J. H. HALL.
CIRCUIT CONTROLLING SYSTEM.
APPLICATION FILED NOV. 28, 1910.

1,053,494.

Patented Feb. 18, 1913.

4 SHEETS—SHEET 1.

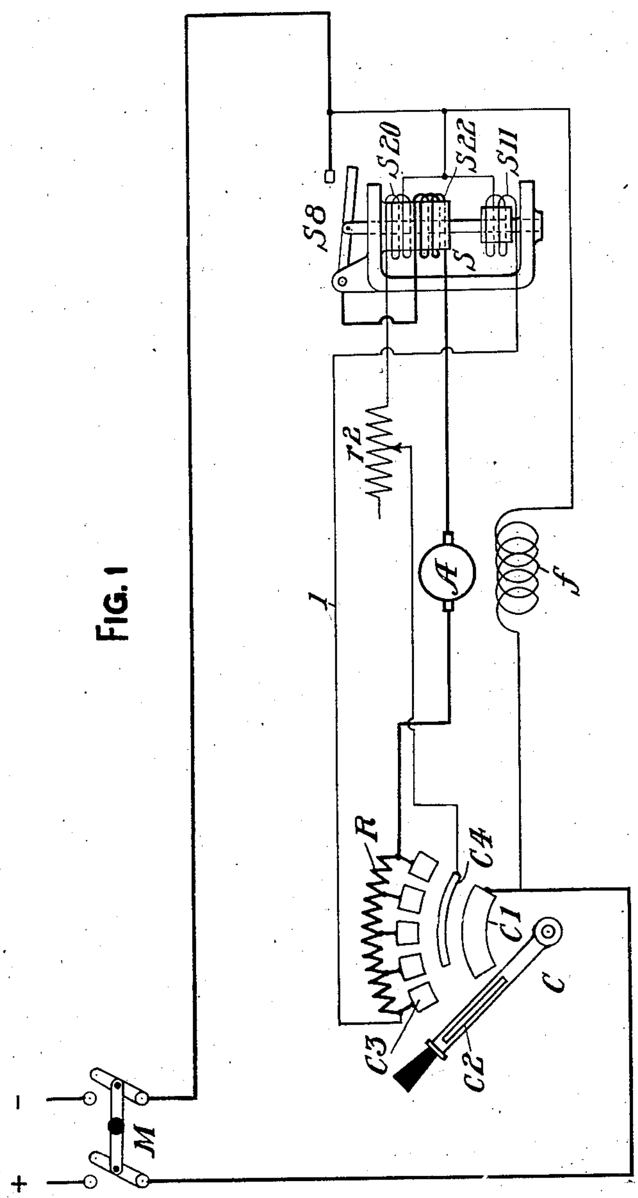

FIG. 1

