Oct. 17, 1933. T. BODDE 1,930,920

TRAIN CONTROL SYSTEM

Filed Oct. 1, 1926 2 Sheets-Sheet 1

FIG. 1.

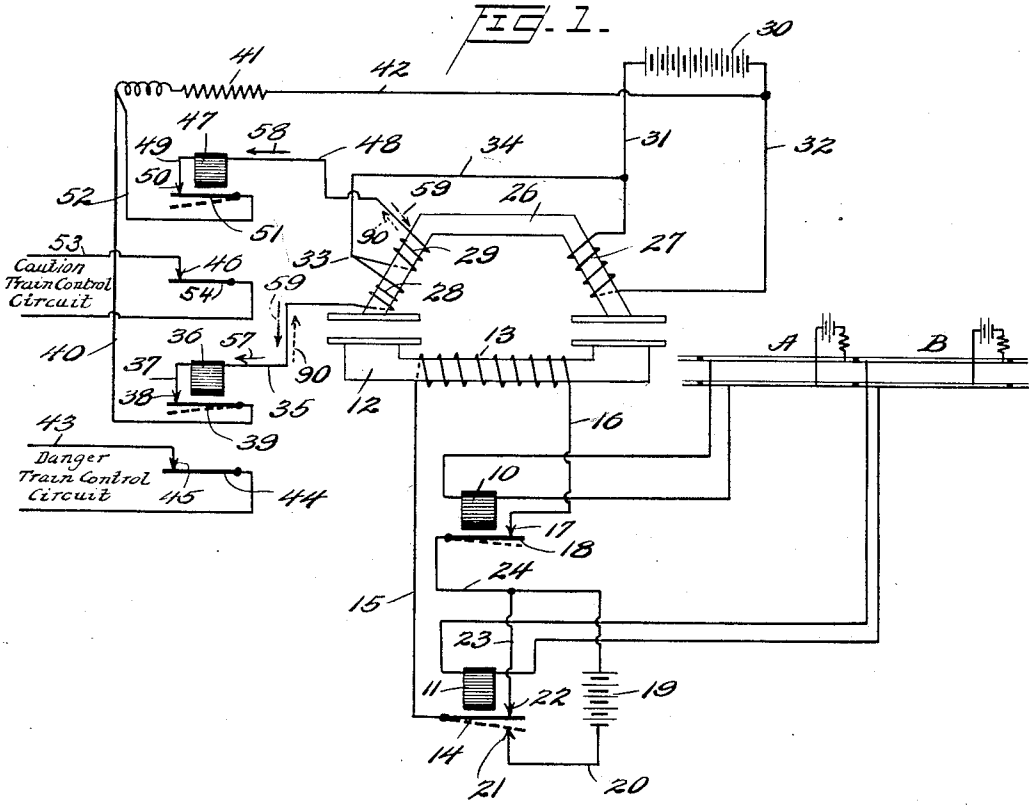
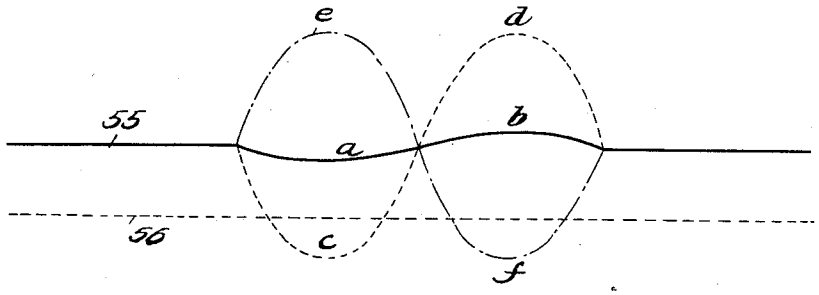


FIG. 2.



Inventor
Theodore Bodde

By Cavanagh & James

Attorney

Oct. 17, 1933. T. BODDE 1,930,920

TRAIN CONTROL SYSTEM

Filed Oct. 1, 1926 2 Sheets-Sheet 2

FIG. 3.

