

[54] **PRESENCE DETECTOR**

[72] Inventor: **George B. Crofts**, 1917 N. Mountain Ave., Claremont, Calif. 91711

[22] Filed: **July 21, 1970**

[21] Appl. No.: **56,807**

[52] U.S. Cl. **246/40, 246/34 CT**

[51] Int. Cl. **B61I 23/30**

[58] Field of Search **246/34 CT, 34 R, 122 R, 40, 246/8; 340/156, 258 C; 307/3**

[56] **References Cited**

UNITED STATES PATENTS

3,450,875	6/1969	Whitten et al.	246/34 CT
3,576,991	5/1971	Wilson.....	246/40
3,189,885	6/1965	Shields.....	246/34 R
3,575,596	4/1971	Schatzel.....	246/8 X

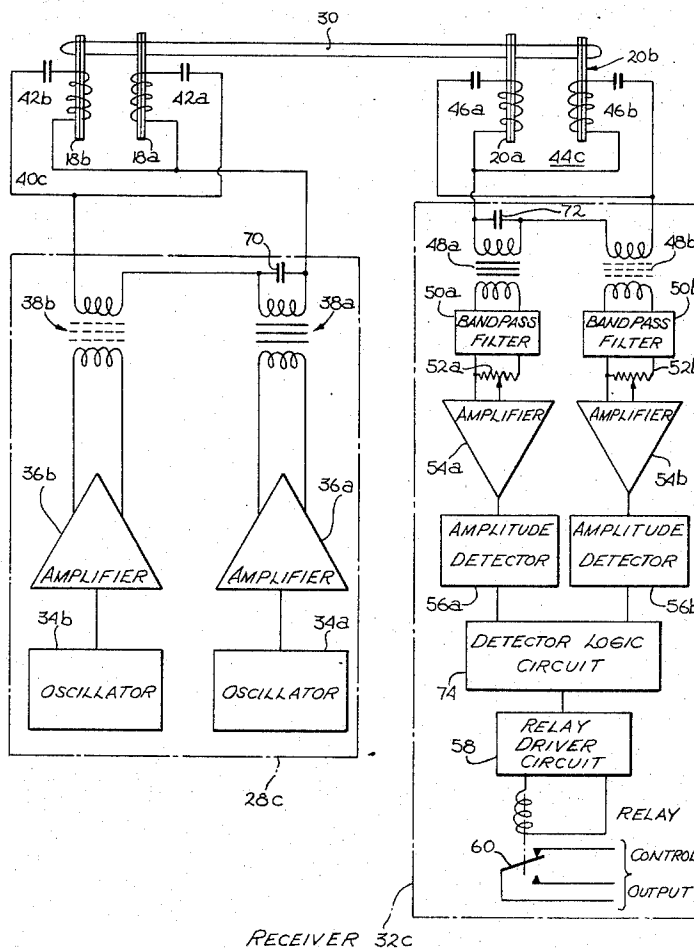
Primary Examiner—Arthur L. La Point
Assistant Examiner—George H. Libman
Attorney—Robert E. Geaugue

