

Sept. 24, 1940.

B. E. O'HAGAN

2,215,823

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 10, 1938

5 Sheets-Sheet 1

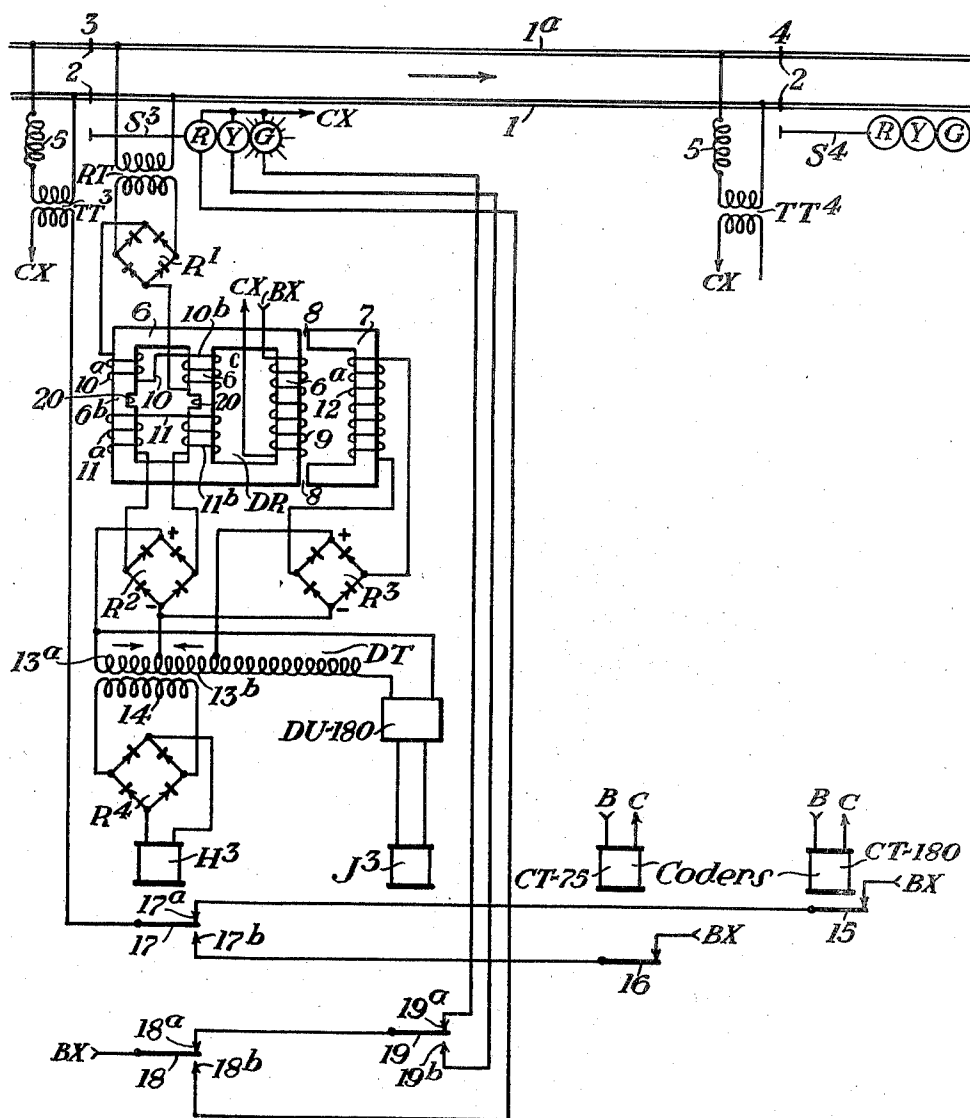


Fig. 1

Inventor
Bernard E. O'Hagan.
BY *Rosen*
his Attorney

Sept. 24, 1940.

