Nov. 7, 1939. W. P. PLACE ET AL 2,178,806

RAILWAY SIGNALING APPARATUS

Filed Jan. 22, 1936 2 Sheets-Sheet 1

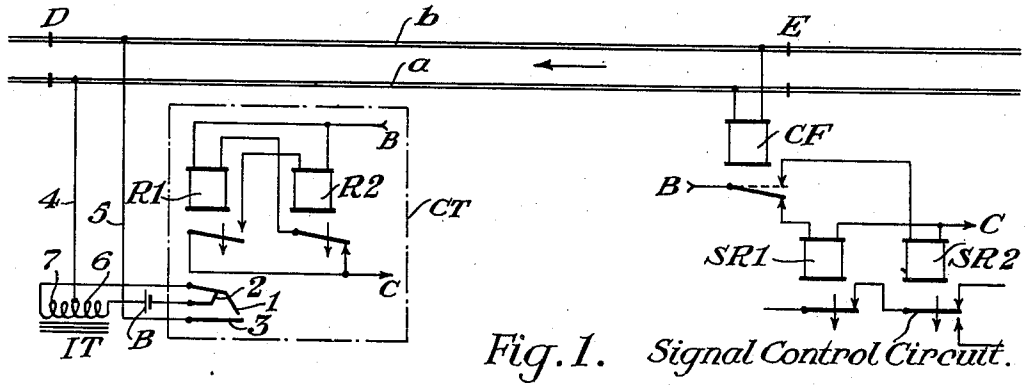


Fig. 1. Signal Control Circuit.

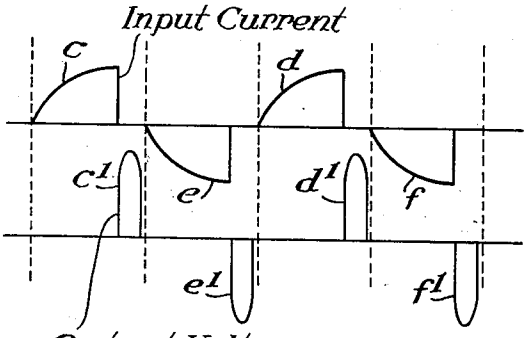


Fig. 2.

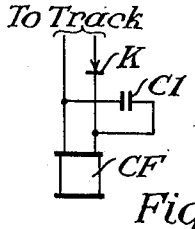


Fig. 3.

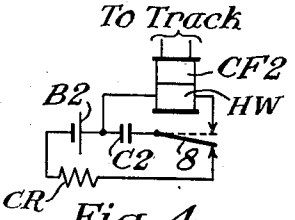


Fig. 4.

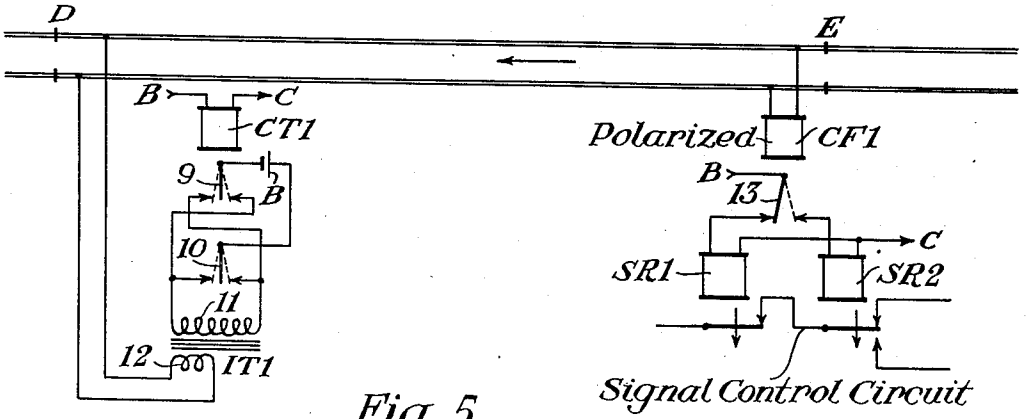


Fig. 5.

