June 20, 1939. H. W. RICHARDS 2,163,520

RAILWAY SIGNAL DEVICE AND TRAIN CONTROL

Original Filed May 26, 1930 6 Sheets-Sheet 1

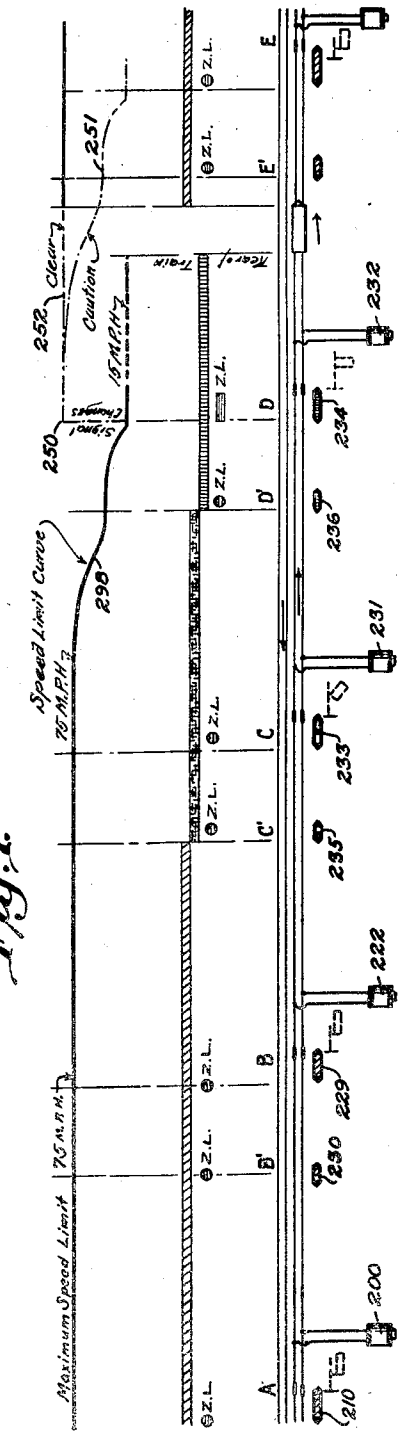


Fig. 1.

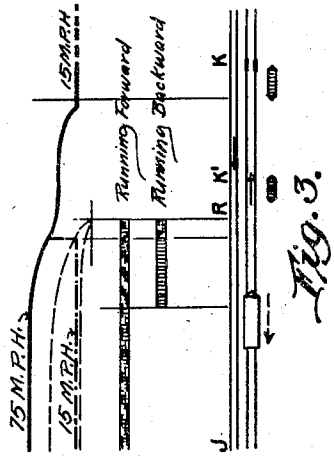


Fig. 3.

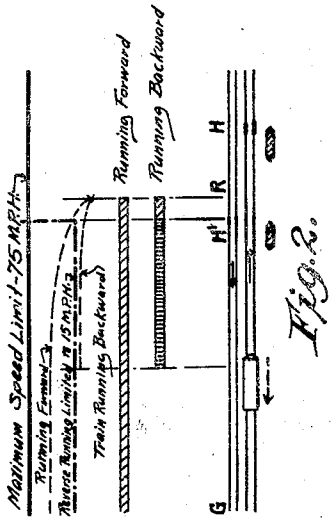


Fig. 2.

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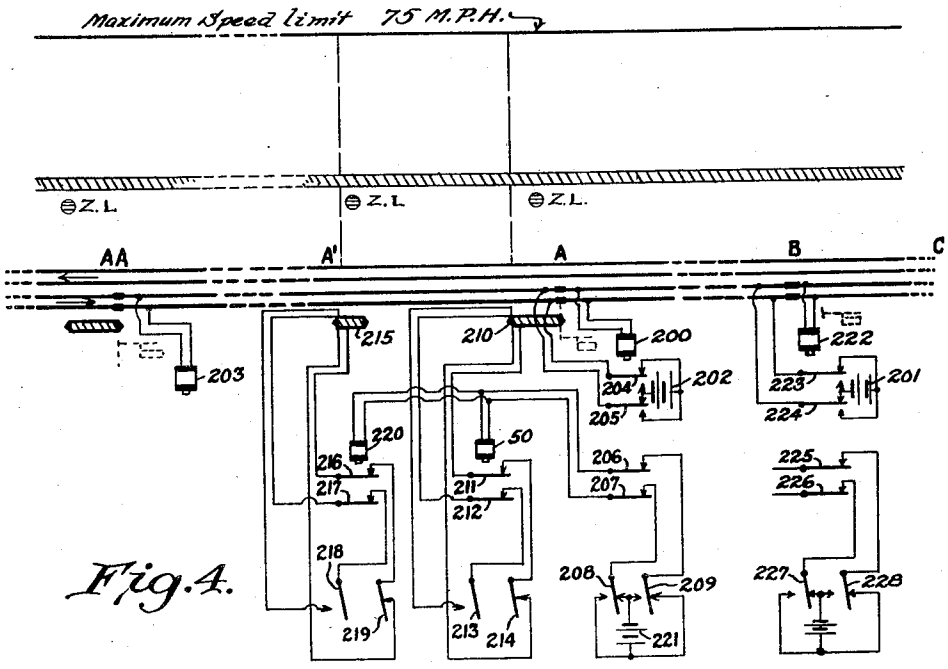
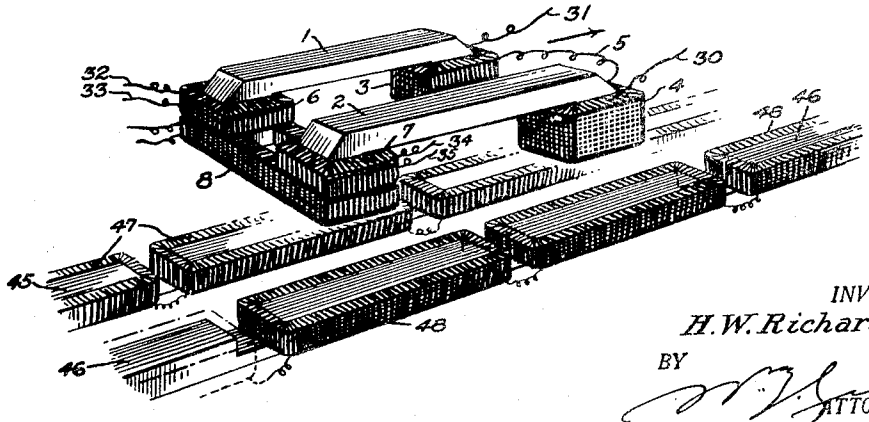


Fig. 4.

Fig. 5.



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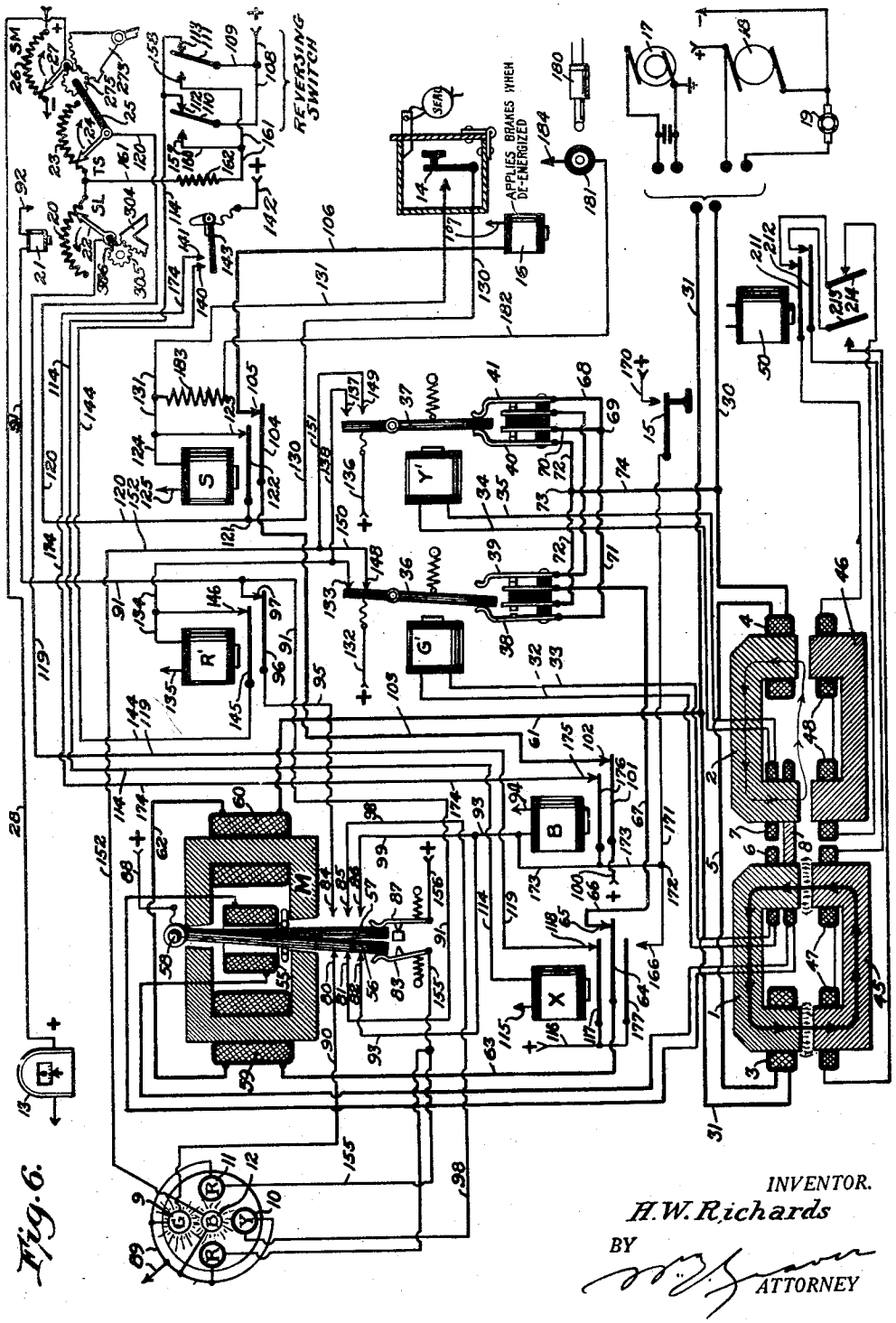


Fig. 6.