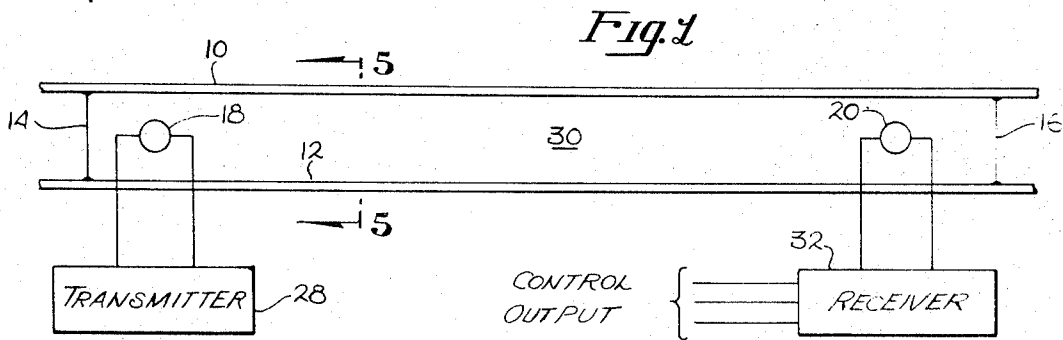
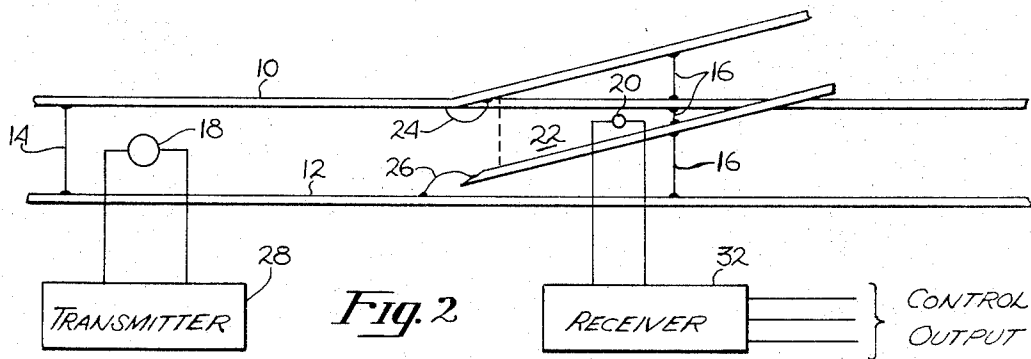
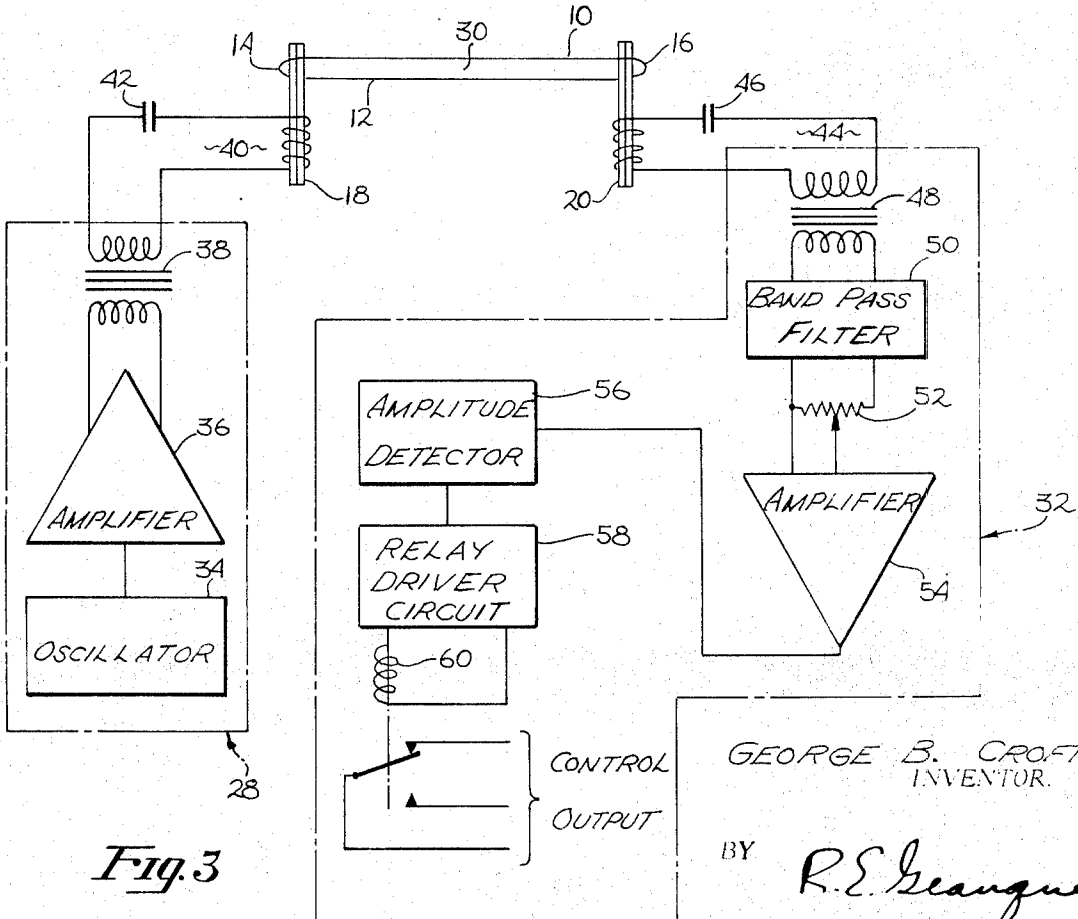
[57]

