Jan. 9, 1951 G. W. BAUGHMAN 2,537,298

TRAFFIC CONTROLLING APPARATUS

Filed Oct. 30, 1945 2 Sheets-Sheet 1

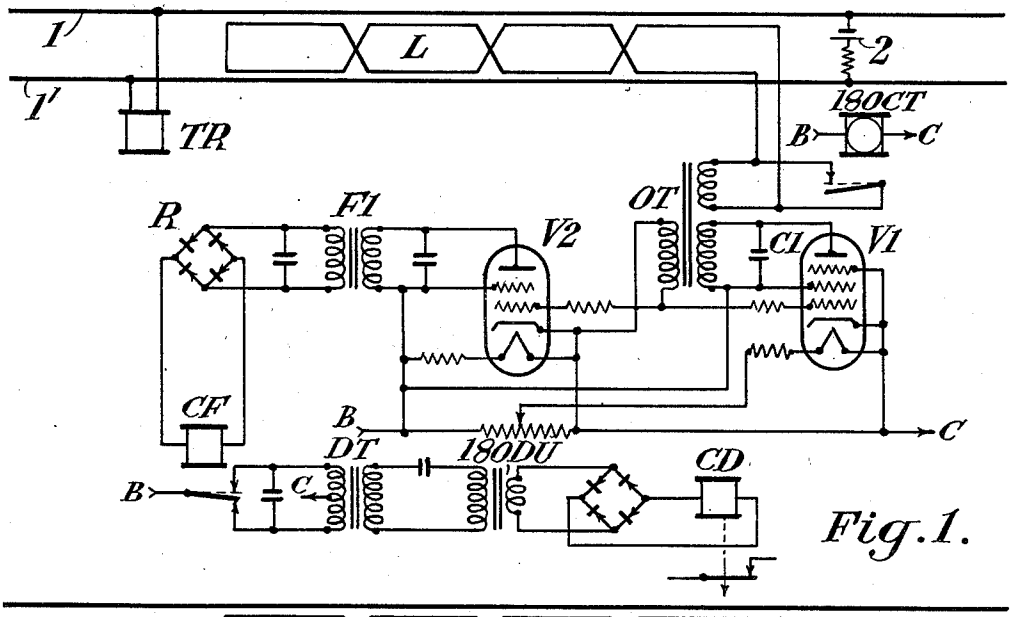



Fig. 1.

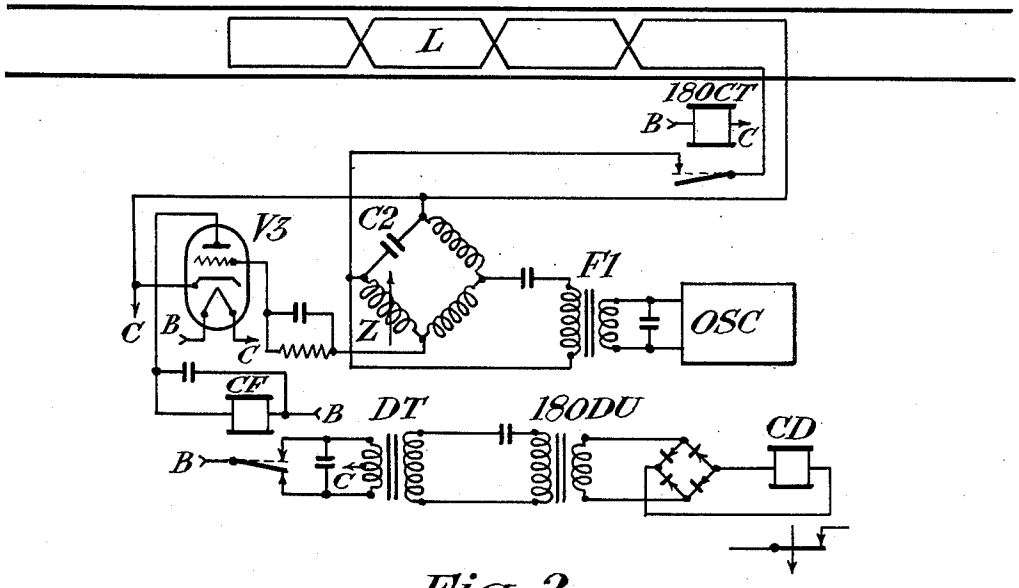



Fig. 2.