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RAILWAY SIGNAL DEVICE AND TRAIN CONTROL

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Fig. 8.

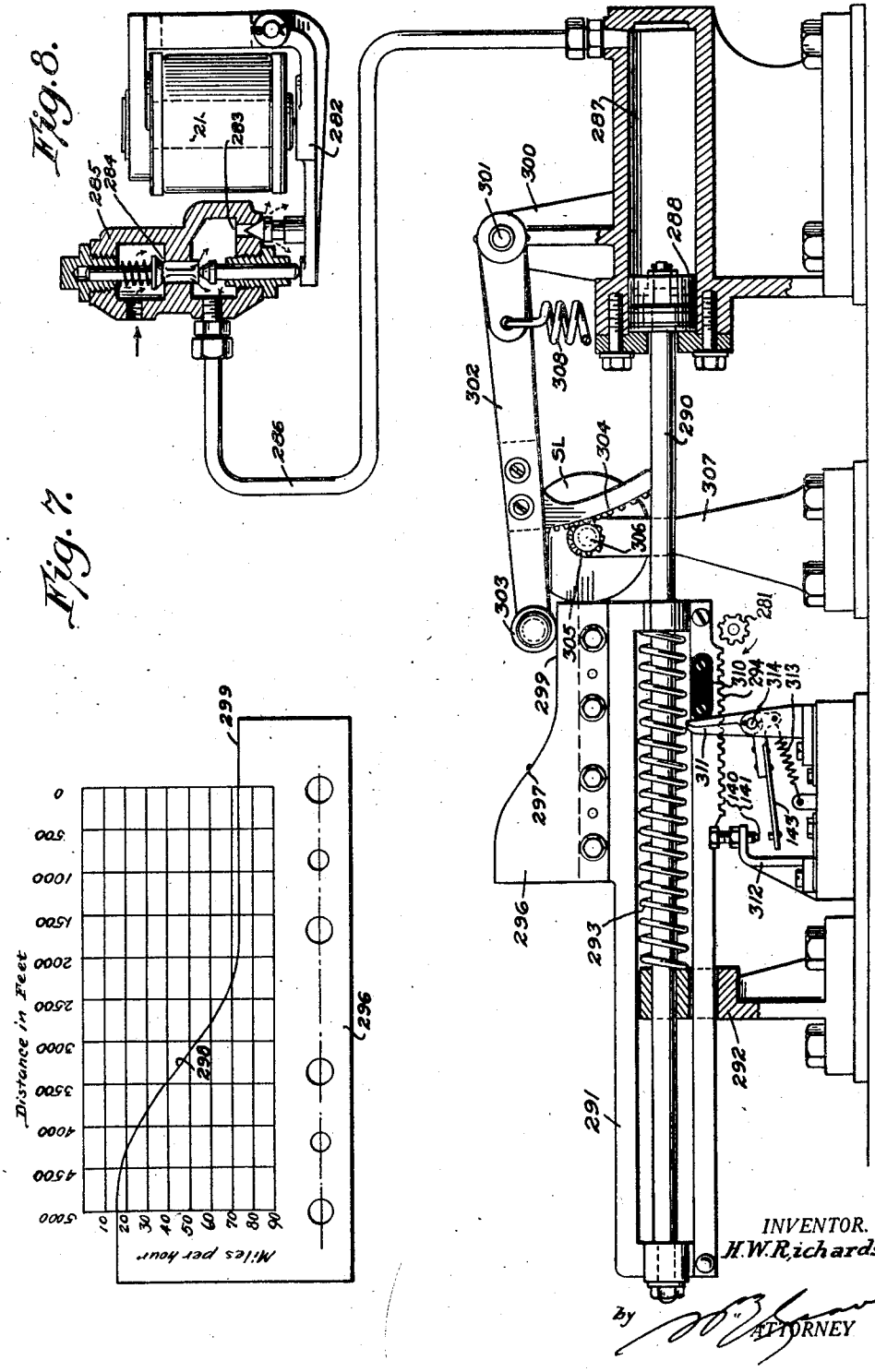


Fig. 7.

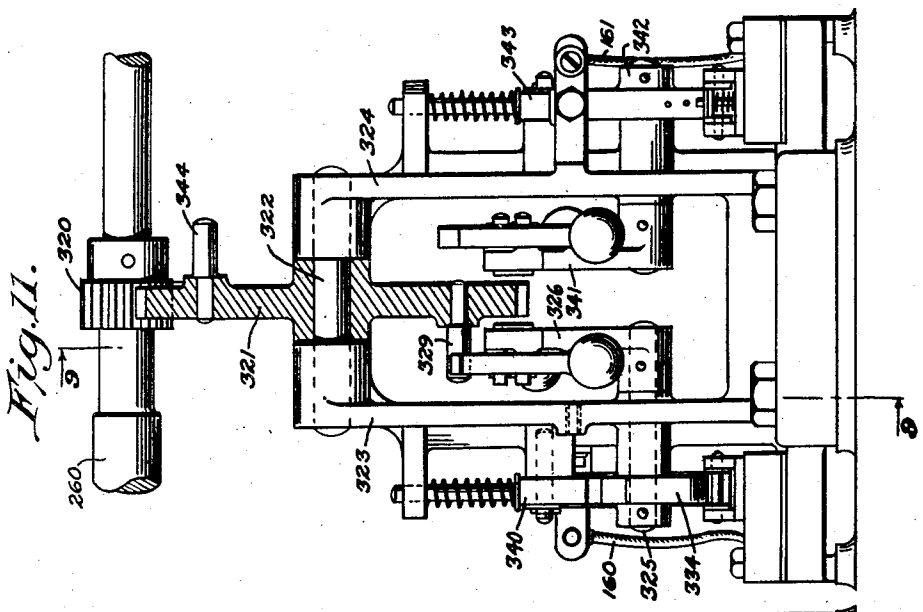
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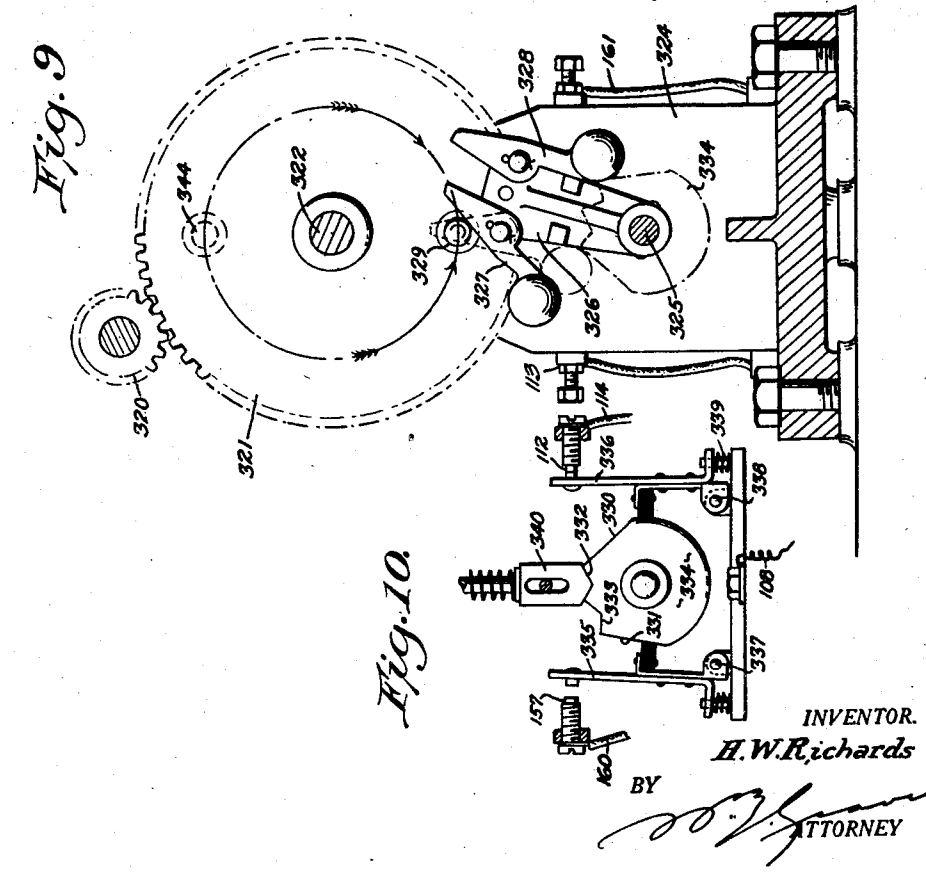
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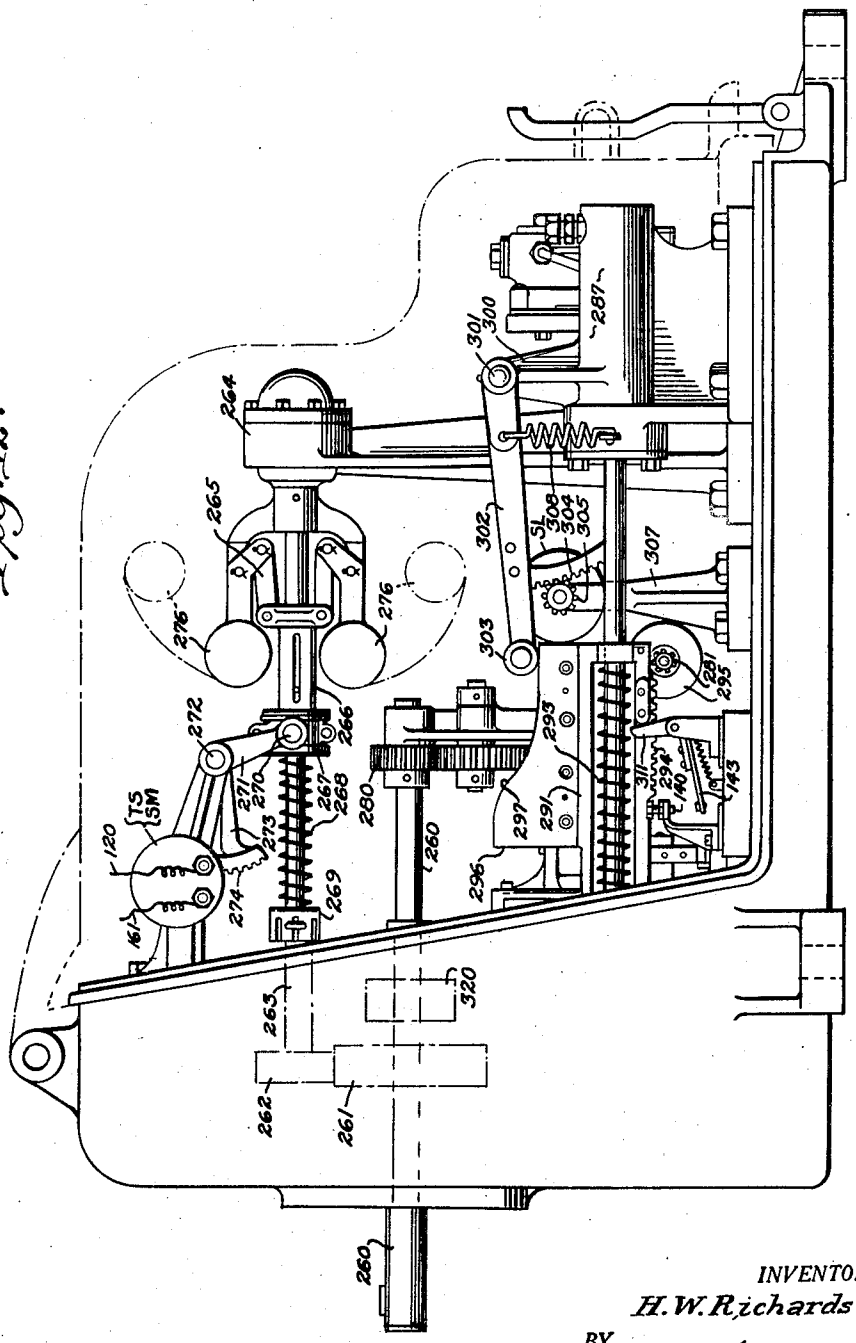
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Fig. 12.



