United States Patent

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[54] TRACK COMMUNICATION SYSTEM FOR CONTINUOUS RAIL

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[52] **U.S. Cl.** ..... **246/34 CT**, 246/36

[51] **Int. Cl.** **B61l 23/30**

[58] **Field of Search** ..... 246/34 R, 36, 34 CT

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

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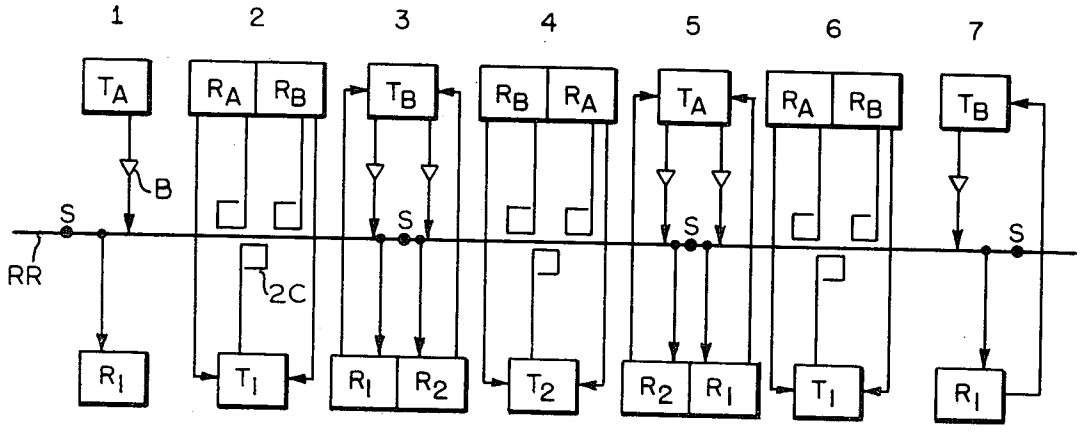
[57] **ABSTRACT**

A communication system for continuous rail track layouts has been provided including a plurality of center fed track circuits. The improvement comprises train occupancy communication means including a plurality of track transmitters each selectively tuned to one of two transmission frequencies alternately coupled to the rails at spaced intervals representing the center of the track circuits and a plurality of receivers each selectively responsive to the transmitter frequencies coupled to the rails at the ends of each of these track circuits for receiving signals from the associated transmitter. Means coupled to the receiver generates an occupancy signal when the communication is cut off for one transmitter and its associated receiver by a vehicle shunt. Control communication means is also included wherein a plurality of control transmitters are each selectively tuned to one of two transmission frequencies different from the track transmission frequencies and are alternately coupled to the rails at each of the adjacent ends of the first track circuits representing a second set of center fed track circuits. A plurality of receivers again each selectively responsive to the transmitter frequencies are coupled to the rails at the center of each of the second set of track circuits for receiving signals from its associated transmitter. Means coupled to each control receiver generates a control signal in accordance with the control receiver signals. The occupancy communication means and the control communication means both simultaneously are capable of transmitting signals along the layout.

