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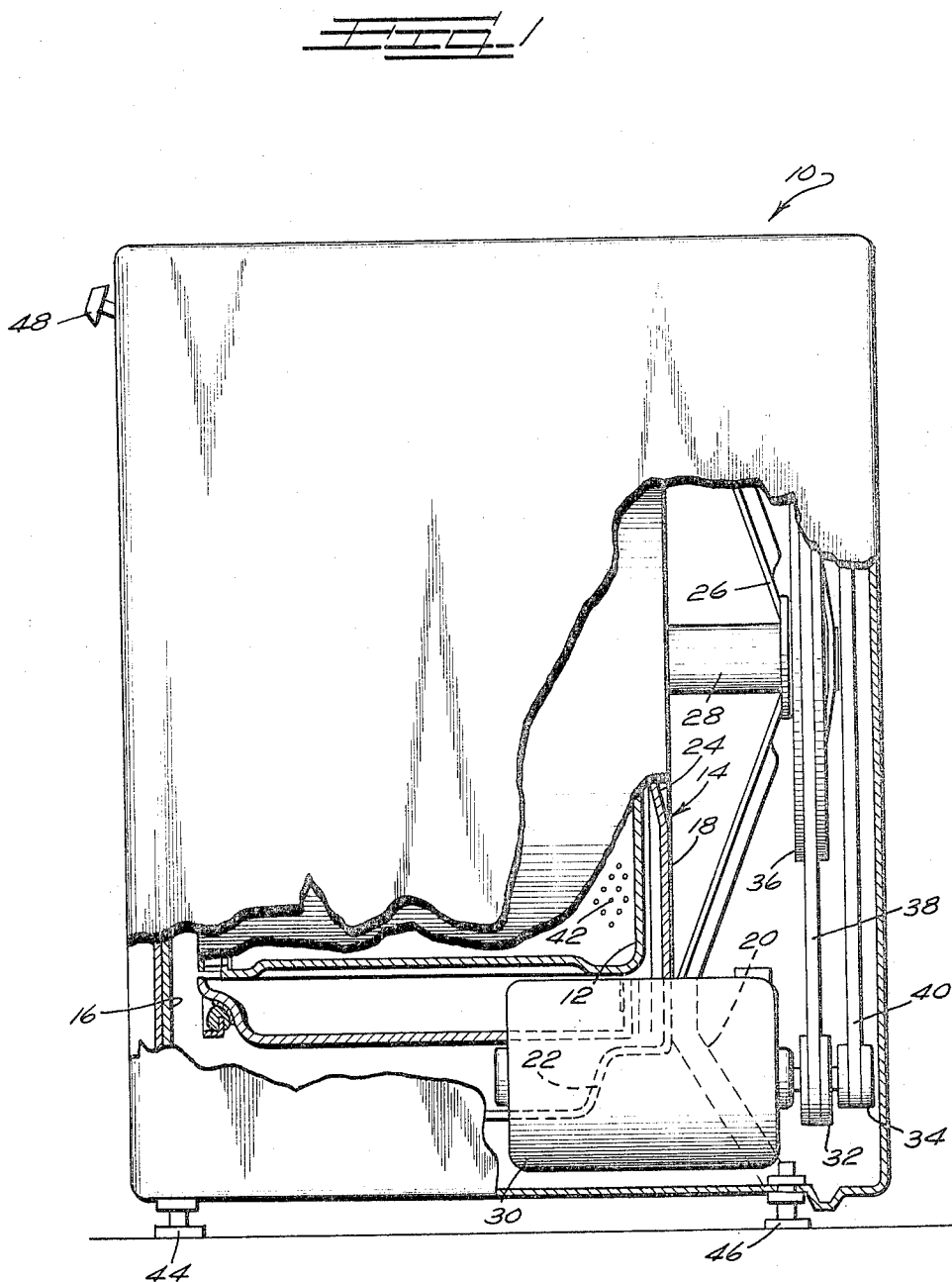
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3,293,889

