May 27, 1941. B. E. O'HAGAN 2,243,740

RAILWAY TRAFFIC CONTROLLING APPARATUS

Original Filed June 10, 1938 2 Sheets-Sheet 1

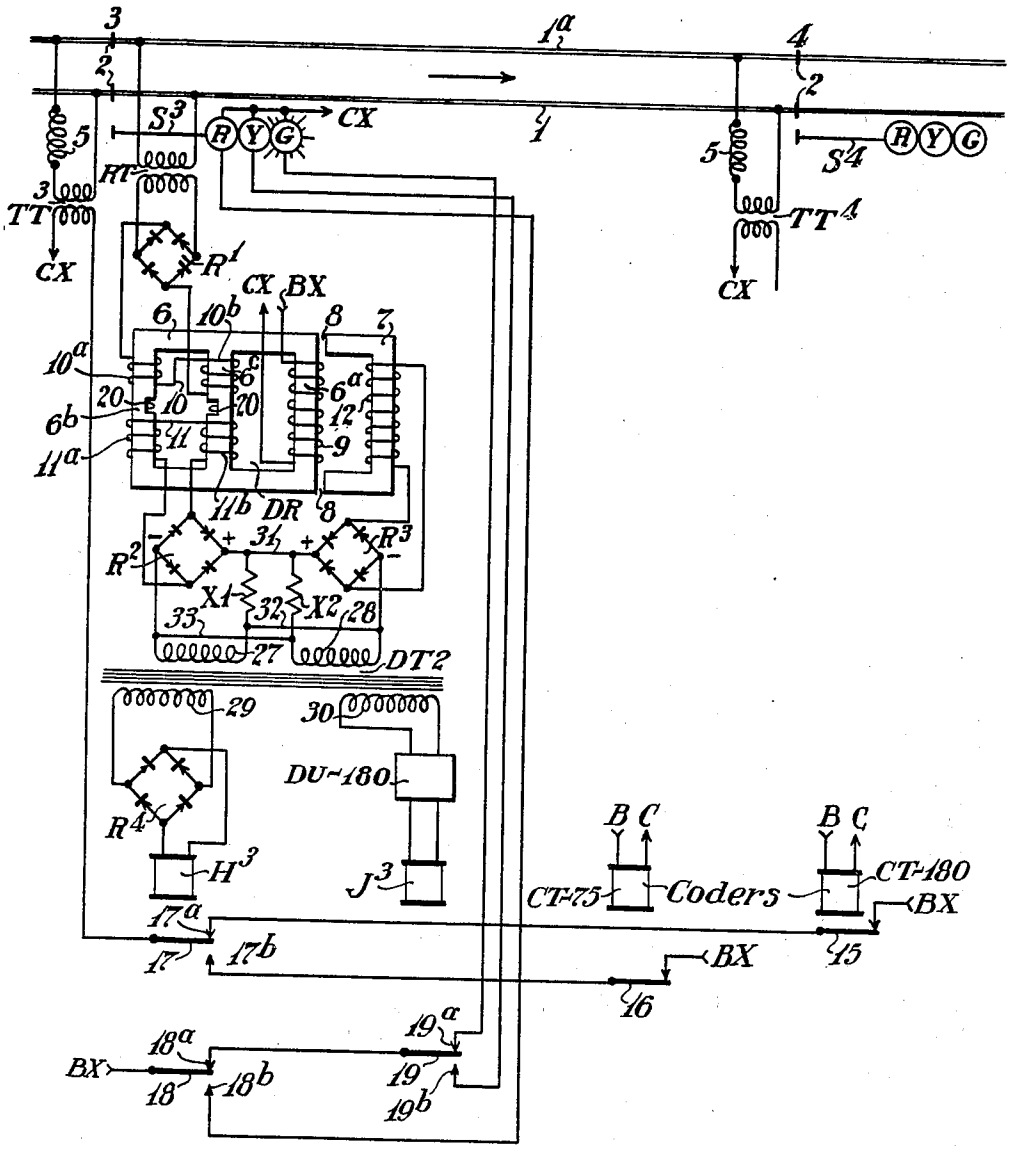


Fig. 1.