6 Claims, 6 Drawing Figures



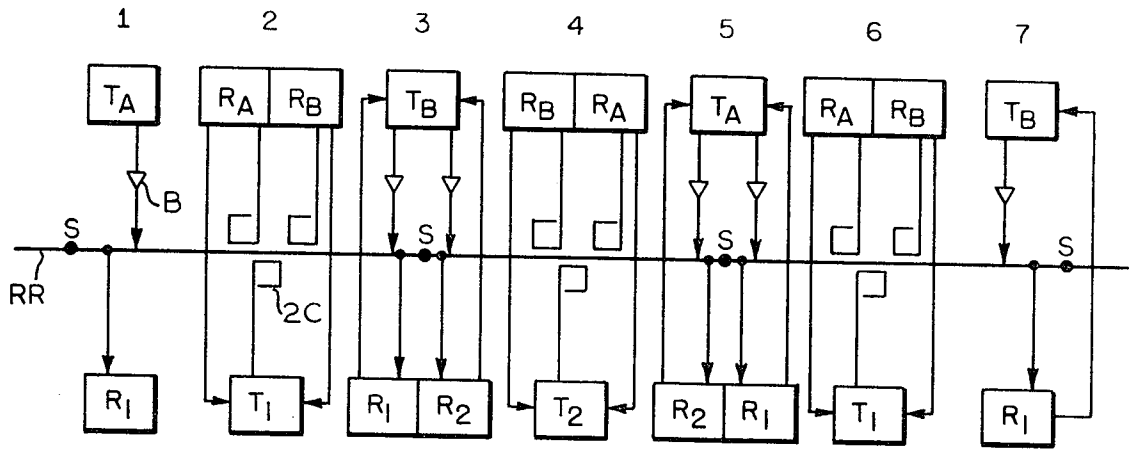


FIG. 1

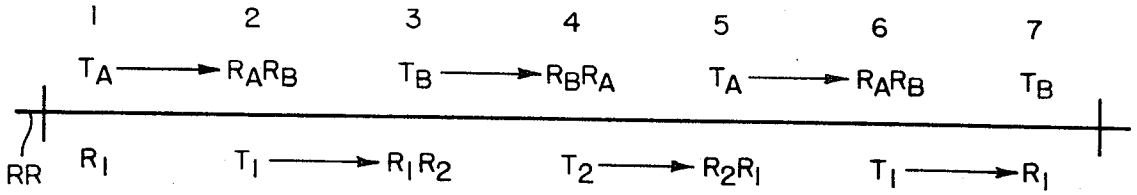


FIG. 2A

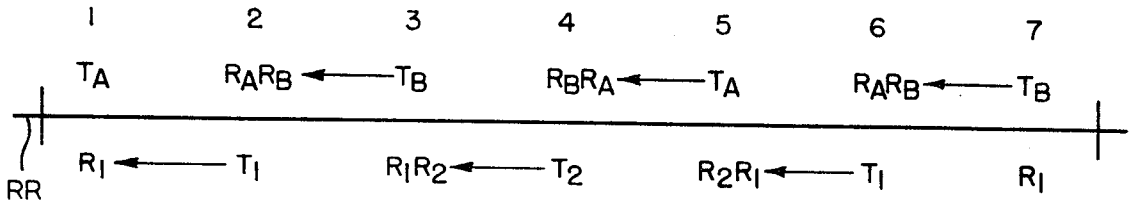


FIG. 2B

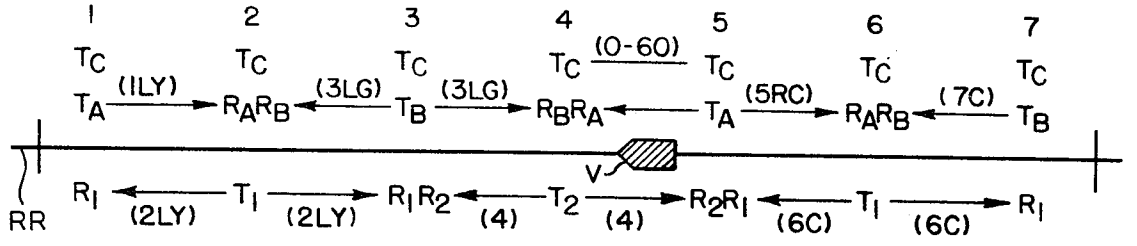


FIG. 3