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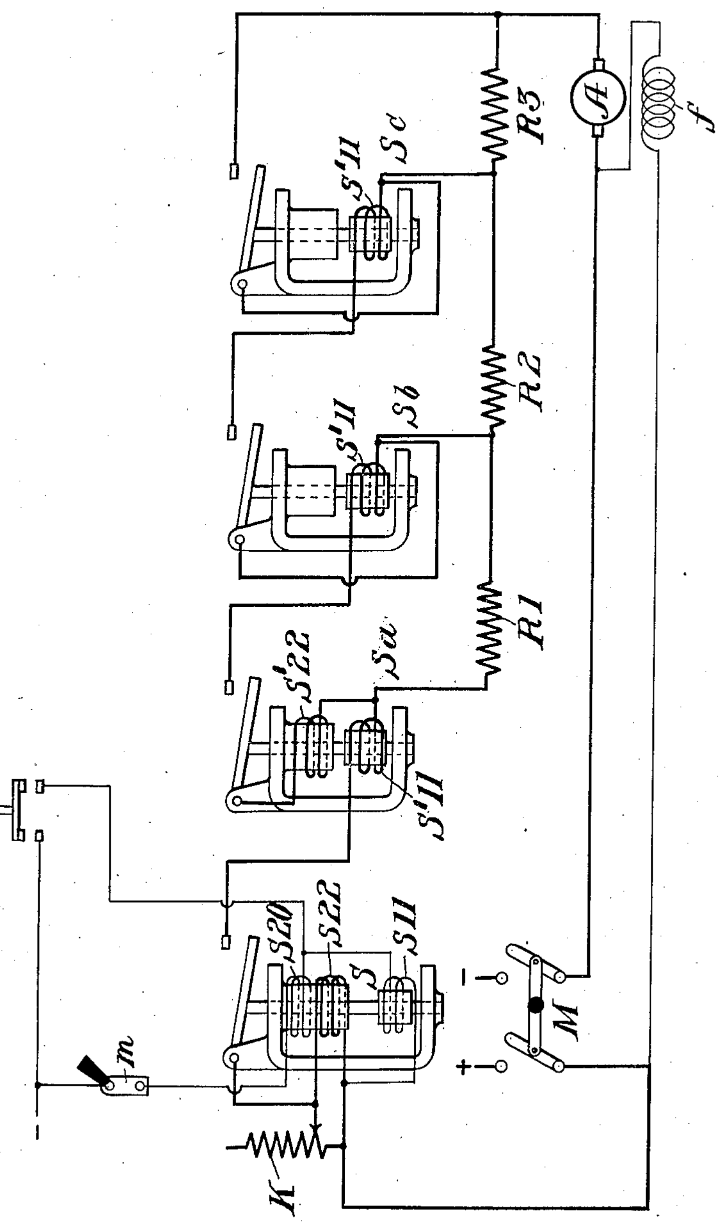
4 SHEETS—SHEET 2.

FIG. 2



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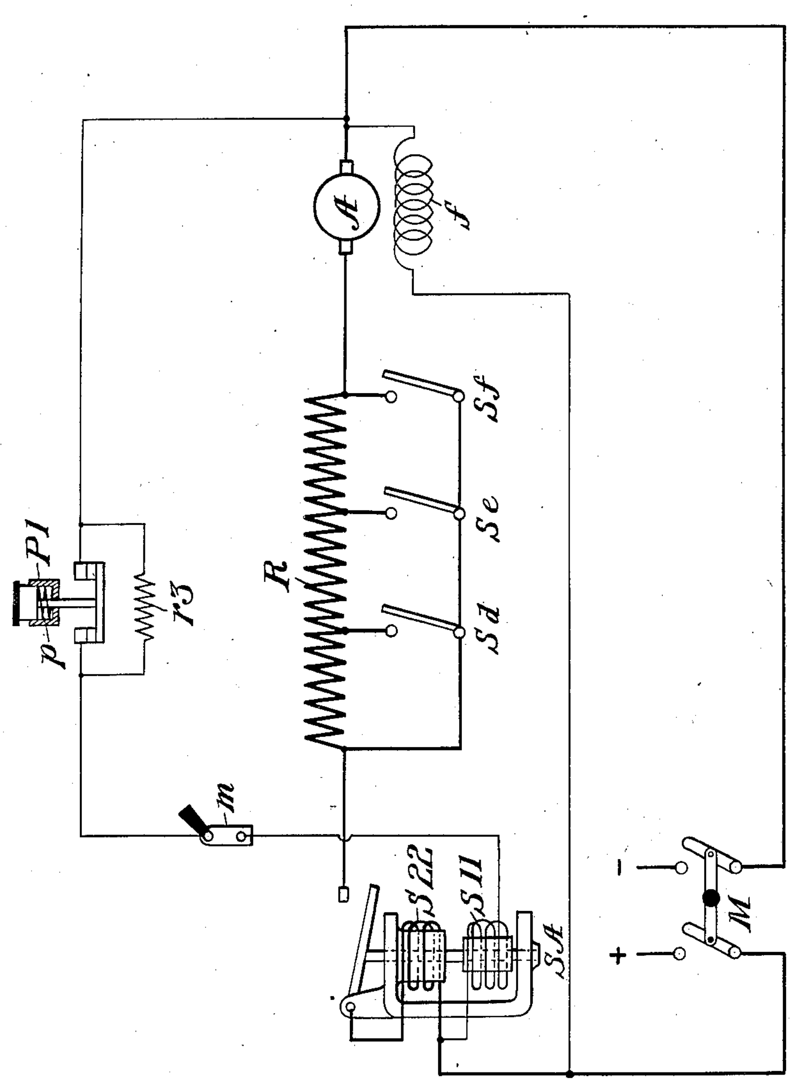
4 SHEETS—SHEET 3.

