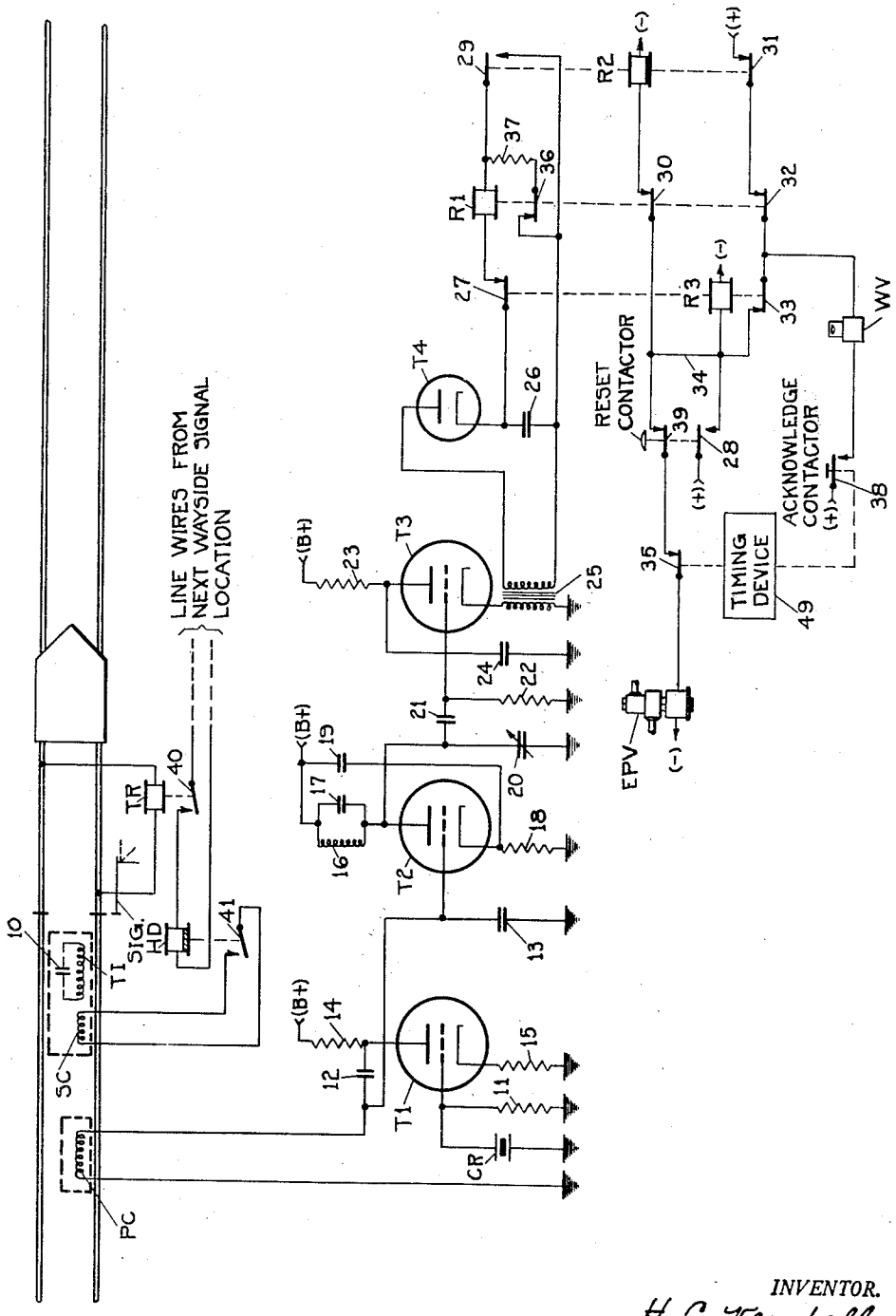
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INDUCTIVE TRAIN BRAKE CONTROL SYSTEM

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INDUCTIVE TRAIN BRAKE CONTROL SYSTEM

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This invention relates to train control systems of the intermittent inductive type.

