Oct. 29, 1957 A. HUFNAGEL 2,811,634

RAILWAY TRAFFIC CONTROL APPARATUS

Filed Sept. 30, 1953 2 Sheets-Sheet 1

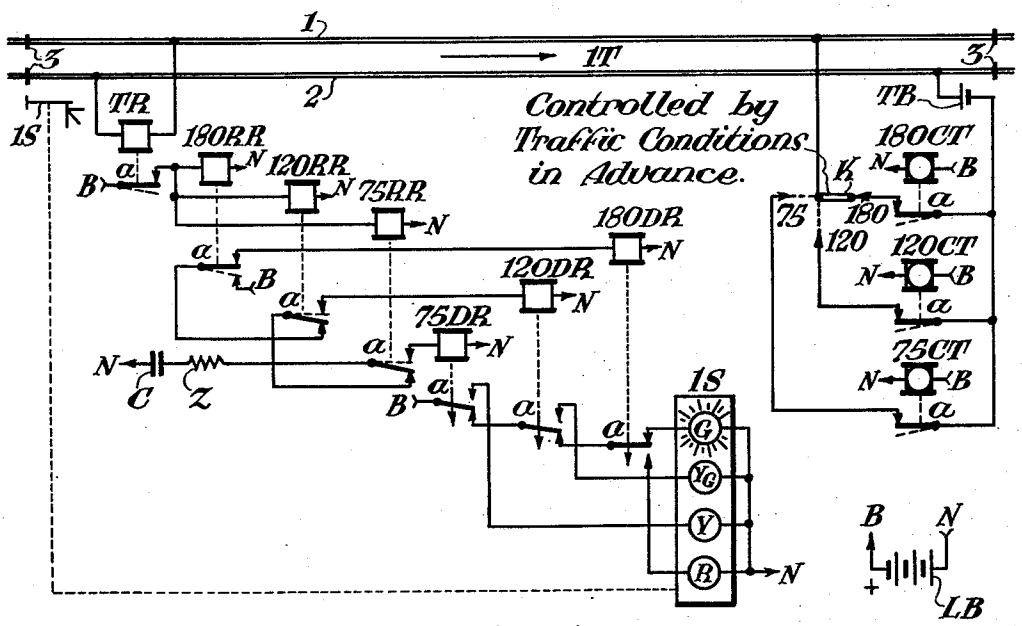


Fig. 1.

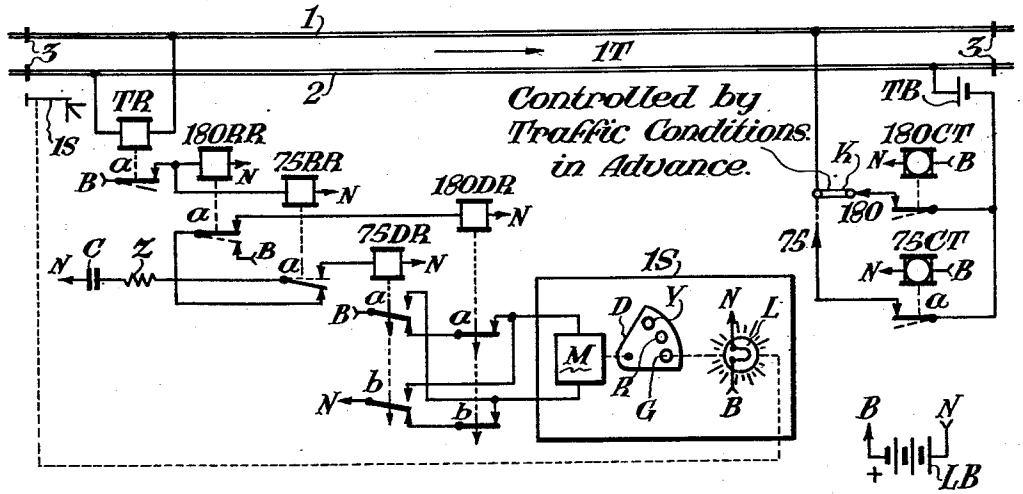


Fig. 2.

