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APPROACH SIGNAL SYSTEM

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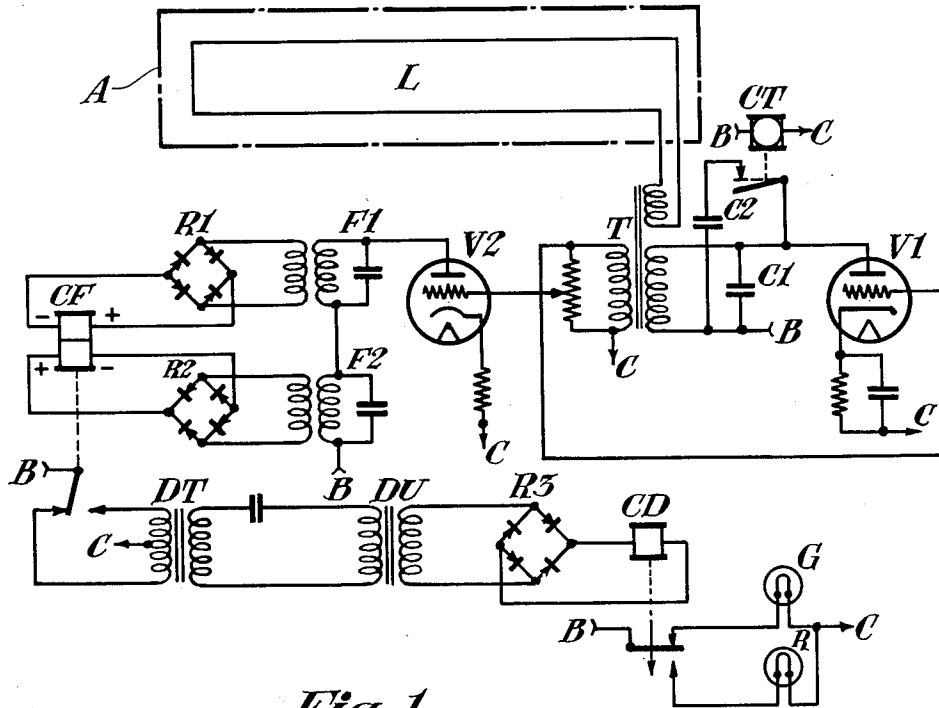


Fig. 1.

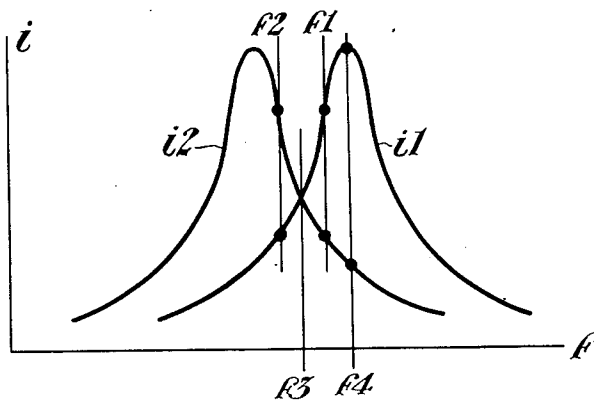


Fig. 2.

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APPROACH SIGNAL SYSTEM

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5 Claims. (Cl. 177—352)

1

My invention relates to traffic controlling apparatus, and more particularly to improved proximity detecting means of the electronic type for detecting the presence of a vehicle or other movable object in a protected space to supplement or to serve as a substitute for a railway track circuit.

The principal object of my invention is to enable the presence of a vehicle to be detected in a stretch of roadway or on a railroad track, or to enable the presence of an airplane or vehicle to be detected in an airport area, without reliance upon physical contact between the airplane or vehicle and the ground.

A further object of my invention is to provide an improved form of detecting apparatus of this character embodying the closed circuit principle of operation.

My invention is an improvement upon that disclosed in my prior application for Letters Patent of the United States, Serial No. 625,561, filed October 30, 1945, for Traffic controlling apparatus.

I shall describe one form of detecting apparatus embodying my invention and shall then point out the novel features thereof in claims.

In the accompanying drawing, Fig. 1 illustrates a preferred form of the apparatus of my invention, while Fig. 2 is a graph which shows how the currents supplied to relay CF of Fig. 1 vary in response to changes in the frequency of the currents supplied to the loop L.

Referring to Fig. 1, the reference character L designates a conductor comprising a loop of insulated wire adjacent to and surrounding the major portion of a protected space A so disposed that when supplied with alternating current a magnetic field is created which is subject to a detectable variation in the presence of a vehicle within the perimeter of the space A as indicated by the broken line. The loop L is energized by an electronic oscillator comprising the tube V1, which is arranged to generate alternating current of a frequency determined by the natural period of a resonant circuit comprising the inductance of the windings of transformer T and of the loop L coupled thereto, and the capacity of the condenser C1, or of condensers C1 and C2 in parallel. The tube V1 is supplied with energy from a local source of direct current having a positive or supply terminal B and a negative or ground terminal C as shown. The input or grid-cathode circuit of tube V1 is supplied with the alternating potential developed in the secondary winding of the transformer T, and alternating current energy is supplied from the plate-cathode

2

circuit of tube V1 to transformer T to maintain the oscillations in the conventional manner. A code transmitter relay CT is provided which is energized over connections to terminals B and C of the local source and operates its contact periodically at a fixed rate, this contact when closed serving to connect condenser C2 to the resonant circuit in parallel with condenser C1, thereby lowering the resonant frequency by a fixed amount. The resonant frequency is also changed by a variable amount when a vehicle occupies the area A, due to its effect upon the magnetic field of the loop L, this change being accompanied by a reduction in voltage across transformer T due to energy absorption by the vehicle.