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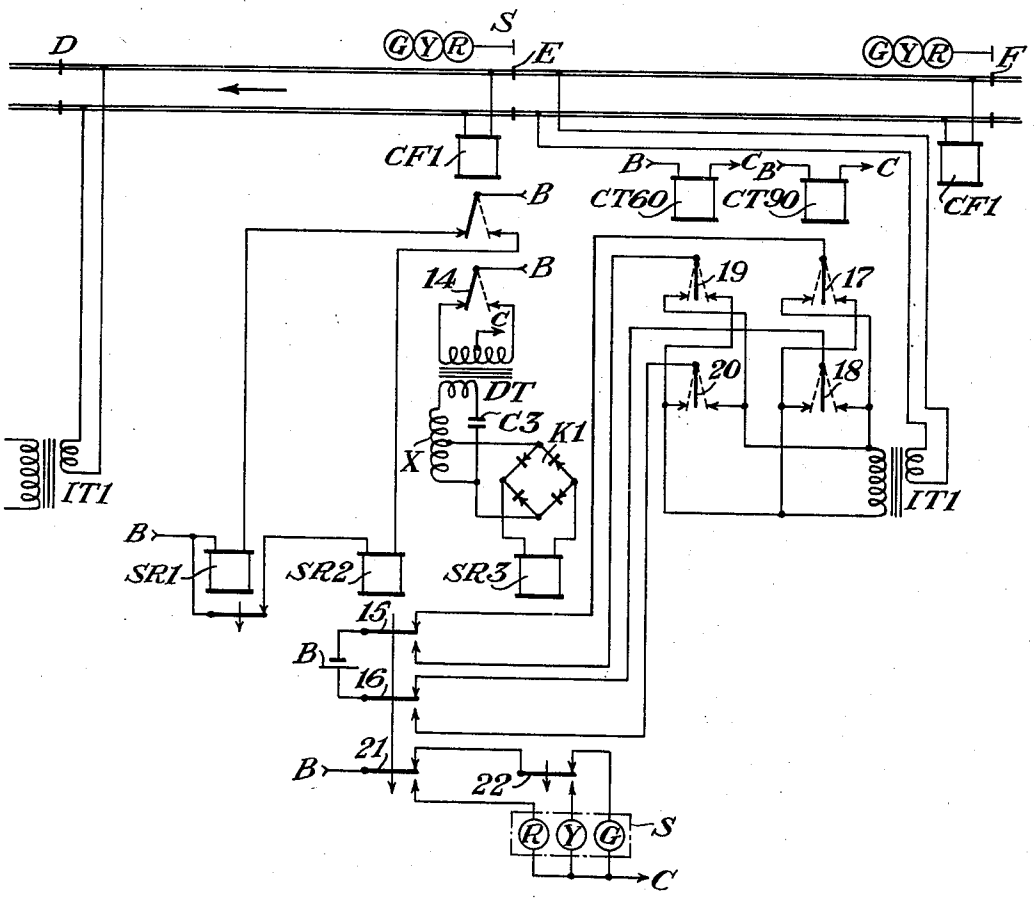


Fig. 6.

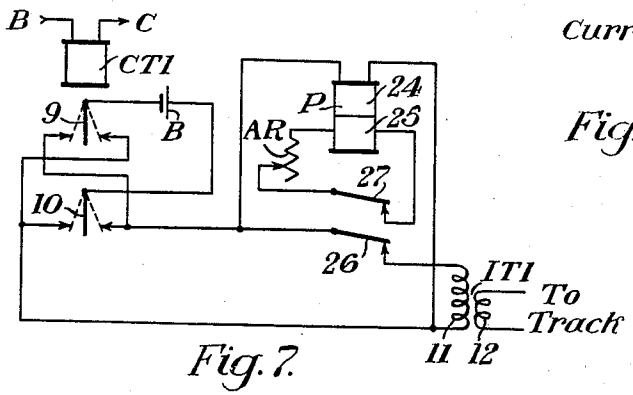


Fig. 7.

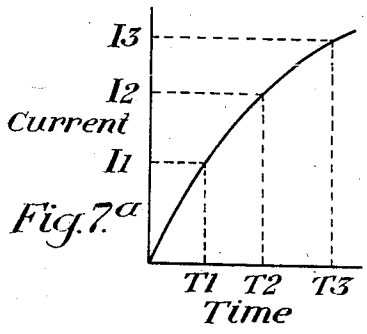


Fig. 7a

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RAILWAY SIGNALING APPARATUS

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Application January 22, 1936, Serial No. 60,240

20 Claims. (Cl. 246—34)

Our invention relates to railway signaling apparatus and more specifically to apparatus of this character in which periodically interrupted or coded current is supplied to the track circuit for controlling wayside and/or cab signaling apparatus.

One object of our invention is to improve the shunting sensitivity of a track circuit. Another object is to decrease the track circuit power input and to maintain this input substantially uniform irrespective of weather conditions. Other objects and advantages will become clear as the description progresses.

We will describe several forms of apparatus embodying our invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of apparatus embodying our invention. Fig. 2 is a diagram showing the shape of the input current and output voltage waves in the track circuit input apparatus embodying our invention. Figs. 3 and 4 are diagrammatic views showing modified forms of a portion of the apparatus of Fig. 1. Figs. 5 and 6 are diagrammatic views showing modified forms of the apparatus shown in Fig. 1, and also embodying our invention. Fig. 7 is a diagrammatic view showing a modified form of a portion of the apparatus shown in Figs. 5 and 6. Fig. 7^a is a current curve for the apparatus of Fig. 7.