Although wayside signalling systems for railroads have proved to be exceptionally reliable, train operation governed by wayside signals only still requires that the train crew respond to the visual indication given by the signals and act accordingly. Such reliance on the human element is considered well to be avoided in present day high speed train operation and, for this reason, it is desirable to supplement the usual wayside signalling system with an automatic train control system which is effective to exercise control over the train only in the event that the required control is not exercised by the train engineer in response to the wayside signals.

In intermittent inductive train control systems, the controlling influences are preferably transmitted inductively from the trackway to the moving vehicle through the medium of trackway inductors which are selectively made effective in response to control from the wayside signalling system. Vehicle-carried coils are also provided, and these are so positioned that they become inductively coupled with the trackway coils during train movement. The trackway inductors are usually located immediately in approach of each wayside signal location, and are controlled by the same apparatus that controls the wayside signals. Thus, the sysem may be so organized that a restrictive control is transferred to each moving vehicle just prior to its entering a new block only if the wayside signal governing the movement of trains into that block is displaying its most restrictive or stop indication. When the control transferred to the moving vehicle is a restrictive one requiring a train speed below the usual maximum value, acknowledgement of such restrictive condition is required by the engineer to forestall an automatic application of the brakes. Such acknowledgement usually comprises manual operation of a switch or contactor. This requirement of acknowledgement of restrictive controls naturally requires close observance at all times of all wayside signal indications by the train crew.

A particular advantage of this train control system is that it is substantially unaffected by the very large magnetic fields present in those regions where electromotive power is used. The undesirable effects of such strong fields upon the vehicle-carried equipment have, in the prior systems, made their use impracticable in electrified zones.

Since the speed of a train over a trackway inductor may vary considerably, the duration of the coupling effect between trackway and vehicle-carried inductors also varies over a large range, being only very momentary when train speeds reach 100 miles per hour. It is essential, however, that the inductive coupling effect be properly detected by the vehicle-carried apparatus so that the desired train control can be effective upon the train for any train speed and it is, consequently, an object of this invention to provide a circuit organization for trackway and vehicle-carried apparatus by which this requirement is met.

Described briefly and without attempting to define in detail the scope of this invention, the train control apparatus of this invention includes an electron tube oscillator which has, among its circuit components, a pick-up inductor which is mounted so that it becomes inductively coupled with the trackway inductors. This oscillator is preferably crystal controlled to provide a stable operating frequency, and the pick-up inductor is a part of the tuned load circuit for the oscillator. The alternating-current output of the oscillator is amplified, rectified, and filtered, and the resulting direct current holds a relay in a normally energized condition.

Each trackway inductor has capacitance associated with it which resonates the inductor to a selected frequency related to the oscillator frequency. The vehicle-carried apparatus is so organized that the oscillator output is affected when a tuned trackway inductor is inductively coupled to the pick-up inductor, provided that the trackway inductor is controlled to be resonated at the time of coupling to said selected frequency. The resulting change in the output of the oscillator causes the momentary release of the nomally energized relay, and this has the effect of controlling the vehicle-carried apparatus to a distinctive condition which requires acknowledgement by the engineer if an automatic brake application is to be averted.

Other objects and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference will be made to the accompanying drawing which illustrates the circuit organization of this invention.

To simplify the illustration and facilitate in the explanation, the various parts and circuits of this invention are shown diagrammatically and certain conventional illustrations have been employed. The drawing has been made to make it easy to understand the principles and manner of operation rather than to illustrate the specific construction and arrangement of parts that might be used in practice. The various relays and their contacts are illustrated in a conventional manner, and symbols are used to indicate the connections to the terminals of batteries or other sources of electrical current instead of showing all of the wiring connections to these terminals. The symbols (+) and (−), for example, indicate connections to the opposite terminals of a source of relatively low voltage suitable for the operation of various relays and the like; whereas, the symbols (B+) and the symbol for a ground connection represent connections to the positive and negative terminals respectively of a source of relatively high voltage which is required for the operation of the various electron tubes.