FIG. 3



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4 SHEETS—SHEET 4.

FIG. 4

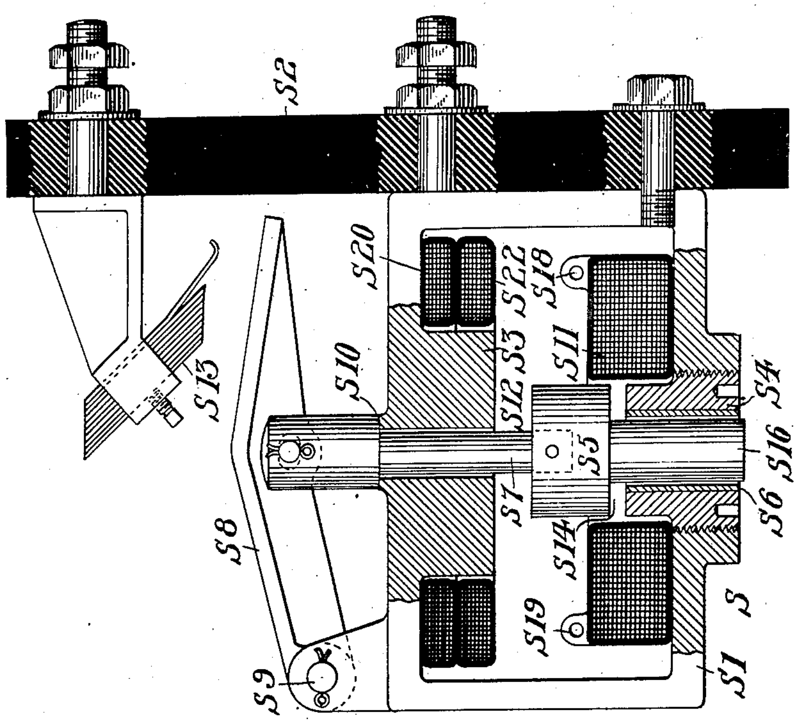
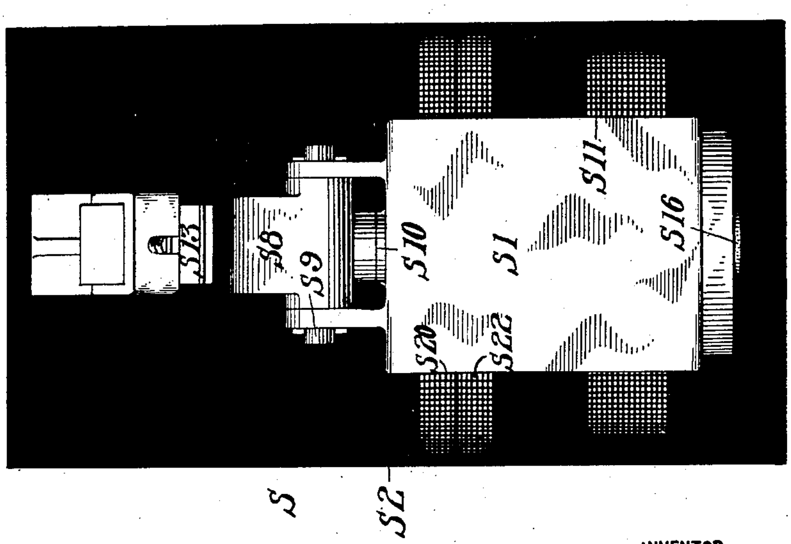


FIG. 5



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CIRCUIT-CONTROLLING SYSTEM.

1,053,494. Specification of Letters Patent. Patented Feb. 18, 1913.

Application filed November 28, 1910. Serial No. 594,440.