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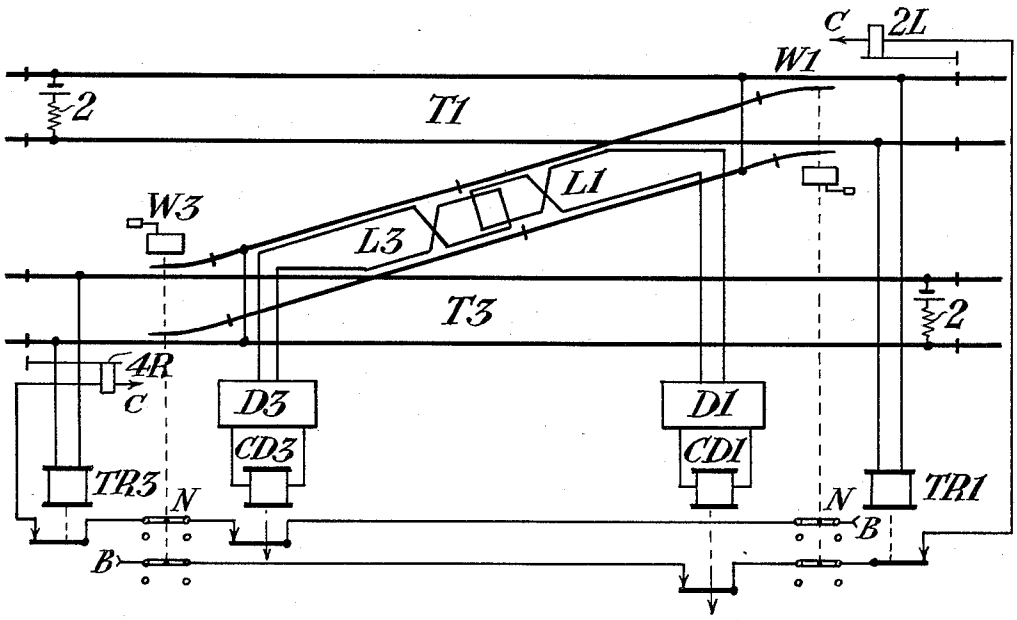



Fig. 3.

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# UNITED STATES PATENT OFFICE

2,537,298

## TRAFFIC CONTROLLING APPARATUS

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10 Claims. (Cl. 177—352.2)

1

My invention relates to traffic controlling apparatus, and more particularly to electronic means for detecting the presence of a railway car in an extended stretch of track which means does not depend upon electrical contact between the wheels of the car and the track rails.

The principal object of my invention is to provide improved proximity detecting means to supplement or to serve as a substitute for a railway track circuit for use, for example, to detect the presence of a car on the tracks of a crossover which may have a high contact resistance due to infrequent train movements, or to detect the presence of light weight vehicles or of those having insulated wheels and incapable of shunting the usual track circuits, or to detect the presence of cars on railway crossings or at other locations where the installation of track circuits is impracticable.

A further object of my invention is to provide means for reliably detecting the presence of a movable object in a protected space, which means is suitable for use in traffic control systems in which track circuits cannot be used. The apparatus of my invention is thus adapted to provide the equivalent of railway track circuit protection in systems for the control of non-rail traffic, and may be used for example for the detection of the presence of road vehicles on highways or for the detection of such vehicles, or of airplanes on the ground, in airport areas.

The apparatus of my invention detects the presence of a vehicle by measuring the variation in the impedance of an electric circuit element, such as a loop of wire surrounding the protected space. An additional object of my invention is the provision of self-checking apparatus for this purpose, comprising a Wheatstone bridge which, although it employs a "null" method of impedance measurement, has incorporated therein the closed circuit principle of operation which is a necessary requisite for safety devices of this character. In respect to this feature, my invention is an improvement upon that disclosed in my United States Patent No. 2,385,487, issued September 25, 1945, for Hot Bearing Alarms.

