July 9, 1929. A. H. JACKSON 1,720,189

ELECTRIC MOTOR CONTROL SYSTEM

Filed March 5, 1926 2 Sheets-Sheet 1

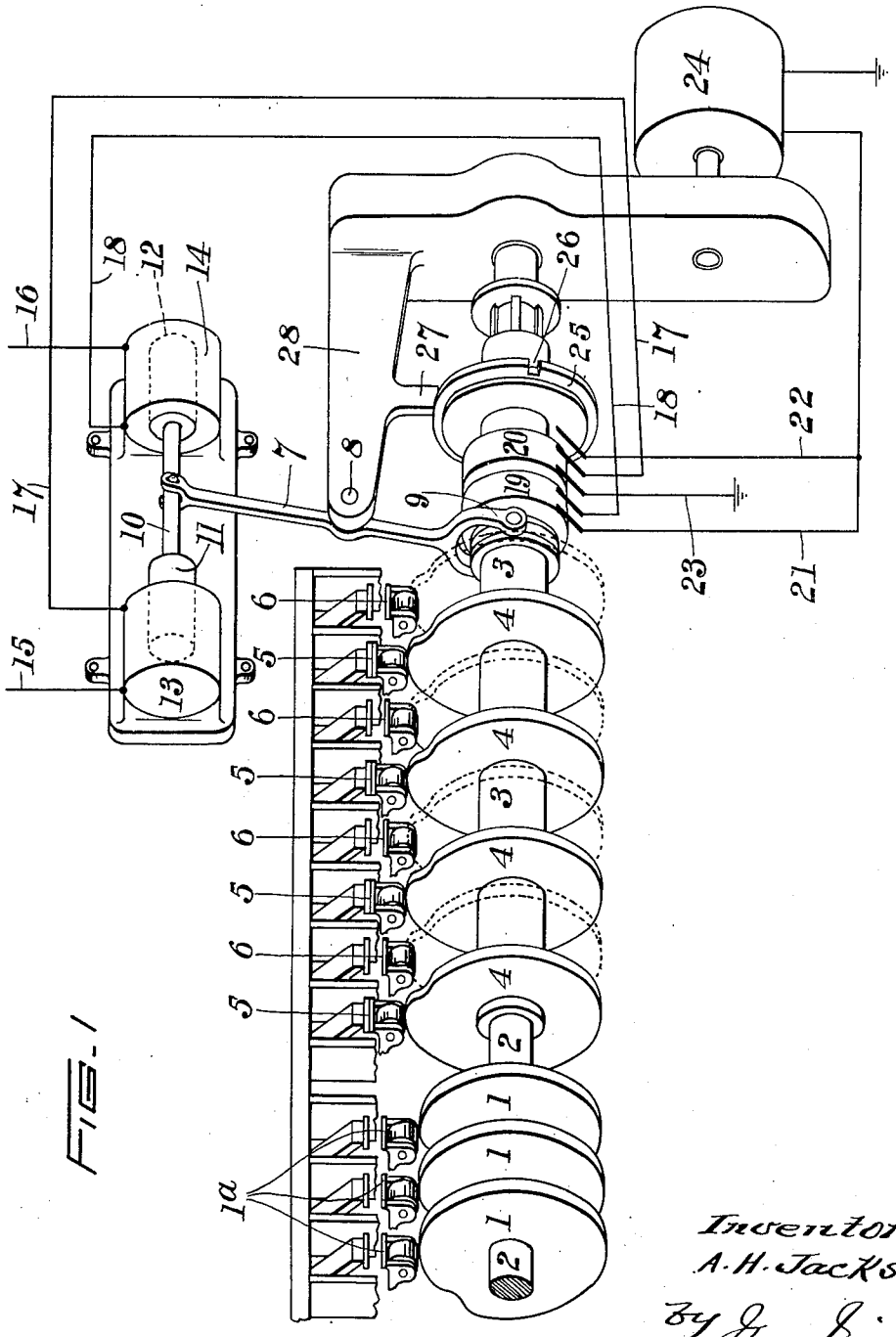

FIG. 1

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FIG. 2

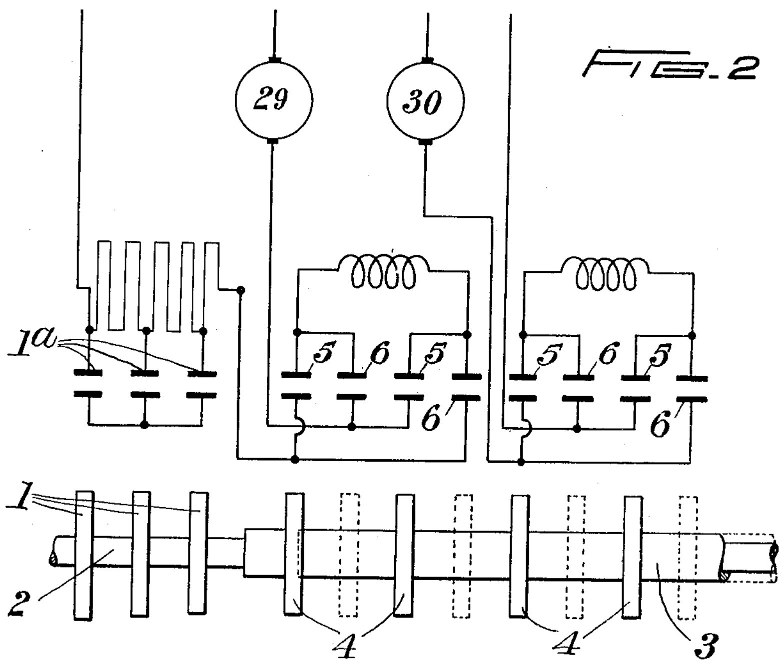
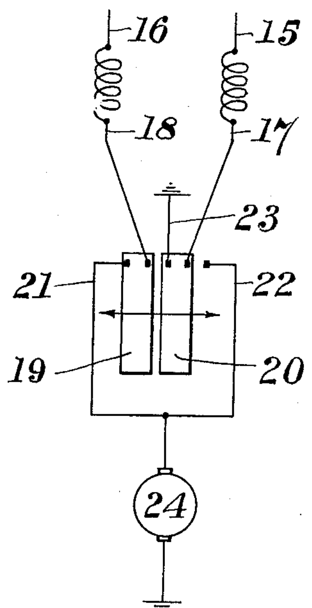


FIG. 3



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UNITED STATES PATENT OFFICE.

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ELECTRIC-MOTOR-CONTROL SYSTEM.

Application filed March 5, 1926, Serial No. 92,591, and in Great Britain May 25, 1925.

This invention relates to electric motor control systems of the type in which the variation of conditions in the circuit of the electric motors is effected through the agency of contactor switches mechanically actuated from a shaft carrying a series of cams.

Such systems of control are largely used on electric trains the control mechanisms of the several propelling vehicles being normally remote-controlled from a master controller. These systems are known in practice as "cam-shaft" systems, and the driving medium for the cam-shaft may, for example, be an auxiliary electric motor or pneumatic cylinders electrically controlled.

Heretofore it has been the practice for the cam-shaft to operate only such contactor switches as are necessary to effect the variations of current in the motor circuits and the changes of grouping of the motors, as, for example, by the insertion and withdrawal of resistance and by grouping the motors first in series and then in parallel connection. The switch or switches for reversing the motors for driving the train in the reverse direction has constituted a separate apparatus operated preferably either by electric solenoids or by electro-magnetically controlled penumatic cylinders.

The chief object of this invention is to incorporate on the cam-shaft the mechanism for reversing the main motors and to thus dispense with the said separate apparatus, which is both costly, bulky and heavy.

