G. BRIGHT, G. H. F. HOLY AND H. K. HARDCASTLE.

CONTROL SYSTEM.

APPLICATION FILED NOV. 12, 1915.

1,347,890. Patented July 27, 1920.

2 SHEETS—SHEET 1.

Fig. 1.

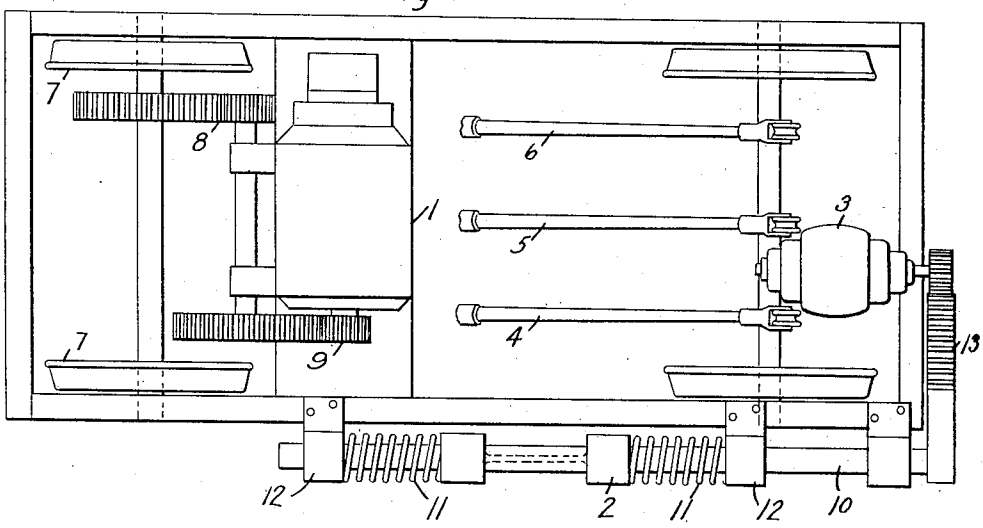
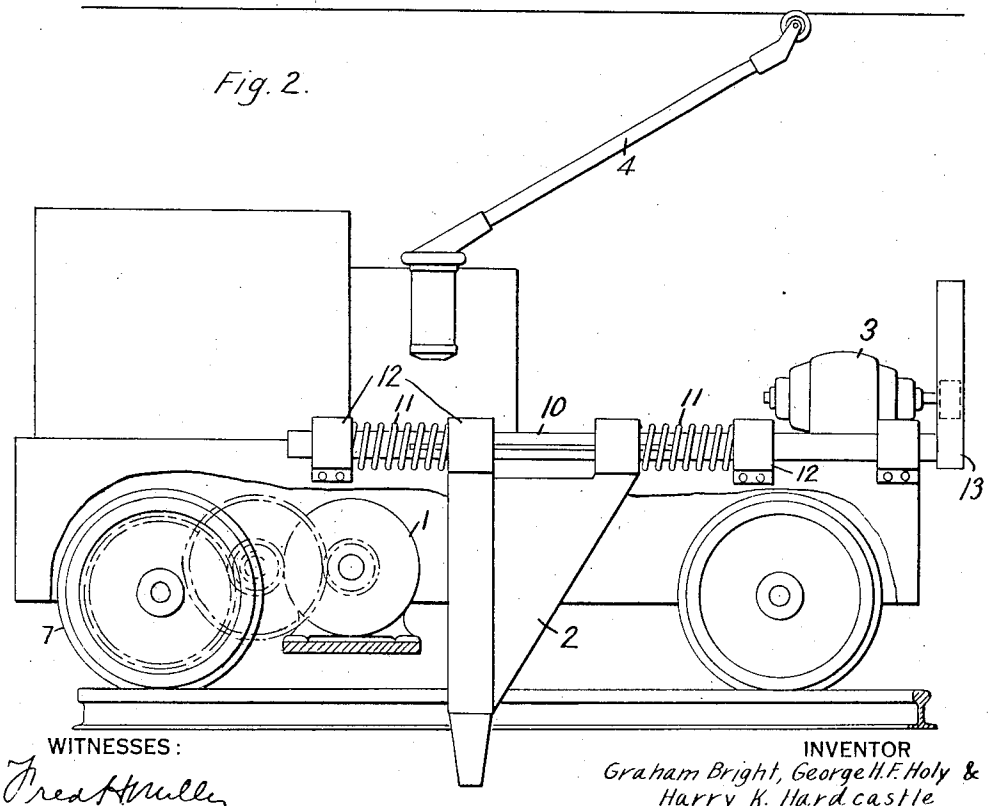


Fig. 2.



