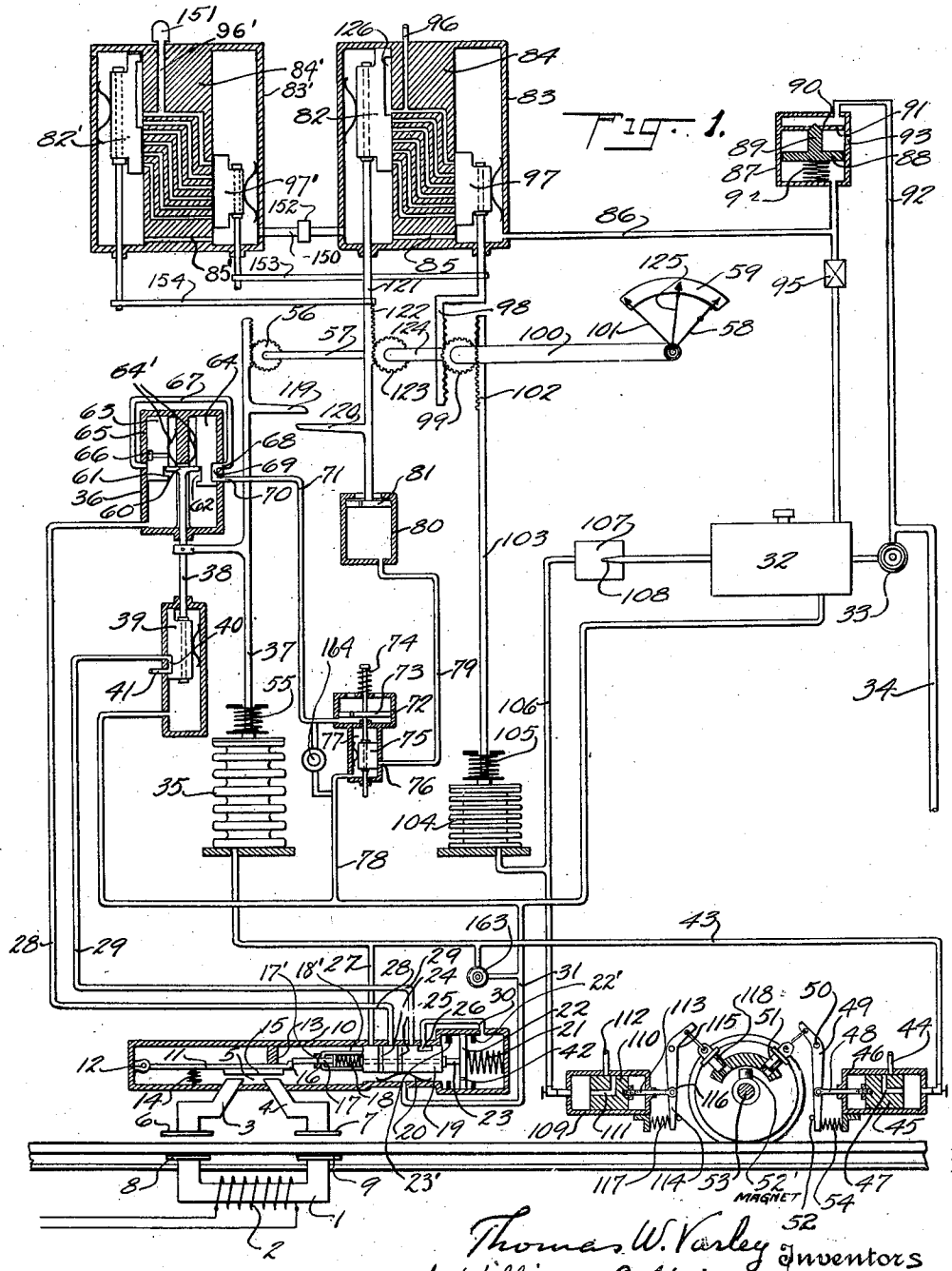
June 24, 1930. T. W. VARLEY ET AL 1,765,782

PNEUMATIC TRAIN CONTROL

Original Filed May 6, 1921 2 Sheets-Sheet 1

Fig. 1.