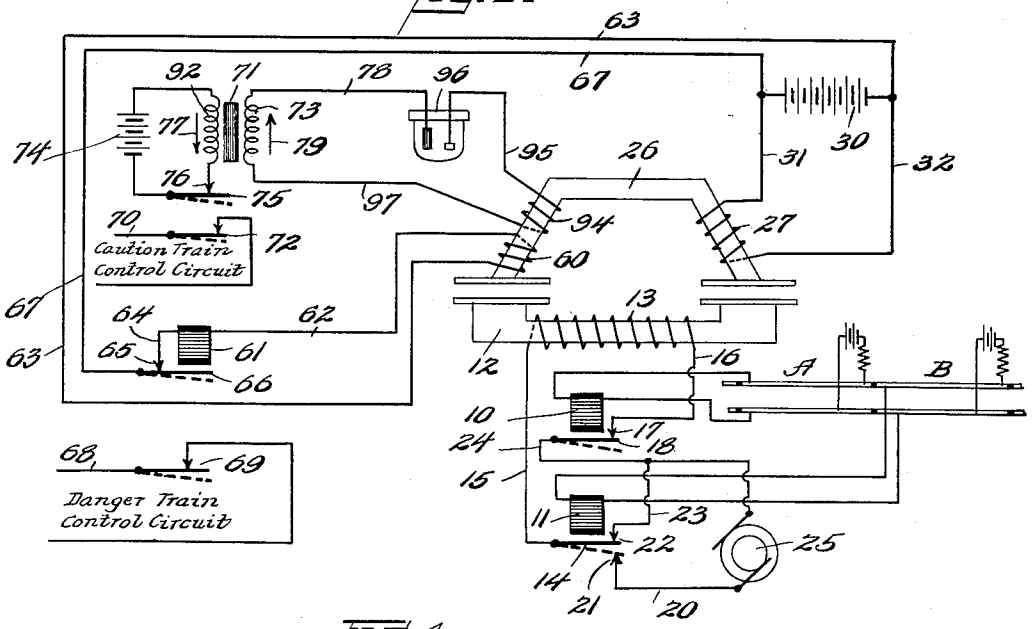


FIG. 4.

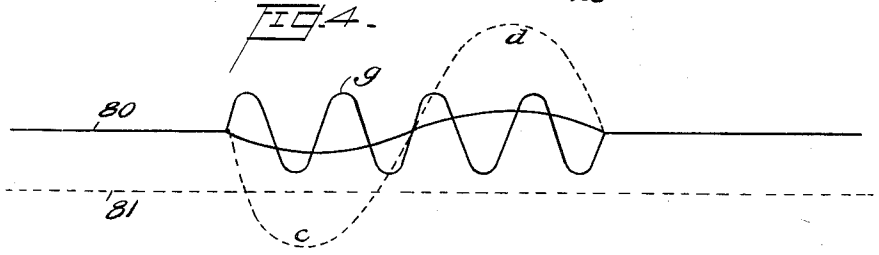
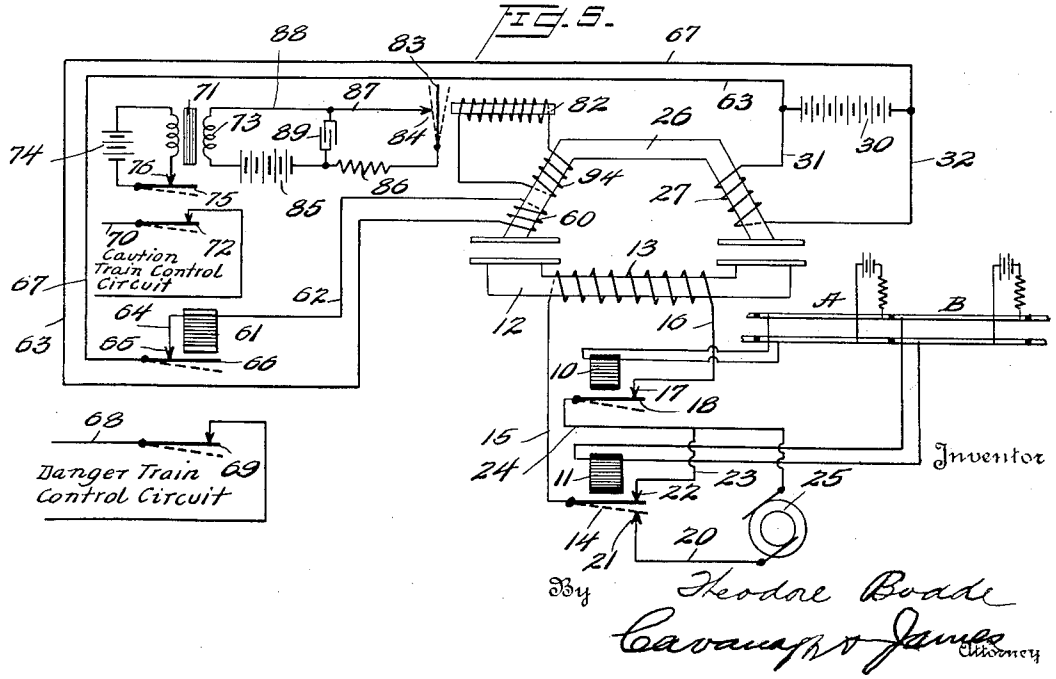