B. E. O'HAGAN

2,215,823

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 10, 1938

5 Sheets-Sheet 2

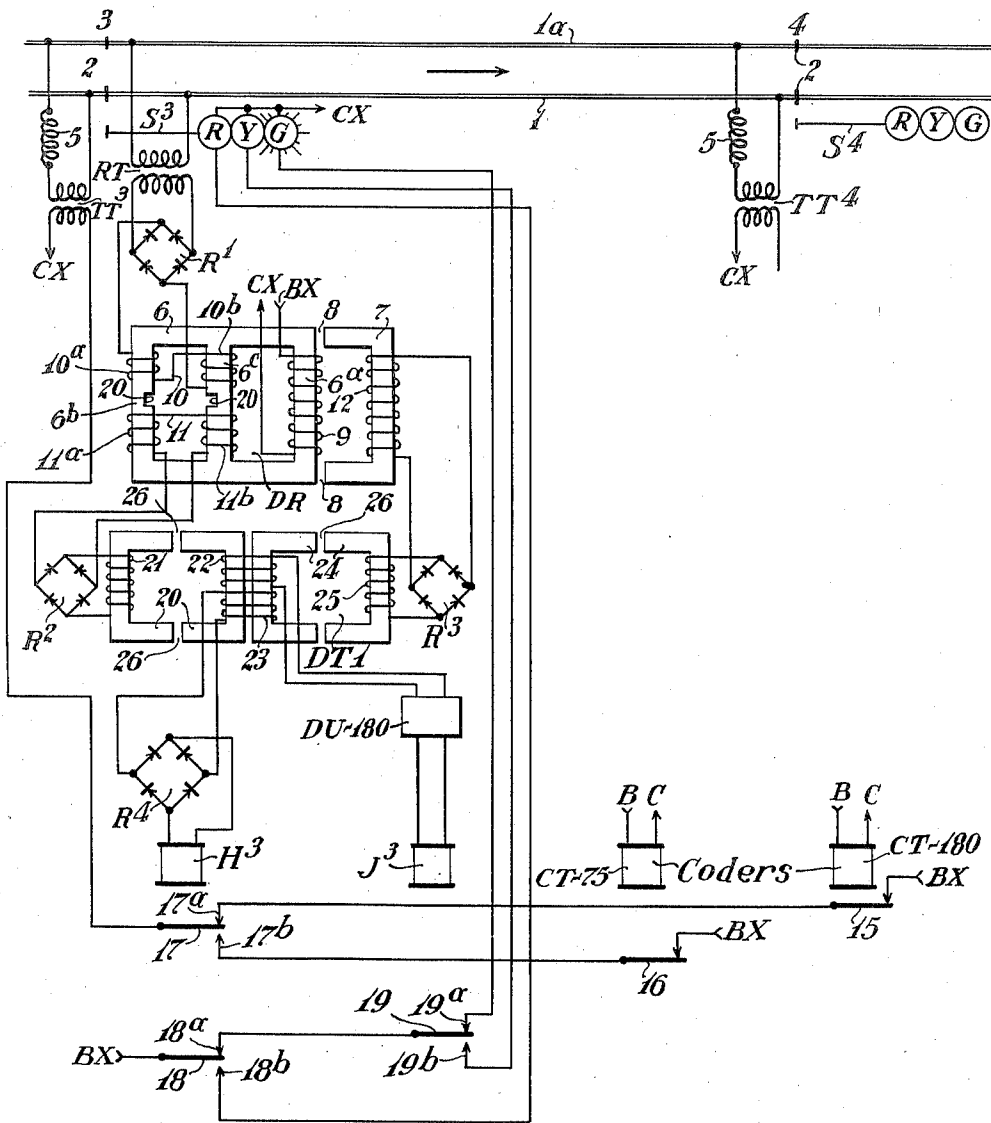


Fig. 2

INVENTOR
Bernard E. O'Hagan
BY *Robert*
ATTORNEY

Sept. 24, 1940.

B. E. O'HAGAN

2,215,823

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 10, 1938

5 Sheets-Sheet 3

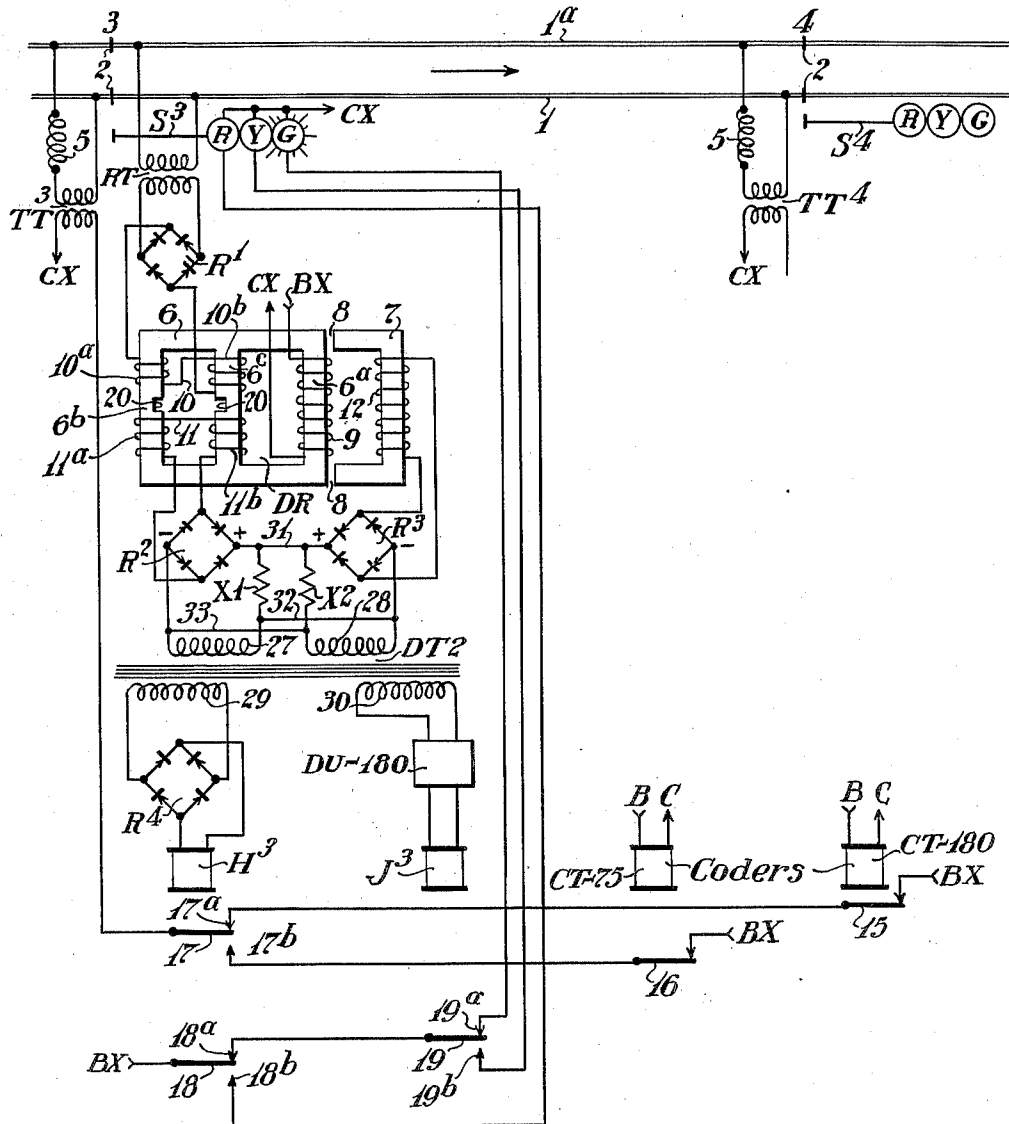


Fig. 3

INVENTOR
Bernard E. O'Hagan.
BY *Richard*
his ATTORNEY

Sept. 24, 1940.

