S. H. KEEFER.

MOTOR CONTROLLING SWITCH.

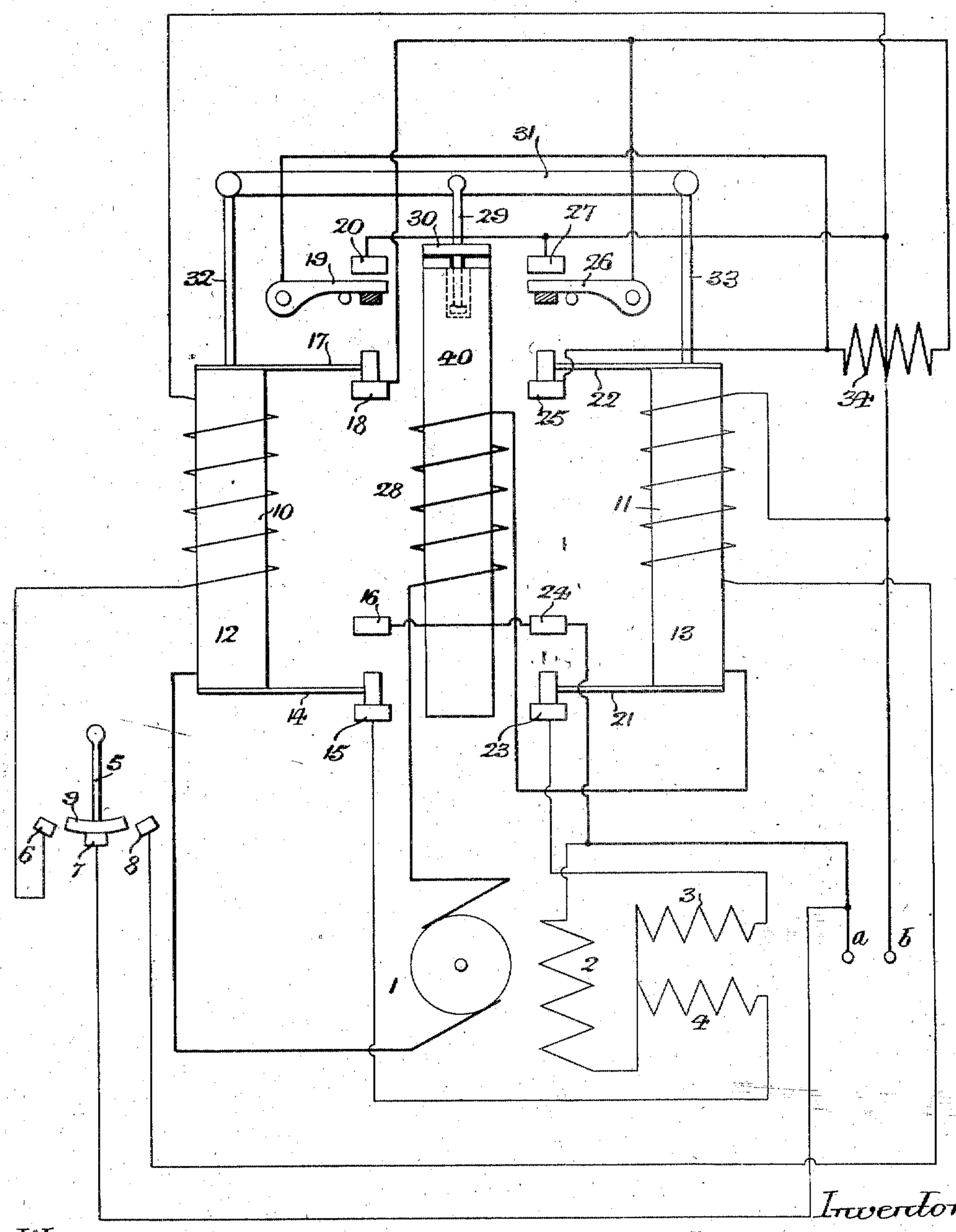
APPLICATION FILED NOV. 8, 1909.

983,063.

Patented Jan. 31, 1911.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 3.

