BEST AVAILABLE COPY

Feb. 13, 1923. 1,444,947.

A. H. CANDEE.

CONTROL APPARATUS.

ORIGINAL FILED OCT. 30, 1918.

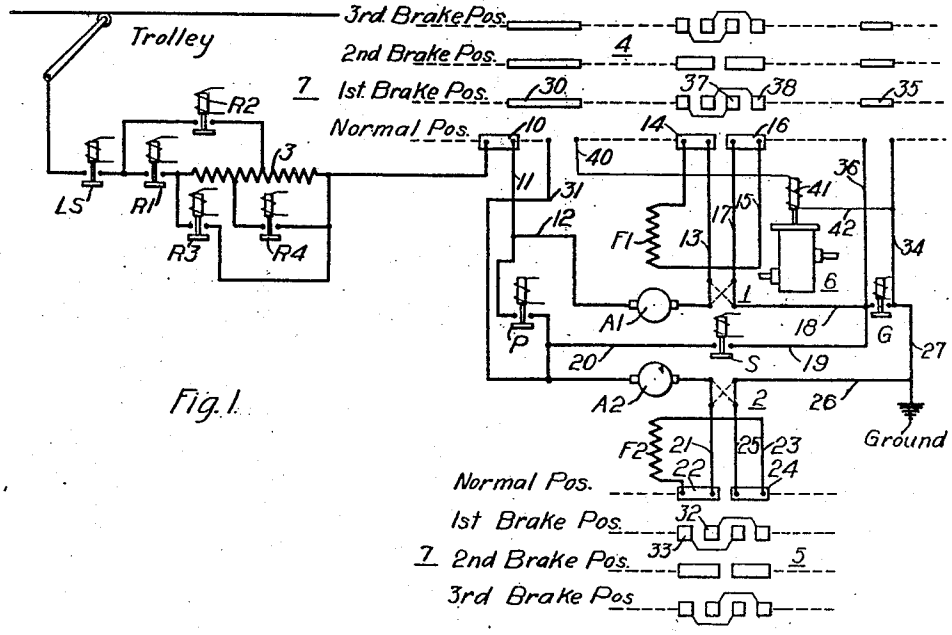


Fig. 1.

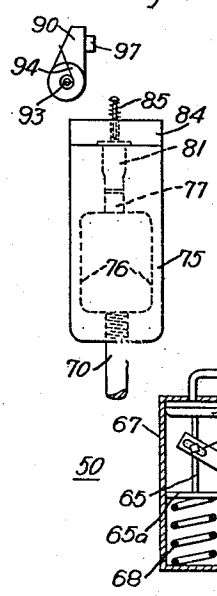


Fig. 3.

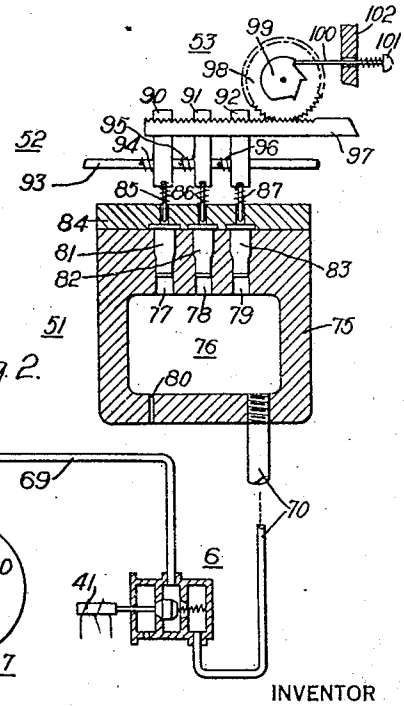


Fig. 2.

WITNESSES:

H. B. Funk.

W. R. Coley

INVENTOR

Andrew H. Candee.

BY

Wesley G. Carr

ATTORNEY

Patented Feb. 13, 1923.

BEST AVAILABLE COPY

1,444,947

UNITED STATES PATENT OFFICE.

ANDREW H. CANDEE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

CONTROL APPARATUS.

Application filed October 30, 1918, Serial No. 260,308. Renewed August 8, 1922. Serial No. 580,586.