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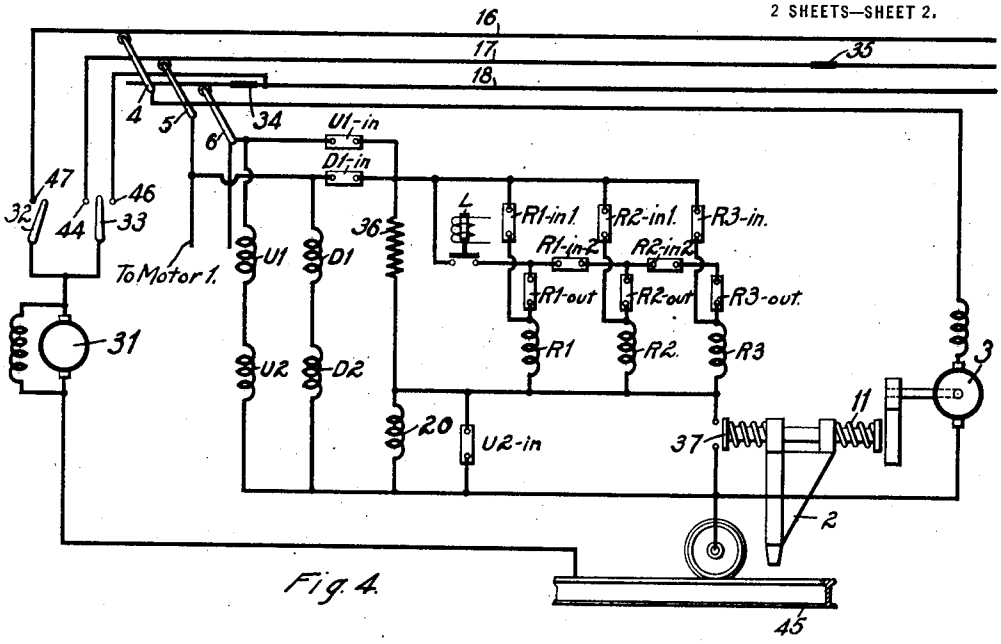


Fig. 4.