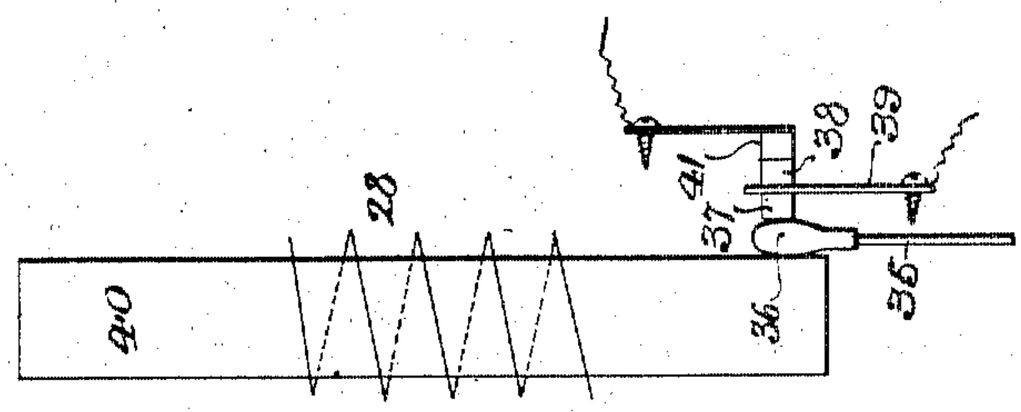
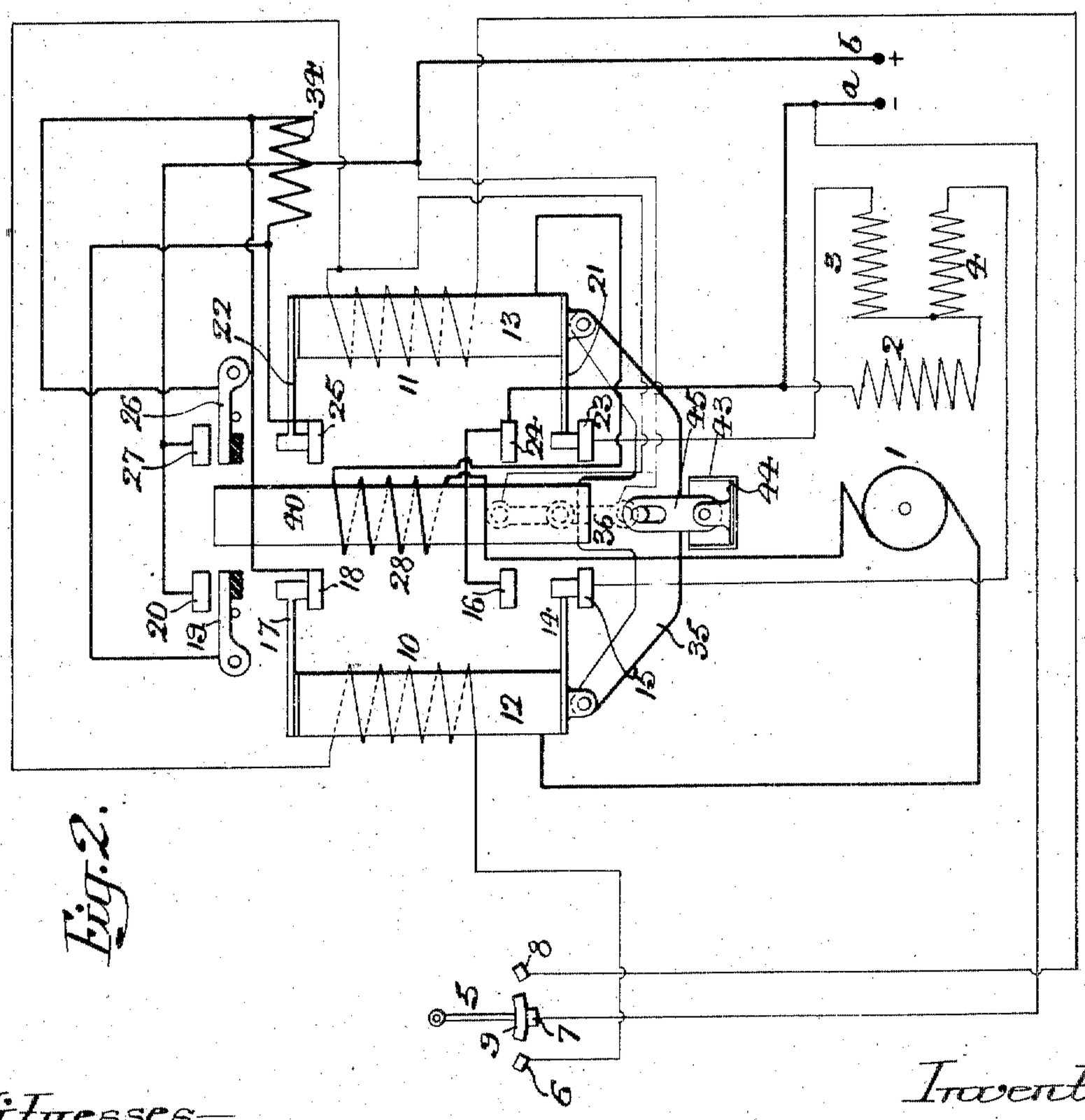


Fig. 2.



