

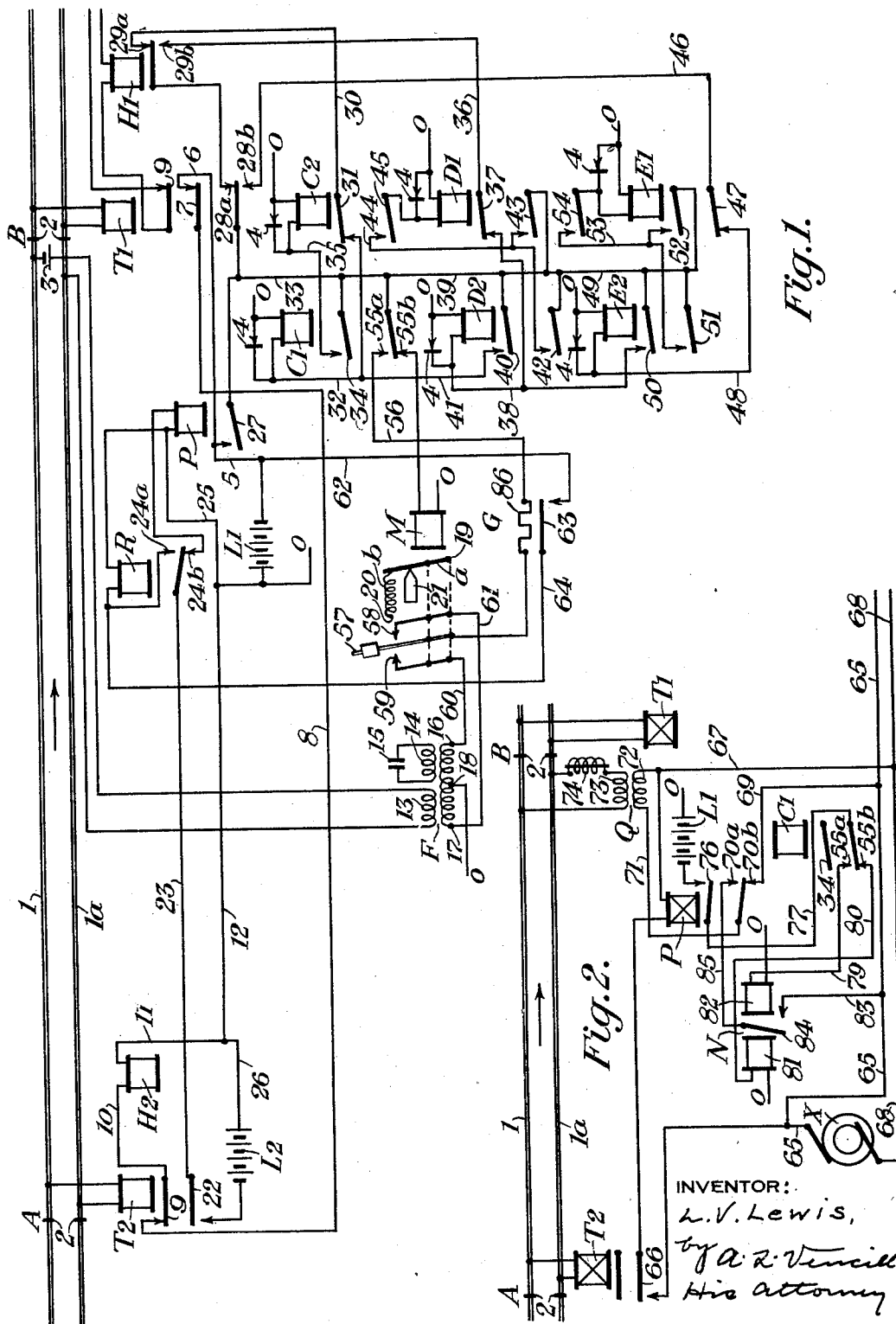
Sept. 2, 1930.

L. V. LEWIS

1,774,754

APPARATUS FOR TRANSMITTING CODED CURRENTS

Filed March 26, 1929



UNITED STATES PATENT OFFICE

LLOYD V. LEWIS, OF EDGEWOOD BOROUGH, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

APPARATUS FOR TRANSMITTING CODED CURRENTS

Application filed March 26, 1929. Serial No. 350,001.