CONTROL FOR CONTINUALLY VARYING TUMBLE SPEED

Filed Aug. 24, 1964

2 Sheets-Sheet 1



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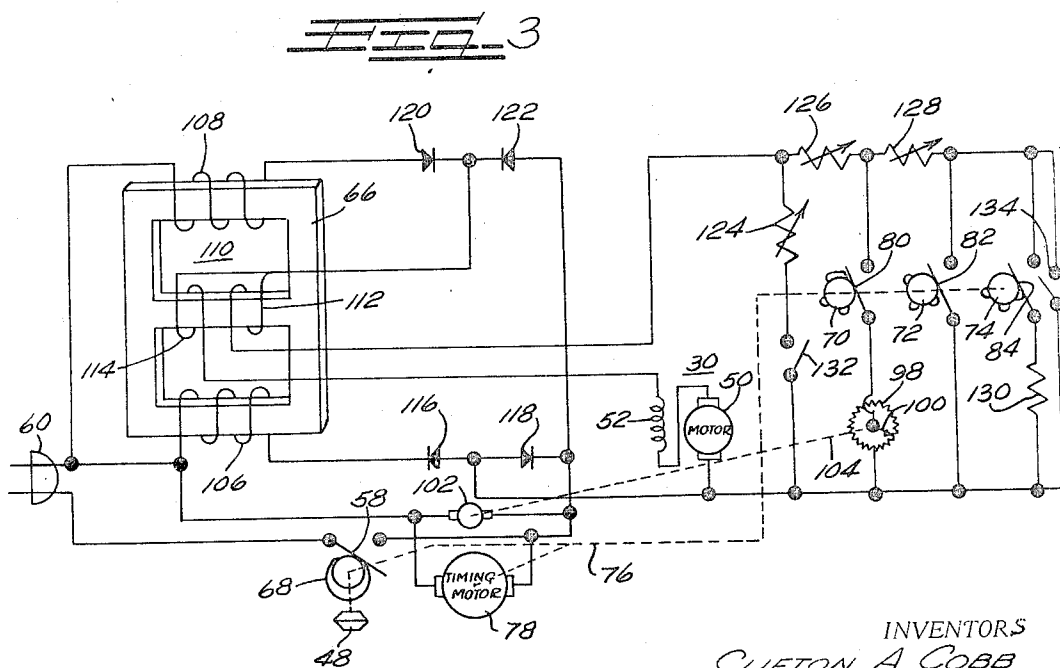
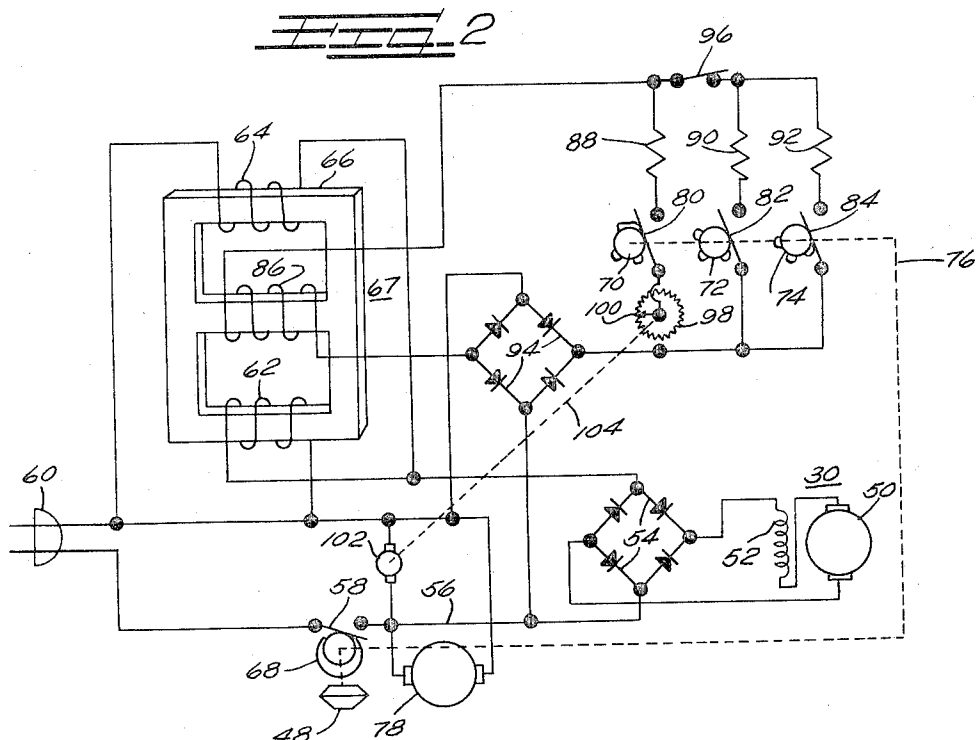
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2 Sheets-Sheet 2



