

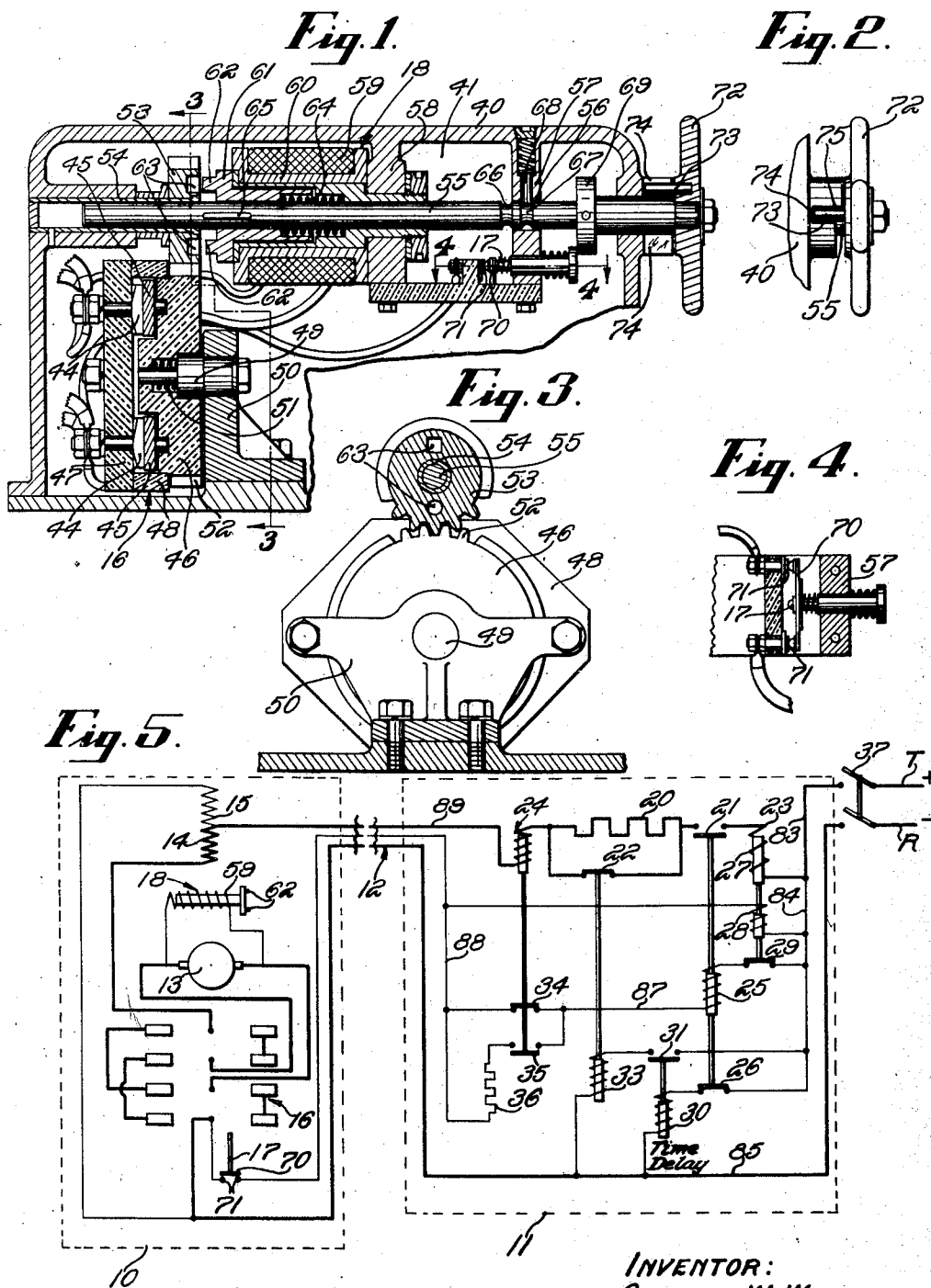
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ELECTRICAL APPARATUS

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ELECTRICAL APPARATUS

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This invention relates to electrical apparatus, and more particularly to electrical controlling apparatus for reversible motors.

An object of my invention is to provide improved controlling apparatus. A second object of my invention is to provide improved starting, stopping and reversing mechanism for an electric motor. A still further object of my invention is to provide improved starting, stopping and reversing mechanism for an electric motor in which starting is impossible in predetermined positions of the reverse switch and in which movement of the reverse switch is precluded both when line current is being supplied to the motor and when, after the discontinuation of the supply of line current to the motor, the motor is still rotating at such speed that there is material regeneration taking place. A still further object of my invention is to provide an improved controlling mechanism both for a reverse switch and for current supply means for a motor including a common controlling element for both the reverse switch and the current supply means having means associated therewith for disconnecting the same from the reverse switch and thereby precluding movement of the reverse switch, whenever the motor is rotating at a speed above a predetermined minimum. Yet another object is to provide an improved operating and controlling mechanism for a reverse switch. Other objects and advantages of the invention will subsequently appear.