To all whom it may concern:

Be it known that I, ANDREW H. CANDEE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Control Apparatus, of which the following is a specification.

My invention relates to control apparatus and particularly to emergency braking means for use in connection with electric railway vehicles and the like.

In the interests of safety, various schemes have been proposed in the past to provide emergency braking means for railway vehicles in case the usual source of power failed for any reason. For instance, various emergency braking systems, dependent upon air pressure, have been offered in order to allow the necessary braking effect in the event of a failure of supply-circuit voltage. However, so far as I am aware, no system has ever been proposed for providing an ultimate and practically infallible emergency braking system in cases where supply-circuit voltage and air pressure both fail.

One object of my present invention is to provide such an ultimate emergency braking system, whereby the train operator may readily and reliably brake the vehicle both when it is traveling in a forward direction and when it starts rolling backward.

More specifically stated, it is one object of my invention to provide means for braking railway motors, without employing the regular circuit-reversers or the customarily employed auxiliary control apparatus, by utilizing a controllable explosive action.

Another object of my invention is to provide auxiliary control apparatus associated with an auxiliary switching device for independently firing a series of cartridges to manipulate the switching device to successive braking positions, to retard the vehicle movement in either direction.

A further object of my invention is to provide, in connection with an emergency braking system of the character just indicated, a valve dependent upon the building-up of the machine voltages for preventing the successive movements of the braking device even though another cartridge is fired.

My invention may best be understood by reference to the accompanying drawing, wherein Fig. 1 is a diagrammatic view of the main circuits of a system of control to which the present invention may be applied; Fig. 2 is a view, partially in section and partially in elevation, of an apparatus constructed to carry out my invention in connection with a switching device, the circuits of which are illustrated in Fig. 1; and Fig. 3 is a view, in side elevation, of a portion of the apparatus that is illustrated in Fig. 2.

Referring to Fig. 1 of the drawing, the system shown comprises suitable supply-circuit conductors Trolley and Ground; a plurality of dynamo-electric machines respectively having commutator-type armatures A1 and A2 and field windings F1 and F2 of the familiar series type, these machines being employed for the usual purpose of propelling a railway vehicle; reversing switches 1 and 2, preferably of a familiar electrically-controlled type, which may be mounted upon a single drum member, for reversing the electrical relations of the armatures and field windings under normal conditions; an accelerating resistor 3; a plurality of circuit-adjusting switches LS, R1, R2, R3, R4, S, P and G; an auxiliary switching device or braking drum 7, divided into two contact-carrying portions 4 and 5, which is shown as having a normal position and three brake positions; and an electrically-controlled valve member 6 for a purpose to be described.

It should be understood that the application of my invention is not restricted to the particular control system herein illustrated, but may readily be employed in connection with various other types of control systems, the chief requisite being that either two motors or a single motor and a suitable braking circuit are employed under emergency conditions for providing a dynamic-braking effect.

The auxiliary switching device 7, having sections 4 and 5 that are associated with the respective motors, preferably comprises a single drum member of a familiar type and, under normal running conditions, occupies the illustrated position designated as "Normal Position" for permitting the customary electrical connections and circuit adjustments that are employed in connection with the familiar series-parallel control of railway motors. However, when the switching

BEST AVAILABLE COPY

device is moved to its "First Brake" position, three circuit changes are effected, namely, the machines are disconnected from the supply circuit and are then connected in parallel relation, with the field windings reversed, thereby causing the machines to provide the familiar dynamic-braking effect. Movement to the "Second Brake" position is employed to again reverse the field windings and thus provide the desired braking action in case the vehicle attempts to roll backwardly, as more fully hereinafter described.

Inasmuch as the particular auxiliary control system that is to be employed in connection with the illustrated main circuits may be readily devised by those skilled in the art, I have not deemed it necessary to show such a system, and only sufficient description of the main control system will be given to render clear the operation of my present invention and the application thereof to a familiar type of series-parallel railway-motor control.

