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SYSTEM OF CONTROL.

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1,360,746. Patented Nov. 30, 1920.

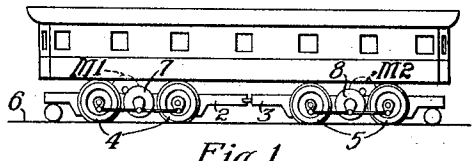


Fig. 1.

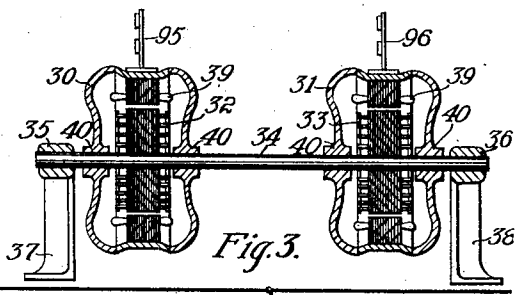


Fig. 3.

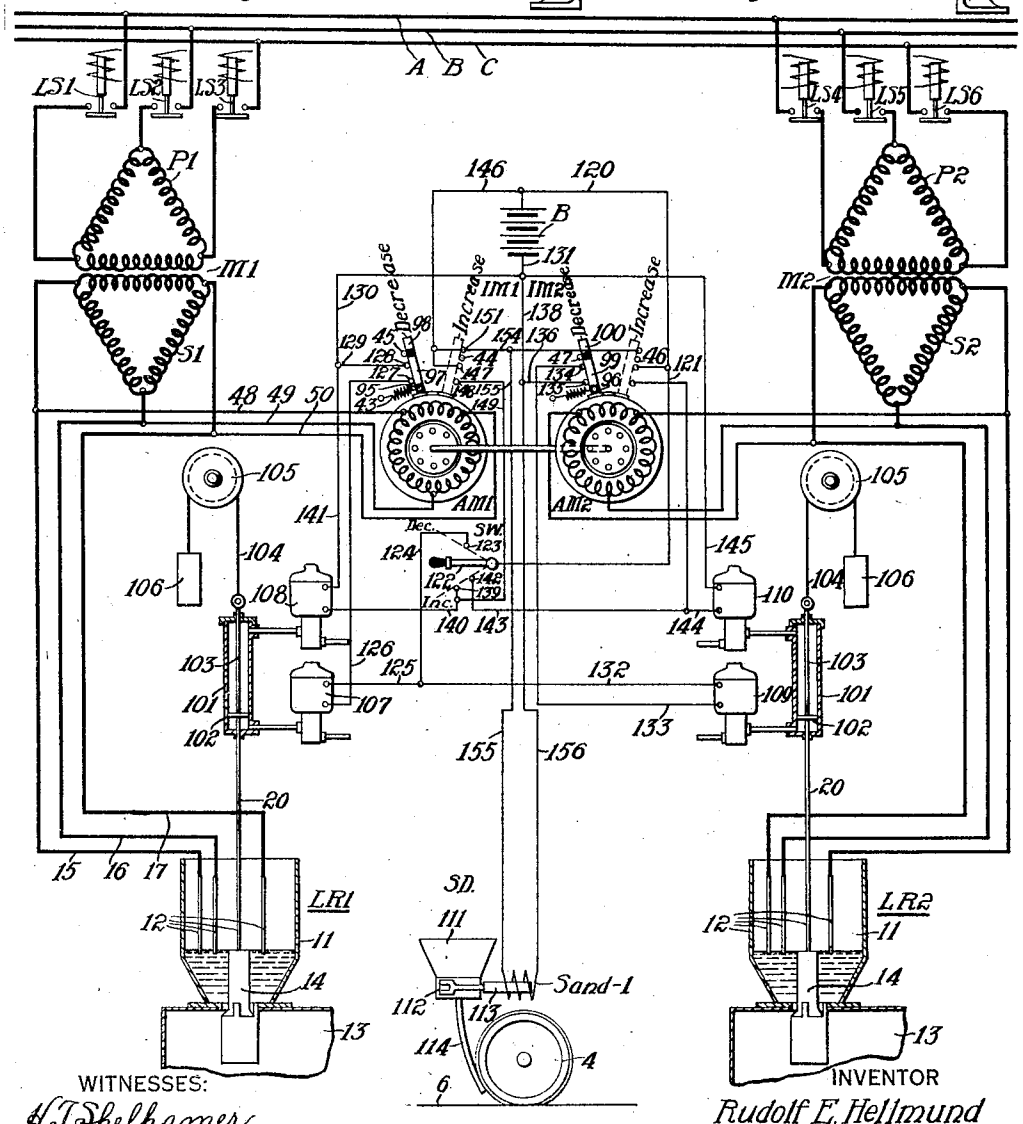


Fig. 2.

