Sept. 13, 1966 W. J. MATTHEWS 3,272,981

INTERMITTENT INDUCTIVE TRANSMISSION SYSTEM

Filed April 4, 1963 4 Sheets-Sheet 1

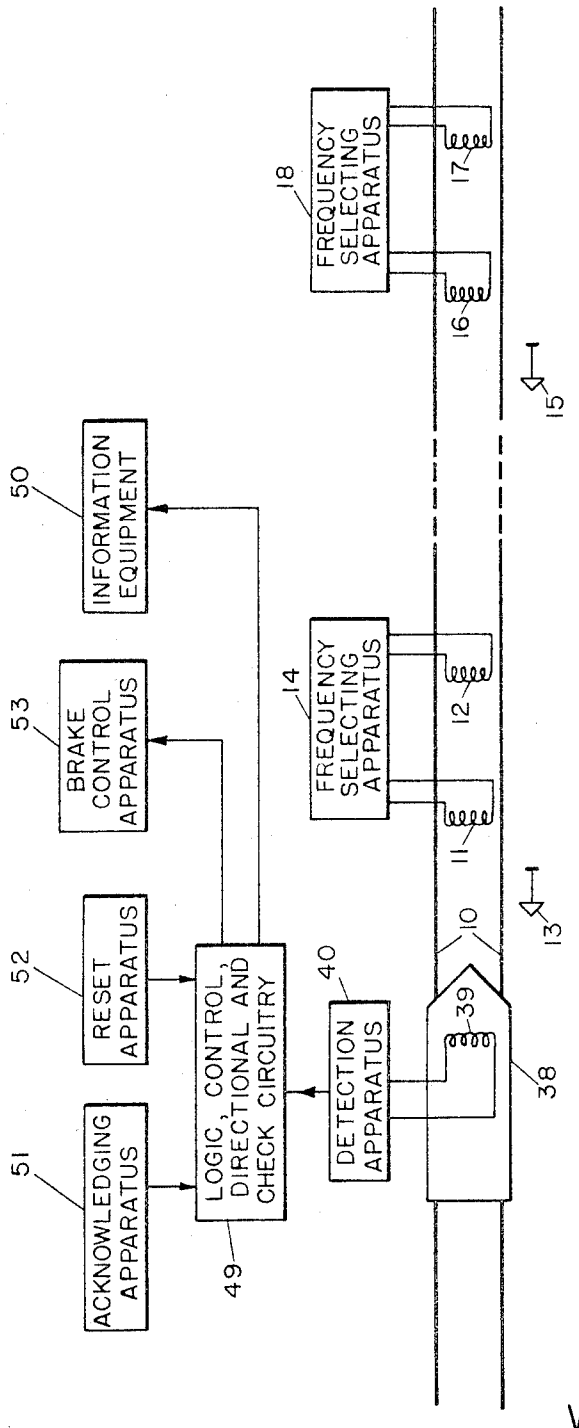


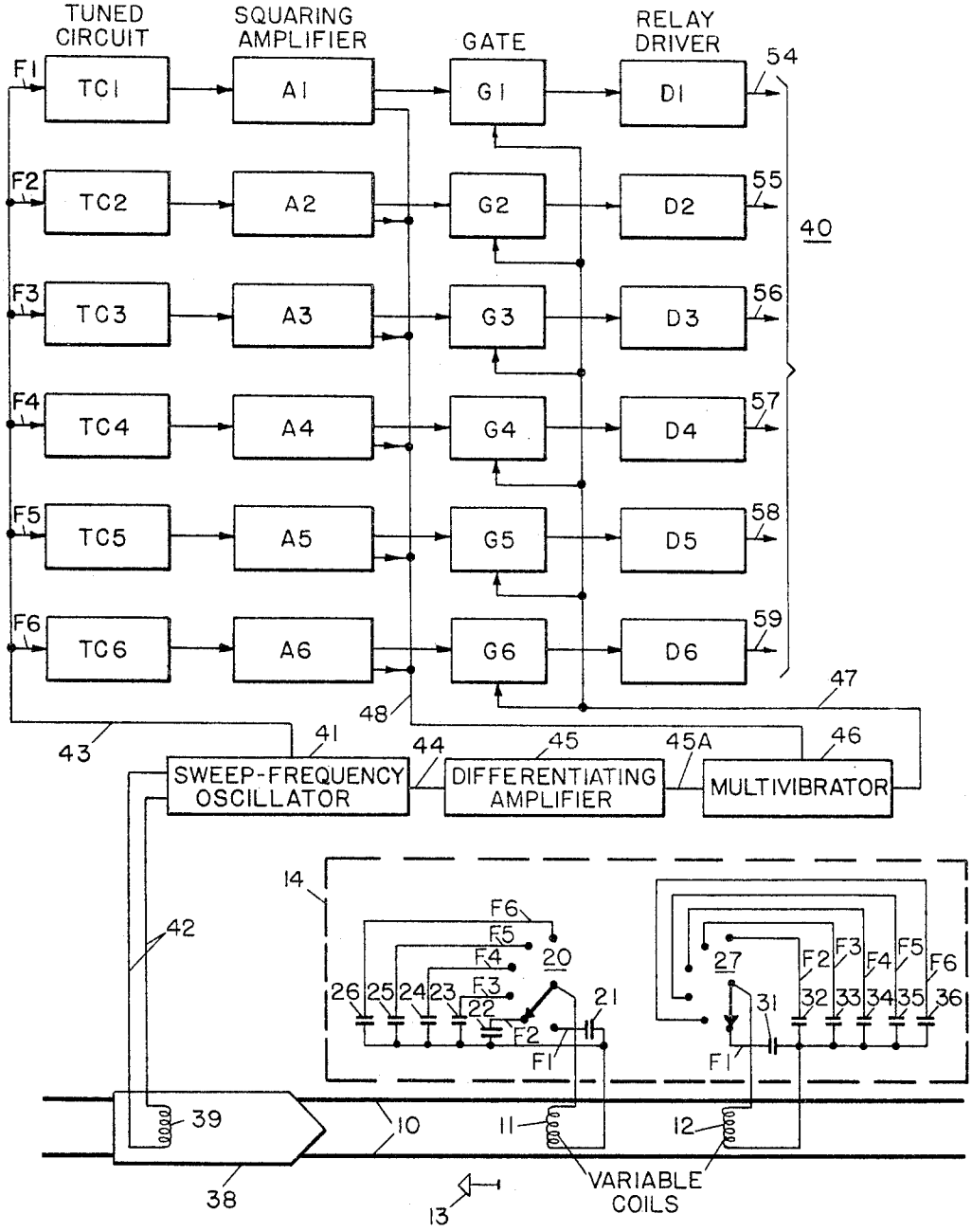
FIG. 1

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INTERMITTENT INDUCTIVE TRANSMISSION SYSTEM

Filed April 4, 1963 4 Sheets-Sheet 2