To all whom it may concern:

Be it known that I, JAY H. HALL, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Circuit-Controlling Systems, of which the following is a specification.

My invention relates to circuit controlling systems and particularly to the control of electric motors in which it is desired to protect the motor from being restarted without the attention of an operator upon an overload or failure of voltage, and to protect the motor from being started with any of the starting resistance cut out.

The object of my invention is to provide a controlling system which will secure these results without the use of auxiliary contacts or relays. To accomplish this I use a magnetically-operated switch which serves the purpose of a main switch for making and breaking the motor circuit, and which in itself is an overload device and cannot be closed after an overload or a failure of voltage without further attention from an operator, and which cannot be closed if any of the starting resistance is cut out.

Referring to the accompanying drawings, Figures 1, 2, and 3 are diagrams illustrating three of the many species which my invention may assume. Fig. 4 is a vertical section, partly in side elevation showing the magnetically-operated switch hereinbefore mentioned. Fig. 5 is a front elevation of Fig. 4.

The switch S shown on Figs. 4 and 5 is the same as that shown and described in my application, Serial Number 583,747, except that the upper boss or core is provided with two windings instead of one. This switch is briefly described as follows: The frame S′ of magnetic material is secured to the base S^2 of insulating material and has the upper pendent boss or core S^3, surrounded by the two independent windings S^{20} and S^{22}. The frame is also provided with the adjustable lower boss or core S^4 surrounded by the winding S^{11}. S^5 is the plunger or armature movable between the cores under the control of the said windings as will be presently explained. The plunger is connected by the preferably non-magnetic rod S^7 to the switch arm S^8 pivoted to the frame on the pin S^9 and arranged to engage the brush S^{13} mounted on the base S^2. S^6 is a sleeve of non-magnetic material surrounding the preferably magnetic reduced extension S^{16} of the plunger S^5. The core S^4 is threaded in the frame so that the length of the lower air-gap S^{14} may be adjusted. S^{12} represents the upper air-gap which is between the core S^3 and the plunger. S^{18} and S^{19} are the terminals of the winding S^{11}. S^{10} is a shoulder to limit the descent of the plunger S^5. If either of the windings S^{20} or S^{22} is energized with a small amount of excitation, the switch arm S^8 cannot be operated by the winding S^{11}, but if after the switch is once operated by the winding S^{11} and the gap S^{12} is closed, a small amount of excitation of the winding S^{20} or S^{22} will not cause the switch to open; but a very large amount of excitation of either of these windings, or both together, will cause the winding S^{11} to pull the plunger S^5 down, thereby opening the switch S. To obtain this action the magnetic flux set up by the windings S^{20} and S^{22} should be in a direction opposite to the flux set up by the winding S^{11}.

Fig. 1 shows conventionally the switch S used in connection with a manually operated starting rheostat or controller C to control the motor having the armature A and the shunt field *f*. I have shown the shunt field *f* connected directly across the source of supply as soon as the switch M is closed. When the arm of the controller is moved to the first running position, the brush C^2 connects the segments C′ and C^3 and a circuit is established through the operating winding S^{11} of the switch S from the positive to the contact C′, the brush C^2, the contact C^3, the wire 1, and the winding S^{11} to the negative main. This circuit causes the switch S to close its contacts and establish a motor circuit through the armature A including all of the starting resistance R and the winding S^{22}. The motor now starts at its slowest speed. As the controller handle is moved to the right, the starting resistance R is gradually cut out, and in the final right-hand position the motor armature is connected directly across the line.