INVENTOR
Bernard E. O'Hagan
BY
HIS ATTORNEY

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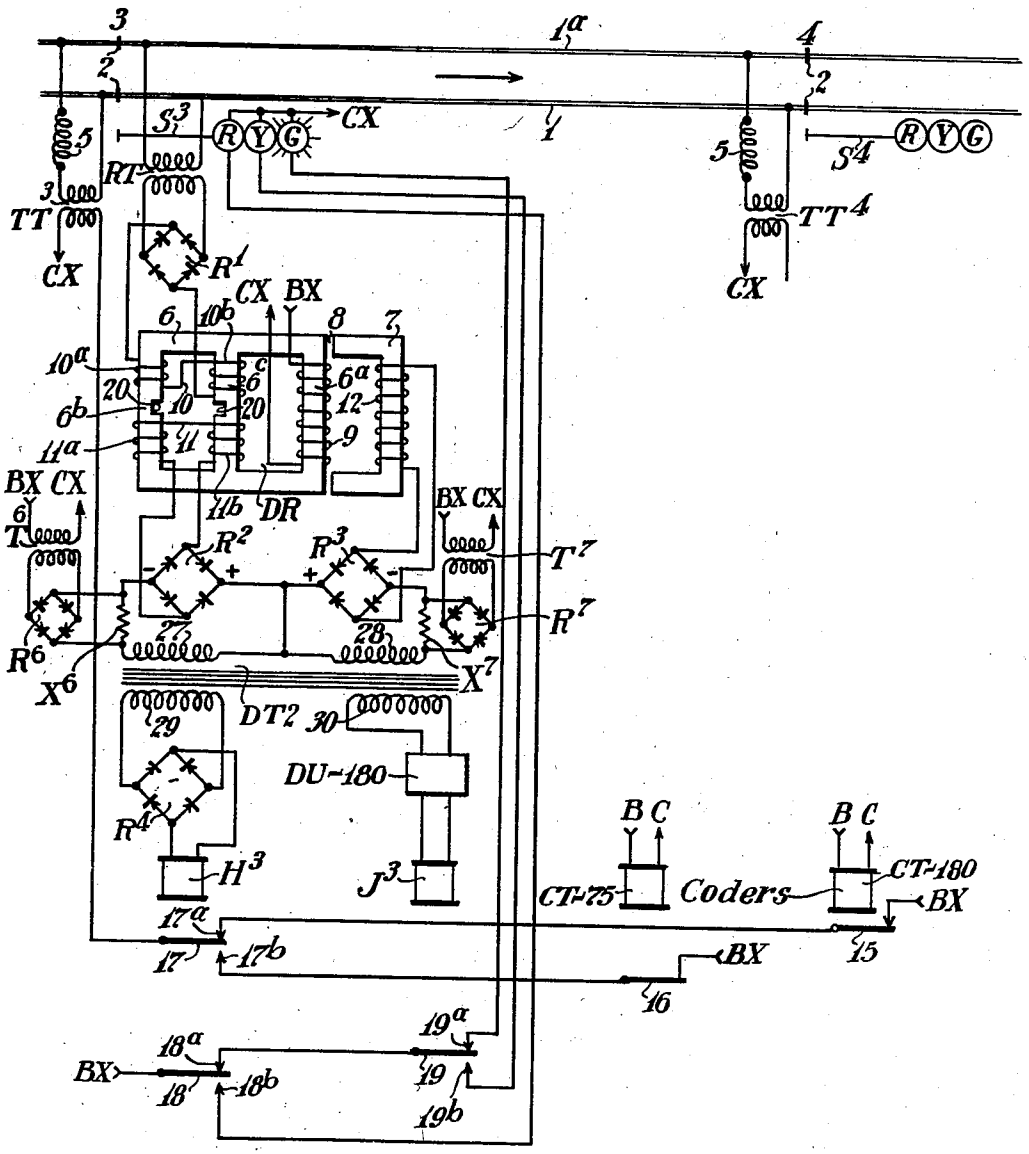


Fig. 2.