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SYSTEM OF CONTROL.

1,360,746. Specification of Letters Patent. Patented Nov. 30, 1920.

Original application filed January 5, 1916, Serial No. 70,437. Divided and this application filed March 13, 1920. Serial No. 365,397.

To all whom it may concern:

Be it known that I, RUDOLF E. HELLMUND, a citizen of the German Empire, and a resident of Swissvale, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Systems of Control, of which the following is a specification, this application being a division of my copending application, Serial No. 70,437, filed January 5, 1916.

My invention relates to electrically-propelled vehicles and to systems of control therefor and especially to vehicles that are driven by a plurality of induction motors.

One object of my invention is to provide, in connection with a system of the above-indicated character, means which shall be relatively simple and inexpensive in construction and effective and reliable in operation for automatically sanding the rails when any set of driving wheels "slips," that is, rapidly rotates without gripping the rails.

According to my present invention, I provide electrical relay means that are electrically connected with the rotors of the several driving induction motors and are adapted to counter-balance each other under normal and substantially equal-speed conditions of the motors but which are adapted to produce an unbalanced effect under predetermined unequal rotor-speed conditions, such as occur upon the slippage of one motor and the corresponding wheels, and I associate with the relay means certain switching means for automatically effecting adequate sanding of the rails to assist in restoring normal conditions.

In the accompanying drawings, Figure 1 is a diagrammatic view of an electric locomotive unit embodying a plurality of driving motors to which my invention may be applied; Fig. 2 is a diagrammatic view of the essential circuits of a system of control embodying my invention; and Fig. 3 is a diagrammatic view, showing the details of construction of a portion of the apparatus that is shown in Fig. 2.

Referring to Fig. 1, the structure shown comprises a locomotive cab 1 which is suitably supported upon a plurality of articulated trucks 2 and 3 of suitable design and which respectively embody a plurality of driving wheels 4 and 5, that are adapted to run upon rails 6, in accordance with usual practice. A plurality of driving induction motors M1 and M2 are provided and may be associated with the wheels of the various trucks in any suitable manner, as by driving mechanisms 7 and 8 of a familiar type.

Referring now to Fig. 2, the system shown comprises a plurality of suitable three-phase supply-circuit conductors A, B and C; the driving induction motors M1 and M2 that may respectively comprise delta-connected primary windings P1 and P2 and coöperating delta-connected secondary or rotor windings S1 and S2; a plurality of suitable variable accelerating resistors LR1 and LR2 for the rotor windings S1 and S2 respectively; a plurality of main-circuit switches LS1, LS2 and LS3 for connecting the primary winding P1 to the supply-circuit conductors; a plurality of similar switches LS4, LS5 and LS6 for performing a similar function with respect to the primary winding P2; a plurality of auxiliary induction motors AM1 and AM2 that are associated with the main rotor windings S1 and S2 in a manner and for a purpose to be described; an auxiliary source of energy, such as a battery B; a sanding device SD and a starting switch SW.

The variable resistors LR1 and LR2 are here shown as comprising resistors of the familiar liquid-rheostat type and severally embodying suitable electrolyte-containing tanks or chambers 11, within which are disposed a plurality of suitable immersible plates or electrodes 12, as is customary; and lower compartments 13 from which the electrolyte may be pumped into the tanks 11 and to which the electrolyte may be returned in accordance with the action of suitable regulating and discharge valves 14 that are more fully described in a Patent, No. 1,300,383, granted to Arthur J. Hall on April 15, 1919, and assigned to the Westinghouse Electric & Manufacturing Company. Inasmuch as the particular type of rheostat and the structural details thereof are immaterial to my present invention, I do not deem it necessary to describe the same any further.

The electrodes or plates 12 of the rheostat LR1 are respectively connected to the terminals of the secondary winding S1 by conductors 15, 16 and 17, and the electrodes of the other rheostat LR2 are similarly connected to the secondary winding S2.

The operating mechanism for each of the

valves 14, whereby electrolyte is admitted to the tank 11 to gradually decrease the rotor-circuit resistance or is discharged from the tank 11 to the compartment 13 to increase such resistance, comprises a suitable operating cylinder 101 within which is disposed a piston member 102 that is associated with the rod 20 of the valve 14, while a second rod 103 is secured to the opposite side of the piston 102 and is of a sufficient length to extend through one end of the cylinder 101 when the piston 102 is located at the other end thereof. The rod 103 is connected to a cord or cable 104 that passes over a pulley 105 and has a suitable counterbalancing weight 106 attached to its outer end. A pair of standard magnet valves 107 and 108 are associated with the respective ends of the cylinder 101 for admitting fluid pressure to the one or the other side of the piston 102 in accordance with the energization of the respective valve magnets. The other liquid rheostat LR2 is provided with a similar pair of operating valve magnets 109 and 110.