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UNITED STATES PATENT OFFICE

2,163,520

RAILWAY SIGNAL DEVICE AND TRAIN CONTROL

Harry W. Richards, New York, N. Y.

Substitute for abandoned application Serial No. 455,903, May 26, 1930. This application March 16, 1937, Serial No. 131,218

9 Claims. (Cl. 246—63)

This invention relates to automatic speed control for railways and the like and has for its object to provide a system including constructional elements which are simple in parts and more efficient in operation both individually and in the combination of the system than those heretofore proposed.

With these and other objects in view the invention resides in the novel details of construction and combinations of parts constituting the apparatus as well as in the novel steps and combinations of steps constituting the method of control as will be disclosed more fully hereinafter and particularly pointed out in the claims.

Referring to the accompanying drawings forming a part of this specification in which like numerals designate like parts in all the views:

Fig. 1 is a diagrammatic representation of a section of track with speed limit curve associated therewith according to the blocks;

Fig. 2 is a detail view similar to Fig. 1 representing conditions when a train is brought to a stop and reversed in a clear block;

Fig. 3 is a view similar to Fig. 2 in which a train is brought to a stop and reversed in a caution block;

Fig. 4 is an enlarged diagrammatic view of a section of track showing the speed limit curve as well as track side wiring diagrams;

Fig. 5 is a perspective detail view illustrating the train receiver passing over a track side inductor;

Fig. 6 is a wiring diagram used in connection with this system;

Fig. 7 is a diagram illustrative of the method by which the cam is designed for any desired speed limit curve;

Fig. 8 is a view illustrating the speed limiting device used in connection with this system;

Fig. 9 is a partial side elevational view of the reversing switch;

Fig. 10 is a detail view illustrating some of the parts of the reversing switch in one position;

Fig. 11 is an end elevational view of the reversing switch; and

Fig. 12 is a side elevational view of the assembly of the speed governor and the speed control.

This application is a substitute or refile of applicant's prior application Serial No. 455,903, filed May 26, 1930.

The diagram of speed limit curves illustrated in Fig. 1 indicates principles of speed control, and the rate of speed are merely illustrative. The speeds as well as the braking distances may be varied to suit operating conditions.

This figure shows a typical section of track comprising four blocks, with the block DE occupied. Automatic block signals are shown standing at "clear", "caution" and "stop", but the system may be operated without roadside signals. A track inductor, designated as the "home" inductor is located at each wayside signal location or block entrance, and another designated as the "approach" inductor is located at a point about 1000 feet in advance of the "home" inductor.

The upper portion of this figure is a speed-distance diagram, the curves representing the speed limits imposed by the speed-control mechanism on the train as it runs through the blocks. Below these curves there is shown a series of horizontally extending areas, each area lined to represent a color, the colors representative of the cab signal indication displayed. Lastly, below these long areas are shown, at trackside inductor locations, small circles or rectangles, each lined for the color blue and identified by the letters Z. L. meaning "zone light".

The system is standardized to three cab signal indications, i. e., green, yellow and red, indicating the condition of the circuits in the block being approached, and a blue cab signal, designated as the "zone" light, which shows while the locomotive is over a track inductor. By aid of the zone light, the train can easily be stopped with the receiver over the home track inductor in position to receive proceed signal indications.

The speed control mechanism comprises a speed-limiting device, a speed governor, and a reversing switch mechanism which changes the circuits on the locomotive after the engine has moved a distance such as fifty feet in the reverse direction. The speed-limiting device (shown in Fig. 9) comprises a speed-limit cam, designed to provide speed limits according to operating requirements, which is held in normal or "high speed" position by a piston and air cylinder when the cab signal indication is green, and the train may proceed at the maximum rate. When a yellow or caution signal is received, the air is exhausted from the air cylinder, permitting the cam to move to its "slow speed" position, the stroke of the cam being retarded by a pinion geared to the axle of the locomotive, so as to impose decreasing speed limits varying from the maximum to the slow speed rate in a predetermined distance traveled by the locomotive. Should the locomotive be reversed, the reversing switch mechanism will automatically lower the speed limit for example to 15 M. P. H. and the cab signal indication to red, after the engine

has moved a short distance in the reverse direction, thus permitting certain necessary movements of the engine without affecting the control circuits.

Assuming the block DE to be occupied, a following train, on entering block AB will receive clear signals at track inductors at A and B', and the speed-limiting device permits the train to proceed at maximum speed. A full service application of the brakes will automatically result should the train, at any time, exceed the prescribed maximum rate.

On entering block BC, the train receives a clear signal at inductor B and there is no change of cab signal or speed limits. At inductor C' the train receives a yellow or caution signal, which allows the speed-limiting device to begin its cycle of operation. The speed-limit cam is so designed that the cam moves in a straight line while the engine travels the first 1000 feet, and therefore the speed limit does not begin to decrease until that distance has been traveled, which gives the engineman time to act to control his train.

At inductor C a second caution impulse is received. This impulse automatically resets the speed-limiting device back to its normal position from which it is immediately released to repeat its cycle of operation. The engine relays being in caution position, the yellow cab signal is maintained.

The speed-limiting device having been reset by the second caution impulse, the speed limit curve between the caution inductors C' and C appears as a straight line and a continuation of the maximum speed limit line. As the train approaches the home signal at D the speed device lowers the speed limit to the low-speed rate, in accordance with the prescribed curve set by the speed-limit cam.

When the train passes inductor D' the cab signal is changed to "red". The speed device continues its cycle of operation, reducing the speed limit to the slow speed rate as the train approaches the home inductor D. At the end of its cycle of operation the speed device maintains the slow-speed limit until it is reset to normal position by a clear or caution impulse.

When the engine is over each of the inductors a blue "zone" light will be displayed in the cab but while the train is travelling swiftly this display will have an infinitesimal duration and as indicated by the small circles ZL in Figure 1. When, however, the train speed is reduced then the duration of this display will be longer and when, as just described, the train speed is brought to its minimum by the engineman at the block entrance D, this duration is comparatively lengthy as indicated by the rectangle ZL, thus giving the engineman opportunity to stop the train with the train receiver over the track inductor in position to receive signal indications upon a change of traffic conditions.

Should the signal change to "clear" the speed-limiting device will be automatically restored to normal position and the speed limit raised and maintained at the maximum rate.

Should the signal change to "Caution" the speed-limiting device will be restored to normal position, but will be immediately released to repeat its cycle of operation as the train runs through block DE.

In each block the "approach" inductor is controlled by the "home" inductor and both give the same signal indication. The approach inductor will transmit to the cab the signal indication which is being displayed by the automatic wayside block signal, at a point for example 1000 feet in advance of said wayside signal and where the wayside signal would ordinarily be observed by looking down the track. The cab signal indications thus conform, in every respect, to those given by the wayside block signal.

Figures 2 and 3 show the change of cab signal and speed limits when running in the reverse direction in a clear or caution block respectively. In the clear block G—H the train has been brought to a stop at a point R and reversed. The full heavy line represents the maximum speed limit when running forward, and the dashed line represents the actual speed of the train in its movements in the block. When the engine has moved say 50 feet in the reverse direction the cab signal will be automatically changed to red, and the speed limit drops from the maximum to a predetermined low speed rate, as indicated by the dot and dash line. The red cab signal and slow speed limit is maintained until a clear or caution signal is received from a track inductor, when the speed limit will be automatically changed. In the caution block JK the train is shown running under a yellow cab signal indication with the speed-limiting device in operation. The train has been stopped at some point in the block, such as the point R, and reversed. After a movement of 50 feet in reverse direction the cab signal changes to red, and the speed limit drops to the prescribed low-speed rate. The red indication is maintained and the slow-speed limit imposed until a clear or caution inductor is passed.

Should the prescribed speed limit be exceeded at any time, the speed-limiting device, working in conjunction with the speed governor, will cause an automatic stop, requiring a reset button to be operated before the brakes can be released. As soon as the engineer handles his train properly there will be no automatic brake applications. The system is so designed that should a red indication be received on the train when it is proceeding under a green signal the brakes will be immediately automatically applied regardless of the speed, or of any condition of the speed control mechanism. The speed-limiting device is so designed that a failure of any of its essential parts will result in an automatic brake application. The foregoing is a general description or outline of the functions of this train control system. The structural details by which these functions are secured will be described fully in the following pages.