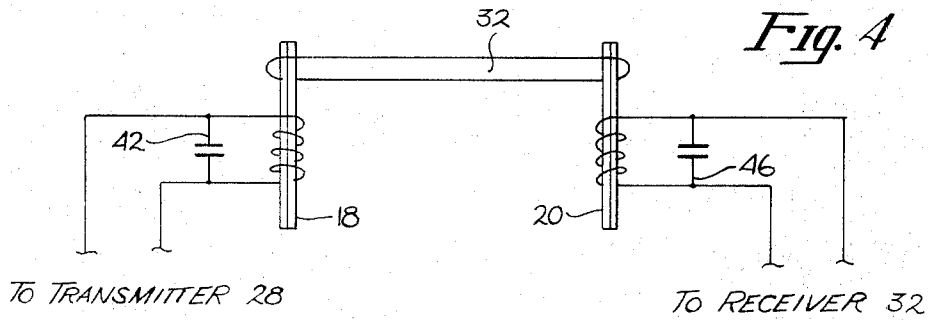
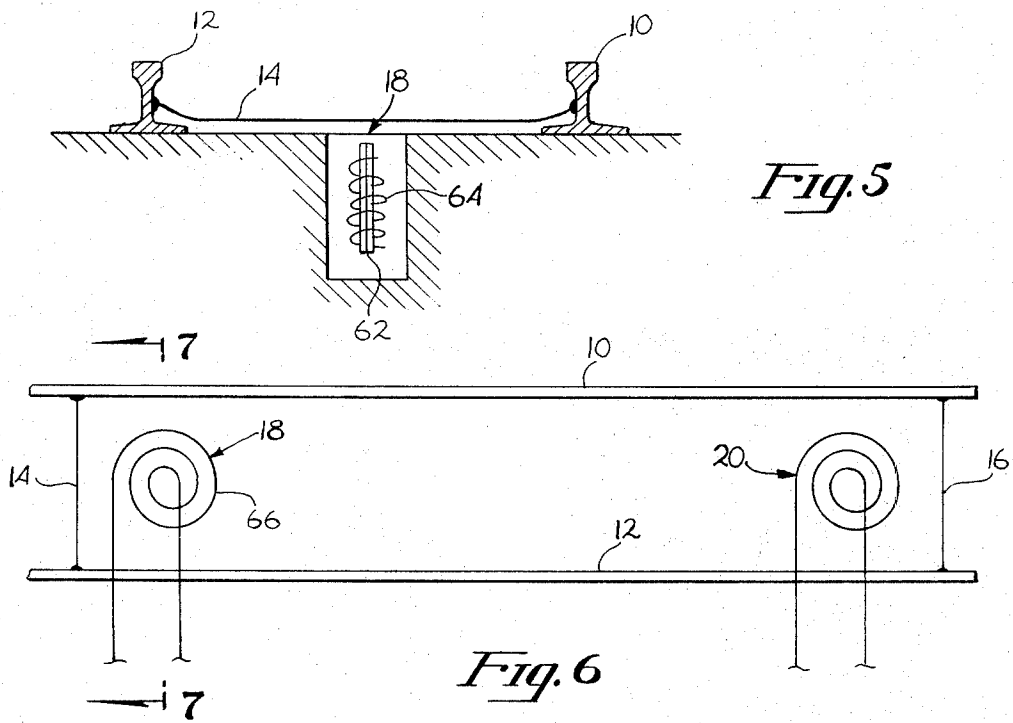
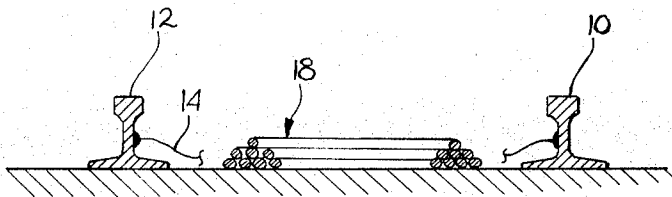
ABSTRACT

Herein is described an apparatus for detecting the presence of a car within a section of railway track. The track section is defined by low impedance electrical connections between rails at opposite ends thereof, and the section is inductively coupled to transmitter and receiver units. In one embodiment, the transmitter unit operates in the audio frequency range and the proximity of a car is detected by a reduction in the received signal due to electromagnetic coupling of the metallic mass of the car to the track section. In another embodiment the transmitter operates in the ultrasonic frequency range and the presence of a car within the section is detected by a reduction in the received signal caused by the shunting effect of the wheels and axle of the car. In a third embodiment the transmitter unit applies a pair of signals at different frequencies, and the proximity of the metallic mass of the car is detected by a variation in the received amplitude of one of the signals, and the shunting effect of the wheels-axle set is detected by a variation in the other signal.

13 Claims, 9 Drawing Figures







GEORGE B. CROFTS
INVENTOR.

