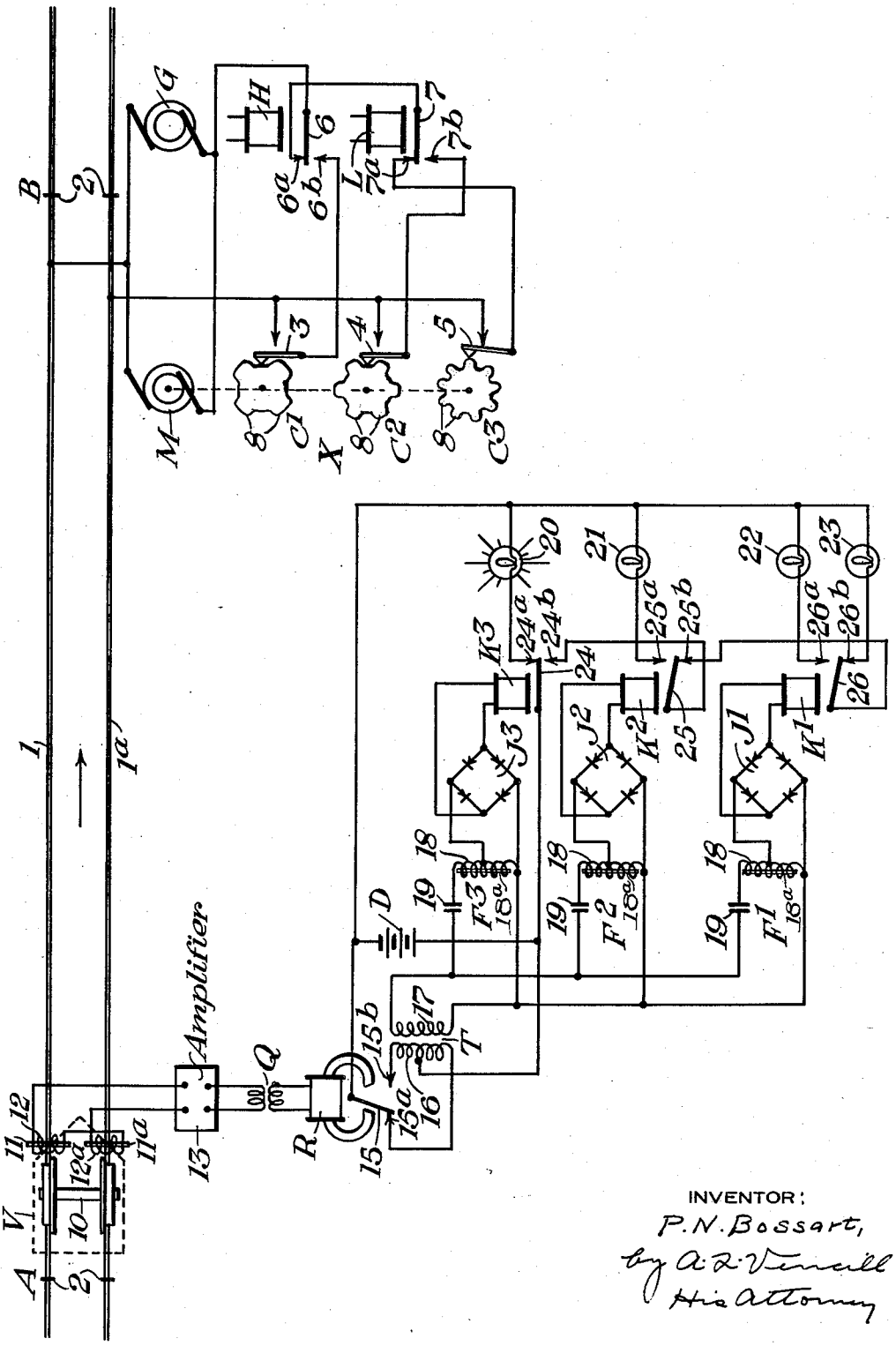
Aug. 19, 1930. P. N. BOSSART 1,773,472

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Feb. 7, 1927



INVENTOR:
P. N. Bossart,
by A. R. Vinall
His Attorney

Patented Aug. 19, 1930 1,773,472

UNITED STATES PATENT OFFICE

PAUL N. BOSSART, OF SWISSVALE, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

RAILWAY-TRAFFIC-CONTROLLING APPARATUS

Application filed February 7, 1927. Serial No. 166,407.