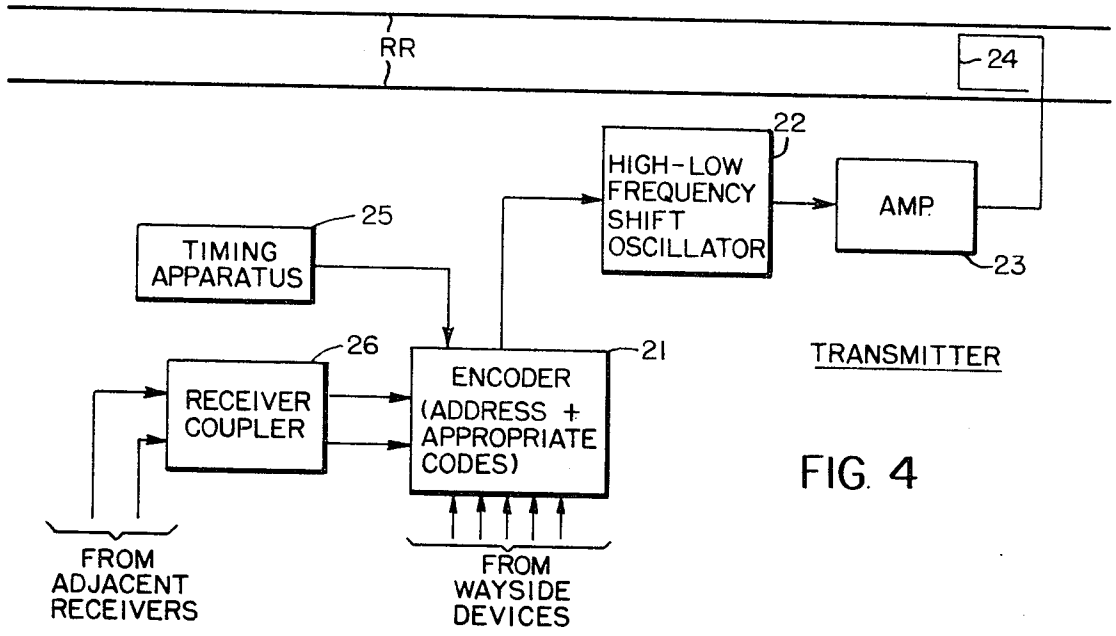

RR
24
22
HIGH-LOW FREQUENCY SHIFT OSCILLATOR
AMP.
23
25
TIMING APPARATUS
26
21
RECEIVER COUPLER
ENCODER (ADDRESS + APPROPRIATE CODES)
TRANSMITTER
FROM ADJACENT RECEIVERS
FROM WAYSIDE DEVICES