INVENTOR
Bernard E. O'Hagan
BY
HIS ATTORNEY

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UNITED STATES PATENT OFFICE

2,243,740

RAILWAY TRAFFIC CONTROLLING APPARATUS

Bernard E. O'Hagan, Swissvale, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Original application June 10, 1938, Serial No. 213,016. Divided and this application August 24, 1940, Serial No. 354,080

4 Claims. (Cl. 246—34)

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.

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.

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

The present application is a division of my copending application, Serial No. 213,016, filed on June 10, 1938, for Railway traffic controlling apparatus.

I shall describe two forms of apparatus embodying my invention, and shall 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 view similar to Fig. 1 showing a modified form of the apparatus illustrated in Fig. 1, and also embodying my invention.

Similar reference characters refer to similar parts in both views.

Referring first to Fig. 1, the reference characters 1 and 1a 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 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, 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.

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 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 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—17a, or the back contact 17—17b of a relay H 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 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 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 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—17a is closed, the rails of the section next in rear will be supplied with alternating current which is 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—17b is closed, the rails of the section next in rear will then be supplied with alternating 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 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 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 illustrated 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 6a of the core 6 by a pair of air gaps 8. The main core 6 is provided with a primary winding 9 consisting of a single coil disposed on the leg 6a; with an input or saturation winding 10 consisting of two coils 10a and 10b disposed on the two legs 6b and 6c, 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 R^1 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 apparatus also 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 a rectifier R^2 in series with a resistor X1, and the primary winding 28 is connected with the output terminals of a rectifier R^3 in series with a resistor X2. The input terminals of the rectifier R^2 are connected with the secondary winding 11 of the decoding relay DR, and the input terminals of the rectifier R^3 are connected with the secondary winding 12 of the decoding relay DR. The resistor X1 is also connected with the output terminals of the rectifier R^3 by means of two wires 31 and 32, while the resistor X2 is similarly connected with the output terminals of the rectifier R^2 by means of the wire 31 and a wire 33, whereby when the rectifier R^2 is delivering current, a voltage will be impressed on the resistor X2 and when the rectifier R^3 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 parts are so arranged that the pulsating direct current which is supplied to the primary windings 27 and 28 from either the rectifier R^2 or the rectifier R^3 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 R^2 will traverse the core of the transformer in the opposite direction from that which is set up by current from the rectifier R^3. It will be seen, therefore, that when coded current is being supplied to the decoding relay DR, an alternating voltage will be induced in the secondary windings 29 and 30 of the decoding transformer 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 function of the resistors X1 and X2 and the associated connections is to provide a sharp cut-off in the output of each rectifier R^2 and R^3 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 R^2 exceeds the potential drop across resistor X2 due to the decaying current from rectifier R^3, the current from rectifier R^3 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 R^3 exceeds the potential drop across resistor X1 due to the decaying current from rectifier R^2, the output of rectifier R^2 will be interrupted. It will be seen, therefore, that with the arrangement shown in Fig. 1 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.

The decoding transformer DT2 supplies energy to the relay H^3 for section 3—4 through the medium of the secondary winding and a

rectifier R^4. Relay H^3 is a direct current relay and is so designed that it will remain energized whenever transformer DT2 is receiving energy from either the 75 or the 180 code. The decoding transformer DT2 for section 3—4 also supplies energy to a direct current decoding relay J^3 which is connected with the secondary winding 30 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 J^3, whereby this relay will be energized when and only when the 180 code is being supplied to the decoding relay.

