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AUTOMATIC TRAIN CONTROL SYSTEM.

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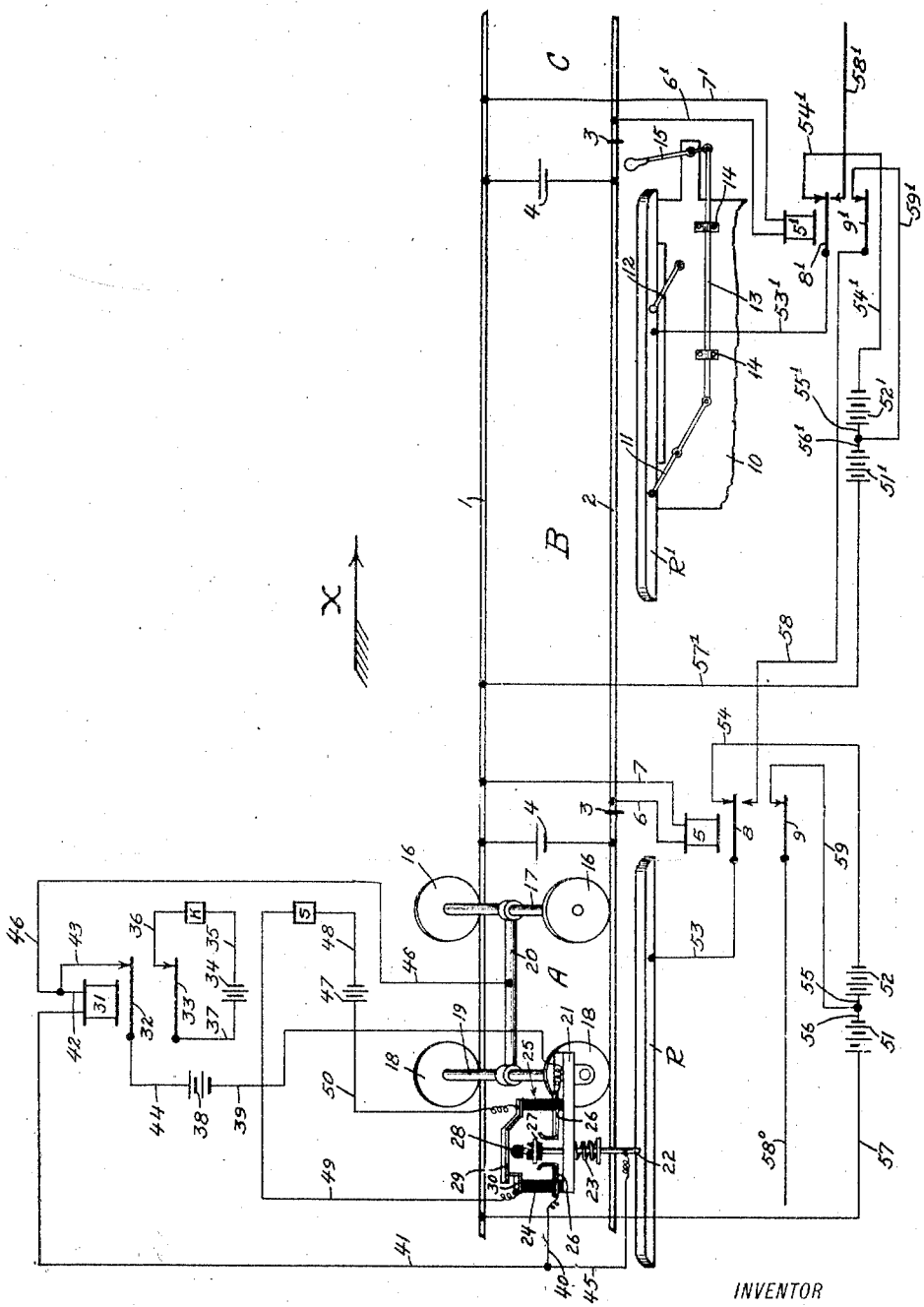

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AUTOMATIC TRAIN-CONTROL SYSTEM.

