Aug. 7, 1928. 1,679,390

B. F. WOODING

AUTOMATIC TRAIN CONTROL SYSTEM

Filed Oct. 1, 1925

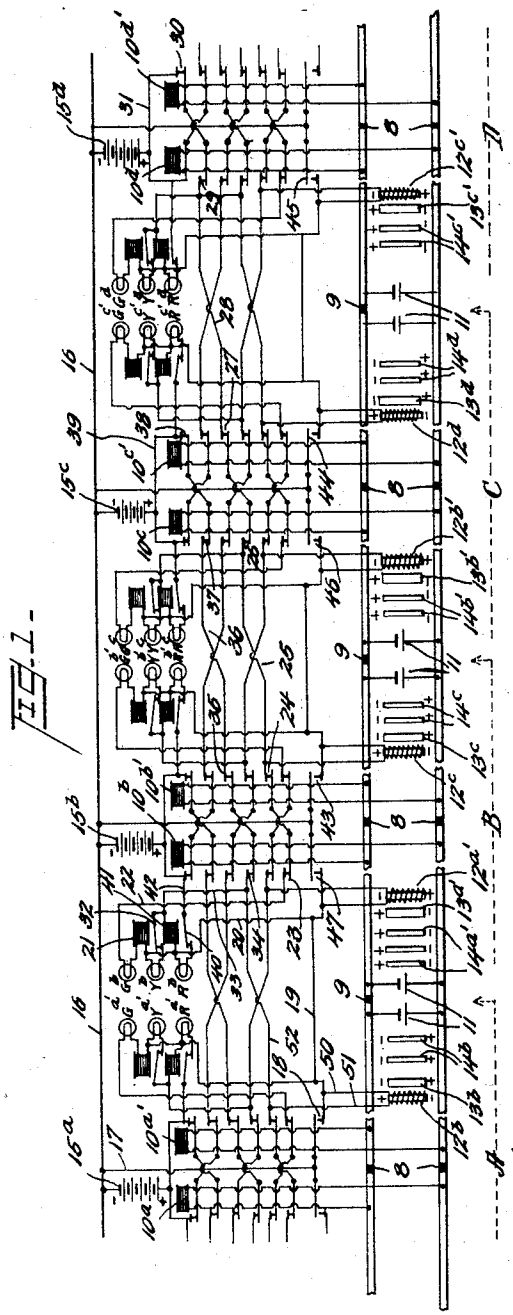


FIG. 1.

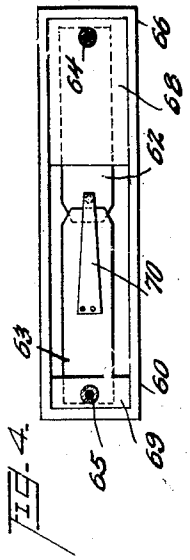


FIG. 4.

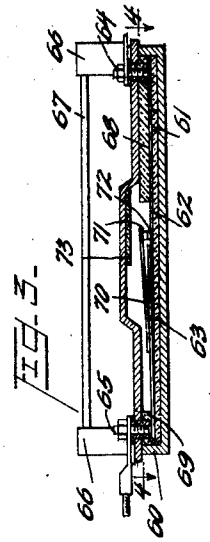


FIG. 3.

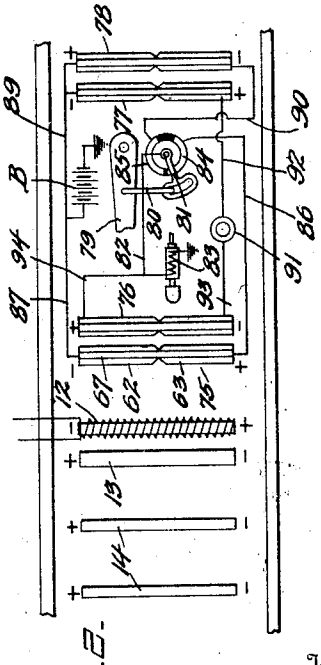


FIG. 2.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TRAIN-CONTROL SYSTEM.

Application filed October 1, 1925. Serial No. 59,869.

The present invention relates to railway signalling, and more particularly to combined signal and automatic train control systems.