The locomotive equipment shown diagrammatically in Fig. 6 consists of a receiving element which comprises a pair of laminated core members 1 and 2 disposed relatively to each other in the same relationship as are the core members of the track inductors, said members 1 and 2 having at one end of each a primary coil, indicated at 3 and 4, connected as by the wire 5. At the other end of each core member is a secondary winding indicated at 6 and 7 and the common coil 8 is wound about a magnetic pole of both core members. For clearness of illustration the core members of the locomotive receiver and those of the track inductor are shown "spread out" in diagrammatic form. The actual design of these members is indicated in Fig. 5.

This equipment is supplemented as at 9, 10 and 11 respectively by green, yellow and red cab signals, and a blue cab signal indicated at 12 and designated as the "zone" light which latter shows whenever the locomotive is within the magnetic

zone of a track inductor. There is further included a speed indicator 13 of the voltmeter type, relays M, G', Y', B, R', S and X, an engineer's reset button 14 presealed in open position, an emergency reset button 15, a speed control mechanism, an automatic brake valve controlled as by the magnet 16, and generators to supply current.

The receiving element and the master relay M may be operated as from the generator 17 on alternating current, or as from the generator 18 on direct current with the aid of an interrupter 19. All other equipment is operated from the D. C. headlight generator, the completion of the circuits being inferred from the plus and minus signs. The interrupter used in the D. C. power circuit may be of the commutator type, mounted on the generator shaft or driven by a small electric motor.

The speed-limiting device diagrammatically illustrated in Fig. 6 at SL includes a rheostat 20 arranged to vary the resistance in the speed control circuit in accordance with the speed limit set by the speed-limiting device, as will be described hereinafter. The speed-limiting device is controlled by the electro-magnet 21 so that when this magnet is energized the speed-limiting device and the rheostat 20 will be maintained in their normal or high speed position. In normal position the said rheostat offers only a small part of its resistance to the speed control circuit. When the magnet 21 is de-energized, the contact arm 22 of the rheostat will be moved to the left as seen in Fig. 6 as the train moves through the block, causing the resistance to be gradually increased as the engine approaches the stop signal.

The speed governor device diagrammatically illustrated in Fig. 6 at TS includes a rheostat 23 having its contact arm 24 arranged to be operated by a centrifugal device geared to the axle of the locomotive, to vary the resistance in the speed control circuit according to the actual train speed. The rheostats 20 and 23 are connected in series so that their combined resistance will control the current to the speed-control relay S, which operates the automatic brake valve circuit as hereinafter explained.

The shaft 25 turning the arm 24 of the speed governors TS also operates a potentiometer SM which includes a resistance 26 and contact arm 27 controlling the voltage applied to the voltmeter type speed indicator 13 in accordance with the train speed. The two terminals of the potentiometer resistance are connected across the generator circuit, and the contact arm 27 is connected by the wire 28 to the plus side of the speed indicator, thus providing a range of voltage from 0 to the full voltage of the generator.

The primary coils 3 and 4 of the locomotive receiver are continuously energized as over the wires 30 and 31 with either alternating or with interrupted direct current. The magnetic flux set up by the coil 3 induces a current in the secondary coil 6 which energizes the magnet coils of relay G' by virtue of the connecting wires 32 and 33. Likewise, the magnetic flux set up by the coil 4 induces a current in the secondary coil 7 which energizes the magnet coils of relay Y' by virtue of the connecting wires 34 and 35. The armatures 36 and 37 of relays G' and Y' respectively are maintained in a balanced condition by spring action when the engine receiver is not in magnetic registry with a track inductor, so that the contacts 38, 39, 40 and 41 operated thereby, will be closed.

The "home" inductor is located at the end of the block, and comprises two separate laminated core members 45 and 46 each provided with a plurality of magnetic poles, each of which poles has wound thereabout a choke coil such as indicated at 47 and 48 for controlling the passage of magnetic flux through the poles. From Figs. 5 and 6 it will be readily seen that the core members of both the train receiver and the track inductor are relatively similarly disposed so that the members of the receiver may pass over the members of the inductor. The number of poles in the latter may be varied in each trackside group with their choke coils connected in series. That is to say, all of the coils 47 are serially connected, and all of the coils 48 are serially connected, but coils 47 and 48 are not connected with each other. The series of core members 45 and 46 are of sufficient length to enable the engineer to stop the train with the engine receiver at some point over the inductor. At a clear signal the series of coils 47 are open circuited, while the coils 48 on the opposite core member are close circuited through the contacts of the line relay 50. At a caution signal the condition of the choke coil circuits is reversed. At the stop signal both series of choke coils 47 and 48 are open circuited as to be explained hereinafter.

The "approach" inductors indicated in Fig. 1 at B', C', etc. are each located approximately 1000 feet in the rear of their associated "home" inductors indicated at B, C, etc., in said figure and are similar in construction to the latter, except that they are shorter in length. The approach inductor is designed to indicate the condition of the circuits in the block being approached.

Both inductors are preferably fastened to the ties but may be placed elsewhere as found most suitable either between the rails or outside thereof. The coils and laminated core members of said inductors are preferably enclosed in a metal housing for protection.

The secondary coil 8 is wound so as to include one leg of each of the cores of the receiving elements 1 and 2, and the primary coils 3 and 4 being similar in every respect, but of opposite polarity, the current induced in coil 8 by the primary coils will normally be neutralized. However, should the primary coil 3 be in magnetic registry with a track inductor on which the choke coils 47 are open circuited, and the primary coil 4 be in registry with the choke coils 48 which are in closed circuit, the soft iron core 45 of coils 47 will form a path of low reluctance for the flux of primary coil 3 as clearly indicated, whereby the current induced in coil 8 by the primary 3 will be greatly increased. The choke coil 48 being in closed circuit the flux from coil 4 cannot enter the soft iron core 46 as shown in Fig. 6, and therefore there will be no increase of flux in the primary coil 4. Therefore the flux of the coil 3 being greater than that of coil 4, a current will be induced in coil 8 of a relative polarity corresponding to the flux in the core of primary coil 3. The current thus induced in coil 8 energizes the winding 55 to polarize the armatures 56 and 57 commonly pivoted as at 58 to the master relay M.

Relay coils 59 and 60 are constantly energized by the same power unit that energizes the primary coils 3 and 4, in a circuit which includes the wire 31, wire 61, coil 60, wire 62, coil 59, wire 63, the armature 64, contact 65, wire 66, wire 67, to and through the serially connected contacts 39 and 41, wire 68 to point 69 where the current divides, thence through either closed contact 40 or 38 as by the wires 70 or 71, respectively, over

the common wire 72 to the point 73, thence over the wire 74 to wire 30 leading to the generator.

The armatures 56 and 57 of the master relay M each operate through half the distance between the poles of the coils 59 and 60 and are attracted to the right or left position in accordance with the relative polarity of the current energizing the coil 8, and its relation to the relative polarity of the coils 59 and 60. Each of the armatures is provided with a stop not illustrated but against which it rests at its center position when it is not attracted by the poles of the coils 59 and 60. When said armatures are attracted to the left as seen in Fig. 6, armature 56 closes the contacts 80, 81 and 82 and opens contact 83, while simultaneously the other armature 57 is moved to its center position where it comes to rest against the aforementioned stop, thereby causing contacts 84, 85 and 86 to be open and contact 87 to be closed. Thus, since the armatures are metallically and electrically connected through their pivot 58 and wire 88 to the generator 18, the circuit will be established from the relay armature 56 through contact 80 over the wire 90 to and through the green cab light 9 back to generator over wire 89; and from the said armature 56 through contact 81 current is supplied over the wire 91 to energize the control magnet 21 of the speed-control mechanism connected to the generator as by the wire 92; and current from said armature 56 through contact 82 and wire 93 energizes the magnet coils of relay B connected to the generator as by the wire 94.

When the armatures 56 and 57 are attracted to the right the contacts 84, 85 and 86 will be closed and contact 87 opened by the armature 57, while the contacts 80, 81 and 82 operated by the armature 56 will be opened and contact 83 will be closed. This completes a circuit from the armature 57 through contact 84 and wire 95 to the armature 96 of the relay R' which if closed against contact 97 will energize the control magnet 21 through the wire 91. A circuit from said armature 57 through contact 85 over wire 98 lights the yelow cab signal light 10 connected to the generator return wire 89. Through contact 86 current is supplied by said armature, over the wires 99 and 93 to energize the coils of relay B.

The coils 59 and 60 of the relay M are of equal ampere turns, so that the attraction from each pole upon an armature 56 or 57, in the center stop position, is neutralized. When either armature is attracted to the right or left position it will be maintained in that position due to the difference in the air gaps. Should the circuit to the coils 59 and 60 be opened the armature being held by one of the poles will be released, and both armatures will then remain in central position until all the coils 59, 60 and 55 become energized.

A circuit from the generator 18, over wire 100 through the armature 101 and front contact 102 of relay B, over wire 103, armature 104 and front contact 105 of relay S, over the wire 106, energizes the brake valve magnet 16 conected to generator as by the wire 107.

When the engine is running forward, current is supplied from the generator 18 over the wires 108 and 109 through the switch members 110 and 111 respectively, and contacts 112 and 113 of the reversing switch, over the wire 114 to and through the magnet coils of relay X conected to the generator as by the wire 115. A front contact 118 of this relay is included in the speed control circuit, the circuit being from the generator 19 over wire 116, armature 117 and front contact 118, over wire 119 to the contact arm 22 and through the rheostat resistances 20 and 23 through the contact arm 24, over wire 120 to point 121, to the armature 122, contact 123, wire 124 and the magnet coils of relay S back to generator over the wire 125, forming a stick circuit.

As long as the combined resistance of rheostats 20 and 23 is not sufficiently high to cause relay S to drop its armature, the circuit will be maintained through front contact 105 to the brake valve magnet 16. However, when the control magnet 21 becomes de-energized, the rheostat arm 22 will be operated by the speed-limiting device to cause its resistance 20 to be gradually increased as the train advances through the block, requiring a reduction of the train speed to lessen the resistance 23 of rheostat TS, otherwise, the combined resistance of 20 and 23 will be increased to the point where relay S will be deenergized, thereby causing an application of the brakes. Relay S, being in a stick circuit, will remain deenergized until the engineer's reset button 14 is operated, thus forming a shunt by the wires 130 and 131 around contact 123 so that relay S will be restored to energized condition provided the speed has been properly reduced. As the circuit through the engineer's reset button 14 is a branch of the speed control circuit, the operation of the button will have no effect if the speed is above the prescribed rate.