Fig. 7

BY *R. E. Geanque*
ATTORNEY

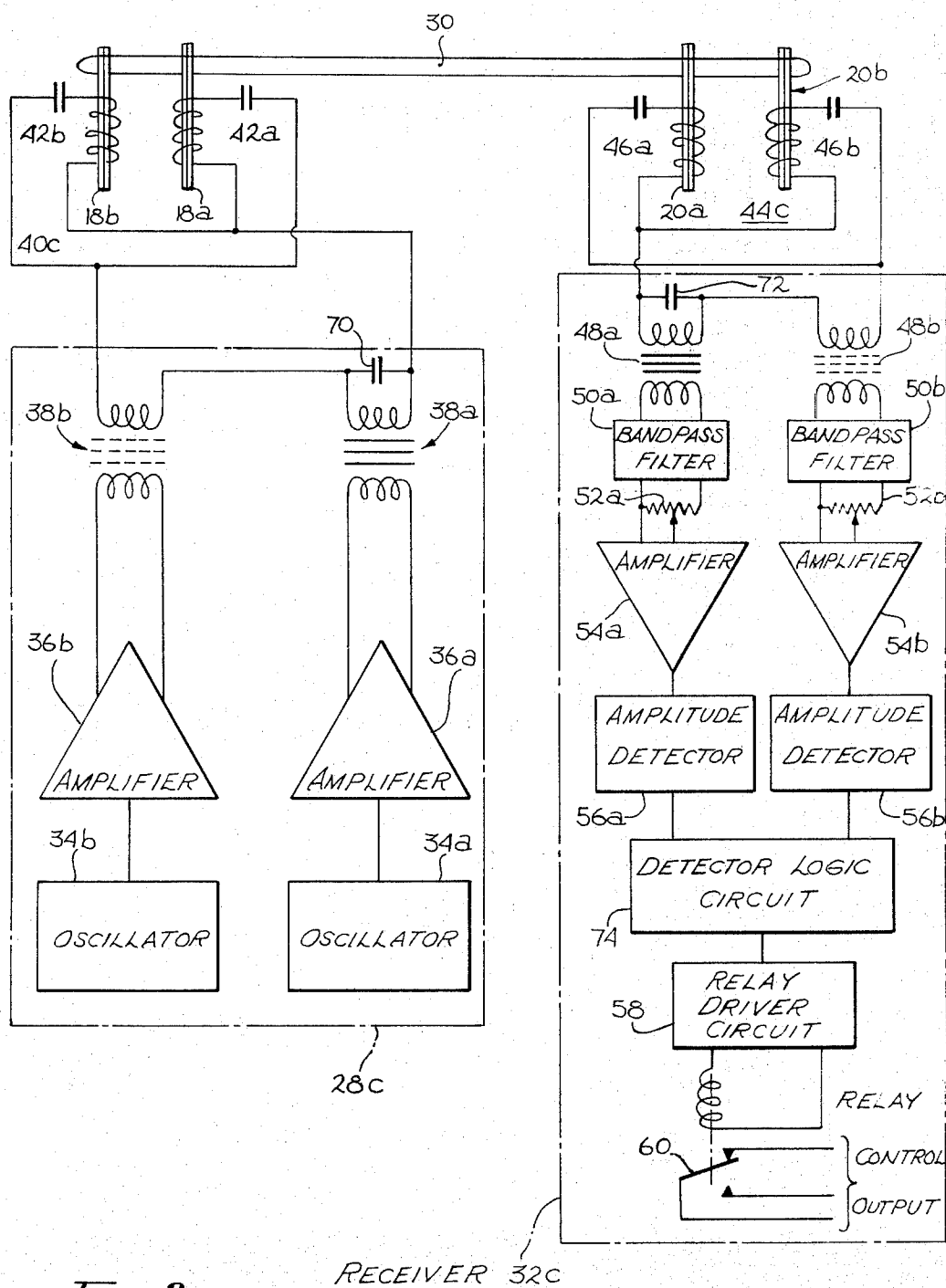


Fig. 8

GEORGE B. CROFTS
INVENTOR.