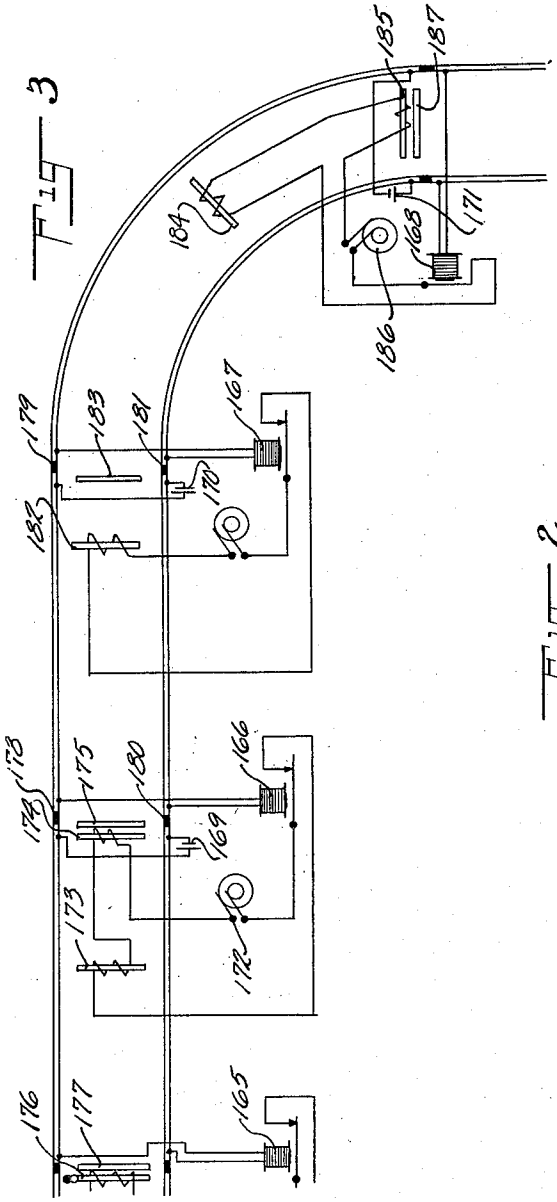


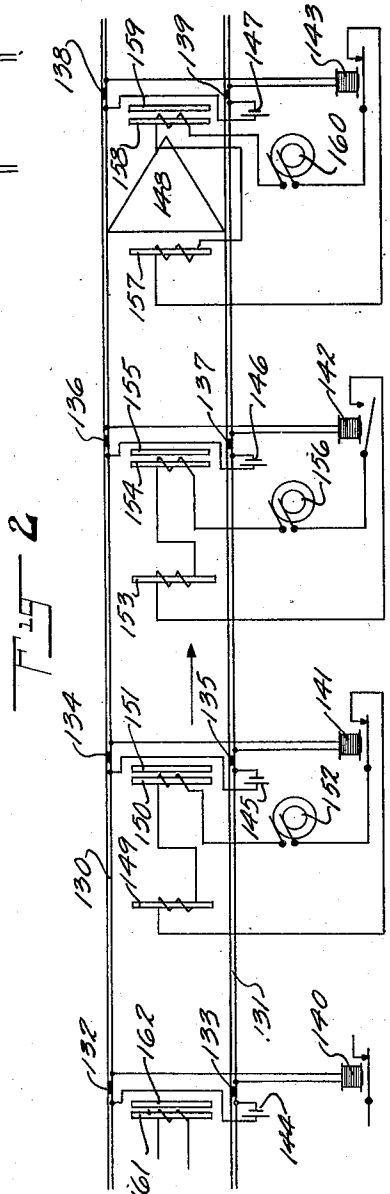
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PNEUMATIC TRAIN CONTROL

Original Filed May 6, 1921 2 Sheets-Sheet 2





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UNITED STATES PATENT OFFICE

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PNEUMATIC TRAIN CONTROL

Application filed May 6, 1921, Serial No. 467,362. Renewed November 11, 1925.

This invention relates to train control systems wherein a train or vehicle is allowed to proceed or is compelled to be slowed down to a predetermined speed or stopped according to track conditions. Suitable signals may also be included in the equipment to indicate existing conditions to the driver of the vehicle.

The present invention is an improvement upon that of Patent 1,598,758 granted on our application Serial Number 273,959 filed January 30, 1919, the control devices in the present application, as well as in the prior application referred to, being operated by fluid pressure controlled by inductors distributed along the right of way or track, the present case setting forth improved controlling devices.

Claims 6–14 inclusive in this application were allowed in the application of the present applicants, Ser. No. 537,113 (renewal of application Ser. No. 117,534, filed August 29, 1916); application Ser. No. 537,113 having become abandoned September 12, 1924.

Other and ancillary objects of the invention will appear hereinafter.

In the accompanying drawings which illustrate the invention—

Fig. 1 is a diagrammatic view showing the arrangement of pneumatically operated apparatus upon the vehicle and its relation to the track apparatus.

Fig. 2 is a diagrammatic view showing the arrangement of track inductors and circuits; and

Fig. 3 is a diagrammatic view of track inductors and circuits as applied to the control of the speed of a vehicle on a curve.

Referring to the drawings and first to Fig. 1, an inductor is indicated as comprising an iron yoke 1 energized by means of a winding 2 controlled according to track conditions, as will be hereinafter more fully referred to. Arranged upon the vehicle is a magnetic yoke comprising horns 3 and 4 between which is an air gap 5 and connected with each of these horns are plates 6 and 7 adapted to be presented to, and spaced away by an air gap from, plates 8 and 9 on the track inductor. Horns 3 and 4 extend within a receptacle 10 and within said receptacle and bridging the gap 5 is a magnetic member 11 pivoted to the receptacle at 12 and normally held in elevated position against the abutment 13 by means of a spring 14. A brass plate 15 upon the member 11 prevents that member from freezing to the pole pieces 3 and 4.

When the winding 2 of the track inductor is energized, and the vehicle is so positioned that the plates 6 and 7 are passing over the plates 8 and 9, the magnetic circuit of the yoke 1 will be completed through the horns 3 and 4 and the member 11. This will result in the attraction of a member 11 and a drawing down of the end 16 of that member out of the path of a plunger 17 which bears against one end of a spring 18, the other end of the spring bearing against the piston-like structure 19, acting as a slide valve, and which is held against its seat by a spring 20 assisted by the air pressure in the receptacle 10. The drawing down of the end 16, as described, will result in the unlocking and movement of the valve 19 to the left (Fig. 1) under the influence of a spring 21 interposed between the piston 22 and the end of the receptacle 10, the piston being secured to the end of the valve 19 by means of a rod 23. The spring 21 is stronger than the spring 18 so that after the valve 19 has been moved to the right so that the piston 22 comes against the stop 22′, the spring 21 will compress the spring 18 until the collar 17′ fixed on the plunger 17 comes against the frame 18′ secured to the valve 19. The spring 18 is thus set to shoot the plunger outwardly as soon as the member 11 is depressed.

Within the valve 19 are three ports or passages 24, 25 and 26 which are normally out of registry respectively with the pipes 27, 28 and 29. When, however, the member 11 is drawn downwardly as before referred to, and the valve 19 moves to the left the port 26 will connect the pipes 29 and 30 and the pipes 27 and 28 will be connected with the interior of the receptacle 10 which is connected by a pipe 31 with the low pressure reservoir 32 of compressed air, the reservoir 32 receiving its supply through a suitable reducing valve 33 from the pipe 34 which is

directly connected with the fluid supply for operating the air brakes.

The pipe 27 leads to the interior of an expansible receptacle 35 which may be what is commonly known in the art as a "sylphon," that is to say it is a closed cylinder with corrugated walls of thin material such that it lengthens or expands as the pressure within it is increased, and contracts or shortens as such pressure is decreased. The pipe 28 leads to the interior of a receptacle 36. When, therefore, the vehicle passes over an energized track inductor, compressed air will be admitted into the sylphon 35 and receptacle 36. The rod 37 secured to the end of the sylphon will then be forced upwardly carrying with it the stem 38 of the valve 39, which stem is secured to the rod 37. This movement will continue until the valve port 40 connects the pipe 29 with the exhaust to the atmosphere at 41.

Upon the drawing down of the member 11, the valve 19 is moved to the left by the action of the spring 21, and the fluid pressure on the sides of the piston 22 having been equalized by leaking through a port 42 of restricted area this movement takes considerable time. This moving to the left having connected the sylphon 35 with the source 32 of fluid pressure, the sylphon expands as before described, until the pipe 29 is placed in communication with the atmosphere, as above referred to.