FIG. 2



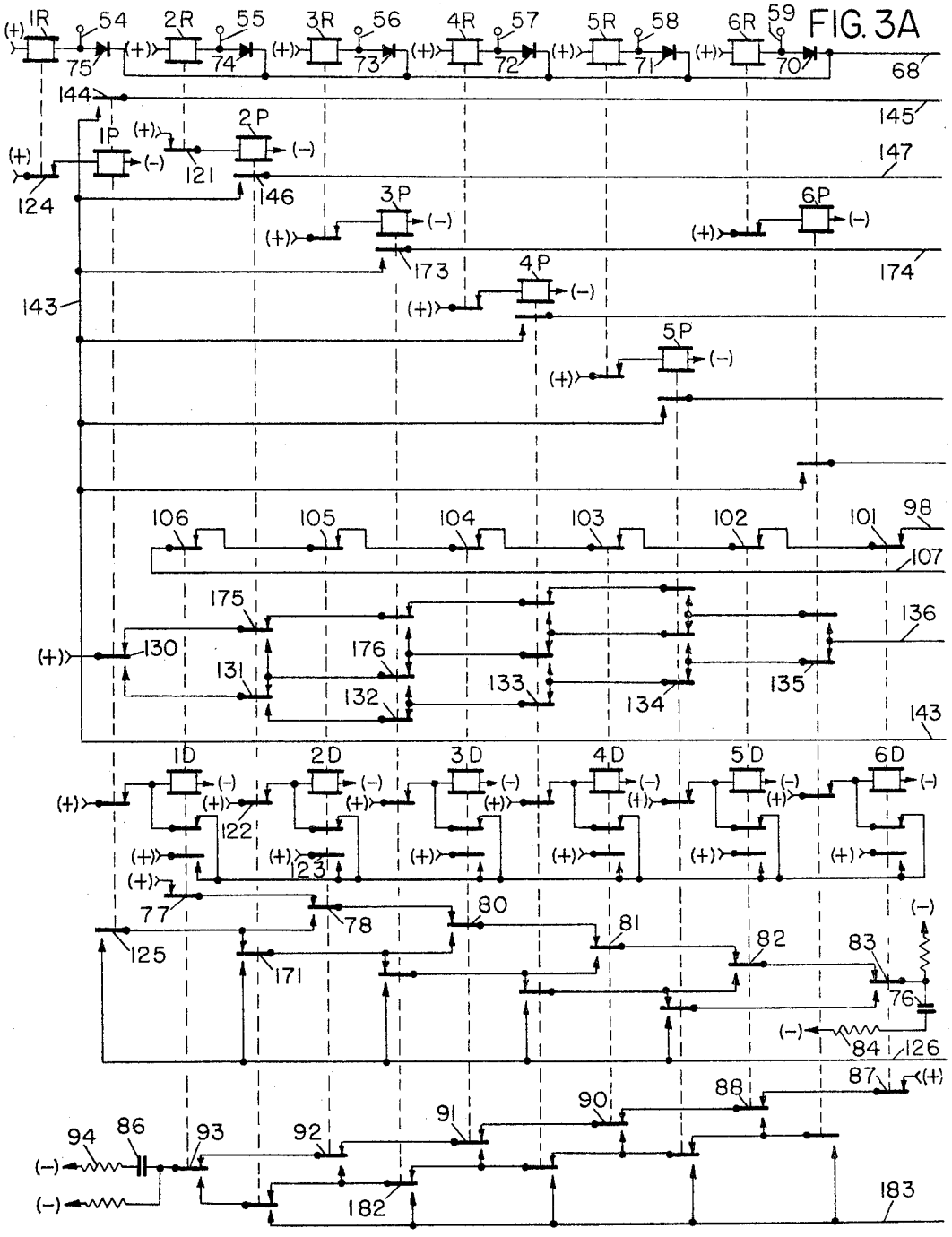
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INTERMITTENT INDUCTIVE TRANSMISSION SYSTEM

Filed April 4, 1963 4 Sheets-Sheet 3

FIG. 3A



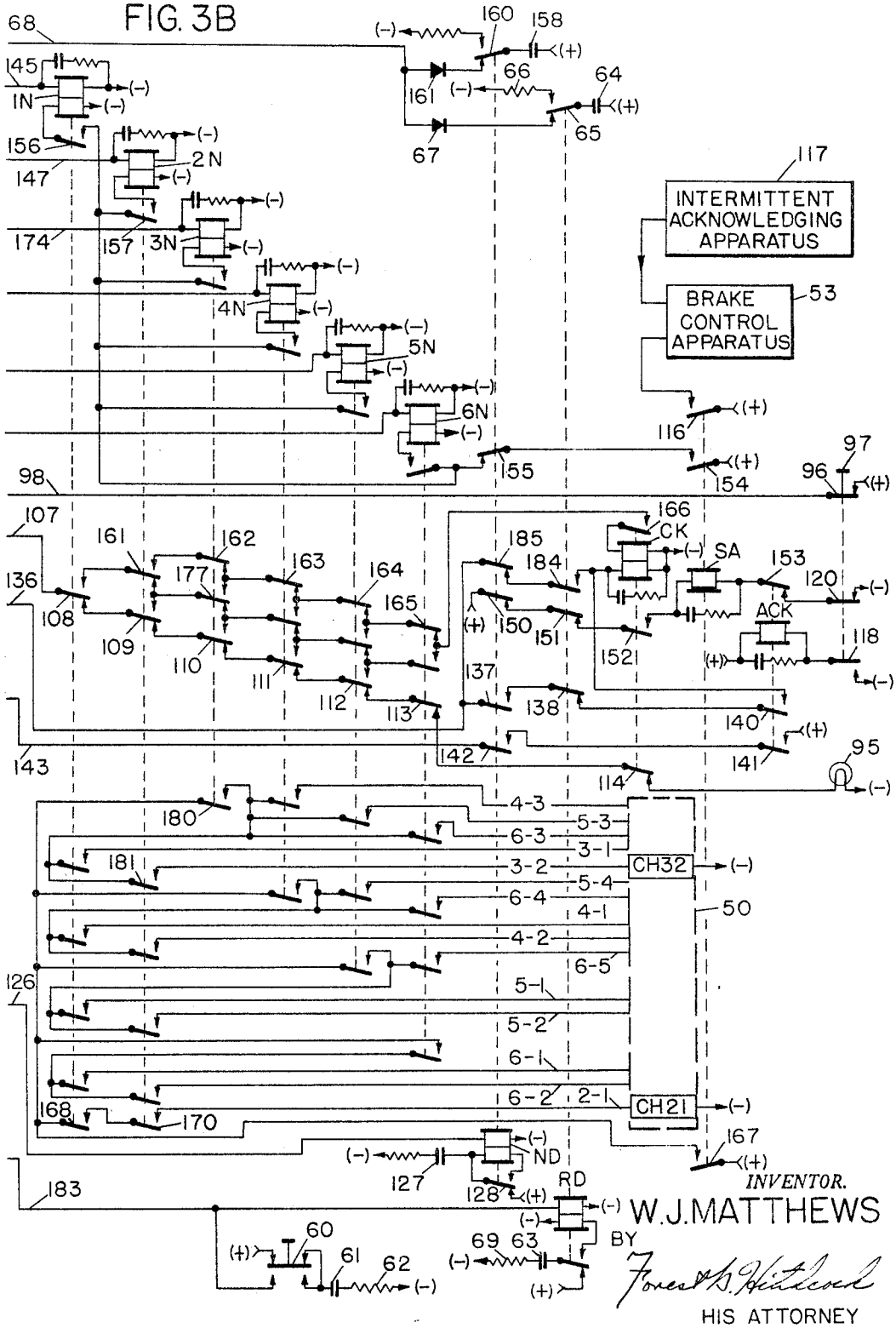
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INTERMITTENT INDUCTIVE TRANSMISSION SYSTEM