B. E. O'HAGAN

2,215,823

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 10, 1938

5 Sheets-Sheet 4

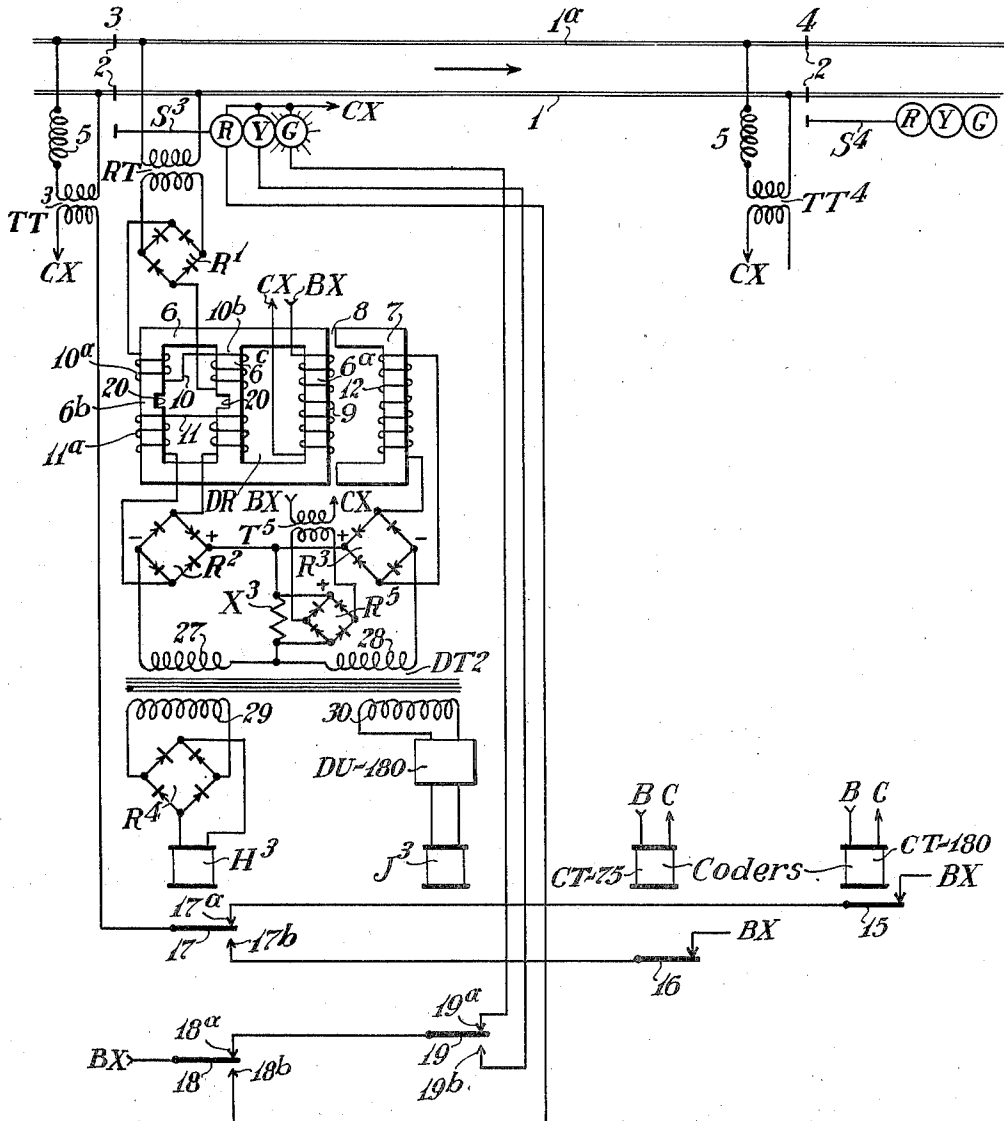


Fig. 4

INVENTOR
Bernard E. O'Hagan
BY *Hakwood*
ATTORNEY

Sept. 24, 1940.