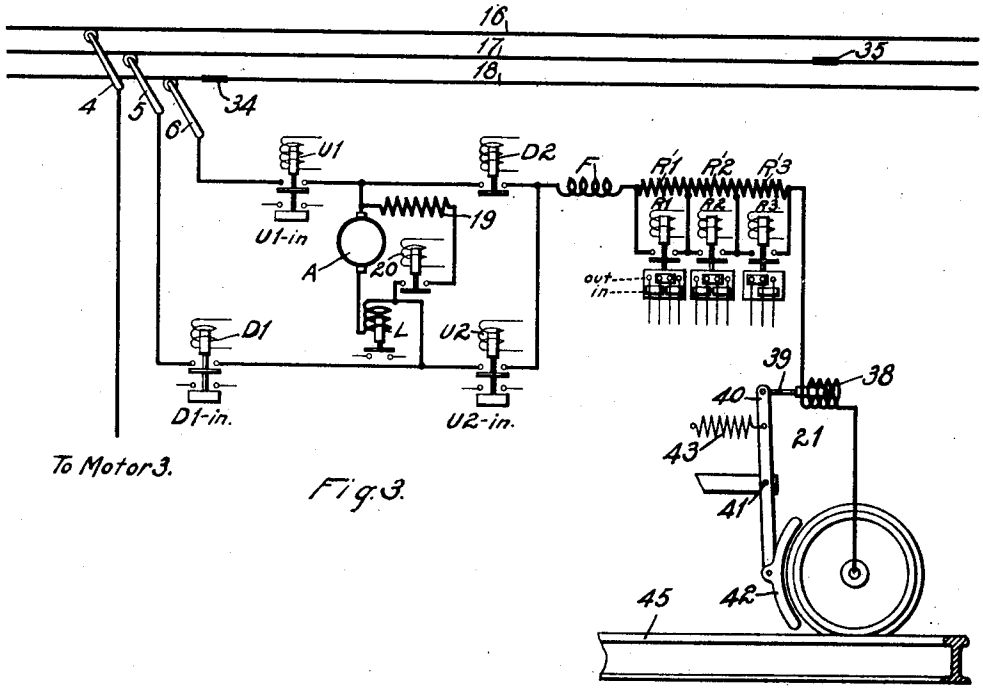


Fig. 3.

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GRAHAM BRIGHT, OF WILKINSBURG, GEORGE H. F. HOLY, OF PITTSBURGH, AND HARRY K. HARDCASTLE, OF WILKINSBURG, PENNSYLVANIA, ASSIGNORS TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

CONTROL SYSTEM.

1,347,890. Specification of Letters Patent. Patented July 27, 1920.

Application filed November 12, 1915. Serial No. 61,056.

To all whom it may concern:

Be it known that we, GRAHAM BRIGHT, a citizen of the United States, and a resident of Wilkinsburg, and GEORGE H. F. HOLY, a citizen of the United States, and a resident of Pittsburgh, and HARRY K. HARDCASTLE, a citizen of the United States, and a resident of Wilkinsburg, respectively, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Control Systems, of which the following is a specification.

Our invention relates to control systems for poling locomotives and more specifically to the remote control of locomotives of this class.

One object of our invention is to provide a system by means of which the operator may fully control the operation of a locomotive from a remote point.

Another object of our invention is to provide a system through the agency of which a locomotive may be automatically accelerated and be prevented from developing full torque in one direction of operation until the load has been applied, and to provide means by which the operation of the poling arm, which is attached to the side of the locomotive and used for pushing cars along adjacent tracks, may be controlled from a point remote from the locomotive.

A further object of our invention is to make provision for automatically stopping the locomotive when either end of the track is reached and for preventing its being started again except in a reverse direction.

In the prior art, locomotives employing poling arms attached to the sides thereof, whereby a locomotive on one track may be used to shift or push cars on an adjacent track, have been employed. In such cases, however, the presence of an operator is required upon the locomotive for the purpose of governing its operations.

According to our present invention, however, the operation of a locomotive and its poling arm may be controlled by an operator located at a point remote from the locomotive.

Our invention is illustrated in the accompanying drawings, in which Figure 1 is a plan view, and Fig. 2 is a view, in side elevation, of a locomotive that is adapted to be controlled in accordance with our invention; Fig. 3 is a diagrammatic view of the main-circuit connections of a system of control embodying our invention, and Fig. 4 is a diagrammatic view of the auxiliary control circuits therefor.

Referring to Figs. 1 and 2, the locomotive shown is provided with a driving motor 1, a poling arm 2, an auxiliary motor 3 and three trolley poles 4, 5 and 6.

The driving motor 1 operates driving wheels 7 by means of two sets of gear wheels 8 and 9 and is furnished with power by the trolley poles 5 and 6.

The poling arm 2 is mounted on a shaft 10 and has a key-and-slot connection therewith which allows the arm to slide along the shaft but insuring rotative movement therewith. The arm 2 is normally held in a central position on the shaft 10 by springs 11 which are disposed on opposite sides thereof and are adapted to take up the shock when a load is applied to the arm. The shaft 10 is mounted in a set of bearings 12 and is connected to the auxiliary motor 3 by a set of gear wheels 13. The motor 3 is supplied with power through the trolley pole 4. The arm 2 may be positioned by a spring (not shown) in opposition to the motor 3 when the arm is raised to a horizontal position, or a counter-balanced weight (not shown) may be used to minimize the torque required to raise the arm 2 and to return it to a vertical position when the supply of energy to the motor is interrupted.