Similar reference characters refer to similar parts in each of the several views.

In attempting to obtain satisfactory shunting of the track by light weight rail cars or by cars of standard weight on stretches of track not frequently used, it has been found that track circuits of the usual type cannot be reliably shunted by such vehicles because of the presence of a thin coating or film of relatively high resistance frequently present on the rail surface. The voltages usually employed in track circuit work are ordinarily insufficient to puncture this film. If higher voltages are employed, then the track circuit power input tends to become excessive and other disadvantages are also introduced. Our invention is directed to the provision of apparatus by means of which track voltages of sufficient value to insure reliable track shunting may be used without at the same time rendering the power required for operating the track circuit excessive.

Referring to Fig. 1, we have shown a section of railway track D—E in which traffic moves from right to left as indicated by the arrow. The apparatus designated by the reference character CT within the dotted rectangle at the left-hand end of Fig. 1 is conveniently termed a code transmitter and comprises a pair of slow-acting relays R1 and R2 which are energized from a suitable source of current having the terminals B—C. Relay R1 controls the energization of relay R2 over a front contact, and relay R2 controls the energization of relay R1 over a back contact in a manner which will be obvious from the drawings. Consequently, as long as current continues to be supplied from the source B—C, relays R1 and R2 will continue to operate at a rate which is determined by the retardation period of these two relays. In this manner, intermittent or coding operation of contact finger 3 of relay R1 is obtained. Obviously, the relays R1 and R2 can be replaced by any suitable type of code transmitter, the essential requirement being that contact finger 3 operate periodically at the desired rate. This rate can, for purposes of illustration, be assumed to be of the order of 60 operations per minute.

The reference character IT designates an input transformer or reactor, the full winding 6 of which is periodically energized from a suitable source of current which may be a battery B, by means of a circuit which will be clear from the drawing and which includes the back contact 1—2 of relay R1. A portion of the winding of transformer IT is connected to the track rails by means of wires 4 and 5, contact 3—1 being included in the rail circuit, as will also be clear from the drawing. Each time that contact 1—2 becomes closed, energy is stored in the magnetic circuit of the transformer IT, and each time contact 1—2 is opened, the magnetic energy rapidly collapses and causes the transmission of a relatively short impulse of relatively high peak voltage from winding 7 of transformer IT to the track rails.

Referring for the moment to Fig. 2, it will be seen that the input current to the full winding 6, which current establishes the flux in the core of transformer IT, builds up along curves such as c and d, in the usual manner. As soon as contact 1—2 opens, the sudden decrease in the input current causes a very rapid decay of flux in the core, thus inducing the relatively high output voltage impulses which may be represented by the curves c^1 and d^1 shown in the lower diagram of Fig. 2. (The curves e, f, and e^1, f^1 will be referred to later for illustrating voltage and current conditions in the apparatus of Figs. 5 and 6, and are not involved in the operation of the apparatus of Fig. 1.)

Referring again to Fig. 1, it will be noted that the contacts operated by contact finger 3 of relay R1 are of the so-called "continuity transfer" type. That is, front contact 1—3 closes before back contact 1—2 opens. The reason for this is to insure that the output circuit to the track rails will be closed before any discharge from the transformer IT takes place, thus insuring that the full effect of the output voltage is obtained in the track circuit. Since the initial decay of the flux in transformer IT takes place at a very rapid rate and consequently, the high output voltage peak appears almost instantly, the full benefit of this peak cannot be obtained if the connections to the track are made at some later instant, after the input circuit to the transformer is opened. However, if the full peak voltage output is not necessary, the continuity transfer feature of the contacts 1—2 and 1—3 can be dispensed with.

The apparatus is preferably so designed with respect to the time constant of the circuit which includes the input winding of transformer IT that the current to winding 6 supplied from battery B requires about one second to reach its maximum value. Obviously, this time can be varied widely by suitable proportioning of the apparatus and is used here for illustrative purposes only, in order to provide a more clear understanding of the invention.

The operation of the apparatus so far described is as follows. When relay R1 releases after a completed operation, the circuit through the battery B and the coil 6 becomes closed. The current through this coil gradually increases until at the end of the release period of relay R2 it will have just reached its maximum value. When relay R2 releases, relay R1 is immediately picked up over the back contact of relay R2 and relay R1 now operate the contact finger 3, first closing the circuit from the coil 6 to the track and immediately thereafter opening the battery circuit so that the electrical energy stored in the transformer during the previous second becomes discharged into the track. Meanwhile, relay R2 again becomes energized, releasing relay R1 which opens the circuit to the track and again closes the battery circuit to resume the charging of the transformer for the next impulse.