1,360,219. Specification of Letters Patent. Patented Nov. 23, 1920.

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To all whom it may concern:

Be it known that I, WINTHROP K. HOWE, a citizen of the United States, and a resident of the city of Rochester, in the county of Monroe and State of New York, have invented a new and useful Automatic Train-Control System, of which the following is a specification.

This invention relates to systems for automatically controlling railway trains, and more particularly to such systems in which the movement of the train is controlled, in some appropriate way, by speed control apparatus and by automatic stop mechanism on the train, the control of said speed control apparatus and said stop mechanism being accomplished by ramps or similar devices located along the track for the trains and adapted to coöperate with shoes or similar devices carried by the train.

One of the principal objects of the invention is to construct and arrange the parts of a train control system so that the same shoe carried by the train may be used to control the operation of the speed control apparatus and the automatic stop mechanism.

A further object of the invention is to devise a simple and reliable automatic train control system by which the speed of the train may be automatically controlled according to traffic conditions, and by which the train may be brought to a stop at certain points in its travel when necessary, as for instance, in territory governed by an interlocking plant, where the movement of a train, if continued even at a low speed, might conflict with the route of a fast moving train and result in a serious accident.

Other objects and advantages will appear as the description of the invention progresses, and the novel features of the invention will be particularly pointed out in the appended claims.

Generally stated, the invention consists in a shoe carried by the train which can be moved to different positions from its normal position, one of the operated positions of said shoe controlling the speed control apparatus of the train and another operated position of said shoe controlling the automatic stop mechanism of said train, together with ramps arranged to coöperate with said shoe, some of said ramps being capable of movement to different positions so as to move the shoe on the train to different operated positions.

The invention further consists in the parts, and in the arrangements and combinations of parts, more fully set forth hereinafter.

In describing the invention in detail, reference is had to the accompanying drawing, wherein I have illustrated a preferred physical embodiment of my invention, and wherein like characters of reference designate corresponding parts throughout the several views, and in which:

The figure is a diagrammatic illustration of a railway train or vehicle and a track for said train, and shows the parts of an automatic train control system embodying the invention, both those parts which are associated with the train and those which are located along the track, together with the circuits and electrical connections between said parts, the operative parts being shown in said figure in their normal positions and in the condition existing when a train is passing over one of the ramps and when traffic conditions permit said train to proceed at unrestricted speed.

Referring to the accompanying drawings, one track rail 1 of the railway track is electrically continuous, the separate rail sections thereof being suitably bonded together; and the other track rail 2 is divided into electrically distinct blocks A, B and C in any suitable manner, as by insulating joints 3. The blocks A, B and C may be of any length required to obtain the desired spacing of the trains, and although only one block B and a portion of the adjacent blocks A and C are shown in the drawing, it is to be understood that the entire length of the trackway protected by the system is divided into similar blocks. Across the track rails 1 and 2 at one end of each block is connected a source of electric current, as a battery 4; and to the other end of each block section a track relay 5 is connected across the track rails 1 and 2 by conductors 6 and 7. Although the electrical wiring for both the

block B and the block C is shown, this wiring is the same for the block C as for the block B, and for the sake of clearness the parts and the conductors associated with the block C will be given the same reference character as the corresponding conductors of the block B with a distinctive exponent "1" added thereto. The track relay 5, for each block, together with the track rails 1 and 2 and the track battery 4 of that block, constitute the well known normally closed track circuit; and when no train occupies the corresponding block the track relay 5 is normally energized by the battery 4 and the armatures 8 and 9 of said track relay are in their upper position, as shown in the drawing.