The invention provides in combination with a block system, giving visual indications of a predetermined stretch of track, simple mechanism controlled by the system for automatically applying the brakes of a train on entering a danger zone unless certain conditions are satisfied.

The object of the invention, in general, is to provide automatic train control mechanism having permissive features which afford the maximum degree of flexibility in train movements consistent with safety.

In practical railroad operation it often becomes desirable that a train enter a stretch of track which the signals indicate is occupied by another train or is in an otherwise dangerous condition, and to maneuver in such stretch without automatic restrictions. Therefore absolute train control systems, which require a train to stop upon the reception of a danger signal and wait until a proceed signal is displayed, are impractical; and those permissive systems which, although permitting a train to enter a danger zone, automatically restrict its movements in such zone to a low speed, are undesirable, because of the time that would be lost by such restricted movements and furthermore because it is often necessary for a train operating in a danger zone to increase its speed for short distances above that imposed automatically.

Prior to Nov. 24, 1915, the date on which the application for my Patent No. 1.216,038 was filed I recognized these requirements of practical railroad operation and devised the automatic permissive control system shown therein to meet the situation. This system is fully permissive, being restrictive only so far as to require the speed of the train to be reduced to or below a predetermined value on entering a danger zone and to require the engineer to show by a conscious manual act his knowledge of the situation. The system thus assures that when a train enters a danger zone its speed will be low and the engineer will be aware of the fact that he is entering a danger zone. These two factors, low speed and alertness of the engineer on entering a danger zone, fully satisfy all requirements of safe railroad operation, as is now recognized by the authorities, although for a long time subsequent to my invention approval was withheld from any but purely automatic systems.

The train control mechanism of the present invention operates on precisely the same broad principle as that of the mechanism shown in my patent, but applies that principle in the operation of an entirely different character of mechanism. In the system of the present invention there is no mechanical coaction between train and track elements, as in the system shown in said patent, but communication between the track and train is effected by the inductive action of track magnets on train carried elements. The speed limits are imposed by the relations between the train and track elements, requiring no complicated speed responsive mechanism; and the train carried mechanism is accordingly of very simple construction, adapted to be easily and cheaply installed. The invention is applicable to single track roads on which traffic moves in both directions or to roads on which traffic moves in one direction only.

More specific objects and advantages of the invention will become apparent hereinafter.

Referring to the accompanying drawings for a particular description of one system embodying the invention, with the understanding that the invention is easily capable of embodiment in mechanisms substantially different from the specific mechanisms illustrated:—

Figure 1 is a diagrammatic view of the track system;

Figure 2 is a diagrammatic view on a larger scale showing one set of track magnets and a vehicle installation;

Figure 3 is a longitudinal vertical section through one of the train carried units; and

Figure 4 is a horizontal sectional view of a train carried unit with the cover of the housing removed.

The system illustrated provides for traffic in both directions.

The track is divided into sections by insulated joints 8 in the two track rails, and each section is subdivided by an insulated joint 9 in one track rail. Blocks A, B, C, D etc. are defined by the insulated joints 9. For each block there are two track relays, the track relays for the blocks A, B, C and D being designated respectively, 10^a, $10^{a'}$; 10^b, $10^{b'}$; 10^c, $10^{c'}$; and 10^d, $10^{d'}$. These re-

lays may be energized by track current of any suitable character, batteries 11 being shown for this purpose.

Considering the direction of traffic to be east and west, there is provided for block A a set of signal lamps $G^{a'}$, $Y^{a'}$ and $R^{a'}$, colored respectively green, yellow and red, for the control of west-bound traffic and located at the east end of block A, a similar set of lamps (not shown) being provided at the west end of this block for the control of east-bound traffic. Similarly, for block B, lamps G^b, Y^b and R^b control east-bound traffic and lamps $G^{b'}$, $Y^{b'}$ and $R^{b'}$ control west-bound traffic: for block C, lamps G^c, Y^c and R^c control east-bound traffic and lamps $G^{c'}$, $Y^{c'}$, and $R^{c'}$ control west-bound traffic: for block D, lamps G^d, Y^d and R^d control east-bound traffic.

