Feb. 28, 1933. D. H. SCHWEYER 1,899,642

AUTOMATIC TRAIN CONTROL

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FIG. 1.

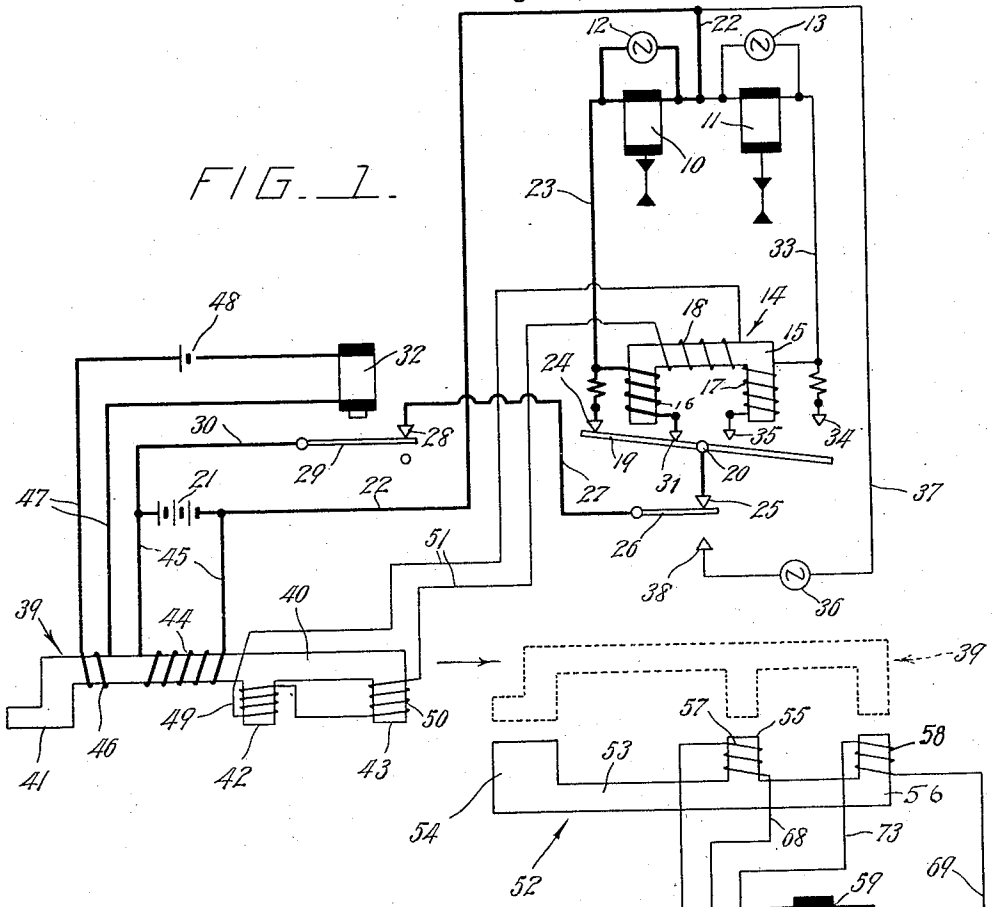
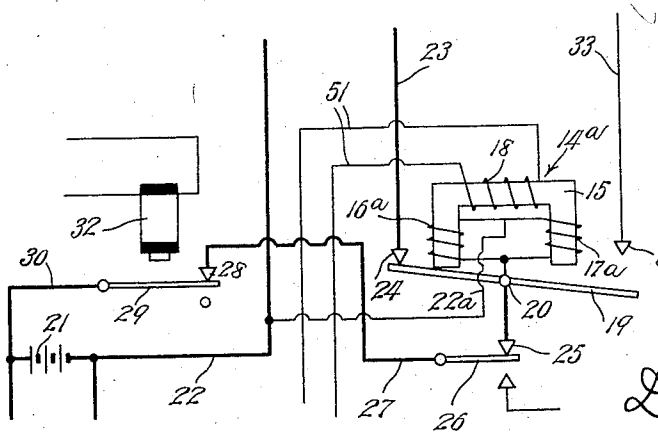


FIG. 2.



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FIG. 3.

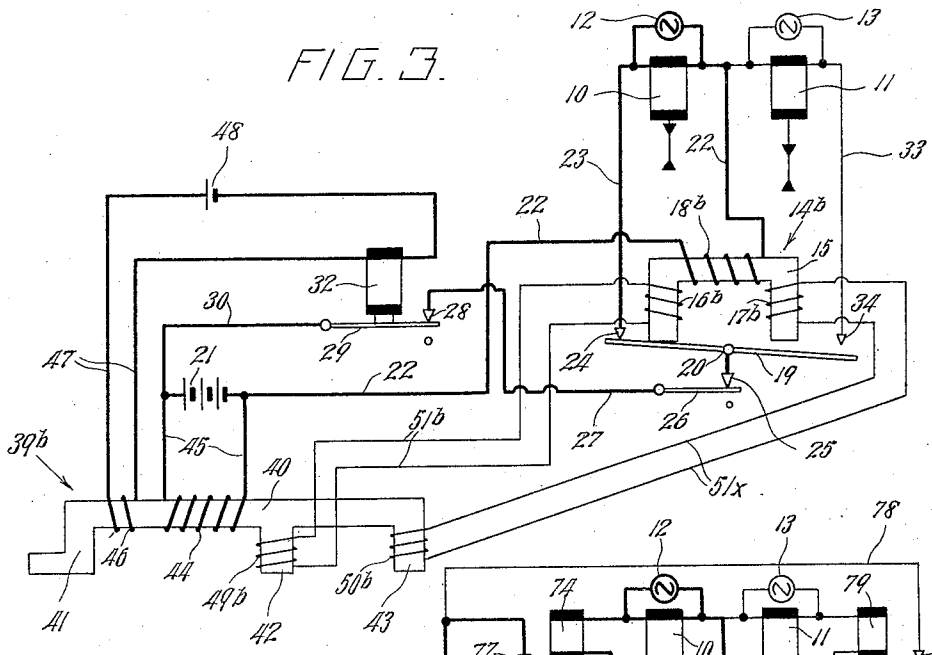
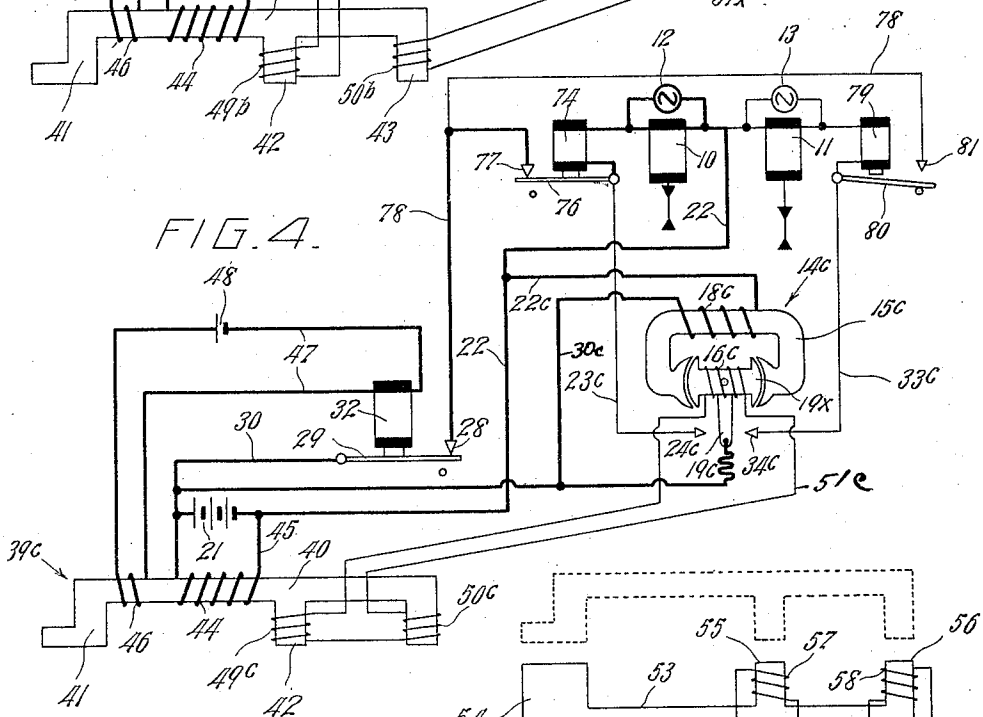


