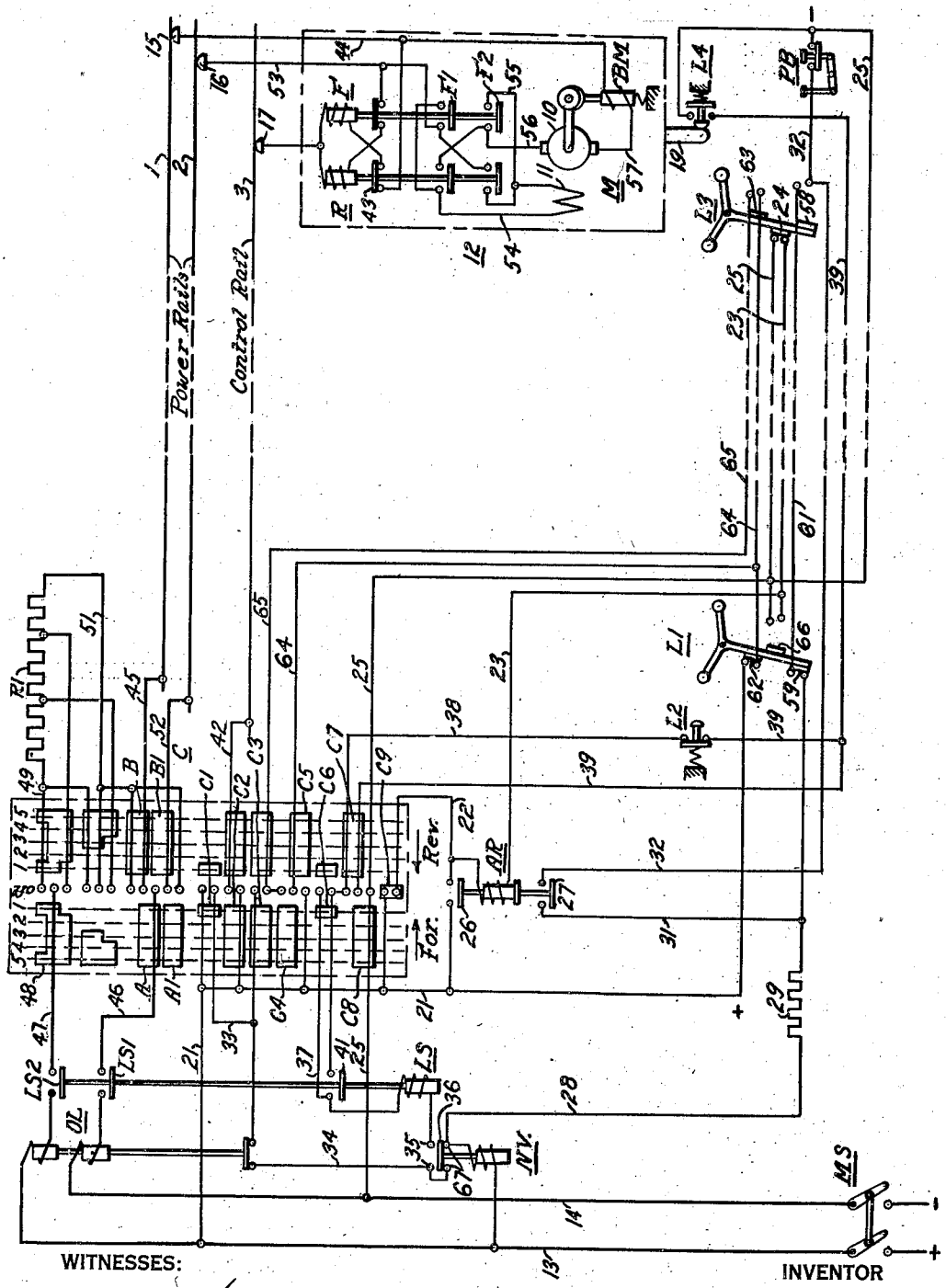
March 26, 1946. H. C. KRAPF 2,397,185

CONTROL SYSTEM

Filed July 24, 1943



Patented Mar. 26, 1946 2,397,185

UNITED STATES PATENT OFFICE

2,397,185

CONTROL SYSTEM

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Application July 24, 1943, Serial No. 495,984

2 Claims. (Cl. 104—151)

My invention relates, generally, to control systems and, more particularly, to systems for remotely controlling the operation of electrically-propelled vehicles.

It is frequently desirable to control the operation of an electrically-propelled car or locomotive from a control station or pulpit which is located remotely from the car and an object of my invention is to provide a simplified and improved system for remotely controlling the operation of such a vehicle.