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CONTROL FOR CONTINUALLY VARYING TUMBLE SPEED

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This invention relates generally to a drive system for a clothes receptacle of a laundry machine and more particularly to a drive circuit employing a continuously varying element for varying the rotational speed of the clothes receptacle through a predetermined range.

Automatic laundry machines, particularly those of the washer-dryer combination type, wherein the clothes are tumbled in a receptacle rotated on a substantially horizontal axis, require speed control of the receptacle. Such speed control is necessary for providing optimum performance and operating conditions.

In laundry machines an optimum washing and tumbling speed exists for each particular load of clothes. This optimum speed is primarily dependent upon the weight of the load. However, a speed which might be optimum for one particular load of clothes may not be effective for another load of clothes, since the weight and water retention capabilities of each might be different. Therefore, if the speed of the receptacle is below optimum for a particular load, the clothes tend to roll upon each other and become tangled.

Such a condition would result in improper cleaning of the clothes, since the clothes would not be distributed evenly nor tumbled properly. If the speed of the clothes receptacle is higher than the optimum, the clothes tend to gather at one side of the receptacle which would result in the clothes not tumbling for proper wash conditions. Furthermore, if the clothes gathered to one side of the receptacle, the machine would become unbalanced resulting in wear of mounting structures and general vibration of the entire machine.

The optimum speed is attained when the clothes are carried to an upper portion of the receptacle during its rotation and allowed to fall to a bottom portion thereof. Such optimum tumbling condition allows the clothes to separate during the fall and allows the laundry liquids an opportunity to perform their cleaning action.

Prior attempts to overcome the problem of attaining an optimum speed for the clothes receptacle have been unsatisfactory. For example, in one arrangement of the prior art the clothes receptacle was driven by means of a gear train having at least two elliptical gears therein, thus producing a continuous variation in the driving speed. Such a gear train requires excessive space within the machine. Furthermore, complicated gearing such as elliptical gears are expensive to manufacture and maintain and therefore increase the resultant cost of the machine. In addition, the time response to such gearing is limited to a minimum period which may not be satisfactory for optimum operating conditions. This time period is primarily dependent upon the inertia of the gear train, and being mechanical, it will exceed that of an electrical system.

It is, therefore, an object of this invention to provide a laundry machine with a control circuit for continually varying the tumble speed of the clothes receptacle through a predetermined range.

It is another object of this invention to provide a laundry machine having a speed control circuit which requires a minimum amount of mechanical linkage.

Still another object of this invention is to provide a

laundry machine with a speed control circuit which has a minimum time response period for effecting immediate change of speed.

These and other objects of the present invention will be more fully realized from the novel structure thereof which generally includes a variable impedance element in the motor control circuit which is continuously driven between a minimum and maximum value to attain a continually varying speed of the clothes receptacle.

The invention, however, will be more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein an exemplary embodiment is described by way of illustration of the principles of the invention.

On the drawings:

FIGURE 1 is a side elevational view of a laundry machine with portions of the cabinet structure removed for clarity of illustration;

FIGURE 2 is an electrical schematic diagram of one preferred embodiment of the control circuit; and

FIGURE 3 is an electrical schematic diagram of an alternate embodiment of the speed control system.

As shown on the drawings:

Like reference numerals throughout the various views of the drawings are intended to designate the same or similar elements.