My invention relates to railway traffic controlling apparatus, and particularly to apparatus of the type comprising means for supplying the trackway with alternating current which is periodically varied at different frequencies, and governing means on the train selectively responsive to the frequency of such variations.

I will describe one form of railway traffic controlling apparatus embodying my invention, and will then point out the novel features thereof in claims.

The accompanying drawing is a diagrammatic view illustrating one form of railway traffic controlling apparatus embodying my invention.

Referring to the drawing, 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 rails are divided, by means of insulated joints 2, into a plurality of successive track sections only one of which, A—B, is shown complete in the drawing. Train controlling current is supplied to the rails of this section from a suitable source of energy such as an alternator G. The current supplied to the trackway by this alternator may be of a frequency of the order of the usual commercial alternating current such for example as 60 cycles or 100 cycles per second.

The supply of current to the track rails is controlled by a coding device designated in general by the reference character X and comprising a plurality of rotatable cams each designated by the reference character C with a suitable distinguishing exponent. The cams C are driven at a constant speed by a suitable motor M which is supplied with current from the alternator G. The cam C^1 is provided with a plurality of swells 8 spaced about its periphery and which swells successively engage a contact 3 to periodically close the contact as the cam C^1 is rotated. In similar manner the cams C^2 and C^3 are provided with different numbers of swells 8 which control contacts 4 and 5, respectively. One terminal of the alternator G is constantly connected with rail 1 of section A—B, and the other terminal of the alternator is connected with the rail 1^a through one of the contacts 3, 4 or 5, depending upon traffic conditions.

It is manifest that the alternating current supplied to the rails of the trackway by alternator G is periodically varied at the frequency of operation of the contact of the device X that is interposed between the alternator and the track rail 1^a. The coding device X may be constructed to cause such variations at any reasonable frequencies, but for purposes of illustration, I will assume that the cams C are rotating at 20 revolutions per minute, that cam C^1 has 4 swells, that cam C^2 has 6 swells, and that cam C^3 has 9 swells. The selection between the several contacts of the coding device X in accordance with traffic conditions may be accomplished in any suitable manner such, for example, as by means of a home relay H and a distant relay L. The circuits for controlling these two relays form no part of my present invention and are omitted from the drawing for the sake of simplicity. For present purposes it is sufficient to state that home relay H is normally energized but is de-energized when a train occupies the section immediately to the right of point B. The distant relay L is also normally energized but is de-energized when a train occupies either the first or the second section immediately to the right of point B. With the apparatus thus far described, when relays H and L are both energized so that front contact 6—6^a of relay H and front contact 7—7^a of relay L are closed, current from alternator G, which current I will assume to be of 100 cycles per second, is supplied to the track rails over contact 5 operated by cam C^3. Under these conditions the alternating current supplied to the trackway is periodically varied at a frequency of 180 cycles per minute. Current supplied to the trackway under these conditions, I will hereinafter term the "proceed code". When relay H is energized and relay L is de-energized, the closing of back contact 7—7^b of relay L includes contact 4 controlled by cam C^2 in the trackway circuit, and under these conditions the track-

way is supplied with 100 cycle current interrupted at a frequency of 120 cycles per minute; this current I shall hereinafter term the "caution code". In similar manner when relay H is de-energized, the closing of back contact 6—6^b of this relay completes a circuit from alternator G to the track rails through contact 3 operated by cam C^1. Under these conditions the trackway is supplied with 100 cycle current interrupted at a frequency of 80 cycles per minute, which current I will call the "slow code".