At the entrance to each block a ramp is suitably supported adjacent to the track rails but insulated therefrom. Some of said ramps are immovable, like the ramp R shown at the entrance to the block B, at the left-hand part of the figure, the direction of traffic being from left to right, as indicated by the arrow X in said figure. At certain other points along the trackway, as for instance, at the entrance to a territory govened by an interlocking plant, the ramps are so constructed and mounted as to be movable. Such a movable ramp R^1 is shown at the entrance to the block C, and is movably mounted upon a base 10 of wood or similar insulating material by two pairs of parallel links 11 and 12. One link of the pair 11 is extended below its fixed pivot, and pivotally connected to this extension of said link 11 is an operating rod 13 which is slidably supported on the base 10 by suitable guides 14. The operating rod 13 may be actuated in any way, by power or manually; but is shown as arranged to be operated by a hand lever 15.

The circuits and electrical connections between the ramps and the armatures of the track relays 5 will not be described in detail, since these connections and the different operating circuits will be set forth fully hereinafter in the description of the operation.

The apparatus on the train for controlling the movement thereof comprises a device K which is constructed and arranged to control the movement of the train when it should proceed cautiously. Various devices are well known in the art which satisfy the requirements of the device K, and since the device K forms no part of this invention, its detail construction will not be shown and described. The device K may be used to automatically control the speed of the train immediately upon its operation, or according to the speed of the train and the distance it has traveled after the device K has been set into operation.

The automatic train control apparatus also includes a stop device S constructed and arranged to bring the train to an absolute stop, as for instance, by instantaneously applying the emergency brakes. Since this device S, like the device K, forms no part of this invention and various devices well known in the art are capable of performing its necessary functions, a detail description of the construction of the device S is deemed unnecessary.

The train or vehicle is shown in the drawing as comprising two pairs of wheels 16—16 and 18—18 connected by the usual axles 17 and 19 respectively; and a bar 20 is shown connecting the axles 17 and 19 to represent the frame or body of the train or vehicle. A support or bracket 21 is secured to the train or vehicle in any suitable way, as for instance, by being mounted upon a journal box or axle of the vehicle, as shown in the drawings; and supported on the bracket 21 is a vertically movable shoe or plunger 22 which is pressed downwardly by a spring 23. The shoe 22 is arranged in a plane of the ramps R and R^1 and is adapted to contact with said ramps as the train passes along the track. The shoe 22 is designed to be raised as each ramp is passed, so as to break a normally closed circuit on the train. To accomplish this purpose, the shoe 22 may be provided with a disk 27 of conducting material suitably mounted on said shoe but insulated therefrom; and supported by members 24 and 25 of insulating material fixed to the bracket 21 are two contact springs 26 which are arranged to coöperate with the disk 27 when the shoe 22 is in its lower position. When the shoe 22 is raised, however, the disk 27 is moved out of contact with the contact springs 26. The shoe 22 is also arranged to break another normally closed circuit when raised to a still higher position; and to accomplish this purpose the shoe 22 is provided with a button 28 of insulating material, which engages the underside of a contact spring 29 fixed to the member 25 and arranged to coöperate with a contact member 30 fixed to the member 24.

The operation of the speed control apparatus K is controlled by a relay 31 on the train or vehicle which has two armatures 32 and 33. When the relay 31 is energized and its armature 33 is in its upper position, current is supplied to the speed control device K from a local source of current, as a battery 34, according to the following circuit: battery 34, conductor 35, device K, conductor 36, armature 33 in its upper position and conductor 37 back to the battery 34. The control relay 31 is supplied with current from a local battery 38 when its armature 32 is in its upper position and the shoe 22 is in its lower position according to a circuit which may be traced as follows:

from the battery 38, conductor 39, contact spring 26, disk 27, contact spring 26, conductors 40 and 41, relay 31, conductors 42 and 43, armature 32 of the relay 31 in its upper position, and conductor 44 back to the battery 38. A partial circuit including the shoe 22 and the frame of the train is also provided for the control relay 31, said partial circuit being as follows: from the shoe 22, conductors 45 and 41, relay 31, conductors 42 and 46 to the frame 20 of the vehicle. The function of this partial circuit will be more fully described hereinafter in the description of the operation.