FIG. 4.



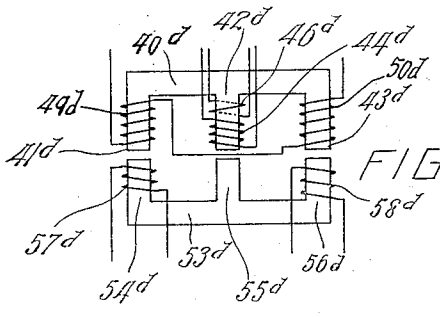


FIG. 5.

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UNITED STATES PATENT OFFICE

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AUTOMATIC TRAIN CONTROL

Application filed August 18, 1926. Serial No. 130,012.

The present invention relates to automatic train control utilizing the intermittent type of apparatus, and aims to provide a novel and improved apparatus of that kind operable by induction between the track and train for obtaining different vehicle controlling conditions selectively.

Another object of the invention is the provision of novel inductive devices or inductors on the track and train, with controlling means on the track, and controlled means on the train, whereby a plurality of train controlling conditions may be obtained selectively, such as "danger", "caution" and "clear" conditions, without physical contact of the devices or portions thereof between the track and train.

A further object is the provision of such an apparatus for obtaining three condition control and embodying a single unit electromagnet device on the train and a single unit inductive control device on the track, thereby providing a simple and economical structure, as well as providing for practical and efficient control.

A still further object is the provision of such an apparatus wherein no electrical current is required for the track part of the apparatus, the electrical energy being carried by the train, thereby affording a saving in maintenance costs.

With the foregoing and other objects in view, which will be apparent as the description proceeds, the invention resides in the construction and arrangement of parts, as hereinafter described and claimed, it being understood that changes can be made within the scope of what is claimed, without departing from the spirit of the invention.

The invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a diagrammatical view of the apparatus.

Fig. 2 is a fragmentary diagrammatical view illustrating a modification.

Fig. 3 is a diagrammatical view of a modified form of the train part of the apparatus.

Fig. 4 is a diagrammatical view illustrating another variation.

Fig. 5 is a diagrammatical view of the cooperating vehicle and track inductors illustrating a further modification.

In carrying out the invention there is provided an electromagnet or solenoid 10, or other translating device, controlling an air valve or other means, in order that when said magnet 10 is energized clear conditions will exist on the train (the term "train" being used broadly to include a vehicle or car). A second electromagnet, solenoid or translating device 11 is provided controlling an air valve or other means for obtaining caution conditions on the train when the magnet 11 is energized with the magnet 10 deenergized. Electric lamps 12 and 13 are connected in parallel with the respective magnets 10 and 11 to indicate, when lighted, clear and caution conditions, respectively, and any other suitable signal devices may be used.

The magnets or translating devices 10 and 11 are controlled by a doube acting electromagnet 14 having the U-shaped core 15 on the limbs of which are wound the coils 16 and 17, and a third coil 18 is wound on the yoke of said core. A double switch 19 is fulcrumed, as at 20, between its ends and between the poles of the core 15, and said switch constitutes an armature in the field of the core 15. This is also known as a three-position relay or mechanism which produces three distinct conditions, as, for instance, when armature 26 is in the energized position and armature 19 is raised at the left end to energize magnet 10, when armature 19 is reversed and raised at the right end to energize magnet 11, and when armature 26 is deenergized to close the circuit at 38 and energize light 36.

The electrical energy for the electromagnets 10, 11 and 14 is supplied by a battery 21 on the train, and under clear running conditions on the train, the magnet 10 and coil 16 are energized, over a circuit including the battery 21, conductor 22, magnet 10 and lamp 12, conductor 23, contact 24, switch 19 raised against the contact 24, contact 25, switch 26, conductor 27, contact 28, switch 29 and conductor 30. The switch 26 is within the field of the electromagnet 14 so as to be raised against the contact 25 whenever the magnet

14 is energized. The switch 29 is within the influence of an electromagnet 32 which will be described more fully hereinafter. A shunt of said circuit includes the coil 16 having one terminal connected to the conductor 23 and having a contact 31 connected to its opposite terminal, the left hand arm of the switch 19 when raised bearing against both contacts 24 and 31. Suitable resistance is employed so that only part of the current will flow through the coil 16, from the conductor 23 to the switch 19, although, in some cases, the contact 24 may be dispensed with. It will be observed that magnet 16, by controlling armature 19, controls its own circuit at 31.

The magnet 11 and coil 17 are energized under caution conditions, with the magnet 10 and coil 16 de-energized. The caution circuit includes the battery 21, conductor 22, magnet 11 and lamp 13, conductor 33, contact 34, right hand arm of switch 19 when raised, contact 25, switch 26, conductor 27, contact 28 and conductor 30. The coil 17 has one terminal connected to the conductor 33 and has a contact 35 connected to its opposite terminal, so that the right hand arm of the switch 19 when raised bears against both contacts 34 and 35, thereby bringing the coil 17 into a shunt of said caution circuit, part of the current flowing through the coil 17, and, in some cases, the contact 34 may be eliminated. The shunt connection of the coils 16 and 17 is used in order to regulate the magnetic flux created by said coils when energized by using suitable resistance between the conductors 23, 33 and the respective contacts 24, 34. Magnet 17 also controls its own circuit through 19 and 35.