The electrical relay means that here comprise the auxiliary induction motors AM1 and AM2 are more clearly structurally illustrated in Fig. 3. The auxiliary induction motors respectively comprise stators 30 and 31, and squirrel-cage rotors 32 and 33 that are rigidly mounted upon a suitable shaft 34 the ends of which are carried in suitable bearings 35 and 36 that are respectively supported by pedestals or brackets 37 and 38.

The stators 30 and 31 are severally provided with suitable phase windings 39 and with bearings 40 on the shaft 34, whereby the stators may rotatively move within predetermined limits, as about to be described, under certain torque conditions.

The auxiliary induction motors AM1 and AM2 are respectively provided with switches 95 and 96 that are movable with the respective stators 30 and 31, within predetermined limits, and are provided with pairs of contact members 97 and 98 and 99 and 100, respectively, for purposes to be described. The switches 95 and 96 are respectively biased to positions marked "Decrease" by means of suitable springs 43, and in these positions the switches respectively rest against stops or pins 44 and 46 that are suitably associated with any stationary member, such as projections from the bearing brackets 37 and 38, if desired. The switching devices 95 and 96 are also severally adapted to occupy second positions marked "Increase" when the stators 30 and 31 are actuated as far as second stops or pins 45 and 47, respectively, under predetermined conditions to be described later.

The terminals of the stator winding of the auxiliary induction motor AM1 are connected to the respective terminals of the secondary winding S1 by conductors 48, 49 and 50, and the stator winding of the other auxiliary induction motor AM2 is similarly associated with the other main secondary winding S2.

The sanding device SD may comprise a suitable hopper 111, an appropriate valve member 112 that is associated with the core member 113 of the actuating coil "Sand—1," and a suitable pipe or tube 114 for conveying the sand to the rails 6 in front of the wheels 4.

Assuming that it is desired to effect acceleration of the driving motors, the switches LS1 to LS6, inclusive, may be closed in any suitable manner and the switch SW may be actuated to its upper position marked "Dec.," standing for decrease, whereby a circuit is established from one terminal of the battery B through conductors 120 and 121, the blade 122 of the switch SW, stationary contact member 123, conductors 124 and 125, actuating coil 107 of the operating mechanism of the liquid rheostat LR1, conductor 126, control fingers 127 and 128, which are bridged by contact member 97 of the switching device 95 in its normal position "Decrease," and conductors 129, 130 and 131 to the negative battery terminal. A parallel circuit is completed from conductor 125 through conductor 132, the actuating coil 109 of the operating mechanism of the rheostat LR2, conductor 133, control fingers 134 and 135, which are bridged by contact member 99 of the auxiliary switching device 96, and conductors 136 and 138 to the negative conductor 131. In this way, the operating mechanisms of the liquid rheostats are actuated to admit electrolyte to the tanks 11 and gradually decrease the rotor-circuit resistances of the driving induction motors.

To effect the discharge of the electrolyte from the tanks 11, the switch SW may be actuated to its other position marked "Inc." standing for increase, whereupon one circuit is established from the blade 122 of the switch SW, through stationary contact member 139, conductor 140, actuating coil 108 of the liquid rheostat LR1, and conductor 141 to the negative conductor 130. A simultaneous circuit is completed from the switch blade 122 through stationary contact member 142, conductors 143 and 144, actuating coil 110 of the liquid rheostat LR2 and conductor 145 to the negative conductor 131. Thus, fluid pressure is admitted above the pistons 102, the valves 14 are opened and the electrolyte is discharged from the tanks 11.

Assuming that the wheels 4 that are associated with the driving motor M1 "slip" while the switch SW occupies its position "Dec.", so that the primary current in the winding P1 is relatively low, while the speed

of the rotor winding S1 is relatively high and its frequency low, the rotor 32 of the auxiliary induction motor AM1 will tend to rotate at a lower speed that corresponds to the decreased speed of the rotating field in the stator 30. However, such decreased speed will be prevented, at least partially, by the normal action of the mechanically associated rotor 33 of the other auxiliary induction motor tending to drive the rotor 32 oversynchronously, so that a reactive or generator torque is exerted upon the stator 30, whereby the stator rotatively moves in a clockwise direction until the switching device 95 strikes the stop 44 and the switching device occupies its position "Increase."