The operation of the automatic stop device S is controlled by a circuit controlling device comprising the contact spring 29 and the contact member 30, said automatic stop device being supplied with current from a local battery 47 when said contact spring 29 is in contact with the contact spring 30 according to a circuit as follows: battery 47, conductor 48, device S, conductor 49, contact member 30, contact spring 29 and conductor 50 back to the battery 47.

When the shoe 22 engages a ramp R it is raised to a position, as shown in the figure, in which the disk 27 is out of contact with the contact spring 26, but the shoe 22 is not raised high enough to lift the contact spring 29 out of contact with the contact member 30. When the shoe 22 engages a ramp R^1, when said ramp is raised, the shoe 22 is raised high enough to lift the contact spring 29 out of engagement with the contact member 30. In other words, the shoe 22 has three positions, first, a normal position, second, a first operated position, in which the circuit through the control relay 31 is broken but the circuit through the stop device S is not broken, and third, a second operated position which is caused by the engagement of said shoe with a ramp R^1 in its raised position, and in which the circuit through the stop device S is also broken.

Having described generally the structure and arrangement of the various parts constituting a system for automatically controlling railway trains which embodies the invention; and in general the operation of the parts of this system which are mounted on the train, the operation of the system as a whole will be described for different cases in which certain conditions, such as may occur in practice, are assumed to exist along the trackway.

For the first condition to be considered, assume that the train under consideration is in the block A, as shown in the figure, and is about to enter the block B; that said train has found the trackway unobstructed and is running without being under the control of the device K; and that neither the block B nor the block C are occupied by a train. Since the blocks B and C are not occupied their respective track relays 5 and 5^1 are energized by current supplied from their respective track batteries 4, and the armatures 8, 9, and 8^1, 9^1 respectively of said track relays will be in their upper position as shown in the drawing. Before the train enters the block B, the shoe 22 engages the ramp R and besides being lifted to break the normally closed circuit through the relay 31, as hereinbefore described, said shoe makes electrical contact with the ramp R. A high difference of potential exists between the ramp R and the track rails at this time according to a partial circuit which may be traced as follows: from the ramp R, conductor 53, armature 8 of the track relay 5 in its upper position, conductor 54, battery 52, conductors 55 and 56, battery 51, conductors 57 to the track rail 1. Consequently, when the shoe 22 makes electrical contact with the ramp R current is supplied from the batteries 51 and 52 along the track to the control relay 31 on the car according to a circuit which may be traced as follows: from the battery 52, conductor 54, armature 8 of the track relay 5 in its upper position, conductor 53, ramp R, shoe 22, conductors 45 and 41, relay 31, conductors 42 and 46, frame 20 of the vehicle through the axles 17 and 19 and the wheels 16 and 18 to the track rail 1, conductor 57, battery 51 and conductors 56 and 55 back to the battery 52. In this way, although the normally closed circuit for energizing the control relay 31 is broken by the upward movement of the shoe 22, current is simultaneously supplied to said control relay 31 to maintain it energized, and this condition exists until the first pair of wheels 16—16 enter the block B.

When the first pair of wheels 16—16 enter the block B the track relay 5 is shunted, due to the low resistance of the wheels and axles 17, and the armature 8 of said track relay drops and interrupts the circuit hereinbefore traced for supplying current to the control relay 31 but establishes another circuit for supplying current to said relay 31 as follows: from the battery 51^1, adjacent to the entrance to the block C, conductor 59^1, armature 9^1 of the track relay 5^1 in its upper position, conductor 58, armature 8 of the track relay 5 in its lower position, conductor 53, ramp R, shoe 22, conductors 45 and 41, relay 31, conductors 42 and 46 to the frame 20 of the vehicle and thence by the axles 17 and 19 and the wheels 16 and 18 to the track rail 1 and by conductor 57^1 back to the battery 51^1. Although only the battery 51^1 is supplying current to the relay 31, instead of the battery 51 and the battery 52 in series as was the case before the first wheels of the train entered the block B, this battery 51 alone supplies sufficient current to the relay 31 to hold its armatures 32 and 33 in their raised position, since the current required to hold

the armatures of the relay 31 in their raised position after they have once been raised, is less than that required to raise said armatures from their lower position. This characteristic of the armatures of the relay 31 may result from the decrease in the reluctance of the magnetic circuit for said relay when the armatures are raised, as is commonly the case with ordinary dropaway relays, or the torque for returning said armatures to their lower position may be made variable so as to be greater when the armatures are in their lower position that when they are in their upper position.

