat by conductor 65 through the auxiliary switch 45 by conductor 66 to the main line 33. The rheostat thereupon responds, gradually removing the resistance 41 and bringing the motor up to normal speed. At the same time the main switch through its auxiliary contacts 36 and 38 completes the circuit of the electroresponsive valve 51. Still further when the main switch closes it short circuits through its auxiliary contacts 35 and 37 the switch 15 of the regulator so that when the switch 15 is disengaged from contact 16 there will be no arc produced thereby. As soon as the motor is set in operation it operates the pump thereby causing the creation of a vacuum, which as soon as the motor has been brought up to normal speed with all the armature resistance removed from circuit will be of sufficient value to cause the regulator cylinder to draw in its plunger, thereby raising the regulator. In practice the regulator is preferably so adjusted that it will not respond until the motor has attained normal speed. As soon as the regulator commences to move upwardly it gradually inserts the resistances R and R′ in series with the shunt field winding of the motor. This further accelerates the motor, causing a gradual increase in vacuum and accordingly a gradual increase in the suction of the vacuum cylinder of the regulator. The regulator after once commencing to ascend will continue its upward movement until it reaches the contacts connected by the cross conductor 70. All of the resistances R and R′ will then be included in the shunt field circuit of the motor, and in consequence the motor will have attained its maximum speed. Continued movement of the regulator above this position will gradually short circuit the resistances R and R′ from the shunt field circuit, thereby slowing down the motor. It will thus be seen that the regulator insures full field strength of the motor in starting and thereafter automatically weakens the field to bring the motor up to maximum speed. This gives the maximum supply of vacuum.

To prevent an undesirable decrease in vacuum should the demand on the system be excessive, it is necessary to prevent return movement of the regulator below the contacts connected by cross conductor 70. This is obvious from the fact that should there be an excessive demand on the system after the motor had been brought up to maximum speed, the increased demand would reduce the effectiveness of the cylinder 7, thereby tending to release the regulator and allow the same to descend. Descent of the regulator would remove the resistance from the field circuit of the motor, thereby reducing the speed of the motor. This would result in still further decreasing the degree of vacuum instead of maintaining the same at its maximum. Thus the desirability of providing means for preventing such downward movement of the regulator while the system is in use will be readily apparent. Such downward movement as before set forth is prevented by the solenoid 20. This solenoid becomes energized upon the rheostat reaching full running position. This as before set forth moves the auxiliary switch 45 into engagement with contact 49 thereby completing the circuit of the solenoid 20. This circuit extends from the positive side of the motor armature by conductor 71 through the solenoid winding 20 by conductor 72 through the auxiliary switch 25 by conductor 73 though the auxiliary rheostat switch 45 to the negative line. Hence as the regulator is raised the solenoid draws in its plunger causing the rod 23 on the upper end of its plunger to follow the regulator in its upward movement. When the regulator reaches the high speed position aforesaid the solenoid 20 will have fully responded, maintaining the rod 23 in such a position as to prevent descent of the regulator so long as said solenoid remains energized. When the solenoid has fully responded the switch 25 is opened, thereby inserting the protective resistance 24 in series with the solenoid winding. The solenoid 20 remains energized until the switch 50 is opened to stop the motor or until there is a failure of voltage in the supply circuit. Under either of these two conditions the solenoid 20 is deënergized allowing the regulator to return to the position illustrated giving full field strength for restarting.

Assuming now that the regulator has been brought to high speed position it will function in the following manner:—Assuming that by non-use of a portion of the vacuum system the vacuum rises above a predetermined value, the regulator will be further raised to a degree corresponding to the increase in vacuum. This will gradually short circuit the resistance in the field circuit slowing down the motor until the vacuum has been reduced to the desired degree. Assume now that following such an increase in vacuum there is a sudden decrease caused by an increased demand on the system. The regulator will move downwardly to a degree corresponding to the vacuum variation. This increases the resistance in the shunt field circuit of the motor, thereby increasing its speed and accordingly increasing the vacuum supply. Thus the regulator during use of the system travels up and down in accordance with the vacuum variations due to variations in the demands on the system and to a degree proportional to the variations in vacuum. This automatically varies the speed of the motor in accordance with the vacuum variations and tends to maintain a

substantially constant vacuum or at least maintain the vacuum within certain limits according to the adjustment of the regulator. Should the vacuum unduly increase due to non-use of the system, the regulator would operate switch 15 moving the same out of engagement with contact 16 and into engagement with contact 18. This short circuits the operating winding of the main switch thereby stopping the motor.

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

1. In combination, a circuit controlling device movable to progressively effect a plurality of circuit variations and means acting automatically upon movement of said device from normal position to restrict its range of movement thereafter but permitting freedom of movement of said device in opposite directions within its restricted range.

2. In combination, a circuit controlling device having two ranges of movement, on opposite sides of a certain position thereof and tending to assume one extreme position and automatically controlled means restricting the movement of said device to the range between said intermediate position and its other extreme position.