For each block there are also provided two sets of train control track magnets mounted transversely in any suitable manner on the road bed, each set consisting of an electro-magnet controlled by the track relays, an operating permanent magnet closely associated with the electro-magnet and one or more holding magnets spaced from the operating magnet in the direction of traffic. Each set is located near the entrance to its respective block. Accordingly, in advance of the east end of block A there is a set of track magnets controlling west-bound traffic, consisting of an electro-magnet $12^{a'}$, an operating permanent magnet $13^{a'}$ and three holding permanent magnets $14^{a'}$, a similar set (not shown) being provided in advance of the west end of this block for the control of east-bound traffic; in advance of the west end of block B there is a similar set 12^b, 13^b, 14^b, controlling east-bound traffic, and in advance of the east end, a set $12^{b'}$, $13^{b'}$, $14^{b'}$, controlling west-bound traffic; for block C, set 12^c, 13^c, 14^c controls east-bound traffic and set $12^{c'}$, $13^{c'}$ and $14^{c'}$ controls west-bound traffic; for block D, set 12^d, 13^d, 14^d controls east-bound traffic.

There is further provided for each block a battery 15^a, 15^b, 15^c, 15^d etc., each having its negative pole connected to a common conductor 16, these batteries being adapted to energize the signal lamps and track magnets through connections controlled by the track relays.

Normally, that is when the sections are not occupied, all the signal lamps are extinguished. When a train occupies the section immediately in advance of the block at the entrance of which a set of lamps is located, the green, or clear, lamp of that set will be illuminated provided that particular block and two blocks immediately in advance thereof are clear. If only one block in advance of the particular block is clear, the yellow, or caution, lamp will be illuminated; and if either the particular block or the block in advance is occupied, the red, or danger, lamp will be illuminated.

For example, suppose a train occupies the east section of block A and blocks B, C and D are clear. Under these conditions the following circuit is closed through the clear lamp G^b: from the negative pole of battery 15^d, common conductor 16, conductor 17, back contact 18 of track relay $10^{a'}$, line conductor 19, conductor 20, relay 21, green lamp G^b, conductor 22, front contacts 23 and 24 of track relays 10^b and $10^{b'}$, line conductor 25, front contacts 26 and 27 of track relays 10^c and $10^{c'}$, line conductor 28, front contacts 29 and 30 of track relays 10^d and $10^{d'}$, and by conductor 31 to the positive pole of battery 15^d. Since this circuit includes front contacts of the track relays for blocks B, C and D, it can not be closed unless all these blocks are clear.

Suppose with the train occupying the east section of block A, another train is in block D. The circuit of the clear lamp traced above will then be broken at front contact 29 or 30, and the following circuit will be closed through the caution lamp Y^b: from the negative pole of battery 15^c, common conductor 16, conductor 17, back contact 18, line conductor 19, conductor 20, yellow lamp Y^b, back contact 32 of relay 21, conductor 33, front contacts 34 and 35 of track relays 10^b and $10^{b'}$, line conductor 36, front contacts 37 and 38 of track relays 10^c and $10^{c'}$, and by conductor 39 to the positive pole of battery 15^c. It will be noted that when the circuit of the clear lamp is closed, the circuit of the caution lamp is open at back contact 32, the clear lamp circuit including the winding of relay 21. Since the circuit of caution lamp Y^b includes front contacts of the track relays connected to blocks B and C, if any section of either of these blocks is occupied the caution lamp will remain unlit.

Suppose again that with the train in the east section of block A, another train occupies either block B or block C. The following circuit through the red lamp R^b will then be closed; from the negative pole of battery 15^b, common conductor 16, conductor 17, back contact 18, line conductor 19, conductor 20, red lamp R^b, back contact 40 of relay 41, and conductor 42 to the positive pole of battery 15^b. It will be observed that the circuit of the red lamp is open at back contact 40 of relay 41 when either the green or the yellow lamp is lit, relay 41 being energized at these times. The circuit of relay 41 is as follows: battery 15^c, common conductor 16, conductor 17, back contact 18, line conductor 19, conductor 20, the winding of relay 41, conductor 33, front contacts 34 and 35, line conductor 36, front contacts 37 and 38, and back to battery through conductor 39. Since this circuit includes front contacts of the track relays connected to

blocks B and C only, it will be closed whenever the circuit of the green or the yellow lamp is closed.