From the foregoing it can be seen that if the train approaches the block B, and said block B and the block C are unoccupied, the control relay 31 on the train will first be connected to a high voltage source of current sufficient to raise its armatures and then subsequently be connected to a low voltage source of current which is sufficient to hold its armatures in their upper position. Consequently, the armature 33 of the control relay 31, will not drop and interrupt the normally closed circuit through the speed control device K, or if it drops, will be immediately raised. The result is that the train may proceed through the block B unrestrained by the speed control device K.

For the next condition to be considered, assume that the train is in the block A and is about to enter the block B, as shown in the drawing; that said train has had an unobstructed trackway over which to pass and has been traveling unrestrained by the speed control device K; and that while the block B is unoccupied there is a train in the block C. Under these conditions, the control relay 31 will first be connected to the high voltage source of current, that is, the batteries 51 and 52, as hereinbefore described; but, when the first wheels of the train enter the block B and the armature 8 of the track relay 5 drops, the circuit hereinbefore traced which connects the control relay 31 with the low voltage source of current, the battery 51^1, is interrupted by reason of the fact that the armature 9^1 of the track relay 5^1 is in its lower position due to the presence of the train in the block C. Consequently, before the shoe 22 leaves engagement with the ramp R the supply of current to the control relay 31 is interrupted and its armatures 32 and 33 drop. The dropping of the armature 32 of the control relay 31 opens a break in the circuit which normally energizes said relay when the shoe 22 is in its lower position, so that after the shoe 22 leaves engagement with the ramp R and is forced by the spring 23 to its lower position, the relay 31 will not be reënergized and its armatures will remain in their lower position. When the armature 33 of the control relay 31 drops it interrupts the normally closed circuit through the speed control device K and sets said device K into operation to control the movement of the train with a view to bringing it to a stop or to a predetermined low speed by the time the end of the block is reached. From the foregoing, it can be seen that when the train enters the block B and the block C is occupied the speed control device K will be set into operation to cause the movement of said train to be controlled in accordance with the conditions which require the train to proceed cautiously.

For the next condition to be considered, assume that the train is in the block A and is about to enter the block B, and that the block B is occupied by another train. In this case the train under consideration will have been controlled by the device K which was set into operation at the time this train entered block A, because the presence of the train in the block B caused the operation of the speed control device K when the train entered the block A in the same way, as hereinbefore described, in which the presence of a train in the block C would cause the operation of the device K when the train entered the block B. For this reason the armatures 32 and 33 of the control relay 31 will be in their lower position while the train is passing through the block A and will be in this position when the shoe 22 first engages the ramp R. The presence of the train in the block B shunts the track relay 5 and causes the armature 8 of said track relay to drop, so that the control relay 31 will be first connected to a low voltage source of current, namely: the battery 51^1 according to the following circuit: from the battery 51^1, conductors 56^1 and 59^1, armature 9^1 of the track relay 5^1 in its upper position, conductor 58, armature 8 of the track relay 5 in its lower position, conductor 53, ramp R, shoe 22, conductors 45 and 41, control relay 31, conductors 42 and 46, frame 20 of the train, and thence by the axles and wheels to the track rail 7 and by conductor 57^1 back to the battery 51^1. Since the armatures 32 and 33 of the control relay 31 are in their lower position the current supplied from the battery 51^1 alone is not sufficient to raise the armatures; and the train, if it proceeds into the block B, must do so at the speed imposed upon it by the speed control device K. If it should happen that the block C is occupied by a train as well as the block B, then the circuit just traced will be interrupted at the armature 9^1 of the track relay 5^1, since the presence of the train in the block C causes the armatures of said track relay 5^1 to drop. In this case, no difference of potential would exist between the ramp R and the track rails; and the armatures of the control relay 31 would remain in their lower positions.