BY *R.E. Geanque*
ATTORNEY

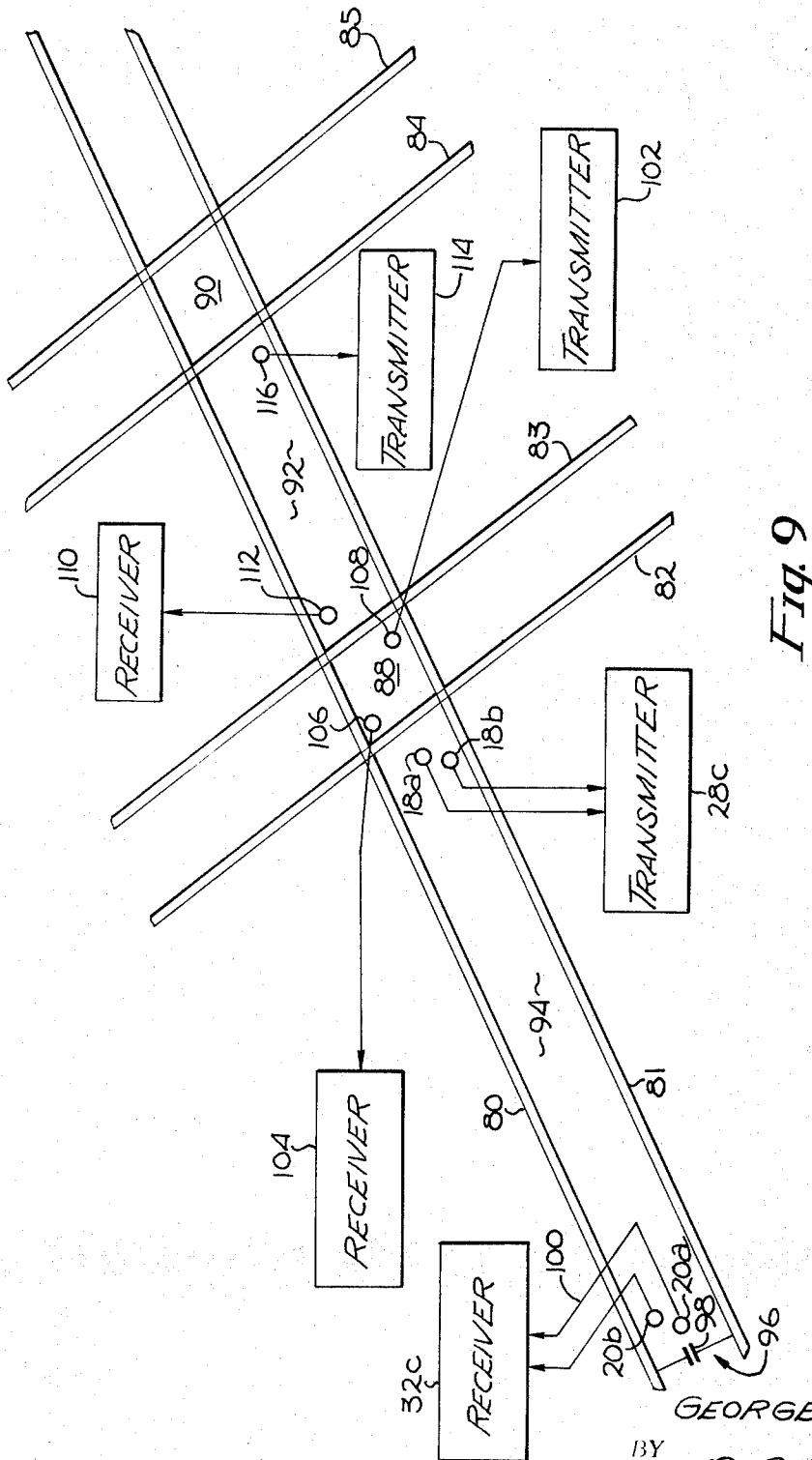


Fig. 9

INVENTOR.
 GEORGE B CROFTS
 BY
R.E. Beaune
 ATTORNEY

PRESENCE DETECTOR**BACKGROUND OF THE INVENTION**

This invention relates to railway signaling devices and more particularly to presence detectors for use in railway classification yards.

In many railway applications it is necessary to determine whether or not a section of track is occupied, and for safe efficient operation the device that indicates this status must be accurate and reliable. Heretofore numerous prior art devices have been developed to provide the just mentioned function but these devices have exhibited one or more serious deficiencies. For example, one type of prior art presence detector uses a loop of wire enclosing a railroad track area in which a car is to be detected. This loop of wire represents a considerable installation and maintenance problem and is subject to damage by dragging equipment. In some of these prior art systems, the loop of wire is part of the resonant circuit of an oscillator whose frequency is changed by the inductance variation of the loop when a car is present, and this change in frequency is utilized as an indication of the presence or absence of a car within the section. It has been found that systems which attempt to base detection upon frequency or phase changes encounter problems in frequency stability which necessitate expensive frequency drift compensation circuits.

Also in recent years the length of the wheel base of some cars has increased to the point that these cars may straddle the track section (without having a wheel and axle set within the section), and therefore prior art detector circuits which operate primarily by sensing the shunting effect of car wheels are unreliable. Increasing the detection section of the track so that a long car cannot straddle the section would slow the processing of traffic. Further, foreign matter such as grease between the wheels and the rails can reduce the reliability of systems relying solely upon sensing the shunting effect of the wheels across the rails. Additionally with some of the longer tank cars, there is about 3½ feet of clearance between the rails and the car body — making proximity detection all the more difficult.

SUMMARY OF THE INVENTION

Therefore it is a primary object of the subject invention to provide a new and improved presence detector which is economical to install and operate, and which reliably indicates the presence of a car within a railway track section.

Another object of the subject invention is to provide a presence detector which will operate reliably for long cars which may straddle the detection section, as well as standard length cars.

Yet another object is to provide a presence detector which may be optimized for detection of both the proximity of the metallic mass of the car, and the shunting effect of a wheel and axle set across the rails.

In accordance with one preferred embodiment, the subject invention realizes the above mentioned economies of installation and maintenance by utilizing a short circuited section of track, upon which the presence of a car is to be detected as the coupling link between transmitter and receiver units. These last mentioned units are inductively coupled to the track section by coupling inductors disposed between the rails at opposite ends of

the track section. The receiver unit senses the reduction of received energy due either to the proximity of the metallic mass of a straddling long car, or to the shunting effect of the wheels and axle when the wheels of a car are within the section. In another preferred embodiment, the subject invention comprises a dual frequency presence detector wherein energy at two different frequencies is inductively coupled to the above described detection section. The value of one of the frequencies is selected to optimize the sensing of the proximity of the metallic mass of the car, and the other frequency is optimized for the detection of the shunting of the rails by the wheels of a car within the section.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are characteristic of the invention, both as to its organization and method of construction and operation, together with further objects and advantages thereof will be better understood from the following description taken in conjunction with the accompanying drawings in which the illustrative embodiments of the invention are disclosed and wherein like reference numerals indicate like or corresponding parts.

In the drawings:

FIGS. 1 and 2 are block diagrams of the presence detector of the subject invention installed in association with a straight section of track and with a track switch, respectively.

FIG. 3 is a more detailed block and schematic diagram of the presence detector of FIGS. 1 and 2, and wherein the track coupling inductor circuits are tuned to series resonance.

FIG. 4 shows another embodiment of a portion of the circuit of FIG. 3 wherein the track coupling inductor circuits are tuned to anti-resonance.

FIG. 5 is a vertical sectional view taken along a line 5—5 of FIG. 1, and shows one type of track coupling inductor suitable for incorporation into the presence detector of the subject invention.