When both magnets 10 and 11 are deenergized, then danger conditions exist on the train, and this is indicated by an electric lamp 36 or other suitable signal device. The lamp 36 is disposed in a conductor 37 connected to the conductor 22 and to a contact 38 which is engaged by the switch 26 when said switch drops due to the deenergization of the magnet 14. The circuit indicating danger conditions includes the battery 21, conductors 22 and 37, lamp 36, contact 38, switch 26 in its lower position, conductor 27, contact 28, switch 29 and conductor 30.

The switch 29 is normally held against the contact 28 by the electromagnet or relay 32 which is normally energized, and is released whenever passing a control location of the track, for producing danger conditions unless the magnet 14 is influenced to obtain either clear or caution conditions through the energization of the coil 18 by current flowing therein in one direction or the other, as will hereinafter more fully appear.

In order to control the magnet 32 and coil 18 there is provided an inductor or electromagnet device 39 on the train having a core with a yoke 40 and three limbs 41, 42 and 43 extending from the yoke. An exciting coil 44 is wound on the yoke 40 between the limbs 41 and 44 and is connected in a circuit 45 with the battery 21, and an impulse coil 46 is also wound on the yoke 40 between the limbs 41 and 42 and is connected in the circuit 47 with the electromagnet 32 and battery 48 and maintains relay 32 normally energized. The coil 44 is continuously energized by the battery 21, while the coil 46 is normally energized by the battery 48. The coils 44 and 45 are wound with reference to the flow of current therein so that the magnetic flux in the core created by the coil 44 induces a single cycle of alternating current in the coil 46, when passing the trackside element, as will hereinafter appear, and one half of the A. C. wave opposes the battery 48 to deenergize the electromagnet 32, the battery 48 being weaker than the battery 21 so that the magnetic flux of the coil 44 is stronger than that of the coil 46. Due to the impedance or reluctance in the magnetic circuit of the coils 44 and 46, including the yoke 40 and limbs 41 and 42, there being a long air gap between the limbs 41 and 42, there will normally be only a slight inductive effect between the coils 44 and 46, and the magnet 32 will be energized sufficiently by the battery 48 to hold the switch 29 against the contact 28. However, when the air gap is bridged by the inductor or armature on the track, as will hereinafter more fully appear, the reluctance or impedance of the magnetic circuit being decreased will result in the magnetic flux from the coil 44 surging through the magnetic circuit thereby inducing in the coil 46 a single cycle of alternating current, one-half wave of which opposes the current in the circuit 47, thereby deenergizing the magnet 32 for an instant, and releasing the switch 29. This action, as will hereinafter appear, is used for obtaining an initiating action or danger condition whenever passing a control location, unless clear or caution conditions are established. Instead of using a separate battery 48, current for the circuit 47 may be taken from the battery 21, as will be obvious and the separate batteries are shown to simplify the diagram.

Impulse coils 49 and 50 are wound on the respective limbs 42 and 43 and are connected in the circuit 51 with the coil 18, said coils being connected in series, and the coils 49 and 50 being wound reversely to one another with reference to the flow of magnetic flux in the limbs 42 and 43. When the magnetic flux created by the coil 44 flows through the limb 42, without flowing through the limb 43, this induces current in the coil 49 and circuit 51 so that the coil 18 is energized to create magnetic flux in the core 15 aiding the magnetic flux created by the coil 16

and opposing the magnetic flux of the coil 17, said coils 16 and 17 being wound oppositely with reference to the magnetic field surrounding the core 15. When the magnetic flux from the coil 44 flows through the limb 43, without flowing through the limb 42, a reverse current is induced in the coil 50 and circuit 51 so that the flux created by the coil 18 in the core 15 will aid the flux of the coil 17 and oppose the flux of the coil 16. The current induced in the coils 49 and 50 may be of an alternating current characteristic, but only one half of the single cycle wave is effective or utilized to influence the coil 18. The first half of the wave will accomplish the action sought, and the last half of the wave will be ineffective if, in fact, it is present at all.

The portion of the apparatus described up to this point is the train-carried equipment, and the track part of the apparatus includes an inductor or inductive control device 52 including a core or armature of iron or other magnetic material and having the yoke 53 and three limbs 54, 55 and 56 extending therefrom. The cores of the devices 39 and 52 are of iron or other magnetic material, and the device 52 is mounted on the track in any suitable manner at the control location, while the device 39 is suspended from or mounted on the train to pass the device 52, the device 39 preferably moving over the device 52, with the limbs 41, 42 and 43 projecting downwardly, and the limbs 54, 55 and 56 projecting upwardly. When the device 39 is over the device 52, the limbs 41, 42 and 43 register or aline with the respective limbs 54, 55 and 56, as seen in dotted lines in Fig. 1.

Choke coils 57 and 58 are wound on the limbs 55 and 56, respectively, for controlling the action of the device 39, and the coils 57 and 58 are disposed in track circuits of low resistance which are controlled by a track electromagnet 59. Said magnet 59 is connected in a circuit of the wayside signal system (not shown) or may be controlled by any suitable means, whereby current flows in one direction in the magnet 59 under clear traffic or track conditions, and flows in the opposite direction in the magnet under caution track conditions, whereas no current flows in the magnet 59 under danger traffic conditions. Polarized reversing switches 60 and 61 and neutral switches 62 and 63 are controlled by the magnet 59, the switches 62 and 63 being raised whenever the magnet 59 is energized, while the switches 60 and 61 move toward the left and the right when current flows through the magnet 59 in opposite directions for clear and caution conditions, respectively. Thus, as shown in Fig. 1, the magnet 59 is energized for clear conditions to move the switches 60 and 61 toward the left, thereby closing the circuit of the coil 57, including the conductor 64, contact 65, switch 60, conductor 66, contact 67, switch 63 and conductor 68. The circuit of the coil 58 is open at the switch 61 under clear conditions. When the flow of current in the magnet 59 is reversed for caution conditions, the switches 60 and 61 are swung toward the right, thereby opening the circuit of the coil 57, and, at the same time, closing the circuit of the coil 58 which includes the conductor 69, contact 70, switch 61 in right hand position, conductor 71, contact 72, switch 62 and conductor 73. The coils 57 and 58 serve to impede the flow of magnetic flux through the limbs 55 and 56, respectively, from the electromagnet device 39 on the train.