Consequently, a circuit is completed from one terminal of the battery B through conductor 146, control fingers 147 and 148, which are bridged by the contact member 97 of the switching device 95, conductors 149 and 140 and thence through the actuating coil 108 of the liquid rheostat LR1. The other actuating coil 107 is simultaneously deenergized by reason of the disengagement of the contact member 97 from the control fingers 127 and 128. Thus, fluid pressure is admitted to the cylinder 101 above the piston 102 and is exhausted from below the piston through the valve that is associated with the magnet 107, and the resistance of the circuit of the rotor winding S1 is gradually increased until the speed of the slipping motor is reduced to normal when the normal motor torque, or such torque, assisted by the spring 43, if employed, will return the switching device 95 to the normal solid-line position.

The movement of the switching device 95 to its position "Increase" establishes another circuit at this time from the control finger 151 of the switching device 95, through conductors 154 and 155, the actuating coil "Sand—1" of the sanding device SD and conductor 156 to the negative conductor 138.

It will be understood that, under slippage conditions of the other main motor M2, the switching device 96 is automatically actuated to its dotted-line position Inc., whereupon the slippage conditions are automatically eliminated and the actuating coil "Sand—1" is also energized. If desired, of course, individual sanding devices for the various sets of wheels may be provided, and only the sanding device that corresponds to the slipping wheels may be actuated.

It will be observed that the movement of the switching device 95 first deënergizes the actuating coil 107 of the liquid rheostat LR1 and energizes the coil 108, whereby the electrolyte is discharged through the valve 14 to the compartment 13, or, in other words, the resistance in the circuit of the rotor winding SR1 is increased until the speed of the rotor S1 has decreased to normal value, when the generator torque of the auxiliary induction motor AM1 disappears and the normal motor torque, assisted by the spring 43, returns the switching device 95 to the position shown in the drawing.

It will thus be seen that I have provided simple and reliable means for automatically sanding the rails whenever a certain motor is "slipping," thus tending to rapidly restore normal conditions.

I do not wish to be restricted to the specific circuit connections or arrangement and location of parts herein set forth, as various modifications thereof may be effected within the spirit and scope of my invention. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. In an electrically-propelled vehicle, the combination with a plurality of parallel connected driving motors, of means dependent upon predetermined slippage conditions of any motor for automatically sanding the rails.

2. In an electrically-propelled vehicle, the combination with a plurality of parallel connected driving motors, of a rail-sanding apparatus, and electrical relay means associated with the several motors and dependent upon slippage conditions in any motor for automatically actuating said apparatus to sand the rails.

3. In an electrically-propelled vehicle, the combination with a plurality of driving induction motors suitably associated with the vehicle wheels, of an electrically-controlled rail-sanding apparatus, and electrical relay means associated with the respective main rotors and dependent upon frequency conditions in any motor for energizing said apparatus to sand the rails.

4. In an electrically-propelled vehicle, the combination with a plurality of driving induction motors suitably associated with the vehicle wheels, of an electrically-controlled rail-sanding apparatus, and means dependent upon relative variations in the rotor frequencies of said motors under slippage conditions of any wheels for automatically energizing said apparatus to sand the rails.

5. In an electrically-propelled vehicle, the combination with a plurality of driving induction motors suitably associated with the vehicle wheels, of an electrically-controlled rail-sanding apparatus, relay means having operating windings actuated in accordance with the frequencies of the respective rotors of said induction motors, said operating windings counterbalancing each other under substantially equal-speed conditions of said rotors and being adapted under predetermined unequal rotor-speed conditions to produce an unbalanced effect, and means dependent upon said unbalancing for automati-

cally energizing said apparatus to sand the rails.

6. In an electrically-propelled vehicle, the combination with a plurality of driving induction motors suitably associated with the vehicle wheels, of an electrically-controlled rail-sanding apparatus, a plurality of auxiliary induction motors having mechanically associated rotors and having their stators electrically connected with the respective main rotors and rotatively movable within predetermined limits, whereby movement of the one or the other auxiliary stator from a normal position occurs only under slippage conditions of the corresponding vehicle wheels and main rotor, and switching means dependent upon said auxiliary stator movement for automatically energizing said apparatus to sand the rails.

7. The combination with a vehicle-driving induction motor, of means responsive to a predetermined variation from normal rotor frequency thereof for sanding the rails.

8. The combination with a vehicle-driving induction motor, of a rail-sanding apparatus, and means electrically responsive to the rotor frequency conditions of said motor for effecting actuation of said apparatus.

9. The combination with a vehicle-driving induction motor, of a rail-sanding apparatus, and electrical frequency controlled relay means connected with the rotor of said motor for effecting actuation of said apparatus under conditions of relatively rapid rotation of said rotor.

In testimony whereof, I have hereunto subscribed my name this 20th day of February, 1920.

RUDOLF E. HELLMUND.