I shall describe two forms of apparatus embodying my invention and shall then point out the novel features thereof in claims.

Referring to the accompanying drawings, Fig. 1 shows one form of train detecting apparatus embodying my invention in which an insulated wire loop L is mounted between the track rails 1 and 1' of an extended stretch of railway track and serves to create a magnetic field in the space

2

about the track rails which would be occupied by a train in an extended stretch of track. An electronic oscillator comprising the tube V1 is normally energized to generate alternating current of a frequency determined by the inductance of loop L, which current is modulated at a low frequency rate by an interrupter relay or code transmitter 180CT, and is amplified by a second tube V2. When the stretch is unoccupied, the modulated current passes through a selective filter F1 and is demodulated to energize a detector relay CD, but when a car occupies the stretch, a change in frequency occurs and relay CD is released. Fig. 2 shows a second form of my invention in which the loop L forms one arm of a Wheatstone bridge which is supplied with current of a fixed frequency by an electronic oscillator OSC, the bridge being balanced only when the loop is unoccupied, to maintain a detector relay CD energized. Fig. 3 shows an application of the train detecting apparatus of Fig. 1 or 2 to a specific problem, namely, that of protecting train movements over a stretch of double track railroad containing a crossover.

Similar reference characters refer to similar parts in each of the views, and in lieu of showing the various sources of current for energizing the apparatus, I have shown only their terminals, the positive or supply terminal being identified by the reference character B, and the negative or common return terminal by the reference character C, in each instance.

Referring to Fig. 1, the electron tube V1 is a pentode of the conventional type having its grid and plate circuits coupled through a transformer OT to function as an oscillator to generate alternating current of a frequency determined by a tank circuit comprising the coils of transformer OT and a condenser C1. The trackway loop L comprises two insulated wires, one adjacent each track rail, connected in a closed circuit to a winding of transformer OT so that the inductance due to the magnetic field of the loop in the space which would be occupied by a car in the stretch forms a part of the inductance tuned by condenser C1 by which the frequency of the current generated by tube V1 is determined.

Usually the track rails 1 and 1' adjacent the loop form a part of a closed track circuit including a battery 2 and a track relay TR, and since the rails in practically all cases are connected together through leakage paths of low resistance as well as through the battery and track relay, they form a closed circuit of relatively low impedance in which induced currents could flow,

having a magnetic field in opposition to that due to current in the loop. To avoid this the wires of the loop are transposed one or more times to place the loop in a non-inductive relation to the track circuit, as shown. A further advantage of transposing the loop is that at points some distance from the track the magnetic field of each section of the loop is neutralized to a large extent by the overlapping opposing field of the adjoining sections and the lines of force are diverted to paths which do not link with the track rails but which lie in planes parallel thereto, increasing the field strength in the space which would be occupied by a car, whereby the effect of the magnetic or conducting material of the car upon the field strength becomes proportionally greater. It follows that by measuring the inductance of the loop, as is accomplished in Fig. 1 by measuring its effect upon the frequency of the oscillations in the track circuit including transformer OT and condenser C1, the presence of a car in the stretch of track over which the loop extends may be reliably detected since the current will have a given frequency *f1* only when the stretch is unoccupied.

To detect the frequency *f1*, an amplifier tube V2 is provided having its grid circuit connected to transformer OT in parallel with that of the oscillator tube V1, the output circuit of tube V2 supplying current to a direct current relay CF through a rectifier R and a tuned filter circuit selectively responsive to current of the frequency *f1*.

Since the apparatus is intended for use at isolated wayside locations, practical considerations limit the voltage of the local battery to about 24 volts, so that the output of tube V2 is relatively small, and relay CF is of a sensitive type responsive to forces smaller than those which govern relays of conventional railway signaling types. Accordingly, the code principle is made use of to provide a safety control in accordance with accepted standards, relay CF controlling a detector relay CD of the standard type through decoding apparatus similar to that shown in Letters Patent of the United States No. 1,773,472, issued August 19, 1930, to Paul N. Bossart.