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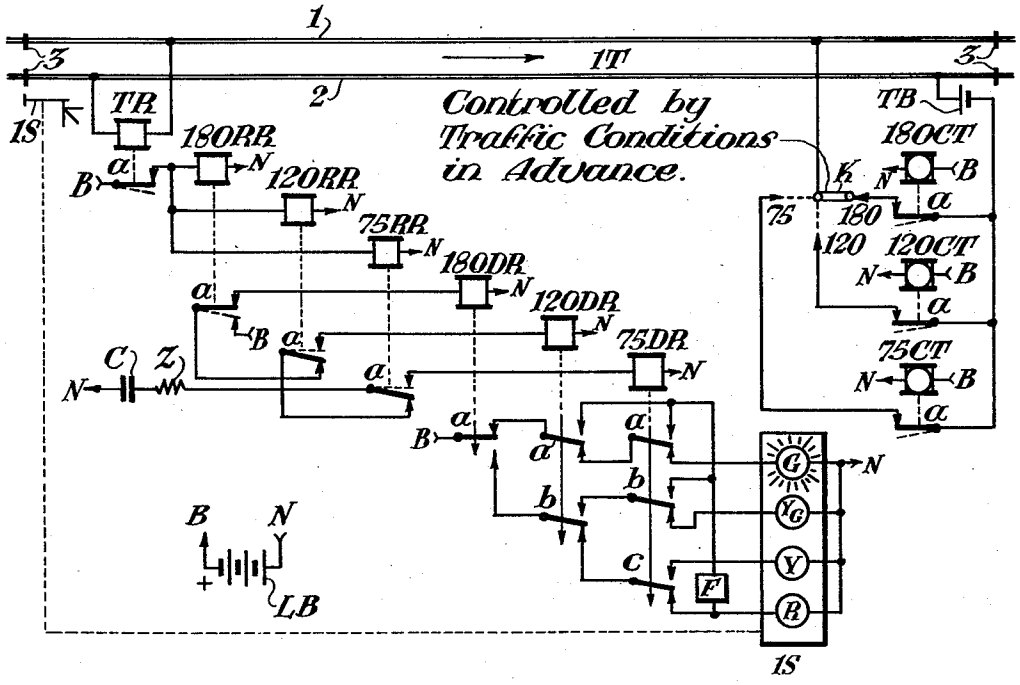


Fig. 3.

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United States Patent Office 2,811,634 Patented Oct. 29, 1957

2,811,634

RAILWAY TRAFFIC CONTROL APPARATUS

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Application September 30, 1953, Serial No. 383,166

2 Claims. (Cl. 246—34)

My invention relates to railway traffic control apparatus and particularly to circuit arrangements for controlling railway signals.

The presence of trains or vehicles in a stretch of railway track is usually detected by dividing the rails of the stretch into insulated sections, and by providing each section with a track circuit comprising a source of energy connected to the rails at one end of the section and a track relay connected to the rails at the other end of the section. The energy supplied to the track circuit may be either direct current or alternating current and it may be coded or steady. When coded energy is employed, codes of varying code rates are usually supplied to the track circuit to control the track relay and associated code detecting apparatus so that the associated signal will display different signal aspects, thus supplying information of traffic conditions in advance of the signal to oncoming trains and vehicles.

The usual practice when employing coded energy is to supply 180 code to control the apparatus so that the associated signal will display a green or clear aspect, 120 code to cause the signal to display a yellow over green or approach medium aspect to thereby inform oncoming traffic that the stretch is clear for two track sections in advance of the signal, and 75 code to cause the signal to display a yellow or approach aspect, which informs oncoming traffic that the stretch is clear for one section in advance of the signal. When steady energy or no energy is supplied to the track relay, the associated signal will display its red or stop aspect which will inform oncoming traffic that the train or vehicle should be brought to a stop at the signal location because the section immediately in advance of the signal is occupied by another train or vehicle.