Filed April 4, 1963 4 Sheets-Sheet 4

FIG. 3B



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United States Patent Office 3,272,981 Patented Sept. 13, 1966

3,272,981

INTERMITTENT INDUCTIVE TRANSMISSION SYSTEM

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Filed Apr. 4, 1963, Ser. No. 270,615
10 Claims. (Cl. 246—63)

The present invention relates to an intermittent inductive transmission system for railways, and more particularly to an improved system for the transmission of information between the wayside and a moving train at spaced locations along a right-of-way.

In intermittent inductive systems, wherein vehicle carried apparatus is influenced distinctively by wayside apparatus in accordance with track or traffic conditions, it is common practice to employ a wayside inductor that influences the vehicle carried equipment in accordance with open or closed condition of a choke coil wound on the wayside inductor. This choke coil is usually controlled by traffic governing apparatus so that the vehicle carried equipment is influenced when the train is required to operate under restrictive conditions. In addition, these systems require an act of acknowledgement on the part of the engineman in order to forestall an automatic brake application when the vehicle carried apparatus is influenced at each of the spaced wayside locations.

Also, in intermittent inductive system where information is transmitted from a moving vehicle to the wayside it has been the practice in many instances to provide a number of coils on the vehicle which are selectively tuned in accordance with the identification of the vehicle for example, and these tuned coils distinctively influence wayside apparatus as the vehicle passes the location, so the passing vehicle may be identified at a central office.

Although the conventional system using the wayside inductor to control the train is failsafe in its operation, it is limited in that it is capable of transmitting only clear or caution information, and if the wayside inductor is missing or not electrically intact, it is possible for a train to pass a restrictive signal unnoticed if the engineman is not vigilant, or his vision is obscured. The intermittent system employing tuned coils is capable of transmitting a plurality of channels of information. However, its practical utility for transmitting information from the wayside to the moving train for providing safe operation of the train has heretofore been limited because of the possibility of transmitting erroneous information, particularly if one of the tuned coils is not electrically intact or missing. Also, these prior systems necessitated proper positioning and a duplication of apparatus if the track is used for both directions of traffic so that a train going in one direction does not inadvertantly receive the information intended for a train in the opposite direction.

The purpose of the present invention is to provide an improved intermittent inductive system which is capable of transmitting selected information for vehicles travelling in either direction over a stretch of track, and requires the integrity of the transmitting apparatus and a separate distinct operation of a portion of the receiving system at each wayside location in order to receive a valid channel of information. In furtherance thereof, one of the objects of the present invention is to provide an improved intermittent inductive transmission system wherein each of a plurality of channels of information is comprised of at least two characters or pieces of information in a code having a plurality of characters or code elements which must be received effectively in a predetermined order to provide a single valid channel of information.

Another object of this invention is to provide an improved intermittent inductive transmission system wherein

an acknowledging operation at each location or information point and at least two distinct pieces of information transmitted in a predetermined order within a certain period of time after acknowledgement, is required to provide a single channel of valid information at each location.

A further object of this invention is to provide an improved intermittent inductive transmission system wherein each of a plurality of codes of information includes at least two characters of information which must be effectively received in a predetermined order, with the first code character always having a distinct characteristic relative to the second code character.

A further object of this invention is to provide an improved intermittent inductive transmission system of the character described which requires only one receiving coil for both directions of travel and uses a minimum of transmitting apparatus to provide a plurality of channels of information.

A still further object of this invention is to provide a system of the character described which is failsafe in its operation and may be used in both electrified and non-electrified territory.

Other objects of this invention will become apparent from the specification, the drawings, and the appended claims.

In the drawings:

FIG. 1 is a block diagram showing the general organization of a system according to one embodiment of the invention;

FIG. 2 illustrates diagrammatically the organization of the components of the detection apparatus of FIG. 1 and illustrates schematically a typical arrangement for a pair of wayside coils at a single transmitting location; and

FIGS. 3A and 3B when placed side by side illustrate schematically the apparatus and circuitry of the vehicle carried equipment governed by the detection apparatus of FIG. 1.

In accordance with the present invention, and without intending to limit its scope, there is mounted at spaced location along the wayside a pair of inert coils that are positioned one ahead of the other in the direction of the travel of the vehicle. Each of these inert wayside coils may be tuned precisely to a different distinct frequency to provide the same information to each vehicle passing the location, or they may be selectively tuned precisely to different frequencies to transmit selected information to a locomotive as it passes the location, in accordance with traffic conditions, or any other information desired to be conveyed to the vehicle. The particular frequency of each of the pair of tuned coils is sensed by a single vehicle carried receiving coil in sequence as it passes thereover. These two code elements provided by the different frequencies of the tuned coils respectively constitute a single code of information on the vehicle. For the vehicle to receive effectively valid information, one of the tuned coils must always have either a higher frequency or a lower frequency than the other coil. Thus, for example at a location having a pair of variable tuned coils with each coil capable of being selectively tuned to six different frequencies, for example, there is provided thirty distinct codes of information when one of the wayside coils is always tuned to a higher frequency than the other wayside coil or vice versa. But if the coils are placed for sequential passage of the receiver and the first coil in the passage is always of the higher frequency, then only fifteen distinct codes of information are available.

The vehicle carried apparatus includes an absorption coil that is mounted to be in inductive relationship with each of the wayside coils in sequence as it passes thereover regardless of the direction of travel of the train.

The absorption coil has its frequency varied continuously by a sweep frequency oscillator to include all possible frequencies of the wayside tuned coils. As the absorption coil passes over a tuned wayside coil a reduction of voltage across the absorption coil occurs at the frequency to which the wayside coils are tuned.