A more specific object of my invention is to provide for remotely controlling the operation of an electrically-propelled vehicle by means of two power rails and a single control rail.

Another object of my invention is to provide for positively stopping the vehicle independently of the operator when approaching the limits of travel.

A further object of my invention is to provide for automatically limiting the vehicle speed when it is moving into the final stop position.

Still another object of my invention is to provide for full speed operation of the vehicle in the opposite direction of travel after it has reached the limit of travel in a former direction.

A still further object of my invention is to provide for stopping the vehicle from a station other than the main control station or pulpit.

Other objects of my invention will be explained fully hereinafter or will be apparent to those skilled in the art.

In accordance with one embodiment of my invention, the operation of an electrically propelled vehicle or car is remotely controlled from a pulpit through two power rails and a single control rail. The contactors for reversing the direction of motion are mounted on the car. Other control apparatus is mounted in the pulpit from which the car is controlled. "Final stop" limit switches are mounted at the extreme ends of the car travel and "intermediate stop" limit switches are mounted along the track at the proper positions to cut off power and stop the car before it reaches the extreme ends of its travel. The car is operated at a reduced speed from the "intermediate stop" position to the "final stop" position.

For a fuller understanding of the nature and objects of my invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawing in which the single figure is a diagrammatic view of a control system embodying my invention.

Referring to the drawing, the system shown therein comprises a motor M, having an armature winding 10 and a field winding 11, which is utilized for propelling a vehicle or car 12, the outline of which is indicated by broken lines. The motor M is provided with a spring applied magnetic brake which is released by the energization of a solenoid coil BM. The direction of operation of the vehicle is controlled by reversing contactors R and F which are mounted upon the vehicle 12 and are utilized for reversing the motor M.

Other apparatus for controlling the operation of the motor M is mounted in a pulpit which is located remotely from the vehicle 12 and includes a line switch LS for connecting power conductors 13 and 14 to a pair of power rails 1 and 2 through a controller C, an overload relay OL having actuating coils connected in the power conductors 13 and 14, a no-voltage relay NV having an actuating coil that is responsive to the voltage across the conductors 13 and 14, an auxiliary relay AR the function of which will be explained more fully hereinafter, and a main switch MS which may be utilized to connect the power conductors 13 and 14 to a suitable source of power (not shown).

As shown, current-collecting devices 15 and 16 are provided on the vehicle 12 for engaging the power rails 1 and 2, respectively. A current-collecting device 17 is also provided on the vehicle 12 for engaging a control rail 3 which is energized from the power conductors 13 and 14 through the controller C. An accelerating resistor R1 is provided for controlling the voltage applied to the motor M. The controller C is provided with a plurality of contact segments which are utilized to shunt the resistor R1 from the motor circuit step-by-step in a manner well known in the art. The operation of the reversing switches R and F is also controlled by the controller C.

In order to insure that the vehicle 12 will be brought safely to a stop at each one of the stations between which it is operated, an "intermediate stop" limit switch L1 and a "final stop" limit switch L2 are provided at one station and similar limit switches L3 and L4 are provided at the other station. As shown, the intermediate limit switches L1 and L3 are of a type which remain in the position to which they have been actuated until returned to the other position by a projection 19 provided on the vehicle 12 for actuating the limit switches. The switches L2 and L4 are normally retained in their closed positions by springs unless engaged by the projection 19 on the vehicle 12.

If desired, a push-button switch PB may be located at either one of the stations or at any other desired location. The push-button switch may be so connected in the control system that the vehicle cannot be operated while the switch is open. Thus, if the switch PB is located at the loading station it will give the loader control over the vehicle to prevent it from being moved until the loading operation is completed. The

push-button switch will also permit stopping the car from the loading station. Once the push-button switch is operated, the car cannot be moved again until the controller C is returned to the "off" position and then actuated to an accelerating position.

In order that the functioning of the foregoing apparatus may be more clearly understood, the operation of the system will now be described in detail. Assuming that the car is in the position shown at one of the stations, which is called the loading station, and that it is desired to move the car to the other station, which is called the unloading station, the main switch MS is closed to energize the conductors 13 and 14.

It should be noted that, regardless of the position of the controller C, the car will not move at this time, as the no-voltage relay NV can be energized only with the controller handle in the "off" position. If the power should fail while the car is running, it will stop and it cannot be started again until power returns and the controller handle is returned to the "off" position where the no-voltage relay is again energized.