The operation of the apparatus is as follows: Under danger traffic conditions, the magnet 59 is deenergized, so that the switches 62 and 63 are released and dropped from the respective contacts 72 and 67. The switches 60 and 61 are also in neutral position away from the contacts 65 and 70, respectively, so that the circuits of the coils 57 and 58 are broken at two different points in each circuit. When the train is travelling in the block, or between control locations, the magnet 32 is energized by the battery 48 to hold the switch 29 against the contact 28, and whether the train has been travelling under clear, caution or danger conditions, a danger condition will exist or become established when the device 39 passes the device 52 with the circuits of the coils 57 and 58 opened. Thus, when the train inductor or device 39 passes over and registers with the track inductor or device 52, the track core or armature bridges the core of the train device 39, with only small clearances between the track and train devices to avoid physical contact. The magnetic flux created by the coil 44 will flow down the limbs 42 and 43 (being divided between said limbs), and will pass through the limbs 55 and 56, yoke 53 and limb 54 back to the limb 41 and yoke 40 of the train device, thus completing the magnetic circuit, part of which includes the limbs 42 and 55 and part the limbs 43 and 56. The impulse of the magnetic flux thus created results in a surge through the magnetic circuit and coil 46, which induces a single cycle of counter E. M. F. in the coil 46 and circuit 47, one half wave of which opposes the current of the battery 48, so that the magnet 32 is deenergized. The switch 29 is therefore released and will drop away from the contact 28, opening the circuit of either the magnet 10 and coil 16 or the magnet 11 and coil 17, depending on whether clear or caution conditions exist as the train approaches the control location. At any rate, the switch 29 being opened will deenergize the electromagnet 14, so that the switch 26 drops down away from the contact 25 and against the contact 38. The magnetic flux created by the coil 44 being divided between the limbs 42 and 43 will pre-

vent the circuit 51 and coil 18 from being energized, inasmuch as the current induced in the coil 49 opposes the current induced in the coil 50. Consequently, the coil 18 remains deenergized so as not to raise the switch 26 or prevent said switch from dropping. As soon as the train inductor or device 39 has passed the track device 52, normal conditions will be restored in the circuit 47, and the magnet 32 will be reenergized from the battery 48, to pick up the switch 29. However, the switch 26 being in a stick circuit with the magnet 14, will result in the circuits of the magnets 10 and 11 remaining broken at the switch 26, so that both magnets 10 and 11 are deenergized, thereby extinguishing the lamps 12 and 13, and producing danger conditions. During these conditions the lamp 36 is lighted to indicate danger, the circuit including the battery 21, conductors 22 and 37, lamp 36, contact 38, switch 26, conductor 27, contact 28, switch 29 (raised) and conductor 30.

Under clear traffic conditions, with current flowing through the magnet 59 to move the switches 60 and 61 toward the right, and maintain the switches 62 and 63 raised, the low resistance circuit of the coil 58 is closed, while the circuit of the coil 57 is open. Now, when the vehicle or train passes the control location, with the vehicle equipment in either danger, caution or clear condition, the magnetic flux from the inductor 39 does not pass through the limb 56 because of the impedance effect of the choke coil 58, but the magnetic flux may flow freely through the limb 55 inasmuch as the circuit of the choke coil 57 is open at the contact 65. Therefore, with the inductor 39 over the track device 52, the magnetic flux created by the coil 44 flows freely through the limbs 42 and 55 so as to complete the magnetic circuit, without passing through the limbs 43 and 56, the choke coil 58 resisting the flow of magnetic flux through said limbs 43 and 56. Consequently, the magnet 32 is deenergized by one half wave of the single cycle of alternating current induced in the coil 46 and circuit 47, as hereinbefore described. Inasmuch as the magnetic flux flows through the limb 42 and not through the limb 43, current is induced in the coil 49 so as to energize the circuit 51 and coil 18. The current flows in the circuit 51 and coil 18 in one direction so that the magnetic flux created in the core 15 by the coil 18 will flow in the same direction as that created by the coil 16, opposing the magnetic flux created by the coil 17. However, when the coil 18 is energized, the switch 29 dropping away from the contact 28, will deenergize either or both of the coils 16 and 17. Although the coils 16 and 17 are deenergized the coil 18 being energized will keep the switch 26 raised against the contact 25. The switch 19 is balanced so as to swing easily to either position. The left hand arm is raised, as seen in Fig. 1, with the train travelling under clear conditions, and the coil 16 energized to hold the left hand arm of the switch against the contacts 24 and 31. The effective magnetic flux created by the coil 18 due to the flow of magnetic flux through the limb 42 when passing the track device 52, will be the same as that created by the coil 16, so that the switch 19 is maintained in clear position. As soon as the inductor 39 has passed the track device 52, the normal clear circuit is restored by the raising of the switch 29 against the contact 28 by the magnet 32. The normal clear circuit includes the battery 21, conductor 22, magnet 10 and lamp 12, conductor 23, contact 24 (and coil 16 and contact 31 in parallel with the contact 24), switch 19, contact 25, switch 26, conductor 27, contact 28, switch 29 and conductor 30. The magnets 10 and 11 are slow-acting so as not to produce danger conditions during the dropping and pick-up of the switch 29 when passing a track device 52, with the switch 26 held against the contact 25 by the energization of the coil 18. Should the switch 19 be in caution position, that is, with the right hand arm up against the contacts 34 and 35, then, the energization of the coil 18 under clear conditions, when passing the track device 52, will result in the magnetic flux of the coil 18 opposing the normal flux of the coil 17 (the switch 29 dropping at this instant) thereby having a tendency to kick the right hand arm of the switch 19 down and raise the left hand arm thereof to reverse the switch 19 and swing it to clear position. Furthermore, if desired, the switch 19 may be of one polarity, such as "north", while the limbs of the core 15 are of the opposite polarity, such as "south". Thus, the lower end of the core of each coil 16 and 17 may be a south pole tending to raise the switch 19 although only one of the coils 16 and 17 may be energized at one time. Both of said coils 16 and 17 being deenergized whenever the conductor 39 passes the track device with the switch 29 open, will give the coil 18 control of the switch 19, and the polarity of the core 15 is (respectively) reversed by the coil 18 when current flows therein in opposite directions for clear and caution conditions. Accordingly, when current flows in the circuit 51 and coil 18, under clear conditions with the switch 29 open, by the flow of magnetic flux through the limb 42, as above described, the magnetic flux in the core 15 created by the coil 18 will raise or hold in raised position the left hand arm of the switch 19. Thus, clear conditions are maintained if they existed when approaching the control location, or such clear conditions are established if the train has been proceeding under caution or danger conditions. If the

train was proceeding under caution conditions the switch 19 being reversed by the passage of the inductor 39 over the track device 52 under clear conditions will open the circuit of the magnet 11 and lamp 13 at the contacts 34 and 35, and if the train was proceeding under danger conditions, the switch 26 being raised by the influence of the coil 18 will extinguish the lamp 36, it being understood that the switch 26 is raised when the coil 18 is energized to influence the switch 19.