Relay R' is energized by a circuit from the generator 18 over wire 132, through the upper end of armature 36, contact 133 of relay G', over wire 134, through the magnet coils of relay R' back to generator by wire 135. Relay R' may also be energized by the generator through the wire 136, upper end of armature 37 of relay Y', through contact 137 over wire 138 leading to wire 134 and relay R'. Relays G' and Y' are operated only while the engine is over a track inductor, and hence relay R' will ordinarily be energized only at this time, except when the speed-limit cam is out of normal position and contacts 140 and 141 of the speed-control mechanism are closed as will be later described; under the last mentioned condition relay R' will be maintained energized after the engine passes off the track inductor, by a stick circuit from the generator 18 over wire 142, spring tensioned switch member 143, (see Fig. 8), contact 140, wire 144, armature 145, contact 146 and coils of relay R' back to generator over wire 135. When the speed mechanism cam is restored to normal position contact 140 will be opened thereby causing relay R' to become deenergized, as hereinafter explained.

When relay G' or Y' is operated by the track inductor, the circuit will be completed through contact 148 or 149 over the wire 150 or 151 respectively to the wire 152, thence to the blue "zone" light 12 connected to the generator as by the return wire 89. Thus the blue light will show whenever the engine is over a track inductor in position to receive signal indications.

When relay M is deenergized and its armatures are both in central stop position, a circuit will be completed from the generator 18 as by the wires 155 and 156 through contacts 83 and 87 to the red cab signal light. Two red lights, operated on independent parallel circuits from relay M, are provided, so that the breaking of a wire between said relay and said lights or the

burning out of a lamp will cause only one red to show instead of two, and thereby providing an indication of trouble.

Should the locomotive be reversed one of the switch members such as 110 of the reversing switch will be operated, opening the contact 112 and closing the contact 157; and after the engine has moved approximately 50 feet in said reverse direction the other switch member such as 111 will be operated, thereby opening the contact 113 and closing the contact 158 as will be later described.

When the reversing switch member 110 is operated, the closing of contact 157 establishes a circuit from the generator through contact 157, over wire 160, to and over the wire 161 containing a resistance 162 imposing a 15 M. P. H. speed limit, through the rheostat 23, its arm 24, wire 120 to the point 121 through the armature 122, contact 123, wire 124, and the coils of relay S back to the generator. When the switch member 111 is operated (after the engine has moved 50 feet) both contacts 112 and 113 will be open and both contacts 157 and 158 will be closed. The opening of the contacts 112 and 113 causes the relay X to be deenergized. As the armatures of relay X are released the contacts 65 and 118 will be opened, and contact 166 will be closed. The movement of the armature 64 from contact 65 opens the holding circuit through the coils 59 and 60 of relay M, thereby causing the armature of relay M to be released to the center stop position, opening contacts 80, 81, 82, 84, 85 and 86, and establishing the circuit to the red cab signal light through contacts 83 and 87. The opening of contact 118 of relay X opens the circuit to the rheostat SL, so that the speed-control circuit will be maintained through the 15 M. P. H. resistance unit 162 in series with rheostat TS, instead of through resistance 20 in series with resistance 23 as in forward running. Therefore, the movement of the engine of more than 50 feet in the reverse direction automatically changes the speed limit from that set by the speed-limiting device SL for forward running, to a predetermined slow speed rate governed by the resistance 162 for reverse running, and at the same time the movement of the armatures of relay M to the center stop position changes the cab signal indication to red. When the engine is run forward again, the members 110 and 111 of the reversing switch will be automatically returned to their forward running position, thereby again energizing the coils of relay X, and through the closing of the contact 65 reestablish the circuit through the coils 59 and 60 of relay M. However, the armatures 56 and 57 will not be moved until they are polarized by current in the coil 55, and the red light and slow speed restriction will therefore be maintained until the engine passes over a track inductor, when the cab signal and speed limit will be automatically changed in accordance with traffic conditions.

Under normal conditions of traffic the cab signal indications will be changed from green to yellow and then to red as the train approaches an occupied block. Should some abnormal condition arise so as to cause the cab signal to change from green to red (without the yellow indication therebetween) the deenergization of relay M and the opening of the contact 86 will deenergize relay B, thereby releasing the armature 101 and opening the contact 102, so as to cause the deenergization of the magnet 16 and an automatic application of the brakes. Should this occur the emergency reset button 15 must be operated, thereby establishing a circuit from the generator over the wire 170 and button 15, over the wire 171 to the point 172, thence over the wire 173 to and through the coils of relay B back to the generator, and relay B will be maintained energized through the stick circuit from the spring tensioned switch member 143, through its contact 141 of the speed-control mechanism over wire 174 to contact 175, armature 176 of relay B, to wire 173 through said relay to generator, said contact 141 will be closed due to the control magnet 21 being deenergized by the opening of contact 81 of relay M thereby permitting the movement of the switch member 143 under the tension of its spring. However, when red follows green during reverse travel in a clear block, relay B will be maintained energized due to the deenergized condition of relay X. That is to say under these conditions the armatures of relay X will be released whereby armatures 177 will close contact with 166 completing the circuit from the generator over wire 116 through said armature and contact to the point 172, thence over the wire 173 through the relay B back to the generator.

A speed indicator 13 of the voltmeter form sealed to read in miles per hour instead of the usual voltage scale may be operated from the potentiometer SM, the contact arm 27 being moved over the resistance 26 from left to right as seen in Fig. 6 as the speed increases, by the same centrifugal device that operates rheostat TS. The D. C. generator 18 is connected across the potentiometer resistance 26, while the moving contact arm 27 connects with the plus terminal of the speedometer 13. When the train is at rest said contact arm is at the negative end of said resistance and there will be no voltage on the speedometer. As the speed increases the contact arm moves over the resistance toward the positive end, increasing the voltage on the speedometer until the positive end of the resistance is reached, where the full voltage of the generator is obtained.

A plug 180 is provided, at a convenient location in the roundhouse or vicinity, which plug is connected to a power line of a voltage higher than that of generator 18, which plug when inserted in the receptacle 181 provided therefor on the locomotive, establishes a circuit over the wire 182 through the resistance 183 to the wires 131 and 124, through the coils of relay S through the wire 125 and common return wire of generator 18 which is connected to the wire 184 leading back to the receptacle. This circuit provides an auxiliary pick-up means for relay S to put the train control system in service without necessitating the operation of the reset button 14. The button 14 is preferably located within a sealed box so as to require the breaking of the seal in order to reach the button. By momentarily inserting the plug 180 into the receptacle 181 relay S will be picked up without the necessity of breaking the seals and operating button 14 every time the engine is started in the roundhouse. A voltage considerably greater than that available on the locomotive is required to pickup relay S through the resistance 183. The resistance 183 being in the auxiliary pick-up circuit prevents the engineer from picking up relay S after an automatic stop occurs by inserting a piece of wire between the plus side of the generator and the receptacle 181 to avoid breaking the seal to operate the re-

set button 14. This button may be operated by the engineer as occasion demands but only after its seal is broken. Since this button, under usual and normal running conditions, need not be operated, the seal is examined at predetermined stations or times and if found broken, an accurate and detailed account of the reason therefor is or may be demanded.

As a matter of safety the relays G' and Y' are provided with the contacts 39 and 41 which are connected in series and in circuit with the holding coils 59 and 60 of relay M as previously described. Should either primary coil 3 or 4 become damaged so as to reduce the normal amount of flux, the magnetic pull of the relay G' or Y' would be less than the normal amount necessary to maintain a balanced condition of its armature and as a result, said armature would be moved in a direction opposite to that described when over a track inductor, thereby opening contacts 39 or 41 either of which opens the circuit to the holding coils 59 and 60, releasing the armatures of relay M, displaying the red cab signal, and causing an automatic application of the brakes.

The trackway circuits are as follows. The track is divided into blocks AA—A, A—B, B—C, C—D, etc. by the usual insulated joints and from Figs. 1 and 4 it will be seen that at the entrance to each block such as A—B there is provided a relay 200 connected across the rails which latter are energized in said block by a battery 201 or its equivalent connected across the rails at the opposite end of said block. Upon the deenergization of the relay 200 by a vehicle occupying the block A—B the armatures and contacts of said relay act as a pole changer, thereby causing a reversal of the polarity of the current supplied by the battery 202, which energizes its associated relay such as 203 in the block AA—A just passed by the vehicle.

That is to say the relay 200 has the neutral armatures 204, 205, 206 and 207 as well as the polar armatures 208 and 209. The neutral armatures are attracted by the relay 200 regardless of the polarity of its controlling current, whereas the polar armatures 208 and 209 will be attracted to the right or left as seen in Fig. 4 in accordance with the polarity of said controlling current.

At the entrance to said block there is a "home" inductor, generally indicated by the numeral 210, whose coils 47 and 48 are connected to polar and neutral armatures of the relay 50 which latter is controlled from the neutral and polar contacts of relay 200. When the neutral armatures 206 and 207 are attracted by the relay 200, the relay 50 will be energized thereby attracting its neutral armatures 211 and 212, while the polar armatures of relay 200 are arranged to control the polarity of the current energizing the relay 50 to swing the polar armatures 213 and 214 in the same direction as were the armatures 208 and 209. That is to say, the relay 50 simply repeats the operations of relay 200. On the other hand, when the relay 200 is denergized then all of its armatures will be released so that the circuit including battery 221 will be opened, thus deenergizing not only the repeating relay 50 but an auxiliary relay 220 connected in parallel therewith and releasing the armatures controlled by both.

At a location in the rear, say 1000 feet, of the "home" inductor there is provided an "approach" inductor 215 which is similar in all respects, except as to size, to the inductor 210. The approach inductor is provided with coils connected to neutral armatures 216 and 217 as well as polar armatures 218 and 219 controlled by a relay 220 which is a substantial duplicate of, and connected in parallel with, the relay 50, whereby the same conditions prevailing at relay 50 will be repeated by the relay 220.

The above trackside circuits have been described in connection with block A—B but it is to be understood that a duplication of these circuits including the inductors occur for each block. That is to say, at the entrance to block B—C is a relay 222 which controls neutral armatures 223, 224, 225 and 226 as well as polar armatures 227 and 228 which are connected to repater relay circuits (not shown for the sake of clearness) which are duplicates in every respect of those heretofore described. Also there is a "home" inductor 229 and an "approach" inductor 230 associated with said block B—C which are similar to the inductors 210 and 215 respectively. Likewise the blocks C—D, D—E etc. are provided with relays 231, 232, and inductors 233, 234, 235 and 236 exactly similar respectively to the relay 200, "home" inductor 210, and "approach" inductor 215. Since the trackside circuits form only a subordinate relation to this invention, which starts with the trackside inductors, it is obvious that other circuits and means may be substituted which will provide choking effects upon the poles of the trackside inductors in accordance with traffic conditions.