B. E. O'HAGAN

2,215,823

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 10, 1938

5 Sheets-Sheet 5

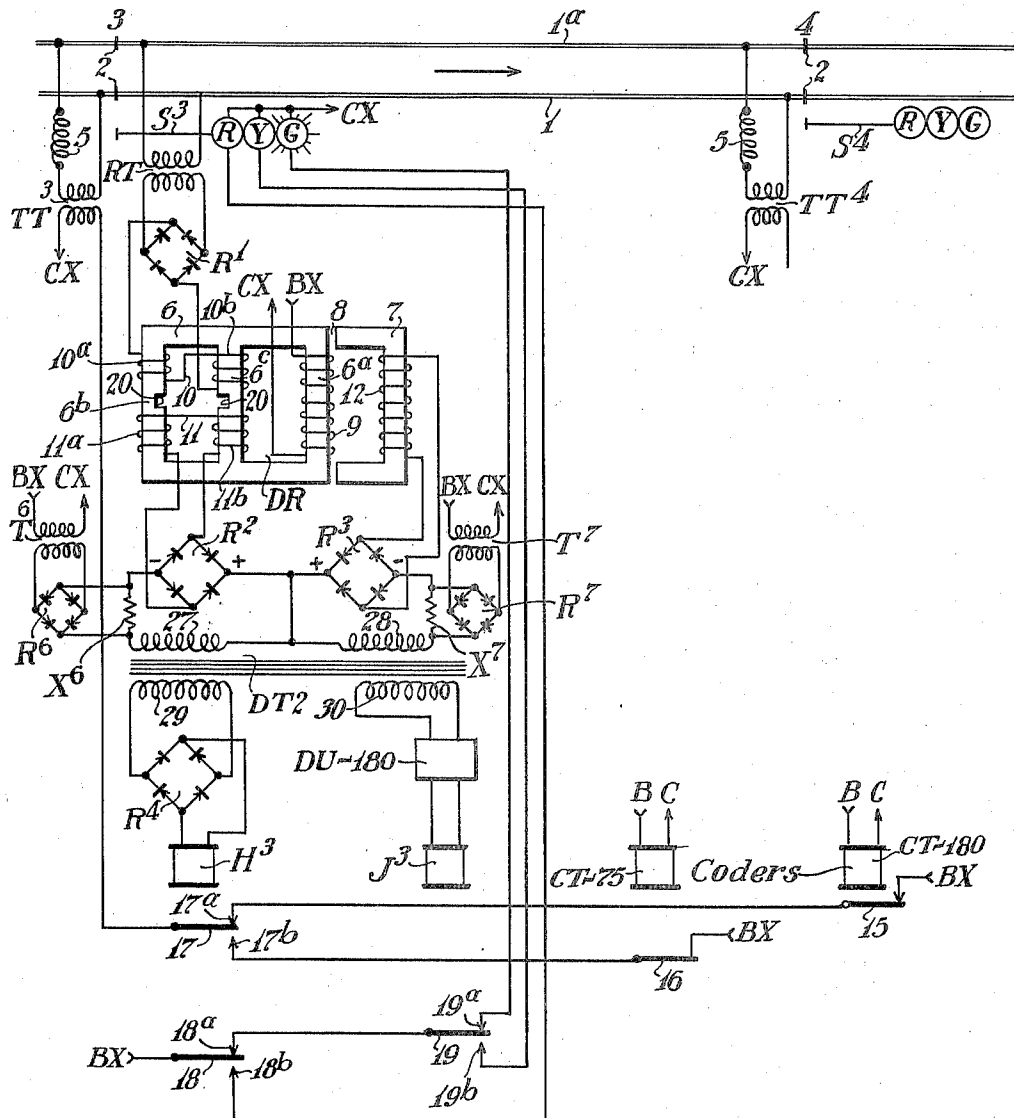


Fig. 5

INVENTOR
Bernard E. O'Hagan.
BY *Kelwood*
ATTORNEY

UNITED STATES PATENT OFFICE

2,215,823

RAILWAY TRAFFIC CONTROLLING
APPARATUSBernard E. O'Hagan, Swissvale, Pa., assignor to
The Union Switch & Signal Company, Swiss-
vale, Pa., a corporation of Pennsylvania

Application June 10, 1938, Serial No. 213,016

12 Claims. (Cl. 246—33)

My invention relates to railway traffic controlling apparatus, and particularly to apparatus for controlling wayside and cab signals by means of coded track circuit current.

5 One feature of my invention is the provision, in apparatus of the type described, of novel and improved means for decoding the coded track circuit current.

10 Other features of my invention will become apparent as the description proceeds.

15 The present application is a continuation in part of my copending application, Serial No. 132,512, filed on March 23, 1937, for Railway traffic controlling apparatus, which latter application is a division of my application, Serial No. 48,884, filed on November 8, 1935, for Electrical relays, now Patent No. 2,117,820, granted May 17, 1938. Certain features of the invention shown herein are disclosed and broadly covered 20 by claims in a copending application, Serial No. 280,997, filed by me on June 24, 1939.

I shall describe several forms of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

25 In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of apparatus embodying my invention. Figs. 2 to 5, inclusive, are views similar to Fig. 1 showing modified forms of the apparatus illustrated in Fig. 1, and also embodying my invention.

30 Similar reference characters refer to similar parts in each of the several 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 normally moves in the direction indicated by the arrow. These track rails are divided, by means of insulated joints 2, into a plurality of similar track sections, only one of which, 3—4, is shown 40 complete in the drawings. Traffic entering each track section is controlled by a signal designated by the reference character S with a distinguishing exponent corresponding to the location. These signals may be of any suitable type but, 45 in the form here shown, these signals are of the color light type, and each comprises a red lamp R, a yellow lamp Y, and a green lamp G, which lamps, when illuminated indicate "stop," "caution," and "proceed," respectively.

50 Located at the leaving end of each track section are means for supplying to the rails of the associated section coded alternating current, the code frequency of which is controlled by traffic conditions in advance. These means form no 55 part of my present invention and in the well-

known form here shown comprise a track transformer designated by the reference character TT, with a distinguishing exponent, the secondary of which is constantly connected with the rails of the associated section in series with the usual 5 current limiting impedance 5, and the primary of which is connected with the terminals BX and CX of a suitable source of current, not shown in the drawings, over the contact 15 of a coding device CT—180, or the contact 16 of a coding device CT—75, according as the front contact 17— 17^a, or the back contact 17—17^b of a relay H 10 which is associated with the section next in advance is closed, only the coding devices CT—75 and CT—180 and the relay H³ which is associated 15 with the section 3—4 being shown in the drawings. The coding device CT—180 is constantly supplied with current from a suitable source the terminals of which are indicated by the reference characters B and C, and this coding device 20 constantly opens and closes its contact 15 at the rate of 180 times per minute. The coding device CT—75 is likewise constantly supplied with current from the terminals B and C, and constantly opens and closes its contact 16 at the 25 rate of 75 times per minute. It will be seen, therefore, that when the relay H of a section is picked up so that its front contact 17—17^a is closed, the rails of the section next in rear will be supplied with alternating current which is 30 periodically interrupted or coded at the rate of 180 times per minute, but that, when the relay H of a section is released, so that its back contact 17—17^b is closed, the rails of the section next in rear will then be supplied with alternating 35 current which is periodically interrupted or coded at the rate of 75 times per minute. The 180 code is used to provide a proceed indication and the 75 code is used to provide the caution indication, in a manner which will be made clear 40 as the description proceeds. Each relay H is controlled by traffic conditions in the associated section in a manner which will also be made clear as the description proceeds.

Each track section is provided at the entering 45 end of the section with what I shall term a decoding relay of the saturation type, designated by the reference character DR, only the relay DR associated with section 3—4 being shown in the drawings. This relay in the form here il- 50 lustrated comprises a main core 6 of the three-legged shell type, and an auxiliary C-shaped core 7 which is separated from the one outside leg 6^a of the core 6 by a pair of air gaps 8. The main core 6 is provided with a primary winding 9 con- 55

sisting of a single coil disposed on the leg 6^a; with an input or saturation winding 10 consisting of two coils 10^a and 10^b disposed on the two legs 6^b and 6^c, respectively, and connected in series in such manner that current flowing in these two coils will cause a flux to circulate around the closed path formed by the associated legs but not in the path including the leg 6^a; and with a secondary or output winding 11 consisting of two coils 11^a and 11^b disposed on the two legs 6^b and 6^c, respectively, and connected in series in such manner that the voltages induced in these two coils due to flux from the primary winding 9 are additive. The auxiliary core 7 is provided with a secondary or output winding 12 consisting as here shown of a single coil.