FIG. 5.



By Theodore Bodde

Cavanagh & James Attorney

Patented Oct. 17, 1933 1,930,920

UNITED STATES PATENT OFFICE

1,930,920

TRAIN CONTROL SYSTEM

Theodore Bodde, Niagara Falls, N. Y., assignor to The Regan Safety Devices Company, Inc., New York, N. Y., a corporation of New York

Application October 1, 1926. Serial No. 138,825

22 Claims. (Cl. 246—63)

This invention relates broadly to induction train control systems. It is the object of the present invention to provide an induction train control system which is operable in accordance with wayside conditions and is responsive to the caution as well as the danger conditions that may exist on the roadside.

Another object of the invention is to provide a three-position roadside inductor which is capable of giving three indications. The three indications are preferably clear, caution and danger.

Another object of the invention is to so modify the train carried system that it may be responsive to the danger and caution conditions of the roadside and control the train carried system in accordance with such conditions on the roadside.

In an induction train control system as known hitherto, a roadside device is provided at the entrance of each block which device consists of a body of magnetic material and a winding thereon. The roadside system operates so that when the block is clear, the winding is short-circuited and the roadside inductor is thereby made to give a clear indication. When the block is occupied or is otherwise in a danger condition, the circuit of the winding is opened and the roadside inductor is thereby made to give a danger indication. It is the object of the present invention to modify the roadside system in such a manner that in addition to the above indications of clear and danger, the roadside device may also be made to give a caution indication. This object is accomplished by providing a source of energy in the roadside device which under caution condition is connected to said winding, and the roadside inductor is thereby made to give a caution indication.

A further object of the present invention is to modify the train carried system so that it may be responsive to each of the three indications on the roadside device. In similar systems known hitherto, the train carried system is provided with an inductor which is so disposed that it passes directly over the roadside inductor at the entrance to a block. The train carried inductor is provided with one primary and one secondary winding. When such an inductor passes over a roadside inductor having its winding short-circuited and thereby giving a clear indication, the conditions in the train carried system remain substantially undisturbed. When, however, such train carried inductor passes over the roadside inductor having its winding open-circuited, a current is induced in the secondary winding which is in opposition to the normal current carried thereby and a danger indication train control circuit is operated thereby. In order to make a system of the type described above responsive to the caution indication of the roadside system, which constitutes a part of the present invention, the train carried inductor is provided with another secondary winding and controls a train carried caution circuit and is responsive to the conditions which exist on the roadside inductor when a source of current is connected thereto.

To the accomplishment of the foregoing objects and such other objects as may hereinafter appear, my invention consists in the elements and their relation one to another as hereinafter particularly described and defined in the appended claims.

In the drawings:

Figure 1 shows one embodiment of my invention.

Figure 2 is a diagrammatic illustration of the current changes that take place in the train carried inductor.

Figure 3 shows another embodiment of my invention.

Figure 4 is a diagrammatic showing of the current changes that take place in the train carried inductor in the system shown in Figure 3.

Figure 5 shows another embodiment of my invention.