Assuming that it is desired to effect acceleration of the illustrated motors, the switches LS, R1 and S are initially closed to establish a circuit from the Trolley through switches LS and R1, the entire accelerating resistor 3, contact segment 10 of the auxiliary switching-device section 4 in its normal position, conductors 11 and 12, armature A1, reversing switch 1, conductor 13, contact segment 14 of the switching device 4, field winding F1, conductor 15, contact segment 16 of the auxiliary switching device, conductor 17, reversing switch 1, conductors 18 and 19, switch S, conductor 20, armature A2, reversing switch 2, conductor 21, contact segment 22 of the auxiliary switching-device section 5, field winding F2, conductor 23, contact segment 24 of the switching device, conductor 25, reversing switch 2, and conductor 26, to the negative supply-circuit conductor Ground. The motors are thus connected in the familiar series relation with the accelerating resistor 3.

To accelerate the machines to full-series relation, the resistor 3 is gradually excluded from circuit by means of the illustrated switches R1, R2, R3, and R4 in a familiar manner which need not be described in detail here.

The customary "shunting" transition of the motors to parallel relation is then effected by opening the resistor switches, closing switch P, opening switch S and then closing switch G, whereby the main circuit follows two branches from the conductor 11, one of which includes conductor 12, the armature A1 and the field winding F1, as previously traced, conductor 18, switch G and conductor 27 to Ground, while the other branch includes the switch P, armature A2 and field winding F2, as already pointed out, and conductor 26, to Ground.

The accelerating resistor 3 is again excluded from circuit, in accordance with familiar principles, to accelerate the motors to full-parallel relation.

Assuming that the motors are running with the series connection and that, by reason of the failure of supply-circuit voltage or air pressure for the usual mechanical braking system, or to avoid accident, it is desired to quickly brake the vehicle, the auxiliary braking apparatus 7, comprising switching devices 4 and 5, is actuated to its "First Brake" position in a manner to be described in detail in connection with Fig. 2, whereby, in the first place, conductor 11 breaks circuit with contact member 10 to thereby disconnect the motors from the supply circuit, and conductors 11, 31 and 40 then make connection with a contact segment 30, while conductors 34 and 36 make connection with another contact segment 35 in the "First Brake" position. The function of contact segments 30 and 35 is to connect the motor circuits, each including an armature and field winding, in parallel relation. Conductor 11 is connected through conductor 12 to one terminal of the armature A1, and conductor 31 is connected to the corresponding terminal of the armature A2. The other ends of the respective motor circuits constitute conductors 18 and 26, which are respectively connected through conductor 36 and through conductors 27 and 34 to contact segment 35.

A further change of connections, namely, the reversal of the field windings F1 and F2 with respect to the corresponding armatures A1 and A2, is also effected by the above-mentioned actuation of the auxiliary switching apparatus to the "First Brake" position. Starting from the reversing switch 1, which, being independent of the auxiliary braking drum 7, does not have its circuit connections changed by the actuation thereof, the new circuit comprises conductor 13, contact segment 38 of the switching device 4, conductor 15, field winding F1, contact segment 37, and conductor 17, which connects with the reversing switch 1. Similar reversal of the field winding F2 is accomplished through the agency of contact segments 32 and 33 in the "First Brake" position of switching device 5, comprising the second section of the auxiliary drum or emergency braking apparatus 7.

As is well understood, the disconnection of the machine circuits from the Trolley, accompanied by a paralleling of the motors, with the field windings reversed, will tend to set up generated currents in both of the momentum-driven machines. However, the unavoidable differences in char-

BEST AVAILABLE COPY

acteristics of the two machines, caused by slight variations in the quality of iron in the magnetic circuit, length of air gap, etc., will cause the action of one of the machines to predominate over that of the other, whereby the more powerful machine will act as a generator to force current through the other machine to reverse its action by causing it to build up a generator-voltage in series with the more powerful machine, thus providing a desirably heavy dynamic-braking action to stop the vehicle. Whether the switch S, which is now connected across each machine, opens or not is immaterial, since, in either case, the desired braking effect will be secured.