In the past, tuned circuits have been used to detect coded energy and to supply energy to an associated decoding relay, only at one particular code rate to thereby cause that relay to establish a circuit for energizing the signal to display the proper signal aspect. These tuned circuits are usually of the type which will pass energy coded at a particular code rate or at a code rate higher than the code rate for which they are tuned. Thus, in a signal circuit which employs three code rates, it can be assumed that on the transmission of the highest code rate, the decoding relays for the two lower code rates, as well as the decoding relay for the highest code rate, will be energized. In addition, it can also be assumed that the decoding relays associated with a particular code rate will not pick up when energy coded at a lower code rate is being transmitted. By associating the highest code rate with the least restrictive signal aspect and so on, the possibility of a less restrictive aspect being displayed upon transmission of a code rate associated with a more restrictive signal aspect can be eliminated. The associated signal control circuits have, in the past, been arranged to operate according to these considerations.

Recently, however, a novel decoding device has been invented which employs a mechanically resonant system rather than electrically tuned circuits. With a mechanically resonant system being employed, sharper tuning can be effected thereby assuring that one and only one decoding device will respond to a code of a given code rate. This novel mechanically resonant system is described in my copending application for Letters Patent of the United States, Serial No. 210,358, filed on February 10, 1951, for Code Following Relay With Frequency Decoding Contacts, now Patent Number 2,730,592, dated January 10, 1956.

However, when the mechanically resonant decoding units are employed, they are subject to false response due to mechanical vibration, for example, which may cause a decoding relay associated with a less restrictive aspect to close its contacts at the same time that coded energy is being transmitted to energize a decoding relay associated with a more restrictive aspect. It is necessary, therefore, in order to provide a system which will give maximum protection, to arrange the circuitry so that upon more than one decoding relay closing its contacts, the most restrictive signal aspect associated with those relays will be displayed.

With a sharp mechanically resonant system being employed, it is desirable to provide signal control circuits which will check to ascertain whether the decoding relays which should not be responding to a particular code rate are falsely responding due to mechanical vibrations, code scrambling or for some other reason, to thereby prevent the establishing of circuits which will cause the associated signal to display an aspect less restrictive than the signal aspect which would be proper under the traffic condition.

Accordingly, it is an object of my invention to provide railway traffic control apparatus in which false operation of decoding relays may be checked.

Another object of my invention is to provide railway traffic control apparatus in which if two decoding relays operate simultaneously, the more restictive of the two associated signal aspects will be displayed by the associated signal.

A further object of my invention is to provide railway traffic control apparatus in which if two decoding relays operate simultaneously, a normally deenergized special warning signal will become energized to thereby warn approaching traffic that the apparatus is not functioning properly.

According to my invention, I supply at one end of a track section energy coded at different code rates in accordance with traffic conditions. A code following track relay at the other end of the section will operate at the code rate of the energy being supplied to the track section. With the track relay operating energy will be supplied to sets of mechanically resonant contacts each of which is tuned to operate at one and only one of the code rates. When a set of resonant contacts operates, an associated code detecting relay will become energized. The code detecting relays control a signal which will display a first aspect when one code detecting relay is energized and a second aspect when a second code detecting relay is energized. The signal control circuits, however, are so arranged that in the event that both code detecting relays become energized, a signal aspect more restrictive than the first aspect will be displayed. In this manner it will be certain that if one of the code detecting relays becomes energized when it normally should be deenergized, a signal aspect less restrictive than the proper signal aspect will not be displayed.

Other objects of my invention will become clear hereinafter as the characteristic features of construction and mode of operation to my novel railway traffic control apparatus are disclosed in detail.

In the accompanying drawings,

Fig. 1 is a diagrammatic view of railway traffic control apparatus embodying my invention associated with a four aspect color light signal.

Fig. 2 is a diagrammatic view of railway traffic control apparatus embodying my invention associated with a three aspect search light signal.

Fig. 3 is a diagrammatic view of railway traffic control apparatus embodying my invention incorporating a special warning signal.