The embodiment of the invention illustrated in the accompanying drawing comprises a circuit organization capable of selectively providing a restrictive control upon moving vehicles. The circuit organization includes an oscillator having a pick-up coil PC which is so mounted on the vehicle that it becomes inductively coupled with each trackway inductor TI during movement of the vehicle. The trackway inductor TI is resonated by capacitance indicated by the symbol **10** for a capacitor. In practice, the distributed capacitance of the turns of the trackway inductor may be utilized to make the inductor self-resonant at the preselected frequency. The inductor TI has inductively coupled to it a disabling or shorting coil SC which is effective to selectively disable the trackway inductor TI in a manner to be described

when a restrictive control is not to be transferred to the moving vehicle.

The trackway inductor and the vehicle-carried coil may be mounted in various ways. In the drawing, the trackway inductor TI and its associated shorting or disabling coil SC are diagrammatically illustrated as being positioned in a horizontal plane on the center line of the track. Under these circumstances, the vehicle-carried receiver or pick-up coil PC is also mounted in a horizontal plane and may be mounted below the vehicle chassis so that it passes parallel to and in relatively close proximity with the trackway inductor. Experiments indicate that the vertical distance between vehicle-carried coil and trackway inductor need not be critically maintained as effective coupling is obtained even when this distance reaches approximately ten inches. An alternative manner of mounting the trackway inductors is to locate them substantially as just described with the exception that they are mounted to one side or the other of the track center line rather than on the center line. The receiver coil on each vehicle is then also shifted in position so that it passes directly over each trackway inductor. This arrangement, when used on track carrying traffic in both directions, makes it possible to use two trackway inductors at each signal location, each respectively effective to control traffic in one direction.

The electron tube oscillator included in the vehicle-carried equipment may be any of various types, but should preferably be of the crystal-controlled frequency kind so that its operating frequency will at all times bear a fixed relationship to the resonant frequency of the trackway inductors. In the particular embodiment of the invention shown in the drawing, the oscillator is a conventional tuned grid-tuned plate oscillator with the tuned grid circuit supplied by a piezoelectric crystal CR. More specifically, this oscillator comprises a tube T1 which has its control grid connected through a piezoelectric crystal CR to ground. A grid leak resistor 11 is connected from the control grid to ground, shunting the crystal CR. The tuned plate circuit for the oscillator includes the pick-up coil PC which has one terminal grounded and the other connected through a D. C. blocking capacitor 12 to the plate of tube T1. A tuning capacitor 13 is connected from the control grid of tube T2 to ground so that this capacitor 13 effectively shunts the pick-up coil PC.

Direct-current energy for the plate of tube T1 is shunt-fed from (B+) to the plate through a resistor 14. An unbypassed cathode resistor 15 provides some self bias when the tube is non-oscillating, and this shifts the tube's quiescent operating point to a region where the amplification factor is such as to facilitate the initiation of oscillation. The tuning capacitor 13 for the pick-up coil PC is of such a value that it tunes the pick-up inductor to resonance for a frequency slightly above the operating frequency of the crystal. This tuning of the resonant plate circuit causes the feedback that takes place between plate and grid circuits through the grid-to-plate interelectrode capacitance to be of the proper phase to sustain oscillations, as is well-known in the art.

The oscillator stage is followed by a tuned buffer amplifier stage including tube T2. This tube has a plate circuit which includes inductor 16 and capacitor 17 connected in parallel and resonated to the oscillator frequency. This inductor 16 and capacitor 17 are preferably chosen to have the proper characteristics so as to provide a resonant circuit which exhibits resonance characteristics for only a relatively narrow frequency range, i. e. this resonant circuit has a relatively high Q. Consequently, the oscillator output is required to be at the predetermined frequency in order that an output may be obtained from the buffer amplifier. Since the circuit organization will thus function properly only when the oscillator is operating at the correct frequency, this ensures that the oscillator will be affected when its pick-up coil PC is coupled inductively to a resonated trackway inductor.

The cathode resistor 18 for tube T2 is effectively shunted by the bypass capacitor 19 connected from the cathode of this tube T2 to the (B+) source of potential. This bypass capacitor 19 is preferably connected in this manner rather than directly in parallel with the cathode resistor 18 so that in the event it should become short-circuited, the tube would become inoperative because of the high potential applied to its cathode which would provide it with a cutoff bias. The variable capacitor 20 connected from the plate of tube T2 to ground is effectively in parallel with the tuning capacitor 17 and thus provides means for adjusting the value of this tuning capacitance so that the resonant frequency of the tuned plate circuit for tube T2 may be adjusted as required.