If the machines are already connected in parallel relation by the closure of switches P and G when the above-mentioned emergency-braking application is made, the same connections are made, although, since the switches P and G are closed, contact segments 30 and 35 of the auxiliary switching device 4 serve to parallel the switches. In this way, it is insured that the desired paralleling of the motors will be effected even though, by reason of failure of the auxiliary control system, the switches P and G should open.

The above-described actions will serve to retard forward movement of the vehicle when the motors are operating either in series or in parallel relation. However, such emergency action might be taken on a slight upward grade, which would cause the vehicle to roll backwardly as soon as it had come to rest since, of course, dynamic-braking action ceases when the rotative movement of the motor stops. To provide braking, under these conditions, also, the auxiliary switching apparatus 7 may be moved to its "Second Brake" position, which merely restores the original field-winding connections or, in other words, again reverses them, thus setting up dynamic-braking currents if the vehicle starts to roll backwardly, and effectively bringing the vehicle to rest.

It will be appreciated that any desired number of emergency braking positions may be provided upon the auxiliary switching apparatus by merely duplicating the first and the second braking positions.

Reference may now be had to Fig. 2 and Fig. 3, which illustrate one form of emergency braking apparatus, whereby a moving vehicle may be rapidly and reliably brought to rest, even though supply-circuit voltage and air pressure should concurrently fail.

The apparatus, in general, comprises a piston-and-cylinder device 50 that is mechanically associated with the drum 7 carrying the auxiliary switching devices 4 and 5, to effect rotative movement thereof to its successive braking positions, as desired; a pressure-chamber device 51, which is utilized for storing fluid pressure created by the explosion of a suitable charge; a firing mechanism 52; and a manual controlling or push-button device 53 that is preferably located adjacent to the usual control apparatus in the cab or on the platform of the vehicle.

The drum 7, carrying the auxiliary switching devices 4 and 5, has a ratchet member 60 secured thereto to be engaged by a spring-pressed pawl member 61 that is mounted upon an arm or rod 62 having an intermediate pivotal point 63 and a suitable lost-motion connection 64 with the piston stem 65 of the fluid-actuating means 50. A piston 66 is secured to one end of the stem or rod 65 to operate within a suitable encasing means or cylinder 67, while, upon the other end of the piston stem 65, is mounted a plate 65^a bearing upon a helical spring 68, which thus normally biases the piston 66 and, therefore, the auxiliary switching drum 7 to the illustrated normal position.

A pipe or passage 69 effects communication between the piston end of the cylinder 67 and the valve member 6, which is of a familiar type having a normally open passage for permitting communication between the pipe 69 and a second pipe 70 that enters the pressure-chamber device 51. The function of the valve member 6 is to interrupt communication between the pipes 69 and 70 whenever the actuating coil 41 is energized, to prevent movement of the fluid-pressure actuating means 50 for a purpose to be set forth.

The pressure-chamber device 51 comprises a receptacle 75 having relatively thick walls to withstand heavy fluid pressure, which enclose the pressure chamber proper 76, with which communicate a plurality of firing passages 77, 78 and 79 and a vent or outlet 80 of relatively small diameter. The firing passages 77, 78 and 79 are shaped to hold a plurality of blank cartridges 81, 82 and 83 of a familiar type, the upper ends of which, comprising the percussion caps, are covered by a suitably secured plate 84 having a plurality of openings or passages of narrow diameter respectively located directly above the percussive centers of the cartridge caps.

A plurality of firing pins 85, 86 and 87 project downwardly into the passages just mentioned and are held just out of contact with the percussive centers of the blank cartridges by means of suitable helical springs, as illustrated.

The firing mechanism 52 comprises a plurality of hammers 90, 91 and 92, which are located opposite the respective firing pins 85, 86 and 87, and are biased to a downwardly-

BEST AVAILABLE COPY

extending firing position by means of helical springs 94, 95 and 96 that are secured to a supporting rod 93 upon which the hammers are loosely mounted. The hammers are normally constrained to their illustrated upright positions, in opposition to the action of the biasing springs 94, 95 and 96, through the agency of a firing rod 97 having a saw-tooth upper edge, or the equivalent, for meshing with a co-operating saw-tooth disk or gear member 98 to which is secured a ratchet member 99. A push-pin or rod 100 normally engages the uppermost notch of the ratchet member 99, the pin being suitably supported by any convenient stationary portion 102 of the car frame or of the control apparatus normally present in the vehicle, and terminating in a suitable spring-pressed push-button 101.