A code transmitter relay 180CT of the pendulum type or the like is provided, which when energized from terminals B and C operates its contacts at a fixed rate of 180 times per minute, and its contacts are arranged to short circuit the loop L so that the oscillations generated by the tube V1 are periodically interrupted or modulated at the same rate. Consequently when relay CF is supplied with current of frequency *f1* it operates its contacts perodically to supply impulses of alternately opposite polarity to the primary of a decoding transformer DT, the secondary of which supplies alternating current of the modulation frequency to a tuned decoding unit 180DU selectively responsive to that frequency by means of which the impulses are rectified and serve to effect the steady energization of the detector relay CD.

Relay CD therefore is steadily energized only when the loop L is unoccupied. Relay CF ceases to operate, and relay CD releases when a car or train occupies the loop and changes the frequency of the current to a value which is not passed by the filter F1.

Referring now to Fig. 2, the oscillator OSC is to be understood to be similar to the one shown in Fig. 1 except that its frequency is not controlled by the loop. The oscillator OSC therefore constantly generates current of frequency *f1*, and this is supplied through a selective filter F1 to a Wheatstone bridge for measuring the inductance of the trackway loop L. One arm of the bridge includes the loop L, tuned by a condenser C2, the loop circuit including in series a periodically operating contact of the code transmitter relay 180CT. The input circuit of a detector tube V3 is connected across the tuned loop and a balancing impedance Z, and the output circuit of V3 includes a code following relay CF controlling a detector relay CD as in Fig. 1 already described. The circuits are so arranged that relay CF is held energized by current of frequency *f1* which passes through the bridge so long as the bridge is not balanced. Impedance Z is so adjusted that a balance is attained whereby relay CF is caused to release each time the contact of relay 180CT closes, provided the measured impedance of the loop indicates that the stretch of track over which the loop extends is unoccupied. It will be seen that although the circuits for tube V3 and relay CF are deenergized when the balanced condition is being detected, the integrity of these circuits is periodically checked by the coding action and the system embodies the closed circuit principle. In the event of a fault in the circuit for relay CF, or in tube V3, or its circuits, or if oscillator OSC fails to supply energy to the bridge, relay CF will remain steadily in its released position, while a fault in the loop circuit or in its connections to the bridge will cause relay CF to remain steadily energized. It follows therefore that relay CF will be operated periodically by relay 180CT to effect the energization of relay CD only when the loop 2 is not occupied by a train, and that relay CD will assume its released position in the event of a fault in any of the circuits.

Referring now to Fig. 3, in this view I have shown two tracks of a double track railroad provided with the usual track circuits T1 and T3, each having a track battery 2 and a track relay TR1 or TR3 for controlling the railway signals 2L and 4R. The two main tracks are connected by a crossover comprising the hand throw switches W1 and W3, protected by the apparatus of my invention, which may be either of the forms shown in Figs. 1 and 2. Two sets of detecting apparatus designated D1 and D3, controlling two detector relays CD1 and CD3 by separate track loops L1 and L3 are provided for the reason that it is desirable to extend the loops to as close to the main tracks as possible in which case the passage of a train on the main track may change the inductance of the adjacent portion of the loop sufficiently to release the detector relay. If there were only one detector relay for controlling the signals on both tracks, the release of the detector relay by a train on one main track would interrupt the circuit for the signal governing movements over the other main track.

The loops L1 and L3 are transposed to place them in a non-inductive relation to the track circuits T1 and T3 and they may a'so be coupled by overlapping them as shown, or otherwise, so that they are in a non-inductive relation to each other.

In the arrangement shown, the track relay TR1 and the detector relay CD1 jointly control signal 2L, and relays TR3 and CD3 jointly control signal 4R so that the clearing of either signal is prevented in the event there is a car on the corresponding half of the crossover, that is to say, within fouling distance of the corresponding main track, even though the car fails to make contact with the track rails sufficient to shunt the track circuit.