FIG. 6 is a plan view of the track section and shows air core track coupling inductors suitable for use in the apparatus of the subject invention.

FIG. 7 is a vertical sectional view taken on a line 7—7 of FIG. 6.

FIG. 8 is a block and schematic diagram of a dual frequency presence detector system in accordance with the subject invention.

FIG. 9 is a block diagram of a track network incorporating several embodiments of the invention for demonstrating some of the applications thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first primarily to FIGS. 1 and 2, the presence detector in accordance with one preferred embodiment of the subject invention is installed in association with a short circuited section of track where detection of the presence of a car is desired. Rails 10 and 12 are shorted together at the end of the desired detection area by heavy wire jumper cables 14 and 16, to form a coupling link (loop) between a transmitter track inductor 18 and a receiver track inductor 20. FIG. 1 shows the system connection for a straight section of track, and FIG. 2 depicts the system connection

for a track section containing a switch 22. Jumper cables 24 and 26 provide low resistance electrical continuity through the track switch 22.

Alternating current energy from a transmitter unit 28 is inductively coupled by means of the transmitter track inductor 18 through the track loop 10, 12, 14, 16 (indicated generally by reference numeral 30) to the receiver track inductor 20. The inductor 20 is coupled to a receiver unit 32, which unit senses a reduction in received signal and provides a control signal indicative thereof when a car is within the track section. When the wheels of a car are between the transmitting and receiving inductors 18 and 20, the wheels and axle shunt the coupling between inductors 18 and 20, thereby reducing the signal to the receiver 32.

It is possible for a long car to straddle the track section 30 with one set of wheels to the left of the inductor 18 and the other set to the right of inductor 20, so that the coupling between inductors is not shunted. However in accordance with the subject invention, the metallic mass of the car is electro-magnetically coupled to the track loop 30, thereby causing a detectable reduction in the signal at the receiver 32. It has been found that this just described proximity effect is observable when the frequency of the transmitter 28 is at least within the audio frequency range (100 to 20,000 Hz). However tests indicate that proximity detection is most efficient at a frequency of approximately 500 Hz for the difficult detection case of long cars which straddle the section with a high clearance (for example 3½ feet) between the body of the car and the rails. The improved proximity detection efficiency at the lower frequencies is believed to be due in part to the relative increase of the strength of the radiated electro-magnetic field ("near field") at the lower frequencies.

Reference is now directed primarily to FIG. 3, which shows the embodiment of FIGS. 1 and 2 in greater detail. The transmitter 28 includes an oscillator 34, the output signal from which is amplified by an amplifier 36 and then coupled by a transformer 38 to a track coupling circuit 40. The circuit 40 comprises a capacitor 42 connected in series with the inductor 18.

The values of the elements of circuit 40 may be selected so that circuit is tuned to series resonance — thereby providing a low impedance and reducing capacitive cable losses when the unit 28 is located a substantial distance from the track loop 32.

Energy radiated by the inductor 18 is coupled through the loop 30 to the inductor 20, which inductor forms a part of the receiver coupling circuit 44. Circuit 44 includes a capacitor 46 and may be tuned to series resonance in a manner similar to that described previously for circuit 40.

Referring momentarily to FIG. 4, it is noted that for installations where long cable runs are not involved, a low current, high impedance configuration of circuits 40 and 44 may be mechanized by connecting capacitors 42 and 46 in parallel with inductors 18 and 20, respectively. In this configuration the circuit values may be selected such that circuits 40 and 44 operate in an anti-resonance (parallel resonance) mode.

Again referring primarily to FIG. 3, the energy induced into inductor 20 is coupled by means of circuit 44 and transformer 48 to a band pass filter 50. A potentiometer 52 is connected across the output terminals of

the filter 50 to form a gain control circuit at the input to an amplifier 54. The output signal of amplifier 54 is detected by an amplitude detector circuit 56. The circuit 56 is coupled to a relay drive circuit 58 and provides an "unoccupied signal" thereto whenever the input signal to the detector 56 is above a predetermined level relative to a quiescent or reference level. In response to the "unoccupied signal," the relay driver circuit energizes the relay 42 (the position shown in FIG. 3) thereby indicating at the control output terminals that a car is not in the track section. When a car is present in the track section 30, the signal coupled to receiving coupling circuit 44 is reduced below the preselected threshold level, the "unoccupied signal" is removed, relay drive circuit 58 is de-energized, and the relay switches to an open position indicative of the presence of a car within the section 30.

One type of track coupling inductor suitable for elements 18 and 20 is shown in FIG. 5 as comprising a laminated core 62 with a coil 64 wrapped on the central position of the core. In one configuration which has proven satisfactory, the core 62 had the approximate dimension of 1 inch by 1 inch by 20 inches. Inductors 18 and 20 may be buried approximately equidistant between the rails, with the longitudinal axis of the coil vertical. Another type of track coupling inductor suitable for the elements 18 and 20 is shown in FIGS. 6 and 7 as an air core inductor with vertical axes. This last mentioned inductor may be formed by a conductor 66 coiled in a circular pattern, and may be situated on the roadbed approximately equidistant between the rails.