Assuming that the above-mentioned emergency conditions have arisen, making it necessary to employ the auxiliary or emergency braking drum, the train operator merely presses the push-button 101 to rotate the ratchet member 99 and the associated gear member 98 through a certain angle corresponding to the distance between the teeth of the ratchet member. In this way, the firing rod 97 is withdrawn from in front of the firing hammer 90, which is thereupon actuated by the biasing spring 94 to strike the firing pin 85 and discharge the blank cartridge 81 through the firing passage 77 into the pressure chamber 76. Since the valve means 6 is normally open, fluid pressure thus produced is transmitted through pipe 70, valve 6 and pipe 69 to the cylinder 67 of the fluid-actuating means 50. The piston 66 is thus depressed, in opposition to the action of the spring 68, whereby the pawl rod 62 is rotatively moved about its pivotal point 63 to cause the pawl 61 to move upwardly and carry the ratchet member 60 and the associated auxiliary braking drum 7 through an angle corresponding to the distance between the teeth of the ratchet member, that is, to the "First Brake" position, as illustrated in Fig. 1.

The piston 66 is slowly returned to its illustrated upper position by the spring 68 after the actuation just described, by reason of the gradual exhaust of the fluid pressure from the cylinder 67 through the pipes 69 and 70 and the vent or outlet 80 of the pressure chamber, whereby the piston and the pawl, in a short time, reassume the illustrated normal positions in readiness for the next movement of the auxiliary braking drum, as about to be described.

In the event that, after the vehicle has been brought to rest, it tends to drift backwardly, the push-button 101 may be again pressed to permit the operation of the second firing hammer 91 by the withdrawal of the firing rod 97 and thus explode cartridge 82, to again actuate the piston-and-cylinder mechanism 50 and the emergency braking drum, which is this time halted in its "Second Brake" position. Such action again reverses the field windings, as previously pointed out, to effect dynamic braking during the backward movement of the vehicle.

It will be appreciated that, in case the momentum-driven machines build up their braking voltage to a suitable degree, it is not desirable to further actuate the auxiliary braking drum; for example, the train operator, in a moment of excitement, might again press the push-button 101, thinking to obtain further braking effect, when already the full braking effort of the machines was being exerted. To prevent any such action, which would immediately eliminate the braking of the vehicle, the valve means 6, with its actuating coil 41, is provided.

When the auxliary braking drum is actuated to its "First Brake" position, in addition to the circuits previously traced in connection with Fig. 1, an auxiliary circuit, including conductor 40, is connected to the contact member 30 of the braking drum. This auxiliary circuit is continued from conductor 40, through the actuating coil 41 and conductor 42, to the negative conductor 34, or, in other words, the actuating coil 41 is connected directly across the momentum-driven machines. Consequently, upon the attainment of predetermined braking-voltage conditions, the actuating coil 41 is energized sufficiently to close the valve member 6 and thus interrupt communication between the pipes 69 and 70. Under these circumstances if the push-button 101 is again accidentally or otherwise pressed, even though a cartridge is fired, no movement of the auxiliary braking drum will occur, but the explosive pressure will be gradually dissipated through the vent 80.

It will be seen that I have thus provided an ultimate emergency braking system that is not dependent upon supply-circuit voltage, braking-system air pressure or any action of the regular control system, but, under any emergency conditions, braking of the vehicle in either a forward or a reverse direction may be effected, as desired. Moreover, in case the first cartridge fails to explode, it is merely necessary to fire the second and third with a short time interval therebetween to permit the pressure caused by the firing of the second cartridge to be dissipated, whereupon the piston 66 reassumes its normal upper position. The firing of the third cartridge will then actuate the auxiliary braking drum to its "Third Brake" position, which is equivalent to the "First Brake" position and thus will effect the desired braking action. The valve means 6 will not operate upon the firing of

the above-mentioned second cartridge, since the braking voltage will not build up with the field windings connected in the manner corresponding to the "Second Brake" position.