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UNITED STATES PATENT OFFICE.

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MOTOR-CONTROLLING SWITCH.

983,063. Specification of Letters Patent. Patented Jan. 31, 1911.

Application filed November 8, 1909. Serial No. 526,932.

To all whom it may concern:

Be it known that I, SAMUEL H. KEEFER, a citizen of the United States, residing in Plainfield, New Jersey, have invented certain Improvements in Motor-Controlling Switches, of which the following is a specification.

My invention relates to that class of switches particularly designed to control the starting and reversal of electric motors; one object of the present invention being to provide a switch of said class which, while being capable of effectually performing the work for which it is designed, shall be simple and substantial in construction and possess but relatively few parts.

I further desire to provide an improved electro magnetic motor-controlling switch which shall be capable of not only governing the starting of a motor but also of determining its direction of rotation; the arrangement and construction of the parts being such that said switch may be itself controlled from a distance by means of a pilot switch.

The invention also contemplates the provision of such a switch with means whereby, after the motor has been driven in one direction, it shall be impossible to supply current to turn it in the opposite direction, even though the pilot switch be suitably manipulated, until the counter E. M. F. of said motor has fallen to a predetermined point.

Another object of the invention is to provide an electro magnetic motor-controlling switch which shall possess but two solenoid windings, and shall, in addition to being capable of reversing the motor, be also capable of causing its gradual starting by a series of steps.

These objects and other advantageous ends I secure as hereinafter set forth, reference being had to the accompanying drawings, in which:—

Figure 1, is a diagrammatic view of the switch constituting my invention; Fig. 2, is a similar view of a slightly modified form of the switch; and Fig. 3, is a side elevation, to some extent diagrammatic, illustrating the detail construction of a switch forming part of the apparatus shown in Fig. 2.

In the above drawings, 1 represents the armature of a motor having a shunt field 2, and two bodies of field resistance 3 and 4. Current is supplied from mains *a* and *b* and its flow to the solenoids is governed by a pilot switch 5 which has three fixed contacts 6, 7 and 8, and a movable contact 9, capable of connecting either of the contacts 6 or 8 with the contact 7.

The main motor switch consists of two solenoids 10 and 11 provided with longitudinally movable cores 12 and 13, of which the first has at its lower end a spring contact 14 capable of engaging, when in its lower position, a fixed contact 15. When in its upper position, this contact 14 is capable of engaging a second fixed contact 16, and the upper end of the core 12 carries a second spring contact 17 which in its lower position is capable of engaging a fixed contact 18. Mounted above the spring contact 17 is a pivoted or otherwise movable contact arm 19, free to be brought into engagement with a fixed contact 20 by the upward movement of said spring contact; there being a body of insulating material, carried in the present instance by the contact arm 19, placed to prevent electrical connection between it and the spring contact 17. Similarly, the core 13 of the solenoid 11 has at its lower end a spring contact arm 21 and at its upper end a second spring contact arm 22. Of these, the first is capable of engaging a fixed contact 23 when in its lower position and a second fixed contact 24 when in its upper position, while the spring contact 22 can engage a fixed contact 25 when in its lower position and when moved upwardly is designed to move a contact arm 26 into engagement with a fixed contact 27; there being as before, a body of insulating material interposed between this spring contact 22 and the arm 26.

A blow out magnet 28 is so mounted that it is capable of producing a magnetic flux in the immediate vicinity of all of the above mentioned contacts so as to break any arc which may be formed; and in the device shown in Fig. 1, there is suitably mounted in the upper end of its core a rod 29 having an armature 30, which, as long as the flux in the core of said magnet is greater than a predetermined amount, prevents the upward movement of either of the cores 12 or 13 under the action of their windings; this being accomplished through the medium of

a cross bar 31 pivotally connected to the rod 29 and to bars 32 and 33, respectively connected to the two cores 12 and 13.

