S. H. KEEFER.

CONTROLLING SYSTEM FOR REVERSING MOTORS.

APPLICATION FILED NOV. 2, 1910.

996,414. Patented June 27, 1911.

Fig. 2.

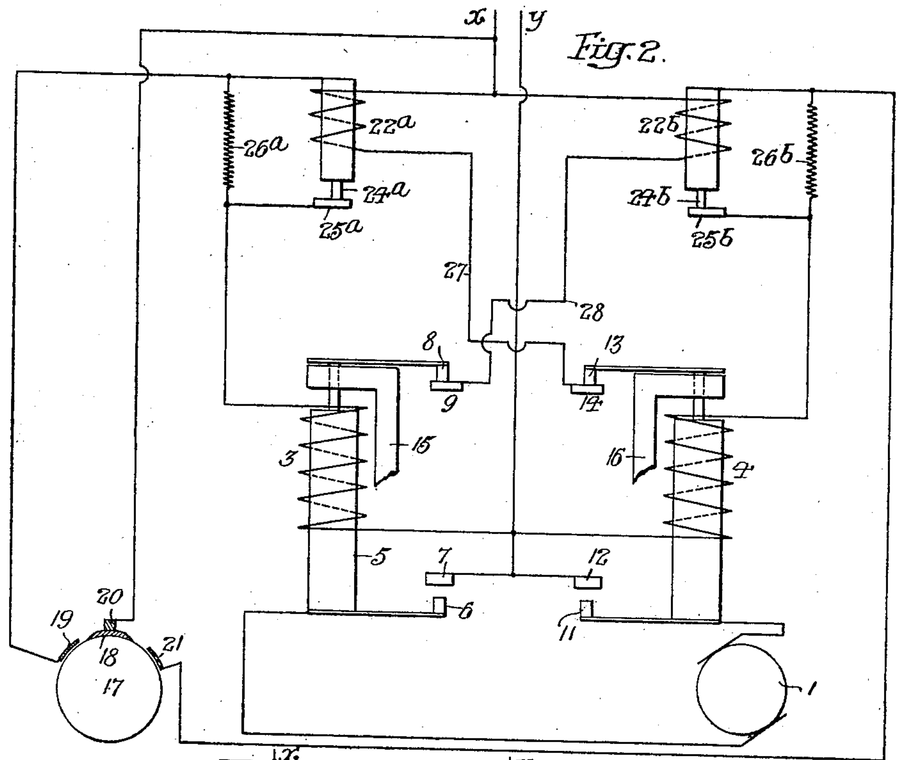
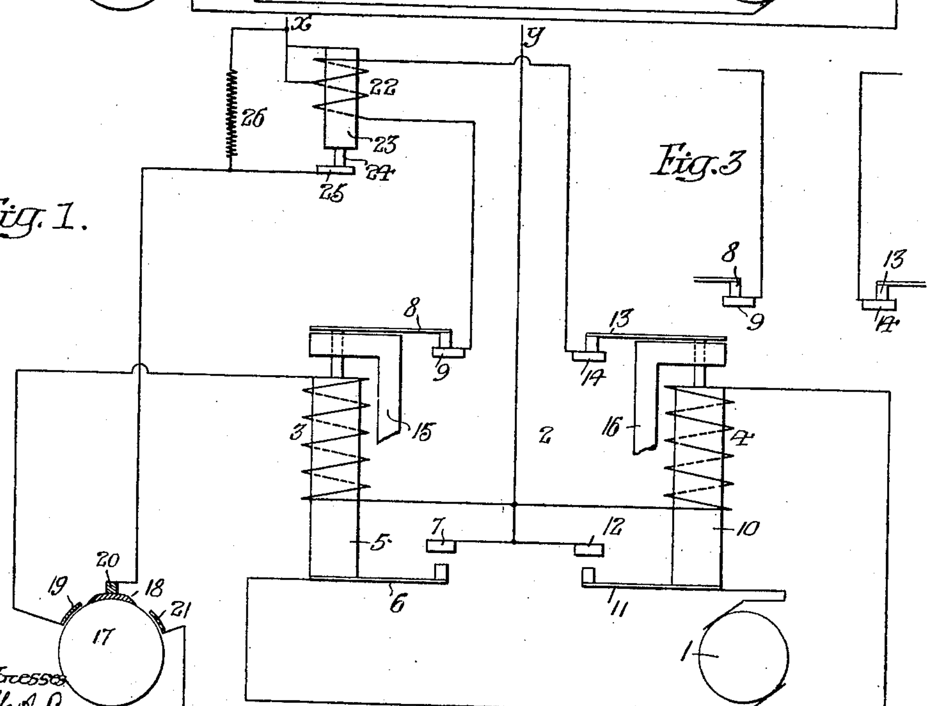


Fig. 1.