When relays H^3 and J^3 are both energized, a circuit is completed for lamp G of signal S^3, which circuit passes from terminal BX of the source through front contact 18—18^a of relay H^3, front contact 19—19^a of relay J^3 and the filament of lamp G to terminal CX. When this circuit is closed, lamp G is lighted and under these conditions signal S^3 indicates proceed. When relay H^3 is energized and relay J^3 is deenergized, lamp Y of signal S^3 then becomes lighted by virtue of a circuit which passes from terminal BX through front contact 18—18^a of relay H^3, back contact 19—19^b of relay J^3 and the filament of lamp Y to terminal X, and under these conditions, signal S^3 indicates caution. When, however, relay H^3 is deenergized, lamp R of signal S^3 becomes lighted by virtue of a circuit which passes from terminal BX of the source through back contact 18—18^b of relay H^3 and the filament of lamp R of signal S^3 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 H^3 and J^3 will both be energized, the circuit for the proceed lamp G of signal S^3 including contact 18—18^a of relay H^3 and contact 19—19^a of relay J^3 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 TT^3 including front contact 17—17^a of relay H^3 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 H^3 will remain picked up but relay J^3 will become released, thus causing signal S^3 to indicate caution. The rails of the section next in rear of section 3—4, however, will continued 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 coding apparatus, and relays H^3 and J^3 will then both become released, thus causing signal S^3 to indicate stop. Furthermore, with relay H^3 released, the circuit for the primary of transformer TT^3 including back contact 17—17^b of relay H^3 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.

Referring now to Fig. 2, as here shown the apparatus is similar to that shown in Fig. 1 with the exception that the biasing resistors X1 and X2 have been replaced by two resistors X^6 and X^7 across which separate constant potentials are maintained by means of associated transformers T^6 and T^7 and rectifiers R^6 and R^7. The parts are so arranged that the current which is supplied to the primary winding 27 from the rectifier R^2 will flow through this winding in a direction opposite to that in which the current which is supplied to the primary winding 28 from the rectifier R^3 flows through this latter winding and the polarities of the rectifiers R^6 and R^7 are such as to oppose the voltages of rectifiers R^2 and R^3. It will be seen, therefore, that the rectifiers R^6 and R^7 may be considered as biasing rectifiers which supply no load except that due to the associated resistors X^6 and X^7, and the purpose of which rectifiers is to prevent current from flowing from either rectifier R^2 or R^3 when their output voltages are below their biasing voltages which latter voltages will always be below the peak output voltages of the rectifiers R^2 and R^3. It follows that this arrangement has the advantage of preventing the continued flow of current from either rectifier R^2 or R^3 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.

Although I have herein shown and described only two 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 transformer comprising two primary windings and a secondary winding inductivly coupled together, means including two rectifiers each connected with a different one of said primary windings in series with a different resistor for alternately supplying to said primary windings pulses of direct current which flow in opposite directions therein to induce in said secondary winding an alternating current having a frequency which depends upon the frequency of said pulses, means for impressing across each resistor a voltage which opposes that due to the associated rectifier to provide a sharp cut-off in the currents supplied to said primary windings, and electroresponsive means controlled in accordance with the frequency of the current induced in said secondary winding.

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 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, two resistors, means for impressing across each resistor a voltage which is in opposition to that supplied by the associated rectifier to provide a sharp cut-off in the current supplied by the rectifier, 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.

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 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, two resistors, one connected between each primary winding of said transformer and the associated rectifier, means for impressing across each resistor the voltage supplied by the rectifier which causes current to flow in the other resistor, 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 transformer comprising two primary windings and a secondary winding inductively coupled together, means including two rectifiers one connected with each said primary winding in series with a resistor 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 frequency of the current pulses, means for connecting each resistor with the rectifier which is not connected in series therewith to at times impress across such resistor a voltage which opposes that due to the associated rectifier to provide a sharp cut-off in the flow of current to said primary windings from the associated rectifier, and electro-responsive means controlled in accordance with the frequency of the current induced in said secondary winding.

BERNARD E. O'HAGAN.