The primary winding 9 of relay DR is constantly connected with terminals BX and CX of the alternating current source, and it will be apparent that with the two coils 10^a and 10^b of the input winding 10 arranged in the manner just described the flux due to the current flowing in the primary winding will normally not induce any net voltage in the winding 10 since the voltages induced in the two coils of this winding will be equal and opposite. The input winding 10 is energized from the associated track section 3—4 through the medium of a relay transformer RT which insulates the winding 10 from the track rails, and a rectifier R¹ which converts the coded alternating current received from the rails into pulses of unidirectional current in winding 10. The parts are so proportioned that during the "on" period of the code, the rectified current in winding 10 will saturate the portion of the main core on which the secondary winding 11 is wound, so that this portion of the core will have a high reluctance for the primary flux. The primary flux will then have a path of lower reluctance through the air gaps 8 and the auxiliary core 7, and the voltage induced in the secondary winding 12 will therefore be relatively high while that induced in the secondary winding 11 will be relatively low. During the "off" period of the code, however, the input winding 10 receives no current, and under these conditions, the portion of the core on which the secondary winding 11 is wound will form a lower reluctance path for the flux from the primary winding than the path through the air gaps 8 and the auxiliary core 7, thus causing the voltage induced in the secondary winding 11 to be relatively high, and the voltage induced in the secondary winding 12 to be relatively low.

In order to reduce the power which is required to saturate the relay core 6, the two legs 6^b and 6^c of this core may be provided with portions 20 of reduced cross section between the input or saturating winding 10 and the secondary winding 11 in the manner shown. With the core constructed in this manner, the current which must be supplied by the track circuit need only be large enough to saturate these portions of reduced cross section of the core, and need not be large enough to saturate the complete magnetic circuit. When the portions of reduced cross section of the core are saturated, these portions of the magnetic circuit are, in effect, two large air gaps which have a greater reluctance than the reluctance of the physical air gaps 8 between the auxiliary core and the main core. With the ordinary three-legged type of saturation relay, it is necessary to saturate a complete magnetic circuit, which must be large in order to provide high

impedance to alternating current when the core is not saturated.

The current which is induced in the secondary winding 11 of the decoding relay DR is rectified by an associated rectifier R², and is impressed across a portion 13^a of the primary winding of an associated decoding transformer DT in such manner that this current will flow through the portion 13^a from left to right, as indicated by the arrow. The current induced in the secondary winding 12 of the decoding relay DR is likewise rectified by an associated rectifier R³, and is impressed across another portion 13^b of the primary winding of the associated decoding transformer DT in such manner that this current will flow through the portion 13^b from right to left, as indicated by the arrow. It will be seen, therefore, that when coded current is being supplied to the decoding relay DR, both portions 13^a and 13^b of the primary of the decoding transformer DT will be supplied with direct current, which current will flow through these portions in opposite directions, but that, during the "on" period of the code, the current which flows in the portion 13^b will be considerably larger than that which flows in the portion 13^a whereas, during the "off" period of the code, the current which flows in the portion 13^a will be considerably larger than that which flows in the portion 13^b. It follows, therefore, that whenever coded current is being supplied to the decoding relay, an alternating current will be induced in the decoding transformer DT in substantially the same manner as has been accomplished heretofore by a decoding relay having a moving contact, and that this alternating current will have a frequency which depends upon the code frequency.

The decoding transformer DT supplies energy to the relay H³ for section 3—4 through the medium of a secondary winding 14 and a rectifier R⁴. Relay H³ is a direct current relay and is so designed that it will remain energized whenever transformer DT is receiving energy from either the 75 or the 180 code. The decoding transformer DT for section 3—4 also supplies energy to a direct current decoding relay J³ which is connected with a portion of the winding of the decoding transformer through a decoding unit DU—180. The details of construction of the decoding unit DU—180 are not shown in the drawings, but this unit usually comprises a rectifier and a reactor condenser tuning unit for tuning relay J³, whereby this relay will be energized when and only when the 180 code is being supplied to the decoding relay.

When relays H³ and J³ are both energized, a circuit is completed for lamp G of signal S³, which circuit passes from terminal BX of the source through front contact 18—18^a of relay H³, front contact 19—19^a of relay J³ and the filament of lamp G to terminal CX. When this circuit is closed, lamp G is lighted and under these conditions signal S³ indicates proceed. When relay H³ is energized and relay J³ is deenergized, lamp Y of signal S³ then becomes lighted by virtue of a circuit which passes from terminal BX through front contact 18—18^a of relay H³, back contact 19—19^b of relay J³ and the filament of lamp Y to terminal X, and under these conditions, signal S³ indicates caution. When, however, relay H³ is deenergized, lamp R of signal S³ becomes lighted by virtue of a circuit which passes from terminal BX of the source through back contact 18—18^b of relay H³ and the filament of lamp R of signal

S³ to terminal X, thus causing this signal to indicate stop.

The operation of the apparatus as a whole is as follows: Section 3—4 will be supplied with the 180 code or the 75 code according as the section next in advance is unoccupied or occupied. When section 3—4 is supplied with 180 code and no train occupies this section, all parts will occupy the positions in which they are shown in the drawings. That is to say, relays H³ and J³ will both be energized, the circuit for the proceed lamp G of signal S³ including contact 18—18^a of relay H³ and contact 19—19^a of relay J³ will be closed, thus causing this lamp to be lighted so that the signal will indicate proceed, and the circuit for the primary of transformer TT³ including front contact 17—17^a of relay H³ and contact 15 of coding device CT—180 will be closed so that the section next in rear of section 3—4 will also be supplied with 180 code.

When section 3—4 is supplied with the 75 code and no train occupies this section, relay H³ will remain picked up but relay J³ will become released, thus causing signal S³ to indicate caution. The rails of the section next in rear of section 3—4, however, will continue to be supplied with 180 code in the same manner as when section 3—4 is supplied with the 180 code and no train occupies this section.