The operation of the device is as follows.

The green or "clear" signal

At a clear signal, relay 50, controlled by the track circuit including the relay 200, will be energized and its polar armatures 213, 214, will be swung to the right due to the polarity of the track circuit, thereby opening the circuit to the choke coils 47 and closing the circuit through the coils 48. The core of coils 47 will form a path of low reluctance, thereby causing an increased magnetic flux to flow in the locomotive receiving element 1 as it passes over said core, said element including the secondary windings 6 and 8. This increased flux in the core 1 causes an increased voltage to be induced in the winding 6 which is in circuit with the magnets of relay G'. Relay G', now being energized with higher voltage and more current, its ampere-turns are correspondingly increased, so that it has greater attraction on its armature causing it to be moved from its normal or balanced position, opening contact 38.

The circuit through choke coil 48 being closed by the contact of relay 50, the amount of flux in the other core member 2 of the receiving element will remain practically normal, so that the ampere-turns of relay Y' will not be effected and the contacts 40 and 41 will be maintained closed so as to cause the windings 59 and 60 of relay M to be maintained energized.

The flux of primary coil 3 is of a polarity relatively opposite to the flux of coil 4, but much greater in amount, so the winding 8, which includes one leg of each core member, will have a current induced therein of a relative polarity corresponding to the flux from the coil 3, energizing the coil 55 so as to polarize the armatures 56 and 57 of relay M, causing them to be attracted to the left by the coil 59 and repelled by the coil 60.

The contacts 80, 81 and 82 now being closed, the circuit is established through contact 80 to the green or "clear" light, and through contact 81 the circuit is established to energize the con-

trol magnet 21 of the speed-control mechanism. Through contact 82 the relay B is maintained energized.

The armature 36 of relay G' being attracted out of balanced position also closes contacts 133 and 148. Through the contact 133 the circuit is established to the coils of relay R; while a circuit through contact 148 lights the blue or "zone" cab signal light 12.

The control magnet 21 being energized, the speed-limiting device is maintained in its normal or "high-speed" position (i. e., with the arm 22 near the right hand end of resistance 20 as seen in Fig. 6), permitting the rheostat TS to be advanced to a position corresponding to a train speed of 75 M. P. H. (i. e., with its arm 24 near the right hand end of resistance 23 as seen in said figure) before the total resistance of SL and TS will cause relay S to open. As long as the train speed is kept within the 75 M. P. H. limit the relay S and the brake valve magnet 16 will be maintained energized, and the train may be run at maximum speed.

When the engine passes off the track inductor the flux in the two members 1 and 2 of the receiving element will again be of equal amount, so that relay G' will be energized with the normal amount of current, permitting the armature 38 to resume its normal balanced position with contact 38 closed, the opening of contacts 133 and 148 deenergizing relay R and extinguishing the blue zone light 12. The current induced in coil 8 by the primary 3 being again equal to that induced by coil 4, the current in coil 8 will be neutralized so that a winding 55 will become deenergized, but the armature 56, being in contact with the poles of winding 59, which is energized, will be held to the left so as to maintain the green indication until the next signal location point is reached.

The yellow or "caution" signal

Relay 50 will be energized but its polar armatures 213, 214 will be swung to the left due to the reversal of the polarity of the track circuit controlling said relay under changed traffic conditions, whereby the circuit through the choke coils 48 will be open and the circuit through the coils 47 will be closed. The core of the coils 48 will now be the path of low reluctance so that the flux will be increased in the primary coil 4 when it passes over the track inductor 46, causing an increased voltage to be induced in winding 7, thereby causing the magnet of relay Y' to atttract its armature 37 so as to open contact 40. The flux in the coil 3 not being affected by the track inductor 45, the ampere-turns in relay G' will not be affected, so that the contacts 38 and 39 will be closed so as to maintain the windings 59 and 60 of relay M energized. The winding 8, now receiving an increased flux from the primary coil 4, will cause a current to flow in the circuit including the winding 55 of relay M, polarizing its armatures 56 and 57. The relative polarity of the flux in the coil 4 being opposite to that of coil 3 the current supplied to winding 55 will be of a relative polarity opposite to that supplied at a clear signal, thereby causing the armatures 56 and 57 to be attracted and swung to the right. The contacts 80, 81, and 82 now being open the circuits controlled thereby to the green light 9 and to the control magnet 21 are broken. Contacts 84, 85 and 86 now being closed, a circuit is established to the control magnet 21 through contact 84 and the armature 96 and contact 97 of relay R'. Through contact 85 the circuit to the yellow cab light 10 is complete. Through contact 86, relay B will be maintained energized. While the engine is over the track inductor under these conditions, the relay R' will be held energized by current from contact 137 of relay Y', and through contact 149 the circuit is established to the blue zone light 12.

When the engine passes off the track inductor the current will again be normal in winding 7, permitting the armature 37 of relay Y' to return to its normal balanced position, closing contact 40 and opening contacts 137 and 149, which extinguishes the blue zone light 12 and deenergizes relay R'. When contact 97 of relay R' is opened the circuit to the control magnet 21 will be broken, causing the speed-limiting device to go into operation. As the movement of the rheostat is automatically controlled by the movement of the train through the block, as will be hereinafter specified, the permitted speed limits will likewise automatically be reduced from the maximum to the low speed rate as the train moves forward a predetermined distance through the block. When the low speed limit is reached it will be maintained until a clear or another caution signal impulse is received to reset the speed-limiting mechanism to normal position.

The current induced in coil 8 by the primary 4 being again equal to that induced by coil 3, the current in coil 8 will be neutralized so that winding 55 will become deenergized. The armature 57, being in contact with the poles of winding 60 which is still energized, will be held to the right so as to maintain the yellow indication until the next signal location point is reached.

Repeating the yellow or "caution" signal

With a train running under a caution signal and, at the next inductor, receiving a repetition of the caution signal, relay 50 will be energized and its polar armatures 213, 214 will be swung to the left, as at the previous caution signal, so that the armatures 56 and 57 of relay M will not be moved, they being already in position when the caution impulse is received from the track inductor.

Relay Y' will be operated as previously described, opening contact 40 and closing contacts 137 and 149, thereby establishing the circuit to the blue zone light 12 through contact 149; while contact 137 completes the circuit to energize relay R'.

The speed-limiting device having been released at the previous caution signal, contacts 140, 141 are closed (as will presently be described), thereby establishing a circuit from contact 140 to the armature 145, contact 146 and the coils of relay R', forming a stick circuit. The closing of contact 97 of relay R', completes the circuit from the armature 57 and contact 84 of relay M to energize the control magnet 21. When magnet 21 becomes energized air is admitted to the cylinder of the speed-limiting device hereinafter described restoring the speed-limit cam and rheostat SL to the normal or high-speed position. When the cam reaches its normal position it causes contacts 140, 141 to be opened, thus breaking the stick circuit and deenergizing relay R', and immediately releasing the speed-limiting device, so that the speed-limits will again be reduced from the maximum to the low speed rate as the train moves through the block.

When the engine passes off the track inductor the armature 57 of relay M will be maintained in

its right hand position by the poles of the coil 60.

The red or "stop" signal

At a stop signal location relay 50 will be deenergized, so that the circuits of choke coils 47 and 48 will both be opened by the opening of the relay armatures 211 and 212. Both core members 45 and 46 of the track inductor will now be in condition to form a path of low reluctance so that the increase in magnetic flux will occur in both members 1 and 2 of the locomotive receiver, thereby causing an increase of current in coils 6 and 7, and causing relays G' and Y' to attract their armatures, opening contacts 38 and 40. The contacts 38 and 40 being open the circuit to the coils 59 and 60 is broken, releasing the armatures 56 and 57 of relay M, causing them to assume the middle position between the poles of the coils 59 and 60, against their respective center stops. The flux being increased a like amount in both members of the receiving element, the current in coil 8 will still be neutralized so that there will be no current flow in the winding 55, and the armatures 56 and 57 will not be magnetized. The armatures 56 and 57 being in the center stop position, the control magnet 21 will be deenergized, thereby causing contacts 140 and 141 to be mechanically closed as shown in Fig. 8 and hereinafter described.

The opening of contacts 84, 85, and 86 opens the circuit to the yellow cab light 10, and also to the coils of relay B. Relay B is, however, not released due to the contacts 140, 141 being closed at the speed control mechanism, so as to maintain the relay B energized by a stick circuit from the contact 141 to contact 175, the armature 176 and magnet coils of relay B.

Should the cab signal indication be changed from green to red without the usual caution signal having been received therebetween, the contacts 140, 141 will be open at the time relay M becomes deenergized, and the stick circuit to relay B will not be completed, causing relay B to be deenergized when the contacts of relay M are opened, resulting in an automatic application of the brakes through deenergization of the brake valve magnet 16, regardless of the speed. Should this occur the emergency reset button 15 must be pressed by the engineer, so as to establish a circuit to the coils of relay B to pick up its armatures. The speed-limiting device having also been released by the opening of contacts of relay M, the contacts 140, 141 will be closed, and the relay B will be maintained energized by the stick circuit when the reset button 15 is released.

The closing of contacts 83 and 87 of relay M completes the circuit to the red cab light 11.

Relays G' and Y' having closed their contacts 133, 137, 148 and 149, the circuit to the blue zone light 12 is complete. Relay R' will be energized by the circuit over contacts 133 and 137, but the contact 84 being open no current is supplied to the control magnet 21 and the speed-control mechanism is therefore not affected.

When the engine passes off the track inductor the current in relays G' and Y' will again be normal, releasing armatures 36 and 37 from their unbalanced positions and closing contacts 38 and 40. The circuit now being completed the windings 59 and 60 will again be energized, but the armatures 56 and 57 will remain in their middle positions, since the attraction of the coils 59 and 60 is equal at the middle point of the air-gaps.