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

Referring now to Fig. 1, a stretch of railway track made up of the track rails **1** and **2** is divided by insulated joints **3** to provide an insulated track section **1T**. Traffic will normally move over this stretch in the direction indicated by the arrow. At the exit end of section **1T**, a plurality of conventionally designed coders **75CT**, **120CT** and **180CT**, which operate at code rates of 75, 120 and 180 per minute, respectively, will code the energy supplied by a track battery TB to the track section **1T**. It should be pointed out that this novel system may be employed in conjunction with a coded alternating current system as well as a coded direct current system and accordingly, my invention is not limited to a coded direct current system. In actual practice, the code rate which is supplied to the rails of the section is automatically controlled in accordance with traffic conditions in advance by suitable relay controlled selecting circuits. One suitable arrangement of such circuits is shown for example in Letters Patent of the United States No. 2,154,265, granted to Charles W. Failor on April 11, 1939, for Railway Traffic Controlling Apparatus. Since these circuits form no part of my present invention, in order to simplify the disclosure I have here shown the means for selecting the code rate as a contact K movable to these positions designated 75, 120 and 180, respectively, it being obvious that when this contact occupies any one of these positions code at the rate corresponding to its designated position will be supplied to the rails of the section **1T** from an associated battery TB over contact *a* of the corresponding coders **75CT**, **120CT** or **180CT**, as the case may be.

At the entrance end of section **1T** is a code following track relay TR which is connected across rails **1** and **2** and which responds to energy supplied from the exit end of the stretch by track battery TB over a contact of one of the several coders. Track relay TR will operate its contact *a* at the code rate of the energy being supplied to it and it, in turn, supplies coded energy to the mechanically resonant sets of contacts herein shown embodied in three distinct resonant relays **180RR**, **120RR**, and **75RR**, which relays are responsive only to codes of 180, 120, and 75 code rates, respectively. It should be clear that the three sets of mechanically resonant contacts can be incorporated in one resonant relay which will be selectively responsive to the various code rates in a manner substantially identical to that shown in Fig. 1.

Controlled by the resonant relays are three decoding relays **180DR**, **120DR** and **75DR**, each of which becomes energized when the contacts of its associated resonant relay operate. A signal **1S** which is located at the entrance end of section **1T** is controlled by the three decoding relays. The energy for the operation of all the apparatus other than that supplied by track battery TB is supplied by a battery LB which has a positive terminal B and a negative terminal N.

The apparatus is shown in Fig. 1 in the condition it assumes when the stretch is clear and contact K is in its 180 position. Energy will be supplied from track battery TB to track relay TR over front contact *a* of coder **180CT** and, accordingly, track relay TR will be operating at a 180 code rate. Accordingly, front contact *a* of track relay TR will be opening and closing 180 times per minute and energy will thereby be supplied to resonant relays **75RR**, **120RR** and **180RR** at a 180 code rate over obvious circuits. With the contacts of the resonant relays being mechanically resonant at selected frequencies, as has already been explained, the contacts of relay **180RR** will operate to open and close 180 times per minute and the contacts of relays **120RR** and **75RR** will be inactive, thereby causing their back contacts *a* to be continuously closed and their front contacts *a* to be continuously open.

Each time back contact *a* of relay **180RR** is closed, energy will be supplied to a capacitor C over a circuit which may be traced from positive terminal B of battery LB, over back contact *a* of relay **180RR**, back contact *a* of relay **120RR**, back contact *a* of relay **75RR**, a resistor Z and capacitor C to negative terminal N of battery LB. Each time relay **180RR** opens its back contact *a* and closes its front contact *a*, it will open the energizing circuit for capacitor C and will close a discharge circuit for capacitor C which may be traced from the right-hand terminal of capacitor C, through resistor Z, over back contact *a* of relay **75RR**, back contact *a* of relay **120RR**, front contact *a* of relay **180RR**, and the winding of relay **180DR** to negative terminal N of battery LB which terminal is also connected to the left-hand terminal of capacitor C. Relay **180DR** will, in this manner, be energized 180 times per minutes. Relay **180DR** is provided with a slow release characteristic which will enable that relay to remain picked up during the time the supply of energy to its winding is cut off between successive discharges of capacitor C and, accordingly, as long as 180 code is being supplied to track relay TR, relay **180DR** will be picked up. At this time, relays **120RR** and **75RR** will be inactive and their back contacts will be closed. Therefore, no energy will be supplied to decoding relays **75DR** and **120DR**, and these relays will be released.