My invention relates to apparatus for transmitting periodically interrupted, or "coded" currents, and is particularly suitable for, though not limited to, supplying the rails of a railway track with periodically interrupted alternating currents which may be used to control trackway signals or train carried governing means or both.

One feature of my invention is the provision of means for selectively controlling the rate and duration of the interruptions by means of relays.

I will describe two forms of apparatus embodying my 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 my invention. Fig. 2 is a diagrammatic view showing another form of apparatus also embodying my invention.

Similar reference characters refer to similar parts in both views.

Referring first to Fig. 1, the reference characters 1 and 1^a designate the track rails of a stretch of railway track over which traffic moves from west to east, which, as indicated by the arrow, is from left to right, as shown in the drawing. These track rails are divided by means of insulated joints 2 into a plurality of track sections only one of which, section A—B is shown complete in the drawing. A track relay, designated by the reference character T with a distinguishing suffix, is connected across the rails adjacent one end of each of these sections and may be used to control other traffic governing apparatus, not shown in the drawing, in any desired manner. Current for operating each relay T is supplied to the respective section by a track battery 3 connected in series with a secondary winding 13 of a transformer F across the rails adjacent the opposite end of the section.

Traffic control relays, designated by the reference letter H with distinguishing suffixes, are controlled by the track relays of two adjoining sections. A back contact 22 of each track relay T controls an approach relay P.

Alternating current is at times supplied to section A—B by secondary winding 13 of

transformer F. This alternating current is "coded", or periodically interrupted, at one of three prescribed rates according to traffic conditions. The rate of interruption is determined by three groups of relays, the first of which groups comprises relays C¹ and C², the second of which groups comprises relays C¹, C², D¹ and D², and the third of which groups comprises relays C¹, C², D¹, D², E¹ and E². For controlling current of each of the three codes, the relays of each of these groups, respectively, are operated in cascade, that is, they are separately, and in turn, repeatedly energized and de-energized.

Normally, section A—B being unoccupied, track relay T² is energized, and all the code control relays are de-energized. Upon relay T² becoming de-energized by the entrance of a train into section A—B, approach relay P becomes energized and closes its contact 27. If relays H¹ and T¹ are both energized, the first group of relays C¹ and C², will be operated; if relay T¹ is energized but relay H¹ is de-energized, the second group of relays C¹, C², D¹ and D² will be operated; and if both relays T¹ and H¹ are de-energized, the third group of relays C¹, C², D¹, D², E¹ and E² will be operated.

Assuming that contact 27 of relay P is closed and that relay C¹ is energized, then when relay C¹ becomes de-energized, the relay magnet M becomes energized, attracting an armature *a* which swings about a hinged end 19 and to the opposite end of which a spring *b* is attached. The end 20 of spring *b* is fixed. Armature *a*, upon being attracted by magnet M, moves away from a fixed stop 21, stretching spring *b*. A tuned reed or vibrator 57, rigidly connected at one end to armature *a* and free to vibrate at its opposite end so as to close alternately contacts 58 and 59, moves with armature *a*. Contacts 58 and 59 are mounted on armature *a* on opposite sides of reed 57, and therefore also move with armature *a*.

When relay C¹ becomes energized, magnet M is de-energized and hence spring *b* retracts armature *a* sharply against stop 21, setting reed 57 into vibration to alternately and repeatedly close contacts 58 and 59. Reed

57 is arranged to vibrate freely with small damping, so that its vibrations will continue for a time at least equal to the time that relay C¹ is energized. Contacts 58 and 59 are connected with end terminals 17 and 16, respectively, of the primary winding of transformer F. A midpoint 18 of this primary winding is connected through wire *o* with the negative terminal of a battery L¹. When reed 57 is vibrating while relays P and C¹ are energized, the positive terminal of a battery L¹ is connected with terminals 16 and 17, alternately, of the primary winding of transformer F through contacts 59 and 58, respectively, causing alternating current to be supplied to rails 1 and 1^a by secondary winding 13 of transformer F. Sparking at contacts 59 and 58 is prevented by means of a secondary winding 14 of transformer F, whose terminals are connected to a condenser 15.

A heat responsive relay G comprises a heater 86 connected in series with reed 57 and a thermostatic contact 63 which controls the pick-up circuit for a stick relay R. The closing of contact 63 occurs only after relay G has been energized for a considerable period of time, such as in the event of long continued de-energization of relay T² by a train having stopped in section A—B. When contact 63 closes as the result of a rise in temperature of heater 86, relay R becomes energized, opening the circuit for relay P which in turn opens its contact 27 thus discontinuing the operation of the code control relays.