A body of armature resistance 34 is provided for the motor and the various parts are so connected that when current is supplied to the mains *a* and *b*, it at once flows through the shunt field winding and through the two bodies of field resistance 3 and 4 in parallel, so that the motor field is energized. If now the pilot switch is so operated that, for example, its contact 9 connects the contacts 6 and 7, current flows from the main *a* through said contacts, through the winding of the solenoid 10 and back to the main *b*. As a result, the core 12 of this solenoid is raised and separates the contacts 14 and 15, thereby open-circuiting the field resistance 4 and slightly weakening the shunt field of the motor. Immediately thereafter the contact 14 engages the contact 16, so that current flows from the main *a* through the contacts 24, 16 and 14 to the core 12, thence to the motor armature 1, the winding of the blow magnet 28, core 13, contacts 22 and 25 and part of the armature resistance 34, to the main *b*. The motor then starts and attains a certain definite speed, which is further increased by reason of the spring contact 17 moving the contact arm 19 into engagement with the contact 20 to cause the short circuiting of the resistance 34. If now the pilot switch be moved to its off position, the solenoid 10 is deënergized; its core 12 drops so as to bring its contact 14 into engagement with the contact 15, and the contact 17 into engagement with the contact 18. The motor armature is thus short circuited on itself through the armature resistance 34 and since the motor field is still energized, the motor at once acts as a generator, the current flowing from the armature to the core 12, through contacts 17 and 18, all of the resistance 34, contacts 25 and 22, core 13, blow magnet 28 and back to the armature. This current naturally produces a magnetic flux in the core of the blow out magnet and attracts to it the armature 30, so that even though the pilot switch be moved to connect the contacts 7 and 8, the energization of the winding of the solenoid 11 is not sufficient to raise the core 13, which is held in its lower position against such action by means of the cross bar 31 and the rod 33, until this current generated in the motor has fallen to a predetermined extent sufficient to permit of the armature 31 being released from the core of the magnet 28. Thereafter the solenoid 11 is free to raise its core 13, and in this case the field resistance 3 is open circuited, while the resistance 4 is left in series with the shunt field winding. As before, the upward movement of the spring contacts 21 and 22 successively completes the main motor circuit, cuts out the armature resistance 34, and when the pilot switch is moved to its off position, causes short circuiting of the armature, so that a braking action is exerted on the armature which is speedily brought to rest.

In the case illustrated in Fig. 2, the various electric connections of the solenoids and of the main contacts actuated by them are substantially the same as previously noted, except that a switch of the construction shown in Fig. 3, and covered in detail in my application for patent on a system of motor control, filed of even date herewith, Serial No. 526,931 is employed for the purpose of preventing the energization of the solenoid windings until the counter E. M. F. of the armature has fallen to a predetermined low point. With this idea in view, there is pivotally connected to the lower ends of the two cores 12 and 13 a transversely extending plate or bar 35 of insulating material, having a central upwardly extending portion 36 designed to be capable of moving between an armature 37 of magnetic material and the core 40 of the blow magnet so as to maintain a contact 38, connected to said plunger, in engagement with a second contact 41 in spite of the attraction of the blow out magnet.

As long as the plate or bar 35 is in its lower position shown in Fig. 2, the armature 37 may be drawn toward the core 40 when the blow magnet is energized so as to break the connection between the contacts 38 and 41. When, however, said plate 35 is raised by the upward movement of either of the cores 12 or 13 of the two solenoids, the contacts 38 and 41 are prevented from separating under the action of the magnetic flux of the blow magnet. As a consequence, if while the motor armature is short circuited owing to the movement of the pilot switch to its off position and current is generated by the motor owing to its continued revolution, the pilot switch be moved from its off position to such a position as would cause closing of the reversing switch and the supply of current to the motor, the windings of neither of the solenoids 10 and 11 can be energized, since as long as current above a predetermined amount is flowing through the armature circuit, the armature 37 is drawn toward the core of the blow magnet and the contacts 38 and 41, which are connected in circuit with the solenoid windings, are separated. It is not until this generated current has fallen to a predetermined low point that said armature is released, and then under the action of the spring arm 39 on which the contact 38 is mounted, the two contacts 38 and 41 are caused to engage each other so that current may flow through them and through the pilot switch to one of the solenoids 10 or 11. Under normal operating conditions these two contacts 38 and 41 are not separated even though the blow out mag-

net 40 be energized, since when either of the cores of the solenoid is in its raised position, the part 36 of the plate 35 is introduced between the core of said magnet and the armature 37, thus holding the two contacts 38 and 41 in engagement.