The train indicated diagrammatically at V is provided with governing means which is responsive to the frequency of the periodic variations in the 100 cycle current supplied to the trackway. In the present embodiment of my invention the train is provided with two magnetizable cores 11 and 11^a located in advance of the forward axle 10 and disposed in inductive relation to the two track rails 1 and 1^a, respectively. Core 11 is provided with a winding 12, and core 11^a is provided with a winding 12^a, the two windings 12 and 12^a being connected in series in such manner that the voltages induced therein by train controlling current flowing in opposite directions in the track rails at any instant are additive. Windings 12 and 12^a are connected through an amplifier 13 and a transformer Q with a polarized relay R. When train controlling current is being supplied to the trackway, pulsating energy is delivered to the primary of transformer Q at the frequency of the periodic variations in such trackway current. For each impulse of energy supplied to transformer Q, during the increase of such current, an impulse of one relative polarity is supplied to relay R and during the decrease of such current, an impulse of the opposite relative polarity is supplied to the relay. The relay R is responsive to the relative polarity of the current supplied thereto and it follows that when the train controlling current supplied to the trackway is being periodically varied, the relay R is operated to close its normal and reverse contacts 15—15^a and 15—15^b alternately at a frequency which corresponds to the frequency of the variations of the trackway current.

Associated with relay R is a transformer T comprising a primary 16 and a secondary 17. Direct current is supplied to the primary 16 of transformer T from a suitable source of energy such as a battery D and the supply of such current is periodically varied in accordance with the frequency at which relay R operates. As shown in the drawing, when relay R is energized in one direction to close contact 15—15^a, current flows from battery D through the lower half of primary 16 in one direction, but when contact 15—15^b is closed current flows from battery D, through the upper half of primary 16 in the opposite direction. It follows that when relay R is operated intermittently, the current in primary 16 of transformer T is periodically reversed and re-established in original direction at the same frequency as the periodic variations in the trackway current.

As a result of this periodic current in the primary of transformer T there is induced in the secondary 17 an alternating electromotive force of a corresponding frequency, which electromotive force is applied to a plurality of circuits each designated by the reference character F with a distinguishing exponent, and each comprising a reactor 18 and a condenser 19 by means of which the several circuits are tuned respectively to the frequencies of the variations in the train controlling current. For example circuit F is tuned to resonance at the frequency of the interruptions in the proceed code or 180 cycles per minute. A relay K^3 is connected across a portion of reactor 18 of circuit F^3 through a rectifier J^3. In similar manner circuit F^2 is tuned to resonance at 120 cycles per minute and relay K^2 is connected across a portion of reactor 18 of this circuit through a rectifier J^2. Relay K^1 is connected, through rectifier J^1, with a portion of reactor 18 of circuit F^1, which circuit is resonant at 80 cycles per minute. The rectifiers J may be of any suitable type but I have discovered that the operation of the apparatus is materially improved if the rectifiers are of the type comprising a symmetrical conductors each made up of a metallic member having formed thereon a compound of the metal. Rectifiers of this type are shown and described in an application for Letters Patent of the United States Serial No. 1111, filed January 7, 1925, by Lars O. Grondahl, for uni-directional current carrying devices. I have discovered that rectifiers of this type which exhibit the peculiarity of materially increasing their rectifying ratios in response to increases in the electromotive force applied thereto may be used to greatly increase the selectivity of a filtering circuit. The advantage obtained by rectifiers of this type in the apparatus illustrated will be explained in detail hereinafter.

In explaining the operation of the apparatus as a whole, I will first assume that the proceed code is being supplied to the trackway so that the trackway current is being interrupted at a frequency of 180 cycles per minute. Relay R therefore operates at a rate of 180 cycles per minute and alternating current of a corresponding frequency is supplied to each of the circuits F. At this frequency circuits F^1 and F^2 are detuned so that the electromotive force across those portions of reactors 18 of these circuits to which the corresponding relays K are connected is comparatively small. Circuit F^3 is tuned to resonance at this frequency and the resonant rise of electromotive force in reactor 18 is comparatively large. A comparatively large

electromotive force is therefore applied to rectifier J^3, resulting in a comparatively large current in the relay K^3. Due to the increase in electromotive force applied to the rectifier J^3 the rectifying ratio of this device also increases. It follows that a correspondingly increased proportion of the current is supplied to relay K^3. As a result of the combination of the tuned circuit and the rectifier, the sensitivity of the relay K^3 to the frequency of the current supplied by secondary 17 of transformer T is materially improved, and although relay K^3 is adjusted to become energized when the proceed code is being supplied to the trackway a very small variation in the frequency of the current supplied to the filter circuits will so reduce the current in the relay K^3 that this relay will open. When the train is receiving the proceed code, therefore, relay K^3 is energized, but relays K^1 and K^2 are de-energized. Under these conditions, current from battery D flows through front contact 24—24^a of relay K^3 to light lamp 20, thereby displaying a proceed indication.