The track relay CF at the right-hand end of the track section is of the code-following type and is capable of responding to very short impulses of current. Relay CF controls a pair of slow-acting relays SR1 and SR2 which check the operation of relay CF and which may be used to control wayside signals or any other suitable signaling apparatus. Relay SR1 is energized over a back contact of relay CF, and relay SR2 is energized over a front contact of this relay. With this arrangement, if relay CF should fail in either position, one of the relays SR1 or SR2 will be released so that a restrictive indication may be obtained at the signal location.

Referring now to Fig 3, this figure shows apparatus for aiding relay CF to pick up on current impulses of relatively short duration. This apparatus comprises a condenser C1 connected across the relay winding and a rectifier K connected in series with this winding. In operation, the condenser becomes charged quickly, but the inductance of the relay winding prevents a rapid increase of current in this winding. When the impulse passes, the charged condenser continues to apply voltage to the winding and thus allows more time for the current to build up sufficiently to pick up the relay. The rectifier prevents a discharge of the condenser through the track.

Referring to Fig. 4, this figure shows apparatus by means of which relay CF2 can be maintained in its energized position for a longer period of time to prevent a premature release of this relay. Due to the shortness of the impulse, unless special provision is made, the usual code-following relay closes its front contacts for an instant only, and during the remainder of the time the back contacts remain closed. In the modified arrangement shown in Fig. 4, the relay CF2 is of the double-wound type, having the usual operating winding and also a holding winding HW. When relay CF2 is released, the contact finger 8 closes a circuit through an auxiliary battery B2, a charging resistor CR, and a condenser C2 of large capacity, thus causing this condenser to become charged. When the track current impulse flows through the operating winding of the relay for causing the relay to pick up, contact finger 8 closes a circuit through the auxiliary or holding winding HW and the condenser C2 in series. The electrical energy stored in condenser C2 will now flow through the winding HW, causing the relay to remain energized for a period of time longer than the duration of a signal impulse, thus preventing a premature release of the relay. If the code is fast, the back contact is closed for a short time only. Consequently, the condenser C2 acquires only a small charge and winding HW is able to hold the relay picked up for only a short time. On the other hand, if the code is slow, condenser C2 acquires a greater charge and winding HW is effective to hold the relay picked up for a correspondingly longer time. By properly proportioning the parts, the time during which the front contacts of relay CF2 remain closed can be made approximately equal to the time during which the back contacts of this relay are closed, for any suitable range of frequencies of the impulses which the code transmitter CT of Fig. 1 may be called upon to supply.

Referring now to Fig. 5, the track input apparatus shown in the left-hand portion of this figure includes a code transmitter CT1 of any suitable type, here shown in the form of a relay, for simplicity. The code transmitter CT1 has two contact fingers 9 and 10 which operate in such a way as to close the right-hand contacts for about one-half second and to close the left-hand contacts for about the same length of time. It will be understood that these particular time values are used for purposes of illustration only. The code transmitter CT1 may, of course, comprise a pair of relays as in Fig. 1 or it may be of the oscillating pendulum type or of the motor driven type if desired. When the contact fingers 9 and 10 pass through their middle position, both right and left-hand contacts remain open for a short period of time. These contacts are included in a circuit with a battery B and the input winding 11 of an input transformer IT1 in such a manner that current flows from the battery B through the winding 11 in one direction when the right-hand contacts are closed and in the reverse direction when the left-hand contacts are closed. The output winding 12 of the transformer IT1 is connected directly across the track rails. Obviously, the transformer IT1 may be of the autotransformer type if desired.

Since the current flow in winding 11 is periodically reversed, it follows that the impulses induced in winding 12 which are transmitted to

the track are also periodically reversed. The general shape of the input current and output voltage curves for the apparatus of Fig. 5 is indicated diagrammatically in the curves *c, e, d, f,* and c^1, e^1, d^1, f^1, respectively, of Fig. 2.

Since the input apparatus of Fig. 5 supplies polarized impulses to the track, the code-following track relay CF1 at the other end of the section may be of the polarized type as shown. This relay is preferably of the "last position" type, that is to say, it is designed to remain in the last operated position until a reverse impulse is received. It will be seen that in response to the output voltage impulses indicated in Fig. 2, relay CF1 will operate its contact finger 13 alternatively to the left and to the right, thus keeping its left-hand contact closed during substantially one-half of the time and keeping the right-hand contact closed during the remainder of the time. The slow-acting relays SR1 and SR2 are energized alternately from a suitable source having the terminals B—C, through the left-hand and right-hand contacts, respectively, of relay CF1. These two relays may be used for the control of signals or any other suitable apparatus, in the same manner as the corresponding relays of Fig. 1. The track relay CF1 need not be of the polarized type, as a neutral code-following track relay may be used for controlling the two relays SR1 and SR2.