Fig. 3



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UNITED STATES PATENT OFFICE.

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CONTROLLING SYSTEM FOR REVERSING-MOTORS.

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To all whom it may concern:

Be it known that I, SAMUEL H. KEEFER, a citizen of the United States, and a resident of Plainfield, county of Union, New Jersey, have invented certain Improvements in Controlling Systems for Reversing-Motors, of which the following is a specification.

One object of my invention is to provide a relatively simple and reliable combination of apparatus for controlling the operation of a reversing motor; the invention particularly contemplating the provision of novel means for preventing operation of certain of the current controlling switches, after current has been cut off from the motor, until the armature thereof has practically ceased to turn.

Another object of the invention is to provide means for preventing the operation of an electromagnetic reversing switch if the armature of the motor connected thereto is turning under its own momentum or is being driven by a device to which it is connected so as to generate current, and which may include automatically acting means for cutting down the current flow through the windings of the reversing switch after these have been energized sufficiently to operate their co-acting parts.

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 illustrating the apparatus and connections constituting my invention, and Figs. 2 and 3, are diagrams illustrating slightly modified forms of the invention.

In Fig. 1 of the above drawings, 1 represents the armature of the reversing motor to be controlled, whose field winding is omitted from the drawings to avoid confusion. 2 is a reversing switch consisting of two electromagnets 3 and 4, each of which in the present instance consists of a winding having a longitudinally movable core; the core 5 of the solenoid 3 having attached to its lower end a movable contact 6 designed to co-act with a fixed contact 7, and carrying on its upper end a contact 8 movable relatively to a fixed contact 9. Similarly, the core 10 of the solenoid 4 has attached to its lower end a contact 11 designed to cooperate with a fixed contact 12 and has mounted on its upper end a second contact 13 co-acting with a fixed contact 14. These two electromagnets or solenoids are preferably made with or include a casing or framework of magnetic material, portions of which are indicated diagrammatically at 15 and 16. For controlling the energization of the two solenoids 3 and 4 a pilot switch 17 is provided consisting in this instance of a suitable supporting structure carrying a contact 18 of such dimensions and position that when the movable member of said switch is moved in one direction, this contact electrically connects two other contacts 19 and 20, and when moved in the opposite direction similarly connects the contact 20 with a third contact 21, to the exclusion of the contact 19.

In addition to the above apparatus, I provide a relay 22, in the present instance shown as a solenoid, having a longitudinally movable core 23 carrying a contact 24 in electrical connection with a current supply main x, and designed to co-act with a fixed contact 25 connected to the contact 20 of the pilot switch. Shunted around the switch formed by these two contacts 24 and 25 is a body of resistance 26 so proportioned that when connected in series with either of the windings of the solenoids 3 and 4 it so far cuts down the current supply to the same that it is unable to lift or raise its core, although it is still capable of maintaining such core in a raised position adjacent the pole piece of the casing or frame 15 and 16, as the case may be. A second current supply main y is electrically connected to the two contacts 7 and 12 of the reversing switch. The winding of the relay 22 is connected between the fixed contacts 9 and 14 of the reversing switch, and the arrangement is such that the movable contacts 8 and 6 of the solenoid 3 are electrically connected to each other, as are also contacts 13 and 11 of the solenoid 4. One end of each of the windings of the solenoids is connected to the current supply main y and while the second end of the winding 3 is connected to the contact 19 of the pilot switch, the second end of the winding 4 is connected to the contact 21 of said switch. The armature terminals of the motor in this instance are shown as connected to the movable members 5 and 10 of the two solenoids 3 and 4;—