According to the present invention a sleeve carrying cams for actuating reversing contactors for the main motors, is slidably mounted on the cam-shaft and according to its position serves to control the main motors so that these are driven either in the forward direction or in the reverse direction. The sleeve is positively actuated by means of electro-magnets which are energized in the known manner by train wires controlled by a master controller. For this purpose one end of a pivotally mounted forked lever is connected to the cores of the electro-magnets whilst its forked end engages with a grooved collar connected to the sleeve. The sleeve is also provided with insulated contacts adapted to co-operate with stationary contacts so as to control the circuit of a pilot motor driving the cam-shaft, the arrangement being such that the pilot motor is not energized until after the sleeve has been moved to one or other of its maximum positions. As a further precaution the sleeve also carries a notched disc of which the notch co-operates with a stationary stop with which it remains in engagement until the sleeve has been moved to its maximum positions.

The invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 shows one form of construction of the apparatus.

Fig. 2 shows a diagrammatic layout of the system and

Fig. 3 shows a partial circuit diagram for the pilot motor.

Referring now to Fig. 1 the usual cams 1 for actuating the resistance and series-paralleling contactors 1^a are keyed to the shaft 2. On this shaft is slidably mounted a sleeve 3 to which are keyed cams 4, preferably four in number. The cams 4, according to the position of the sleeve 3, are adapted to operate either four contactors 5 or four contactors 6 which control the passage of current to the main motors 29 and 30 for the purpose of forward drive or for reversing them. This will be clearly understood from the diagram in Fig. 2 without further description.

The sleeve is also provided with a collar 9 which engages the forked end of a lever 7 fulcrumed at 8 in a bracket 28. The other end of the lever 7 is connected to a rod 10 secured to the cores 11 and 12 of oppositely arranged electro-magnets 13 and 14.

On the sleeve 3 are also provided insulated contacts 19 and 20 which are adapted to co-operate with stationary contact fingers connected to the lines 17, 18, 21, 22 and 23. The line 23 is connected to earth or to the negative terminal of the supply. The lines 17 and 18 are respectively connected to the electro-magnets 13 and 14 whilst the lines 21 and 22 lead to a pilot motor 24 and thence to earth or the negative terminal of the supply.

Two train wires 15 and 16, adapted to be energized from a master controller, not shown, are respectively connected to the windings of the electro-magnets 13 and 14.

The operation of the apparatus is substantially as follows:—

Assuming that the train wire 15 is energized from the master controller current will flow through the winding of electromagnet 13, line 17, the stationary finger of this line, contact 20 and line 23 to earth. The electro-magnet 13 will thus be energized and attract its core, thus drawing the upper end of the

lever 7 to the left (Fig. 1) and throwing the lower end of the lever to the right so that the sleeve 3 will be moved to bring the cams 4 opposite the contactors 6. This movement of the sleeve also causes the contact 20 to be removed from the stationary finger of line 23 and causes it to bridge the stationary fingers of lines 17 and 22, thus closing the circuit of the pilot motor 24 which will now drive the cam-shaft 2 through suitable gearing, not shown. The motors 29 and 30 will now be connected up for driving in one direction.

If now the line 15 is de-energized and the line 16 is energized a circuit will be established from line 16, through electro-magnet 14, line 18, contact 19, and line 23 to earth. The electro-magnet 14 will thus be energized and the sleeve 3 will be moved in the opposite direction so as to bring the cams 4 opposite contactors 5. At the same time the contact 19 will have been moved away from the stationary finger of line 23 and will now bridge the stationary fingers of lines 18 and 21, thus closing the circuit of the pilot motor 24 which will now drive the cam shaft 2. When the sleeve 3 is in this position the motors 29 and 30 will be driven in the opposite direction to that previously described.

In order to prevent the rotation of the cam-shaft and the sleeve 3 until the sleeve 3 has been moved into one or other of its maximum positions, also to prevent the sleeve 3 being slidably redisposed with relation to the cam-shaft except when the cam-shaft is in the off position, the sleeve 3 carries a disc 25 notched at 26, the notch co-operating with a stationary stop 27 on the bracket 28. As will be seen from Fig. 1 the sleeve 3 and cam-shaft 2 are thus prevented from being rotated until the notch 26 has been disengaged from the stop 27 which occurs when the sleeve 3 has been moved to its maximum positions. Conversely when cam-shaft 2 and sleeve 3 have been rotated from the off position sleeve 3 is prevented from being redisposed into the other or opposite position.