Referring now to Fig. 6, we have shown in this figure how the equipment of Fig. 1 or Fig. 5 can be expanded into a system of coded wayside signaling. The track input apparatus of this figure includes a pair of suitable coding mechanisms or code transmitters CT60 and CT90 which operate their respective contacts at the rate of 60 and 90 operations per minute, respectively. If preferred, a single code transmitter having two sets of contacts operating at the proper rates may be used. These two code transmitters are shown as being constantly energized although they may be suitably approach energized, if desired. Depending upon traffic conditions in the advance section D—E as reflected in the operation of the code-following track relay CF1, one or the other code transmitter will be effective to supply current to the rear section E—F.

Relays SR1 and SR2 check the code-following response of relay CF1, as in Figs. 1 and 5, with the difference that in Fig. 6, relay SR2 is controlled over a front contact of relay SR1, in addition to being controlled over a contact of the track relay CF1. Therefore, relay SR2 will not remain energized should relay CF1 stick in its right-hand position due to some mechanical or other fault, but will remain energized only if relay CF1 is actually following code. The retardation period of relays SR1 and SR2 is such that relay SR2 will remain energized when relay CF1 is following either one or the other code, that is, either 60 or 90 code. When relay SR2 is energized, showing that section D—E is unoccupied, current is supplied from battery B to the input winding of transformer IT1 over the front points of contacts 15 and 16 of relay SR2, and the contacts 17 and 18 of code transmitter CT90. This supply circuit need not be traced in detail as it is obvious from the drawings. As a result, section E—F is supplied with current impulses of 90 code. If the forward section D—E is occupied, so that track relay CF1 is not operating and relay SR2 is released, then current impulses of 60 code will be supplied to the rear section over the back points of contacts 15 and 16 of relay SR2, and the contacts 19 and 20 of code transmitter CT60.

In order to provide the necessary selection of the indications of wayside signal S, we make use of the auxiliary relay SR3 which is operated through a tuned circuit so designed that this relay will receive sufficient pickup energy when relay CF1 is following 90 code, but will receive insufficient energy for pickup when relay CF1 is following either 60 code or remains deenergized. The tuned circuit involving decoding transformer DT, reactor X, tuning condenser C3, and rectifier K1 is well-known and need not be described in detail. This tuned circuit forms no part of our invention and it will be sufficient for present purposes to state that contact 14 of relay CF1 periodically reverses the flux in the core of transformer DT, thus inducing an A. C. output of the same frequency as that at which contact 14 operates. The output circuit of transformer DT is selectively tuned for a relatively large output at a frequency of 90 cycles per minute but only a small output at a frequency of 60 cycles per minute. It will be apparent, in view of the foregoing, that if section D—E is receiving 90 code, relay SR3 will be energized in addition to relay SR2 so that the green unit of signal S will be illuminated over the front point of contact 21 of relay SR2 and the front point of contact 22 of relay SR3. On the other hand, if section D—E is receiving 60 code, relay SR3 will be deenergized and the yellow unit of this signal will be illuminated over the front point of contact 21 and the back point of contact 22. If section D—E is occupied, the red unit of the signal will be illuminated over the back point of contact 21. If additional signal indications are desired for indicating the condition of traffic in several sections in advance, such indications can readily be obtained by increasing the number of codes used and providing additional relays similar to SR3 for decoding the added codes. In such event, of course, the particular code which is supplied to a rear section will be selected not only by the relay SR2 but also by the decoding relays of the SR3 type.

It will be understood that the two codes which we have used are illustrative only and are capable of being varied through a wide range, being determined with reference to a large number of factors which it is deemed unnecessary to enumerate here and which are well-known to those skilled in the art.

Referring now to Fig. 7, the apparatus of this figure provides means for regulating the amount of power which is supplied to the rails of the track in the systems illustrated in Figs. 5 and 6. In order to economize the track battery output, it is desirable to control the power input to the track so that this input will not be greater than that which is required for satisfactory operation of the track circuit. Where the track circuits are long, especially if the ballast conditions are poor, a greater track circuit input is required than if the impulse apparatus is used in conjunction with short track circuits having favorable ballast resistance. The usual expedient of using a limiting resistor in series with the battery is undesirable because of battery current wastage.