In the drawings A and B indicate two adjacent blocks. 10 is a track relay associated with block A and 11 is a track relay associated with block B. 12 is a roadside inductor disposed at the entrance to block A and provided with a winding 13. The winding 13 is connected to the armature 14 of the track relay 11 by means of conductor 15. The other end of the winding 13 is connected by means of conductor 16 to the contact 17 of the armature 18 controlled by the track relay 10. One terminal of a source of direct current 19 is connected by conductor 20 to the back contact 21 of the armature 14, and the other terminal is connected to the front contact 22 of the armature 14 by means of conductor 23. The conductor 24 connects the conductor 23 to the armature 18.

When blocks A and B are both unoccupied, that is when block A is in a clear condition, track relays 10 and 11 are both energized and the armatures 14 and 18 are in the full line position shown in the drawings. The winding 13 of the roadside inductor is therefore short-circuited through the following circuit: winding 13, conductor 15, armature 14, contact 22, conductors 23 and 24, armature 18, contact 17, conductor 16 back to the winding 13. The roadside inductor is in its clear indicating condition.

When the block A is occupied or is otherwise in a danger condition, its track relay 10 is de-energized and the armature 18 then assumes its dotted line position. Under such conditions the winding 13 is open-circuited and the roadside inductor gives a danger indication, it being

noted at this point that when the track relay 10 is deenergized, a danger indication is imparted to the roadside inductor 12, regardless of the condition of the track relay 11. In other words the roadside inductor is in a danger condition whenever the track relay 10 is deenergized, whether or not the track relay 11 is energized.

When the block A is unoccupied and the block B is occupied, track relay 10 remains energized and track relay 11 is deenergized and the block A is in a caution condition. Under such conditions the source of energy 19 is connected to the winding 13 of the roadside inductor by the following circuit: source of energy 19, conductor 20, contact 21, armature 14 of the track relay 11, conductor 15, winding 13, conductor 16, contact 17, and armature 18 of the track relay 10, and conductor 24 to the other side of the source of energy 19. The roadside inductor now indicates caution.

The above description of the roadside system applies also to the showing in Figures 3 and 5, except that in these cases a source of alternating current 25 is inserted in lieu of the source of direct current 19 shown in Figure 1.

I shall now proceed with a description of the construction and operation of the train carried system shown in Figure 1. This system comprises a train carried inductor 26 which is provided with a primary winding 27 and two secondary windings 28 and 29. The source of direct current 30 is carried by the train and is connected to the primary winding 27 by means of conductors 31 and 32. The two secondary windings 28 and 29 are connected to each other at the point 33 which in turn is connected to one side of the source of current 30 by means of conductor 34. Conductor 35 leads from the other end of the secondary winding 28 to the danger control relay 36, the other side of the relay being connected by conductor 37 to its contact 38. The armature 39 of the danger control relay 36 is connected by conductor 40 to the resistance 41 and conductor 42 connects the resistance with the other side of the source of current 30.

It will be seen, therefore, that normally a current flows through the relay 36 and the winding 28 through the following circuit: source of current 30, conductor 34, winding 28, conductor 35, relay 36, conductor 37, contact 38 and armature 39 of the relay 36, conductor 40, resistance 41 and conductor 42 back to the source of energy 30.

The circuits are so designed that the current flowing in the circuit traced immediately above is such as to energize the relay 36 sufficiently so that normally it maintains the armature 39 in its full line position in contact with the contact 38. Relay 36 controls the danger train control circuit 43 by the aid of armature 44 and contact 45. The normally energized relay 36 maintains the armature 44 in its full line position in contact with the contact 45, and therefore normally maintains the danger train control circuit 43 closed.

The train carried system is also provided with a caution control circuit 53 which includes the armature 54 and contact 46 which are normally closed and maintained in that closed position by the normally energized caution relay 47. The relay 47 is connected to one end of the winding 29 by means of conductor 48, and is connected at its other end by means of conductor 49 to the contact 50 which normally abuts the armature 51. Conductor 52 connects the armature 51 with the conductor 40. The caution control relay 47 is normally maintained energized by the following circuit: source of current 30, conductors 31 and 34, winding 29, conductor 48, caution relay 47, conductor 49, contact 50 and armature 51 of the caution relay 47, conductor 52, resistance 41 and conductor 42 back to the source of energy 30. The windings 28 and 29 are preferably duplicates and the control relays 36 and 47 are also preferably duplicates. The current flowing in the circuit traced immediately above will therefore be substantially the same as that flowing in the circuit of the danger control relay 36 and will be such as to energize the relay 47 sufficiently to hold the armatures 51 and 54 in their full line positions, thereby maintaining the caution train control circuit 53 normally closed.