It is to be observed that at this time the pipe 30 will be connected with the pipe 29 through the valve port 26 of valve 19 and consequently the pressure will exhaust from the right hand side of the piston 22. The pressure upon the left-hand side of the piston, therefore, (it being in connection with the fluid pressure reservoir 32 by means of the pipe 31,) will force the piston 22 to the right against the pressure of the spring 21. The movement of the vale 19 to the right to a sufficient degree will result in the rising of the member 11 so as to prevent the return of the valve to the left. This movement of the value 19 to the right serves to disconnect the pipes 27, 28 and 29 from receptacle 10 so that the expansion of the sylphon 35 is arrested. It is further to be observed that as soon as the member 11 has been drawn down the plunger 16 will immediately shoot over it so that no matter how fast the vehicle passes the track inductor the member 11 cannot lock the valve 19 until operations as described have been completed.

Communicating with the interior of the sylphon 35 by means of the pipe 27 to which it is joined, is a pipe 43 which, by a suitable valve mechanism, communicates with the exhaust 44 to the atmosphere. This connection is controlled by a reciprocating piston valve 45 which reciprocates in a cylindrical casing 46 and has a port 47 communicating with the interior of the piston 46 and movable into and out of registry with the pipe 44 as the valve is reciprocated. The pipe 43 being in communication with the interior of the cylinder 46, as shown, it will be apparent that when the port 47 is in registry with the port 44, the interior of the sylphon 35 will be connected with the atmosphere. The piston 45 is moved by a piston rod 48 which, at its outer end, is pivoted to the lever 49 which is pivoted to the body or frame of the vehicle at 50 and at its upper end is linked with a plunger 51 of magnetic material, while the lower end of the lever 49 is pressed against a stop 52 by means of a spring 54. The valve 45 is, therefore, normally held in the position as shown in the drawing (Fig. 1) but is thrown to the right so that its port 47 passes the opening of the pipe 44 by the drawing in of the plunger 51 which is occasioned by the passage across its end of the magnet 52′ secured to the axle 53 of the car. This magnet may be a permanent magnet or energized in any other suitable way, and it will be seen that as it passes the end of the plunger 51, that plunger will be drawn in and the valve 45 thrown to the right (Fig. 1) against the force of the spring 54. In this movement the port 47 will pass the pipe 44, the sylphon 35 being thus momentarily connected with the atmosphere during such passage.

The magnet 52′ having passed out of the zone of its influence on the plunger 51, the spring 54 will force the valve 45 to the left (Fig. 1), the port 47 again passing the exhaust pipe 44 and connecting the sylphon 35 with the exhaust. It will be observed that when the valve 45 is in either its extreme right or left hand position, the port 47 will not be in registry with the pipe 44 and that therefore exhaust connection is established only during the passage of the port 47 by the opening of the pipe 44, and that the movement of the valve is occasioned in one direction by the pull of the plunger 51, and in the other direction by the spring 54 so that the rate of travel of the valve in either direction is constant regardless of the speed of the vehicle, and that for each revolution of the axle there are two periods of exhaust communication established and that these periods are of the same duration regardless of the speed of the vehicle.

It will further be observed, however, that the number of the exhaust communications established is a direct function of the number of rotations of the axle of the vehicle and consequently, since the amount of exhaust opening for one revolution is a constant, the total exhaust opening is proportional to the number of revolutions of the axle, that is to the distance traveled by the vehicle. It is thought that it will be apparent that this, the total exhaust opening, is purely a function of the distance and not of the speed, because

the amount of exhaust is dependent upon the number of revolutions of the axle regardless of the time consumed in effecting them. Of course, the rate of exhausting of 35 is directly proportioned to the speed. It having been seen that the sylphon 35 is supplied with a certain amount of air under a certain pressure, it will be seen that thereafter the sylphon will assume a position depending upon the amount of air which has been exhausted from it, and since this is accomplished according to the distance which the vehicle travels, the position of the sylphon is an indication of the distance traveled by the vehicle from a given point. As we have seen the action is initiated by the passing of the vehicle receiver over the track inductor and consequently the sylphon occupies a position according to the distance which the vehicle has traveled from an energized track inductor. As the sylphon 35 expands it pushes up the rack-rod 37 against the tension of the spring 55 and the rack of the rod meshes with the gear 56 fixed to the rod 57. Fixed upon the rod 57 is a pointer 58 adapted to move over a scale 59. When the sylphon is forced upwardly the pointer is moved clockwise into its initial or zero position, and as the sylphon contracts with the distance traveled by the vehicle, the pointer moves counter-clockwise over the scale so as to indicate the distance traveled by the vehicle.

The rising of the rod 37 also causes the rising of the valve stem 38 and the actuation of the valve 39 as above described.