When the east-bound train enters the east section of block B, relay $10^{b'}$ will drop, closing its back contact 43 and thereby completing the circuit of green lamp G^c, if three blocks in advance are clear; or the circuit of yellow lamp Y^c, if only two blocks in advance are clear; or the circuit of red lamp R^c, if either of the two blocks in advance are occupied. Under similar conditions, the circuit of lamp G^d, or Y^d, or R^d is closed when the east-bound train enters the east section of block C and causes closure of the back contact of track relay $10^{c'}$. Similarly, when a west-bound train occupies the west section of block D, it shunts the track relay 10^d and closes at back contact 45, the circuit of green lamp $G^{c'}$ or that of yellow lamp $Y^{c'}$ or that of red lamp $R^{c'}$, depending respectively upon whether three or two blocks in advance are clear or either of the two blocks in advance are occupied. When the west-bound train enters the west end of block C it causes closure of back contact 46 of track relay 10^c, thereby closing the circuit of lamp $G^{b'}$ or $Y^{b'}$ or $R^{b'}$; and when said west-bound train enters the west section of block B it causes closure of back contact 47 of track relay 10^b, closing the circuit of lamp $G^{a'}$ or $Y^{a'}$ or $R^{a'}$. Having described in detail the circuits of lamps G^b, Y^b and R^b, controlling east-bound traffic into block B, it would be a needless repetition to trace the circuits of the remaining lamps, since the circuits of any one set are exactly similar to those of each of the other sets.

Track magnets 12, 13 and 14 are arranged in sets, each set being located a suitable distance in advance of its respective block. Each set comprises an electro-magnet 12, an operating permanent magnet 13 closely associated with the electro-magnet and adapted to be neutralized thereby, and two or more holding magnets 14, the permanent magnets being longitudinally spaced apart at such distances that their zones of influence with respect to the train carried mechanism overlap. The operating permanent magnet is adapted to neutralize the action of a train carried permanent magnet on a normally closed circuit controller in a train control circuit when the train passes over the operating magnet and its associated electro-magnet is deenergized, thus causing the circuit controller to open. The holding magnets 14 function to hold the circuit controller open until the train has passed a predetermined distance out of the influence of the operating magnet 13. These holding magnets are weaker than the operating magnet and of insufficient power to cause the circuit controller to open, but effective to hold said circuit controller open after it has been opened by the action of the operating magnet. When the electro-magnet is energized, it neutralizes the action of the operating magnet and hence a train can pass over the set of magnets without having its circuit controller actuated.

In the illustration, the circuit of each electro-magnet 12 includes front contacts of the track relays connected to two blocks immediately in advance thereof. For example, in the case of the electro-magnet 12^b, belonging to the set controlling east-bound traffic into block B, the circuit is as follows: from the negative pole of battery 15^c, common conductor 16, conductor 17, back contact 18, conductor 50, magnet 12^b, conductor 51, line conductor 52, front contacts 34 and 35 of the track relays connected to block B, line conductor 36, front contacts 37 and 38 of track relays connected to block C, and by conductor 39 to the positive pole of battery 15^c.

The circuit of electro-magnet 12 being closed when a train enters a block and at least two blocks in advance are clear, the said magnet will be energized when either the clear signal lamp or the caution signal lamp is illuminated. Hence a train entering a block under clear or caution conditions can pass the track magnets without having its circuit controller actuated. Under danger conditions however, that is with either of the two blocks in advance occupied, the circuit of electro-magnet 12 is not closed and hence the operating magnet 13 will be effective to actuate the circuit controller and thereby apply the brakes unless the speed has been reduced in accordance with the track signal indications and the engineer has performed a manual operation to insure his alertness to the situation, as will be pointed out in detail hereinafter.

The vehicle equipment includes a magnetically operated circuit controller mounted in a shallow box 60, which is adapted to be secured in any suitable manner transversely beneath the engine or tender of a locomotive or other rolling stock. This box may be composed of any suitable non-magnetic material, metal, wood or composition. Fitting the interior of the box and resting on the bottom thereof is a plate 61 of insulation, and loosely fitting the interior of the box and resting on and attached to the plate 61 are the two members 62 and 63 of the circuit controller. Each member 62 and 63 consists of a thin plate of magnetic material, such as pressed steel, the free ends of the members being beveled with the end of member 63 overlapping that of 62. Members 62 and 63 may be connected in the external circuit by binding screws 64 and 65, which screw through insulating bushings in apertures formed in the box cover. The ends of these screws abut firmly against

members 62 and 63, thereby making electrical contact therewith and clamping the members against any longitudinal shifting.