An asymmetric unit 4 is so connected in multiple with the winding of each code control relay that the high resistance direction of the asymmetric unit is opposed to the flow of current from the source which energizes the respective relay. Each asymmetric unit 4 may be similar to those disclosed and claimed in Letters Patent of the United States, No. 1,640,335, granted to L. O. Grondahl, August 23, 1927. By means of these asymmetric units connected in multiple with the windings of the code relays, the code relays are caused to be slow releasing.

In Fig. 2, the track circuits are supplied with current from the secondary winding 73 of a track transformer Q through the usual impedance device 74. When relay P is de-energized, the primary winding 72 of transformer Q is continuously supplied with alternating current by a source X over wires 65 and 68. Upon the energization of relay P causing code relay C¹ to be operated, winding 82 of a polarized relay N becomes energized, attracting armature 84 which completes the circuit for the primary winding of transformer Q through a front contact of relay P. Upon the subsequent de-energization of relay C¹, this circuit for the primary winding of transformer Q is opened because winding 81 of relay N then opens contact 84.

Having thus described in general the ar-

range and location of the various parts comprising my invention, I will now describe the operation of the apparatus.

As shown in the drawing, all parts are in their normal condition, that is, section A—B and the first and second sections in advance of section A—B are unoccupied. Track relays T¹ and T² and traffic control relays H¹ and H² are therefore energized. The circuit by which relay H² is energized passes from battery L¹, through wires 5 and 6, contact 7 of relay T¹, wire 8, contact 9 of relay T², wire 10, winding of relay H², and wires 11 and 12 back to battery L¹. Relay H¹ is energized by a similar circuit including contact 9 of relay T¹ and a front contact of the track relay for the second section, in advance of section A—B.

I will now assume that an eastbound train de-energizes relay T² which then completes at its back contact 22, the pick-up circuit for relay P passing from a battery L², through contact 22, wire 23, contact 24^b of relay R, winding of relay P, and wires 25, 12, and 26, back to battery L². Relay P thereupon closes its contact 27, completing a pick-up circuit for relay C¹ passing from battery L¹, through wire 5, contact 27 of relay P, contact 28^a of relay T¹, contact 29^a of relay H¹, wire 30, contact 31 of relay C², wire 32, the winding of relay C¹, and wire *o* back to battery L¹.

Relay C¹ upon becoming energized, closes its contact 34, thereby completing the pick-up circuit for relay C² which passes from battery L¹, through wire 5, contact 27 of relay P, wire 33, contact 34 of relay C¹, wire 35, and the winding of relay C² to wire *o*. Relay C², upon becoming energized, opens its contact 31 thus breaking the pick-up circuit for relay C¹. The current flowing in relay C¹ therefore discharges through asymmetric unit 4, and after a short interval the front contacts of relay C¹ open and its back contact 55^b closes, completing the pick-up circuit for magnet M passing from battery L¹, through wire 5, contact 27, wire 33, contact 55^b of relay C¹, and the winding of magnet M to wire *o*. Magnet M therefore picks up armature *a* which carries the vibrator 57 and contacts 58 and 59. Spring 20 is thereby put under tension.

When contact 34 of relay C¹ opens, it breaks the pick-up circuit for relay C². The current flowing in relay C² therefore discharges through asymmetric unit 4 connected across its terminals and after a short interval, relay C² permits its contact 31 to close. Relay C¹, then being energized by its pick-up circuit already traced, opens its contact 55^b and closes its contacts 34 and 55^a. Contact 55^b thus de-energizes magnet M which then releases its armature *a*. Spring *b* thereupon retracts armature *a* until it is arrested by stop 21, and thereby sets the tuned reed 57 in vibration.

A circuit now passes from battery L^1 , through wire 5, contact 27 of relay P, wire 33, contact 55^a of relay C^1 , wire 56, heater 86 of relay G, to reed 57. Reed 57, when vibrating, connects alternately with contacts 59 and 58. When reed 57 connects with contact 59, the circuit is completed through wire 60, terminal 16, right-hand primary coil of transformer F, and terminal 18 to wire o .

When reed 57 connects with contact 58, the circuit is completed through wire 61, terminal 17, left-hand primary winding of transformer F, and terminal 18 to wire o . Battery current is thus supplied alternately to the two end terminals of transformer F, causing alternating current to be delivered to the rails 1 and 1^a by secondary winding 13 of transformer F. The frequency of this alternating current is determined by the rate of vibration of tuned reed 57, and in practice is preferably 100 cycles per second.