3. In combination, a circuit controlling device operable within certain limits to effect certain circuit variations and operable in the same direction within other limits to reestablish the original connections and automatically controlled means to restrict the movement of said device to the range between said last mentioned limits.

4. In combination, a circuit controlling device movable through one range to effect certain circuit variations and through another range to reëstablish the original connections and means automatically operating upon movement of said device through said first range to restrict its subsequent operation to said second range.

5. In combination, a circuit controlling device movable through one range to effect certain circuit variations and through another range to effect other circuit variations, and means operating automatically upon movement of said device through said first range to restrict its operation to said second range.

6. In combination, a circuit controlling device movable through one range to effect certain circuit variations and through another range to effect other circuit variations, and means operating automatically upon movement of said device through said first range to restrict its operation to said second range, said means automatically releasing said device under predetermined conditions.

7. In combination, a circuit controlling device movable in opposite directions from a predetermined position to effect corresponding circuit variations and normally standing in one extreme position and automatic means operating upon movement of said device from said extreme position to restrict subsequent operation to the opposite side of said predetermined position.

8. In combination, a circuit controlling device automatically movable in opposite directions through a certain range and means operating automatically upon movement of said device through a predetermined part of said range to restrict its subsequent operation to the remainder of said range.

9. In combination, a circuit controlling device automatically movable in opposite directions through a certain range and automatic means to restrict its operation to a part of said range, said device effecting like changes in connections when moved in opposite directions from an intermediate position and tending to stand in one extreme position.

10. In combination, a circuit controlling device movable through a certain range and normally standing in one extreme position and automatic means operating upon movement of said device from said extreme position to gradually restrict its range of movement to a predetermined degree.

11. In combination, a circuit controlling device movable through a certain range and normally standing in one extreme position and automatic means operating upon movement of said device from said extreme position to gradually restrict its range of movement to a predetermined degree, said means automatically relieving said device of restraint under predetermined conditions.

12. In combination, a circuit controlling device having a movable member movable throughout a predetermined range, a stop in the path of said member and an operating winding adapted upon movement of said member to cause said stop to follow the same and to prevent its return movement upon passing a predetermined position.

13. In combination, an electric motor, an automatic device adapted during a portion of its movement to accelerate said motor and upon continued movement to slow down said motor, and means for positively restricting the return movement of said device beyond a predetermined position.

14. In combination, an electric motor, an automatic device adapted during a portion of its movement to accelerate said motor and upon continued movement to slow down said motor, and means for positively restricting the return movement of said device beyond a predetermined position, said means automatically permitting the return of said device to initial position when said motor is stopped.

15. In combination, an electric motor, an automatic controlling device movable to a predetermined position to accelerate said

motor and automatically set means for preventing the return of said device from said position, said device being movable back and forth beyond said position to vary the speed of said motor.

16. In combination, an electric motor, an automatic controlling device movable to a predetermined position to accelerate said motor, and automatically set means for preventing the return of said device from said position, said device being movable back and forth beyond said position to vary the speed of said motor, said automatically set means releasing said device to permit the same to return to initial position upon failure of voltage in the motor circuit.

17. In combination, an electric motor, an automatic field regulating device adapted when in initial position to insure full field strength of said motor, said device during a predetermined movement thereof weakening the field of said motor and upon continued movement strengthening the motor field, and means automatically operating to positively maintain said device at a predetermined distance from its initial position during operation of said motor and releasing said device to permit the same to return to initial position upon stopping of said motor.

18. In combination, an electric motor, an automatic field regulating device tending to stand in a position to give maximum field strength, said device being movable to a predetermined position to weaken the motor field and being movable beyond said position to strengthen the motor field, and electroresponsive means for preventing the return of said device beyond said position while said motor is in operation.

19. In combination, an electric motor, an automatic field regulating device tending to stand in a position to give maximum field strength when said motor is started said device being movable to a predetermined position to weaken the motor field and being movable beyond said position to strengthen the motor field, and electroresponsive means for preventing the return of said device beyond said position while said motor is in operation, said electroresponsive means releasing said device to permit the same to return to initial position upon failure of voltage in the motor circuit.

20. In a regulator in combination, a controlling device, a fluid responsive operating means therefor, means for gradually varying the load on said operating means in proportion to the movement of said device, and means for restricting the return movement of said device beyond a predetermined position, but leaving the same free to be moved in either direction throughout the remainder of its range of movement.

21. In an automatic regulator in combination, a regulating device movable back and forth between predetermined limits, said regulator being provided with means for inherently varying its weight according to its position, a fluid responsive operating means for said regulator and an electromagnetically operated device for limiting the range of movement of said device in one direction under predetermined conditions.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

GUY R. RADLEY.

Witnesses:
H. P. REED,
FRANK H. HUBBARD.