Secured to the upper ends of brackets affixed to the top of box 61 is a permanent magnet 67 extending directly above and parallel to the steel members 62 and 63. The member 62 is stiffened by a plate 68 of insulation which extends over said member about three quarters the length thereof, and which is provided with an aperture through which binding screw 64 extends. Member 63, on the contrary, has a considerable degree of flexibility, being bendable from a point where it passes under a bar 69 of insulation located at the end of the box and having an aperture through which the insulating bushing for screw 65 extends. Member 63 has a permanent set tending to make it spring upwardly out of contact with member 62. Normally however the lines of force from the permanent magnet 67 passing through members 62 and 63 longitudinally overcomes this upwardly springing tendency of member 63, holding said member down in the position shown in Fig. 3.

For the purpose of eliminating momentary interruptions of the circuit, which may be caused by the jarring and vibrations producing momentary separations of the ends of members 62 and 63, I provide a path for the current flow independent of the path through the ends of said members. To this end, a light flexible strip of metal 70, preferably non-magnetic, has one end affixed to member 63 with its other end projecting beyond the end of said member and provided with a non-magnetic contact button 71 engaging a similar button 72 on member 62. In the closed position of the controller there is a slight clearance between a greater portion of strip 70 and member 63, whereby the contact buttons 71 and 72 will maintain contact on slight momentary separations of the ends of members 62 and 63. Contact buttons 71 and 72 are made of non-magnetic material in order that they may have no tendency to stick because of any permanent magnetism that might otherwise be induced therein. The upward spring of member 63 is limited by engagement with a plate 73 of insulation secured in any suitable manner to the under side of the box cover.

As indicated by Fig. 2, each train equipment includes four of the controller units shown in Figs. 3 and 4, designated 75, 76, 77 and 78. The units are designed to be secured to the under side of the rolling stock at longitudinally spaced points. Units 75 and 77 operate to control the vehicle when the latter is travelling forward and units 78 and 76 are operative when the vehicle is backing. Any suitable switch mechanism may be employed to connect and disconnect the units according to forward or reverse movement, but in order to make the proper connections automatically, I prefer to provide a switch operated by the reverse lever 79 of the locomotive. Accordingly this lever is shown connected by a link 80 to the slotted head of a pivoted arm 81 connected by a conductor 82 to one terminal 83 of the winding of a magnetically operated brake valve of any suitable construction, but preferably of the construction shown in my Patent No. 1,115,364, the other terminal of said winding being grounded on the locomotive frame. When lever 79 occupies its ahead position arm 81 engages a contact segment 84, and when the lever is thrown to reverse position arm 81 is rotated into contact with a segment 85. Segment 84 is connected by a conductor 86 to one contact member of controller unit 75, the other contact member of this unit being connected by a conductor 87 to the positive pole of a battery B, the negative pole of which is grounded. Hence when the locomotive is traveling ahead the circuit of valve winding 83 is closed through the contacts of controller unit 75 through the following circuit: from the positive pole of battery B, conductor 87, the contact members of controller unit 75, conductor 86, segment 84, arm 81, conductor 82, winding 83 and through ground to the negative terminal of the battery. On the other hand, when the locomotive is backing the circuit through winding 83 includes the contact members of unit 78, said circuit being from the positive pole of battery B, conductor 89, the contacts of unit 78, conductor 90, segment 85, arm 81, conductor 82, winding 83 and by way of ground to the negative pole of the battery. In addition to the two circuits just described the winding has a third circuit including in series a manually operable normally open switch 91 and the contacts of controller units 76 and 77, this circuit being from the positive pole of battery B, conductor 89, contacts of unit 77, conductor 92, switch 91, conductor 93, contacts of units 76, conductor 94, winding 83 and to the negative pole of the battery through ground.