With the apparatus in this condition, energy will be supplied to the green lamp G of signal **1S** over a circuit which may be traced from positive terminal B of battery LB, over back contact *a* of relay **75DR**, back contact *a* of relay **120DR**, front contact *a* of relay **180DR**, and the green lamp G of signal **1S** to negative terminal N of battery LB. Accordingly, signal **1S** will display its proceed aspect and traffic will be permitted to travel over the section at maximum permissive speed.

When a train or vehicle enters setcion **1T**, any energy being supplied from the exit end of the section will be shunted by the wheels and axles of the train or vehicle and, accordingly, track relay TR will release, thereby opening and keeping open all the energizing circuits for the resonant relays. Therefore, the contacts of resonant relays **75RR**, **120RR** will remain inactive and the contacts of relay **180RR** will become inactive. Accordingly, the back contacts *a* of the resonant relays will all be closed and the front contacts will all be open. With the contacts of the resonant relays in this condition, capacitor C will be charged over its previously traced charging circuit but no discharge path will be provided. Therefore, relay **180** DR will release and relays **120DR** and **75DR** will remain released. With the decoding relays all released, a circuit will be established for energizing the red lamp R of signal **1S**, which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay **75DR**, back contact *a* of relay **120DR**, back contact *a* of relay **180DR**, and the red lamp R of signal **1S** to negative terminal N of battery LB. Accordingly, signal **1S** will display its stop aspect and traffic will be required to stop at the signal.

Upon the train vacating section **1T** and entering the section immediately in advance of section **1T**, contact K will be moved to its 75 position and, accordingly, energy will be supplied from track battery TB to section **1T** over front contact *a* of coder **75CT** which is operating at a 75

code rate. Therefore, track relay TR will commence operating at the 75 code rate. Accordingly, the contacts of relays **180**RR and **120**RR will remain inactive and their back contacts *a* will remain closed. The contacts of relay **75**RR, however, will commence operating at the 75 code rate. Therefore, each time back contact *a* of relay **75**RR is closed capacitor C will become charged over its previously traced charging circuit and upon relay **75**RR closing its front contact *a*, capacitor C will discharge through a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, front contact *a* of relay **75**RR, and the winding of relay **75**DR to negative terminal N of battery LB, which is connected to the left-hand terminal of capacitor C. Accordingly, relay **75**DR will be energized 75 times per minute, and relay **75**DR is provided with a sufficiently slow release characteristic to remain picked up during the time its energizing circuit is open between successive energizations. With the decoding relays in the condition described, a circuit will be established for energizing yellow lamp Y of signal **1**S which circuit may be traced from positive terminal B of battery LB, over front contact *a* of relay **75**RR, and the yellow lamp Y of signal **1**S to negative terminal N of battery LB. Accordingly, signal **1**S will display its approach aspect and traffic will be required to move past the signal at medium speed or less so that it can stop at the next signal if necessary.

Upon the train vacating the section immediately in advance of section **1**T and occupying the section two sections in advance of section **1**T, contact K will be moved to its 120 position and **120** code will be supplied to section **1**T from track battery TB over front contact *a* of coder **120**CT which is operating at a 120 code rate. Accordingly, track relay TR will commence operating at the 120 code rate, the contacts of relay **75**RR will become inactive, the contacts of relay **180**RR will remain inactive, and the contacts of relay **120**RR will commence operating at the 120 code rate. Accordingly, each time back contact *a* of relay **120**RR is closed, energy will be supplied to capacitor C over its previously traced charging circuit and each time relay **120**RR closes its front contact, capacitor C will discharge through a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, over back contact *a* of relay **75**RR, front contact *a* of relay **120**RR, and the winding of relay **120**DR to negative terminal N of battery LB, which is connected to the left-hand terminal of capacitor C. Accordingly, relay **120**DR will be energized 120 times per minute and with relay **120**DR provided with a slow release characteristic to maintain it picked up during the time its energizing circuit is open, relay **120**DR will remain picked up as long as 120 code is being supplied to relay TR. With no energy being supplied to relays **75**DR and **180**DR, they will, at this time, be released.