With contact 34 of relay C^1 closed, relay C^2 is energized, by its circuit previously traced, and hence opens, at its contact 31, the circuit for relay C^1 . When contact 55^a of relay C^1 opens, it breaks the circuit to reed 57, and contact 55^b of relay C^1 then closes the circuit for magnet M. The generation of alternating current is thus discontinued. The opening of contact 34 of relay C^1 breaks the circuit for relay C^2 . When contact 31 of relay C^2 then closes, it completes the circuit previously traced for relay C^1 , and the cycle of operation just described is then repeated.

It follows that, as long as relays P and H¹ are energized, relays C^1 and C^2 will be repeatedly energized and de-energized, that alternating current will be supplied to the track rails during the intervals measured by the sum of the pick-up time of relay C^2 and the release time of relay C^1 , and that the alternating current will be discontinued during the intervals measured by the sum of the release time of relay C^2 and the pick-up time of relay C^1 .

If now the train passes out of section A—B, current from battery 3 will again be supplied to track relay T², which will then open its contact 22 and so de-energize relay P and thus stop the generation of alternating current.

I will now assume that the section to the right of location B is occupied so that relays T¹ and H¹ are deenergized. If, now, an east-bound train enters section A—B, relay T² will become de-energized and relay P will then become energized and energize magnet M. In this case, operation of the third group of code control relays is begun by a circuit passing from battery L, through wire 5, contact 27 of relay P, contact 23^b of relay T¹, wire 46, contact 47 of relay E¹, wire 48, and the winding of relay E² to wire o . Relay E² is thus energized, and thereupon closes its contact 50 which completes a pick-up circuit for relay D² passing from battery L¹, through

wire 5, contact 27 of relay P, wires 33, 39 and 49, contact 50 of relay E², wire 38, and the winding of relay D² to wire o . Relay D² thereupon closes its front contact 40, completing a pick-up circuit for relay C^1 passing from battery L¹, through wire 5, contact 27 of relay P, wires 33 and 39, contact 40, wires 41 and 32, and the winding of relay C^1 to wire o . Relay C^1 therefore becomes energized and opens its back contact 55^b, de-energizing magnet M, and closes its front contact 55^a, causing alternating current to again be supplied by secondary winding 13 of transformer F to rails 1 and 1^a. Relay C^1 , upon becoming energized, closes its contact 34, causing relay C^2 to become energized as previously described. Relay C^2 thereupon completes a pick-up circuit for relay D¹ passing from battery L¹, through wire 5, contact 27 of relay P, wires 33 and 39, contact 42 of relay D², wire 44, contact 45 of relay C^2 , and the winding of relay D¹ to wire o . Relay D¹ thereupon closes its contact 54, completing a pick-up circuit for relay E¹ passing from battery L¹, through wire 5, contact 27 of relay P, wires 33, 39 and 49, contact 51 of relay E², wire 53, contact 54 of relay D¹, and the winding of relay E¹ to wire o .

Relay E¹ then opens its back contact 47, thus breaking the pick-up circuit for relay E² which is thereby de-energized. Although contact 51 of relay E² now opens, relay E¹ continues energized by a stick circuit which includes the path already traced for its pick-up circuit as far as wire 49, thence through contact 52 of relay E¹, wire 53, contact 54 of relay D¹, and the winding of relay E¹ to wire o . Relay E², upon becoming de-energized, also opens its contact 50, causing relay D² to become de-energized. Relay D², upon becoming de-energized, opens its contact 42 in the pick-up circuit for relay D¹ which, however, continues energized by a stick circuit which follows the path already traced for its pick-up circuit as far as wire 39, thence through contact 43 of relay D¹, wire 44, contact 45 of relay C^2 , and the winding of relay D¹ to wire o . Relay D², upon becoming de-energized, also opens its contact 40, causing relay C^1 to become de-energized and opens its contact 55^a which interrupts the supply of alternating current from secondary winding 13 of transformer F. Contact 55^b of relay C^1 then closes, causing magnet M to again be energized. Contact 34 of relay C^1 also opens and de-energizes relay C^2 . Contact 44 of relay C^2 , when it opens, breaks the stick circuit for relay D¹ which then becomes de-energized. Relay D¹ thereupon opens its contact 54 in the stick circuit for relay E¹, causing relay E¹ to become de-energized. Relay E¹, upon becoming de-energized, closes its contact 47, causing energy to again be supplied to relay E² and thus start a second operating cycle of the relays of the third group.