Referring to Fig. 3 of the drawings, the system shown embodies trolley conductors 16, 17 and 18, a motor 1 having an armature A and a field-magnet winding F, unit switches U1, U2, D1 and D2 for controlling the direction of current from the conductors 17 and 18 through the armature A, an armature-short-circuiting resistor 19 and a governing switch 20 therefor, unit switches R1, R2 and R3 for governing accelerating resistors R′1, R′2 and R′3, a limit switch L for automatically controlling the progressive operation of said switches R1, R2 and R3, and an electric brake 21.

Referring to Fig. 4, an electric generator 31, or other suitable source of energy, is adapted to supply energy to the trolley conductors 16, 17 and 18 in accordance with

the manipulation of selective switches 32 and 33, and section insulators 34 and 35 are interposed near the opposite ends of the respective trolley conductors 17 and 18, whereby the extremities thereof are always dead. Thus, when the locomotive operates in either direction beyond one of the section insulators referred to, the supply of energy from the trolley conductor in which the insulator is disposed, is cut off, thereby preventing further operation in that particular direction.

When the switch 32 is closed, the trolley conductor 16 is energized and supplies energy to the auxiliary motor 3 for the purpose of raising the poling arm 2. The operation of the several unit switches is dependent upon the particular trolley conductor that is receiving energy from the generator 31. When trolley conductor 17 is energized, the operating coils of the unit switches D1 and D2 are energized to connect the driving motor 1 for one direction of operation, while the other direction of rotation is effected when the operating coils of the unit switches U1 and U2 are energized from the trolley conductor 18.

The energy for the operating coils of the resistor switches R1, R2 and R3 is received from the one or the other of the trolley conductors 17 and 18, and, for the purpose of maintaining a definite voltage across these coils, a control resistor 36 is employed. The closure of the unit switches R1, R2 and R3 is effected progressively and automatically through the action of the limit switch L in conjunction with certain of the interlocked switches, as is customary in the art.

In one direction of operation, when the unit switch U2 is closed, the operating coil of the short-circuiting switch 20 is short-circuited and, therefore, said switch is maintained in its open position to permit the development of full torque by the driving motor 1. In the other direction of operation, the operating coil of the short-circuiting switch 20 is normally energized to effect its closure, whereby the short-circuiting resistor 19 is connected in multiple relation to the armature A of the driving motor. Thus, the operating characteristics of the motor 1 are modified, and it is prevented from developing its full-load torque until an auxiliary switch 37, which is associated with, and actuated by, the poling arm 2 when a load is applied thereto, is closed to short-circuit the operating coil of the switch 20. Switch 20, therefore, is deënergized and opened to interrupt the shunt circuit through the short-circuiting resistor 19, whereby the normal characteristics of the motor 1 are restored and full torque may be developed.

Having set forth, in a general way, some of the essential operating features of our invention, we shall now describe the operation in detail.

The motor 1 is of the series type and, under operating conditions, its armature A and field-magnet winding F are connected in series-circuit relation with the accelerating resistors R′1, R′2 and R′3 and the operating coil of the electromagnetic brake 21.

The several unit switches U1, U2, D1, D2, R1, R2, R3 and 21 are preferably electrically operated and may be of any suitable construction. Certain of these switches embody auxiliary interlock switches which serve, in conjunction with other apparatus, for prescribing the sequence of operation of some of said switches. The interlock switches will be designated hereinafter by the reference characters which are applied to the unit switches with which they are associated, followed by "in" or "out," which signifies the position of the unit switch in which its interlock switch is closed. For example, interlock U1—in indicates that the interlock switch of the unit switch U1 is closed in the "in" position of the switch U1.

The electrically operated brake 21 comprises an electromagnet 38 connected by a link 39 to one end of a lever 40 that is pivoted at 41 intermediate its ends. The lower end of the pivoted lever 40 is connected to a brake shoe 42, and a spring 43 is associated with said lever and is normally adapted to apply the brake when the electromagnet 38 is deënergized.