FIG. 4

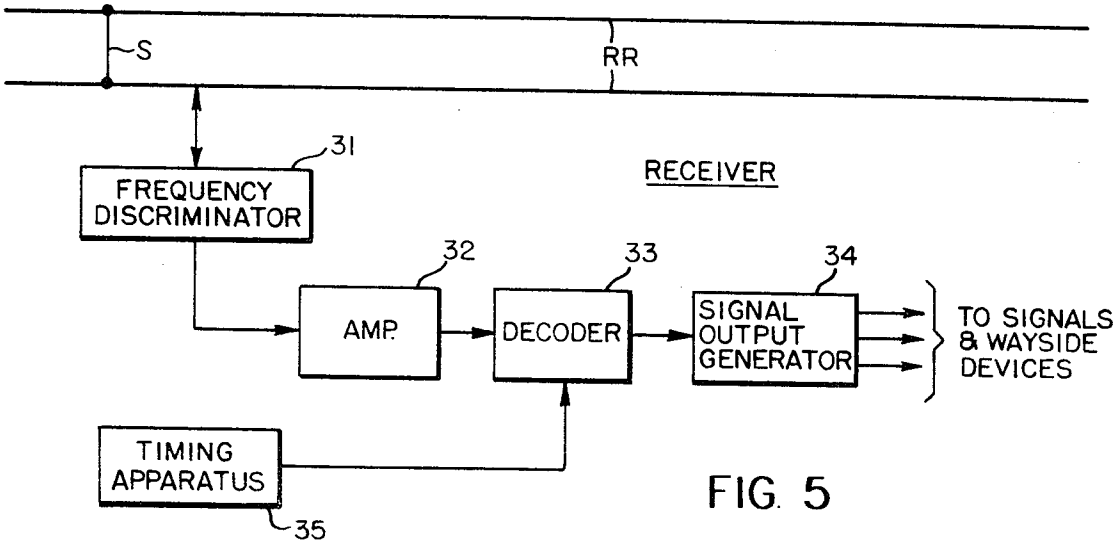

S
RR
31
FREQUENCY DISCRIMINATOR
RECEIVER
32
33
34
AMP.
DECODER
SIGNAL OUTPUT GENERATOR
TO SIGNALS & WAYSIDE DEVICES
TIMING APPARATUS
35

FIG. 5

TRACK COMMUNICATION SYSTEM FOR CONTINUOUS RAIL

BACKGROUND OF THE INVENTION

This invention relates to track circuits and in particular to track circuits for use in conjunction with continuous rail track layouts.

The track circuit is generally used to detect the presence of vehicles in selected intervals or blocks of railroad territory. It is also used to communicate information between signal locations and from block ends to moving vehicles. The basic track circuit comprises a pair of track rails isolated as by a set of insulating joints from the rest of the track and having an energy source at one end and a relay connected across the rails to the other, the presence of a vehicle shunting the rails diverts the current from the energy source through the shunt and causes the relay to drop out thus indicating presence of a vehicle in that block or track circuit. There has been a growing concern about the cost of insulated joints, however, and continuous welded rail has become a favored method of installing railway tracks.

The elimination of insulated joints, except as for example at interlockings and switching points has presented problems in the definition of the blocks or track circuits in which a vehicle is to be detected. A shunt placed at each end of the track circuits does not necessarily solve this problem because there is an uncertain region in the vicinity of the shunt which might lead to an ambigious situation wherein a train is present but none is detected. This ambigious region in addition, is frequency dependent and the lower the frequency which provides long range track circuits, the larger the uncertain area, while with high frequencies, the uncertainty is diminished a great deal but the track circuit must be substantially reduced in range.

It would also be desirable to operate over these track circuits by encoding information and eliminating the use of line wires for central traffic control of vehicles travelling along the control territory.

It is therefore an object of the present invention to provide an arrangement which substantially obviates one or more of the limitations and disadvantages of the described prior art and arrangements.

It is also an object of the present invention to provide a simplified track circuit arrangement using continuous rail.

It is another object of the present invention to provide track communication means over the same continuous rail track circuits.

It is yet another object of the present invention to provide continual train detection and vehicle control over a specified section of track territory.

SUMMARY OF INVENTION

A coded communication system for continuous rail layouts has been provided including a plurality of center fed track circuits. The improvement comprises train occupancy communication means including a plurality of track transmitters each selectively tuned to one of two transmission frequencies alternately coupled to the rails at spaced intervals, for generating signals in the rails and said intervals represent center of a first set of track circuits. A plurality of occupancy receivers has been provided, each selectively responsive to the transmitter frequencies and said occupancy receivers are coupled to the rails at the ends of each of the first track circuits for receiving signals from its associated transmitter. Means coupled to the occupancy receivers generates an occupancy signal when the communication is cut off from one transmitter and its associated occupancy receiver by a vehicle shunt. Control communication means has also been included comprising a plurality of code transmitters each selectively tuned to one of two transmission frequencies different from the first track transmission frequencies alternately coupled to the rails at each adjoining adjacent ends of the first track circuits for defining a second set of track circuits for generating control signals in the rails. A plurality of control receivers each selectively responsive to the transmitter frequencies, coupled to the rails at the center of each of the second track circuits are for receiving control signals from its associated transmitter and means coupled to each control receiver generate control signals in accordance with the control receiver signals. The train occupancy communication means and the control communication means both simultaneously are capable of transmitting signals along said layout.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a plan view of the communications system of the present invention.