The output voltage from the plate of tube T2 is applied through a coupling network comprising capacitor 21 and resistor 22 to the control grid of a cathode follower amplifier comprising tube T3. The plate voltage for tube T3 is applied through a resistor 23 which limits the level of direct current through the tube. The capacitor 24 effectively bypasses resistor 23 and thereby prevents a large alternating voltage drop from appearing across this resistor. The cathode circuit of tube T3 includes the primary winding of a transformer 25, the secondary winding of which supplies an output to the diode rectifier tube T4. Tube T4 rectifies the radio-frequency output of tube T3, and the alternating-current components of the rectified output are substantially filtered out by the capacitor 26 so that a relatively smooth direct current is applied to the winding of relay R1.

As already stated, the pick-up coil PC included in the plate circuit of the oscillator tube T1 is tuned to resonate at a frequency slightly above the operating frequency of the oscillator. As a result, this tuned circuit presents an inductive reactance to the tube T1 thereby ensuring, as is well-known in the art, that the feedback required to sustain oscillation for this tube will be of the proper phase. The trackway inductor and its associated capacitance are also selected to resonate at a frequency slightly above the oscillator operating frequency. This tuned circuit, therefore, also presents an inductive reactance at the oscillator frequency.

When the receiver or pick-up coil PC on the vehicle becomes inductively coupled with the trackway inductor TI, the changing magnetic field surrounding the vehicle-carried coil induces a voltage in the trackway inductor. Since the trackway inductor TI is substantially at resonance at the frequency of this induced voltage, a relatively large current flows in the trackway inductor and its associated capacitance. Thus, a transfer of energy occurs during the coupling interval, from the vehicle-carried coil PC to the trackway inductor TI. This transfer of energy may, for convenience, be represented by a transfer of impedance to the tuned plate circuit of the oscillator. Because the trackway inductor is tuned to a frequency somewhat above the oscillator frequency, the phase relationships of the inductively coupled energy are such that the impedance coupled into the oscillator plate circuit includes capacitive reactance. As a result, the normally inductive reactance of the tuned oscillator circuit is effectively cancelled by this coupled capacitive reactance so that the positive feedback required for oscillations is no longer obtained. The oscillator thus becomes momentarily inoperative, and with no radio-frequency output supplied by the oscillator; and thus a rectified current can no longer be supplied to relay R1 so that it becomes deenergized.

When the train is operating at moderate speeds so that the pick-up and trackway inductors are inductively coupled for a relatively long time interval, the oscillator becomes momentarily inoperative as just described so that the relay R1 is allowed to deenergize. At high train speeds, however, the coupling interval is so short

that the oscillator cannot stop its oscillations. In other words, at high train speeds the mechanical inertia of the crystal CR causes it to continue its vibrations during the short coupling interval so that continued oscillations result. For this reason, the circuit organization of the vehicle-carried equipment is arranged so that another effect of the inductive coupling is utilized to provide the required control over the relay R1.

During the coupling interval, a considerable energy transfer takes place between the pick-up coil PC and the trackway inductor TI. This transfer of energy results in a momentarily lower output voltage at the plate of tube T1. This drop in output voltage may be likened to the drop in the output voltage of a generator that occurs when the load upon such a generator is suddenly increased. Or, it may be considered that the reflected impedance of the trackway tuned circuit causes such a large increase in the resistance of the oscillator tuned circuit that the oscillator output voltage is thereby reduced. The result, however, is that a relatively abrupt decrease of alternating-current voltage occurs at the control grid of the buffer amplifier tube T2, even if the oscillator does not fully stop its oscillations at such time.