In the operation of the system disclosed in Figure 1, when a train carried inductor 26 passes over a roadside inductor 12, having its winding 13 short-circuited, the flux relation in the train carried inductor 26 and the current relations in the circuits connected therewith are not altered in any substantial manner and the relays 36 and 47 remain energized and the train control circuits 43 and 53 remain closed.

In Figure 2 the full line 55 represents the current normally flowing in each of the relays 36 and 47. The straight dash line 56 represents the drop away current of the relays 36 and 47. When the current in such relays is reduced to or below the magnitude represented by the line 56, such relays are deenergized and their armatures drop back to the dotted line positions. The slightly curved portion *a*—*b* of line 55 represents the approximate variation in the current carried by the relays 36 and 47 when the train carried inductor 26 passes over a roadside inductor which is in clear condition. Such variation, it will be seen, is not sufficient to cause the deenergization of the relays and the train control circuits will, therefore, remain closed.

Under these conditions the following circuit which includes the two relays 36 and 47 and the two windings 28 and 29 should be borne in mind: winding 28, conductor 35, danger control relay 36, conductor 37, contact 38 and armature 39, conductor 40, conductor 52, armature 51 and contact 50, conductor 49, caution control relay 47, conductor 48 and winding 29 back to winding 28.

In the circuit just traced, the windings 28 and 29 constitute one continuous winding. In this circuit, therefore, a current will be induced under danger conditions which current may be represented by the curve *c*—*d*. If the relay 36 were not a stick relay, the current carried by it when the train carried inductor passes over a roadside inductor in danger condition, would follow the dotted curve *c*—*d*. The current normally carried by the relay 36 flows in the direction indicated by the arrow 57 and the current carried by the relay 47 normally flows in the direction indicated by the arrow 58. The current induced in the windings 28 and 29, when the train carried inductor passes over a roadside inductor under danger conditions, as represented by the curve *c*—*d*, first flows in the direction indicated by the dotted arrows 90. It will be seen, therefore, that the first portion of the cycle *c*—*d* serves to weaken the current in the relay 36 to a point below its drop away

current, while at the same time serving to strengthen the current flowing in the caution control relay 47. The relay 36 will, therefore, become deenergized, the armatures 39 and 44 will drop away to their dotted line positions, and the danger train control circuit 43 will be broken and operated to give a danger indication, to apply the brakes, or both as desired.

Unless provision is made to prevent it, the second portion of the curve *c—d* will serve to deenergized the relay 47. In the system shown in Figure 1, provision is made against such deenergization by the insertion of resistance 41. As soon as the relay 36 has been deenergized and its circuit broken at the contact 38, the voltage drop in the resistance 41 is reduced to such an extent that the voltage across the relay 47 is increased sufficiently and the current carried thereby is increased sufficiently to overcome the effect of the second portion of the curve *c—d*. The relay 47, therefore, under such conditions, will not become deenergized and the caution train control circuit will remain closed.

When the block A is unoccupied and the block B is occupied, the block A is in caution condition, and the track relay 10 will be energized and the track relay 11 will be deenergized, thereby connecting the source of current 19 to the winding 13 as described hereinabove. When the train carried inductor passes over the roadside inductor 12 under such conditions, the winding 13 serves as a primary to induce secondary current in the windings 28 and 29, which may be shown by the dot and dash curve *e—f*, and which is indicated in Figure 1 by the dot and dash arrows 59. These arrows 59 indicate the direction of flow of this induced current during the first part of the cycle *e—f*. It will be seen that the relations of such current with the relays 36 and 47 is now reversed when compared with the induced current that is generated under danger conditions. The first portion of the induced current now serves to weaken the current normally flowing in the caution control relay 47 and to strengthen such current in the danger control relay 36. As a result thereof, the caution relay 47 will become deenergized before the peak *e* is reached. This will cause the armatures 51 and 54 to drop away to their dotted line positions and the caution control circuit 53 will be deenergized, thereby giving a caution indication, or applying the brakes, or both as desired. The diminution in the voltage drop across the resistance 41 will serve to prevent the subsequent deenergization of the relay 36 by the second portion of the cycle *e—f* as described above.