Upon the closure of the main switch MS with the controller C in the "off" position the actuating coil of the auxiliary relay AR is energized through a circuit which may be traced from the positive conductor 13 through conductor 21, a contact segment C9 on the controller C, conductor 22, the actuating coil of the relay AR, conductor 23, contact member 24 on the limit switch L3 and conductor 25 to the negative conductor 14. A holding circuit for the relay AR is established through its contact members 26 which are closed to bridge the contact members C9 on the controller upon the operation of the relay AR. The operation of the relay AR also closes its contact members 27, thereby establishing an energizing circuit for the actuating coil of the no-voltage relay NV which extends from the positive conductor 13 through the coil of the relay NV, conductor 28, a resistor 29, conductor 31, the contact members 27 of the relay AR, conductor 32, the push-button switch PB and conductor 25 to the negative conductor 14.

When the controller C is actuated in a "forward" direction to the first position, an energizing circuit is established for the actuating coil of the switch LS. This circuit may be traced from the previously energized conductor 21 through a contact segment C1 on the controller C, conductor 33, the contact members of the overload relay OL, conductor 34, contact members 35 of the no-voltage relay NV which are bridged by the contact member 36, the actuating coil of the line switch LS, conductor 37, contact segment C6 on the controller C, conductor 38, the limit switch L2, conductor 39 and the controller segment C8 to the negative conductor 25.

A holding circuit for the switch LS is established through an interlock 41 which is closed to bridge the controller contacts C6 upon the operation of the switch LS. At this time the control rail 3 is also energized through a circuit which extends from the positive conductor 21 through the controller segment C2 and conductor 42 to the control rail 3.

The operation of the controller C to the first position also establishes an energizing circuit for the actuating coil of the reversing switch F. This circuit may be traced from the previously energized control rail 3 through the actuating coil of the switch F, an interlock 43 on the switch R, conductor 44, the current-collecting device 15, the power rail 1, conductor 45, a segment A on the controller C, conductor 46, the contact members LS1 on the switch LS and one of the coils of the overload relay OL to the negative conductor 14.

Upon the operation of the reversing switch F, the motor M is energized through a circuit which may be traced from the positive conductor 13 through one of the coils of the overload relay OL, contact members LS2 of the switch LS, conductor 47, a contact segment 48 on the controller C, conductor 49, the resistor R1, conductor 51, a segment A1 on the controller C, conductor 52, the power rail 2, the current-collecting device 16, conductor 53, contact members F1 on the reversing switch F, conductor 54, the field winding 11, conductor 55, contact members F2 on the switch F, conductor 56, the armature winding 10, conductor 57, the coil of the brake magnet BM, conductor 44, the current-collecting device 15, the power rail 1, conductor 45, the controller segment A, conductor 46, and thence through the contact members LS1 and the coil of the overload relay OL to the negative conductor 14.

As soon as the line switch LS and the reversing switch F are closed, current flows in the motor circuit, thereby releasing the magnetic brake BM and developing torque in the motor to move the car. As the controller C is actuated notch-by-notch to the fifth position the accelerating resistor R1 is shunted from the motor circuit step-by-step in a manner well known in the art.

When the car passes the limit switch L3 this switch is actuated to the other position from that shown in the drawing, thereby opening the circuit through the contact member 24 on the switch L3 and deenergizing the auxiliary relay AR. However, as shown, the relay AR is of a retarded type and the contact members 27 of this relay, which are in the circuit for the coil of the relay NV, do not open for a predetermined time interval after the deenergization of the coil of the relay AR. In the meantime, contact members 58 of the limit switch L3 have been closed, thereby establishing a circuit for the coil of the relay NV through contact members 59 of the limit switch L1 and conductor 61. In this manner the no-voltage relay NV is kept energized and the circuit for the actuating coil of the switch LS is maintained.

As the car passes the "intermediate stop" limit switch L1, the switch is actuated to the other position from that shown in the drawing and the contact members 59 of the limit switch are opened, thereby deenergizing the relay NV. Also the circuit established through the contact members 62 on the switch L1 and contact members 63 on the switch L3 is opened. As shown, this circuit extends from conductor 21 through the contact members 62 of the switch L1, conductor 64, contact members 63 of the switch L3, conductor 65 and the controller segment C3 to the conductor 33 and thence to the actuating coil of the switch LS through the circuit previously traced.