I do not wish to be restricted to the specific circuit connections or arrangement of mechanical parts herein illustrated, since it is evident that any desired number of cartridges, or the equivalent, and corresponding emergency braking positions may be utilized. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. The combination with a rotatable contact-carrying member for controlling an electrical braking system, of a piston-and-cylinder device mechanically connected thereto, and explosive means for effecting the actuation of said piston and said rotatable member to a braking position under predetermined conditions.

2. The combination with a multi-position member, of explosive means for actuating said member to its successive positions in a step-by-step manner.

3. The combination with a rotatable control member, of explosive means for intermittently actuating said member under predetermined conditions.

4. The combination with a multi-position member and actuating means therefor, of a pressure chamber communicating with said actuating means, a cartridge located in firing communication with said chamber, and means for firing said cartridge to effect the movement of said member from one position to another.

5. The combination with a multi-position rotatable contact-carrying member and fluid-pressure actuating means therefor, of a pressure chamber communicating with said actuating means, a plurality of cartridges located in firing communication with said pressure chamber, and means for successively firing said cartridges to effect a step-by-step movement of said rotatable member.

6. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a switching device having emergency means for effecting electrical braking connections of the machines, and means dependent upon an explosive action for rendering said emergency means active.

7. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having an emergency position for paralleling the machines and reversing the electrical relations of the armatures and field windings, explosive means, and means for applying the explosive force thereof to move said switching device into said emergency position.

8. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having a plurality of emergency positions for paralleling the machines and for successively reversing the electrical relations of the armatures and field windings, and explosive means for intermittently actuating said switching device to its successive emergency positions.

9. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having an emergency position for paralleling the machines and reversing the electrical relations of the armatures and field windings, actuating means for said switching device, a pressure chamber communicating with said actuating means, a cartridge located in firing communication with said chamber, and means for firing said cartridge to effect the movement of said switching device to said emergency position.

10. In a control system, the combination with a supply circuit and a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having a plurality of emergency positions for paralleling the machines and for successively reversing the electrical relations of the armatures and field windings and for disconnecting the machines from said supply circuit, fluid-pressure actuating means for said switching device, a pressure chamber communicating with said actuating means, a plurality of cartridges located in firing communication with said pressure chamber, and means for successively firing said cartridges to effect a step-by-step movement of said switching device to the successive emergency positions.

11. In a control system, the combination with a supply circuit and a plurality of dynamo-electric machines severally having armatures and field windings, of means for normally reversing the electrical relations of the armatures and field windings, a switching device independent of said reversing means and having an emergency position for disconnecting the machines from the supply circuit and paralleling the machines and reversing said electrical relations, and means independent of the control system for actuating said switching device to its emergency position.

12. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a switching device having plural emergency means for effecting elec-

BEST AVAILABLE COPY

trical braking connections of the machines, explosive means for rendering one of said emergency means active, and means for preventing the use of another emergency means if predetermined braking conditions obtain in the machine circuits.

13. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having a plurality of emergency positions for paralleling the machines and for successively reversing the electrical relations of the armatures and field windings, explosive means for intermittently actuating said switching device to its successive positions under predetermined conditions, and means for preventing more than one actuation if the machine voltages reach a predetermined value.

14. In a control system, the combination with a plurality of dynamo-electric machines severally having armatures and field windings, of a rotatable switching device having a plurality of emergency positions for paralleling the machines and for successively reversing the electrical relations of the armatures and field windings, fluid-pressure actuating means for said switching device, a pressure chamber communicating with said actuating means, a plurality of cartridges located in firing communication with said pressure chamber, means for successively firing said cartridges to effect a step-by-step movement of said switching device to the successive emergency positions under predetermined conditions, normally open valve means located intermediate said pressure chamber and said actuating means, and an actuating coil energized to close said valve means upon the attainment of predetermined voltage conditions in said machines.

In testimony whereof, I have hereunto subscribed my name this 26th day of Oct. 1918.

ANDREW H. CANDEE.