With the decoding relays in the condition described, a circuit will be established for energizing the lamp Y/G of signal **1**S, which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay **75**DR, front contact *a* of relay **120**DR, and the lamp Y/G of signal **1**S to negative terminal N of battery LB. Accordingly, signal **1**S will display its approach medium aspect thereby requiring traffic to approach the next signal at medium speed.

When the train vacates the section two sections in advance of section **1**T and occupies the section three sections in advance of section **1**T, contact K will be moved to its 180 position and 180 code will be supplied to section **1**T. Accordingly, relay TR will commence operating at the 180 code rate, the contacts of relay **180**RR will commence operating at the 180 code rate, the contacts of relay **120**RR will become inactive and the contacts of relay **75**RR will remain inactive. Therefore, relay **180**DR will pick up, relay **120**DR will release and relay **75**DR will remain released. With the decoding relays in this condition energy will once more be supplied to the green lamp G of signal **1**S over its previously traced energizing circuit. In this manner the apparatus will be restored to its normal condition in which signal **1**S will display its proceed aspect.

Now let it be assumed that due to external mechanical vibrations or due to code scrambling or for some other reason, the contacts of relays **180**RR and **120**RR both commence operating. If this condition were to arise relays **180**DR and **120**DR would both pick up. Relay **75**DR however would be released. With the decoding relays in this condition, an energizing circuit will be established for energizing the lamp Y/G of signal **1**S which circuit may be traced from positive terminal B of battery LB over back contact *a* of relay **75**DR, front contact *a* of relay **120**DR, and the lamp Y/G of signal **1**S to negative terminal N of battery LB. It will be seen that no energy will be supplied to lamp G of signal **1**S since the energizing circuit for that lamp will be open at back contact *a* of relay **120**DR. Accordingly, the more restrictive aspect will be displayed when decoding relays **180**DR and **120**DR are both picked up and, therefore, the signal will display its more restrictive aspect which is on the safe side.

In the event that relays **120**DR and **75**DR are simultaneously energized due to some faulty condition, it will be seen that lamp Y of signal **1**S will be energized over the previously traced energizing circuit for this lamp. Lamp Y/G will not be energized due to the fact that its previously traced energizing circuit will be open at back contact *a* of relay **75**DR. Accordingly, signal **1**S will again display its more restrictive aspect which is on the safe side.

In the event that relays **180**DR and **75**DR are simultaneously energized, the yellow lamp Y of signal **1**S will be energized over its previously traced energizing circuit and green lamp G of signal **1**S will remain deenergized due to the fact that its previously traced energizing circuit will be open at back contact *a* of relay **75**DR. Again signal **1**S will display its more restrictive signal aspect and accordingly the system will be on the safe side. It will be clear therefore that whenever any two resonant relays operate simultaneously, the apparatus will operate on the safe side.

It will be obvious that should all three resonant relays operate simultaneously, only the yellow aspect will be displayed.

Referring now to Fig. 2, a three aspect signal **1**S is shown which signal is of the well known searchlight type. Such a signal has a driving mechanism M which operates a spectacle arm D to any one of three positions depending upon whether or not the mechanism is energized and upon the polarity of the energization if the mechanism is energized. For the purpose of this description, it will suffice to say that when current flows through the mechanism from top to bottom, as viewed in Fig. 2, the spectacle arm D will be moved to its green position, as shown, where light from the lamp L, which is continuously energized, will shine through the green filter G, thereby causing signal **1**S to display its proceed aspect; when current flows from the bottom terminal to the top terminal of mechanism M, the spectacle arm will move to the position in which a yellow or approach aspect will be displayed; and when the mechanism is deenergized, the spectacle arm will occupy the central position and a red or stop aspect will be displayed. If a more detailed description of a searchlight signal of the type described, is desired, reference may be had to United States Patent No. 2,133,603, granted to Wesley B. Wells on October 18, 1938, for Light Signals.