As discussed previously, a frequency of approximately 500 Hz was found to be optimum for proximity detection of long cars with approximately 3½ feet clearance between the car body and the rails. However it has also been noted that systems which operate at low frequencies require a low shunting resistance to reliably detect the wheels of a car within the section. This is due to the reduction in inductive impedance of the rails at the lower frequencies. Since it is quite common to encounter foreign matter such as grease and oil on the rails (especially in classification yards), sometimes the shunting resistance is not low enough to allow detection of a single wheel-axle set at the lower frequencies. At the higher frequencies, for example 50,000 to 1,000,000 Hz, shunting sensitivity is such that the presence of car wheels may be readily detected even with oil on the rails. However the higher frequency systems encounter reduced sensitivity for proximity detection.

The dual frequency presence detector system shown in FIG. 8 uses both a low frequency to optimum proximity detection, and a high frequency for reliable shunt detection. Referring now primarily to FIG. 8, the transmitter unit 28c comprises oscillator 34a, amplifier 36a, and transformer 38a, and provides alternating energy at a low frequency. Oscillator 34b, amplifier 36b and transformer 38b provide the high frequency energy. The secondary windings of transformers 38a and 38b are connected in series to drive one two-wire cable which is connected to track inductor circuit 40c. The secondary winding of the high frequency transformer 38b exhibits a low impedance to the lower frequency and hence readily passes that signal. The secondary winding of the low frequency transformer exhibits a

high impedance to the higher frequency, and is therefore bypassed for the high frequency signals by a capacitor 70 which has negligible effect upon the low frequency signal current.

The track coupling circuit 40c may be constructed in a similar manner to the circuit 40 described previously. In the embodiment of FIG. 8, the capacitors 42a and 42b are connected in association with the low and high frequency inductors 18a and 18b respectively, so that the circuit 40c exhibits series resonance characteristics.

The high frequency inductor 18b may be constructed similar to the low frequency inductor described previously (FIG. 5) except that the core is composed of a material (such as a ferrite) suitable for high frequency operation, and a relatively smaller number of turns are used for the coil.

The high frequency tuning capacitor 42b exhibits a high impedance at low frequencies, and the low frequency inductor 18a has a high reactance at the higher frequencies so the inductor circuits may be conducted in parallel to the common cable with negligible interaction.

Similarly the receiver unit 32c has dual channels with the components followed by the letter *a* indicating the low frequency circuits, and those followed by the letter *b*, the high frequency circuits. A capacitor 72 is added across the primary winding of the low frequency transformer 48a to by-pass the high frequency signal around this low frequency primary winding.

The output signal of the low and high frequency amplitude detector circuits 58a and 58b are combined in a detector logic circuit 74, which may be for example an "AND" gate, which provides a "combined unoccupied signal" if, and only if, an "unoccupied signal" is supplied thereto from both detectors 58a and 58b. The "combined unoccupied signal" energizes relay driver circuit 58 when the absence of a car in the section is verified by both the high frequency and low frequency channels. If either amplitude detector does not apply an "unoccupied signal," the relay 60 is de-energized indicating that a car is within the section.

In the operation of the dual frequency presence detector of FIG. 8, a low frequency signal at approximately 500 Hz, for example, is applied to the loop 30 through the transmitter channel comprising the elements 34a, 36a, 38a, 42a and 18a. This signal is then coupled through the loop to the receiver inductor circuit 44c, and is processed by the elements 48a, 50a, 52a, 54a and 56a. If the low frequency signal applied to the amplitude detector 56a is below a preselected threshold value, the "unoccupied signal" is not generated by this last mentioned unit and circuit 74 does not energize the relay driver circuit 58, thereby indicating that the proximity of the metallic mass of a car has been detected within the section.

Similarly the high frequency transmitter and receiver channel indicated by the letter *b* processes a high frequency signal and if the wheels of a car shunt the rails within the section, the signal to amplitude detector 56b falls below a preselected threshold level, and an "unoccupied signal" is not applied to the circuit 74. The absence of this last mentioned signal causes relay driver unit 58 to be de-energized, indicating that the presence of a car has been detected within the section due to the shunting effect of its wheels.

FIG. 9 illustrates several applications of the above described embodiments of the invention in association with a track network comprising rails 80 through 85. Rails 82, 83 and 84, 85 cross rails 80, 81 to form short track sections at the areas of intersection designated by reference numerals 88 and 90 respectively. A third track section 94 is formed by the portion of the rails 80, 81 between rail 82 and coupling 96. It should be noted that although the embodiments of FIGS. 1 and 2 depict track sections defined by a pair of jumper cables 14, 16 across the rails, the invention is readily adaptable to sections defined by any pair of low impedance paths between the rails. For example, one end of section 94 is formed by the short across rails 80, 81 provided by intersecting track 82, and the other end by coupling 96, which includes a capacitor 98. The value of capacitor 98 is selected so that the coupling is a low impedance at the frequency of operation of the associated detection system, for example, capacitor 98 may be 100,000 microfarads.