As was pointed out hereinabove, the roadside system of Figure 3 differs from the roadside system shown in Figure 1 only in that a source of alternating current 25 is substituted for the source of direct current 19. The train carried system shown in Figure 3 comprises like that shown in Figure 1, the inductor 26 which is provided with a primary 27 connected to the source of direct current 30 by means of wires 31 and 32. The secondary winding 60 is connected to the danger control relay 61 by the conductor 62, and is connected to one side of the source 30 by conductor 63. The relay 61 is connected to the other side of the source of current 30 by conductor 64, contact 65 and armature 66 of said relay, and the conductor 67. The relay 61 is thereby normally energized by a current that flows from the source 30 through the conductor 67, armature 66 and contact 65, conductor 64, relay 61, conductor 62, secondary winding 60 and conductor 63 back to the source.

The danger train control circuit is indicated by reference numeral 68 which is controlled by the relay 61 through the armature 69, which is normally maintained in its full line position by the relay 61, thereby maintaining the danger train control circuit normally closed.

The train is also provided with a caution train control circuit indicated by the reference numeral 70 which is controlled by the relay 71 through its armature 72 which is normally maintained in its full line position by the normally energized relay 71.

The relay 71 is of a differential type, having two windings 92 and 73. The winding 92 is normally connected to a source of direct current 74 through the armature 75 and contact 76 in such a manner that the relay is energized thereby in the direction indicated by the arrow 77. The inductor 26 is also provided with an additional secondary winding 94 which is connected at one end by means of a conductor 95 to the electrolytic valve or rectifier 96, and is connected at the other end by means of conductor 97 to the winding 73. The conductor 73 connects the other end of the winding 73 with the electrolytic valve 96. The connections of the electrolytic valve 96 to the circuit just described is such as to permit a unidirectional current to flow in that circuit in such a direction as to energize winding 73 of the relay 71 in the direction shown by the arrow 79. Such energization it will be seen, is in a direction to oppose the direction due to the winding 92 and will serve to deenergize the relay 71. Normally there is no current flowing in the winding 73, and the relay is therefore normally energized by the winding 92.

Figure 4 is a diagrammatic representation of the current variations that take place in the relay 61 during the operation of the system. The normal current carried by the relay 61 may be represented by the line 80. When the train carried inductor passes over the roadside inductor under clear conditions, the train carried system remains undisturbed, thereby receiving the clear indication. When, however, the train carried inductor passes over a roadside inductor under danger conditions, that is when the winding 13 on the roadside inductor is open-circuited, the windings 60 and 94 receive an induced current illustrated in Figure 4 by the curve *c—d*. Portion *c* serves to reduce the current in the relay 61 to below its drop away value shown by line 81, and the relay 61 thereby becomes deenergized, the danger train control circuit 68 is opened, and a danger indication or an application of the brakes, or both as desired, is given. The system may be so organized that the relay 71 becomes deenergized at the same time, due to the effect of one half of the impulse *c—d* upon the winding 73. In other words a danger indication in the present system may be obtained by the simultaneous deenergization of both relays 71 and 61. If desired, however, the relay 71 may be so designed as not to be affected by the impulse *c—d*. When the train carried inductor passes over a roadside indicator under caution conditions, the winding 13 is connected to the source of alternating current 25, and the train carried inductor therefore receives an induced alternating current illustrated by the curve *g*. This alternating current will not affect the danger control relay 61

because of the insufficient magnitude thereof and the rapid fluctuations thereof as shown in Fig. 4 of the drawings, and such relay will remain energized. The induced current received by the curve *g* in the winding 94 is rectified by the electrolytic valve or rectifier 76, and the resulting unidirectional current flows in winding 73 of the relay 71 in such a direction as to oppose the normal energization of the relay, and thereby deenergize it. Armature 72 and 75 therefore drop away to their dotted line positions and the caution train control circuit is broken.