I will now assume that the caution code is being supplied to the trackway so that relay R is operating at a frequency of 120 cycles per second. Alternating current of a corresponding frequency is therefore supplied to the circuits F by secondary 17 of transformer T. Under these conditions the current supplied to relays K^3 and K^1 is not sufficient to energize the relays but due to the tuning effect of circuit F^2, which filter is resonant at 120 cycles per minute, there is a comparatively high resonant electromotive force in reactor 18. As a result the rectifying ratio of J^2 is comparatively high and sufficient current is supplied to relay K^2 to energize this relay. Under these conditions current from battery D flows over back contact 24—24^b of relay K^3 and front contact 25—25^a of relay K^2 to lamp 21, thereby lighting this lamp to indicate caution.

In similar manner when the slow code is being supplied to the trackway, relays K^3 and K^2 are both de-energized, but circuit F^1 is tuned to resonance at the frequency of the current now supplied by secondary 17 of transformer T so that relay K^1 is energized and current from battery D flows over back contact 24—24^b of relay K^3, back contact 25—25^b of relay K^2 and front contact 26—26^a of relay K^1 to lamp 22. Lamp 22 is therefore lighted to indicate slow.

If section A—B were occupied by a second train located between train V and point B, train controlling current would be shunted away from train V by the wheels and axles of such second train. As a result relay R would be continuously de-energized. If, for this reason, or for any other reason, relay R should fail to operate intermittently, the supply of energy to all the relays K would be discontinued and these relays would be open. Current would then flow from battery D, over back contact 24—24^b of relay K^3 back contact 25—25^b of relay K^2, and back contact 26—26^b of relay K^1 to lamp 23, thereby lighting this lamp to display a stop indication.

For purposes of explanation, I have described the relays K as controlling only the lamps 20, 21, 22 and 23, but it should be understood that these relays may control train governing means of any suitable type not shown in the drawing.

Referring again to the operation of the rectifiers J in improving the discrimination between frequencies, it will be noted that each rectifier is connected in parallel with a portion of the associated reactor 18. The rectifier connected in this manner is electrically equivalent to a small resistance connected in series with the reactor, and when the resistance of the rectifier increases, as it does when the power in the tuned circuit decreases, it has the same effect as a decrease in the equivalent series resistance. The net result is that the rectifier power output, that is, the relay current, is decreased. This operation assists materially in producing sharp selectivity between frequencies supplied to the apparatus.

The resonant circuits F are tuned to frequencies of a comparatively low order of magnitude and I have discovered that in order to accomplish sharp tuning under these conditions it is desirable to construct each reactor 18 with a magnetizable core 18^a and to so proportion the parts of the reactor that at the maximum flux density of the core, the iron comprising the core exhibits approximately its maximum permeability. This maximum flux density of the core will, of course, be variable if the electromotive force of source D is variable, as would be the case if the source were the usual headlight generator on the locomotive. In such event, it is obvious that the parts should be so proportioned that the maximum permeability of the core of each reactor, and hence the maximum inductance of each reactor, will correspond substantially to the maximum flux density for the lowest value of current for which the associated relay K is intended to operate.

Wherever, therefore, in the specification and claims, I have used in this connection, the core of each reactor, and hence the maxmum value of the current" or similar expressions, it is understood that I mean the peak values of the flux density or current for the minimum operating current, when the electromotive force of source D is variable. One advantage of this construction is that the inductive reactance of a reactor of the type described decreases in response to reductions in the current supplied thereto. It follows that any decrease in the current through one of the reactors 18 due, for example, to the re-

sponse of the tuned circuit F including such reactor, to current of a frequency different from that to which the circuit is tuned, decreases the inductive reactance of such reactor and causes the associated circuit F to be tuned to resonance at a slightly higher frequency than that to which it is normally tuned. As a result the current supplied to the associated relay K is still further decreased. With the parts constructed in this manner the harmonics of the fundamental current which is supplied by the secondary of transformer T are suppressed in the tuned circuits due to the high reactance offered to said harmonics by the reactors 18. It is therefore possible to accomplish sharper tuning than with a simple tuned circuit and this tuning is substantially unaffected by variations in the wave form of the current supplied by transformer T. One advantage of this feature is that the apparatus may be operated successfully by the output produced by simply making and breaking a circuit. It will be apparent that the modulations in the current supplied to primary 16 of transformer T are practically square, but the harmonics are choked out and the apparatus gives substantially the same response as if the primary currents were modulated according to a pure sine wave.