Magnets 67 of controller units 75 and 77 are arranged with their north poles adapted to pass directly above the south poles of track magnets 13 and 14 belonging to the sets controlling west-bound traffic, whereby the lines of force passing through the contact plates due to magnets 67 are opposed to the lines passing through said plates due to the track magnets. Thus when these controller units pass above the track magnets controlling west-bound traffic, the said track magnets tend to neutralize the action of magnets 67 in holding the contact plates engaged. The track magnets controlling east-bound traffic are reversed with respect to those controlling west-bound traffic, so that the

effect of the former is additive to the effect of the train carried magnets in holding the contact plates of units 75 and 77 engaged. The magnets 67 of controller units 78 and 76 are reversed with respect to those of controller units 75 and 77, whereby units 78 and 76 are adapted to cooperate with the track magnets controlling east-bound traffic and are unaffected by those controlling west-bound traffic. It is of course understood that the description has reference to a train travelling west. When the train is travelling east the controller units are reversed and the units 75 and 77 then coact with the track magnets controlling east-bound traffic while the units 78 and 76 coact with the track magnets controlling west-bound traffic.

Considering the operation with respect to west-bound traffic; suppose an advance vehicle is in block A and a rear vehicle equipped with the controlling units and connections shown in Fig. 4 has arrived at the entrance to block C. Under these conditions it will be understood from the foregoing description that the circuits of the caution signal lamp $Y^{c'}$ and electro-magnet $12^{c'}$ will be closed, these circuits being closed when blocks B and C are clear and back contact 45 is closed. The controller units 75 and 77 therefore can pass over the set of track magnets $12^{c'}$, $13^{c'}$ and $14^{c'}$ without having their contacts opened. The rear vehicle can accordingly pass the caution signal and travel through block C without automatic limitation.

When the rear vehicle passes the set of magnets 12^{d}, 13^{d} and 14^{d}, controlling east-bound traffic into block D, its controllers 75 and 77 will remain closed whether or not the electro-magnet 12^{d} is energized, since as before pointed out, the effect of the track magnets controlling east-bound traffic on controllers 75 and 77 is cumulative on the effect of the train carried magnets 67.

When the rear vehicle arrives at the entrance to block B, with the advance vehicle still in block A, the red lamp $G^{b'}$ will be illuminated and electro-magnet $12^{b'}$ will be de-energized. If now the rear vehicle should pass this danger lamp and enter block B, its brakes would be applied automatically, as will hereinafter appear unless the engineer had reduced speed to or below a predetermined value, in obedience to the caution signal received at the entrance to block C and, furthermore, unless he holds closed the push button 91 while passing the track magnets.

Let it be assumed that the speed of the vehicle has been reduced and that the engineer holds closed push button 91 while passing the track magnets. When controller unit 75 passes over operating magnet $13^{b'}$ the action of magnet 67 will be neutralized, and plate 63 will accordingly spring upwardly out of engagement with plate 62, thereby opening the normal circuit of winding 73. However the circuit of this winding which passes through the contacts of controllers 76 and 77 and push button 91, in series, is closed at this time. It is to be noted that the contacts of controller 75 after being opened by the action of magnet $13^{b'}$ will remain open as long as the controller remains within the effective influence of holding magnets $14^{b'}$, these magnets, as before pointed out, acting in opposition to train magnet 67 and being sufficiently strong to prevent said train magnet from closing the contacts of the controller, although too weak to cause the contacts to open. It is further to be noted that after the controller passes out of the influence of the last magnet $14^{b'}$, contact plate 63 does not instantly close on plate 62, due to the inertia of this plate and the retarding action of the air, said plate having a large area and therefore displacing a considerable volume of air in moving from its open to its closed position. In short, there is a definite and substantial interval of time following the passage of controller 75 from the influence of the last magnet $14^{b'}$ during which the contacts of controller 75 remain open. It is still further to be noted that the distance between operating magnet $13^{b'}$ and the last magnet $14^{b'}$ is substantially less than the distance between the controller units 75 and 77, so that there is an interval of time between the passage of controller 75 from the influence of the last magnet $14^{b'}$ and the passage of controller 77 over operating magnet $13^{b'}$, this interval obviously varying in inverse proportion to the speed of the vehicle. If the vehicle is travelling below a predetermined low speed (which is the assumption made above) the contacts of controller 75 will close in advance of the opening of the contacts of controller 77, so that the normal circuit of winding 83 through the contacts of controller 75 is reclosed in advance of the opening of the circuit of this winding through the contacts of controllers 76, 77 and push button 91. Thus with the vehicle travelling at low speed over the track magnets, under danger conditions, there is no instant in which the brake magnet 83 is not energized, provided push button 91 is held closed. Accordingly, under these restrictions a vehicle can pass a danger signal without having its brakes automatically applied. Obviously, if the engineer does not hold closed switch 91 while passing the track magnets under danger conditions, the brakes will be applied when the contacts of controller 75 are opened by magnet $13^{b'}$, irrespective of the speed of the vehicle. If the speed of the vehicle has not been reduced to or below the predetermined low speed, the contacts of controller 75 will not have closed before the contacts of controller 77 open, and