As the locomotive approaches a location or information point, the engineman is required to operate momentarily an acknowledging push button which conditions a portion of the circuitry for a predetermined period of time only. Within this period of time the absorption coil must be influenced by the frequency of each of the pair of tuned wayside coils for the train to receive valid information. The second encountered wayside coil must also influence the detection equipment within this period of time and within a certain time after it is influenced by the first encountered wayside coil.

The influence of the first encountered wayside coil is distinctively transmitted by way of the detection apparatus to condition the circuitry on the locomotive in accordance with this particular frequency. Simultaneously, a portion of the circuitry is conditioned so that without the reception of another distinct frequency within a certain period of time an out of order condition is registered on the locomotive. The influence of the frequency of a second wayside coil within this period of time completes the number of characters required for a single valid code. The frequency of the second coil is compared with the frequency registered by the first wayside coil, and as is the case in the illustrated embodiment, if the frequency of the first coil is higher than the second coil, the two characters constitute a valid code. If the reverse is true, no valid information is received.

Thus, as will be described in detail, an out of order condition is registered on the locomotive in the absence of an act of acknowledgement for the direction being traveled, the reception of more or less than two code characters, or an act of acknowledgement at any other time than at a pick-up point. The out of order condition may be used with the system to provide a penalty brake application or to remove information from information equipment.

Referring in detail to the drawings, FIG. 1 illustrates a section of track **10** having a pair of variable tuned coils **11** and **12** positioned longitudinally along the wayside a predetermined distance apart at a location marked by a suitable wayside marker **13**. The coils **11** and **12** each may be tuned to any one of six different frequencies as selected by the apparatus referred to at **14** to provide a total of fifteen distinct pieces of information, as above described, that may be transmitted from the wayside to the train at this location. FIG. 1 also illustrates at a location marked by a suitable wayside marker **15**, a pair of variable tuned coils **16** and **17** together with a frequency selecting apparatus **18** which are assumed to be identical to the apparatus described in connection with the location **13**.

The frequency selecting apparatus such as **14**, for example (FIG. 2) may include a selector switch **20** for connecting any one of the capacitors **21** through **26** consecutively to tune the coil **11** to any one of six distinct frequencies **F1** through **F6**. Similarly a selector switch **27** is provided to connect any one of the capacitors **31** through **36** in the circuit with the wayside coil **12** to tune the coil **12** to any one of same six frequencies **F1** through **F6**. Thus, the coil **11** may be tuned to the frequency **F2** as shown by the selector switch **20** and the coil **12** may be tuned to the frequency **F1** as shown by the selector switch **27** to provide for the transmission of a single information code to the locomotive represented by the combination of the frequencies **F2** and **F1** as respective first and second characters.

The locomotive referred to at **38** (FIGS. 1 and 2) is provided with an absorption coil **39** which is positioned to inductively couple with the wayside coils such as **11** and **12**, and **16** and **17** as it passes thereover. The coil **39** is connected to detection apparatus **40** which includes a conventional sweep frequency oscillator **41** capable of periodically varying the frequency on the absorption coil **39** from the frequency **F1** through the frequency of **F6**. The time necessary for the oscillator **41** to sweep through these frequency ranges may be approximately one and four tenths milliseconds, for example. The oscillator **41** then returns from the frequency **F6** to the frequency **F1** in six tenths millisecond, for example. This cycle is repeated continuously at the rate of 500 times per second. The actions of the circuitry are suppressed during the intervals when the frequency of the oscillator **41** is decreasing in accordance with gating circuits disclosed in detail in the prior Kendall Patent No. 2,817,012, granted December 17, 1957. The gate **27** of that patent provides suppression as described above. The output of the sweep frequency oscillator **41** is jointly applied to the absorption coil **39** by wires **42** and to a plurality of tuned circuits referred to consecutively as **TC1** through **TC6** over an output **43**. Output **44** of the sweep frequency oscillator **41** is applied to a differentiating amplifier **45** which detects any rapid change in its input or in other words a rapid change in the amplitude of the oscillator output **44** and produces in response to such a rapid change an output pulse of short duration as **45A**. The output **45A** of the differentiating amplifier **45** is connected to a bi-stable multivibrator **46** which is turned "on" in response to each of the short pulses from the amplifier **45**. When turned "on," the multivibrator **46** produces an output on wire **47** to each of a plurality of gates referred to at **G1** through **G6** consecutively. Connected to the output of each of the tuned circuits **TC1** through **TC6** respectively is an associated squaring amplifier **A1** through **A6**. Each squaring amplifier **A1** through **A6** converts the output from its associated tuned circuit **TC1** through **TC6** to a square pulse. A square pulse at the output of any one of these squaring amplifiers **A1** through **A6** is conducted over a common output **48** to the multivibrator **46** for turning "off" the multivibrator **46** which was turned "on" in response to an output from the differentiating amplifier **45**. Each output of the amplifiers **A1** through **A6** also provides an input to one of the gates **G1** through **G6**. A plurality of relay drivers referred to as **D1** through **D6** consecutively, are normally in a condition to provide energy at their outputs referred to as **54** through **59** respectively. Each one of the gates **G1** through **G6** is connected at its output to a respective one of the relay drivers **D1** through **D6**. Thus, one input to each of the gates **G1** through **G6** is applied from its associated squaring amplifier **A1** through **A6** respectively, and the other input to the gates **G1** through **G6** is common to the input of the multivibrator **46**. The presence of energy on the output **47** of the multivibrator **46** at the same time that energy is applied to one of the inputs of the gates **G1** through **G6** from its associated squaring amplifier **A1** through **A6**, causes the particular gate to inhibit or shut off its associated relay driver **D1** through **D6**. For example, if the absorption coil **39** causes the sweep frequency oscillator **41** to reduce its amplitude when it sweeps the frequency **F2**, the differentiating amplifier **45** causes the multivibrator **46** to turn "on," and the tuned circuit **TC2** provides an output to its squaring amplifier **A2** which causes the gate **G2** to inhibit or shut off the relay driver **D2**. Thus, depending upon the frequency to which the wayside coils such as **11** and **12** are tuned, a particular one of the relay drivers **D1** through **D6** is deenergized as the absorption coil **39** on the locomotive **38** passes thereover.

With reference to the block diagram of FIG. 1, the output of the detection apparatus **40** provides the input to the locomotive carried apparatus and circuitry referred to at **49**. This circuitry **49** provides a single channel of information to the so-called information equipment **50** at each location if all of the requirements of the system are met. Acknowledging apparatus **51** conditions portions

of the circuitry 49 to provide the proper operation of the system at each information point. Reset apparatus 52 is provided to place the system in condition for operation when the locomotive is first started up. Conventional brake control apparatus 53 may be used to apply a penalty brake application in the event of an out of order indication. The information equipment may be used to control a cab signal, or any other locomotive governing equipment in accordance with the requirements of practice.