The rising of the rack rod 37 also performs another operation as will now be described. The rod 38 which moves up and down with the rod 37 has at its upper end a cross head 60 which engages in the recesses 61 and 62 in the slide valves 63 and 64 in the receptacle or casing 65. When the rod 38 is pushed to its uppermost position as shown in the drawings, the valves 63 and 64 are in their uppermost position, the valve port 66 is out of registry with the end of the pipe 67 which connects with the port 68 while the valve port 69 connects the port 68 with the port 70 from which leads the pipe 71. It will be seen that as the head 60 drops as the sylphon 35 is exhausted, the head 60 will come against the bottom of the recess 61 and carry along with it the valve 63. After a small movement of the valve, the port 66 in the valve 63 will register with the end of the pipe 67, thereby connecting the interior of the receptacle 65 with the pipe 67 which communicates (the valve 64 remaining in its uppermost position on account of the pressure exerted by a spring 64′ coacting therewith) with the pipe 71 and if the valve 19 is, at this time, in its left hand position, as above described, the interior of the receptacle 36, and pipe 71, will be connected to the compressed air reservoir 32. If, however, at this time valve 19 is in its right hand position, any pressure trapped in 36 is exhausted through pipe 71 and the bleed port in piston 73, the volume of trapped pressure fluid being wholly insufficient to cause any actuation of this piston 73. It may here be observed that when the head 60 is moved upwardly it engages with the valves 63 and 64 as shown in Fig. 1 so that during the upward movement no connection is established with pipe 71 because at no time when the port 66 registers with the pipe 67 are the ports 68 and 69 connected. The pipe 71 communicates with the cylinder 72 beneath the piston 73 which is forced upwardly against the resistance of the spring 74. The piston 73 is connected with a slide valve 75 controlling the port 76 and when the piston 73 is forced upwardly as described, the port 76 is opened to the interior of the receptacle 77 which is connected by a pipe 78 with the pressure reservoir 32 and consequently pressure is supplied through a pipe 79 to a cylinder 80 beneath the piston 81. This will force to its uppermost position the piston 81 and its connected slide valve 82 within the receptacle 83, which controls the ports in a block 84 which divides the receptacle 83. The two sides of the receptacle 83 are, however, in communication by a passage 85 and both are in communication through a pipe 86 with a cylinder 87 below a piston 88 which carries a valve 89 cooperating with a port 90 in a diaphragm 91. The space above the diaphragm 91 is in communication with the train pipe 34 by means of a pipe 92 and the space between the piston 88 and diaphragm 91 is in communication with the atmosphere through an opening 93 so that, on opening the valve 89, the train pipe 34 will be exhausted and the brakes applied in the well known way. A spring 94 tends to hold the valve 89 closed. Also the space beneath the piston 88 is in communication with the reservoir 32 through a throttling device 95 having a restricted opening so that the air flows slowly into the receptacle from the reservoir. It follows that when the air is exhausted from beneath the piston 88 it takes a considerable time after the exhaust is closed for the pressure beneath the piston to rise to that of the reservoir 32. When the pressure has so risen the valve 89 is seated because the aggregate pressure of the relatively low pressure from the reservoir 32, together with that of the spring 94, is greater than the aggregate downward pressure exerted by the relatively high pressure from the train pipe upon the smaller area presented by the top of the valve.

Returning now to a consideration of the operations taking place in the container 83 (see Fig. 1), and observing that the upper one of the passages or ports in the block 84 is connected with the atmosphere at 96, it will be seen that the passages or ports in the block 84 are controlled upon the side opposite

the valve 82 by a valve 97 which is connected with a rack 98 in mesh with a pinion 99 on a sleeve 100, to which is secured the pointer 101 moving over the scale 59 and indicating speed as will hereinafter appear. The pinion 99 is also in mesh with a rack 102 upon the rod 103 secured to the top of the sylphon 104 so that as the sylphon expands or lengthens the rod 103 will be pressed upwardly which will cause a downward movement of the rack 98 and valve 97. The retraction of the sylphon and rod 103 from the expanded position may be assisted by a spring 105. The position of the valve 97 as shown in Fig. 1 is its lowermost position which it occupies under the greatest pressure which can be applied to the sylphon 104. If, therefore, the vehicle should remain standing and the pressure accumulate in the sylphon 104 to a value equal to that of the reservoir 32, the valve 97 would not move downward sufficiently to uncover the right hand end of the upper one of the passages in the block 84. The pressure within the sylphon 104, therefore, or position of the valve 97 is made to depend upon the speed of the vehicle because of arrangements which will now be described.

The interior of the sylphon 104 is connected by means of a pipe 106 with a receptacle 107 which receives fluid pressure from the reservoir 32 through a nozzle 108 so proportioned and constructed that the fluid is discharged into the receptacle 107 at the desired rate. It will thus appear that if there were no exhaust from the receptacle 107, the pressure in the receptacle and its connected sylphon 104 would become equal to that of the reservoir 32. On account of the restricted area of the nozzle 108, however, this would require time to accomplish, and if the exhaust from the receptacle is made to depend upon the speed of the vehicle, the pressure in the receptacle and its connections will assume a value dependent upon the speed. This may be accomplished by means similar to that already described in connection with the exhaust from the sylphon 35. Thus the pipe 106 connected with the container 107 and the sylphon 104 is in communication with the interior of a cylinder 109 within which slides a piston 110 having a port 111 communicating with the interior of the cylinder and which in its passage from one extreme position to the other communicates with a passage 112 to the atmosphere.

The piston 110 is connected by a piston rod 113 with the arm 114 pivoted at 115, the rod 113 being pivoted to the arm 114 at 116. A spring 117 normally presses the arm and its connected piston 110 to the right as shown. Connected to the upper end of the arm 114, however, is connected a plunger 118 of magnetic material which is drawn inwardly upon the passage of the magnet 52′ as already described in connection with the plunger 51. This operates to quickly thrust the piston 110 to the left, with an exhaust from the sylphon 104 and receptacle 107 being effected in the passage. When the plunger 118 has been released, the spring 117 throws the piston 110 to the right, again connecting the sylphon and receptacle with the exhaust. Thus the sylphon 104 and receptacle 107 are connected with the atmosphere twice in every revolution of the axle of the vehicle, and it will be seen that the duration of connection with the exhaust is independent of the speed of the vehicle, and that the aggregate duration of the exhaust openings, during a given time, is accurately equal to the duration of one opening multiplied by the number of openings. This is of importance because if the period of an opening were dependent upon the speed of the vehicle, such opening would be longer when the vehicle speed was lower and the opening shorter when the speed was fast and so a given number of openings would not represent a fixed duration of aggregate openings.

With the structure shown the aggregate duration of exhaust openings during a given time is directly proportional to the speed of the vehicle.

As the pressure in the sylphon 104 varies according to the speed, the sylphon and its connected valve 97 take up positions accordingly, i. e., valve 97 assumes a position dependent upon vehicle speed.

It will now appear that the slide valves 82 and 97 exercise a joint control upon the air brakes of the vehicle, that the valve 97 varies in position according to the speed of the vehicle, being moved upwardly as the speed increases, while the valve 82 varies in its position according to other conditions as will be hereinafter referred to. The downward movement of the valve 82 is caused by the engagement of a projection 119 on the rod 37 with the projection 120 on the rod 121 so that when the hands 58 operated by shaft 57 and 125 operated by shaft 124 have come into registry the projections 119 and 120 will be in engagement and the rod 121 will move downward with the rod 37 according to the distance traveled by the vehicle and the valve 82 will be moved downwardly accordingly. The actuating rod 121 carries upon it a rack 122 which engages with a pinion 123 on the sleeve 124 which is concentric with the rod 57 and has secured to its end the stop arm or pointer 125 for indicating the position of the valve 82. Normally the valve 82 and its connected pointer 125 are set to a position of normal maximum speed and the valve is not moved downwardly because the projection 119 will not move far enough to come against the projection 120 unless it be desired to reduce that maximum. When that is the case the track inductors are arranged as hereinafter described to cause the distance device

or arm 58 to set the valve 82 for a lower speed maximum. Normally the distance device 58 is advanced and restored without disturbing the valve 82.