Under caution traffic conditions, with current flowing in the magnet 59 to swing the switches 60 and 61 toward the left, as seen in Fig. 1, the circuit of the coil 58 is opened at the contact 70, while the circuit of the choke coil 57 is closed. The action is substantially of the same character as under clear conditions, excepting that it is reversed. Thus, the choke coil 57 is effective to prevent the magnetic flux of the inductor 39 passing through the limbs 42 and 55, while the magnetic flux has a clear path through the limbs 43 and 56. The magnet 32 becomes deenergized, the same as occurs whenever the inductor or device 39 passes a track device 52, thus providing an intermittent or periodic opening of the switch 29 at predetermined control locations of the track. The impedance of the choke coil 57 will direct the magnetic flux from the coil 44 through the limbs 43 and 56 as the path of least resistance, and current is therefore induced in the coil 50, so as to flow in the circuit 51 and coil 18 in the direction opposite to the flow of current under clear conditions. Consequently, the core 15 is traversed by magnetic flux reversely to that under clear conditions, and the right hand arm of the switch 19 is raised against the contacts 34 and 35, or if proceeding under caution conditions the right hand arm of said switch is held against said contacts. The switch 26 becomes raised if the train has been proceeding under danger conditions, so as to step up to caution conditions. The caution circuit, after the switch 29 is raised as soon as the inductor 39 has passed the device 52, includes the battery 21, conductor 22, magnet 11 and lamp 13, conductor 33, contact 34 (and coil 17 and contact 35 in parallel with the contact 34), switch 19 with its right hand arm raised, contact 25, switch 26, conductor 27, contact 28, switch 29, and conductor 30.

It is thus possible by controlling the circuits of the choke coils 57 and 58 to divide the magnetic flux of the coil 44 between the coils 49 and 50 for danger conditions, or to divert the magnetic flux practically entirely through either coil 49 or 50 for selectively obtaining clear and caution conditions, the initiating action resulting in the deenergization of the magnet 32 and dropping of the switch 29 occurring regardless of whether either or both of the track circuits of the coils 57 and 58 are open. The initiating impulse for opening the switch 29 and the clear or caution circuit is also used, under clear or caution track conditions for obtaining an impulse in the electromagnet or device 14 to obtain or maintain clear or caution conditions selectively. The coils 44, 46, 49 and 50 are all wound on the same core, thus providing a simple electromagnetic and transformer unit, and the same is true of the coils 57 and 58 and core of the track device 52. This provides for simplicity and economy both in installation and maintenance.

Fig. 2 illustrates a modification. The coils 16*a* and 17*a* on the core 15 of the device 14*a* are connected by a branch conductor 22*a* with the conductor 22, and are also connected with the contact 25, whereby the coils 16*a* and 17*a* are both energized normally, the circuit including the battery 21, conductors 22 and 22*a*, coils 16*a* and 17*a*, contact 25, switch 26, conductor 27, contact 28, switch 29 and conductor 30. The switch 19 will therefore be held in either of its positions. The coils 16*a* and 17*a* oppose one another, creating opposite magnetic flux in the core 15. Thus, when the coil 18 is energized, while passing a control location, by current flowing in the circuit 51 in one direction, the magnetic flux created by the coil 18 will aid the magnetic flux created by the coil 16*a* and oppose the magnetic flux by the coil 17*a*, thereby raising the left hand arm of the switch 19, whereas when the current flows in the opposite direction in the circuit 51 and coil 18, the magnetic flux of the coil 18 will assist that of the coil 17*a* and oppose the magnetic flux of the coil 16*a*, thereby raising the right hand arm of the switch 19. The operation is the same as that hereinbefore described, the coils 16*a* and 17*a* being deenergized when the switch 29 drops open, in passing a control location, thereby providing danger conditions unless the coil 18 is energized for clear or caution conditions.

Fig. 3 illustrates another modification. The coil 18*b* of the device 14*b* is disposed in the conductor 22 so as to be in the circuits of the magnets 10 and 11. The coil 16*b* of the device 14*b* is connected in the circuit 51*b* with the coil 49*b* on the limb 42 of the inductor 39*b*, while the coil 17*b* is connected in circuit 51*x* with the coil 50*b* on the limb 43 of the inductor. With this arrangement the coil 18*b* is the normal energizing coil of the electromagnet device 14*b*, the switch or armature 19 being neutral so as to be held in either position against the contact 24 or the contact 34. When the inductor 39*b* passes over the track device as hereinbefore described, the magnet 32 is deenergized so that the switch 29 drops open, thereby deenergizing the coil 18*b* and ultimately either of the magnets 10 and 11. If the coil 16*b* is energized from the coil 49*b*,

with the coil 17*b* remaining deenergized, such as happens under clear conditions, the magnetic flux of the coil 16*b* will raise or hold in raised position the left hand arm of the switch 19, to provide for clear conditions. When the coil 17*b* is energized from the coil 50*b*, with the coil 16*b* remaining deenergized, such as happens under caution conditions, the right hand arm of the switch 19 is raised, thereby establishing caution conditions. The caution and clear circuits including the magnets 11 and 10, respectively, are substantially the same as hereinbefore described, excepting that the coil 18*b* is in either circuit by being disposed in the conductor 22. It will be apparent that each of the coils 16*b* and 17*b* being disposed on one limb of the core 15 will, when energized, raise the corresponding arm of the switch 19, inasmuch as the magnetic flux will be stronger in the limb on which the energized coil is located than in the opposite limb on which the coil remains deenergized.

In Fig. 4 a still further variation is depicted. A motor type of device 14*c* is employed comprising the field core 15*c* on which the field coil 18*c* is wound, said coil being connected by the branch conductors 22*c* and 30*c* with the respective battery conductors 22 and 30, so that said field coil is continually energized. The armature 19*x* of the motor 14*c* has a winding or coil 16*c* thereon connected in the circuit 51*c* with the coils 49*c* and 50*c* of the inductor 39*c*. The armature 19*x* carries the switch 19*c*. The motor 14*c* is used for establishing alternative circuits for the magnets 10 and 11 under clear and caution conditions, respectively. The normal or primary clear circuit includes the battery 21, conductor 22, magnet 10 and lamp 12, a slow-acting magnet 74, switch 76 of the slow-acting stick relay 74, contact 77, conductor 78, contact 28, switch 29 and conductor 30. Thus, when the switch 29 is released by the magnet 32 when passing a control location, the magnets 10 and 74 are deenergized, and the switch 76 being released will keep said circuit open unless the magnet 74 is energized by way of an alternative pick-up circuit. The primary caution circuit includes the battery 21, conductor 22, magnet 11 and lamp 13, a slow-acting electromagnet 79, switch 80 of the slow-acting stick relay 79, contact 81, conductor 78, contact 28, switch 29 and conductor 30. The stick relays of the clear and caution circuits control the energization of the clear and caution magnets 10 and 11, respectively. Thus, with the switch 76 raised against the contact 77, the magnets 10 and 74 will be energized, with the switch 29 closed, thereby establishing the clear circuit, with the switch 80 raised the magnets 11 and 79 will be energized, with the switch 29 closed, so as to establish the caution circuit.