Because the system shown in Fig. 2 uses a three aspect signal, only two coders are required and they are here shown as coder **180**CT and coder **75**CT. Coder **180**CT is employed to supply 180 code to section **1**T which code will actuate apparatus in order to indicate that the stretch of railway track is clear, and coder **75**CT is employed to

code energy supplied from battery TB to section 1T at a 75 code rate, thereby actuating the apparatus to show that the section in advance of section 1T is occupied. Accordingly, only resonant relays 180RR and 75RR will be employed and associated with them will be decoding relays 180DR and 75DR, respectively.

The apparatus is shown in Fig. 2 in the condition it assumes when the stretch is vacant. Contact K will be in its 180 position and energy will be coded at a 180 code rate. Therefore, track relay TR will be operating at a 180 code rate, the contacts of resonant relay 180RR will be operating at a 180 code rate and the contacts of relay 75RR will be inactive. Therefore, capacitor C will be charged 180 times per minute over a circuit which may be traced from positive terminal B of battery LB, over back contact *a* of relay 180RR, back contact *a* of relay 75RR, a resistor Z, and capacitor C to negative terminal N of battery LB. When the front contact of relay 180RR is closed, capacitor C will discharge through a circuit which may be traced from the right-hand terminal of capacitor C, resistor Z, back contact *a* of relay 75RR, front contact *a* of relay 180RR, and the winding of relay 180DR to negative terminal N of battery LB which is connected to the left-hand terminal of capacitor C. Therefore, relay 180DR will be energized 180 times per minute and with relay 180DR provided with a slow release characteristic, as long as 180 code is supplied to section 1T, relay 180DR will remain picked up. With relay 75RR inactive relay 75DR will be released.

With the decoding relays in the condition described, a circuit will be established for energizing mechanism M of signal 1S so that current will flow from its upper terminal to its lower terminal, which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay 75DR, front contact *a* of relay 180DR, mechanism M of signal 1S from top to bottom, front contact *b* of relay 180DR, and back contact *b* of relay 75DR to negative terminal N of battery LB. Therefore, spectacle arm D will be moved to its green position in which the light from the continuously lighted lamp L will shine through green lens G and signal 1S will thereby display its green or proceed aspect.

When a train moves into section 1T, the wheels and axles of the train will shunt any energy being supplied by track battery TB and, accordingly, relay TR will release. Therefore, no energy will be supplied to the resonant relays and the contacts of relay 180RR will become inactive and the contacts of relay 75RR will remain inactive. Accordingly, the charging circuit for capacitor C will be established and capacitor C will charge up to the terminal voltage of battery LB, but no circuit will be established for discharging capacitor C. Accordingly, relay 75DR will remain released and relay 180DR will release. With the decoding relays in the condition described, it will be seen that no energy will be supplied to mechanism M of signal 1S and, accordingly, the spectacle arm D of signal 1S will move to the position in which signal 1S will display its red or stop aspect.

When the train vacates section 1T and occupies the section immediately in advance of section 1T, contact K will be moved to its 75 position in which 75 code energy will be supplied to section 1T. Relay 1TR will commence operating at a 75 code rate. Therefore, resonant relay 75RR will commence operating its contact at a 75 code rate and the contacts of relay 180RR will remain inactive. Therefore capacitor C will be charged 75 times per minute over its previously traced charging circuit and capacitor C will discharge 75 times per minute through a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, front contact *a* of relay 75RR, and the winding of relay 75DR to negative terminal N of battery LB which is connected to the left-hand terminal of capacitor C. Therefore, relay 75DR will be energized 75 times per minute and with relay 75DR provided with a slow release characteristic, relay 75DR will remain picked up during the time its energizing circuit is open. Accordingly, as long as 75 code is being supplied to section 1T, relay 75DR will remain picked up. At this time, of course, relay 180DR will remain released. Therefore, energy will be supplied to mechanism M of signal 1S in such a manner that current will flow through the mechanism from its bottom terminal to its top terminal. The energizing circuit for signal 1S may be traced from positive terminal B of battery LB, over front contact *a* of relay 75DR, through mechanism M from bottom to top, and front contact *b* of relay 75DR to negative terminal N of battery LB. Accordingly, mechanism M will move spectacle arm D to its yellow position in which the signal 1S will display its yellow or approach aspect.