The valve 82 has a recess 126 which is closed from the interior of the receptacle 83 and is adapted to bridge all of the ports within the block 84. In the position of the apparatus as shown in Fig. 1, the valve 82 is at the uppermost portion of its travel and none of the other ports in the block 84 is connected with the uppermost port which is connected with the exhaust 96. As the valve 82 moves downwardly more and more of the ports will be placed in communication with the exhaust 96 until they are all in communication therewith. A further movement of the valve 82 will result in uncovering the upper one of the ports and thereby connecting the interior of the container 83 with the atmosphere through pipe 96 and applying the brakes, this notwithstanding the fact that the right ends of the passages in the block 84 are closed by the speed positioned valve 97 in the position as shown in Fig. 1. As the speed of the vehicle increases the valve 97 will rise and first uncover the lowest port and successively uncover the ports above it. When the lowermost port is uncovered by the valve 97 it will be necessary, in order to apply the brakes that the valve 82 shall move downwardly sufficiently to interconnect the lowermost and uppermost ports on the left hand side of the member 84. When the valve 97 has risen so as to uncover the second port from the bottom, it will only be necessary for the valve 82 to move downwardly sufficient to connect the passage from that port with the uppermost port, and so as the speed rises, the distance traveled by the valve 82, before the brakes are applied, will become less and less thus giving a speed distance curve within which the train speed must be kept to prevent an automatic brake application.

It is further to be observed that with the valves in the position as shown in Fig. 1, which corresponds to the passing of the vehicle by a given control point, if the speed is sufficiently great so that the valve 97 is positioned sufficiently high to uncover the uppermost port, the brakes will be applied regardless of the position of valve 82. In other words if a speed prohibitive at all times is attained, the brakes will be applied whatever the position of the vehicle may be.

In Fig. 2 is shown a straight stretch of railway track wherein the rails 130 and 131 are insulated into block sections by means of the sections of insulation 132 and 133, 134 and 135, 136 and 137 and 138 and 139 as is customary in block signal work, and track relays 140, 141, 142 and 143 are connected across the track rails near the ends of the respective sections, while track batteries 144, 145, 146 and 147 are respectively connected across the rails at the other ends of the sections. When a vehicle, as is represented in this figure, as 148, is in a block it connects the rails by a short circuit thereby depriving the track relay of that section of current. Mounted in the road bed between the rails, each block section has three magnets or inductors; thus the block between the insulated sections 132 and 134 has the electro-magnet inductors 149 and 150 and the permanent magnet inductor 151. Each of these magnets may be of the form of the track inductor shown in Fig. 1 so as to cooperate with the receiver of the vehicle of which plates 6 and 7 are the pole pieces. As shown, the coils of the electro-magnets 149 and 150 are connected in series with each other and with a suitable source of current such as the dynamo 152, through front contacts of the track relay 141, the circuit of these magnets thus being closed when the track relay is energized. Similarly the next block to the right is provided with electro-magnet inductors 153 and 154 and a permanent magnet inductor 155 and a dynamo 156 while the block still further to the right is similarly provided with electro-magnet inductors 157 and 158 and a permanent magnet inductor 159 and dynamo 160 and so a uniform equipment of the blocks may be carried on indefinitely.

Tracing the operation of the apparatus on the vehicle as it passes along the track as just described, the receiver on the vehicle of Fig. 1 passes the electro-magnet inductor 161, which inductor is energized because the succeeding block is unoccupied and consequently the track relay 140 is energized and holds its contacts closed. The arm 11 will therefore be depressed and the valve 19 thrown to the left by the spring 21. The sylphon 35 will therefore be expanded. This operates to restore the distance arm 58 to its zero position and also moves the valves 63 and 64 to their uppermost positions. The vehicle then passes on, the valve 39 having caused the valve 19 to assume its initial position once again the sylphon 35 meanwhile contracting according to the distance traveled by the vehicle. When the vehicle has traveled a certain distance, the various ports of valves 63 and 64 will be in such relation, as before described, that the pipe 28 will be placed in communication with the space beneath the bottom of the piston 73. If at this instant the receiver on the vehicle comes within the influence of an active inductor in the track so that the valve 19 is released to move to the left pressure will be supplied beneath the piston 73 which will cause that piston to rise, and the valve 75 with it, thereby connecting the interior of the cylinder 80 with the pressure source 32, and thereby restoring the valve 82 connected with the stop arm 125 to its zero position. Also

the sylphon 35 is again expanded so as to reset distance arm 58, and also reset the valves 63 and 64 to their uppermost position. Also the valve 39 will be moved upwardly so as to open an exhaust to permit the return of the valve 19 to the right as before described.

The permanent magnet inductor 162 is set in the trackway at the ending of a block and the inductor 161 is at such a distance preceding it that the second release of the valve 19 will occur at the proper moment to reset the stop arm 125 and the valve 82 as above described. This occurs at the ending of the block if there be no vehicle in the next block. In starting on this next block, therefore, both the distance and stop arms 58 and 125 and the valve 82 start from zero as shown in Fig. 1. The distance arm 58 and rod 37 move with the sylphon 35 as it contracts and at a certain point in its travel the projection 119 on the rod 37 engages the projection 120 so that the valve 82 moves downwardly with the further contraction of sylphon 35, (see Fig. 1).

We have already seen that in order to effect an application of the brakes the speed valve 97 and its connected arm 101 and the valve 82 with its connected stop arm 125 must be in certain relative positions.

The zero or initial position of the valve 82 and its connected stop arm 125 is that of the maximum running speed of the train desired, as, say, eighty miles per hour. This speed can then not be exceeded as the speed arm 101 will meet stop arm 125 and the valves 82 and 97 will, at that speed, come into such relationship as to apply the brakes. The engineer or motorman can readily see the stop and speed arms and by suitable regulation of the speed keep it within such limits that the speed arm 101 which moves to the right with increase of speed will not reach stop arm 125 and so indicate a brake applying relationship of the valves 82 and 97.