When the oscillator tube T1 is operated under its normal condition, a large bias voltage is developed across the cathode biasing resistor 18 for tube T2. More specifically, the cathode biasing resistor for tube T2 is so chosen that with no signal applied to the grid of this tube T2, the quiescent current value for this tube produces a bias voltage that is near the cutoff value for the tube. Upon the application of an input signal to the grid of tube T2, the negative half-cycles of the input voltage cause the grid voltage to swing more negative so that the plate current is cut off during these negative half-cycles. The positive half-cycles of this input voltage, however, cause the grid voltage to become less negative so that the plate current increases. The increase in plate current on the positive half-cycles more than offsets the slight plate current decrease occurring on the negative half-cycles so that the average value of the plate current increases as a result of the input signal being applied to the grid. Therefore, the direct-current voltage drop across the cathode biasing resistor 18 is substantially increased. As a result, the voltage that then exists between the cathode and the base line of voltage about which the grid swings is substantially greater than the cutoff voltage for the tube. Each positive half-cycle of input voltage, however, still causes the control grid voltage to rise above the cutoff voltage so that plate current is produced to keep the bias voltage at the same level.

When the output voltage of the oscillator tube is suddenly decreased because of the coupling between the pick-up and trackway inductors, the oscillations on the grid of the buffer amplifier tube are so reduced that they do not produce plate current even on the positive peaks of this input voltage. Ordinarily, this condition would result in an immediate decrease of voltage across the cathode biasing resistor 18 so that plate current would again flow. The relatively large bypass capacitor 19 for the cathode biasing resistor 18 prevents such sudden decrease of voltage across the cathode resistor, however, so that the bias voltage is maintained at approximately the same level during this short interval in which the amplitude of oscillations is reduced. The tube T2 is thus momentarily cutoff so that no alternating voltage appears at its plate. With this cessation of alternating-current output from tube T2, the rectifying action of tube T4 ceases since no input is provided to it by the cathode follower tube T3 and, as a result, relay R1 becomes deenergized.

The releasing of relay R1 may, therefore, be considered to be effective in either of two different ways. At relatively slow speeds, such as speeds below 45 miles per hour, the oscillator is momentarily quenched because of the loading effect of the tuned trackway inductor. At these lower speeds, the decrease of oscillator output does not occur at a very fast rate so that the effect on the buffer amplifier tube T2 is merely the removal of its input caused by the quenching of the oscillator. At higher speeds, the oscillator is not fully quenched but its output decreases so rapidly in amplitude that the buffer amplifier tube is momentarily cut off in the manner described.

The relay circuit organization associated with relay R1 is, in many respects, similar to that provided for the intermittent inductive train control system shown in the Pat. No. 1,686,434 to C. S. Bushnell, dated April 16, 1925.

When all power is removed from the vehicle-carried apparatus as when the vehicle is not in operation, all of the relays included in this vehicle-carried equipment are dropped away. When power is first applied, the oscillator becomes operative but this cannot cause the energization of relay R1 because the pick-up circuit for relay R1 includes front contact 27 of relay R3 which is also now dropped away. It is necessary, therefore, that the reset contactor first be operated. The closure of back contact 28 of this reset contactor causes relay R3 to be energized so that relay R1 can then be picked up through a circuit which includes front contact 27 of relay R3 and back contact 29 of relay R2. When relay R1 is picked up, a circuit is then closed through back contact 28 of the reset contactor and front contact 30 of relay R1 to energize relay R2. With both relays R1 and R2 energized, a stick circuit for relay R3 is provided which includes front contact 31 of relay R2, front contact 32 of relay R1, and front contact 33 of relay R3. The reset contactor can then be released as relay R3 is now held energized through this stick circuit.

The stick circuit for relay R3 which has just been described also provides energy over wire 34 and through front contact 35 of the acknowledge contactor and the front contact of the reset contactor to supply energy to electro-pneumatic brake valve EPV. With electrical energy thus applied to this valve EPV, the brakes on the train are not applied except as they are controlled by the engineer. However, if for any reason energy is removed from the valve EPV, an immediate service brake application results.