hence there will be an interval in which neither circuit of winding 83 is closed, and the brakes will be applied whether or not push button 91 is held closed. It will be clear therefore that the system of the present invention provides for the passage of a vehicle past a danger signal, but only provided the speed of the vehicle has been reduced to, or below, a certain low value and provided further that the engineer shows by holding closed push button 91 his recognition of the fact that he is entering a danger zone.

The permissive speed of the vehicle on passing a danger signal is governed by the distance separating the members of a cooperating pair of controller units, as 75 and 77, as compared with the distance separating operating magnet 13 and the last holding magnet 14. With a fixed distance separating the controller units 75 and 77, the permissive speed will vary inversely with the distance separating magnet 13 from the last magnet 14, this latter distance of course being always smaller than the former. Conversely, with a fixed distance separating magnet 13 from the last magnet 14, the permissive speed will vary directly as the distance between controller units 75 and 77. The permissive speed therefore may be varied either by adjusting the distance between magnet 13 and the last magnet 14 or by adjusting the distance between the controller units, or by adjusting both distances. In the system illustrated, it is designed to have the distance between the controller units fixed and to vary the permissive speed as desired by varying the distance between the track magnets. Accordingly, there is shown at the entrance a block A a set of track magnets governing west-bound traffic, consisting of an operating magnet $13^{a'}$ and three holding magnets $14^{a'}$, whereas the other sets shown each consists of an operating magnet and two holding magnets. The permissive speed, therefore, for west-bound traffic into block A is less than that for the other blocks shown. The permissive speed can thus be varied to accord with permanent conditions obtaining in any particular stretch of track.

Now having particularly described a system embodying my invention, without intending by such particular description to limit the scope of the invention, what I claim as new and desire to secure by Letters Patent is:—

1. In an automatic train control system, a vehicle having two devices mounted thereon at longitudinally spaced points, permanent magnets on the track operating said devices successively as the vehicle passes thereover, the forward of said devices having a retarded movement, and means for controlling the vehicle when the rear device is operated in advance of the return of the forward device to normal position.

2. In an automatic train control system, a vehicle having two devices mounted thereon at longitudinally spaced points, permanent magnets on the track operating said devices successively, the forward of said devices having a retarded movement, means for applying the brakes on operation of the forward device and manually operable means for preventing a brake application provided the speed of the vehicle is sufficiently low to permit the return of said forward device to normal position before the rear device is operated.

3. In an automatic train control system, a vehicle having two devices mounted thereon at longitudinally spaced points, track devices operating said vehicle devices successively, said track devices being spaced longitudinally a smaller distance than that separating said vehicle devices, the forward of said vehicle devices having a retarded movement, and means for controlling the vehicle when the rear device is operated in advance of the return of the forward device to normal position.

4. In an automatic train control system, a vehicle having two normally closed circuit controllers mounted thereon at longitudinally spaced points, induction means on the track acting directly on said controllers and causing them to open successively as the vehicle passes thereover, the forward one of said controllers having a sluggish action, and means for controlling the vehicle if its speed is sufficiently high to cause the rear controller to open before the forward controller closes.