In the accompanying drawing in which there is shown for purposes of illustration one form which the invention may assume in practice,

Fig. 1 is an approximately vertical section through a casing in which a portion of my improved controlling mechanism is arranged.

Fig. 2 is a detail view of the handle construction.

Fig. 3 is a vertical section corresponding to the broken line 3—3 of Fig. 1.

Fig. 4 is a horizontal section corresponding to the line 4—4 of Fig. 1.

Fig. 5 is a diagrammatic layout of a controlling system in which my invention is incorporated.

Referring to the drawing and at first more particularly to Fig. 5, the dotted line rectangle 10 represents a mining machine of the coal cutter type. The dotted rectangle 11 represents a control mechanism which is, when the mechanism to be controlled is a mining machine, preferably arranged in a control box or the like at a point remote from the point of operation of the machine. The three conductors indicated at 12 are two power conductors and a pilot wire arranged in a cable extending between the box 11 and the mining machine 10. It will be evident that the invention need not be incorporated in a system

of this character but can be used wherever a safe control of a reversible motor is required.

The mining machine comprises a motor 13 having a series field 14 and a shunt field 15. The direction of rotation of the motor is controlled by a reverse switch mechanism generally designated 16. A pilot switch 17 controls circuits and apparatus later described through which current supply to the motor is governed. Mechanism generally designated 18 is provided to prevent movement of the reverse switch from either of its current establishing positions when the motor is revolving at a material speed.

The pilot switch and the controlling mechanism are arranged in the mining machine frame, in the particular embodiment of the invention herein shown. The mechanism controlled by the pilot switch may obviously assume many forms, and herein for purposes of illustration a very simple form has been selected. This mechanism includes, within the casing 11, a starting resistance 20, a main contactor 21, a resistance cut-out contactor 22, overload control mechanism generally designated 23, a series relay device generally designated 24, and suitable controlling devices to effect automatic connection of the motor 13 to the line through the resistance 20 and subsequent cutting out of the resistance. The contactor 21 is provided with an operating solenoid 25 which may advantageously be of the "half-voltage" type, and an interlock 26 moves with the contactor 21. The overload protective device comprises an overload coil 27, a holding coil 28, and a switch element 29. The holding coil 28 cannot exert a sufficient pull to open the switch 29 but will maintain it open if it is opened by the solenoid 27. A time delay relay mechanism 30, which may advantageously be of the copper-jacketed coil type, controls a switch 31 which is normally open, and delays opening of the latter suitably after the current supply to the coil is interrupted. There is no delay in the closing action of the switch 31 on current supply to the solenoid 30. The resistance cut-out contactor 22 is controlled by a solenoid 33; and the series relay 24 controls a pair of switches 34 and 35, one or the other of which is always closed. The switch 35 is adapted to introduce a resistance 36 in series with the half-voltage coil 25 when the switch 34 opens and the switch 35 closes. A main line switch is shown at 37 and serves to connect a trolley T and a rail R with the conductors in the box 11.

The mining machine 10 has a frame, a portion of which is shown at 40, and within the frame is a chamber 41 within which the pilot switch 17, the reverse switch 16, and operating means for these switches are housed. The reverse switch comprises a series of, herein four, stationary contacts 44 and a pair of arcuate moving contacts 45. The latter are carried upon a generally circular

block 46 of insulating material which forms, with the bottom member 47 and a side wall forming member 48, an enclosure for the contact members 44 and 45. The block 46 rotates upon a stud 49 carried by a bracket 50 and is yieldably pressed by a spring 51 toward the bottom member 47 so that the contacts 44 and 45 are yieldingly pressed towards each other.

The rotatable contact carrying block 46 carries upon its periphery a series of teeth 52 with which the teeth of a pinion 53 mesh. The pinion 53 is rotatable upon a sleeve 54 supported in the chamber 41. A longitudinally slidable operating shaft 55 is supported at one end within the sleeve 54 and extends through an opening 56 in a projecting web 57 of the casing 40. Another projecting web 58 supports a solenoid 59 having a hollow magnetizable core 60. An armature or plunger 61 is mounted coaxial with and slidable relative to the solenoid 59 and carries clutch teeth 62 which are adapted to engage within recesses 63 formed in the pinion 53. Preferably, as shown, the teeth 62 should be of different shapes, with the recesses correspondingly shaped, so that only in one relative position can connection be effected. A spring 64 maintains the clutch teeth 62 in engagement with the recesses 63 except when the solenoid 59 is energized. When the solenoid is energized, the armature or plunger 61 is moved toward the right in Fig. 1 and the pinion 53 cannot be rotated by rotation of the shaft 55. It will be understood that brass, fiber, or other suitable material will be used for such parts as may need to be constructed of non-magnetic material in order to promote the best working of the control mechanism.