FIGS. 2A and 2B show communication channels between positions 1 and 7.

FIG. 3 shows the apparatus of FIG. 1 but with wayside train control apparatus added, a train in one of the blocks, and typical messages between each of the transmitters and receivers.

FIG. 4 is a block diagram appropriately labeled showing a typical transmitter used on the present invention.

FIG. 5 is a block diagram of a typical receiver of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The concept of the present invention contemplates the use of two sets of center fed track circuits. A first set for providing train detection information and a second set for providing communications from one section of track to the next without the necessity of using line wires.

The drawing in FIG. 1 shows seven apparatus positions which are at spaced distances along the right of way of a continuous rail track system. Transmitters at various locations are denoted by the letter T with appropriate subscripts which shall be described later on and receivers are described by a letter R also with the particular subscript. A numeral before either of the letters T and R will be used to indicate which of the transmitters or receivers is being called for according to its position along the right of way.

A first track circuit begins at position 1 at shunt S and continues to position 3 at shunt S. These shunts are used to terminate the continuous rail track circuits and assist in providing definition to the ends of such track circuits. The circuit from 1 to 3 is fed by a transmitter $2T_1$, which is voltage coupled through coil 2C to the rails RR. A signal generated by transmitter T_1 is induced in the rails RR and transmitted in both directions to positions 1 and 3. Receivers $1R_1$ and $3R_1$ are current coupled to the rails RR and are adapted to receive these signals induced by transmitter $2I_1$. Similarly, $4T_2$ transmits signals from position 4 to positions 3 and 5 as these signals are received by $3R_2$ and $5R_2$. In the event of the presence of a vehicle in, for example, the section of rails between positions 3 and 4, the signal from $4T_2$ is shunted by the vehicle wheels and $3R_2$ does not receive the transmitter $4T_2$ signal. Immediately receiver $3R_2$ is conditioned to generate signals in accordance with this situation.

A second set of track circuits is coordinated with the first set and from FIG. 1 it can be seen that the transmitters $1T_A$, $3T_B$, $5T_A$, and $7T_B$ are spaced at substantially the same intervals as the previously described transmitter and receivers except that the positions of the transmitters and receivers are shifted over so that they alternate. Transmitter $3T_B$ generates control signals and is coupled to the rails for transmitting signals to receiver $2R_B$ and $4R_B$ and similarly transmitter $5T_A$ transmits signals through the rails RR to $4R_A$ and $6R_A$ while transmitter $1T_A$ and $7T_B$ are respectively coupled through the rails R to their receivers $2R_A$ and $6R_B$. The numbered subscripts on the transmitters and receivers represent those

devices used for transmitting the occupancy information while the lettered subscripts of the transmitters and receivers indicate that apparatus which is used for the communications channel of the apparatus of the present invention. In addition, the subscripts 1 and 2 indicate different frequencies of transmission as well as A and B. It will be noted that for the occupancy channel only two frequencies are necessary because the distances between positions are long enough so that there will not be any cross-coupling between different track circuits. It should be noted that the shunts ar positions 1, 3, 5 and 7 terminate the track circuits sufficiently so that this problem does not exist.

There are connections between the occupancy transmitters and receivers and the control transmitters and receivers at the particular apparatus locations. As previously described, a train located between positions 3 and 4 will not only be detected by $3R_2$ but also this information is signalled to the transmitter $3T_B$ which then encodes this information and transmits it in both directions to positions 2 and 4 respectively.

It is a consideration in the present invention to have two different types of track circuits overlapping each other; one of which is designed to be highly responsive to a train shunt while the other is designed with average communication in mind.

While both current and voltage coupling of receivers and transmitters are shown in the drawings, it is for the purpose of illustrating the preferred embodiment. The efficacy of overlapping track circuits is not dependent upon its mode of coupling to the rail. Efficiency, on the other hand, may be highly dependent upon coupling mode and therefore, the present embodiment illustrates what is believed to be the most efficient embodiment of the present invention.