Although I have herein shown and described but two forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. Apparatus for detecting the presence of a movable object such as a vehicle in a protected area, comprising a loop of insulated wire enclosing said area, a code transmitter, means controlled by said code transmitter for periodically energizing said loop by alternating current at a fixed rate to create a field of force for recurrent brief periods in the space which would be occupied by a vehicle in said area, measuring means responsive to said alternating current for measuring the electrical characteristics of said loops to detect variations therein due to the presence of a vehicle in said area, a code following relay, a detector relay, means controlled by said measuring means for energizing said code following relay, whereby said relay is maintained energized except when the electrical characteristics of the loop are being measured and such measurement indicates that the area is not occupied by a vehicle, and means responsive to the periodic operation of said code following relay at said fixed rate for energizing said detector relay.

2. Apparatus for detecting the presence of a movable object such as a vehicle in a protected area, comprising a loop of insulated wire enclosing said area, a Wheatstone bridge circuit normally supplied with alternating current for comparing the electrical characteristics of said loop with those of a balancing impedance to detect varitions in the impedance of said loop due to the presence of a vehicle in said area, said bridge circuit being balanced when said area is unoccupied but becoming unbalanced when a vehicle occupies the area, a code following relay deriving its energization from said bridge circuit and arranged to remain energized only so long as said bridge is unbalanced, a code transmitter relay arranged to unbalance said bridge periodically regardless of the condition of occupancy of said loop, a detector relay, and means for selectively energizing said detector relay in response to the periodic operation of said code following relay.

3. Self-checking apparatus for detecting when the impedance of an electric circuit element is of a particular value, comprising a Wheatstone bridge which is balanced only when said circuit element is of said particular value and is effectively included in one of its arms, a source of current connected to the input terminals of the bridge and constantly supplying current of a given character thereto, a sensitive relay controlled by means responsive to current of said given character derived from the output terminals of said bridge whereby said relay is maintained energized when the bridge is unbalanced and releases when the bridge is substantially balanced, contact means operating periodically to vary the impedance of one of said arms to cause said relay to recurrently assume its released position in the event the impedance of said circuit element is substantially of said predetermined value and to then return to its energized position thereby checking the integrity of the bridge circuits, a detector relay, and means controlled by said sensitive relay for maintaining said detector relay energized in response to the periodic changes in the position of said sensitive relay.



4. Self-checking apparatus for detecting variations in the impedance of an electric circuit element comprising a detector relay, a sensitive relay, and a Wheatstone bridge having input terminals connected to a source of current of a given character and output terminals for delivering current of said character to a sensitive relay, said bridge consisting of four impedances one of which includes said circuit element so proportioned that said sensitive relay assumes its released position even though its circuit is intact when said circuit element is being supplied with current by said bridge, provided the impedance of said circuit element is of such value that the bridge is balanced, contact means for unbalancing one arm of said bridge to render said sensitive relay responsive to the current of said given character supplied to the bridge to cause said relay to assume its energized position regardless of the impedance of said circuit element, means for operating said contact means periodically, and means selectively responsive to the periodic operation of said sensitive relay which results from the operation of said contact means when the bridge is periodically balanced for energizing said detector relay.

5. In combination with an electric circuit element the impedance of which is subject to change from a normal value, a Wheatstone bridge having two ratio arms, an arm which includes said variable circuit element and one which includes a balancing impedance said bridge having its input terminals normally connected to a source of current, a sensitive relay deriving its energization from connections to the output terminals of said bridge but which assumes its released position when the bridge is balanced, a movable contact in the circuit for one arm only of said bridge which in one position enables the bridge to be balanced and in another position unbalances the bridge regardless of the impedance of said variable circuit element, means for operating said movable contact periodically to cause the periodic operation of said sensitive relay provided said current of given character is continuously supplied to the bridge and the characteristics of said variable circuit element as measured thereby are substantially similar to those of said balancing impedance, a detector relay and means dependent upon the periodic operation of said sensitive relay for energizing said detector relay.