that is, to the two pairs of contacts 8—6 and 13—11 respectively. With this arrangement of apparatus and connections it will be obvious that under the action of gravity the cores 5 and 10 normally maintain the contacts 8—9 and 13—14 respectively in engagement with each other, although there can be no current flow from the mains x and y with the pilot switch in the position shown. If, however, the movable member of said switch be moved to electrically connect the contacts 19 and 20, current immediately flows from the main x through the contacts 24 and 25 of the relay, through contacts 20, 18 and 19 of the pilot switch, to the winding of the solenoid 3 and thence to the current main y. As a result, the core 5 is raised so as to bring the contact 6 into engagement with the contact 7, whereupon current flows from the supply main x to what is substantially the middle point of the winding 22 of the relay, thence through one-half of this winding to contacts 14 and 13 of the solenoid 4, to the core 10, through the armature of the motor, thence through the core 5 of the solenoid 3 and contacts 6 and 7 to the current main y. The motor therefore starts and comes up to speed, and it is noted that the flow of current through one-half of the winding 22 of the relay raises its core 23, thereby opening the switch formed by the contacts 24 and 25 so as to cause the current supply to the winding 3 to pass through the resistance 26. As a result this current flow is cut down to such an amount that it energizes said solenoid to an extent just sufficiently to hold the core 5 in its raised position. Since such current is relatively small, heating of the winding 3 is effectually prevented and there is considerable saving from an operating standpoint. If now it be desired to stop the motor, current is cut off from the winding of the solenoid 3 by moving the pilot switch to break the connection between its contacts 18 and 19, whereupon the core 5 drops to its lower position, breaking the motor circuit at the switch formed by the contacts 6 and 7 so that the core 23 of the relay likewise drops to its lower position. Inasmuch, however, as the contact 8 immediately thereafter engages the contact 9, the armature of the motor is short circuited on itself through the core 5, contacts 8 and 9, all of relay winding 22, contacts 13 and 14, and core 10, so that the motor at once acts as a generator in the well known manner (its field winding being energized) and produces a heavy current which shortly brings its armature to rest. If instead of the pilot switch being permitted to remain in its off position, it is moved directly from the position connecting the contacts 19 and 20 to one connecting the contacts 20 and 21, it is very possible that serious damage might result to the motor if the winding 4 were energized so as to raise its core 10 and immediately supply current to the motor while its armature was still turning under its own momentum. With my arrangement of apparatus, however, such an action is effectually prevented, for the current produced by the armature flowing through the relay winding energizes this sufficiently to separate the contacts 24 and 25, so that whatever current flows from the main x through the pilot switch to the winding of the solenoid 4, necessarily passes through the resistance 26, which so reduces it that said solenoid 4 has not sufficient power to raise the core 10. When, however, the speed of the armature has been so far diminished as to reduce the current generated by it to a relatively small amount, the relay 22 is so far deënergized as to permit its core 23 to drop, whereupon the engagement of the contacts 24 and 25 permits current, at full line voltage, to be delivered to the winding 4, thus operating it and starting the motor as described in connection with the solenoid 3. In this instance, however, the motor circuit includes the second or lower half of the relay winding 22 and the current flow, as before, is sufficient to raise the core 23 so as to again place the resistance 26 in circuit with the winding 4. Current flow is thus reduced in this winding to a minimum at which point it is maintained during the operation of the motor until the pilot switch is again operated.

In some cases it may be advisable to provide a pair of relays instead of a single relay 22 as shown in Fig. 1, and in this case I may employ such an arrangement of apparatus as is shown in Fig. 2. The contact 9 of the reversing switch now has a solenoid winding 22^b connected between it and the current supply main x, while a second solenoid winding 22^a is connected between the contact 14 and the same supply main. The relay of which the solenoid 22^a forms a part has attached to its core a contact 24^a designed to co-act with a fixed contact 25^a. These two contacts are shunted by a body of resistance 26^a, and similarly the relay of which the solenoid 22^b forms a part, has a fixed contact 25^b and a movable contact 24^b; the latter being controlled by the core of said solenoid, and both contacts being shunted by a body of resistance 26^b. With this arrangement of parts the completion of the circuit including the solenoid 3 raises the core 5 and permits current to flow from the supply main x to the motor armature 1 as before, though in this case the armature circuit includes the relay winding 22^a, which, although momentarily deënergized by the moving of the pilot switch to its off position, is caused to raise its core under these conditions so as to separate the contacts 24^a and