Prior to the closing of the contact members 63 on the switch L3, the circuit for the coil of the switch LS was maintained through a controller segment C4 which bridges the contact members 63. Likewise, the controller segment C5 bridges the contact members 62 on the limit switch L1 to permit acceleration of the car in the reverse direction. In this manner the circuit is maintained for the actuating coil of the switch LS when the controller is actuated from position 1 to position 5, thereby permitting the motor to be accelerated in the manner previously described. The contact members 66 on the switch L1 are closed when the

car passes this switch in a direction toward the unloading station.

As explained hereinbefore, the opening of the normally closed contact members on the limit switch L1 deenergizes the no-voltage relay NV and the line switch LS. Accordingly, power is removed from the motor M and the magnetic brake BM is set to stop the car. The car cannot be moved further in the same direction until the controller is actuated to the "off" position when the actuating coil of the relay AR is energized in the manner hereinbefore described. The relay AR closes its contact members 27 to re-establish an energizing circuit for the relay NV, as hereinbefore explained, thereby causing the relay NV to close its contact members to establish the energizing circuit for the actuating coil of the line switch LS and reconnect the motor M to the power source.

The controller C may now be actuated in the forward direction to the first position and the car will move at a speed corresponding to this position toward the unloading station. However, if the controller is moved past the first position, power is cut off the motor and the car stopped, since, as explained hereinbefore, the holding circuit for the switch LS through the limit switches L1 and L3 was interrupted when the car passed the switch L1. In this manner the car is moved slowly to the unloading station. When the unloading station is reached, the "final stop" limit switch L2 is actuated to open the circuit for the actuating coil of the switch LS. The car cannot be operated further in this direction.

After the car is unloaded, the controller C is actuated to the first position in the "reverse" direction and the car is moved toward the loading station in a manner similar to that described for movement from the loading to the unloading station. The interlocking is such that the car can be accelerated to full speed in this direction independently of the position of the limit switches at the unloading station. As the loading station is approached, the "intermediate stop" limit switch L3 causes the car to stop in the same manner as at the unloading station and further operation is the same as when the car approached the unloading station. The limit switch L4 brings the car to a final stop at the loading station and it cannot be operated further in that direction. When the direction of operation is changed, the limit switches are returned to their normal position, thereby setting up the protective circuits which require the slow operation of the car to the "final stop."

As explained hereinbefore, the push-button switch PB may be utilized to prevent the car from being moved from the loading station until the loading operation is completed. The push-button switch will also permit stopping the car at any time during its operation. Once the push-button switch is operated the car cannot be moved again until the controller C is returned to the "off" position and again actuated to one of the accelerating positions. The opening of the push-button switch PB deenergizes the coil for the relay NV, thereby causing the contact member 36 of this relay to bridge contact members 67 which establishes a shunt circuit around the actuating coil of the relay NV and prevents the energization of this coil until the controller C has been moved to the "off" position to interrupt the shunt circuit around the actuating coil of the relay NV. When the controller is moved to the "off" position the relays AR and NV are energized in a manner hereinbefore explained and the motor may be accelerated in the usual manner.

From the foregoing description it is apparent that I have provided a control system which makes it possible to control remotely the operation of an electrically-propelled vehicle or car by means of two power rails and one control rail. The car is brought to a positive stop independently of the operator prior to its movement to its final position at either one of the stations at the end of its travel. The car cannot again be started until the controller is returned to the "off" position and the car is limited to slow speed operation into the final stop position. When the final limit is reached the car cannot be operated further in the same direction. Full speed operation is permitted in the opposite direction of travel after the limits in the former direction have been reached. The car can be stopped at will from a station located remotely from the main control pulpit but can be started only by the operator who is located in the main control pulpit. The car can be held in any location within the limits of its travel independently of the operator. Therefore, it is evident that the present system has numerous advantages over systems previously known in the art.

Since numerous changes may be made in the above described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a control system, in combination, a motor for propelling a vehicle between predetermined stations, means on the vehicle for reversing the motor, a manually operable controller located remotely from the vehicle for controlling the operation of said reversing means and the voltage applied to the motor, switching means actuated by the vehicle for stopping the vehicle prior to its arrival at one of said stations and control means cooperating with said controller and said switching means to prevent the application of full voltage to the motor while the vehicle is moving in the same direction that it was prior to the operation of said switching means.

2. In a control system, in combination, a motor for propelling a vehicle between predetermined stations, means on the vehicle for reversing the motor, a manually operable controller located remotely from the vehicle for controlling the operation of said reversing means and the voltage applied to the motor, switching means actuated by the vehicle for stopping the vehicle prior to its arrival at one of said stations and control means cooperating with said controller and said switching means to prevent the application of full voltage to the motor during movement of the vehicle to said station after the operation of said switching means.

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