The fact that the pick-up current for a relay is generally required to be greater than the value of current required to keep it picked up is well-known. Therefore, once relay R1 is picked up through back contact 29 of relay R2, a stick circuit is completed through front contact 36 of relay R1, and this stick circuit includes a resistor 37 which decreases the current through the winding of relay R1 to a value just above that required to keep this relay in its picked up condition. Consequently, only a relatively small decrease in the output obtained from the radio-frequency oscillator unit is required to cause relay R1 to drop away. Also, since relay R1 is maintained energized by a circuit including its own front contact 36, any decrease of current to the relay great enough in amplitude and of long enough duration to cause front contact 36 to open even momentarily causes complete deenergization of relay R1 so that it drops away.

When a moving vehicle equipped with the vehicle-carried apparatus shown in the drawing approaches a wayside signal location at which a stop indication is being given, the trackway inductor TI at that signal location is controlled to be resonant to a preselected frequency. The inductive coupling occurring between this trackway inductor TI and the pick-up coil PC mounted on the vehicle causes relay R1 to be deenergized in a manner which has already been described. The dropping away of relay R1 opens front contact 32 thereby opening the stick circuit for relay R3. To forestall the deenergization of relay R3, it is necessary that the acknowledge contactor be operated so as to close the normally open contact 38 and establish an alternate stick circuit through

the winding of whistle valve WV, front contact 33 of relay R3, and the winding of relay R3, to (—). This acknowledging operation also serves to keep the valve EPV energized through normally closed contacts 39 and 35 of the reset and acknowledge contactor and thus prevents an automatic brake application from taking place. If the acknowledge operation is properly made, contact 35 of the acknowledge contactor remains closed as will presently be described.

If the acknowledge contactor is not actuated prior to the dropping away of relay R1, R3 becomes deenergized and opens its front contact 33. Even though the acknowledge contactor is then subsequently actuated, energy cannot be supplied over wire 34 to keep valve EPV energized because of the open front contact 33 so that an automatic brake application occurs. Relay R3 can then again be picked up only by actuating the reset contactor which causes the normally open contact 28 to close and energize the winding of relay R3. The complete resetting operation then occurs as previously described: relays R1 and R2 pick up in order and, upon restoration of the reset contactor to its normal condition, the valve EPV is energized, thereby making it possible for the brakes to be released.

To ensure that the automatic brake application resulting from failure to acknowledge a stop indication is effective to reduce the train speed to a safe level, the circuit organization is so arranged that the resetting operation cannot be effective to energize relay R3 until the safe speed is reached. One way in which this objective is commonly carried out is to locate the reset contactor so that it is inaccessible while the train is in motion, as by mounting it on the side of the locomotive. Alternatively, a time delay mechanism may be employed which permits resetting to occur only after an interval of sufficient duration to ensure that the train speed has been reduced to a sufficiently low level by the automatic brake application. Or, a speed governor may be employed which allows resetting to occur only when the speed has reached a preselected level. With respect to the system shown in the drawing, it is assumed for purposes of illustration that the reset contactor is mounted in a position accessible to the crew only after the train is brought to a stop. In other words, as the train approaches the wayside signal location providing this stop indication, the train engineer is required to operate the acknowledge contactor as an indication of the fact that he is alert and fully aware of the presence of the restrictive signal.

Contacts 39 and 35 of the reset and acknowledge contactor respectively are included in series in the energization circuit for the valve EPV. The inclusion of these contacts in the circuit prevents the engineer from improperly operating the reset and acknowledge contactors in an attempt to circumvent the control provided by this train control system. For example, an attempt to operate the vehicle with the reset contactor continually actuated so as to prevent dropping away of the penalty relay R3 also causes normally closed contact 39 of the reset contactor to open so that the valve EPV is then deenergized and a brake application results. A somewhat similar organization is provided for the acknowledge contactor. The normal procedure requires that the acknowledge contactor be operated in response to each restrictive signal indication as already explained. Therefore, no penalty brake application resulting from the energization of the valve EPV should occur when the acknowledging contactor is operated while the train is in motion. However, it should also be impossible for the train to operate with the acknowledge contactor continuously operated with the object of preventing deenergization of the penalty relay R3. For this reason, normally closed contact 35 of the acknowledge contactor included in the circuit to the valve EPV is controlled indirectly by the acknowledge contactor mechanism through a timing device represented diagrammatically by the block 49 in the drawing. This timing device is set into operation by actuation of the acknowledge contactor and causes the normally closed contact 35 to open only if the acknowledge contactor is maintained for an excessively long time in its actuated condition. An acknowledge contactor having such a timing device is fully shown and described in Pat. No. 1,725,729, to C. S. Bushnell, dated August 20, 1929. In one embodiment of this invention, the timing device 39 was effective to open normally closed contact 35 only after the acknowledge contactor had been actuated continuously for 15 seconds, thereby allowing a sufficient time interval for actuation of this contactor to acknowledge restrictive signal indications without causing this normally closed contact to open.