Referring to FIGS. 3A and 3B each of a plurality of primary relays 1R through 6R consecutively are connected to respective outputs of the relay drivers D1 through D6. The winding of relays 1R through 6R are connected to their relay drivers D1 through D6 over output 54 through 59, respectively. These relays 1R through 6R, which may be reed relays, are normally energized or picked up when its associated relay driver does not detect the presence of a tuned coil. However, the output from the relay drivers D1 through D6 is insufficient to initially pick up its associated primary relays 1R through 6R, but is capable of maintaining it picked up once it is in its energized condition. Associated with each primary relay 1R through 6R is a repeater relay 1P through 6P which is picked up and dropped away in response to the picking up and the dropping away of its respective primary relay. For each of the repeater relays there is a direction relay referred to at 1D through 6D which is picked up by its associated repeater relay 1P through 6P as hereinafter described to determine the direction in which the locomotive is traveling.

For each of the repeater relays 1P through 6P is an information relay 1N through 6N which is energized in response to the dropping away of its associated repeater relay 1P through 6P when valid information has been received. An acknowledging relay ACK is picked up in response to a manual act of acknowledgement and permits the information relays 1N through 6N to be energized only during the time interval that the acknowledging relay ACK is picked up. The acknowledging relay is assumed to have a drop away time of approximately six seconds, for example, after energy is removed from its winding.

A check relay CK which has a drop away time of three or four seconds after energy is removed from its lower winding is provided to check that the repeater relays 1P through 6P and the directional relays 1D through 6D are normally energized, and that only two of the information relays 1N through 6N are picked up at any one time. This relay CK also checks that only two repeater relays release when the locomotive passes a location or information pick-up point.

A slow acting relay SA which has a drop away time of eight seconds, for example, to permit a complete cycle of operation, is provided to insure that the two code characters are received properly within a specific time after the acknowledging contactor is operated and released. Directional control relays ND and RD are energized selectively depending upon whether or not the first received frequency is higher or lower than the second; and this determines whether or not the locomotive is moving in the proper direction with respect to the wayside coils.

The system according to the illustrated embodiment of the invention will be described in detail in connection with its operation. To place the system in operation, when the locomotive receiver is not at an information point, reset button 60 (FIG. 3B) is operated which energizes the relay RD by discharging capacitor 61 through the upper winding of the relay RD. The capacitor 61 is normally charged by a circuit which extends from (+) and includes the reset push button 60 in its unoperated position, the capacitor 61, and a resistor 62 to (−). Once the relay RD is picked up, it is held energized for a predetermined period of time as controlled by the time constant of an RC circuit which includes a capacitor 63 and a resistor 69. The capacitor 63 is charged through a back contact of the relay RD before being energized and discharges through the lower winding of the relay RD upon being picked up. The picking up of the relay RD charges a capacitor 64 by a circuit which extends from (+) and includes the capacitor 64, front contact 65 of the relay RD, and a resistor 66 to (−). When the relay RD drops away, in response to the depletion of the charge on the capacitor 63, the capacitor 64 is discharged to pick up the primary relays 1R, 2R, 3R, 4R, 5R and 6R. The circuit for picking up thse primary relays extends from capacitor 64, and includes the back contact 65 of the relay RD, diode 67, wire 68, and the winding of the relays 1R through 6R by way of diodes 70 through 75 respectively and a positive source of energy connected to each winding of the relays 1R through 6R. Once picked up, the relays 1R through 6R are maintained energized by the output from their respective relay drivers 1D through 6D as previously described. The diodes 70 through 75 prevent the energy from the respecitve relay drivers 1D through 6D from reaching the winding of any other of the primary relays 1R through 6R except the one with which it is associated. A front contact of each primary relay 1R through 6R energizes an associated repeater relay 1P through 6P respectively by an obvious circuit. In response to the picking up of the repeater relays 1P through 6P, the directional relays 1D through 6D respectively are picked up, each by a circuit which includes a front contact of its associated repeater 1P through 6P as shown in FIG. 3A. The picking up of the relays 1D through 6D charges a capacitor 76 (FIG. 3A) by a circuit which extends from (+) and includes front contact 77 of relay 1D, front contact 78 of relay 2D, front contact 80 of relay 3D, front contact 81 of relay 4D, front contact 82 of relay 5D, front contact 83 of relay 6D, the capacitor 76 and a resistor 84 to (−). The picking up of the relays 1D through 6D also charges a capacitor 86 by a circuit which extends from (+) and includes front contacts 87, 88, 90, 91, 92, and 93 of the relays 6D through 1D respectively, a capacitor 86 and a resistor 94 to (−). To notify the engineman that the system has been reset, a lamp 95 is illuminated (FIG. 3B) by a circuit which extends from (+) and includes front contact 96 of acknowledging contactor 97, wire 98, front contacts 101, through 106 consecutively of the relays 6D through 1D, wire 107, back contacts 108 through 113 consecutively of the information relays 1N through 6N, back contact 114 of the checking relays CK and lamp 95 to (−). At this time the locomotive carried apparatus is ready to receive information stored, but there is no information on the locomotive by the code storage relays 1N through 6N, and the relay CK is deenergized, the relay SA is deenergized, and the acknowledging relay ACK is deenergized. Because the brake control apparatus referred to at 53 in FIG. 3B is connected in a conventional manner through a front contact 116 of the relay SA to prevent an automatic brake application; and which operates to apply the brakes automatically any time the relay SA is deenergized, the brake control apparatus 53 may be controlled in a conventional manner by intermittent acknowledging apparatus 117 which must be operated every thirty seconds, for example, in order to keep the brakes of the locomotive released. This intermittent acknowledging apparatus 117 is well known in the art and merely illustrates how brakes may be released before the locomotive reaches the first set of tuned wayside coils. Also, this intermittent acknowledging apparatus 117 is required only when there is a total absence of control information, i.e., all relays 1N through 6N are deenergized. Normally, after the train has passed the first pair of wayside coils, the brakes of the train are maintained released independent of the acknowledging apparatus 117 by the closure of front contact 116 of relay SA in accordance with the storage of a code as will be hereinafter described.

When the locomotive 38 approaches the wayside

marker 13, the engineman operates the acknowledging contactor 97 which extinguishes the reset lamp 95 by opening its previously described energizing circuit at contact 96 of the contactor 97. The closing of contact 118 of the contactor 97 picks up the relay ACK by a circuit which extends from (+) and includes the winding of ACK and the back contact 118 of the contactor to (—). The opening of front contact 120 of the contactor 97 removes energy from the slow acting relay SA if it had been previously energized.