When a train enters section 3—4, the train will shunt away coded current from the decoding apparatus, and relays H³ and J³ will then both become released, thus causing signal S³ to indicate stop. Furthermore, with relay H³ released, the circuit for the primary of track transformer TT³ including back contact 17—17^b of relay H³ and contact 16 of coding device CT—75 will now be closed, thus causing the rails of the section next in rear of section 3—4 to be supplied with the 75 code.

When rectified current is supplied to the two portions 13^a and 13^b of the primary winding of the decoding transformer DT in the manner shown in Fig. 1, the two rectifiers R² and R³ provide low resistance paths for the currents induced by flux decay in the transformer core, and as a result when either portion of the primary winding becomes deenergized, the flux set up by that portion does not die down to a low value immediately. Inasmuch as the flux in the core of the transformer DT alternately reverses its direction, this delay in the decay of the flux makes it difficult to build up current quickly in the portion of the primary winding which is to be next energized, and the overall efficiency of the decoding transformer as well as the efficiency of the decoding apparatus as a whole is therefore lowered somewhat. The efficiency of the decoding apparatus may be improved by using a different type of decoding transformer which is designed particularly with a view to enable it to operate efficiently in connection with the decoding relay DR and the associated rectifiers R² and R³, and in Fig. 2, I have shown the apparatus modified to include one type of decoding transformer which is suitable for this purpose.

Referring to Fig. 2, the apparatus here shown is similar in all respects to that shown in Fig. 1 except for the decoding transformer which is here designated DT¹. This transformer comprises a core 20 provided with a primary winding 21 which is connected with the output terminals of the rectifier R², and a core 24 provided with a primary winding 25 which is connected with the output terminals of the rectifier

R³. This transformer also comprises two secondary windings 22 and 23 which link both cores 20 and 24, and which are connected respectively with the input terminals of the rectifier R⁴ and with the input terminals of the decoding unit DU—180. The primary windings are so arranged that the unidirectional fluxes which are set up in the cores 20 and 24 when current is being supplied to these windings will thread the secondary windings in opposite directions, and in order to cause the flux to decay quickly in the cores 20 and 24 when the associated primary winding becomes deenergized in spite of the low resistance paths provided by the rectifiers R² and R³ for the currents induced in the primary windings by the decaying flux, each core is provided with one or more air gaps 26 or their equivalent, two such air gaps being shown in the drawings because of the greater ease of assembly of the transformer which is afforded by this arrangement.

With the decoding transformer constructed and arranged in this manner it will be apparent that when the decoding relay DR is being supplied with coded current, the primary windings 21 and 25 of the decoding transformer will be alternately supplied with pulses of direct current and will set up in the cores 20 and 24 pulsating unidirectional fluxes which in turn will induce alternating currents in both secondary windings 22 and 23 to thereby operate the relays H³ and J³ in substantially the same manner as was previously described in connection with Fig. 1. It will also be apparent that due to the fact that the cores 20 and 24 have relatively high reluctances, and the further fact that the fluxes set up in these cores always thread these cores in the same directions, the rate of growth and decay of the fluxes in these cores will be very rapid, whereby the efficiency and operation of the decoding apparatus as a whole is materially improved.

Referring now to Fig. 3, the apparatus in the form here shown includes a decoding transformer DT² provided with two primary windings 27 and 28 and two secondary windings 29 and 30. The primary winding 27 is connected with the output terminals of the rectifier R² in series with a resistor X¹, and the primary winding 28 is connected with the output terminals of rectifier R³ in series with a resistor X². The resistor X¹ is also connected with the output terminals of the rectifier R³ by means of two wires 31 and 32, while the resistor X² is similarly connected with the output terminals of the rectifier R² by means of the wire 31 and a wire 33, whereby when the rectifier R² is delivering current, a voltage will be impressed on the resistor X² and when the rectifier R³ is delivering current, a voltage will be impressed on the resistor X¹. It will be noted that the wires 32 and 33 also serve to connect the two primary windings 27 and 28 in parallel. The secondary winding 29 is connected with the input terminals of the rectifier R⁴ and the secondary winding 30 is connected with the input terminals of the decoding unit DU—180.

The parts are so arranged that the pulsating direct current which is supplied to the primary windings 27 and 28 from either the rectifier R² or the rectifier R³ will set up cumulative fluxes in the core of the transformer DT², but that the flux which is set up by current from the rectifier R² will traverse the core of the transformer in the opposite direction from that which is set up by current from the rectifier R³, and it will be seen, therefore, that when coded current is be-

ing supplied to the decoding relay DR, an alternating voltage will be induced in the secondary windings 29 and 30 of the decoding transformer to thereby operate the relays H³ and J³ in a manner similar to that described in connection with Fig. 1. The function of the resistors X¹ and X² and the associated connections is to provide a sharp cut-off in the output of each rectifier R² and R³ when the current supplied to such rectifier from the associated secondary winding 11 or 12 of the decoding relay DR is decreasing. For example, assume that the voltage induced in secondary winding 11 is increasing and the voltage induced in secondary winding 12 of relay DR is decreasing, as will be the case during the "off" period of the code. Under these conditions, as soon as the voltage from rectifier R² exceeds the potential drop across resistor X² due to the decaying current from rectifier R³, the current from rectifier R³ will be stopped just as though it had been stopped by opening the contact of a relay. In like manner, during the "on" period of the code when the voltage in winding 12 is increasing and that in winding 11 is decreasing, as soon as the voltage from rectifier R³ exceeds the potential drop across resistor X¹ due to the decaying current from rectifier R², the output of rectifier R² will be interrupted. It will be seen, therefore, that with the arrangement shown in Fig. 3 the amount of saturating current fed into the decoding relay from the track circuit need not be great enough to completely saturate the relay core, but need only be sufficient to cause, when present, voltage from the winding 11 to be less than the voltage from winding 12 and, when not present, to permit the voltage from winding 12 to be slightly greater than the voltage from winding 11.