As the vehicle moves from the beginning of the block between the insulated sections 132 and 134 and the distance arm 58 is moved to the left starting from its zero position at the beginning of the block, the stop arm 125 and its connected valve 82 being moved only by the distance device, the engineer is practically unlimited, (within the maximum speed before referred to) in the speed which he may employ. As the vehicle progresses along the track, however, if the distance device proceeds far enough the stop arm 125 and valve 82 are picked up, the stop arm 125 being moved toward the left, and the valve 82 moved downwardly so that the speed which may be employed without bringing the valves 82 and 97 into brake operating relationship steadily becomes less. The engineer must observe these conditions and hold his speed accordingly.

At a certain distance from the end of the block and from the inductors 161 and 162, an electro-magnetic inductor 149 upon the track will operate to restore the distance arm 58 to its zero position. This inductor 149 is located such a distance from the beginning of the block that the stop arm 125 and valve 82 will have been picked up and carried along by the distance device 58 and lug 119 and when the latter is restored the former, valve 82 and arm 125, will be left in their then position, such position depending upon the distance of the inductor 149 from the beginning of the block or from the inductor 162. In other words it depends upon the distance of the inductor 149 from the inductor 162. The position to which the valve 82 is moved, therefore, may be made any that is desired by suitably spacing the inductor 149 along the track from the magnet inductor 162. The valve 82 having been left in this position, the engineer must see to it that the speed of his vehicle does not become great enough to permit the valves 82 and 97 to be brought into such relationship as to apply the brakes.

As the vehicle then progresses beyond the inductor 149, the valve 82 remains in the position to which it has been placed because, as will be seen, there is no other inductor suitably spaced from 149 to give the impulse at the right moment to restore the valve 82. When the receiver on the vehicle reaches the inductor 150, the valve 19 is again released, again resetting the valves 39, 63, and 64 and the distance arm 58 to their original positions, and on passing further along it will encounter the permanent magnet inductor 151 at the end of the block. As will be seen, this inductor has spaced from it the inductor 150 by the same distance that inductor 161 is spaced from the permanent magnet inductor 162. Consequently the valve 19 will be again actuated by the spring 21 at the right moment to restore the distance and stop arms 58 and 125 and the valve 82, and they will start from their zero positions at the beginning of the next block, that is, the block between the insulating sections 134 and 136.

As the vehicle progresses to the right (see Fig. 2) the distance arm 58 moves to the left (See Fig. 1) and after a certain distance has been traversed the vehicle will pass over the inductor 153. Due, however to the fact that the next block (between the insulation sections 136 and 138) is occupied, the track relay 142 is de-energized so that the inductor 153 will produce no effect whatever upon the receiver on the vehicle and therefore the sylphon 35 carrying with it the valve 82 and the stop and distance arms 125 and 58, will continue movement and the speed of the vehicle must be kept below the limit which becomes lower and lower as the vehicle progresses. By the time the receiver on the vehicle arrives at the electro magnet inductor 154 the distance and stop arms 58 and 125 will be well over to the left hand side of the scale and the

valve 82 well towards its bottom position (Fig. 1) so that the speed of the vehicle must be maintained very low in order to keep the speed valve 97 from opening the train pipe exhaust. Then as the vehicle still progresses, if it reaches the permanent magnet inductor 155 before being stopped, the sylphon 35 and distance arm 58 will be reset to their zero positions but the stop arm 125 will be left so far over at the left hand side of the scale and the valve 82 so near the bottom of its travel (Fig. 1) that the vehicle can progress only at a very slow speed and at this speed can enter the danger block containing the vehicle 148. If, however, it is desired to absolutely prevent the vehicle from entering a danger block, the permanent magnet inductor 155 is omitted, when the stop hand will certainly be carried sufficiently to the left and the valve 82 moved sufficiently far down to uncover the upper one of its ports and apply the brakes. In this way the train may be controlled as to its speed and stopping in the blocks, and according to track conditions, throughout an indefinite number of blocks.

A valve 163 is provided whereby a connection may be formed at will by the engineer between the pressure supply reservoir 32 and the distance control sylphon 35. This provides means whereby the engineer may, if occasion arises, restore the distance hand 58 and so prevent the stop arm 125 and valve 82 from being moved into a position of lower speed.

Also a valve 164 is provided which may be operated at the will of the engineer to connect the pressure supply of the reservoir 32 beneath the piston 73 so as to reset the stop arm 125 and valve 82 at will.

In Fig. 3 is shown an arrangement whereby the speed of the vehicle may be regulated, for instance, in slowing up the speed at which it may pass around a curve. In Fig. 3 is shown a track extending around a curve and divided into blocks by insulation which divides the track into sections as is apparent. Thus in the respective blocks are shown track relays 165, 166, 167 and 168 the blocks having at their ends furthest from these relays track batteries 169, 170 and 171. In the block at the left hand end of Fig. 3 is shown a circuit including the front contacts of the relay 166, a dynamo 172 and the electro-magnet inductors 173 and 174, the windings of 173 and 174 being connected in series. Also the block contains the permanent magnet inductor 175. At the beginning of the block or just at the end of the preceding block are the electro-magnet inductor 176 and a permanent magnet inductor 177 arranged as are 174 and 175. The arrangement thus far is the same as that employed in the blocks of Fig. 2. Consequently the vehicle on entering the block between the insulation sections 178 and 179 on the one hand, and 180 and 181 on the other, will, at the beginning of the block, have its stop and distance arms 125 and 58 and the valve 82 in their initial positions. As the vehicle progresses along this block the distance arm will move toward the left (Fig. 1) as before described, until the vehicle apparatus is operated upon by the inductor 182. It will be noted that this inductor 182 is much further from the beginning of the block then 173 is from the beginning of its block and consequently the distance and stop arms and the valve 82 will have moved a greater distance, when the distance arm is reset by the action of 182, it having previously picked up the stop arm and valve 82 and moved them to a lower speed limit so that the engineer will be held to a much lower running speed than in the preceding block. The vehicle then progressing from 182 will pass over the permanent magnet inductor 183 at the end of the block. This inductor 183 being unaccompanied by a properly spaced electro-magnet inductor will only restore the distance arm 58, thus leaving the valve 82 and stop arm 125 at their setting as just referred to. Consequently the vehicle will enter the block to the right of the insulation sections 179 and 181 at its enforced low speed and will consequently enter upon the curve of that block at such low speed. In the block last referred to is an electro magnet inductor 184 in series with a second electro magnet inductor 185 in the circuit of the dynamo 186 and the contacts of the track relay 168. The inductor 184 is spaced from the beginning of its block by the same distance that 182 is spaced from the beginning of its block, so that when the distance arm 58, which was reset at the beginning of the block, is reset by 184, the stop arm retains its setting while the vehicle is passing around the curve in its block. Near the end of this block the permanent magnet inductor 187 is placed, and adjacent thereto and spaced therefrom by a suitable distance to effect the resetting of both the distance and stop arms 58 and 125 and valves 63, 64 and 82 as the vehicle passes over them, is the electro-magnet inductor 185. The vehicle will thus enter into the next block, provided it is clear, with both the speed and distance arms at zero when they will operate as described in connection with the straight stretch of track of Fig. 2 or the left hand block of Fig. 3. If danger conditions exist in any of the blocks of Fig. 3, it will be apparent that the track relay of that block will be dropped and, this being the case, there will be no resetting of the distance arm 58 in the preceding block and the movement of the distance and stop arms and of the valve 82 will continue either to stoppage or a predetermined low speed of the train as before referred to.