Assume that a resonated trackway inductor TI causes relay R1 to drop away but that relay R3 has been maintained in its picked up condition because of prior actuation of the acknowledge contactor. As soon as front contact 32 of relay R1 opens, the current holding relay R3 energized must pass through the alternate stick circuit for relay R3, and this circuit includes the winding of the whistle valve WV, causing the whistle to blow. The opening of front contact 30 of relay R1 causes relay R2 to be deenergized, but relay R2 does not immediately drop away because of its slow release characteristics as indicated by the heavy base line for the symbol representing this relay. When relay R2 does finally drop away, its back contact 29 closes so that the pick-up circuit for relay R1 is again established with the result that relay R1 is quickly picked up. With relay R1 again picked up, front contact 30 closes so that relay R2 is once more energized and is picked up. With both relays R1 and R2 picked up, both front contacts 31 and 32 are closed so that the whistle valve WV is shunted and the whistle stops blowing. Thus, when the whistle stops blowing, this indicates to the engineer that the resonated trackway inductor has been passed and that relays R1 and R2 are restored to their normal condition; the acknowledge contactor can, therefore, be restored to its normal condition.

The trackway inductor at each signal location may be selectively controlled by the wayside signalling system in various manners. In the embodiment of the invention illustrated in the drawing, the wayside signalling system is of the type in which the control for the wayside signals is transmitted between signal locations over line wires. Track occupancy is detected in the usual manner by a track relay TR connected across the rails at the entrance end of each track section. A polar-neutral relay HD at each wayside signal location is selectively energized over line wires extending from the wayside signal location in advance, all in accordance with principles well-known in the railway signalling art. A front contact of the track relay, such as contact 40 of track relay TR, is included in the circuit to the relay HD so that this relay is deenergized when the associated track relay is dropped away. Thus, as a result of occupancy of the track section ahead, the shorting coil SC is open circuited as the result of the open front contact 41 of relay HD. The shorting coil SC has, therefore, substantially no effect upon the trackway inductor so that this trackway inductor TI and its associated capacitance 10 may then be effective upon the vehicle-carried equipment of a passing train. If, on the other hand, the track section in advance is not occupied, front contact 40 of the track relay TR is closed so that the relay HD may then be energized with one polarity or the other depending upon existing traffic conditions. The closed front contact 41 of relay HD now causes the shorting inductor to effectively detune the trackway inductor so that it is no longer resonant at the preselected frequency. As a result, the trackway inductor has substantially no inductive effect upon the vehicle-car-

ried apparatus when this inductor becomes coupled with the pick-up inductor of such vehicles.

The pick-up coil PC need comprise only a relative few turns. In one embodiment of this invention, the pick-up coil consisted of approximately 24 turns of insulated wire. Such a coil, it has been found, does not tend to have any substantial voltages induced therein even when in the presence of very strong magnetic fields such as might be present in electrified zones. Tests have shown, for example, that changing magnetic fields even up to a magnitude of 2,000 ampere turns do not tend to affect the oscillator so as to cause the dropping away of the relay R1.

Having described an intermittent inductive train control system as one specific embodiment of this invention, it should be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume. It is to be further understood that various modifications, adaptations, and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the invention.