What I claim is:

1. In a switch for electric motors including forward contactors, reverse contactors, a cam shaft, a sleeve slidably mounted on said cam shaft, a plurality of cams on said sleeve, said last mentioned cams co-operating with the forward contactors in one position of the sleeve and with the reverse contactors in another position of the sleeve, a grooved collar on said sleeve, a bracket, a forked lever pivoted to said bracket, a pair of electromagnets and circuits therefor, a rod connecting the cores of said electromagnets, said forked lever engaging at its forked end with the grooved collar and at its other end being hinged to the rod, insulated contacts on the sleeve, stationary contacts co-operating with the insulated contacts, said stationary contacts being included in the circuits of the electromagnets, a notched disc on the sleeve, a stop on the bracket, said stop co-operating with the notched disc, and an auxiliary motor included in the circuits of the electromagnets, said auxiliary motor being adapted to drive the cam shaft.

2. An electric motor control apparatus including a rotatable shaft, cams fixed on the shaft for controlling the current variations to the motor circuit, a sleeve rotatable with and slidable on the shaft, and a plurality of cams fixed to the sleeve to permit reversal of the motors.

3. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, and means to operate the sleeve longitudinally on the shaft.

4. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, and electrically actuated means to operate the sleeve longitudinally on the shaft.

5. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, a lever for operating the sleeve longitudinally on the shaft, and electrically actuated means for controlling the lever.

6. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, a lever for operating the sleeve longitudinally on the shaft, and a pair of electromagnets adapted to be energized alternatively and connected to and operating the lever.

7. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, a grooved collar secured to the sleeve, a lever cooperating with the collar to move the same and thereby the sleeve, a pair of electromagnets to be energized alternatively, a rod operated by the energized electromagnet, and a connection between said rod and lever.

8. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, means to

operate the sleeve longitudinally on the shaft, and a mechanically interlocking device to prevent rotation of the sleeve until it has been moved to one or the other of its maximum end positions.

9. A switch for electric motors including forward and reverse contactors, comprising a cam shaft, a sleeve slidably mounted on the shaft, a plurality of cams on said sleeve adapted to cooperate alternatively with the forward and reverse contactors, means to operate the sleeve longitudinally on the shaft, a notched disk carried by the sleeve, and a stationary stop cooperating with the notch in said disk to prevent rotation of the sleeve until the sleeve has been moved to one or the other of its maximum end positions.

10. An electric motor control apparatus comprising a rotatable shaft, a series of cams fixed on the shaft, contactors adjacent the shaft to be operated by the cams, a sleeve rotatable with and slidable on the shaft, cams fixed to the sleeve, means for operating the sleeve to either of two predetermined positions, and contactors to be selectively operated by the cams according to the position of the sleeve.

11. In an electric motor control apparatus of the type comprising a series of contactors mechanically operated by cams on a rotatable shaft, a sleeve rotating with and slidable axially upon said shaft, and cams upon said sleeve adapted mechanically to operate selectively one or other of two sets of additional contactors according to whether the sleeve is disposed into one or other of two selectable positions.

12. A switch for electric motors including a cam shaft, cams thereon for controlling certain contactors, a sleeve slidable on the shaft, cams on said sleeve, means for operating the sleeve to position the cams in either one of two determinate positions, contactors to be operated by the sleeve-carried cams in either of such positions, and means for preventing cam operation by the cam shaft until the sleeve has been placed in either one or the other of said predetermined positions.

13. A switch for electric motors including a cam shaft, cams thereon for controlling certain contactors, a sleeve slidable on the shaft, cams on said sleeve, means for operating the sleeve to position the cams in either one of two determinate positions, contactors to be operated by the sleeve-carried cams in either of such positions, and means for preventing cam operation by the cam shaft until the sleeve has been placed in either one or the other of said predetermined positions, said means operating to prevent operation of the sleeve from one position to the other except in a predetermined position of the cam shaft.

In testimony whereof I affix my signature.

ALBERT H. JACKSON.