FIG. 2A shows a typical communications channel from position 1 to position 7, while FIG. 2B shows a channel from 7 to 1. The communication channel exists from each transmitter to each of its associated receivers and from the receivers in one track circuit to the transmitter in the adjacent overlapping track circuit and so forth. This permits continuous transmission of information and control signals from one block to the next.

FIG. 3 shows the apparatus as previously described but in addition, includes transmitters $1T_C$ through $7T_C$ which are used for wayside-to-train cab signalling or automatic train operation. These cab signal apparatus may be coupled to the rails RR to a central location over the line wires. Only one train control transmitter T_C is turned on at any one time, the switching being controlled by the train movement as it is registered at the receiver location directly ahead of the train. In addition, FIG. 3 provides an illustration of a typical layout with a train placed between positions 4 and 5. The arrows and bracketed legends associated therewith are used to describe the messages transmitted back and forth to the various locations along the right of way. As will be described later, each transmitter in addition to the message is capable of transmitting an address code identifying itself to its adjacent receivers, otherwise said receivers are not capable of using the information so provided. The legends, therefore, include the associated transmitter address. The letters following the numbers are used as symbols of the signals being transmitted.

A train between positions 4 and 5 on the right of way may, for example, set up the conditions and messages as shown in the FIG. 3. Transmitter $4T_2$ generates signals in the rails for transmission to receivers $3R_2$ and $5R_2$ and when a vehicle V is present between the locations 4 and 5, receiver $5R_2$ is apprised of the vehicle presence. In addition, the receiver $3R_2$ is also notified of this condition because the current induced in the track circuit by transmitter $4T_2$ is for the most part shunted across the rails by the presence of the vehicle wheels and receiver $3R_2$ reacts thereto by providing some indication of this condition.

Each transmission includes identity and a message, the identity having been previously described are the numbers. The remainder of the transmission; that is, the message is carried by another code word. Some typical messages are tabulated below:

1LY = left-yellow from location 1
2LT = left-green from location 2
5RC = track clear to the right location 5
6C = track clear both sides of location 6.

An identity only, such as 4, is transmitted when part of the block is occupied. The code word on the cab signal carrier conveys a speed command, for example, 0–60. 0 is the identity of the cab signal channel while 60 is the maximum allowable speed.

In the example just discussed, highway crossings can be overlaid using additional frequencies in the conventional manner. The status of the block is available at any point by simply monitoring one of the signal track circuits, the danger of reading the wrong overlay signal can be eliminated by accepting a signal only when the block is occupied, that is, when the train is shunting the signal from the other transmitters. If the crossing protection is of a type feeding the track at the crossing only, the track signal may not be applied until the approach block is occupied. Switches and other apparatus at the wayside may be controlled similarly by providing different frequencies for different functions.

The apparatus of the present invention is shown in FIG. 4 and is typical of that contemplated in the present invention. The transmitter 20 includes an encoder 21 which is capable of providing an address and an appropriate code for particular functions. The encoder drives the high-low frequency shift oscillator 22 which is used to modulate the carrier frequency. This signal is coupled to amplifier 23 for inductive coupling to the rails R over loop 24. Timing apparatus 25 drives the encoder at a proper rate. Receiver coupler 26 is capable of coupling signals from adjacent receivers to the encoder so that appropriate codes may be generated for transmission to the rails and subsequently to other transmitters and receivers.

A receiver 30 shown in FIG. 5 includes a current coupled frequency discriminator 31 which detects the carrier frequencies transmitted over the rails RR. If the signal is in proper frequency, it is coupled to amplifier 32 for a gain increase and thence to decoder 33 for a demodulation of the messages therein. Timing apparatus 35 drives the decoder at a proper rate and signal output generator 34 provides signals to the wayside signals and also to its adjacent transmitter as shown in FIG. 1. These transmitters and receivers are only typical of the type which may be used in the present invention. The current coupling as shown in FIG. 1 for the receivers is used because it provides better zone definition. However, for the purpose, voltage coupling through the loop 24 is also an adequate method of providing the necessary signals to the rails.