The ramp R^1, although it is movably mounted, is provided with the same controlling circuits at the ramp R, and in its lower position said ramp R^1 performs the same function as the ramp R. However, at some points along the track it may be necessary or desirable to bring the train to an absolute stop by applying the brakes instantaneously and independently of the speed control device K. This is accomplished by raising the ramp R^1, which may be done by actuating the operating rod 13 to rock the link 11. When the shoe 22 engages the ramp R^1 in its upper position, said shoe is raised high enough to lift the contact spring 29 out of engagement with the contact member 30 so as to interrupt the normally closed circuit through the stop device S. The deënergization of the stop device S may be utilized in any suitable way to cause an immediate automatic application of the brakes to bring the train to an immediate stop.

The electrically operated devices along the track are shown as provided to be operated by direct current alone; but it is to be understood that with a simple modification, which will be apparent to those skilled in the art of railway signaling, these devices may be so constructed that alternating current may be used as the controlling medium, both for the devices on the train and along the track, with the advantage that stray direct current will not falsely operate the system. Only one shoe is shown, but any number of shoes and any number of motor cars or locomotives may be included in the train without affecting the operation of the system. The mounting of the movable ramps and the means for actuating said ramps to their different operated positions may take various other forms than that shown and described; and the shoe shown and described may be of any other form suitable for performing its necessary functions.

Although I have particularly described the construction of one physical embodiment of my invention, and explained the operation and principle thereof; nevertheless, I desire to have it understood that the form selected is merely illustrative, but does not exhaust the possible physical embodiments of the idea of means underlying my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a system for automatically controlling railway trains, in combination: a ramp movably mounted adjacent to the track for the trains, a shoe carried by the train and adapted to coöperate with said ramp, said shoe being movable to different operated positions by said ramp according to the position to which said ramp has been moved, automatic speed control apparatus for said train operated by the movement of said shoe from its normal position to one of its operated positions, automatic stop mechanism for said train controlled by the movement of said shoe from its normal position to another of its operated positions, and means for moving said ramp to different positions.

2. In a system for automatically controlling railway trains, in combination: a ramp mounted adjacent to the track for the trains and movable vertically, a vertically movable shoe carried by the train and adapted to coöperate with said ramp, said shoe being moved by said ramp to different operated positions, a circuit controlling device operated by said shoe and closed when said shoe is in its normal position and opened when said shoe is raised to one of its operated positions, another circuit controlling device operated by said shoe and closed when said shoe is in its normal position and in said operated position and opened when said shoe is raised beyond said operated position, automatic speed control apparatus carried by said train and controlled by said first-mentioned circuit controlling device, automatic stop mechanism controlled by said last-mentioned circuit controlling device, and means for moving said ramp.

3. In a system for automatically controlling railway trains, in combination: ramps located along the trackway for the trains, some of said ramps being movable, a shoe carried by a train and adapted to coöperate with said ramps, said shoe being actuated by all of said ramps to one of its operated positions and being actuated to a position beyond said operated position by said movable ramps when said movable ramps are moved from their normal position, and automatic train controlling apparatus controlled by said shoe.

4. In a system for automatically controlling railway vehicles, in combination with a railway track divided into blocks, of a ramp movably mounted along the track for the trains, said ramp being insulated from the rails of said trackway, means responsive to the presence of a train on the next block for creating a high difference of potential between said ramp and said track rails, means responsive to the presence of a train on the second succeeding block for creating a low difference of potential between said ramp and said track rails, and automatic speed control apparatus and automatic step mechanism carried by the train and controlled selectively by said differences of potential and the position of said ramp respectively.

5. In a system for automatically controlling railway vehicles, a shoe carried by the train and movable vertically, a circuit controlling device operated by said shoe and closed when said shoe is in its normal position and opened when said shoe is raised to one of its operated positions, another circuit controlling device operated by said shoe

and closed when said shoe is in its normal position and in said operated position, and opened when said shoe is raised beyond said operated position, automatic apparatus for regulating gradually the progress of the vehicle controlled by one operated position of the shoe, and a separate automatic stop mechanism for immediately arresting the movement of the vehicle controlled by the other operated position of the shoe.