It follows, therefore, that as long as relay P is energized and relays T¹ and H¹ are de-energized, relays C¹, C², D¹, D², E¹ and E² will be repeatedly energized and de-energized, and that alternating current will be supplied to the track rails during the intervals measured by the sum of the pick-up times of relays C², D¹ and E¹, and of the release times of relays E², D² and C¹, and will be discontinued during the intervals measured by the sum of the release times of relays C², D¹ and E¹, and the pick-up times of relays E², D², and C¹.

I will now assume that the first section to the right of location B is unoccupied, but that the second section to the right of location B is occupied, so that relay T¹ is energized but relay H¹ is de-energized. If, now, an east-bound train enters section A—B, de-energizing relay T² and thus energizing relay P, the operation of the second group of relays is begun by a circuit passing from battery L¹, over wire 5, contact 27 of relay P, contact 28^a of relay T¹, contact 29^b of relay H¹, wire 36, contact 37 of relay D¹, wire 38, and the winding of relay D² to wire *o*. Relay D², becoming energized, completes the second pick-up circuit previously traced for relay C¹, causing relay C¹ to become energized. Relay C¹, upon becoming energized, opens its back contact 55^b, thus breaking the circuit for magnet M which has previously been energized upon the closing of contact 27 of relay P. Armature *a* is then released by magnet M, and, upon the closing of contact 55^a of relay C¹, transformer F is caused to supply alternating current to rails 1 and 1^a as already described. Relay C¹, upon becoming energized, also closes its contact 34 thus causing energization of relay C². Relay C², upon becoming energized, completes the pick-up circuit for relay D¹ as already traced through contact 45 of relay C².

Relay D¹ then opens its contact 37, causing relay D² to become de-energized. Although contact 42 of relay D² is now open, relay D¹ continues energized by its stick circuit previously traced. Relay D², by opening its contact 40, causes relay C¹ to be de-energized and thus interrupt, at its contact 55^a, the circuit for causing the supply of alternating current by transformer F to the track rails. Relay C¹ also opens its contact 34, causing relay C² to again be de-energized and in turn de-energize relay D¹ by the opening of contact 45. Relay D¹, upon becoming de-energized, closes its contact 37, thus again completing the second pick-up circuit for relay D² and starting a second operating cycle of the relays in the second group.

It follows, therefore, that as long as relays P and T¹ are energized and relay H¹ is de-energized, relays C¹, C², D¹ and D² will be repeatedly energized and de-energized, and that alternating current will be supplied to

the track rails during the intervals measured by the sum of the pick-up times of relays C² and D¹ and the release times of relays D² and C¹, and will be discontinued during the intervals measured by the sum of the release times of relays C² and D¹ and the pick-up times of relays D² and C¹.

I will now assume that, when all parts of the apparatus are again in their normal condition, as previously described, a train enters and stops in section A—B. If the train remains long enough in section A—B, the repeated energization of the winding of heat responsive relay G, by current flowing through it to the primary winding of transformer F, will cause relay G to close its contact 63. Stick relay R will then be energized by its pick-up circuit passing from battery L¹, through wire 62, contact 63 of relay G, wire 64, winding of relay R, and wire 25 back to battery L¹. Relay R, upon becoming energized, opens, at its contact 24^b, the circuit for relay P which then opens its contact 27, interrupting the flow of current from battery L¹ to the code control relays and to transformer F. Relay R, as long as the train subsequently remains in section A—B, continues energized by its stick circuit which passes from battery L², through contact 22 of relay T², wire 23, contact 24^a of relay R, winding of relay R, and wires 25, 12 and 26 back to battery L². The code control relays will not again become energized until relay T² has become energized and has de-energized relay R, and has then become de-energized and has energized relay P.

Each of the relays in the three groups referred to may have any desired characteristics. In further discussing the operation of these groups, I will assume a time unit of 1/60th of a second. I will next assume that, as an example, each of the relays has a pick-up time of one of these units, that relays C¹ and C², when operated in multiple, with asymmetric units 4 in the circuits of Fig. 1, have a release time of 9 units, that relays D¹ and D² in the circuits shown have a release time of 4 units, and that relays E¹ and E² in the circuits shown have a release time of 6½ units.