I have disclosed apparatus which supplies only three codes to the trackway and have shown train carried governing means adapted to distinguish only between these three codes. It should be understood, however, that my invention is not limited to this number of codes but that the equipment could be expanded to provide additional code frequencies and additional tuned circuits on the train to select between such frequencies.

Although I have herein shown and described only one form of railway traffic controlling 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 source of alternating currents of different frequencies of the order of 80 to 180 cycles per minute, a plurality of circuits all receiving energy from the source and each comprising a reactor and a condenser tuned to resonance at one of said frequencies, a relay connected with a portion of each reactor, and a rectifier interposed between each relay and the associated reactor.

2. Railway traffic controlling apparatus comprising means for supplying alternating current to the trackway, means for periodically varying such current at different frequencies, a train carried relay responsive to such variations but not to such alternating current, a transformer, means controlled by the relay for supplying periodic currents to the primary of the transformer at a frequency depending upon the frequency of such variations, a plurality of parallel circuits connected with the secondary of the transformer and each tuned to resonance at a different one of said frequencies, a plurality of other relays, one for each of said circuits, and each connected in parallel with a portion of the associated circuit, and governing means selectively controlled by the other relays.

3. Railway traffic controlling apparatus comprising means for supplying alternating current to the trackway, means for periodically varying such current at different frequencies, a train carried transformer, means for supplying periodically varying current to the primary of the transformer at the same frequency as the frequency of such variations, a plurality of parallel circuits connected with the secondary of the transformer and each tuned to resonance at a different one of said frequencies, a plurality of other relays, one for each of said circuits, and each connected in parallel with a portion of the associated circuit, and governing means selectively controlled by the other relays.

4. In combination, a source of periodic current, a reactor comprising a winding connected with the source and a magnetizable core offering its maximum permeability to the flux created therein by maximum values of the current in said winding, means for tuning the winding to resonance at the frequency of such current, and a relay connected with a portion of the winding.

5. In combination, a source of periodic currents of different frequencies, a plurality of reactors each comprising a winding connected with the source and a magnetizable core so proportioned that the maximum density of the flux created in the core by current supplied to the winding from the source approximately corresponds to the maximum permeability of the core, means for tuning each reactor to resonance at one of such frequencies, and a plurality of relays one connected with a portion of each said reactor winding.

6. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, a train carried reactor comprising a magnetizable core and a winding receiving energy according to such variations and tuned to resonance at one of such frequencies, said core having its maximum permeability at substantially the density of the flux created therein by maximum values of the current supplied to the windings, a relay connected across a por-

tion of the winding, and governing means controlled by the relay.

7. Railway traffic controlling apparatus comprising means for supplying the track rails with alternating current of a commercial frequency periodically varied at different frequencies of the order of 80 to 180 cycles per minute, a train carried relay controlled by said current and responding to the periodic variations thereof, a transformer, means controlled by said relay for supplying the primary of said transformer with current at the frequency of operation of the relay, a plurality of parallel circuits connected with the secondary of said transformer and tuned to resonance respectively at the several frequencies of periodic variation of said track rail current, each circuit including a reactor comprising a winding on a magnetizable core which offers its maximum permeability to the flux created therein by the maximum value of the current in the associated winding, a full wave rectifier connected across a portion of each reactor and having the characteristic of increasing its rectifying ratio with increases of voltage, a relay supplied with current by each rectifier, and governing means controlled by said latter relays.

8. Railway traffic controlling apparatus comprising means for supplying the track rails with alternating current of a commercial frequency periodically varied at different frequencies of the order of 80 to 180 cycles per minute, a train carried relay controlled by said current and responding to the periodic variations thereof, a plurality of circuits tuned to resonance respectively at the several frequencies of periodic variation of the current in the track rails, means for supplying all said circuits with periodic current at the frequency of operation of the relay, a rectifier connected across a portion of each said circuit, a relay supplied with current by each rectifier, and governing means controlled by said latter relays.