Referring now to Fig. 4, as here shown the apparatus is the same as that shown in Fig. 3, except that the two primary windings 27 and 28 of the decoding transformer DT2 instead of being connected with the output terminals of the associated rectifiers R² and R³ through separate resistors are connected with the output terminals of these rectifiers through a common resistor X³ across which a constant potential is maintained by means of a transformer T⁵ and a rectifier R⁵. The parts are so arranged that the current which is supplied to the primary winding 27 from the rectifier R² will flow through this winding in the opposite direction to that which is supplied to the primary winding 28 from the rectifier R³, and the polarity of rectifier R⁵ is such as to oppose the voltages of rectifiers R² and R³. It will be seen, therefore, that the rectifier R⁵ may be considered as a biasing rectifier which supplies no load except that which it supplies to resistor X³, and the purpose of which is to prevent current from flowing from either rectifier R² or R³ when their output voltages are below this bias voltage which will always be below the peak output voltage of the rectifier. With this arrangement, when the voltage of the secondary winding 11 of decoding relay DR predominates so that current is being supplied to secondary winding 27 of decoding transformer DT2 through rectifier R² the voltage drop across the resistor X³ due to this current will be high enough to prevent current from being supplied to secondary winding 28 from secondary 12 through rectifier R³, and when the voltage of secondary winding 12 of decoding relay DR predominates so that current is being supplied to secondary winding 28 of decoding transformer DT2 through rectifier R³, the

voltage drop across resistor X³ due to this latter current will be high enough to prevent current flowing from secondary winding 11 to secondary winding 27 through rectifier R². It will be seen, therefore, that this arrangement has the advantage of preventing the continued flow of current from either rectifier R² or R³ due to their short circuiting action across the associated primary windings 27 and 28 when the alternating current supply to them is interrupted or reduced to a relatively low value.

The operation of the apparatus as a whole when constructed as shown in Fig. 4 is similar to that previously described in connection with Fig. 1 and it is believed, therefore, that this operation will be readily understood from the foregoing description without further detailed description.

Referring now to Fig. 5, the apparatus here shown differs from that shown in Fig. 4 only in that the common biasing resistor X³ and associated biasing rectifier R⁵ shown in Fig. 4 have been replaced by two separate biasing resistors X⁶ and X⁷ across which separate biasing potentials are maintained by means of associated transformers T⁶ and T⁷ and rectifiers R⁶ and R⁷. With this arrangement the biasing rectifiers and associated resistors act to interrupt the currents set up by the decaying flux in the transformer core at a predetermined value in exactly the same manner as was described for the common biasing rectifier R⁵ and resistor X³ in Fig. 4.

Although I have herein shown and described only a few forms of 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, a section of railway track, means for supplying coded current to the rails of said section; a saturation relay comprising a primary winding, a saturation winding, and two secondary windings inductively coupled in such manner that if said primary winding is supplied with alternating current a relatively high voltage will be induced in the one secondary winding or the other secondary winding according as said saturation winding is or is not supplied with direct current; means for constantly supplying said primary winding with alternating current, means for supplying said saturation winding with coded direct current from the rails of said section, a decoding transformer having two primary windings, means including a rectifier connected with the one primary winding of said decoding transformer for supplying it with direct current from said one secondary winding of said relay, means including another rectifier connected with the other primary winding of said decoding transformer for supplying it with direct current from said other secondary winding of said relay, traffic controlling apparatus controlled by the alternating current which is induced in said decoding transformer by the direct currents supplied to its two primary windings, and impedance means associated with the primary windings of said decoding transformer for reducing their inductance when the supply of direct current thereto is cut off to minimize the short circuiting action of said rectifiers on said windings for currents induced therein due to the

decaying flux of the transformer core to improve the efficiency of the apparatus.

2. In combination, a section of railway track, means for supplying coded current to the rails of said section; a saturation relay comprising a primary winding, a saturation winding, and two secondary windings inductively coupled in such manner that if said primary winding is supplied with alternating current a relatively high voltage will be induced in the one secondary winding or the other secondary winding according as said saturation winding is or is not supplied with direct current; means for constantly supplying said primary winding with alternating current, means for supplying said saturation winding with coded direct current from the rails of said section, a decoding transformer comprising two primary windings and a secondary winding and two separate cores one linking each primary winding with said secondary winding, means including a rectifier for connecting the one primary winding of said decoding transformer with said one secondary winding of said saturation relay, means including another rectifier for connecting the other primary winding of said decoding transformer with said other secondary winding of said saturation relay, whereby when coded current is being supplied to the rails of said section there will be induced in the secondary winding of said decoding transformer an alternating current having a frequency corresponding to the code frequency, and traffic governing apparatus controlled by the alternating current which is induced in said last mentioned secondary winding, each said core being provided with an air gap to reduce the impedance of the associated primary winding after power is removed to improve the efficiency of said transformer.

3. In combination, a section of railway track, means for supplying coded current to the rails of said section; a saturation relay comprising a primary winding, a saturation winding, and two secondary windings inductively coupled in such manner that if said primary winding is supplied with alternating current a relatively high voltage will be induced in the one secondary winding or the other secondary winding according as said saturation winding is or is not supplied with direct current; means for constantly supplying said primary winding with alternating current, means for supplying said saturation winding with coded direct current from the rails of said section, a decoding transformer having two primary windings, means including one rectifier connected with the one primary winding of said decoding transformer for supplying it with direct current from said one secondary winding of said relay, means including another rectifier connected with the other primary winding of said decoding transformer for supplying it with direct current from said other secondary winding of said relay, impedance means associated with the primary windings of said transformer for causing a quick cut-off in the currents supplied to said windings, and traffic controlling apparatus controlled by the alternating current which is induced in said decoding transformer by the direct currents supplied thereto by said secondary windings of said relay.