With reference to FIGURE 1, there is shown a laundry washer-dryer combination generally designated with the reference numeral 10 which is generally representative of washer-dryer combinations known in the art. The control system of the present invention may be employed with any laundry machine, however, that shown in FIGURE 1 is exemplary of a so-called horizontal axis machine wherein a drum rotates on a substantially horizontal axis. The laundry machine 10 includes a clothes receptacle 12 mounted within a fixed casing 14 having a front wall 16 and back wall 18. The casing 14 is mounted on a support member 20 and includes a sump 22 for draining of laundry liquid from the casing 14 into a household drain.

The rear wall 18 of the casing 14 has a centrally apertured embossed portion 24 cooperable with a support spider 26 connected in firm assembly with the rear wall 18 to rigidly mount a bearing assembly generally designated at 28. A journaled shaft means (not shown) within the bearing assembly 28 is connected for corotation with a perforated drum or receptacle 12 rotatable within the casing 14.

A direct current motor 30 is mounted on the casing 14 and is provided with a pair of output pulley wheels 32 and 34. A pulley wheel 36 is connected to pulley wheel 32 by means of a belt 38 for rotating the clothes receptacle 12. A belt 40 extends from pulley wheel 34 for driving an air translating means such as a blower to circulate air within the clothes receptacle 12. The outer peripheral wall of the clothes receptacle 12 is formed by a foraminous wall and is particularly characterized by a plurality of openings 42 through which liquid may escape from the interior of the clothes receptacle 12 into the casing 14.

The laundry machine 10 is supported by means of front legs 44 and back legs 46. A sequence timer or cycle switch 48 is disposed at the top front of the laundry machine 10 for access by the user to control the operation of the laundry machine, thereby providing a sequential control means for automatically operating the machine through a programmed sequence of washing, rinsing and drying periods.

FIGURE 2 illustrates one preferred embodiment of the control circuit of the present invention which may be employed with the exemplary laundry machine illustrated

in FIGURE 1. As shown therein, the drive motor 30 having an armature 50 and a field 52 is connected across the D.C. output terminals of a bridge rectifier 54.

One A.C. input terminal of the bridge rectifier 54 is connected by means of a line 56 through a switch 58 to one side of a power plug 60. The other A.C. input terminal of the bridge rectifier 54 is connected through a gate winding 62 and a gate winding 64 to the other side of power plug 60. The gate windings 62 and 64 are connected in parallel with one another and are wound in opposition to one another on a core 66 of a magnetic amplifier or saturable reactor 67. This circuit arrangement provides a controllable source of power for the motor 30.

The sequence timer 48 is connected to a set of sequence cams 68, 70, 72 and 74 by means of a common shaft indicated by the dotted line 76. The cam 68 controls the switch 58 for completing the circuit from power plug 60 to the motor 50. A timing motor 78 is also connected to the common shaft 76 and is electrically connected in parallel with power plug 60. The motor 78, therefore, controls the rotational operation of the sequence cams 68, 70, 72 and 74. Each of the sequence cams 70, 72 and 74 control switches 80, 82 and 84 respectively.

A control winding circuit including a control winding 86 wound on the core 66, and a parallel circuit including resistors 88, 90 and 92 control the effective impedance of gate windings 62 and 64. The control winding circuit is energized from D.C. output terminals of a rectifier bridge 94 having A.C. input terminals connected in parallel with power plug 60. Resistors 88, 90 and 92 are connected in parallel with one another and their respective connection in the control winding circuit is controlled by switches 80, 82 and 84 respectively. Each of the resistors 88, 90 and 92 introduces a resistance value into the control winding circuit for controlling the speed of the motor 30 within definite respective speed ranges. An unbalanced sensing switch 96 is connected in the control winding circuit to control the connection of resistors 90 and 92 therein.

In operation, the control knob 48 is operated so as to close the switch 58, whereupon A.C. power is applied to the timing motor 78 which will control the operational sequence of the cams 70, 72 and 74. Each of these cams 70, 72 and 74 are contoured in accordance with the requirements of the cycle of a complete washing operation in the laundry machine 10.