9. Railway traffic controlling apparatus comprising means for supplying the track rails with alternating current of a commercial frequency periodically varied at different frequencies of the order of 80 to 180 cycles per minute, a train carried relay controlled by said current and responding to the periodic variations thereof, a plurality of circuits tuned to resonance respectively at the several frequencies of periodic variation of the current in the track rails, means for supplying all said circuits with periodic current at the frequency of operation of the relay, a full wave rectifier connected across a portion of each reactor and having the characteristic of increasing its rectifying ratio with increases of voltage, a relay supplied with current by each rectifier, and governing means controlled by said latter relays.

10. Railway traffic controlling apparatus comprising means for supplying the track rails with alternating current of a commercial frequency periodically varied at different frequencies of the order of 80 to 180 cycles per minute, a train carried relay controlled by said current and responding to the periodic variations thereof, a plurality of circuits tuned to resonance respectively at the several frequencies of periodic variation of the current in the track rails, each circuit including a reactor comprising a winding on a magnetizable core which offers its maximum permeability to the flux created therein by the maximum value of the current in the associated winding, means for supplying all said circuits with periodic current at the frequency of operation of the relay, a rectifier connected across a portion of each reactor, a relay supplied with current by each rectifier and governing means controlled by said latter relays.

11. In combination, a source of periodic current, a reactor comprising a winding connected with said source, means for tuning said winding to resonance at the frequency of said current, a full wave rectifier connected across a portion of said winding and having the characteristic of increasing its rectifying ratio with increases in voltage, and an electro-responsive device supplied with current by said rectifier.

12. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current, means for periodically varying such current at different frequencies, and a plurality of train carried devices all controlled by energy received from the trackway and respectively tuned to electrical resonance at said frequencies.

13. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, a plurality of devices on the train respectively tuned to electrical resonance at such frequencies, and means for supplying each such device with periodic current of the same frequency as the variations of the first named current.

14. Railway traffic controlling apparatus comprising a train carried transformer, means located partly in the trackway for supplying the primary of the transformer with periodic currents of different frequencies of the order of 80 to 180 cycles per minute, and a plurality of devices connected with the secondary of the transformer through circuits tuned respectively to electrical resonance at such frequencies.

15. In combination, a source of alternating current, means for periodically varying the current delivered by the source at different frequencies, a plurality of devices receiving energy according to such variations and tuned respectively to electrical resonance at such

frequencies, and governing means selectively controlled by such devices.

16. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current, means for periodically varying such current at different frequencies, a plurality of rectifiers on the train, a plurality of relays one connected in the output circuit of each rectifier, and an input circuit for each rectifier receiving alternating current of the same frequencies as the frequencies of such variations and tuned to resonance at such frequencies respectively.

17. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, a first train carried relay controlled by energy received from the trackway and operating at the frequency of such variations, two other relays on the train, means controlled by the first relay for supplying such other relays with periodic current of the frequency of such variations, means for tuning one of such other relays to electrical resonance at one of such frequencies, and governing means selectively controlled by such two other relays.

18. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current of commercial frequency periodically interrupted at different frequencies of the order of 80 to 180 cycles per minute, and a plurality of train carried devices all controlled from the trackway and tuned respectively to electrical resonance at the different frequencies of periodic interruption of said trackway current.

19. Railway traffic controlling apparatus comprising means for supplying alternating current to the trackway, means for periodically varying such current at different frequencies, means including a source of energy on the train controlled by such periodically varied trackway current for delivering alternating currents of different frequencies corresponding to the frequencies of such variations, and resonant means on the train selectively responsive to the frequencies of the currents delivered by said last mentioned means.

20. In combination, a first source of alternating current, means for periodically varying such current, means for producing a second alternating current the frequency of which depends upon the frequency of the variations of the current from the first source, and a plurality of devices each tuned to resonance at a different frequency and all receiving such second alternating current.

21. In combination, a section of railway track, means for supplying the track rails of said stretch with alternating current periodically varied at different frequencies, and a plurality of governing devices all controlled by energy received from the track rails and respectively tuned to electrical resonance at said frequencies.

22. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, and a plurality of governing devices all controlled by energy received from the trackway and respectively tuned to electrical resonance at said frequencies.

23. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, a plurality of devices all controlled by energy received from the trackway and respectively tuned to electrical resonance at said frequencies, and governing means selectively controlled by said devices.