Stopping at the "home" inductor

Upon receipt of the red signal from an "approach" inductor the speed of the train is reduced and the engineman is required in the absence of orders to the contrary to bring the train to a full stop at the entrance to the following block. With the locomotive receiver over the "home" trackside inductor he is enabled to receive an indication in the cab of the change in traffic conditions or, if there be provided the usual wayside automatic signals, he may stop his train in view of the signal at said block entrance without coincidence of the inductor and receiver, and get his proceed signal indication direct from the semaphore. In the former case, the trackside "home" inductor is made of sufficient length to permit the train to be brought to a stop with the engine carried receiver in a superposed position thereover.

By proceeding slowly to the home inductor the stop can be easily made, as the blue zone light shows when the engine is in position to receive the signal indication, as hereinbefore mentioned.

Clearing of the "stop" signal

When the indication of the "home" inductor is changed from red to yellow, the armature 57 of relay M will be attracted to the right as previously described for a yellow signal, closing contacts 84, 85 and 86. The circuit is then completed through contact 84, the armature 96 and contact 97 of relay R', to the control magnet 21, restoring the speed-limit cam to normal position as diagrammatically indicated at 250 in Fig. 1, The opening of contact 87 extinguishes the red cab light 11 and, through the contact 85 the circuit to the yellow light 10 is established. Under these conditions, when the engine passes off the track inductor, relay R' will be deenergized, opening contact 97 and deenergizing the control magnet 21, thereby releasing the speed-limit cam and causing the speed-limit to be reduced from the maximum to the low speed rate as the train moves through the block as diagrammatically indicated by the dot and dash "caution" curve line 251 in said Fig. 1.

Should the indication of the home inductor change from red to green the armature 56 of relay M will be attracted to the left as previously described for clear signal, closing contacts 80, 81 and 82. Through the contact 80 the circuit is established to the green light 9, and through contact 81 current is supplied to energize the control magnet 21 so that the speed-control mechanism will be restored and maintained in its normal position, permitting maximum speed as indicated diagrammatically by the dot and dash "clear" line 252 in said Fig. 1.

More particularly referring to Figures 7 to 12 the following description will cover the mechanisms and operations of the speed governing device, the speed limiting device, and the reversing switch device. Power from a locomotive axle is transferred to a shaft such as 260 suitably supported and having mounted thereon a gear 261 enmeshing with another gear 262 carried on one end of a shaft 263 whose other end is supported in a bracket 264. Near this said bracket is mounted any suitable and well known type of centrifugal governor, such as clearly indicated in Fig. 12, and which comprises balls 276 connected to toggles 265 which latter are connected with a sleeve 266 adapted to slide on the shaft 253 when the balls are moved outwardly by centrifugal action.

The sleeve 266 carries rigidly therewith a grooved collar 267 normally controlled as by the spring 268 seating against a fixed stop 269. Riding in the groove of the collar is a pin 270 carried at one end of a crank arm 271 pivoted as at 272 and adapted upon movement to partially rotate about said pivot the other crank arm 273 carrying at its outer end a gear segment 274 whose teeth are adapted to rotate a pinion 275 mounted upon the insulated shaft 25 which carries the arms 24 and 27 of the speed-governor rheostat and the potentiometer respectively, see Fig. 6. The pinion 275 is preferably mounted intermediate the arms 24 and 27 whereby substantial equal movement of each is effected. As the balls 276 move outwardly under increased train speed they will force the collar 267 to the left as seen in Fig. 12 and this, in turn, not only compresses the spring 268 but moves the segmental gear 274 to rotate the aforementioned arms 24 and 27. As the speed of the train reduces, the balls will be returned toward the governor shaft and the arms 24 and 27 will be reversely moved by action of the spring 268, all as will be readily understood.

The shaft 260, connected to an axle of the engine, likewise has mounted thereon a gear 280 adapted to enmesh with speed-reduction gearing ultimately driving a pinion 281 which pinion only functions at certain times, otherwise rotating inactively. In other words, the pinion 281 is adapted to be rotated while the train is moving, but only performs service when the control magnet 21 is deenergized. That is to say, and with particular reference to Fig. 8, when said control magnet is energized it attracts a pivoted armature 282 which in turn closes the exhaust port 283 and opens the inlet port 284 of an air control valve 285, whereby air is permitted to pass through the conduit 286 to the chamber of a cylinder 287 having therein the piston 288. It thus results that the pressure in the cylinder 287 forces said piston to one limit of said chamber. When the control magnet 21 is deenergized its armature will fall and thus open the exhaust port 283 and permit the inlet 284 to be closed by spring pressure whereby the air from the brake line is prevented from passing through the air valve 285, and the air in the cylinder 287 may exhaust through the conduit 286 and the port 283 to the atmosphere.

The piston 288 is mounted on one end of the rod 290 which carries at its other end a frame 291 adapted to slide through a guideway in the rod supporting bracket 292. A heavy duty spring 293 is disposed on the rod 290 and is interposed between the bracket 292 and one end of the frame to normally force said frame to the right as seen in Fig. 8. In other words, the action of the spring 293 is counter to the pressure of the air in the cylinder 287, the strength of said spring being less, in its compressed condition than the pressure on the air line. It will therefore be seen that the air in said cylinder may force the piston and the associated frame to the left as seen in Fig. 8 putting compression on the spring 293 but, when the air pressure is relieved, said spring will force the piston and its frame to the right.

On the underside of the frame 291 is mounted a rack 294 mounted in tangential alignment with the pinion 281 for enmeshment therewith when the frame is moved to the right, the length of the rack 294 being such, with relation to the pitch diameter of the pinion 281 which latter is rotated from the locomotive axle shaft, that the frame 291 will be moved from its left hand position to its right hand position in the interval of time required for the engine to traverse a predetermined distance regardless of its speed. That is to say, the speed reduction gearing between the pinion 281 and the axle of the locomotive is precalculated, and the pinion 281 is preformed of a size such that, when the pinion is in enmeshment with the rack 294 which latter is also of a precalculated length, a known distance will have been traversed by the engine during the time that the rack and pinion are in engagement. The pinion is adapted to be out of engagement with the rack and freely rotatable both before and after the rack has passed the pinion.

Further, between the pinion 281 and the aforementioned gearing reduction, there is interposed a one-way clutch generally indicated at 295 in Fig. 12 whereby the normal rotation of the pinion 281 may be stopped or reversed at certain times through the slippage of the clutch when the rack is moved from its extreme right hand position to its left hand position, as when air is admitted to the cylinder 287. Thus it will be seen that since the pinion 281 normally rotates in the direction indicated by the arrow with the movement of the train through the block, the stroke of the frame 291 is retarded thereby as contra-distinguished from a feeding or driving of said frame by said pinion. As the thrust of the rack 294 is in the same direction as the rotation of the pinion, the clutch is designed to "hold back" the load caused by the compression of the spring 293 leaving the pinion free to turn in the direction opposite to its normal direction when the frame 291 is reset by air pressure against the piston 288. Should the clutch, for any reason, fail to hold, the pinion would be free of its shaft and the spring 293 would move the frame 291 to the end of its stroke immediately, instead of in a retarded manner, resulting in an immediate and automatic application of the brakes. Therefore, any failure of the clutch or pinion mechanism will be on the side of safety.

The upper side of the frame 291 has interchangeably mounted thereon a plate 296 having its upper edge in the shape of a cam 297 the contour of which has been determined by a previously plotted curve such as disclosed in Fig. 7. In other words, miles per hour and distance in feet form the co-ordinates for determining the curve representing the normal braking application effect in a predetermined distance. For instance, if the low speed limit of 15 miles per hour is desired, and a maximum speed limit of 75 miles per hour is permissible, then the curve shown at 298 in Fig. 7 is plotted in accordance with the operating requirements of the railroad, and in this particular curve it will be seen that this speed reduction is permitted within the limit of 3500 feet. The cam surface 297 is therefore made as a true copy of this curve but the end of said cam is prolonged as at 299 in a horizontal plane permitting a predetermined travel of the engine before actual reduction of the speed limits.

A bracket 300 mounted on the cylinder 287 carries at its upper end a pivot 301 about which an arm 302 oscillates, said arm having at its free end a roller 303 adapted to ride upon the cam surface 297. Near the roller 303 there is rigidly secured to the arm an arcuate rack 304 enmeshing with a pinion 305 mounted on one end of an insulated shaft 306 suitably supported as by the bracket 307, and to said shaft is also secured the arm 22 of the SL rheostat. A spring 308 is

disposed between the arm 302 and the above mentioned cylinder in order to maintain the roller 303 in contact with the cam 297, but it will readily be seen that when the said roller travels over the horizontal section 299 of said cam there will be no actuation of the arm 302 and consequently no actuation through the rack 302 of the SL rheostat. On the other hand, when the roller 303 rides on the inclined portion of the cam then said arm will cause the rack and pinion 305 to rotate the arm 22 to change the resistance in the circuit of the rheostat, see Fig. 6. The mechanical and electrical connections are such that when the arm 302 is raised the pinion 305 will rotate the arm 22 causing the resistance of the rheostat SL to be increased an amount corresponding to the movement of the arm 302 by the cam 297. That is to say, the resistance of the rheostat SL will be according to the predetermined shape and arrangement of the cam 297, and as the rheostat SL is connected in series with the train speed rheostat TS and the brake control relay S, the greater the resistance of SL the lower must be the speed of the train and the corresponding lower resistance of the rheostat TS operated thereby, in order to prevent the total resistance of the rheostats from deenergizing relay S, and causing an application of the brakes.

To the rack 294 of the speed limiting cam frame 291 is rigidly fixed a block of insulation 310 adapted to engage a vertically disposed member 311 of a crank, the other member 143 of which constitutes a switch finger adapted to close with the contacts 140 and 141 (see Fig. 6) which are insulatedly mounted on a bracket 312, in Fig. 8 these contacts being one behind the other. A spring 313 through the crank exerts a pressure on the switch member 143 to close said contacts when the other member 311 of said crank is permitted movement toward the right as seen in Fig. 8. That is to say, when air in the cylinder 287 is exhausted by virtue of the deenergization of the control magnet 21, the piston 288 as well as the frame 291 will move toward the right carrying with the latter the block 310, permitting oscillation of the crank about its pivot 314 whereby the said contacts are closed but, when air is again admitted to the cylinder, the piston and its frame 291 are moved in a reverse direction whereupon the block 310 will strike the vertical member 311 of the crank and, in the continued movement of the frame, cause the disengagement of the member 143 from said contacts. The crank is so mounted that the contact closing finger 143 overbalances the same and therefore, should the spring 313 become broken or displaced, gravity would cause the finger 143 to drop away from the contacts 140 and 141, this failure being on the side of safety.