In the operation of the first group, the pick-up and release values of relays C¹ and C² being as thus assumed, relay C¹ picks up in one unit of time after the application of energy to its winding. Relay C² then picks up after the lapse of a second unit of time. Relay C¹, now being de-energized by the opening of contact 31 of relay C², opens its front contacts after a lapse of 9 units of time. Relay C², then being de-energized, closes its back contact after the lapse of a second period of 9 units thus putting the circuit for relay C¹ in condition for the beginning of a second cycle of operation. It is thus clear that the first cycle of operation

consumes a total period of time including the pick-up periods and the release periods of both relays C^1 and C^2 , summing up to 20 units, and that alternating current is supplied to the track for 10 units, and is cut off for 10 units. Each succeeding operating cycle of this first group of relays requires a like period of 20 units of time. In the operation of the relays in the second group, the total time required for each cycle consists of the pick-up periods of four relays and the release periods of these four relays, resulting in a total period of 30 units, and alternating current is supplied to the track for 15 units, and is cut off for 15 units. Similarly, the total time for each cycle of operation of the relays in the third group is 45 units, during $22\frac{1}{2}$ of which alternating current is supplied to the track, and during $22\frac{1}{2}$ of which alternating current is discontinued.

It is therefore clear that, for a complete operating cycle of the first, second or third groups of relays, the time required is respectively $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ of a second. The first group therefore has an operating frequency of three cycles per second, the second group has an operating frequency of two cycles per second, and the third group has an operating frequency of $1\frac{1}{3}$ cycles per second. It is clear that, by controlling magnet M and transformer F by contacts of relay C^1 , alternating current, interrupted three times per second, is supplied by transformer F to rails 1 and 1^a when the first group of relays is operated; alternating current, interrupted twice per second, is supplied to rails 1 and 1^a when the second group of relays is operated; and alternating current, interrupted one and one-third times per second is supplied to rails 1 and 1^a when the third group of relays is operated.

With the arrangement shown in Fig. 2, the three groups of relays are assumed to operate in cascade similarly to the manner described in connection with Fig. 1. In Fig. 2, alternating current is supplied by a source X instead of by the arrangement including battery L^1 , magnet M and transformer F shown in Fig. 1. With relay P de-energized, rails 1 and 1^a , as shown in Fig. 2, are supplied with alternating current by secondary winding 73 of transformer Q by means of a circuit passing from source X, through wires 65 and 69, contact 70^b of relay P, wire 71, primary winding 72 of relay Q, and wires 67 and 68 back to source X. As in Fig. 1, so, in Fig. 2, relay P becomes energized when relay T^2 becomes de-energized, the circuit for relay P in Fig. 2 passing from source X, through wire 65, contact 66 of relay T^2 , winding of relay P, and wires 67 and 68 back to source X.

When relay P becomes energized, winding 81 of relay N becomes energized by its circuit passing from battery L^1 , through

contact 76 of relay P, wire 77, contact 55^b of relay C^1 , wire 80, and winding 81 to wire o. Each time relay C^1 becomes energized during a cycle of operation of any one of the three groups of relays while relay P is energized, winding 82 of polarized relay N becomes energized by a circuit passing from battery L^1 , through contact 76 of relay P, wire 77, contact 55^a of relay C^1 , wire 79, and winding 82 to wire o. Winding 82, becoming energized, causes contact 84 to close, and current is now supplied to primary winding 72 of transformer Q by a circuit passing from source X, through wires 65 and 83, contact 84 of relay N, wire 85, contact 70^a of relay P, wire 71, primary winding 72, and wires 67 and 68 back to source X. Upon the subsequent de-energization of relay C^1 while relay P is energized, winding 82 becomes de-energized and winding 81 again becomes energized, opening contact 84 and breaking the circuit through primary winding 72 of transformer Q.

The supply of current to primary winding 72 is thus interrupted every time relay C^1 becomes de-energized while relay P is energized. It is therefore clear that, while the first group of relays is operating, the alternating current being supplied to primary winding 72 of transformer Q is interrupted three times every second; while the second group of relays is operating, the current supplied to primary winding 72 is interrupted twice per second; and while the third group of relays is operating, the current supplied to primary winding 72 is interrupted one and one-third times per second.

Although I have, for purposes of illustration, assumed definite values for the pick-up and release periods of the relays in each of the three code-control groups, it should be pointed out that my invention is not limited to these particular values.