The shaft 55 has a splined connection 65 with the armature 61. Annular grooves 66 and 67 in the shaft 55 are engageable with a spring pressed pin 68 for the purpose of holding the shaft 55 in either of two positions. A collar 69 is pinned to the shaft, and in the position of the latter shown, presses the pilot switch bar 70 yieldingly into contact with the stationary contacts 71. A handle 72 is non-rotatably connected to the shaft 55 and is provided with a pin 73 which can engage in either of two slots 74, dependent upon the position thereof. Abutments 75 are preferably provided to limit the rotation of the handle to the proper range. Obviously, except when the pin 73 is opposite one of the slots 74, longitudinal movement of the shaft 55 to the position shown in Fig. 1 is impossible. The pinion 53 may be made with a pitch diameter one-half that of the gear 52, and accordingly rotation of the handle 72 through 180° will rotate the gear 52 through 90°. With the handle 72 in a position with the pin 73 midway between the notches 74, the reverse switch will be in neutral position, and a quarter turn of the handle 72 in either direction will bring the reverse switch to an operating position and also bring the pin 73 opposite one of the slots 74. Accordingly, with the reverse switch in either of the operative or "on" positions, the handle 72 may be slid to the position shown in Fig. 1 and the pilot switch may close. Opposite movement to permit opening of the pilot switch is possible at any time, but unless the clutch pins 73 engage in the recesses 74 the reverse switch cannot be rotated. To prevent rotation of the reverse switch except when there is no substantial current flowing in the motor armature, the solenoid 59 is connected directly across the armature of the motor. It will therefore be evident that whenever the motor is connected across the line,

or is rotating at a substantial speed after disconnection from the line, the solenoid 59 will draw the armature 61 to the position shown in Fig. 1 and prevent any movement of the pinion 53 and gear 52 even though the hand wheel 72 is drawn to the right, so as to permit rotation of the shaft 55, and then rotated.

From the foregoing explanation the mode of operation of the mechanism may be readily understood. It will be appreciated that the pilot switch 70 will be open except when it is desired to run the motor, and the reverse switch will, moreover, normally be in its neutral position, that is, in the position which it occupies when the pin 73 is midway between the slots 74.

The connections not heretofore mentioned in the control circuits will be described in connection with the description of the operation.

When the main line switch 37 is closed, a circuit will be established from the trolley line T, through the main line switch, through a conductor 83, a second conductor 84, the normally closed switch 26, and the time delay relay coil 30 to a conductor 85, the other pole of the main line switch 37 and the rail R. Accordingly the switch 31 will be closed, the coil 33 energized, contactor 22 moved to open position, and flow of current to the motor on closure of contactor 21 will be impossible save through the resistance 20. Until the pilot switch 17 is closed, no further action takes place in the box 11. When the machine runner wants to start the motor, he will turn the reverse switch to its desired running position by rotating the handle 72, thereby causing the shaft 55, through the clutch 62 and 63, to rotate the pinion 53 and thereby the gear 52, to bring the reverse switch into one of its operating positions. When a running position is reached, it will be possible to move the shaft 55 longitudinally into the position shown in Fig. 1, for the pin 73 will then be opposite one or the other of the slots 74. When the shaft 55 is moved toward the left in Fig. 1 to the position shown in that figure, the pilot switch 17 will be closed, i. e. the contact 70 will connect the stationary contacts 71. When this occurs, a circuit will be established through the holding coil 28, but no movement of the switch member 29 will take place as the coil 28 has, as indicated above, only sufficient pull to serve as a holding and not as a moving coil. A circuit will likewise be established from the trolley T through conductor 83, conductor 84, normally closed overload switch 29, solenoid 25, wire 87, switch 34, pilot wire 88, pilot switch 70, and conductor 85 back to the track R, and as a result the main line contactor 21 will close, putting the motor on the line through the conductor 83, overload coil 27, contactor 21, starting resistance 20, series relay coil 24, conductor 89 in the cable 12, and back through the conductor 85 to the rail R.