The reversing switch mechanism includes the shaft 260 connected suitably to a locomotive axle, said shaft having mounted thereon a pinion 320 which enmeshes with a gear 321, see Figs. 11 and 12, the gear 321 being mounted on a shaft 322 carried by spaced brackets 323 and 324. The bracket 323 has freely mounted therein a pivot pin 325, on the inner end of which is secured a lever 326 having freely pivoted at its outer end a pair of spaced dogs 327 and 328, each dog being weighted at its lowermost end. The upper end of each dog is adapted to extend into the orbit of a pin 329 rigidly mounted on one face of the gear 321 whereby, when said pin rotates anticlockwise as seen in Fig. 9, the pin will ride over the end of the dog 327 as indicated in full lines, pivoting said dog without effecting the movement of the lever 326, but when the pin 329 moves in a clock-wise direction as seen in said figure, it will engage the side of the upper end of said dog 327 which will be in a position indicated in dotted lines. Continued movement of the pin in said clockwise direction will cause an oscillation of the lever and its shaft 325, said lever snappingly moving (as later described) to a symmetrical position to the left of the line passing through the centers of the shafts 322 and 325. This is made possible because the weight at the end of said dog 327 serves as a stop against the side edge of the lever to prevent pivotal movement of the dog in one direction. The dogs 327 and 328 are symmetrically formed as well as symmetrically disposed on the central longitudinal axis of the lever 326 so that the aforementioned actions are permissible with either dog in either right or left positions of the lever.

On the outer end of the pin 325 is rigidly mounted a somewhat circular member simulating a cam and having two flats 330 and 331, and a pair of notches 332 and 333 disposed between said flats. On opposite sides of this cam member, generally indicated by the numeral 334, are disposed switch members 335 and 336 each pivoted to a suitable support as at 337 and 338. Each of these switch members has associated therewith a block of insulation adapted to contact with the edge of the cam member 334 under the exertion of springs such as 339. These two switch members 335 and 336 are disposed in substantial parallelism, or rather they are adapted to move as a pair in unison, and therefore in Fig. 6 they have been combined diagrammatically in the one member 110. When these fingers are permitted movement toward the right, the finger 336 closes with the contact 112 and when they move to the left, finger 335 closes with the contact 157, current being supplied through said fingers from the charged support receiving current over the wire 108.

It will therefore be seen that when the lever 326 is in the position indicated in Fig. 9, the cam member 334 rigidly associated therewith will be in the position indicated by the dot and dash line but, on the other hand, when the said lever has moved to its left position, then said cam member will have been similarly moved or oscillated to such a position as is shown in Fig. 10. The notches 323 and 333 are so disposed that when the cam member is in either of the positions thus shown, a spring pressed detent 340 will engage a notch and tend to hold the cam member from accidental displacement. Thus it will be seen that the lever 326 is never operatively in a vertical mid-position, but is always in an operative snapped position to either side of the vertical, or in other words is always to the right or left in accordance with the direction of movement of the pin 329. The flats 330 and 331 are so disposed on said member that they will permit such engagement with the insulation blocks, carried by the fingers 335 and 336, that the fingers will be out of engagement with the contact points 157 and 112. The circular portion of the cam member throws the insulation blocks outwardly, correspondingly moving the fingers 335 and 336 about their pivots and into engagement with the aforementioned contacts, but it is important to observe that when one contact finger is disengaged, the other finger is engaged with a contact.

The bracket 324 is similarly but reversely formed with respect to the bracket 323, and all of

the parts hereinbefore mentioned as associated with the bracket 323 are duplicated on the bracket 324, all as will be clear from Figure 11. That is to say, there is a second lever 341 carrying a pair of dogs which are exactly the same as the parts 326, 327 and 328, and there is a second cam member 342 (with a pair of associated contact fingers generally indicated in Fig. 6 by the numeral 111) which is exactly the same as the cam member 334, with a detent 343 for frictionally engaging the member 342. The gear 321 has mounted thereon a pin 344 exactly similar to the pin 329, but diametrically disposed thereto on the opposite side of the gear in the same orbit with the pin 329. The action of the pin 344 with the dogs of the lever 341 is just the same as that described with reference to the other pin 329 and its lever.

As hereinbefore stated, the shaft 260 is directly connected through speed reduction gearing to an axle of the locomotive, and the gear 321 of the reversing switch is connected to the shaft 260. The gear reduction of these various connections is such that with a predetermined distance travelled by the locomotive (say 100 feet) the gear 321 will make one complete revolution. Therefore, by providing the two pins 329 and 344 diametrically opposed and each pin adapted to actuate a switch member in the circuit, it is apparent tha the locomotive will move at least fifty feet in reverse before the completion of the actuation of the switch elements generally indicated by the numerals 110 and 111 and which cause the speed limit to be reduced to 15 miles per hour, and the cab signal changed to red, as hereinbefore described. The matter of fifty feet is not a fixed distance but only arbitrary since other distances could be as well selected within the requirements and flexibility of the system, but this distance is found well suited to operating conditions.

It is obvious that those skilled in the art may vary the details of construction constituting the apparatus as well as the steps constituting the method without departing from the spirit of the invention and therefore it is not desired to be limited to the foregoing except as may be demanded by the claims.

What is claimed is:

1. In a train control the combination of a track inductor influenced by traffic controlled circuits; a train receiver adapted to move over the track inductor and be influenced by said circuits; a train carried circuit constantly energized by a pulsating current said circuit including a primary coil on the train receiver and a relay; a closed circuit also carried by the train said circuit including an electromagnet and a secondary coil on the train receiver, said circuit adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; a second closed circuit on the train including a winding on the armature of said relay and another secondary coil on the train receiver said second circuit likewise adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; two resistances connected in series one controlled by the speed of the train, the other controlled by a speed limiting device; and train carried circuits including said resistances as well as switch, signal and brake control devices subject to influence by the currents induced in said closed circuits.

2. In a train control the combination of a track inductor influenced by traffic controlled circuits; a train receiver adapted to move over the track inductor and be influenced by said circuits; a train carried circuit constantly energized by a pulsating current said circuit including a primary coil on the train receiver and a relay; a closed circuit also carried by the train said circuit including an electromagnet and a secondary coil on the train receiver, said circuit adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; a second closed circuit on the train including a winding on the armature of said relay and another secondary coil on the train receiver said second circuit likewise adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; two resistances connected in series one controlled by the speed of the train, the other controlled by a speed limiting device, one of said resistances being variable and cut out of circuit under reverse running of the train and a third fixed resistance cut in to provide a slow speed limit; and train carried circuits including said resistances as well as switch, signal and brake control devices subject to influence by the currents induced in said closed circuits.

3. In a train control the combination of a track inductor influenced by traffic controlled circuits; a train receiver adapted to move over the track inductor and be influenced by said circuits; a train carried circuit constantly energized by a pulsating current said circuit including a primary coil on the train receiver and a relay; a closed circuit also carried by the train said circuit including an electromagnet and a secondary coil on the train receiver, said circuit adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; a second closed circuit on the train including a winding on the armature of said relay and another secondary coil on the train receiver said second circuit likewise adapted to receive induced current from the magnetic flux created in said receiver by said primary coil; two resistances connected in series one controlled by the speed of the train, the other controlled by a speed limiting device; and train carried circuits including said resistances as well as switch, signal and brake control devices subject to influence by the currents induced in said closed circuits, and also including a relay actuating the brake control device when the sum of said resistances is sufficient to release said relay.

4. A train control system comprising, a permissive speed device normally setting up a maximum speed limit and when released setting up speed limits in predetermined arrangement including the maximum, minimum and all speeds therebetween when the train is running with the current of traffic, and means for changing automatically from the forward running speed limits set up by the permissive speed device to a different and predetermined low speed limit when running against the current of traffic after the train has moved a certain predetermined distance in reverse; an actual speed device electrically connected in circuit with the permissive speed device; and means for applying the brakes of the train when the speed of the train exceeds the speed limit set up by said permissive speed device.

5. A train control system comprising electrically actuated speed controlling means on the vehicle for imposing different speed limits in

predetermined arrangement of the maximum, minimum and all speeds therebetween as the train progresses along the trackway, said speed controlling means including a member adapted to be normally held in high speed position under compression by air pressure and when released to be moved to an ultimate low speed position imposing different speed limits in predetermined arrangement, and mechanical means for retarding the movement of said member in accordance with the movement of the train through a predetermined distance along the trackway.

6. In a train control, speed limiting mechanism including inductively influenced traffic controlled circuits having an electromagnet and a resistance including a movable arm therein; a vehicle carried reciprocable cam and a member controlled thereby, said member arcuately engaging a pinion adapted to rotate said arm to vary said resistance; and means to operate said member in a predetermined distance of train travel causing application of brakes when said resistance reaches a predetermined amount.

7. In a train control, speed limiting mechanism including inductively influenced traffic controlled circuits having an electromagnet and a resistance including a movable arm therein; a vehicle carried reciprocable cam and a member controlled thereby, said member arcuately engaging a pinion adapted to rotate said arm to vary said resistance; and means to operate said member in a predetermined distance of train travel causing application of brakes when said resistance reaches a predetermined amount, said means including a rack carried by said cam and a pinion geared to an axle of the train.

8. A train control system comprising a permissive speed device including an electrical resistance and a reciprocable member normally setting up a maximum speed limit and when released setting up speed limits in predetermined arrangement including the maximum, minimum and all speeds therebetween when the train is running with the current of traffic, and means for changing automatically from the forward running speed limits set up by the permissive speed device to a different and predetermined low speed limit when running against the current of traffic after the train has moved a certain predetermined distance in reverse; an actual speed device including another electrical resistance serially connected in circuit with the resistance of the permissive speed device; and means for applying the brakes of the train when the speed of the train exceeds the speed limit set up by said permissive speed device.

9. A train control system comprising electrically actuated speed controlling means on the vehicle for imposing different speed limits in predetermined arrangement of the maximum, minimum and all speeds therebetween as the train progresses along the trackway, said speed controlling means including a member adapted to be normally held in high speed position and when released to be moved to an ultimate low speed position imposing different speed limits in predetermined arrangement, and mechanical means for retarding the movement or said member in accordance with the movement of the train through a predetermined distance along the trackway.

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