To detect the condition of the loop circuit as reflected by transformer T, an amplifier tube V2 is provided, having its input or grid-cathode circuit connected across a portion of the secondary winding of transformer T and its output or plate-cathode circuit supplied with energy from the terminals B and C and arranged to deliver amplified alternating current energy to two selectively timed circuits F1 and F2 which are connected differentially through rectifiers R1 and R2 to the windings of a sensitive relay CF. Relay CF is of the stick polar type and operates its contacts from left to right when the current supplied to its upper winding through the circuit F1 exceeds the opposing current supplied to its lower winding through the circuit F2 by a small amount which corresponds to the pick up or minimum operating point of the relay, and the contacts of relay CF are operated from right to left when the current supplied through the circuit F2 exceeds that supplied through the circuit F1 by the same amount.

Referring to Fig. 2, the curves marked i1 and i2 represent the rectified currents supplied to relay CF through the resonant circuits F1 and F2, respectively, as the frequency is varied. It will be clear from the curves that the relay currents are balanced at a particular frequency f3, and that uniform periodic operation of the relay is attained when the frequency alternates periodically between two values such as f1 and f2, equally spaced above and below f3. Values for the condensers C1 and C2 which determine the frequencies generated by tube V1 are so chosen that normally, when the loop L is unoccupied, the frequency f1 is generated when the contact of relay CT is open, this being below the peak of the resonance curve i1 for circuit F1. The frequency f2 is above the peak of the resonance curve i2 for

3

circuit F2, and is generated when the contact of relay CT is closed.

One effect of the periodic operation of relay CT is to modulate the frequencies f_1 and f_2 to produce side bands corresponding to the sum and difference of the loop and code frequencies. In practice the frequency of operation of relay CT is 3 cycles per second or less and that applied to the loop is of several kilocycles, so that this effect is relatively so small that it may be disregarded. It will be seen, therefore, that as long as the loop L is unoccupied, relay CF is operated periodically at the code frequency rate determined by relay CT as a result of its energization by the currents i_1 and i_2 , substantially as indicated in Fig. 2.

In response to its periodic operation, relay CF supplied impulses of alternately opposite polarity to the primary winding of a decoding transformer DT, the secondary of which supplies alternating current through a decoding unit DU resonant at the code frequency to a rectifier R3 to effect the steady energization of a slow release detector relay CD controlling suitable indication means illustrated typically by the lamps G and R.

This decoding apparatus is of a well-known type such as is disclosed in the United States Patent to Bossart No. 1,773,472, issued August 19, 1930, and a detailed description thereof is deemed unnecessary.

Assuming now that a vehicle enters the protected area A, it will be found that the principal effect of the high frequency current in the loop L is to induce opposing currents in the metallic portions of the vehicle which have an almost complete shielding effect, so as to change the value and distribution of the magnetic field and to reduce its volume so as to decrease the loop inductance, consequently the two frequencies generated alternately by tube V1 will both be increased. It will be clear from Fig. 2 that an increase in frequency from the values f_2 and f_1 to the values f_3 and f_4 causes the resultant current by which relay CF is operated toward the left to drop to zero, and to reverse in direction with a further increase in frequency. As the frequency supplied through circuit F2 approaches the value f_3 , the code operation ceases, the current i_2 decreasing rapidly and the current i_1 increasing rapidly with a relatively small increase in frequency. Concurrently, the change in frequency from the value f_1 to the value f_4 increases the current by which relay CF is operated toward the right to hold the relay firmly in that position.

It will be seen that as a vehicle enters the space A, relay CF continues to receive impulses for operating it to the right, but ceases to operate when the impulses for operating it to the left become less than the minimum required for operation, and then relay CD releases to extinguish lamp G and to light lamp R. When the vehicle leaves the space A, the operation of relay CF is resumed as soon as the impulses for operating it to the left reach the minimum value referred to, whereupon relay CD is reenergized to light lamp G and to extinguish lamp R.

By the provision of low loss circuits and by the choice of two operating frequencies which are relatively close together, the system may be made extremely sensitive and responsive to relatively small changes in the impedance of the loop circuit due to the presence of a vehicle, as will be readily apparent from the foregoing description

4

of its mode of operation. It follows that the loop may be arranged to include a protected space A which is relatively large in extent in comparison with the size of the vehicles to be detected.

It will also be seen that the proximity detecting apparatus of my invention embodies the closed circuit principle of operation, and it follows that it may properly be used for any of the purposes for which railway track circuits are ordinarily employed, the detector relay CD being the functional equivalent of the conventional track relay.