5. In an automatic train control system, a vehicle having two circuit controllers mounted thereon at longitudinally spaced points, said controllers being biased to open position, a permanent magnet associated with each controller operating normally to hold it closed, an operating permanent magnet and a holding permanent magnet on the track longitudinally spaced from each other a less distance than that separating said controllers, an electro-magnet controlled by traffic conditions associated with said operating magnet and adapted when energized to neutralize the action thereof, said operating magnet being adapted to open said circuit controllers and said holding magnet acting to hold said controllers open, the forward controller having a sluggish action, whereby the rear controller will open before the forward controller closes if the speed of the vehicle is excessive, and a brake magnet having two circuits, one of which includes the forward controller and the other the rear controller, and a manually operable normally open switch in the latter circuit.

6. In an automatic train control system, a vehicle having two normally closed circuit controllers mounted at longitudinally spaced

points, induction means on the track causing said controllers to open sucessively as the vehicle passes thereover, the forward controller having a sluggish action, whereby if the speed of the vehicle is excessive the rear controller will open before the forward controller closes, and a brake controlling magnet having a circuit including contacts of the forward controller and a second circuit including in series the contacts of the rear controller and a normally open manually operable switch.

7. In an automatic train control system, a vehicle having two magnetic devices mounted thereon at longitudinally spaced points, induction means on the track affecting said devices successively as the vehicle passes thereover, the forward one of said devices having a retarded action whereby it does not resume initial condition after being affected by said induction means until the expiration of a substantial interval, means for applying the brakes when said forward device is affected, and manual means controlled by the rear device for preventing a brake application if the speed of the vehicle is below a predetermined value.

8. In an automatic train control system, a vehicle having two normally closed circuit controllers mounted thereon at longitudinally spaced points, magnets on the track causing said controllers to open successively as the vehicle passes thereover, the forward one of said controllers having a sluggish action, whereby it will remain open for a definite interval of time after passing from the influence of said magnets, the rear controller coming within the operating influence of said magnets an interval after the passing of the forward controller out of said influence, a brake magnet having two circuits passing respectively through said controllers, whereby said magnet will be deenergized unless the speed of the vehicle is sufficiently low to permit one circuit to reclose at the forward controller before the other is opened at the rear controller.

9. In an automatic train control system, an operating permanent magnet mounted on the road bed, an electro-magnet associated therewith adapted when energized to substantially neutralize the action thereof, means for deenergizing said electro-magnet under danger conditions, a plurality of holding permanent magnets spaced along the track from said operating magnet in the direction of traffic, a vehicle travelling on the track having two magnetically operated circuit controllers secured thereto at longitudinally spaced points for coaction with said track magnets, magnetic means on the vehicle normally holding said circuit controllers closed, said operating permanent magnet being sufficiently powerful to overcome the action of said magnetic means so as to cause the circuit controllers to open when passing thereover with said electro-magnet deenergized, said holding magnets being weaker than said operating magnet and having sufficient strength to cause the circuit controllers to remain open while within the influence thereof but being of insufficient strength to cause said controllers to open, the forward one of said controllers having a sluggish action whereby it will remain open a definite time after passing from the influence of said holding magnets, a brake magnet having a circuit including the contacts of said forward controller and having a second circuit including the contacts of the rear controller and in series therewith the normally open contacts of a manually operable switch, the distance between said controllers being substantially greater than the distance between said operating magnet and the foremost holding magnet, whereby the brake magnet will be deenergized under danger conditions unless the speed of the vehicle is sufficiently low to give time for reclosing the first circuit before the second circuit is opened and unless the manually operable switch is closed during the passage over said track magnets.

10. In an automatic train control system, a vehicle having two devices mounted thereon at longitudinally spaced points, a track device operating said vehicle devices successively as the vehicle passes thereover, and means for controlling the vehicle when the rear device is operated in advance of the return of the forward device to normal position.

11. In an automatic train control system, a vehicle having two inductively operable devices mounted thereon at longitudinally spaced points, train control mechanism controlled by said devices and actuated only when both of said devices are in abnormal position, and a magnet on the track causing said devices to move to abnormal position successively as the vehicle passes thereover.

12. In an automatic train control system, a vehicle having two normally closed circuit controllers mounted thereon at longitudinally spaced points, train control mechanism having a circuit including said circuit controllers in parallel, induction means on the track acting directly on said controllers and causing them to open successively as the vehicle passes thereover, and means to cause the forward controller to close before the rear controller opens only if the speed of the vehicle is below a predetermined value.

In testimony whereof I hereunto affix my signature.

BENJAMIN FRANKLIN WOODING.