The interlock 26 is opened when the contactor 21 closes, and this results in de-energization of the time delay relay coil 30, and as soon as the current dies out in this coil, which requires a little time in view of its construction, the switch 31 will drop open, thereby de-energizing the coil 33 and permitting the contactor 22 to move to closed position, shunting the resistance 20. The motor will then be directly on the line. It will be understood that the time delay provided by the construction of the coil 30 is adequate to permit the motor to come up to an appropriate speed before the resistance is cut out. The energization of the series relay coil 24 moves the

switch 34 to open position and closes the switch 35. This places the resistance 36 in series with the coil 25 and thereby cuts down the current consumed in maintaining the contactor 21 closed. Evidently, since the coil 59 is connected across the motor armature, immediately upon the supply of current to the motor, the clutch teeth 62 are withdrawn from the recesses 63 and thus it is made impossible to rotate the reverse switch so long as the motor is connected to the line, and in fact, so long as the motor is running at a speed sufficient to effect much regeneration.

The motor is stopped by opening the pilot switch 70. This breaks the circuit through the solenoid 25, allowing the contactor 21 to open, and the parts in the box 11 then return to the positions which they occupied prior to the closure of the pilot switch. The shaft 55 cannot be rotated, however, until the motor has slowed down to a small fraction of its normal running speed, as the coil 59 connected across the armature is energized by the regenerative armature current until the motor speed is largely lost. It will be appreciated, as pointed out above, that though the handle 72 has been moved in effecting opening of the pilot switch to a position in which it may be rotated (because the pin 73 is no longer in the slot 74), rotation of the clutch teeth 62 with the shaft 55 is without result for these teeth are held out of engagement with the recesses 63 in the pinion 53. When the motor comes substantially to a stop, the coil 59 will no longer hold the teeth 62 out of the recesses 63, and thus it will be possible to rotate the pinion 53, and thereby the gear 52, to move the reverse switch to neutral position.

From the foregoing description it will be evident that I have provided herein an improved electric controlling system, and an improved electric controlling mechanism in which a single handle or other manually operated element may be used both to position a reverse switch and to effect the closure of a pilot switch; that the pilot switch can only be closed in one of the "on" positions of the reverse switch; and that the reverse switch cannot be moved from its "on" position while the pilot switch is closed and cannot be moved from its "on" position, even after the pilot switch has been opened, while the motor is running at a substantial speed. It will further be evident that the parts are simple, that the reverse switch is wholly prevented from injury due to burning of its contacts since it is not moved at all during the time when substantial currents are flowing in the motor, and that all the parts are of substantial and durable construction.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

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

1. In combination, a motor, a controlling device therefor, reversing mechanism for controlling the direction of rotation of said motor, a single operating element for directly actuating the controlling device and the reversing mechanism, and means for disconnecting said operating element from the reversing mechanism

automatically whenever the motor is rotating above a predetermined minimum speed.

2. In combination, a motor, a controlling device therefor, a reversing mechanism therefor, an operating element operative upon predetermined movement to move said reversing mechanism and upon a different predetermined movement to effect control of said controlling device, and means for effecting disconnection between said operating element and said reversing mechanism whenever said motor is rotating above a predetermined minimum speed.

3. In combination, an electric motor, a reversing switch therefor, controlling mechanism for the motor for supplying current thereto initially through a resistance and subsequently with the resistance cut out including a pilot switch, operating means for the pilot switch, and means including a releasable clutch for connecting said pilot switch operating means in operative relation with the reverse switch.

4. In combination, an electric motor, a reversing switch therefor, controlling mechanism for the motor for supplying current thereto initially through a resistance and subsequently with the resistance cut out including a pilot switch, operating means for the pilot switch, and means including an electrically operated clutch for connecting said pilot switch operating means in operative relation with the reverse switch.

5. In combination, an electric motor having an armature, a reversing switch therefor, controlling mechanism for the motor for supplying current thereto initially through a resistance and subsequently with the resistance cut out including a pilot switch, operating means for the pilot switch, means including a clutch for connecting said pilot switch operating means in operative relation with the reverse switch, and controlling means for said clutch including a solenoid connected across the armature of the motor.

6. In combination, an electric motor, a reversing switch therefor, and controlling means for the reversing switch including operating means for the latter and means for disconnecting said operating means therefrom and precluding connection thereof when said motor is running at a speed in excess of a predetermined minimum.

7. In combination, an electric motor, a reversing switch therefor, and controlling means for the reversing switch including operating means for the latter and electrically operated means for disconnecting said operating means therefrom and precluding connection thereof when said motor is running at a speed in excess of a predetermined minimum.

8. In combination, an electric motor, a reversing switch therefor, a rotatable operating shaft for said reversing switch, and an electrically operated clutch coaxial with said shaft for connecting said reversing switch to said shaft and controlling the operation of the reversing switch thereby.

9. In a motor controlling system, an electric motor, a reversing switch therefor, and current supply means therefor, and controlling means for said reversing switch and current supply means including an operating shaft having coaxial therewith members for respectively controlling the current supply means and the reverse switch, and means controlled by the operation of the motor for controlling the connection of one of said coaxial members with said shaft.

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