The system shown in Figure 5 is identical with that shown in Figure 3 in all substantial respects and in its manner of operation, except for the rectifying system that is disposed between the secondary winding 94 of the train carried inductor 26 and the winding 73 of the relay 71. In the system shown in Figure 5, the secondary winding 94 is connected to the winding of the electro-magnet 82, which operates a vibrator 83 to make and break contact with a fixed contact 84. The winding 73 of the relay 71 is connected in the circuit which includes the source of direct current 85, resistance 86, vibrator 83, contact 84, conductor 87, conductor 88 and the winding 73 back to the source of current 85. The condenser 89 is connected from one terminal of the battery to the conductor 87.

The operation of the system shown in Figure 5 under clear and danger conditions is the same as the operation of the system shown in Figure 3. Under caution conditions, however, the alternating current impulse *g* transmitted to the electro-magnet 82, causes the vibrator 83 to vibrate in unison therewith, and thereby bring about the flow of a unidirectional current in the winding 73, derived from the source 85. The condenser 89 serves to prevent arcing between the vibrator and armature 83 and the contact 84.

What I claim is:

1. A roadside apparatus for an induction train control system comprising an induction element for producing in its inert state a danger indication, circuit means associated with said element for producing any one of a plurality of other indications on said element, said induction element having the same main flux path for all of said indications, and a pair of devices responsive to the traffic conditions of the immediate block and of the block next ahead controlling said circuit means.

2. A roadside apparatus for an induction train control system comprising an induction element for producing in its inert state a danger indication, circuit means associated with said element, and a pair of cooperating track relays for variably closing said circuit to produce other indications in said induction element, said induction element having the same main flux path for all of said indications.

3. A roadside apparatus for an induction train control system comprising an induction element for producing in its inert state a danger indication, a winding on said element, circuit means for said winding for producing either of two other indications in said induction element, said induction element having the same main flux path for all of said indications, and means operable in accordance with roadside conditions to control said circuit means.

4. A roadside apparatus for induction train control systems comprising an inductive element for producing a danger indication when in its inert state, a winding on said element, circuit means for said winding and track relays operable in accordance with track conditions for variably closing said circuit to produce indications of clear or caution conditions, said inductive element having the same main flux path for all of said indications.

5. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding means on said element, a circuit mean for said winding means, and selective switch means for opening, short-circuiting and for connecting a source of energy to said circuit means to produce any of three indications in said element, said selective switch means comprising a track relay operable in accordance with the condition of the immediate block and another track relay operable in accordance with the condition of the block next ahead.

6. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding on said element, a circuit for said winding, a source of energy, means responsive to the condition of one block for opening and closing said circuit independent of the connection of the source of energy thereto, and means responsive to the condition of another block for connecting and disconnecting said source of energy in said circuit.

7. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding means on said element, a circuit means for said winding means, a source of current, and selective switch means for opening, for short-circuiting and for connecting said source of current to said circuit means to selectively produce the three indications of said element.

8. A road side three-position indicator for inductive train control systems comprising an element of magnetic material, a winding means on said element, a circuit means for said winding means, a source of current, and selective switch means comprising a pair of cooperating track relays for opening, for short-circuiting and for connecting said source of current to said circuit means to selectively produce the three indications of said element.

9. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding means on said element, a circuit means for said winding means, a source of alternating current, and selective switch means comprising a relay operable in accordance with the condition of the immediate block and a relay operable in accordance with the condition of the block next ahead for opening, for short-circuiting and for connecting said source of current to said circuit means to selectively produce the three indications of said element.

10. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding on said element, a circuit for said winding, a pair of normally energized relays for opening and closing said circuit, a source of energy and means whereby said source of energy is introduced into said circuit when one of said relays is deenergized, said circuit being operated by said relays to selectively produce the three indications in said element.

11. A roadside three-position indicator for inductive train control systems comprising an element of magnetic material, a winding means on said element, a circuit means for said winding means, a pair of normally energized relays for closing said circuit, a source of energy, means whereby said source of energy is introduced into said circuit when one of said relays is deenergized, and means for opening the circuit when the other relay is deenergized, said circuit means being operated by said relays to selectively produce three indications in said element.