Track section 94 which could exceed 30 feet in length, is monitored by a dual frequency detector system such as described relative to FIG. 8. In FIG. 9, receiver 32c and transmitter 28c are coupled to associated track coupling inductors 18 and 20 respectively, by composite leads (two conductors per lead) such as lead 100.

The length of track section 88, sometimes referred to as a "dead section," is too short for effective proximity detection and so a high frequency wheel-axle shunt detecting system is employed. The detection system associated with section 88 comprises a high frequency transmitter 102 and a high frequency receiver 104 with the associated coupling inductors 106 and 108 disposed in opposite corners of section 88. Receiver 104, transmitter 102 and inductors 106, 108 may be constructed in accordance with the description of the high frequency channel of FIG. 8.

A significant advantage is obtained by locating the inductors 106 and 108 in opposite corners of the section, whereby the presence of a car is detected regardless of whether it is traveling on rails 82, 83 or 80, 81.

Assuming that section 92, which may be 15 feet in length, for example, is too short for effective proximity detection, then only high frequency shunt detection would be utilized. As shown in FIG. 9, inductors 112 and 116, transmitter 114 and receiver 110 are disposed in the section 92 in a similar manner to that described for section 88, and these units may be identical to the corresponding units of section 88.

Also although not shown in FIG. 9, the section 90 could be monitored in an identical manner to section 88.

It is noted that in the interest of clarity, the receiver unit 32 has been shown in block diagram form as including the amplitude detector and relay circuits in addition to the coupling circuit, filter and amplifier elements. However it will be readily recognized that the elements 44, 48, 50, 52 and 54 could be considered receiving means, while elements 56, 58 and 60 could be identified as detection means.

Having thus described a new and novel presence detector which is highly reliable in operation, and economical to manufacture, install and maintain, what is claimed is:

1. An apparatus for detecting the presence of a car within a section of a railway track defined by low impedance electrical connections across the rails at opposite ends of the track section, said apparatus including:

transmitter means including a pair of oscillators for inductively coupling electrical energy at first and second frequencies to said track section;

receiver means inductively coupled to said track section for providing first and second electrical signals representative of the electrical energy at said first and second frequencies, respectively, coupled to said receiver means from track section;

detection means, coupled to said receiver means, for detecting variations in said first and second electrical signals;

means for indicating the presence of a car within said track section as a function of the variations in said first and second electrical signals;

a pair of transmitter track coupling inductor circuits; and

means for applying the output signals from said pair of oscillators in an electrical parallel arrangement to said pair of transmitter coupling inductor circuits.

2. The apparatus of claim 1 wherein each of said transmitter track coupling inductor circuits including separate circuit means for operating each of said inductor circuits at approximately series resonance for a different one of said frequencies.

3. The apparatus of claim 1 wherein said means for applying the output signals includes a pair of transformers with each transformer having a primary winding excited by energy at a different one of said frequencies, and a secondary winding series coupled with the secondary winding of the other transformer.

4. The apparatus of claim 3 wherein one of said secondary windings is shunted by a capacitor.

5. The apparatus of claim 1 further including a pair of receiver track coupling inductor circuits; and wherein said receiver means including means for applying the output signals from each of said receiver track coupling inductor circuits in an electrical parallel arrangement to separate circuits for providing the first and second electrical signals.

6. The apparatus of claim 1 including a pair of receiver track coupling inductor circuits; and wherein said receiver means including means for applying the output signals from each of said receiver track coupling inductor circuits in an electrical parallel arrangement to separate circuits for providing the first and second

electrical signals.

7. An apparatus for detecting the presence of a car within a section of railway track, said apparatus including:

transmitter means for coupling electrical energy at first and second frequencies to said track section; receiver means for providing first and second electrical signals representative of the electrical energy at said first and second frequencies, respectively, coupled to said receiver means from said track section;

track coupling inductor circuits, said transmitter and said receiver means being inductively coupled to said track section by different track coupling inductor circuits, said track coupling inductor circuits each including a different pair of inductors disposed at opposite end sections of said track section substantially equidistant between the rails of said track section;

detector means, responsive to said first and second electrical signals for detecting variations in said first and second signals; and,

means, coupled to said detector means, for indicating the presence of a car within said section as a function of variations in either said first or second electrical signals.

8. The apparatus of claim 7 wherein said transmitter means includes means for generating said first frequency at a frequency below 20,000 Hz and said second frequency at a frequency above 50,000 Hz.

9. The apparatus of claim 8 wherein said coupling inductor circuits each including a separate coil wrapped metallic core inductor located in the roadbed at opposite ends of said track section.

10. The apparatus of claim 8 wherein said coupling inductor circuits each including a separate air core inductor positioned approximately equidistant between the rails within said track section.

11. The apparatus of claim 8 wherein said track coupling inductor circuits each including means for operating at approximately a series resonance condition.

12. The apparatus of claim 8 wherein said track coupling inductor circuits each including means for operating at approximately a parallel tuned anti-resonance condition.

13. The device of claim 8 wherein the track section includes a track switch and further comprises connection means for providing low impedance electrical continuity through the track switch.

* * * * *

55

60

65