6. In an automatic train control system, impulse devices located at intervals along a railway track, one or more particular impulse devices being capable of assuming different controlling positions, trackway circuits for rendering the controlling condition of all of said impulse devices dependent upon traffic conditions in advance, automatic speed control apparatus on a vehicle traveling over the track which is controlled by the controlling conditions of all of said impulse devices, and an automatic stop mechanism on the vehicle governed by the controlling position of said particular impulse devices.

7. In an automatic train control system, an impulse device having different controlling conditions dependent upon the presence or absence of other trains in advance and also adapted to assume a distinctive controlling position, manually operable means for governing the controlling position of said impulse device, automatic speed control apparatus on a vehicle responsive to the controlling conditions of said impulse device, and an automatic stop mechanism on the vehicle responsive to the controlling position of said impulse device.

8. In an automatic train control system, a vehicle having an apparatus for regulating gradually its progress along the track and a separate apparatus for immediately arresting its movement, a track for the vehicle divided into track circuit sections, an impulse device associated with each track section and responsive to traffic conditions in advance for governing the gradually acting apparatus, and manually operable means associated with one or more of said impulse devices for causing that impulse device to assume a distinctive controlling position capable of initiating the operation of the quick acting apparatus.

9. In an automatic train control system, a track divided into track circuit sections, ramps located at the entrances to said track sections and capable of having different electrical controlling conditions, controlling circuits for each ramp selectively governed by the track circuits of the track sections in advance, one or more particular ramps being capable of movement to a distinctive controlling position, manually operable means for operating the particular ramps, and separate automatic train control devices on a vehicle, one controlled by the electrical conditions of all of said ramps, and the other governed by the position of a particular ramp.

10. In an automatic train control system, a track divided into track circuit sections, a ramp associated with each track section, a source of current of different potentials associated with each ramp, means controlled by each track circuit for establishing a connection between the high potential source and the corresponding ramps, means controlled by each track circuit for establishing a connection between the low potential source and the ramp next in the rear, one or more particular ramps being capable of movement to a distinctive controlling position, manually operable means for operating said particular ramps, automatic apparatus on a vehicle for regulating gradually the progress thereof which is controlled by the electrical conditions of said ramps, and an automatic stop mechanism for immediately arresting the movement of the vehicle which is controlled by the position of said particular ramps.

11. In an automatic train control system, in combination with a vehicle and a track therefor, of means on the vehicle for regulating the speed thereof from point to point along the track in accordance with traffic conditions existing for a predetermined distance ahead of the respective points, an impulse device at one or more particular points capable of assuming different controlling positions, and means on the vehicle governed by the positions of said impulse devices for immediately arresting the movement of the vehicle independently of the first mentioned means.

12. In an automatic train control system, a controlling ramp supported by parallel links and adapted to assume different elevated positions without having its alinement with reference to the horizontal changed, manually operable means for controlling the position of said ramp, and traffic controlled circuits for supplying current to said ramp irrespective of its position.

13. In an automatic train control system, an impulse device along a railway track adapted to assume different controlling positions and different electrical controlling conditions, traffic controlled trackway circuits for determining the controlling conditions of said device, means for moving said device to its different controlling positions, and automatic train control apparatus on a vehicle traveling over the track which is selectively responsive to the controlling conditions and positions of said impulse device.

14. In an automatic train control system, the combination with a railway vehicle and a track therefor, of impulse transmitting means comprising elements partly on the

vehicle and partly along the track, one or more particular trackway elements of said means being capable of assuming a distinctive controlling position which has a controlling effect on the vehicle-carried element different from the other trackway elements, automatic train control apparatus on the vehicle, and normally closed circuits for selectively governing said apparatus, said circuits being selectively controlled by the particular trackway elements and the other trackway elements.

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