When the absorption coil 39 on the locomotive passes over the wayside coil 11, which is tuned to the frequency F2, the energy on the output 55 of the relay driver D2 is removed as previously described causing the primary relay 2R to drop away. The dropping away of the relay 2R deenergizes the repeater relay 2P by opening front contact 121 in its energizing circuit. The dropping away of the relay 2P deenergizes its associated directional relay 2D by the opening of front contact 122 in the energizing circuit of the relay 2D. The dropping away of the relay 2D sticks the other directional relays 1D, 3D, 4D, 5D and 6D by a circuit which extends from (+) and includes back contact 123 of the relay 2D, the front contact of the other directional relays in their respective windings to (—) as is shown in FIG. 3A. The dropping away of the relay 2D removes charging energy from the capacitor 76 by the opening of front contact 78 of the relay 2D in its previously described charging circuit. The opening of the front contact 92 of the relay 2D also removes charging energy from the capacitor 86.

When the absorption coil 39 next passes the wayside coil 12 which is tuned to the frequency F1 energy on the output 54 of the relay driver D1 is removed, and the primary relay 1R drops away. The dropping away of the relay 1R deenergizes its repeater relay 1P by the opening of the front contact 124 of the relay 1R. The dropping away of the relay 1P picks up the relay ND (see FIG. 3B) by discharging the capacitor 76 over a circuit which extends from the capacitor 76 and includes the front contact 83 of the relay 6D, front contact 82 of the relay 5D, the front contact 81 of the relay 4D, front contact 80 of the relay 3D, the back contact 78 of the relay 2D, back contact 125 of the relay 1P, wire 126, and the upper winding of the relay ND to (—). The relay ND remains energized until the charge on the capacitor 76 is dissipated, or the charge on a capacitor 127 which was previously charged over the back contact 128 of the relay ND, whichever is longer. The picking up of the relay ND completes a circuit for energizing the check relay CK which extends from (+) and includes back contact 130 of the relay 1P, back contact 131 of the relay 2P, front contacts 132, 133, 134, and 135 of the relays 3P, 4P, 5P and 6P respectively, wire 136, front contact 137 of the relay ND, back contact 138 of the relay RD, front contact 140 of the relay ACK and the lower winding of the relay CK to (—). The picking up of the relay ND also completes a circuit for energizing the code storage relays 1N and 2N associated with the primary repeater relays 1P and 2P. This circuit extends from (+) and includes front contact 141 of the relay ACK, front contact 142 of the relay ND, wire 143, back contact 144 of the relay 1P, wire 145, and the upper winding of the relay 1N to (—). The circuit for picking up the relay 2N extends from the wire 143 and includes back contact 146 of the relay 2P, wire 147 and the upper winding of the relay 2N to (—).

When the charge on the capacitor 127 is dissipated, the relay ND drops away which picks up the relay SA by a circuit that extends from (+) and includes back contact 150 of the relay ND, back contact 151 of the relay RD, front contact 152 of the relay CK, the winding of the relay SA, back contact 153 of the relay ACK, and the front contact 120 of the acknowledging contactor 97 to (—). The picking up of the relay SA closes a stick circuit for the relays 1N and 2N, which relays remain energized for approximately two seconds after energy is removed from the pick up winding. This pick up circuit extends from (+) and includes front contact 154 of the relay SA, back contact 155 of the relay ND, front contacts 156 and 157 of the relays 1N and 2N and their respective lower windings to (—).

The dropping away of the relay ND discharges the capacitor 158 which was previously charged over front contact 160 of the relay ND. This discharge circuit includes the capacitor 158, the back contact 160 of the relay ND, a diode 161, the wire 68, and the windings of the primary relays 1R through their respective diodes referred to consecutively as 70 through 75. The discharging of this capacitor 158 over the previously described circuit picks up the primary relays 1R and 2R, which in turn pick up their respective repeater relays 1P and 2P by an obvious circuit. The picking up of the relay 2P picks up the directional relay 2D and opens the previously described stick circuit for the remaining directional relays 1D and 3D through 6D. When the relay 2D is picked up, a stick circuit is completed for the relay CK which extends from (+) and includes the front contact 96 of the acknowledging contactor 97, the wire 98, the front contacts 101 through 106 of the directional relays 1D through 6D, the wire 107, front contact 108 of the relay 1N, front contact 161 of the relay 2N, back contacts 162, 163, 164 and 165 of the relays 3N through 6N respectively, front contact 166 of the relay CK, and the upper winding of the relay CK to (—). The picking up of the relays 1N and 2N provides a distinctive single code of valid information if the relay SA is picked up, by completing a circuit which extends from (+) and includes front contact 167 of the relay SA, front contact 168 of the relay 1N, front contact 170 of the relay 2N, and a channel of information referred to as CH21 of the information equipment. After having received and stored the first valid information code, the relay SA remains picked up, and the relay CK remains picked up. The relay CK is being held energized because of the picked up condition of the two information relays 1N and 2N, and the picked up condition of the directional relays 1D through 6D. The relay SA is energized through the front contact 152 of the relay CK and the back contact 153 of the relay ACK and the front contact 120 of the acknowledging contactor 97.

Now assuming the locomotive approaches the wayside marker 15 as shown in FIG. 1 and the engineman operates the acknowledging contactor 97 momentarily, the relay ACK is picked up which removes energy from the relay SA. Also, relay CK is dropped away immediately by the opening of the front contact 96 of the acknowledging contactor in the stick circuit for the relay CK. The relay SA is now held up by virtue of its slow drop away characteristics. Assuming that the wayside coil 16 is tuned to a frequency F3 for example, the primary relay 3R is deenergized when the absorption coil 39 passes thereover which in turn drops away the relay 3P and the relay 3D as previously described. The dropping away of the relay 3D removes charging energy from the capacitors 76 and 86.

Assuming that the wayside coil 17 is tuned to a frequency F2, the absorption coil 39 passing over the coil 17 causes the primary relay 2R to drop away which in turn drops away its repeater relay 2P as previously described. In response to the dropping away of the relay 2P, the capacitor 76 is discharged to pick up the relay ND by a circuit which extends from the capacitor 76 and includes the front contacts 83, 82, and 81 of the relays 6D, 5D, 4D respectively, back contact 80 of the relay 3D, back contact 171 of the relay 2P, the wire 126 and the upper winding of the ND relay to (—). The picking up of the relay ND opens the stick circuit for the code storage relays 1N and 2N causing them to immediately drop away. The picking up of the ND relay also applied energy to the upper winding of the

relay 3N and 2N, respectively, by the circuit which extends from (+) and includes the front contact 141 of the relay ACK, the front contact 142 of the relay ND, the wire 143, the back contact 146 of the relay 2P, and a back contact 173 of relay 3P, the wire 147 and a wire 174 respectively to the upper winding of the relays 2N and 3N to (−). The relay CK is also picked up in response to the picking up of the relay ND by a circuit which extends from (+) and includes the front contact 130 of the relay 1P, back contact 175 of the relay 2P, back contact 176 of the relay 3P, the front contacts 133, 134 and 135 of the relays 4P, 5P and 6P respectively, the wire 136, the front contact 137 of the relay ND, back contact 138 of the relay RD, the front contact 140 of the relay ACK and the lower winding of the relay CK to (−). When the relay ND releases because of the dissipation of the charge on the capacitor 127, the primary relays 2R and 3R are picked up which pick up their respective repeater relays 2P and 3P and the directional relay 3D. Upon the picking up of the directional relay 3D a stick circuit is completed for relay CK through the front contact 109 of the relay 2N, a front contact 177 of the relay 3N, and back contacts 163, 164, and 165 of the information relays 4N, 5N and 6N and the front contact 166 of the relay CK through its upper winding to (−).