When the inductor 39*c* passes the track device 52, with the circuits of both choke coils 57 and 58 open, the flux from the coil 44 is divided between the coils 49*c* and 50*c*, so that the coil or winding 16*c* of the armature 19*x* remains deenergized, and the switch 19*c* will remain between the contacts 24*c* and 34*c* out of engagement therewith. However, the switch 19*c* being released will open either the clear or the caution pick-up circuit, which ever is closed, so that both magnets 10 and 11 are deenergized, to establish danger conditions. If, when passing the control location, the circuit of the choke coil 58 is closed, so that the magnetic flux of the coil 44 does not pass through the coil 50*c* and passes through the coil 49*c*, the armature winding 16*c* is energized by current flowing in one direction in the circuit 51*c*, thereby turning the armature 19*x* and switch 19*c*, so that said switch engages the contact 24*c*. This will establish an alternate pick-up circuit for the magnets 10 and 74, said circuit including the battery 21, conductor 22, magnet 10 and lamp 12, magnet 74, conductor 23*c*, contact 24*c*, switch 19*c*, branch conductor 30*c* and conductor 30. Thus, while the switch 29 is open, an alternate pick-up circuit for the magnets 10 and 74 is closed by the switch 19*c*, and when the inductor 39*c* leaves the device 52, so that the switch 19*c* moves away from the contact 24*c*, the switch 29 is reclosed so as to keep the magnets 10 and 74 energized by establishing the normal or primary clear circuit.

When the inductor 39*c* passes the track device 52 with the circuit of the choke coil 57 closed, the magnetic flux of the coil 44 passing through the coil 50*c*, will energize the armature winding 16*c* by current flowing in the circuit 51*c* in a direction oppositely to that last described above. This will swing the switch 19*c* against the contact 34*c*, thereby establishing an alternate pick-up circuit for the caution magnets 10 and 79, said circuit including the battery 21, conductor 22, magnet 11 and lamp 13, magnet 79, conductor 33*c*, contact 34*c*, switch 19*c*, branch conductor 30*c* and conductor 30. This will energize the magnets 11 and 79, or keep them energized if the train has been proceeding under caution conditions, and as the inductor 39 leaves the track device, the switch 29 being raised will complete the caution circuit to maintain the magnets 11 and 79 energized, while the switch 19*c* leaves the contact 34*c*.

Fig. 4 also illustrates a simplified track relay, including a single polarized switch 60*c* controlled by the track magnet 59, the switch 60*c* being connected by the conductors 66*c* and 71*c* with the coils 57 and 58, respectively, and said coils being connected by the respective conductors 64 and 69 with the contacts 65*c* and 70*c*. The switch 60*c* moves toward the left against the contact 65*c* to close the circuit of the coil 57 when current flows in one direction in the magnet 59, and said

switch is moved toward the right against the contact 70*c* to close the circuit of the coil 58 when current flows in the opposite direction in the magnet 59, whereas the switch assumes a neutral position when the magnet 59 is deenergized.

As shown in Fig. 5, the coils 44*d* and 46*d* may be located on the limb 42*d* of the core 40*d*, and the coils 49*d* and 50*d* may be located on the limbs 41*d* and 43*d*, respectively, while the coils 57*d* and 58*d* of the track element may be located on the limbs 54*d* and 56*d*, respectively, of the core 53*d*.

Having thus described the invention, what is claimed as new is:—

1. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and a plurality of impulse coils in inductive relation with the exciting coil, the impulse coils being reversed with reference to the flux of the exciting coil, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled means to selectively impede the flow of magnetic flux from the exciting coil through either of the impulse coils, and polarized train-controlling means controlled by reverse impulses from said impulse coils to obtain different conditions selectively.

2. An inductor for an automatic train control apparatus comprising a core having three limbs, independent impulse coils on two of said limbs, and an exciting coil and a third impulse coil on said core between said limbs and the third limb, in combination with translating means controlled by all three impulse coils for obtaining one condition when the third impulse coil is affected and for obtaining other conditions selectively when the firstnamed impulse coils are affected selectively.

3. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and a direct current energized exciting coil on said core to direct magnetic flux through both of said limbs, the impulse coils being reversed with reference to the flux of the exciting coil; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the secondnamed core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and polarized train-controlling means controlled by reverse impulses from said impulse coils to obtain different conditions selectively.

4. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and a plurality of impulse coils in inductive relation with the exciting coil, the impulse coils being reversed with reference to the flux of the exciting coil, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled means to selectively impede the flow of magnetic flux from the exciting coil through either of the impulse coils, and polarized train-controlling means affected whenever the exciting coil is rendered active as aforesaid to establish one condition and also controlled by reverse impulses from said impulse coils to avoid said condition and obtain other conditions selectively.

5. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and an exciting coil on said core to direct magnetic flux through both of said limbs, the impulse coils being reversed with reference to the flux of the exciting coil and the exciting coil being energized by direct current; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the secondnamed core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and polarized train-controlling means controlled by said magnetic flux to obtain a danger condition and also controlled by impulses from said impulse coils to avoid said condition and obtain caution and clear conditions selectively by reverse impulses.

6. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and three impulse coils in inductive relation with the exciting coil, two of the impulse coils being reversed with reference to the flux of the exciting coil, the third impulse coil being so related with reference to the magnetic flux of the exciting coil as to be deenergized when the exciting coil becomes active, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled means to selectively impede the flow of magnetic flux from the exciting coil through either of the two firstnamed impulse coils, and polarized train-controlling means controlled by said impulse coils operable for obtaining a danger condition by the deenergization of the third impulse coil and operable to avoid said condition and establish clear and caution conditions selectively by reverse impulses from the two firstnamed impulse coils.

7. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs, and an exciting coil and a third impulse coil on said core between said limbs and the third limb, the exciting and third im-

pulse coils being energized by direct current to oppose one another, with the flux of the third impulse coil weaker than the flux of the exciting coil; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the secondnamed core, one for each of the two firstnamed impulse coils, to impede the flow of magnetic flux through the said impulse coils; means for selectively controlling the circuits of said choke coils; and train-controlling means controlled by all of said impulse coils to obtain a danger condition when only the third impulse coil is affected by magnetic flux from the exciting coil and operable to avoid said condition and obtain clear and caution conditions selectively by impulses from the two firstnamed impulse coils.

8. Automatic train control apparatus comprising train-carried impulse coils, means energized by direct current and including a track inductor for directing magnetic flux through said coils when passing a control location of the track, said inductor including choke coils for selectively impeding the flow of magnetic flux through either of said coils, and train-controlling means controlled by impulses from said coils for obtaining different conditions.

9. Automatic train control apparatus comprising train-carried impulse coils, means energized by direct current for directing magnetic flux through said coils when passing a control location of the track including a core on the track in the magnetic circuits of said coils and choke coils on said core, one for each impulse coil, means for selectively controlling the circuits of said choke coils, and train-controlling means controlled by impulses from said impulse coils to obtain different conditions selectively.

10. Automatic train control apparatus comprising a train-carried inductor having an exciting coil energized by direct current and having a plurality of independent impulse coils in inductive relation with the exciting coil, a track inductor with which the train-carried inductor is inductively cooperable to render the exciting coil active and having controlled means to impede the flow of magnetic flux from the exciting coil selectively through either of the impulse coils, and train controlling means controlled by impulses from said impulse coils for obtaining different conditions selectively.

11. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and a plurality of impulse coils in inductive relation with the exciting coil, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled choke coils to selectively impede the flow of magnetic flux from the exciting coil through either of the impulse coils, and train-controlling means controlled by impulses from said impulse coils to obtain different conditions selectively.

12. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and an exciting coil on said core energized by direct current to direct magnetic flux through both of said limbs; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the second named core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and train-controlling means controlled selectively by impulses from said impulse coils to obtain different controlling conditions.

13. An inductor for a train control apparatus comprising a core having three limbs, independent impulse coils on two of said limbs, and an exciting coil and a third impulse coil on said core between said limbs and the third limb and both energized by direct current, in combination with translating means controlled by all three impulse coils for obtaining one condition when the third impulse coil is affected and for obtaining other conditions selectively when the firstnamed impulse coils are affected selectively.

14. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and a direct current energized exciting coil on said core to direct magnetic flux through both of said limbs; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the secondnamed core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and train-controlling means controlled by impulses from said impulse coils to obtain different conditions selectively.

15. Automatic train control apparatus comprising train-carried impulse coils, means energized by direct current and including a track inductor for directing magnetic flux through said coils when passing a control location of the track, said inductor including choke coils for selectively impeding the flow of magnetic flux through either of said coils, and train-controlling means controlled by said magnetic flux to obtain one condition and also controlled by impulses from said coils for avoiding said condition and obtaining other conditions selectively.

16. Automatic train control apparatus comprising train-carried impulse coils, means energized by direct current for directing magnetic flux through said coils when passing a control location of the track including a core on the track in the magnetic circuits of said coils and choke coils on said core, one for each impulse coil, means for selectively controlling the circuits of said choke coils, and train-controlling means controlled by said magnetic flux to obtain one condition and also controlled by impulses from said coils to avoid said conditions and obtain other conditions selectively.

17. Automatic train control apparatus comprising a train-carried inductor having an exciting coil energized by direct current and two impulse coils in inductive relation with the exciting coil, a track inductor with which the train carried inductor is cooperable to render the exciting coil active and having controlled means to impede the flow of magnetic flux from the exciting coil through either of the impulse coils, and train-controlling means affected whenever the exciting coil is rendered active as aforesaid to establish one condition and also controlled by said impulse coils for avoiding said condition and obtaining other conditions selectively when said impulse coils are selectively affected inductively by the exciting coil.

18. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and a plurality of impulse coils in inductive relation with the exciting coil, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled choke coils to selectively impede the flow of magnetic flux from the exciting coil through either of the impulse coils, and train-controlling means affected whenever the exciting coil is rendered active as aforesaid to establish one condition and also controlled impulses from said impulse coils to avoid said condition and obtain other conditions selectively.

19. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and an exciting coil on said core energized by direct current to direct magnetic flux through both of said limbs; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs of the secondnamed core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and train-controlling means controlled by said magnetic flux to obtain one condition and also controlled by the impulses from said impulse coils to avoid said condition and obtain other conditions selectively.

20. Automatic train control apparatus comprising a train-carried inductor having a core with three limbs, impulse coils on two of said limbs and an exciting coil on said core energized by direct current to direct magnetic flux through both of said limbs, the exciting coil being energized by direct current; a track inductor having a core with three limbs to register with the limbs of the firstnamed core when the train passes, and choke coils on two limbs on the secondnamed core, one for each impulse coil, to impede the flow of magnetic flux through the corresponding impulse coils; means for selectively controlling the circuits of the choke coils; and train-controlled means controlled by said magnetic flux to obtain a danger condition and also controlled by impulses from said impulse coils to avoid said condition and obtain caution and clear conditions selectively.

21. Automatic train control apparatus comprising three train-carried impulse coils, means energized by direct current and including a track inductor for directing magnetic flux through said coils when passing a control location of the track, said inductor including means for selectively impeding the flow of magnetic flux through either of two of said coils, the other coil being affected by said magnetic flux whenever passing a track inductor, and train-controlling means controlled by all of said impulse coils to obtain one condition when only the last named impulse coil is affected and for avoiding said condition and obtaining other conditions selectively when the two firstnamed impulse coils are selectively affected by said magnetic flux.

22. Automatic train control apparatus comprising three train-carried impulse coils, means energized by direct current for directing magnetic flux through said coils when passing a control location of the track including a core on the track in the magnetic circuits of said coils and choke coils on said core, one for each of two of said impulse coils, the other impulse coil being affected whenever passing a track core, means for selectively controlling the circuits of said choke coils, and train-controlling means controlled by said impulse coils to obtain one condition when only the lastnamed impulse coil is affected by the magnetic flux and for obtaining other conditions selectively when said two impulse coils are affected selectively by said magnetic flux dependent on the closing of the circuits of the choke coils.

23. Automatic train control apparatus comprising a train-carried inductor having an exciting coil energized by direct current and having three impulse coils in inductive relation with the exciting coil, a track induc-

tor with which the train carried inductor is cooperable to render the exciting coil active and having controlled means to impede the flow of magnetic flux from the exciting coil through either of two of the impulse coils, the other impulse coil being inductively affected whenever the exciting coil is rendered active as aforesaid, and train-controlled means controlled by said impulse coils for obtaining one condition when the last named impulse coil only is affected and for obtaining other conditions selectively when two firstnamed impulse coils are selectively affected inductively by said exciting coil.