As soon as the controller handle is moved to the second contact, the brush C^2 connects the contact segment C^4 to the segment C', thereby establishing a circuit through the winding S^{20} and the adjustable resistance r^2. During the running of the motor the windings S^{20} and S^{22} are both energized, but the switch S may be so adjusted by the core S^4 and these windings so proportioned that for all safe values of current through the armature the switch will remain in its closed position. If, however, an overload occurs, the current in the winding S^{22} increases and causes the switch S to open, thereby disconnecting the motor from the source of supply. The handle of the controller C still remaining in the position at which the overload occurred, both of the windings S^{11} and S^{20} remain energized. This energization of the winding S^{20} prevents the switch from closing until the handle is moved back to the first running position, or until the brush C^2 has left the contact C^4, at which position the winding S^{20} becomes deënergized, and allows the winding S^{11} to again close the switch and restart the motor. If, while the handle of the controller C is left in a running position, there should be a failure of voltage, all of the windings become deënergized, causing the switch S to open and disconnect the motor from the source of supply. Upon a return of voltage the windings S^{11} and S^{20} will be energized simultaneously, thereby preventing the switch from closing and it will be necessary for the operator to move the handle back to the first running position in order to restart the motor. It is, therefore, seen that it is impossible to close the switch S to start the motor with any of the starting resistance cut out.

To stop the motor, the switch M may be opened or the controller handle may be moved to the off-position.

The switch may be adjusted to operate on different overload currents either by the adjustment of the magnetic circuit by means of the boss S^4, or by the adjustment of the resistance r^2.

In Fig. 2, I have shown the switch S used in connection with a series of magnetic switches for automatically cutting out the starting resistances R', R^2, R^3 by means of the magnetic switches S^a, S^b, S^c of the type described in Canfield's applications, Serial Number 583.000, filed September 21, 1910, and Serial Number 604,331, filed January 23, 1911, and in Eastwood's patent, No. 1,040,292, granted October 8, 1912. In these applications and in this patent, particularly in Fig. 2, the switches have the peculiar characteristic that they remain in their open position when their operating windings are energized above a predetermined value, and operate to close their contacts when the energization falls to this value. As soon as the switch M is closed, the shunt field f is immediately energized, and a circuit is also established from the positive through the windings S^{11} and S^{20} to the negative. As before explained, the simultaneous excitation of these two windings prevents the switch S from closing.

When it is desired to start the motor the operator presses the push button P, which short-circuits the winding S^{20}, allowing the winding S^{11} to close the switch. A motor circuit is now established from the positive through the winding S^{22}, the contacts of the switch S, the operating winding S'^{11} of the switch S^a, the starting resistances R', R^2, and R^3, and the motor armature A to the negative. The motor starts with all the resistance in series, and operates at its slowest speed. When the motor armature has speeded up and the current therein is diminished to a certain predetermined value, the winding S'^{11} closes the switch S^a, thereby short-circuiting the resistance R' and connecting the operating winding S'^{11} of the switch S^b in the motor circuit. Similarly the switches S^b and S^c close successively when the armature current has diminished to a predetermined value, thereby automatically bringing the motor up to speed and finally connecting the armature directly across the line. If now an overload occurs, the winding S^{22} in the switch S will cause this switch to open, and since the windings S^{11} and S^{20} are still connected across the source of supply, the switch S will be prevented from closing again until the operator again closes the push button switch P. Similarly, on the occasion of failure of voltage while the motor is running, all of the switch windings will be deënergized, the switch S will open, and upon the return of voltage the windings S^{11} and S^{20} will be energized simultaneously, thereby preventing the switch S from closing until the operator has again closed the push button switch P.

To stop the motor the switch M or the small switch m may be opened.

In Fig. 2 I have shown another means of adjusting the point at which the overload current will cause the switch S to be opened, which consists in using an adjustable resistance shunt K, which may be connected across the terminals of the winding S^{22}. On the upper boss of the switch S^a I have shown a winding S'^{22}, which is connected in the motor circuit when the switch S^a closes its contacts. This winding may be so proportioned, and the magnetic circuit of the switch so adjusted that for all ordinary values of the motor current the switch S^a will remain closed, but upon the occasion of an increased current through the motor which would not be large enough to cause the main switch S to open, but which would be too large for a safe running value, the winding S'^{22} will cause the switch S^a to open and insert all the starting resistance in series with the motor armature. This switch then becomes a torque limit device which will insert a certain amount of the starting resistance in series with the motor upon an increase of current above a certain predetermined value. If the overload is removed, the switches will again close automatically, cut out the starting resistance, and bring the motor up to speed.