The picking up of the relays 3N and 2N provides an output on information channel CH32 of the information equipment 50 by a circuit which extends from (+) and includes the front contact 167 of the relay SA, front contact 180 of the relay 3N, front contact 181 of the relay 2N and the channel CH32 to (−).

Assuming that the coil 16 was tuned to the frequency F2 and the coil 17 tuned to the frequency F3, and the engineman operated the acknowledging contactor at the approach to the location, the directional relay 2D is deenergized in response to the dropping away of the primary relay 2R and its repeater 2P. Instead of the relay ND being picked up when the absorption coil 39 passes the second encountered wayside coil 17, the RD relay is energized by a circuit which extends from the capacitor 86 and includes the front contact 93 of the relay 1D, back contact 92 of the relay 2D, back contact 182 of the relay 3P, wire 183, and the upper winding of the relay RD to (−). The closing of front contact 184 of the relay RD closes a pick up circuit for the relay CK, which extends from (+) and includes the previously described front and back contacts of the repeater relays 2P and 3P, the wire 136, back contact 185 of the relay ND, the front contact 184 of the relay RD, and the lower winding of the relay CK to (−). However, because the ND relay never picked up since the first frequency was lower than the second frequency, the previously described pick up circuit for the information relays 3N and 2N is not completed, nor is the stick circuit for these information relays broken. And the locomotive apparatus rejects this new information and continues to display the information that it had received at the previous location. The relay SA under these circumstances remains energized because the relay CK picks up in response to the picking up of the relay RD, and the relay SA energizing circuit is thus completed. In this example, the train is running in a direction to which these coils do not apply and no acknowledgement is required.

Assuming that the engineman fails to acknowledge in approaching a location wherein the frequency F3 is detected before the frequency F2, for example, the relay ACK remains deenergized and the relay CK immediately drops away in response to the dropping away of a distinct one of directionaly relays 1D through 6D in response to the passage of the locomotive by the first encountered wayside coil. In response to picking up of the ND relay when the locomotive passes the second tuned wayside coil as previously described, the pick up circuit for the relay CK is not completed because the front contact 140 of the relay ACK is opened. Also, the information is not transferred to the concerned information relays 1N through 6N because front contact 141 of the relay ACK in the energizing circuit for the information relays is opened. Thus, the slow acting relay SA drops away approximately eight seconds after the locomotive is influenced by the first wayside coil. The dropping away of the relay SA may be used to cause an automatic brake application by the opening of its front contact 116 in the energizing circuit of the brake control apparatus 53. Under these circumstances the engineman must operate the reset button 60 to pick up the primary relays 2R and 3R in their associated repeater relays 2P and 3P and the directional relay 3D, which relays were dropped away passing the wayside tuned coils. The operation of the system under conditions of resetting has previously been described.

Assuming that the engineman acknowledges as he approaches a wayside location, but instead of releasing the acknowledging contactor immediately after operating it, he holds it in its energized position, the relay SA drops away approximately eight seconds after the engineman initially operated the acknowledging contactor 97. Because the time for dropping away the relay ACK after the ackonwledging contactor is released, is approximately six seconds, in this example the acknowledging contactor 97 should be depressed and released in a period of less than two seconds so the relay SA does not drop away.

Assuming that the engineman operates and releases the acknowledging contactor 97 some distance before he reaches a wayside location marker, the relay ACK will drop away before the relay CK is picked up in response to the passage of the locomotive past the second encountered wayside coil. In this example the relay SA drops away approximately eight seconds after the acknowledging contactor is released.

The time interval between the release of the acknowledging contactor 97 and the time that the relay CK is picked up in response to the passage of the absorption coil over the second encountered wayside coil must be less than the drop away time of the relay ACK which may be six seconds for example. The relay ND which closed its front contact 137 to complete the pick up circuit for the relay CK must drop away before the operation of the drop away time of the relay SA which may be eight seconds for example; and the system is returned to normal with all of the primary relays, the repeater relays and the direction relays energized to complete the stick circuit for the relay CK while the relay CK is picked up by its lower winding after the relay ND drops away which may be three or four seconds for example. Also, in order to pick up the respective pairs of code relays, the relay ND must be picked in repsonse to the passage of the locomotive past the second encountered wayside coil before the drop away time of the relay ACK while its front contact 141 is closed.

Also, in the event that the engineman acknowledges and one of the wayside coils is missing or not electrically intact, the relay CK will drop away in response to opening of the contact 96 but cannot thereafter be picked up which prevents the closing of the energizing circuit for the relay SA, and it will drop away approximately 8 seconds after the release of the acknowledging contactor.

Assuming that the engineman fails to acknowledge and one of the wayside coils is missing or not electrically intact, the relay CK drops away in response to the influence of whichever one of the wayside coils is present, and the relay SA is deenergized in approximately 8 seconds after the relay CK opens its front contact 152. Thus it is seen by this example, that the locomotive could detect a missing information coil for an information point designated for a train traveling in the opposite direction.

If the engineman acknowledges and both of the way-

side coils are missing or if he acknowledges when there are no wayside coils the stick circuit for the relay CK is opened at contact **96** of the acknowledging contactor and the relay CK drops way to open the energizing circuit for the relay SA. If more than two code characters are received, the relay CK drops away, which in turn drops the relay SA because the contacts of the code storage relays **1N** through **6N** are so connected according to the present invention that the stick circuit for the relay CK is not completed when the particular directional relay **1D** through **6D** is picked up upon restoration of the system to normal.

From the preceding description and the drawings it is apparent that if any of the primary relays **1R** through **6R** the repeater relays **1P** through **3P** or the directional relay **1D** through **6D** the relay SA or the relay CK should inadvertently drop away, an out of order condition is registered on the locomotive. Also, if the relays ND, or RD, any of the code storage relay **1N** through **6N** or the relay ACK should fail to pick up or drop away an out of order condition results.

Although a system has been shown and described capable of transmitting 15 distinctive codes to the locomotive, it is apparent that more or less may be used in a system according to the present invention. Although the information equipment **50** has been shown generally, it is understood that this apparatus may take the form of a cab signal or other information that may be required on the train in accordance with the needs of practice. Further, although an intermittent acknowledging apparatus **117** is shown as a means for releasing the brake control apparatus after resetting and prior to the trains receiving valid information from the wayside, it is understood that other means and apparatus could be used with this system.