In Fig. 7, the power input to the track is controlled by a double-wound relay P having an operating winding 24 and a retarding winding 25. The retardation of winding 25 is controlled by means of an adjustable resistor AR.

When contacts 9 and 10 of the code transmitter CT1 become closed, current starts to flow through winding 11 of the input transformer IT1

having the back contact 26 of relay P in series therewith. This current increases with time, as indicated in the curve of Fig. 7a, until relay P picks up and opens contact 26. If contact 26 opens at time T2, for example, the energy of the impulse which is applied to the track is proportional to $(I2)^2$. This amount of energy may be taken to represent the amount required for average track conditions. If the track section is unusually long or the ballast is poor, or both, then an impulse of greater energy is required. To increase the energy of the impulse, it is only necessary to delay the pickup of relay P by adjusting the resistor AR so as to decrease the resistance in series with the retarding winding 25. This allows winding 11 of the input transformer to remain connected for a time T3 so that the current now builds up to a value I3. For short blocks or those in which ballast conditions are favorable, the pickup time of relay P can be adjusted to T1, with a correspondingly small current I in the winding 11.

The apparatus of Fig. 7 not only permits an adjustment of track energy which compensates for different track circuit conditions but also automatically compensates to a large degree for changes in voltage of the source *B*. For example, when the battery voltage falls below normal the input transformer will charge more slowly but the relay P will pick up more slowly also, thus tending to maintain the energy of the impulse at the desired level. Conversely, should the voltage of the source increase, the input transformer will charge more quickly, but the pickup of relay P will also be correspondingly accelerated, so that the track input tends to remain at a constant level irrespective of voltage fluctuations at the source. If the source is a primary battery, such a battery can be permitted to become more completely exhausted before renewal than is possible with track circuits of the usual type because, with the apparatus of Fig. 7, a satisfactory track input can be maintained at a lower battery voltage.

When the code transmitter contacts 9 and 10 close at such time as contact 26 of relay P is closed, current is supplied to winding 11 until relay P picks up. As soon as relay P picks up, the current to winding 11 is interrupted until contacts 9 and 10 open, releasing relay P, and close subsequently to repeat the above cycle of operation. Thus, it will be apparent that the contacts 9 and 10 determine only the timing of the track impulses, but the energy of these impulses is determined by the amount of delay in the pickup of relay P, as determined by the adjustment of the resistor AR. Consequently, when proper adjustment is once made, the track energy level will remain at the desired value within limits, regardless of the code frequency at which contacts 9 and 10 are operated.

We have shown a back contact 27 included in the retarding circuit for relay P, which contact aids to make the relay quick releasing. The use of this contact is optional, however, and if desired, the retarding winding 25 can be short-circuited directly through the resistor AR.

From the foregoing description of Fig. 7, it will be obvious that we have provided apparatus for controlling the energy of the track current impulses whereby the output of the track current source is economized and a substantially constant track input is maintained irrespective of the rate at which the code impulses are supplied to the track.

Although we have shown the apparatus embodying our invention as being applied to the control of wayside signaling apparatus only, it will be apparent that locomotive-carried apparatus can similarly be controlled. That is, the track current impulses can be picked up inductively, or in any other suitable and well-known manner, for operating a locomotive-carried relay similar to the code-following relay CF, by means of such impulses.

The foregoing description makes it apparent that we have provided apparatus which applies a succession of relatively short impulses of sufficiently high peak voltage to aid in breaking down the resistance film on the rail surface, thus making it possible for light weight rail cars to shunt a track circuit, and improving the shunting sensitivity, in general, for all rail vehicles. Furthermore, since the current flow to the track circuit in our system is intermittent in character, the track circuit power is substantially decreased over that which is ordinarily required. Since no current-limiting resistors or reactors are necessary, all of the power taken from the track battery is available for being discharged into the track itself. Another advantage is that with our system peak voltages of 30 volts or more, for example, can be transmitted to the track from a two-volt track battery.

It will be clear that the apparatus embodying our invention, as shown in Figs. 1 and 5, for example, can be carried on a rail vehicle to provide improved shunting effectiveness for such vehicles. For example, the output of the transformer IT, which transformer is now carried on the car, can be applied to the track by means of rail brushes or other suitable contacting devices, thus aiding to break down the rail film resistance to improve the usual wheel and axle shunt, or to render an auxiliary car-carried shunt more effective. In order to check that the peak voltage impulses actually pass to the rails, a suitable car-carried indicating relay, energized by these impulses through a suitable receiving circuit, can be provided. When the peak voltage impulses are applied from aboard a car, the track relay in the wayside must be of such character as to be immune to such impulses, in order to prevent the possibility of false energization thereof when a car equipped with the peak voltage apparatus occupies the section.