Assuming the circuit connections and apparatus to be as shown in the drawings, the operation of the system is as follows: If it is desired to raise the arm 2, the switch 32 is closed to complete a circuit from the generator 31 which includes the conductor 16, trolley pole 4, motor 3, and return-circuit conductor or rail 45 to the generator 31. The motor 3 is supplied with energy and is operated to raise the arm 2 from a vertical to a horizontal position, so that cars on a track adjacent to the locomotive may be moved by it.

In order to operate the locomotive in a direction to the right, as shown upon the drawing, switch 33 is moved to the left to engage contact terminal 44 and close a circuit including power conductor 17, trolley pole 5 and the operating coils of unit switches D1 and D2 to the return conductor 45. Unit switches D1 and D2 then operate to close a main motor circuit from power conductor 17, which includes trolley pole 5, unit switch D1, the energizing coil of limit switch L, armature A of the motor 1, unit switch D2, field-magnet windings F, resistors R′1, R′2 and R′3, and brake magnet 38 to the ground-return conductor 45. Thus, driving motor 1 is operated to propel the locomotive in the desired direction, the coil of the limit switch L being energized to raise

said limit switch, and the brake magnet 38 being energized to release the brake 21.

When the current passing through the armature A is reduced to a certain amount, the limit switch L will drop to close a circuit from the power conductor 17, which includes interlock switch D1—in, which is closed when the unit switch D1 is operated, limit switch L, interlock R1—out, operating coil of the resistor switch R1, and the operating coil of the short-circuiting switch 20 to the ground-return circuit 45. The unit switch R1 is thereby energized and operated to shunt the resistor R'1 from the circuit of the motor 1, causing the motor to increase its speed under increased current.

As soon as the switch R1 is closed, its interlock R1—out is opened and its interlock R1—in—1 is closed concurrently to establish a holding circuit through its operating coil, while its interlock R1—in—2 is closed to prepare a circuit for the operating coil of the unit switch R2.

Upon the completion of the circuit just traced, the short-circuiting switch 20 is simultaneously energized and closed to connect the short-circuiting resistor 19 around the armature A of the motor 1 and prevent the locomotive developing full torque until a load is applied to the poling arm 2 to close the switch 37. The switch 37, when operated, closes the shunt circuit around the operating coil of unit switch 20 and renders the same inoperative. Thus, said switch is deënergized and is permitted to open and to remove the short-circuiting resistor 19 from the circuit, after which the load may be operated under full-torque conditions of the locomotive. Upon the exclusion of the resistor R'1, the increased motor current traversing the energizing coil of the limit switch L, causes it to be raised to prevent the closure of the resistor switch R2 until the motor current has fallen to a predetermined value. As the motor 1 accelerates, the amount of current flowing through the energizing coil of the limit switch L is decreased, thus permitting the limit switch L to be closed to complete an energizing circuit through the operating coil of the unit switch R2.

The resistor switches R2 and R3 are thus automatically operated in sequence to exclude the resistors R'2 and R'3 in a manner similar to that described in connection with the switch R1, which will be readily understood by those skilled in the art without further description.

If the switch 33 is kept closed, the locomotive will continue in the direction considered until the trolley pole 5 passes over the section insulator 35 which breaks the power circuit for the motor 1 and all switches, thus applying the brake 21 and stopping the locomotive.

The locomotive, being at the right hand end of the track, as shown in the drawings, may be operated in a reverse direction by moving switch 33 into contact with the contact terminal 46, thereby closing a circuit from the generator 31 including switch 33, power conductor 18, trolley pole 6, operating coils of the unit switches U1 and U2 and the return conductor 45 to the generator 31. The unit switches U1 and U2 are operated to close a main motor circuit from the power conductor 18, which includes unit switch U1, armature A, coil of limit switch L, unitl switch U2, field-magnet winding F, resistors R'1, R'2 and R'3, and brake magnet 38 to ground 45. In this circuit, the current flows through the armature A in a reverse direction to which the current flowed when the circuit was closed by the unit switches D1 and D2. Therefore, the motor 1 operates in a reverse direction.