What I claim is:

1. An intermittent inductive train control system comprising, a trackway inductor adapted to be selectively resonated according to traffic conditions, vehicle-carried apparatus including a pick-up coil mounted so as to pass through an inductive relationship with said trackway inductor during motion of said vehicle, an oscillator associated with said pick-up coil and operating at a predetermined frequency, said trackway inductor when resonated at a frequency related to said predetermined frequency of said oscillator inductively affecting said pick-up coil, the inductive effect of said trackway inductor upon said pick-up coil when said vehicle is moving at high speed being effective to cause a rapid decrease in amplitude of the output of said oscillator, an electron tube having a cathode biasing resistor to provide near cutoff bias for said tube, means for applying the output of said oscillator as an input to the control grid of said tube, said input causing the direct-current voltage drop across said biasing resistor to increase substantially beyond the cutoff level of bias for said tube, a bypass capacitor for said resistor to maintain the voltage across said resistor substantially constant when the output of said alternating-current source is momentarily rapidly reduced by the inductive effect of said trackway inductor when resonated, relay circuit means held normally energized by the alternating-current output of said electron tube, electromechanical train controlling means held inactive by the energized condition of said relay circuit means, the reduction in amplitude of the output of said oscillator being effective to momentarily cut off the plate current of said tube to thereby deenergize said relay circuit means, whereby said controlling means is selectively made effective according to existing traffic conditions.

2. In an intermittent inductive train control system, vehicle-carried apparatus comprising crystal-controlled electron tube oscillator operating at a preselected frequency, a trackway inductor selectively resonated to a frequency slightly above said preselected frequency, said oscillator including a resonant plate circuit having a pick-up coil positioned so as to couple inductively with said trackway inductor during movement of said vehicle, an amplifier tube having the output of said oscillator applied thereto, relay circuit means held normally energized dependent upon the output of said amplifier tube, a cathode biasing resistor for said amplifier tube effective to provide a no-signal bias near cutoff, a bypass capacitor for said biasing resistor, circuit means for applying the output of said oscillator to said amplifier tube to thereby produce a voltage drop across said biasing resistor greater than the cutoff grid-cathode voltage for said tube, said capacitor chosen to have a sufficient capacitance to maintain the voltage drop across said biasing resistor at substantially the same level when the input to said amplifier is suddenly reduced in amplitude, whereby for short coupling intervals between said pick-up coil and trackway inductor the decrease in output of said oscillator causes said amplifier tube to be momentarily cut off.

3. An intermittent inductive train control system comprising, a trackway inductor selectively resonated to a predetermined frequency, vehicle-carried equipment including an electron tube oscillator, a pick-up coil associated with said oscillator and positioned so as to couple inductively with said trackway inductor during movement of said train, said vehicle-carried equipment also including, an electromagnetic relay, a pick-up circuit for said relay effective when said relay is dropped away to apply energy governed by said oscillator to the winding of said relay, circuit means governed by the picking up of said relay to open said pick-up circuit, a stick circuit for said relay including a resistor in series with the winding of said relay to decrease the current through said relay to a value slightly above that required to maintain said relay in its energized condition, train controlling circuit means controlled to become effective by the dropping away of said relay, whereby the inductive coupling between said resonated trackway inductor and said pick-up coil reduces the output of said oscillator and causes the dropping away of said relay to thereby make said train controlling circuit means effective.

4. In an intermittent inductive train control system, an inert trackway inductor being selectively resonated to a predetermined frequency in accordance with traffic conditions, vehicle-carried equipment including an electronic oscillator providing electrical oscillations at a frequency related to the resonant frequency of said trackway inductor, a pick-up coil associated with said oscillator and positioned so as to couple inductively with said trackway inductor during train movement, amplifier means including resonant circuit means tuned to the frequency of said oscillations for amplifying the output of said oscillator, relay circuit means including an electromagnetic relay being normally maintained energized by the output of said amplifier means, said tuned circuit in said amplifier means permitting the normal energization of said relay only when said oscillator is providing electrical oscillations at the predetermined frequency properly related to the frequency of resonance of said inert trackway coil, the loading effect of said inert trackway inductor upon said vehicle-carried receiver when said trackway inductor is controlled to its resonant condition and when said inductor and receiver are coupled inductively affecting the output of said oscillator and causing the deenergization of said relay circuit means, train controlling means governed by said relay circuit means, whereby the inductive coupling between said inert inductor when resonated and said pick-up coil causes said train controlling means to become effective.

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