Although we have herein shown and described only a few forms of apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. In combination with a section of railway track, a source of unidirectional current, a transformer having an input circuit normally receiving energy from said source and having an output circuit including the rails of said track, and means for periodically closing said output circuit and for simultaneously interrupting said input circuit whereby a relatively high peak voltage is induced in said output circuit and is applied across the rails of said track section.

2. In combination with a section of railway track, a transformer, a source of unidirectional current, a coding device having a front and a back contact, an input circuit for said transformer including said source and the back contact of said coding device, and an output circuit

for said transformer including the rails of said section and the front contact of said coding device.

3. In combination with a section of railway track, a transformer, a source of unidirectional current, a coding device having a first and a second contact so arranged that said first contact closes before said second contact opens, an input circuit for said transformer including said source and said second contact, and an output circuit for said transformer including the rails of said section and said first contact.

4. In combination with a section of railway track, a transformer having a magnetizable core, means including a source of direct current for supplying a magnetization to the core of said transformer, means for intermittently interrupting said magnetization to induce a relatively high peak voltage in the output winding of said transformer, and a circuit for applying said peak voltage across the rails of said section for energizing said track section when the section is unoccupied and for breaking down the rail film resistance as an aid to shunting when the section is occupied.

5. In combination with a section of railway track, a transformer having a normally closed input circuit including the full winding of the transformer as well as a source of direct current and having a normally open output circuit including a portion only of said transformer winding as well as the rails of said section, and means for periodically closing said output circuit and for interrupting said input circuit at such time as said output circuit is closed.

6. In combination with a section of railway track, a transformer, means including a source of unidirectional current for supplying a magnetization to the core of said transformer, means for periodically interrupting said magnetization at a rate determined in accordance with a predetermined code frequency to induce voltage impulses of relatively high peak value in the output winding of said transformer, a circuit for applying said voltage impulses across the rails of said section, a track relay for said section capable of following said voltage impulses, and signaling apparatus controlled by said track relay and selectively responsive in accordance with the code frequency of the voltage impulses received by said track relay.

7. In combination with a section of railway track, a transformer, a source of unidirectional current, a circuit including the output winding of said transformer and the rails of said section, means for supplying periodically reversed current from said source to the input winding of said transformer whereby periodically reversed voltage impulses of relatively high peak value are induced in said circuit, and a polarized code-following track relay for said section responsive to said voltage impulses.

8. In combination with a section of railway track, a transformer, means including a source of unidirectional current for supplying a magnetization to the core of said transformer, means for periodically interrupting said magnetization at a rate determined in accordance with traffic conditions in advance of said section to induce voltage impulses of relatively high peak value in the output winding of said transformer, a circuit for applying said voltage impulses across the rails of said section, a code-following track relay for said section capable of following said voltage impulses, decoding apparatus controlled by said track relay, and a signal controlled by said decoding apparatus.

9. In combination with a section of railway track, a transformer having a primary and a secondary winding, a source of direct current, a polarized code-following track relay for said section, a first slow-acting relay energized over a normal contact of said track relay, a second slow-acting relay energized over a reverse contact of said track relay as well as over a front contact of said first slow-acting relay, a first coding contact operating at a given rate, a second coding contact operating at a different rate, means for supplying periodically reversed current from said source to said primary winding over said first or said second coding contact according as said second slow-acting relay is energized or de-energized respectively whereby periodically reversed voltage impulses of relatively high peak value are induced in said secondary winding, and a circuit connecting said secondary winding with the rails of said section.

10. In combination with a section of railway track, a transformer, a source of direct current, an input circuit for said transformer including said source, a plurality of periodically operating contacts for rapidly varying the energization of said input circuit to thereby induce a relatively high peak voltage in said transformer, means for selectively including one or another of said contacts in said input circuit, an output circuit for said transformer including the rails of said section, and a track relay operatively energized by the output from said transformer.

11. In combination with a section of railway track, a transformer, a source of direct current, an input circuit for said transformer including said source, means for periodically interrupting said input circuit to induce a relatively high peak voltage in the output winding of said transformer, means for controlling said input circuit by traffic conditions in advance of said section, a circuit connecting the output winding of said transformer with the rails of said section, whereby said peak voltage is effective to break down the rail film resistance as an aid to shunting, and a track relay operatively energized by the output from said transformer.

12. In combination with a section of railway track, a transformer, a code-following relay, a circuit including a contact of said code-following relay for supplying coded direct current to the input winding of said transformer whereby voltage impulses of relatively high peak value are induced in the output winding of the transformer, means for applying said voltage impulses to the track, means for supplying coded current from said circuit for operating said code-following relay, and retarding means for said relay for controlling the length of time during which a code impulse is supplied to said transformer thereby to control the energy of said induced voltage impulses.