When the switch 58 is closed, power is applied to the bridge rectifier 54 and to the bridge rectifier 94 through the gate windings 62 and 64 and the control winding 86, respectively. The gate windings 62 and 64 and the bridge rectifier 54 are connected in series, and present an effective impedance which is controlled by the control voltage applied. That is, when little or no control voltage is applied to the control winding 86, the saturable reactor 67 offers maximum impedance in series with the bridge rectifier 54 thereby applying minimum D.C. voltage to the motor 30. As the control voltage increases on the control winding 86, the iron core 66 of the saturable reactor becomes more saturated, thereby offering less impedance in series with the bridge rectifier 54, which in turn applied a higher D.C. voltage to the drive motor 30. It may be noted that the gate windings 62 and 64 are effectively connected in phase opposition with respect to the control winding 86 to minimize the induction of A.C. currents in the control winding circuit.

Therefore, the speed of motor 15 is dependent upon the control voltage applied to control winding 86. The control voltage developed across the winding 86 is determined by the resistance in circuit therewith. In order to control one of the cycles in the laundry operation for operation at varying speeds of rotation of the clothes receptacle, it is contemplated by this invention that the resistance in

circuit with the control winding 86 be varied through a predetermined range.

More specifically, the motor 30 includes a continuously variable rheostat 98 having a wiper arm 100 driven by a motor 102 through a mechanical linkage indicated by the dotted line 104. As shown, the rheostat 98 provides an element in circuit with the resistor 88 which continually varies the resistance of the control winding circuit when the switch 80 is closed.

The operation of the control circuit, therefore, is such that when the sequence cam 70 biases the switch 80 to a closed contact position, the resistor 88 and the rheostat 98 are placed in electrical circuit with the control winding 86 for controlling the impedance offered by gate winding 62 and 64. Since the motor 102 is connected in parallel with power plug 60, the arm 100 of the rheostat 98 is continually driven during the operation of the machine. As the wiper arm 100 is rotated, the speed of the motor 30 will continually vary between a minimum and a maximum dependent upon the resistance values of the resistor 88 and the rheostat 98 in circuit with the control winding 86. The motor 30, therefore, can effectively be controlled through a predetermined range of speeds and the response time thereof would be exceedingly small as compared to mechanical control structures.

One practical example of the response time of the present structures permits the machine to cycle approximately every 30 seconds, or, in other words, accomplish about 28 cycles during a normal washing period of 14 minutes. Therefore, such a continuously variable cycle insures an optimum tumbling speed for each particular load of laundry at least as many times as there are cycles.

The modified form of the speed control circuit is shown in FIGURE 3, wherein a pair of gate windings 106 and 108 of a magnetic amplifier or saturable reactor 110 are connected in such a manner as to provide a feedback arrangement to the saturable reactor 110 depending on the motor load. A pair of control windings 112 and 114 are wound on the core 66 in such a manner that they produce opposing magnetic fields when current passes through them simultaneously. Rectifying diodes 116, 118, 120 and 122 are provided for producing direct current operation of the circuit.

The entire drive control circuit is connected in a bridge circuit arrangement. One leg of the bridge circuit arrangement includes gate winding 106 and the diode rectifier 116; the second leg including gate winding 108 and diode rectifier 120; the third leg including diode 118; and the fourth leg containing diode rectifier 122. Connected between the D.C. output terminals of the bridge circuit is a first series circuit including the motor 30 and the control winding 114. Control voltage in the control winding 112 is dependent upon the parallel circuit arrangement including switches 80, 82 and 84 and resistors 124, 126, 128, and 130.

Rheostat 98 is also included in the parallel circuit arrangement for variably controlling the effective resistance during one cycle of the machine operation. This parallel circuit arrangement is connected in series with the control winding 112. The series circuit of the control winding 112 and the parallel resistance circuit is connected across the D.C. output terminals of the bridge circuit arrangement and in parallel with the motor 30 and the control winding 114.

In operation, therefore, the current passing through the motor 30 also passes through the control winding 114. This provides a magnetic field suitable to saturate the saturable reactor 110 and causes the motor 30 to run at high speed. A control voltage is applied to the control winding 112 which will produce a magnetic field in the opposite direction. This will place a limiting saturation point on the saturable reactor 110, thereby limiting the maximum speed of the motor 30.