For example, the lamps G and R may be located in a control tower for the assistance of an operator in controlling traffic, or may be embodied in wayside signals for the control of traffic entering or approaching the protected area A, or the contacts of relay CD may be employed in safety circuits for interlocking purposes, as will be readily understood.

Although I have herein shown and described only one form of apparatus embodying my invention, it will be 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. 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 and normally energized by alternating current to create a magnetic field which varies in the presence of an object in said space, an electron tube oscillator normally supplied with energy and having an output circuit coupled to said loop for supplying said alternating current thereto, a resonant circuit connected to the input circuit of said tube for determining the frequency of said alternating current comprising a capacity element tuned by the inductance of said loop, said resonant circuit having a natural frequency which depends upon the condition of occupancy of said space, coding means for periodically changing the value of said capacity element to cause the frequency of said current to alternate periodically between two closely related frequencies, a sensitive relay of the stick polar type, frequency responsive means energized by said oscillator for operating said relay in one direction or the other, depending upon whether the frequency of the current supplied thereto is above or below the mean of the two frequencies generated when the loop is unoccupied, a detector relay, and means for selectively energizing said detector relay in response to the periodic operation of said sensitive relay.

2. A system for detecting the presence of a vehicle in a protected area comprising a conductor normally energized by alternating current and arranged in the form of a loop surrounding at least a portion of said area to create a magnetic field which varies in the presence of a vehicle therein, an electron tube oscillator normally supplied with energy and having a resonant output circuit coupled to said loop for supplying said alternating current thereto and having an input circuit coupled to said resonant circuit to maintain the tube in oscillation and to determine the frequency of said alternating current, a sensitive relay of the two position type, frequency responsive means energized by said oscillator for operating said relay to a first position in response to

5

a given frequency supplied only when said loop is unoccupied and for operating said relay to its second position in response to a different frequency, coding means for periodically changing the frequency supplied by said oscillator to cause said relay to assume its second position regardless of the condition of said loop, a detector relay, and means for selectively energizing said detector relay in response to the periodic operation of said sensitive relay.

3. A system for detecting the presence of a vehicle in a protected area comprising a conductor normally energized by alternating current and arranged in the form of a loop surrounding at least a portion of said area to create a magnetic field which varies in the presence of a vehicle therein, an electron tube oscillator normally supplied with energy and having a resonant output circuit coupled to said loop for supplying said alternating current thereto and having an input circuit coupled to said resonant circuit to maintain the tube in oscillation at the natural frequency of said resonant circuit, a sensitive relay of the two position type, frequency responsive means for energizing said relay by current derived from said resonant circuit to cause said relay to assume one position in response to a given frequency supplied only when said loop is unoccupied and to assume its other position in response to a different frequency, coding means for periodically changing the natural frequency of said resonant circuit to cause said relay to assume its second position regardless of the condition of said loop, a detector relay, and means for selectively energizing said detector relay in response to the periodic operation of said sensitive relay.

4. A system for detecting the presence of a vehicle in a protected area comprising a conductor normally energized by alternating current and arranged in the form of a loop surrounding at least a portion of said area to create a magnetic field which varies in the presence of a vehicle therein, an electron tube oscillator normally supplied with energy and having a resonant output circuit coupled to said loop for supplying said alternating current thereto and having an input circuit coupled to said resonant circuit to maintain the tube in oscillation at a frequency corresponding to the natural period of said resonant circuit, coding means for periodically varying the natural period of said resonant circuit to cause

6

the frequency of the current supplied to the loop to alternate between two closely related frequencies both of which are subject to variation in the presence of a vehicle in said area, a sensitive relay, two frequency responsive circuits energized by said oscillator for supplying currents differentially to said relay to effect its operation in opposite directions depending upon whether the frequency of the current supplied thereto is above or below the mean of said two frequencies, a detector relay, means for selectively energizing said detector relay in response to the periodic operation of said sensitive relay, and traffic governing means controlled by said detector relay.

5. A system for detecting the presence of a vehicle in a protected area comprising a conductor normally energized by alternating current and arranged in the form of a loop surrounding at least a portion of said area to create a magnetic field which varies in the presence of a vehicle therein, an electron tube oscillator normally supplied with energy and having a resonant output circuit coupled to said loop for supplying said alternating current thereto and having an input circuit coupled to said resonant circuit to maintain the tube in oscillation at a frequency corresponding to the natural period of said resonant circuit, coding means for periodically varying the natural period of said resonant circuit to cause the frequency of the current supplied to the loop to alternate between two closely related frequencies both of which are subject to variation in the presence of a vehicle in said area, a sensitive relay, two frequency responsive circuits deriving their energization from said resonant circuit for supplying currents differentially to said relay to effect its operation in opposite directions, said circuits being resonant to different frequencies which are respectively above and below the frequencies normally supplied to the loop in the absence of a vehicle in said area, a detector relay, means for selectively energizing said detector relay in response to the periodic operation of said sensitive relay at a rate corresponding to the frequency of operation of said coding means, and traffic governing means controlled by said detector relay.

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No references cited.