To provide an audible signal to indicate to the engineer that he is nearing the limit of his speed and that a further increase of speed

will cause an application of the brakes, there is provided a container 83′ connected with the interior of the receptacle 83 by a pipe 150; this container encloses a block 84′, valves 82′ and 97′ and a passage 96′ communicating with a whistle or other audible signal 151, one side of the block 84′ being connected with the other by means of a passage 85′. The construction and arrangement of the container 83′ and its contents, as described, is precisely the same as that of the container 83, the alarm passage 96′ corresponding to the exhaust passage 96, but in the case of the alarm this passage leads to the whistle instead of to the atmosphere.

To prevent the application of the brakes by exhaust from the container 83′ through the passage 96′ a throttling device 152 is placed in the pipe 150 so that pressure can be accumulated in the receptacle 83′ to sound the alarm but cannot cause an exhaust from the cylinder 87 sufficient to apply the brakes. The valve 97′ is rigidly connected with the valve 97 by means of a bar 153 so that the valves move together and the valve 97′ occupies the same position with relation to its ports that the valve 97 does to its ports. Also the valve 82′ is rigidly connected by a bar 154 with the valve 82 so that they move together but the valve 82′ does not occupy the same position with relation to the ports in the block 84′ that the valve 82 does to the ports in the block 84. The valve 82′ is so related to the valve 82 that it is one step (one port) further downward. Thus in the drawing the valve 82 is shown in its uppermost position so that only the uppermost port is connected with the passage 96, while the valve 82′ is sufficiently low to connect the first two of its ports with the passage 96′. The result is that the valve 82′ is one port ahead, in a downward direction, of the valve 82 so that for a given position of the valves 97 and 97′ the valve 82′ will connect the pressure source with the alarm 151 at the next higher port than that at which the valve 82 would apply the brakes. The result is that the whistle 151 is sounded to give the alarm just within the speed at which the brakes would be applied and being so advised the engineer may avoid a stopping of the train.

While the invention has been illustrated in what are considered its best applications, it may have other embodiments without departing from its spirit and is not therefore, limited to the structures shown in the drawings.

What we claim is:

1. The combination with a vehicle, of air brakes therefor, a plurality of slide valves controlling the application of the brakes, one being operated according to the speed of the vehicle, the other being operated according to the distance traveled by the vehicle.

2. The combination with a vehicle, of air brakes therefor and a plurality of slide valves controlling the application of the brakes, one being operated according to the speed of the vehicle, the other being operated according to the distance traveled by the vehicle, the means for moving the valve controlled according to the distance travelled comprising an expansible container adapted to receive fluid from a fluid pressure source and means for exhausting the fluid from said container according to the distance traveled by the vehicle.

3. The combination with a vehicle, of air brakes therefor and a plurality of slide valves controlling the application of the brakes, one being operated according to the speed of the vehicle, the other being operated according to the distance traveled by the vehicle, the means for operating the said valve according to the speed comprising an expansible container in continuous communication with a source of fluid pressure and means for exhausting fluid from the said container comprising a valve operated according to the speed of the vehicle.

4. The combination with a vehicle, of air brakes therefor and a plurality of slide valves controlling the application of the brakes, one being operated according to the speed of the vehicle, the other being operated according to the distance traveled by the vehicle, the means for moving the valve controlled according to the distance travelled comprising an expansible container adapted to receive fluid from a fluid pressure source, means for exhausting the fluid from said container according to the distance traveled by the vehicle, the means for operating the said valve according to the speed comprising an expansible container in continuous communication with a source of fluid and means for exhausting fluid from said container comprising a valve operated according to the speed of the vehicle.

5. The combination with a track instrument, of vehicle, means including a sylphon adapted to receive a fixed amount of fluid from a pressure source, means operated from the running gear of the vehicle for exhausting the fluid from said sylphon, a second sylphon in constant communication with a pressure source, means operated from the running gear of the vehicle for exhausting the fluid from said second sylphon, a slide valve operated by the first mentioned sylphon, a valve operated by said second sylphon, a block having a plurality of ports controlled jointly by said valves, fluid pressure operated brakes on said vehicle, said passages and valves controlling the said brakes.

6. The combination with a track, of a vehicle movable along the same, magnets along the track, a non-polarized relay on said vehicle adapted to be affected magnetically by said magnets, means controlled by the speed

of the vehicle tending to exert a certain controlling influence on the movement of said vehicle and means controlled by said relay for preventing the exercise of said influence.

7. The combination with a track, of a vehicle movable along the same, magnets along the track, a non-polarized relay on said vehicle adapted to be affected magnetically by said magnets, a train of mechanism driven from a moving part of said vehicle for controlling the movement of said vehicle adapted to be restored to its initial condition by means controlled by the relay and means for stopping said vehicle if said mechanism fails to operate.

8. The combination with a track, of a vehicle movable along the same, magnets along said track, a non-polarized relay on said vehicle adapted to be affected magnetically by said magnets, a stop arm, means driven from a movable part of the vehicle for driving said stop arm, means controlled by said relay for controlling the engagement of said stop arm with its said driving means, a member positioned according to the speed of said vehicle, and a brake actuating means controlled by the relative position of said stop arm and member.