From the above, it will be noted that by the use of two solenoids whose energization may be controlled from a distance by a pilot switch, I am enabled to gradually start a motor in a plurality of steps and to control the direction of rotation of its armature; at the same time providing means whereby current is prevented from being supplied to the motor after the pilot switch has been moved to its off position, until the speed of the armature has fallen to such a point as will permit of the introduction of current without danger of injury. Moreover, the arrangement is such that I am enabled to employ two independent bodies of field resistance of which one is in circuit when the motor is turned in one direction and the other is in circuit when it is turned in an opposite direction.

In order that the operation of the solenoids may not be too quick, I may connect to their movable elements a retarding device—in the present case a dash pot 43 of the oil film type. This has its piston 44 connected through a slotted link 45 with the middle of the plate 35, so that while either of the cores 12 or 13 is retarded to a definite extent when moved upwardly under the action of its winding, it may be free to quickly return to its extreme lower position by reason of the slotted connection between the link and the plate 35 as soon as current is cut off from said winding.

I claim:—

1. A motor controlling switch consisting of a solenoid; two contacts carried by the movable member of said solenoid; two fixed contacts placed to be respectively engaged by said solenoid contacts when the solenoid is deënergized; and two other fixed contacts placed to be successively engaged by the solenoid contacts after the solenoid has been energized.

2. A motor controlling switch consisting of a solenoid; two contacts carried by the opposite ends of the movable member of said solenoid; a pair of fixed contacts respectively placed to be engaged by said solenoid contacts when the solenoid is deënergized; a third fixed contact placed to be engaged by one of the solenoid contacts after the solenoid has been energized; and a pair of contacts of which one is placed to be movable into engagement with the other by the second solenoid contact.

3. A motor controlling switch consisting of a solenoid having a movable core; two contacts yieldingly mounted on said core; two contacts placed to be engaged by said core-carried contacts when the solenoid is deënergized; and two other contacts placed to be successively engaged by said core-carried contacts after the solenoid has been energized.

4. A motor controlling switch consisting of a supporting structure; a solenoid having a movable core; two contacts yieldingly mounted on said core; and three contacts on the supporting structure of which two are placed to be successively engaged by said core-carried contacts when the solenoid is energized; one of said three contacts being free to move into engagement with another contact under the action of one of the core contacts.

5. A motor controlling switch consisting of a solenoid having a movable core; two spring contacts carried by said core; a fixed contact placed to be engaged by one of said spring contacts; and a pair of contacts, of which one is movable toward and from the other, placed to be closed by the second spring contact.

6. A motor controlling switch consisting of a solenoid having a movable core; two spring contacts carried by said core; a fixed contact placed to be engaged by one of said spring contacts; a pair of contacts, of which one is movable toward and from the other, placed to be closed by the second spring contact; with two additional contacts placed to be respectively engaged by the spring contacts when the solenoid is deënergized.

7. A system including an electro magnetic reversing switch having two solenoids; a motor; a pilot switch in circuit with the solenoids of the reversing switch; a magnet in circuit with the motor; and mechanism controlled by the magnet to positively hold the movable members of either solenoid from operation until the current flowing in the magnet falls below a predetermined point after the motor has been short circuited by said reversing switch.

8. A motor controlling switch consisting of a solenoid winding having a movable core; a pilot switch therefor; contacts controlled by the solenoid core; a blow out magnet for said contacts; and a mechanical device actuated by said magnet for forcibly opposing movement of the core under predetermined conditions.

9. A system including a motor; an electro-magnetic reversing switch therefor; a blow magnet for said reversing switch, in circuit with the motor; a pilot switch for the reversing switch; and a mechanical device controlled by the blow magnet for preventing operation of the reversing switch under predetermined conditions.

10. A system including a motor; a pair of solenoids having contacts connected to serve as a reversing switch for the motor; a pilot switch connected to the windings of the so-

lenoid; a blow out magnet for the reversing switch; an armature for the blow out magnet; and means for connecting said armature with the cores of the solenoids to prevent movement of said cores while the blow out magnet is energized.

11. The combination in a motor controlling switch of two solenoids; contacts controlled by said solenoids; a blow out magnet for said contacts; means for controlling the energization of said solenoids; with a bar loosely connected to the cores of the solenoids; and an armature for the blow out magnet, said armature being connected to said bar so as to prevent movement of the solenoid cores until the magnetic flux of said blow out magnet has fallen to a predetermined point.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

SAMUEL H. KEEFER.

Witnesses:
WILLIAM E. BRADLEY,
WM. A. BARR.