24. Automatic train control apparatus comprising a train-carried inductor having a direct current energized exciting coil and three impulse coils in inductively relation with the exciting coil, two of the impulse coils being for resetting control, a third impulse coil being so related with reference to the magnetic flux of the exciting coil as to be deenergized when the exciting coil becomes active, a track inductor with which said train-carried inductor is cooperable to render the exciting coil active and having controlled means to selectively impede the flow of magnetic flux from the exciting coil through either of the two firstnamed impulse coils, and train-controlling means controlled by said impulse coils operable for obtaining a danger condition by the deenergization of the third impulse coil and operable to avoid said condition and establish clear and caution conditions selectively from the two firstnamed impulse coils.

25. Automatic train control apparatus, comprising the combination of a train-carried inductor having an exciting coil and two impulse coils in inductive relation to the exciting coil, said exciting coil being normally inductively inactive with respect to said impulse coils, a track inductor with which the train-carried inductor is co-operative to render the exciting coil inductively active upon movement of the train-carried inductor thereover and having controlled choke coils to impede the flow of magnetic flux from the exciting coil through one or the other or neither of the impulse coils upon movement of one inductor over the other, and train-controlling means effective whenever the exciting coil is rendered active as aforesaid to establish one condition and also controlled by said impulse coils for avoiding said condition and obtaining other conditions selectively when said impulse coils are selectively affected inductively by the exciting coil.

26. Automatic train control apparatus, comprising a train-carried inductor having an exciting coil and three impulse coils in inductive relation to the exciting coil, said exciting coil being normally inductively inactive with respect to said impulse coils, a track inductor with which the train-carried inductor is co-operable to render the exciting coil inductively active upon the passage of one inductor over the other and having controlled means to impede the flow of magnetic flux through either of two of the impulse coils, the other impulse coil being normally de-energized and inductively affected whenever the exciting coil is rendered active as aforesaid, and train-controlling means controlled by said impulse coils for obtaining one condition when the flux is directed through all three impulse coils, and for obtaining other conditions selectively when the two first-named impulse coils are selectively affected inductively by said exciting coil.

27. Automatic train control apparatus, comprising the combination of a train-carried inductor including a core, an exciting coil on said core, a source of current for said exciting coil, a pair of impulse coils on said core, a third impulse coil on said core connected in circuit with a source of direct current and a relay, a track inductor adapted to complete the magnetic circuit of the core of said train-carried inductor as the latter passes thereover, selectively controlled means associated with said track inductor for directing magnetic flux through two or more of the impulse coils of said train-carried inductor, and train-controlling means jointly controlled by said relay and said first-mentioned pair of impulse coils for obtaining a selected train-controlling condition in accordance with the selective control of the track inductor.

28. In a train control system, the combination of track-way inductors having a condition of clear or proceed and a condition of danger or stop, a vehicle having an inductor registering with said track-way inductors as the vehicle passes thereover, means on the vehicle for energizing said vehicle inductor, a normally energized first relay, a circuit operatively connecting said relay with said vehicle inductor, a second relay, a second circuit operatively connecting said second relay with said vehicle inductor and controlled by said second relay, a translating device controlled by said first and second relays, and means whereby said first relay is de-energized at each track-way inductor and said second relay remains energized when said track-way inductor is in the proceed condition and is de-energized when said track-way inductor is in the stop condition.

29. In a train control system, the combination of trackway inductors having conditions of clear, caution and stop, a vehicle having an inductor registering with said track-way inductors as the vehicle passes thereover, means on the vehicle for energizing said vehicle inductor, a normally energized first relay, a closed circuit operatively connecting said relay with said vehicle inductor, a three-

position second relay, a second circuit operatively connecting said second relay with said vehicle inductor, a translating device controlled by said first and second relays, means whereby said first relay is de-energized at each track-way inductor, and means whereby said second relay is selectively positioned by said track-way inductor in the clear or caution condition and is de-energized by said track-way inductor in the stop condition.

30. In a train control system, the combination of track-way inductors having conditions of clear, caution and stop, a vehicle having an inductor registering with said track-way inductors as the vehicle passes thereover, means on the vehicle for energizing said vehicle inductor, a normally energized first relay, a closed circuit operatively connecting said relay with said vehicle inductor, a three-position second relay, a second circuit operatively connecting said second relay with said vehicle inductor, said second relay controlling said second circuit, a translating device controlled by said first and second relays, means whereby said first relay is de-energized at each track-way inductor, and means whereby said second relay is selectively positioned by said track-way inductor in the clear or caution condition, and is de-energized by said track-way inductor in the stop condition.

31. In a train control system, the combination of track-way inductors having proceed and stop conditions, a vehicle having an inductor registering with said trackway inductors as the vehicle passes thereover, a coil in a direct current circuit for energizing said vehicle inductor, a normally energized first relay, a second coil inductively coupled with said first-named coil connected in circuit with said relay, a second relay, a second circuit operatively connecting said second relay with said vehicle inductor, a translating device controlled by said first and second relays, and means whereby said first relay is de-energized at each track-way inductor and said second relay remains energized when said track-way inductor is in the proceed condition and is de-energized when said trackway inductor is in the stop condition.

32. In a train control system, the combination of track-way inductors having clear, caution and stop conditions, a vehicle having an inductor registering with said track-way inductors as the vehicle passes, a coil for energizing said vehicle inductor, a normally energized first relay, a second coil inductively coupled with said first-named coil and connected in circuit with said relay, an electrically operated three-position mechanism, a second circuit operatively connecting said mechanism with said vehicle inductor, means whereby said first relay is normally de-energized at each track-way inductor, means whereby said mechanism is selectively positioned by said track-way inductors in clear and caution condition and is de-energized by said track-way inductors in stop condition, and a translating device having a circuit controlled by said relays.

33. In a train control system, the combination of track-way inductors having clear, caution and stop conditions, a vehicle having an inductor registering with said track-way inductors as the vehicle passes thereover, a coil in a direct current circuit for energizing said vehicle inductor, a first relay, a direct current circuit inductively coupled with said coil for normally energizing said relay, a three-position mechanism energized by direct current and having a circuit operatively connected with said vehicle inductor, means whereby said first relay is normally de-energized at each track-way inductor, means whereby said mechanism is selectively positioned by said track-way inductors in clear and caution conditions and is moved to a de-energized position by said track-way inductors in stop condition, a translating device, and a circuit for said translating device interrupted by said first relay in the de-energized position and by said mechanism in the de-energized position.

In testimony whereof I hereunto affix my signature.

DANIEL HERBERT SCHWEYER.