25[a] as long as the motor is generating current. Such a generation of current also energizes the solenoid 22[b] so that the contacts 24[b] and 25[b] are separated, with the result that, as before, no possible manipulation of the pilot switch can cause either of the reversing switch solenoids 3 and 4 to be energized sufficiently to raise its core. When, however, the armature 1 has come to rest the two relay cores are permitted to drop, and since the resistances 26[a] and 26[b] are short circuited, it is then possible for either of the reversing switch solenoids 3 or 4 to receive sufficient current to raise its core and cause current to be supplied to the motor. It is of course noticeable that in this case as before only a relatively small current flows through that one of the solenoids 3 or 4 which is energized since the resistance 26[a] or 26[b] is in circuit with such winding during the operation of the motor. In case, however, it should not be desirable to cut down the energizing current for one of the solenoids 3 or 4 after it has operated its core, the connections 27 and 28 from the contacts 8 and 14 to the relays 22[a] and 22[b] may be arranged as shown in Fig. 3, in which case the bodies of resistance 26[a] or 26[b] would be respectively connected in series with the solenoid windings 3 or 4, while the solenoids of said relays maintained their cores raised as when the motor was generating current. With this condition the operation of the pilot switch in either direction from its off position cannot result in an energization of either solenoid 3 or 4 until the armature 1 has practically come to rest.

I claim:—

1. The combination in a system of motor control of a motor; a reversing switch therefor having electromagnetic operating means; a body of resistance; and means including a winding connected in the main armature circuit of said motor controlled by the speed of the motor armature for maintaining the body of resistance in the operating circuit of said electromagnetic operating means until such speed has fallen to a predetermined point.

2. In a system of motor control, the combination of a motor; reversing mechanism therefor; electromagnetic means for actuating said reversing mechanism; a body of resistance; and a device for interposing the body of resistance in the circuit of said electromagnetic means after said means has been energized, said device including an electromagnet connected in the main armature circuit of the motor and a switch in circuit with the actuating means of the reversing mechanism.

3. The combination in a system of motor control of a motor; a reversing switch therefor including electromagnetic operating means; a pilot switch for governing the flow of current to said means; an electromagnet in the main armature circuit of the motor; a switch governed by said magnet and in circuit with the electromagnetic operating means for the reversing switch; and a body of resistance in parallel with said electromagnet.

4. In a system of motor control, the combination of a motor; electromagnetic reversing apparatus for said motor; and means dependent upon the motor for controlling the operating circuit of said apparatus to prevent reversal of said motor after current has been cut off from the same until its speed has been substantially reduced;— said means including a device for reducing the current flow to said reversing apparatus when current is flowing through the motor armature to a point sufficient to maintain the movable element thereof displaced from its normal position but insufficient to primarily actuate said element.

5. The combination in a system of motor control of a motor; a reversing switch therefor including two electromagnets; a pilot switch for governing the flow of current to said electromagnets; a third electromagnet having its winding in the main circuit of the motor armature; a switch governed by said latter electromagnet and in circuit with the windings of said reversing electromagnets; and a body of resistance in parallel with said latter switch.

6. The combination of an electric motor; a reversing switch therefor including electromagnetic operating means; an electromagnet having its winding connected in the main circuit of the motor armature when the operating means of the reversing switch is deënergized; a switch governed by said electromagnet and in circuit with the operating means of the reversing switch; and a resistance in parallel with said magnet-governed switch.

7. The combination in a system of motor control of a motor; a reversing switch therefor having electromagnetic operating means; a pilot switch for governing the flow of current to said operating means; and a device including an electromagnetic switch having a winding in the main armature circuit of the motor, and a body of resistance controlled thereby for automatically reducing the current flow to said electromagnetic operating means without causing operation thereof, after such operation has once occurred.

8. The combination in a system of motor control of a motor; a reversing switch therefor having electromagnetic operating means; an electromagnet in circuit with the motor armature and connected at substantially its middle point to one of the current supply mains; a switch controlled by said electromagnet and in circuit with

the electromagnetic operating means of the reversing switch; with a body of resistance in parallel with said electromagnet.

9. The combination of an electric motor; a reversing switch therefor including two electromagnets; a pilot switch for governing the flow of current to said electromagnets; two other electromagnets, both capable of being placed in circuit with the motor; with switches controlled by said latter electromagnets and respectively in circuit with the electromagnets of the reversing switch, for preventing flow of current to the motor until its speed has fallen to a predetermined point.

10. The combination of an electric motor; a reversing switch therefor including two electromagnets; a pilot switch for governing the flow of current to said electromagnets; two other electromagnets both capable of being placed in circuit with the motor; with switches controlled by said latter electromagnets and respectively in circuit with the electromagnets of the reversing switch for preventing flow of current to the motor until its speed has fallen to a predetermined point; with bodies of resistance respectively in parallel with the two latter electromagnets.

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.