24. Railway traffic controlling devices comprising means for supplying the trackway with alternating current periodically varied at different frequencies in accordance with traffic conditions, a plurality of devices controlled by energy received from the trackway and respectively tuned to electrical resonance at said frequencies, and governing means selectively controlled by said devices.

25. In combination, a source of alternating current periodically varied at different frequencies, a plurality of devices receiving energy in accordance with such variations and tuned respectively to electrical resonance at such frequencies, and governing means selectively controlled by such devices.

26. In combination, a source of varying current of one periodicity, means for periodically varying the current delivered by such source at a selected one of a plurality of different frequencies, a plurality of devices all controlled by energy from said source nd each tuned to electrical resonance at an individual one of such different frequencies, and governing means selectively controlled by said devices.

27. In combination, a source of periodic current, means for periodically varying the current delivered by said source at different frequencies, a plurality of devices receiving energy according to such variations and tuned respectively to electrical resonance at such frequencies, and governing means selectively controlled by said devices.

28. In combination, a source of periodic current, means for periodically varying the current delivered by said source at different frequencies of the order of 80 to 180 cycles per minute, a plurality of devices all controlled by energy received from said source and tuned respectively to electrical resonance at such frequencies, and governing means selectively controlled by said devices.

29. Railway traffic controlling apparatus comprising means for supplying the trackway with periodic current periodically inter-

rupted at different frequencies of the order of 80 to 180 cycles per minute, and a plurality of governing devices all controlled from the trackway and tuned respectively to electrical resonance at the different frequencies of periodic variations of said trackway current.

30. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current of commercial frequencies periodically varied at different frequencies of the order of 80 to 180 cycles per minute, and a plurality of governing devices all controlled from the trackway and tuned respectively to electrical resonance at the different frequencies of the periodic variations of said trackway current.

31. Railway traffic controlling apparatus comprising means for supplying the trackway with periodic current regularly varied at different frequencies, and a plurality of governing devices all controlled by energy received from the trackway and respectively tuned to electrical resonance at said frequencies.

32. In a frequency selective circuit supplied with periodic current, a condenser, and an iron core reactor for tuning said circuit to resonance at the frequency of such current, the core of said reactor exhibiting substantially its maximum permeability for the resonant current in the circuit.

33. In a frequency selective circuit supplied with periodic current, a condenser, and an iron core reactor for tuning said circuit to resonance at the frequency of such current, the core of such reactor exhibiting substantially its maximum permeability for the flux density corresponding to the peak values of the resonant current in said circuit.

34. In a frequency selective circuit supplied with periodic currents of different frequencies, a capacity and an iron core reactor for tuning said circuit to resonance at one of said frequencies, said reactor offering substantially its maximum inductance at current values corresponding to resonance in said circuit.

35. In combination with a source of periodic current and a load, a circuit for supplying current from the source to the load and comprising a condenser and an iron core reactor having an inductance which balances the capacity of said condenser at the frequency of said current for the specific value of current in said circuit corresponding to the resonant condition of the circuit, the inductance of said reactor decreasing in response to any change in said current from said specific value to detune said circuit at said frequency.

36. In a frequency selective circuit supplied with periodic current, a condenser, and an iron core reactor for tuning said circuit to resonance at the frequency of such current, the core and winding of such reactor being so proportioned that increases in current in said circuit up to the value corresponding to resonance increase the inductance of said reactor.

37. In a frequency selective circuit supplied with periodic currents of different frequencies, a capacity and an iron core reactor for tuning said circuit to resonance at one of said frequencies, said reactor having its core and winding so proportioned that any change in the magnitude of such current due to a change in the frequency of such current away from the resonant frequency of the circuit decreases the inductance of said reactor and detunes the circuit at said one frequency.

38. In combination, a source of periodic current, a circuit receiving energy from said source and containing a condenser and a reactor for tuning said circuit to resonance at the frequency of such current, and a magnetizable core for said reactor having its maximum permeability corresponding substantially to the peak values of the current in said circuit at resonance, whereby any change in the current in said circuit from its resonant value decreases the inductance of said reactor and tunes the circuit to resonance at a higher frequency than that of said source.