Having thus described one embodiment of the present invention for improved intermittent transmission system, it is understood that various modifications may be made to the specific form shown without departing from the spirit or scope of the present invention as defined by the appended claims.

What I claim is:

1. An intermittent inductive system for communicating information from the wayside to a moving vehicle comprising, a pair of transmitting coils disposed along the wayside, one of the coils being disposed ahead of the other in the direction of travel of the vehicle, each of the coils being tuned to a selected distinctive frequency, receiving means on the vehicle having a sweep frequency oscillator connected to a receiving coil positioned to be influenced by the distinctive frequency to which each of the transmitting coils is tuned when the receiving coils passes in close proximity with the transmitting coils respectively, acknowledging means on the vehicle activated for a predetermined time interval in response to manual operation thereof, first and second means on the vehicle for registering the reception of distinctive frequencies of the respective transmitting coils as they are received by said receiving means, information output means on the vehicle operative when activated to provide a single information code in response to the distinctive frequencies registering by said first and second means jointly, control means governed by the acknowledging means and the first and second means operative to activate the output means in response to the reception of the vehicle from both of the transmitting coils provided such reception is within the predetermined time interval and only provided that the distinctive frequencies registered by said first and second means are in a predetermined order as to relative frequency values.

2. An intermittent system according to claim **1** wherein the one distinct frequency followed by the other distinct frequency within said predetermined time interval cancels the single information code from the activated output means provided by a previous activation of the output means.

3. An intermittent inductive system according to claim **1** further including a normally inactive out of order information means operative when activated to indicate an out-of-order condition, and timing means operative to activate the out of order information means when the one and/or the other distinct frequencies are received without the said predetermined time interval.

4. An intermittent inductive system according to claim **1** further including a normally inactive out of order information means operative when activated to indicate an out of order condition, and timing means operative to activate the out of order information means a predetermined time interval after the reception of one of the distinct frequencies when the acknowledging means is in an inactive condition.

5. An intermittent inductive system for transmitting information from the wayside to a moving vehicle, comprising a pair of transmitting coils disposed along the wayside one of the coils being disposed ahead of the other in the direction of travel of the vehicle, each of the coils being tuned to a distinct frequency, receiving means on the vehicle having a sweep frequency oscillator connected to a receiving coil positioned to be influenced by the frequency of each of the transmitting coils when the receiving coil passes in close proximity with the transmitting coils respectively, acknowledging means on the vehicle activated for a predetermined time interval in response to a manual operation thereof, a first and second detecting means on the vehicle normally in one condition and each operated to a second condition in response to reception from said transmitting coils respectively, normally energized out of order circuit means deenergized in response to the activation of the acknowledging circuit means, checking circuit means normally in one condition when the first and second means are in one condition and operated to another condition upon the operation of the acknowledging means and/or the operation of the first of the first and second means to its second condition, means responsive to the operation of the first and second means to their second conditions in sequence when the acknowledging circuit means is activated to operate the checking circuit means to its one condition, and means responsive to the operation of the checking circuit means to its one condition when the acknowledging circuit means is in an inactive condition to energize said normally energized out of order circuit means.

6. An intermittent inductive system for transmitting information from the wayside to a moving vehicle, comprising a pair of tuned transmitting coils disposed along the wayside one of the coils being disposed ahead of the other in the direction of travel of the vehicle, each of the coils being tuned to a distinct frequency, receiving means on the vehicle having a sweep frequency oscillator connected to a receiving coil positioned to be influenced distinctively by the frequency of each of the transmitting coils in succession upon passage of the vehicle, a first and second circuit means on the vehicle normally in one condition and each operated to its second condition in response to the distinctive influence of a respective one of the transmitting coils upon the receiving means, an acknowledging circuit means on the vehicle activated for a predetermined time interval in response to a manual operation thereof, a normally energized out of order circuit means deenergized in response to the activation of the acknowledging circuit means and operative a predetermined time interval after being deenergized to indicate an out of order condition, checking circuit means normally in one condition when the first and second circuit means are in one condition and operated to another condition upon the operation of the acknowledging means and/or the operation of either one of the first and second means to its second condition, a third circuit means responsive to the operation of both the first and

second means to their second condition in sequence during the time interval when the acknowledging circuit means is activated to operate the checking circuit means to its one condition, and means responsive to the operation of the checking circuit means to its one condition and the operation of the acknowledging circuit means to an inactive condition and effective before the expiration of the predetermined time interval of the out of order circuit means to energize the normally energized out of order circuit means.

7. A system according to claim 6 including a fourth circuit means responsive to the operation of the first and second means to their second condition in reverse sequence to operate the checking circuit means to its one condition, and information output means operative to provide a single channel of information only in response to the operation of the checking circuit means to its one condition by the third circuit means.

8. An intermittent inductive train control system for detecting on a vehicle distinctive frequencies to which wayside coils are tuned comprising, a normally energized means operative a first predetermined time after being deenergized to apply the brakes of the train, receiving means on the vehicle including an oscillator and a receiving coil operative to detect a distinct frequency of a tuned coil as the receiving coil passes the tuned coil, a plurality of primary circuit means operatively connected to the receiving coil, all of which are normally energized when the receiving coil is not detecting the frequency of a tuned coil and each one of which is deenergized in response to the detection of a distinct frequency, an acknowledging circuit means operative when energized in response to a momentary manual operation thereof to deenergize the brake applying means for a second predetermined time interval less than the first predetermined time interval, a first circuit means operated to one condition in response to the deenergizing of only one primary circuit means to store the distinct frequency detected by the receiving coil, a second circuit means operated to one condition when the first circuit means is in one condition in response to the deenergization of a second of the plurality of primary circuit means, means responsive to the operation of the second circuit means to one condition followed by its operation to its other condition operative to energize the brake applying means when the acknowledging circuit means is energized and to energize the primary circuit means irregardless of the condition of the acknowledging circuit means, an information output means operative when activated to energize a distinct information channel for a pair of detected distinct frequencies, and circuit means operative to activate the information output means when the second of the primary circuit means is deenergized for a distinct frequency of a predetermined value relative to the first deenergized primary circuit means.

9. A system according to claim 8 including circuit means operative to deenergize the brake applying means and the information output means in response to the deenergizing of more or less than two primary circuit means for a predetermined time interval greater than the first predetermined time interval.

10. A system according to claim 8 including means operative to energize the brake applying means when the acknowledging circuit means is in an inactive condition and the second of the primary circuit means is deenergized by a distinct frequency of a second predetermined value relative to the first deenergized primary circuit means, and means responsive to the said deenergization of the last named primary circuit means to render the information output means ineffective to provide a single channel of information corresponding to the pair of distinct frequencies.

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