The interlock switch U1—in, the limit switch L, and the resistor interlock switches coöperate to cause the resistor switches R1, R2 and R3 to close the shunt circuits around the resistors R'1, R'2 and R'3 in a predetermined sequence similar to that described in connection with the operation of the locomotive in the opposite direction.

However, in operating the locomotive in the direction last considered, interlock switch U2—in is closed to complete a shunt circuit around the coil of unit switch 20 so that said switch 20 is prevented from closing the shunt circuit around the armature A. Thus, the locomotive is allowed to develop its full torque at once, when operating in this direction.

At the end of the travel of the locomotive in the direction under consideration, the trolley pole 6 passes over the section insulator 34 which opens the circuit of the motor 1 and all the unit switches, thus deënergizing the brake 21 and stopping the locomotive.

Various modifications in the circuit connections and improvements of the operation may be effected without departing from the scope and spirit of our invention, and we desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

We claim as our invention:

1. In a control system, the combination with an electric locomotive, and a plurality of extraneous supply-circuit conductors two of which respectively correspond to forward and reverse operation, of means controlled at a distance from the locomotive for operating the same through the medium of said conductors, and means dependent upon the position of the locomotive relative to the respective conductors for automatically stopping the locomotive.

2. In a control system, the combination with an electric locomotive, a source of en-

ergy and a plurality of extraneous supply-circuit conductors one of which is connected to one terminal of said source, of means controlled at a distance from the locomotive and including a selective connection of one or the other conductors to the remaining terminal of said source for operating the locomotive in the one or the other direction, said other conductors having oppositely-located dead end-sections to automatically stop the locomotive and to prevent the restarting of it except in the reverse direction.

3. In a control system, the combination with an electric locomotive having a poling arm, of means controllable at a point remote from the locomotive for governing the operation of the poling arm and the locomotive.

4. In a control system, the combination with an electric locomotive, of a movable poling arm and means for electrically operating said poling arm.

5. In a control system, the combination with an electric locomotive having a poling arm, of means controlled at a distance from the locomotive for operating the poling arm.

6. In a control system, the combination with an electric locomotive having a poling arm, of means controlled at a distance from the locomotive for operating the poling arm and means controlled at a distance for operating the locomotive.

7. In a control system, the combination with an electric locomotive having a poling arm, of means controlled at a distance from the locomotive for operating the poling arm, means controlled at a distance from the locomotive for operating the locomotive and means for automatically stopping the locomotive at a predetermined point and for preventing the starting of it except in a reverse direction.

8. In a control system, the combination with an electric locomotive having a poling arm and electrically operated brakes, of means controlled at a distance from the locomotive for operating the poling arm, means controlled at a distance for operating the locomotive and means for automatically applying the brakes when the source of power is interrupted.

9. In a control system, the combination with an electric locomotive having a poling arm, of means controlled at a distance from the locomotive for operating the poling arm, means controlled at a distance from the locomotive for operating the same, and means for preventing the development of the full driving effort of the locomotive until a load is applied to the poling arm.

10. In a control system, the combination with an electric locomotive having a poling arm, of means for operating the poling arm, means for operating the locomotive, and means for preventing the operation of the locomotive at full torque until a load is applied thereto.

11. In a control system, the combination with an electric locomotive and a driving motor therefor, of means for controlling the operation of said motor, means for normally shunting the armature of the motor, and means for opening the shunt circuit when a load is applied to the locomotive.

12. In a control system, the combination with an electric locomotive having a poling arm and a driving motor for said locomotive, of means associated with the locomotive for effecting its operation in either direction, means for operating the poling arm, a plurality of trolley conductors for supplying energy to said driving motor, a trolley conductor for supplying energy to the operating means of said poling arm and selective means for determining the trolley conductor to be utilized.

In testimony whereof we have hereunto subscribed our names this 26th day of Oct., 1915.

GRAHAM BRIGHT.
GEORGE H. F. HOLY.
HARRY K. HARDCASTLE.