Although I have herein shown and described only two forms of coded current transmitting apparatus embodying my 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 my invention.

Having thus described my invention, what I claim is:

1. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by a contact of a relay of each of said groups for supplying a plurality of coded currents to said conductor.

2. In combination with a conductor, a plurality of groups of relays, a code relay included in all of said groups, means for operating in cascade the relays in each of said

groups, a source of current, and means including said source and controlled by a contact of said code relay for supplying a plurality of coded currents to said conductor.

3. In combination with a conductor, a plurality of groups of relays, certain relays of each of said groups included in each of the other said groups, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by a contact of a relay of each of said groups for supplying a plurality of coded currents to said conductor.

4. In combination with a conductor, a plurality of groups of relays, certain relays of each of said groups included in certain of the other said groups, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by a contact of a relay of each of said groups for supplying a plurality of coded currents to said conductor.

5. In combination with a conductor, a series of groups of relays, the first group in said series including a plurality of relays, the second group in said series including the relays of said first group and additional relays, similarly each succeeding group in said series including the relays of the next preceding group and additional relays, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by a contact of a relay of each of said groups for supplying a plurality of coded currents to said conductor.

6. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by a contact of a relay of each of said groups for supplying a respective coded current to said conductor.

7. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, a source of current, a code relay controlled by said groups, and means including said source and controlled by a contact of said code relay for supplying a plurality of coded currents to said conductor.

8. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for repeatedly energizing and de-energizing in cascade the relays in each of said groups, a source of current, and means including said source and controlled by said relays for supplying a plurality of coded currents to said conductor.

9. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, a source of current, and

means including said source and controlled by each of said relay groups for supplying said conductor with a coded current of a different characteristic from the coded current which is controlled by each of the other said groups.

10. In combination with a conductor, a series of groups of relays, the first group in said series comprising a pair of relays the first of which has a pick-up circuit controlled by a back contact of the second, and the second of which has a pick-up circuit controlled by a front contact of the first, the second group in said series comprising a third and a fourth relay as well as the relays of said first group, a pick-up circuit for said fourth relay controlled by a back contact of said third relay, a second pick-up circuit for said first relay controlled by a front contact of said fourth relay, a pick-up circuit for said third relay controlled by front contacts of said second and fourth relays, a stick circuit for said third relay controlled by a front contact of said second relay, each succeeding group in said series comprising the next preceding group and two additional relays, the second of said additional relays having a pick-up circuit controlled by a back contact of the first said additional relay, a front contact of said second additional relay controlling a second pick-up circuit for the second additional relay of the next preceding group, the said first additional relay having a pick-up circuit controlled by front contacts of the accompanying said second additional relay and of the first additional relay of the next preceding group, each said first additional relay having a stick circuit controlled by a front contact of the first additional relay of the next preceding group, means for causing the operation of each of said groups separately from each of the other said groups, a source of current, and means including said source for supplying said conductor with current of one code or another according as one or another of said groups of relays is operating.

11. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, an asymmetric unit connected in multiple with the winding of each of said relays, a source of current, and means including said source and controlled by said relay groups for supplying a plurality of coded currents to said conductor.

12. In combination with a conductor, a series of relays operating in cascade, an asymmetric unit connected in multiple with the winding of one of said relays, a source of current, and means including said source and controlled by said relays for supplying coded current to said conductor.

13. In combination with a conductor, a plurality of inter-inclusive groups of relays,

means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by said groups of relays for supplying a plurality of coded currents to said conductor.

14. In combination with a conductor, a plurality of inter-inclusive groups of relays, means for operating in cascade the relays in each of said groups, a source of current, and means including said source and controlled by said relay groups for at different times supplying said conductor with current of different codes.

15. In combination with a conductor, a stretch of railway track, a plurality of inter-inclusive groups of relays, means for operating in cascade one or another of said groups of relays according to traffic conditions within said stretch, a source of current, and means including said source and controlled by said groups of relays for supplying a plurality of coded currents to said conductor.

16. In combination, a stretch of railway track over which traffic moves in one direction, a plurality of inter-inclusive groups of relays, means for operating in cascade one or another of said groups of relays according to traffic conditions in forward sections of said stretch, a source of current, and means including said source and controlled by said groups of relays for supplying a plurality of coded currents to a rear section of said stretch.

In testimony whereof I affix my signature.

LLOYD V. LEWIS.