12. In an induction train control system, danger and caution receiving circuits, a relay controlling said danger circuit, a train carried inductor having a winding, a circuit comprising a source of current, said relay and said winding, a second relay controlling said caution circuit, said circuit comprising a normally energizing winding and a normally deenergized winding, and means operable to energize said deenergized winding to deenergize the relay, said means comprising a second winding on the inductor, and a roadside inductor cooperating with said train carried inductor.

13. In an inductive train control system, a roadside inductor having a single flux path, a winding on said inductor, circuit means associated with said winding operable in accordance with roadside conditions to indicate clear, caution or danger, in combination with train carried caution and danger circuits, and a train carried inductor cooperating with said roadside inductor having one winding for controlling the danger circuit and another winding for controlling the caution circuit.

14. In an induction train control system, danger and caution circuits, a train carried inductor having a winding for controlling the danger circuit and a second winding for controlling the caution circuit, a roadside inductor, the train carried and roadside inductors having a single flux path, circuit means associated therewith operable in accordance with roadside conditions, whereby when the train carried inductor passes over the roadside inductor under caution conditions, a current will be induced in said windings which will effect an operation of the caution circuit.

15. In an induction train control system, danger and caution circuits, normally energized relays controlling said circuits, and cooperating roadside and train carried inductors, having a single main flux path operable in accordance with roadside conditions whereby an induced current of one wave form is applied to said relays under danger conditions and of another wave form under caution conditions.

16. In an induction train control system, danger and caution circuits, normally energized relays controlling said circuits, cooperating roadside and train carried inductors having a single main flux path operable in accordance with roadside conditions whereby an induced current of one wave form is applied to said relays under danger conditions and of another wave form under caution conditions and rectifying means associated with one of said relays.

17. In an induction train control system, danger and caution circuits, normally energized relays controlling said circuits, and cooperating roadside and train carried inductors having a single main flux path operable in accordance with roadside conditions whereby an induced current of one wave form is applied to said relays under danger conditions and of another wave form under caution conditions, each relay being responsive to only one of said wave forms.

18. In an inductive train control system, a vehicle carried inductor including primary and secondary windings arranged in a single magnetic flux path, vehicle carried devices operated by said windings for producing any one of three indications, a roadside inductor having a flux path cooperating with the single flux path of the vehicle carried inductor, and means responsive to any one of three roadside conditions for operating the inductors to selectively and correspondingly produce the said indications in said vehicle carried devices.

19. In an inductive train control system, a vehicle carried inductor including a primary and a plurality of secondary windings arranged in a single magnetic flux path, a vehicle source of energy for said inductor, vehicle carried devices selectively operated by the plurality of the secondary windings for producing any one of three indications, a roadside inductor having a flux path cooperating with the single flux path of the vehicle carried inductor, and means responsive to any one of three roadside conditions for operating the inductors to selectively and correspondingly produce the said indications in said vehicle carried devices.

20. In an inductive train control system, a vehicle carried inductor including primary and secondary windings arranged in a single magnetic flux path, direct current circuits for said primary and secondary windings, vehicle carried devices operated by said windings for producing any one of three indications, a roadside inductor having a flux path cooperating with the single flux path of the vehicle carried inductor, and means responsive to any one of three roadside conditions for operating the inductors to selectively and correspondingly produce the said indications in said vehicle carried devices.

21. In an inductive train control system, a vehicle carried inductor including a primary and a plurality of secondary windings arranged on a core in a single magnetic flux path direct current circuits for said primary and for at least one of said secondary windings, vehicle carried devices selectively operated by said secondary windings for producing clear, caution and danger indications, a roadside inductor having a flux path cooperating with the single flux path of the vehicle carried inductor, and means responsive to any one of three roadside conditions for operating the inductors to selectively produce the said indications in said vehicle carried devices.

22. In an inductive train control system, a vehicle carried inductor including primary and secondary windings arranged on a core in a single magnetic flux path, direct current circuits for said inductor, vehicle carried devices selectively operated by said secondary of said inductor for producing any one of three indications, a roadside inductor also having a single flux path which cooperates with the single flux path of the vehicle carried inductor, and means responsive to any one of three roadside conditions for operating the inductors to selectively produce the said indications in said vehicle carried devices in correspondence with the three roadside conditions.

THEODORE BODDE.