39. In combination, a source of periodic current, a circuit receiving current from said source and including a reactor having a magnetizable core and a condenser the impedance of which balances the maximum impedance of said reactor at the frequency of said source, the reactor being so proportioned that the maximum impedance of said reactor corresponds to the maximum values of the magnetization of said core.

40. In combination, a source of periodic current, a circuit containing a condenser and a reactor having a winding for tuning said circuit to resonance at the frequency of such current, a magnetizable core for said reactor exhibiting substantially its maximum permeability at the peak values of the current in said circuit at resonance, and a load connected with a portion of said winding.

41. In combination, a source of periodic current, a circuit containing a condenser and a reactor having a winding for tuning said circuit to resonance at the frequency of such current, a magnetizable core for said reactor exhibiting substantially its maximum permeability at the peak values of the current in said circuit at resonance, a fully wave rectifier connected across a portion of said winding and having the characteristic of increasing its rectifying ratio with increases in the electromotive force applied thereto, and an electroresponsive device supplied with current by said rectifier.

42. In combination a source of periodic current of the order of 80 to 180 cycles per minute, a circuit receiving energy from said source and containing a condenser and an

iron core reactor having its maximum impedance equal to the impedance of said condenser at the frequency of said source, and a relay receiving energy from said circuit.

43. In combination, a source of periodic current of the order of 80 to 180 cycles per minute, a circuit receiving energy from said source and containing a condenser and an iron core reactor having its maximum impedance equal to the impedance of said condenser at the frequency of said source, a rectifier connected across a portion of said reactor and having the characteristic of increasing its rectifying ratio in response to increases in the electromotive force supplied thereto, and a relay receiving energy from said rectifier.

44. The method of rendering a circuit selective to the frequency of the current supplied thereto which consists in combining in the circuit a capacity and an iron core reactor tuned to resonance at a particular frequency, and proportioning the parts so that the inductance of said reactor decreases in response to a change in the current in the circuit from its resonant value.

45. The method of rendering a relay selectively responsive to the frequency of the current supplied thereto which consists of supplying current to the relay through a circuit containing a capacity and a reactor, and proportioning the parts so that for the maximum inductance of the reactor the circuit is resonant at a particular frequency.

46. The method of tuning a circuit to resonance at a particular frequency which consists in combining in the circuit a capacity and a reactor having a variable inductance the maximum value of which tunes said capacity to resonance at said frequency and corresponds to the peak values of the resonant current in said circuit.

47. The method of rendering a relay selectively responsive to the frequency of the current from a source which consists in supplying the current to a circuit including a capacity and a reactor having a variable inductance the maximum value of which tunes said capacity to resonance at a particular frequency and corresponds to the peak values of the resonant current in said circuit, and connecting said relay with a portion of said reactor through a rectifier having the characteristic of increasing its rectifying ratio in response to increases in the electromotive force applied thereto.

48. The method of discriminating between periodic currents of different frequencies which consists in supplying the currents to a circuit including a reactor having a magnetizable core and a condenser having the same impedance as the maximum impedance of said reactor at one of said frequencies, and proportioning said reactor in such manner that the impedance of the reactor reaches its maximum values with the maximum values of the magnetization of such core.

49. In combination, a source of periodic currents of different frequencies of the order of 80 to 180 cycles per minute, a plurality of rectifiers, a relay connected with the output circuit of each rectifier; and an input circuit for each rectifier including the source, a condenser, and a reactor in series and each such input circuit being tuned to resonance at a different one of such frequencies.

50. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, two train carried relays, a circuit for each relay supplied with periodic current of the same frequency as such variations, means included in one circuit for tuning such circuit to electrical resonance at one of such frequencies, and governing means selectively controlled by said relays.

51. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current periodically varied at different frequencies, a plurality of train carried relays, a plurality of circuits each including one of said relays and tuned respectively to such frequencies, means for supplying all said circuits with periodic current of the frequency of such variations, and governing means selectively controlled by the relays.

52. Railway traffic controlling apparatus comprising means for supplying the trackway with alternating current of commercial frequency, means for periodically varying such current at 80 or 120 cycles per minute according to traffic conditions, two relays on the train each provided with a circuit receiving periodic current of the same frequency as the variations in the trackway current, means included in one said circuit for tuning such circuit to resonance at 120 cycles per minute, and governing means selectively controlled by said relays.

In testimony whereof I affix my signature.

PAUL N. BOSSART.