13. In combination with a section of railway track, a transformer, a code-following relay, a circuit including a contact of said code-following relay for supplying coded direct current to the input winding of said transformer whereby voltage impulses of relatively high peak value are induced in the output winding of the transformer, means for applying said voltage impulses to the track, means for supplying coded current from said circuit for operating said code-following relay, retarding means for said relay for controlling the length of time during which a code impulse is supplied to said transformer, and means for varying the effectiveness of said retarding means

to thereby vary the energy of said induced voltage impulses.

14. In combination with a section of railway track, a transformer, a code-following relay, a circuit including a back contact of said relay for supplying coded direct current to the input winding of said transformer whereby voltage impulses of relatively high peak value are induced in the output winding of the transformer, means for applying said voltage impulses to the track, means exclusive of said contact for energizing said code-following relay from said circuit, and means including a retarding winding and an adjustable resistor for varying the pickup time of said code-following relay to thereby vary the energy of said voltage impulses.

15. In combination with a track transformer, a source of coded direct current, a code-following relay energized from said source, means including a contact of said code-following relay for energizing said transformer from said source of coded current to induce voltage impulses of relatively high peak value in the output winding of said transformer, and retarding means for said relay for controlling the length of time during which a code impulse is supplied to said transformer thereby to control the energy of said induced voltage impulses.

16. In combination with a track transformer, a source of coded direct current, a code-following relay energized from said source, means including a front contact of said code-following relay for energizing said transformer from said source of coded current to induce voltage impulses of relatively high peak value in the output winding of said transformer, retarding means for said relay for controlling the length of time during which a code impulse is supplied to said transformer, and means for varying the effectiveness of said retarding means to thereby vary the energy of said induced voltage impulses.

17. In combination with a section of railway track having a shunting condition of abnormal difficulty due to the presence of a rail film such that the mechanical effect of the vehicle passing thereover is of itself inadequate to produce effective shunting of the usual values of track circuit voltage, an energy storing device, a source of unidirectional current, means including said source for causing energy to be stored in said device and for intermittently causing a rapid discharge of said energy, the rate of discharge of said energy being sufficiently rapid to induce a peak voltage impulse of sufficient intensity to break down the rail film under said abnormal shunting condition, said peak voltage extending over only a small fraction of the discharge cycle whereby notwithstanding the high voltage the track circuit power is conserved due to the short duration of said peak voltage, and means for applying said peak voltage discharge from said device to the rails of said section.

18. Apparatus for improving the shunting of a railway track circuit having a track relay receiving energy therefrom comprising, in combination with a section of railway track including the rails of said track circuit, said section of track having a shunting condition of abnormal difficulty due to the presence of a rail film such that the mechanical effect of the vehicle passing thereover is of itself inadequate to produce effective shunting at the usual values of track circuit voltage, means for periodically applying across the rails of said section a peak voltage impulse of sufficient intensity to break down the rail film under said abnormal shunting condition to thereby shunt said track relay when the section is occupied, said peak voltage extending over only a small fraction of the time between said periodic applications whereby notwithstanding the high voltage the track circuit power is conserved due to the short duration of said peak voltage impulses.

19. Apparatus for improving the shunting of a railway track circuit having a track relay receiving energy therefrom comprising, in combination with a section of railway track including the rails of said track circuit, said section of track having a shunting condition of abnormal difficulty due to the presence of a rail film such that the mechanical effect of the vehicle passing thereover is of itself inadequate to produce effective shunting at the usual values of track circuit voltage, a transformer, and means including said transformer for intermittently applying across the rails of said section a peak voltage impulse of sufficient intensity to break down the rail film under said abnormal shunting condition to thereby shunt said track relay when the section is occupied, said peak voltage extending over only a small fraction of the time between said intermittent applications whereby notwithstanding the high voltage the track circuit power is conserved due to the short duration of said peak voltage impulses.

20. Apparatus for improving the shunting of a railway track circuit having a track relay receiving energy therefrom comprising, in combination with a section of railway track including the rails of said track circuit, said section of track having a shunting condition of abnormal difficulty due to the presence of a rail film such that the mechanical effect of the vehicle passing thereover is of itself inadequate to produce effective shunting at the usual values of track circuit voltage, a reactance device, and means including said reactance device for intermittently applying across the rails of said section a peak voltage impulse of sufficient intensity to break down the rail film under said abnormal shunting condition to thereby shunt said track relay when the section is occupied, said peak voltage extending over only a small fraction of the time between said intermittent applications whereby notwithstanding the high voltage of the track circuit power is conserved due to the short duration of said peak voltage impulses.

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