9. In combination with a track, a vehicle movable along the same, a relay on said vehicle, a power line on said vehicle controlled by the operation of said relay, single pole magnet along the track controlling the operation of said relay, a brake actuating means on said vehicle controlled by the combined speed of the vehicle and distance of travel of the vehicle along the track and means for allowing a minimum speed of the vehicle independently of the other conditions.

10. In an automatic train control system, a track, a vehicle, an air-brake control, means for operating said air-brake control actuated by the movement of the vehicle to continuously approach said control and magnetic means controlled from the track for restoring said vehicle actuated means to its starting position.

11. In an automatic train control system, a track, a vehicle, an air-brake control, means for operating said air-brake control actuated by the movement of the vehicle to continuously approach said control and magnetic means controlled from the track for restoring said vehicle actuated means to its starting position, said magnetic means being controlled by the track conditions.

12. In an automatic train control system, a track, a vehicle, an air-brake control, means for operating said air-brake control actuated by the movement of the vehicle to continuously approach said control within limits and magnetic means controlled from the track for restoring said vehicle actuated means to its starting position.

13. In an automatic train control system, a track, a vehicle, an air-brake control, a speed indicating hand, a stop hand, means for continuously moving the stop hand and means for moving the speed indicating hand controlled by the movement of the vehicle, magnetic means controlled from the track for restoring the stop hand to its starting position and means actuated by the combined stop hand and speed indicating hand for operating the air-brake control.

14. In an automatic train control system, a track, a vehicle, an air-brake control, a speed indicating hand, a stop hand, means for continuously moving the stop hand and moving the speed indicating hand controlled by the movement of the vehicle, magnetic means for restoring the stop hand to its starting position said magnetic means being controlled by the track conditions, and means actuated by the stop hand for operating the air-brake control.

15. In an automatic train control system, a track, a vehicle, a brake control, a speed indicating hand, a stop hand, means including a drive arm having a lost motion connection with the stop hand for continuously moving the stop hand after driving connection has been established and means for moving the speed indicating hand controlled by movement of the vehicle, means controlled from the track for restoring the stop hand to its starting position, and means actuated by the combined stop hand and speed indicating hand for operating the brake control.

16. In an automatic train control system, a track, a vehicle, a brake control, a speed indicating hand, a stop hand, means including a drive arm having a lost motion connection with the stop hand for continuously moving the stop hand after driving connection has been established and means for moving the speed indicating hand controlled by movement of the vehicle, a track control for restoring the drive arm only to its initial position, to thereby change the amount of lost motion between the drive arm and the stop hand, means controlled from the track for restoring the stop hand to its starting position, and means actuated by the combined stop hand and speed indicating hand for operating the brake control.

17. In an automatic train control system, a track, a vehicle, an air brake control, a speed indicating hand, a stop hand, means including a drive arm having a lost motion connection for continuously moving the stop hand after the lost motion has been taken up to thereby impose a decreased maximum speed on the vehicle and means for moving the speed indicating hand controlled by the movement of the vehicle, track means for restoring the drive arm only to its initial position to thereby prevent further lowering of maximum speed restriction, and track means for restoring the stop hand to its starting po-

sition, said track means being controlled by traffic conditions ahead, and means actuated by the stop hand for operating the air brake control.

18. In an automatic train control equipment, the combination with apparatus operated upon a change in the signal indication for effecting an application of the brakes, of a brake pipe, a fluid pressure controlled valve device operative to prevent the operation of said apparatus and comprising valve means, a spring, and a diaphragm subject to the opposing pressures of said spring and a chamber, and means for controlling the fluid pressure in said chamber.

19. In a train control system, in combination, car-carried apparatus for at times automatically applying the brakes, and trackway means for controlling said car-carried apparatus, said car-carried apparatus including, a first valve movable in accordance with vehicle speed, a second valve movable in accordance with distance of vehicle travel, movement of each valve tending to cause a brake application which brake application is caused to be arrived at sooner by movement of the other valve.

20. In a train control system, in combination, car-carried apparatus for at times automatically applying the brakes, and trackway means for controlling said car-carried apparatus, said car-carried apparatus including, a first valve movable in accordance with vehicle speed, a second valve movable in accordance with distance of vehicle travel, movement of each valve tending to cause a brake application which brake application is caused to be arrived at sooner by movement of the other valve, each said valve becapable of producing a brake application due to its movement quite regardless of movement of the other valve.

21. In a train control system, in combination, wayside means, car-carried means controlled by said wayside means, and brake applying means controlled by said car-carried means, said car-carried means including, a valve movable in but one direction to initiate said brake applying means, and fluid pressure operated control means for said valve for positively moving said valve in but one direction at a rate proportional to the speed of the train.

22. In a train control system, in combination, wayside means, car-carried means controlled by said wayside means, and brake applying means controlled by said car-carried means, said car-carried means including, a reservoir charged with pressure fluid in accordance with control by said wayside means, means for exhausting said reservoir at a rate proportional to the speed of the train, a valve movable to positions corresponding to the state of exhaustion of said reservoir, and means having a plurality of ports controlled by said valve in its movement to initiate said brake applying means.

23. In a train control system, in combination, wayside means, car-carried means controlled by said wayside means, and brake applying means controlled by said car-carried means, said car-carried means including, a reservoir charged with pressure fluid in accordance with control by said wayside means, means for exhausting said reservoir at a rate proportional to the speed of the train, a valve movable to positions corresponding to the state of exhaustion of said reservoir, means having a plurality of ports controlled by said valve in its movement to initiate said brake applying means, and speed controlled means for selectively making effective, certain of said ports to cause brake initiation by said valve.

24. In a train control system, in combination, car-carried apparatus, including, brake applying means, an actual speed device movable to assume various positions dependent upon train speed and make active a plurality of means each conditionally capable of initiating said brake applying means, a permissive speed device movable to selectively and successively make effective for brake initiation the active plurality of means, and pressure operated means controlling movement of said permissive speed device.

25. In a train control system, in combination, trackway apparatus, car-carried apparatus controlled thereby and including brake applying means, a first controller for initiating said brake applying means and including a valve controlled by the train speed and a valve controlled by the distance travelled by the train, a warning signal and a second controller identical with said first controller having its valves connected respectively to those of said first controller to operate therewith, parts of said second controller being adjusted in advance of the corresponding parts of said first controller to thus initiate said warning signal just prior to initiation of said brake applying means.

In testimony whereof I have signed this specification this 30th day of April, 1921.

THOMAS W. VARLEY.
WILLIAM C. NEIN.