I am aware that a torque limit in itself is not new, but this method of obtaining it without the use of a separate switch or relay is believed to be entirely new.

Fig. 3 shows a system of motor control in which the main switch SA has only the two windings S^{11} and S^{22}. As soon as this system is connected to a source of supply by the closing of the switch M, the shunt field f becomes energized, and a circuit is established from the positive through the winding S^{11}, the switch m and the contacts of the switch P′ to the negative. The winding S^{11}, when energized without operating the push button switch P′, is designed to cause the switch SA to be locked open by the action of too large a current for closing it. In order to close the switch SA to start the motor the operator must open the contacts of the push button switch P′, thereby inserting the resistance r^3 in the circuit. This resistance reduces the current in the winding S^{11} to a value at which it will operate the switch SA, which upon operation closes the motor circuit, including the winding S^{22}. The resistance switches S^d, S^e, and S^f of any type, such as shown in Fig. 2, may now be closed, short-circuiting the resistance R and bringing the motor up to speed. As soon as the operator removes his hand from the switch P′, the spring p closes its contacts again, increasing the current through the winding S^{11}, so that, upon an overload in the winding S^{22}, which causes the switch SA to open and cut off the motor from the line, the winding S^{11} will be fully energized and lock the switch SA open until the operator again actuates the push button switch P′ to restart the motor. The same action occurs upon the occasion of no-voltage, at which the switch SA opens. Upon the return of voltage, the winding S^{11} will be fully energized and lock the switch open until the operator actuates the push-button switch P′.

To stop the motor the switch M or the switch m may be opened.

I have shown my invention in connection with the control of shunt-wound non-reversing motors, but it will be readily understood by those skilled in the art that it may also be applied to series or compound-wound motors either reversing or non-reversing.

The arrangement described in connection with Fig. 1 for preventing the closure of the main switch S when any of the starting resistance is cut out can also be applied to magnetic switch controllers by the proper arrangement of connections.

I claim—

1. In a motor control system, a motor, a switch in the motor circuit having its operating winding connected to the motor circuit, a second winding on said switch in the motor circuit which causes said switch to open when the motor current exceeds a predetermined value.

2. In combination, a switch having a winding which when energized at one value prevents the switch from closing and when energized at a lower value causes said switch to close, a circuit controlled by said switch, and a winding in said circuit which causes said switch to open when the current in said circuit becomes too large.

3. In combination, a circuit, a switch having contacts in said circuit, a winding on said switch which, energized at one value, will hold said switch open, and which, energized at a lower value, will cause said switch to close, a second winding on said switch which when energized above a certain value causes said first winding to open said switch.

4. In combination, a main circuit, a main switch having contacts therein, a master switch and circuit connections for controlling said main switch, and a winding on said main switch connected to said main circuit which causes said switch to open when the current in said main circuit is too large.

5. In a circuit controlling system, a circuit, a switch, an operating winding therefor, a second winding therefor which when energizen prevents said switch from closing, a thord winding in said circuit which causes said switch to open when the current in said third winding is above a predetermined value.

6. In a circuit controlling system, a switch having two windings which, when both are energized, prevent said switch from closing, means for reducing the current in one winding to cause the switch to close, and a third winding on said switch for causing said switch to open when the current therein is too large.

7. In a motor control system, a motor, a switch for closing the motor circuit having two windings which when normally excited prevent the switch from closing, means for reducing the excitation of one of said windings to cause said switch to close, a third winding on said switch connected to the motor circuit which causes the switch to open when the motor current is above a predetermined value.

8. In a motor control system, a motor, a switch having a winding connected to the motor circuit which causes the switch to open when the current in the motor circuit

becomes too large, said switch having a second winding which when normally energized holds said switch in its open position.

9. In a circuit, a switch having a movable member of magnetic material, means for producing a flux at one end of said member to prevent said switch from operating, means for changing said flux to cause said switch to operate, and a winding in said circuit acting on said member to cause it to open the switch when the current in said circuit is above a predetermined value.

Signed at Cleveland, Ohio, this 25th day of November, A. D. 1910.

JAY H. HALL.

Witnesses:
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R. H. BENNETT.