6. A system for detecting the intrusion of a movable object in a protected space, comprising an extended conductor adjoining said space for creating a field of force which varies in the presence of an object in said space when said conductor is supplied with alternating current, a Wheatstone bridge having its input terminals connected to a source of alternating current for comparing the electrical characteristics of said conductor with those of a balancing impedance whereby said bridge may be balanced when said conductor is included in one of its arms, provided said space is unoccupied, a sensitive relay deriving its energization from the output terminals of said bridge but which assumes its released position even though its circuit is intact when the bridge is balanced, a movable contact in the circuit for one arm of said bridge which in one position enables the bridge to be balanced and in another position unbalances said bridge irrespective of the condition of occupancy of said space, means for operating said movable contact peri-

odically, a detector relay, and means selectively responsive to the periodic operation of said sensitive relay for energizing said detector relay.

7. A system for detecting the intrusion of a movable object in a protected space, comprising an extended conductor adjoining said space for creating a field of force which varies in the presence of an object in said space when said conductor is supplied with alternating current, a Wheatstone bridge having its input terminals connected to a source of alternating current for comparing the electrical characteristics of said conductor with those of a balancing impedance whereby said bridge may be balanced when said conductor is included in one of its arms provided said space is unoccupied, a sensitive relay deriving its energization from the output terminals of said bridge but which assumes its released position even though its circuit is intact, when the bridge is balanced, a movable contact in the circuit for said conductor by which said conductor may be disconnected from said bridge to cause said sensitive relay to assume its energized position if its circuit is intact, irrespective of the condition of occupancy of said space, means for operating said movable contact periodically, a detector relay, and means dependent upon the periodic operation of said sensitive relay for maintaining said detector relay energized only as long as said space is unoccupied.

8. A system for detecting the presence of a movable object in a protected space, comprising a conductor arranged in the form of a loop surrounding at least a portion of said space to create a magnetic field therein which varies in the presence of an object in said space when said loop is energized by alternating current, a Wheatstone bridge having its input terminals connected to a source of alternating current, means comprising a movable contact for connecting said loop to said bridge to effect its energization and to compare its impedance with that of a balancing impedance in said bridge, a sensitive relay deriving its energization from the output terminals of said bridge but which assumes its released position even though its circuit is intact, provided the impedance of said loop as compared with said balancing impedance indicates that said space is unoccupied, means for operating said movable contact periodically to indicate the balance of said bridge by the periodic energization of said sensitive relay, and a detector relay selectively responsive to the periodic operation of said sensitive relay for indicating the condition of occupancy of said space.

9. A system for detecting the presence of a movable object in a protected space, comprising a conductor arranged in the form of a loop surrounding at least a portion of said space to create a magnetic field therein which varies in the presence of an object in said space, when said loop is energized by alternating current, a Wheatstone bridge having its input terminals connected to a source of alternating current for effecting the energization of said loop and for comparing its impedance with that of a balancing impedance in said bridge of such a value that the bridge is balanced when the space is unoccupied, an electron tube for detecting the potential difference at the output terminals of the bridge, a sensitive relay maintained in its energized position by energy supplied by said tube except when said bridge is substantially balanced, means independent of the condition of said space for periodically unbalancing said bridge whereby said relay alternately assumes its energized and released positions when said space is unoccupied but remains in its energized position when said space is occupied, and a detector relay which assumes its energized position in response to the periodic energization and release of said sensitive relay.

10. A system for indicating the presence of a movable object in a protected area, comprising a conductor energized by alternating current and arranged in the form of a loop to create a magnetic field in said area, a Wheatstone bridge having the source of said current connected to its input terminals and said loop included in one of its arms, the other arms of said bridge comprising fixed impedances of such value that the bridge is balanced when said area is unoccupied and becomes substantially unbalanced when a movable object enters said area, a sensitive relay responsive to the condition of energization of the output terminals of the bridge, said relay assuming its energized position when the bridge is unbalanced by a movable object in said space and assuming its released position when the bridge is balanced, means for periodically unbalancing said bridge to effect the energization of said relay irrespective of the condition of occupancy of said space, a detector relay, means for maintaining said detector relay energized to indicate the unoccupied condition of said area in response to the alternate energization and release of said sensitive relay due to the periodic operation of said unbalancing means and indication means controlled by said detector relay.

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