In FIG. 1 it can be seen that the lettered subscript transmitters are coupled to the rails directly by a buffer B. However, they are connected at points capable of transmitting the signals without interference from the shunt.

When a train occupies the zone between 5 and 6 the receiver $5R_1$ responsive to this condition provides a signal to transmitter $5T_A$ which in turn supplies this information to the receiver $4R_A$ and thence to $4T_2$, coupled as shown. Transmitter $4T_2$ relays this information down the rails RR to $3R_2$ and $3T_B$. Under these conditions, train occupancy information and train controlled information may be transmitted back and forth ahead of and behind the train occupying any one of the block sections.

The characteristic of the signals transmitted by each set of track transmitters is chosen for optimum efficiency of the function involved and compatibility one to the other. The signal characteristics for one set of track circuits are chosen for high sensitivity to train shunts for accurate end zone detection while the signal characteristics of the other track circuits are chosen in order to maximize communication distance. Each of the signal characteristics however, are chosen with reference to the characteristics of the other so that the two track circuit systems are compatible.

There has been provided therefore a system which is capable of communicating occupancy information and control information along a section of continuous rail right of way. The system further permits the additional figures as defined in

zone detection and communication between the detection and control apparatus for fully coupling the various conditions along the particular right of way.

While there has been described what is at present considered to be the preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A code communication system for continuous rail track layouts including a plurality of center fed track circuits wherein the improvement comprises:

I. train occupancy communication means including:

a. a plurality of track transmitters each selectively tuned to one of two transmission frequencies alternately coupled to the rails at spaced intervals, for generating signals in the track rails, and said intervals representing the center of a first set of track circuits;

b. a plurality of occupancy receivers each selectively responsive to the transmitter frequencies coupled to the rails at the ends of each of said first track circuits for receiving signals from its associated transmitter; and

c. means coupled to the occupancy receivers for generating an occupancy signal when communication is cut off from one transmitter and its associated occupancy receiver by a vehicle shunt, and

II. control communication means including:

a. a plurality of control transmitters each selectively tuned to one of two transmission frequencies, different from the track transmission frequencies, alternately coupled to the rails at each adjoining adjacent ends of the first track circuits defining a second set of track circuits superimposed on the first set of track circuits in the same stretch of railway track for generating control signals in said rails;

b. a plurality of control receivers each selectively responsive to the transmitter frequencies, coupled to the rails at the center of each of the second track circuits for receiving control signals from its associated transmitter, and

c. means including the first and second sets of track circuits superimposed one on the other for the same stretch of railway track for activating an occupancy transmitter at a center feed point in each of the first track circuits in response to a control receiver at that point and for activating a control transmitter at the end of each of the first track circuits in response to an occupancy receiver at that point,

d. whereby a distinctive control signal can be communicated through the track layout in either direction by cooperation of the first and second track circuits and the control signal can be modified in character by the presence of a train to provide a double direction railway signaling system without requiring the use of wayside line wires for signal control purposes.

2. A code communication system according to claim 1 wherein a train speed control communication means is connected to the track rails at the locations of the occupancy and control transmitters for substantially continuously communicating speed control signals to an approaching train in the associated track section.

3. A code communication system according to claim 2, wherein the train speed control communication means is selectively rendered active in accordance with occupancy detection by the first track circuits.

4. A code communication system according to claim 1 wherein at least some of the transmitters and receivers are inductively coupled to the track layout.

5. A code communication system according to claim 4, wherein the transmitters and receivers at the center feed points are inductively coupled to the track layout and the transmitters and receivers at the ends of the track circuits are directly connected to the track layout.

6. A code communication system according to claim 5, wherein track shunts are provided at spaced locations in the track layout which correspond to ends of the first track circuits.

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