The control winding 112 is also connected through the resistor 124 to an unbalanced sensing switch 132 and is

also connected through a resistor 126 to the switch 80 and to a resistor 128. The resistor 128 is connected to the switches 82 and 84 and another unbalance sensing switch 134.

The saturable reactor 110 and rectifiers 116, 118, 120 and 122 operate in a manner, and in the art of saturable reactors to control the D.C. voltage in accordance with the magnetic flux developed by the control windings 112 and 114. During one cycle of the machine's operation, therefore, a variation in the speed of the motor 30 may be attained by the motor 102 continuously rotating the wiper arm 100 of the rheostat 98. During that cycle of operation, of course, sequence cam 70 has actuated the switch 80 to a closed circuit position and has placed the rheostat 98 in circuit with the control winding 112 of the saturable reactor 110. As the rheostat wiper arm 100 is rotated, the resistance presented by the rheostat 98 in circuit varies from a minimum or zero to a maximum value and back to a minimum or zero. This cycle of operation of the rheostat 98 is repeated continuously through the cycle of the sequential cam 70 at a rate as desired. Therefore, the optimum speed required of a particular load of clothes is obtained during each cycle of rotation of the wiper arm 100.

Although various modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a laundry machine,
a rotatable receptacle for tumbling clothes,
a motor for driving said receptacle having a control winding circuit,
plural resistors for introducing selected values of resistance into said control winding circuit,
sequential control means including switch means regulating the selection of said resistors and automatically operating the machine through a programmed sequence of washing, rinsing and drying periods and controlling the operation of said motor at correspondingly different speeds during different cycles in said sequence,
continuously adjustable resistance means in circuit with one of said plural resistances and including a motor driven movable control member to continually vary the rotational speed of said receptacle during operation of said movable control member,
thereby to produce said continually varying rotational speed during the washing period of the programmed sequence.

2. A laundry machine comprising
a machine housing having a clothes receptacle mounted for rotation within said housing,
a D.C. motor directly connected for rotating said receptacle and for having a constant speed ration therewith,
a saturable core reactor having a control winding and an output winding,
an output circuit including said output winding having a first terminal for being connected to a power source and a second terminal connected to said D.C. motor,
a timing motor,
and a plurality of resistors each having a series connected switch operated by said timing motor
whereby said timing motor will operate said switches to incorporate selected ones of said plural resistors for varying the energization of

said motor through selected ranges of operational speeds corresponding to the washing and spinning operations of the clothes receptacle, and

means to continually vary the rotational speed of said receptacle during the washing operation comprising continuously adjustable resistance means in circuit with one of said plurality of resistances and including a motor driven movable control member, whereby said continually varying rotational speed will be produced during the washing operation.

3. In a laundry machine,
a rotatable clothes receptacle,
a D.C. motor directly connected for rotating said receptacle and for having a constant speed ratio therewith,
a saturable core reactor having a control winding and an output winding,
an output circuit including said output winding having a first terminal for being connected to a power source and a second terminal connected to said D.C. motor.

a timing motor,
a plurality of resistors each having a series connected switch operated by said timing motor,
an input circuit including said control winding having a first terminal for being connected to a power source and a second terminal connected to one terminal of each of said resistors,

each of said series connected switches being closed sequentially by said timing motor to complete said input circuit with said associated resistor, thereby to automatically operate the laundry machine at different speeds corresponding to different operations of tumbling and spinning,

and means for continually varying the tumbling speed of said receptacle comprising continuously adjustable resistance means in circuit with one of said plurality of resistors,

and a motor driven movable control member for said continuously adjustable resistance means to produce said continually varying rotational speed during the tumble speed operation of the machine.

4. In a laundry machine as defined in claim 3,
said continuously adjustable resistance means comprising a rheostat and said movable control member comprising a wiper arm.

5. In a laundry machine as defined in claim 4,
said continuously adjustable resistance means comprising a rheostat having a resistance element with a common terminal at each end thereof,

said resistance element having a resistance value range increasing from the common terminal to a maximum at the mid point thereof,

and said movable element comprising a wiper arm for said rheostat to provide in each cycle of operation an increasing resistance value from a minimum to a maximum value and a decreasing resistance value from the maximum to the minimum value of resistance.

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