4. In combination, a section of railway track, means for supplying coded current to the rails of said section; a saturation relay comprising a primary winding, a saturation winding, and two secondary windings inductively coupled in such manner that if said primary winding is supplied

with alternating current a relatively high voltage will be induced in the one secondary winding or the other secondary winding according as said saturation winding is or is not supplied with direct current; means for constantly supplying said primary winding with alternating current, means for supplying said saturation winding with coded direct current from the rails of said section, a decoding transformer having two primary windings, means including a rectifier connected with the one primary winding of said decoding transformer for supplying it with direct current from said one secondary winding of said relay, means including another rectifier connected with the other primary winding of said decoding transformer for supplying it with direct current from said other secondary winding of said relay, said two primary windings of said decoding transformer being so arranged that the currents supplied thereto will flow therein in opposite directions, means including a biasing resistor connected in series with the primary windings of said decoding transformer for providing a sharp cut-off in the output of said rectifiers, and traffic controlling apparatus controlled by the alternating current which is induced in said decoding transformer by the direct currents supplied to its primary windings.

5. In combination, a section of railway track, means for supplying coded current to the rails of said section; a saturation relay comprising a primary winding, a saturation winding, and two secondary windings inductively coupled in such manner that if said primary winding is supplied with alternating current a relatively high voltage will be induced in the one secondary winding or the other secondary winding according as said saturation winding is or is not supplied with direct current; means for constantly supplying said primary winding with alternating current, means for supplying said saturation winding with coded direct current from the rails of said section, a decoding transformer having two primary windings, means including a rectifier connected with the one primary winding of said decoding transformer for supplying it with direct current from said one secondary winding of said relay, means including another rectifier connected with the other primary winding of said decoding transformer for supplying it with direct current from said other secondary winding of said relay, said two primary windings of said decoding transformer being so arranged that the currents supplied thereto will flow therein in opposite directions, a resistor connected between said primary windings of said decoding transformer and the associated rectifier and acting as a common path for the flow of current from each rectifier to the associated primary winding, means for impressing across said resistor a biasing voltage which opposes the voltage of the rectifiers, and traffic controlling apparatus controlled by the alternating current which is induced in said decoding transformer by the direct currents supplied to its primary windings.

6. In combination, a section of railway track, means for supplying coded current to the rails of said section, a transformer comprising two primary windings and a secondary winding inductively coupled together, means including two rectifiers one connected with each primary winding and a relay connected with the rails of said section for alternately supplying to said primary windings pulses of direct current in accordance with the code frequency to induce in said secondary winding an alternating current the fre-

quency of which depends upon the code frequency, traffic governing means controlled in accordance with the frequency of the current induced in said secondary winding, and impedance means associated with the primary windings of said transformer for reducing their inductance after each direct current pulse is supplied thereto to minimize the short circuiting action of the associated rectifier for currents induced in the windings by the decaying flux in the transformer core to improve the efficiency of the apparatus.

7. In combination, a transformer comprising two primary windings and a secondary winding inductively coupled together, means including two rectifiers one connected with each primary winding for alternately supplying to said primary windings pulses of direct current to induce in said secondary winding an alternating current having a frequency which depends upon the rate at which the direct current pulses are supplied to said primary windings, resistance means associated with each primary winding of said transformer for reducing the inductance of the associated winding following each current pulse supplied thereto to improve the efficiency of said transformer, and electroresponsive means controlled by said secondary winding and selectively responsive to the frequency of the alternating current induced therein.

8. In combination, a transformer comprising two primary windings and a secondary winding inductively coupled together, means including a pair of rectifiers for alternately supplying direct current to said primary windings to induce in said secondary winding an alternating current having a frequency which depends upon the rate at which the direct current is alternately supplied to said primary windings, impedance means associated with said primary windings for causing the flux induced by the direct current supplied to said primary windings to decay quickly between pulses of current, and signaling means controlled by said secondary winding and selectively responsive to the frequency of the alternating current induced therein.

9. In combination, a transformer comprising two primary windings and a secondary winding, two separate cores one linking each primary winding with said secondary winding, means including two rectifiers one connected with each primary winding for alternately supplying to said primary windings pulses of direct current to induce in said secondary winding an alternating current having a frequency which depends upon the rate at which the direct current pulses are supplied to said primary windings, an air gap in each said core for causing the flux in the core to decay quickly following each current pulse supplied to the associated primary winding, and electroresponsive means controlled by said

secondary winding and selectively responsive to the frequency of the alternating current induced therein.

10. In combination, a transformer comprising two primary windings and a secondary winding, two separate cores one for linking each primary winding with said secondary winding, means for alternately supplying current to said primary windings from separate sources of alternating current through rectifiers whereby an alternating current will be induced in said secondary winding having a frequency which depends upon the rate at which current is supplied to said primary windings, said cores being constructed to have reluctances sufficiently high so that the flux in each core will decay quickly between the pulses of current which are supplied to the associated primary winding, and signaling means connected with said secondary winding and selectively responsive to the frequency of the current induced in said secondary winding.

11. In combination, a transformer comprising two primary windings and a secondary winding inductively coupled together, a resistor, means including two rectifiers one connected in series with each of said primary windings through said resistor for alternately supplying to said primary windings current pulses in such manner that the current pulses always flow in said resistor in the same direction but flow in opposite directions in said primary windings, whereby an alternating voltage is induced in said secondary winding having a frequency which depends upon the frequency of said current pulses, means for impressing across said resistor a voltage which opposes that due to said rectifiers to provide a sharp cut-off in the current supplied to said primary windings, and an electroresponsive device controlled in accordance with the frequency of the current induced in said secondary winding.

12. In combination, a transformer comprising two primary windings and a secondary winding inductively coupled together, a resistor, means including two rectifiers one connected in series with each of said primary windings through said resistor for alternately supplying to said primary windings current pulses in such manner that the current pulses always flow in said resistor in the same direction but flow in opposite directions in said primary windings, whereby an alternating voltage is induced in said secondary winding having a frequency which depends upon the frequency of said current pulses, means including a third rectifier for impressing across said resistor a voltage which opposes that due to said first mentioned rectifiers to provide a sharp cut-off in the currents supplied to said primary windings, and an electroresponsive device controlled in accordance with the frequency of the current induced in said secondary winding.

BERNARD E. O'HAGAN.