When the train vacates the section in advance of section 1T and occupies the section two sections in advance of section 1T, contact K will be moved to its 180 position, 180 code will be supplied to section 1T and the apparatus will commence operating in the manner already described in which signal 1S will display its green or proceed aspect.

Now let it be supposed that for some reason the contacts of resonant relays 180RR and 75RR commence operating simultaneously. Under such a condition, relays 75DR and 180DR will both pick up and, accordingly, energy will be supplied to mechanism M of signal 1S in its reverse or bottom to top direction over the previously traced energizing circuit which is closed when relay 75DR alone is energized. The fact that relay 180DR is picked up will have no effect on the apparatus since the normal or positive energizing circuit for mechanism M of signal 1S will be open at back contacts *a* and *b* of relay 75DR and, accordingly, with both decoding relays picked up, signal 1S will display its yellow aspect. Therefore the more restrictive aspect will be displayed by signal 1S when there is false operation of a decoding relay and, accordingly, the system operates in a safe manner.

As shown in Fig. 3, the third embodiment of my invention appears in its normal condition in which 180 code is being supplied to the track section 1T by a circuit which is obvious from inspection and which includes front contact *a* of coder 180CT. Accordingly, relay TR will be operating at a 180 code rate and supplying energy to resonant relays 180RR, 120RR and 75RR at the 180 code rate. Therefore, the contacts of relay 180RR will be operating at the 180 code rate and the contacts of relays 120RR and 75RR will be inactive. When back contact *a* of relay 180RR is closed, energy will be supplied to capacitor C over a circuit which may be traced from positive terminal B of battery LB, over back contact *a* of relay 180RR, back contact *a* of relay 120RR, back contact *a* of relay 75RR, resistor Z and capacitor C to negative terminal N of battery LB. When front contact *a* of relay 180RR is closed, the energy stored by capacitor C during the charging cycle will be discharged through the winding of relay 180DR to thereby energize that relay over a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, back contact *a* of relay 75RR, back contact of relay 120RR, front contact *a* of relay 180RR, and the winding of relay 180DR to negative terminal N of battery LB, which is connected to the left-hand terminal of capacitor C. Accordingly, relay 180DR will be energized 180 times per minute. Relay 180DR is provided with a sufficiently slow release characteristic to keep it picked up during the time its energizing circuit is open, and, accordingly, as long as 180 code is being supplied to section 1T, relay 180DR will be picked up. At this time, relays 120DR and 75DR will be released. Therefore, green lamp G of signal 1S will be energized by a circuit which may be traced from positive terminal B of battery LB, over front contact *a* of relay 180RR is closed, the energy stored by capacitor C dur- of relay 75DR and the green lamp G of signal 1S to negative terminal N of battery LB.

When a train or vehicle occupies section 1T, no energy will be supplied to relay TR and, accordingly, relay TR will release. Therefore, the contacts of relay 180RR will become inactive and the contacts of relays 120RR and 75RR will remain inactive. Capacitor C will be charged over its previously traced charging circuit but when it becomes charged up to the terminal voltage of battery LB, no current will flow in the charging circuit. With the contacts of all the resonant relays inactive, no discharge circuit will be established for capacitor C and, therefore, relays 180DR, 120DR and 75DR will at this time all be released. Accordingly, a circuit will be established for energizing the red lamp R of signal 1S which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay 180DR, back contact *b* of relay 120DR, back contact *c* of relay 75DR, and the red lamp R of signal 1S to negative terminal N of battery LB.

When the train or vehicle vacates section 1T and occupies the section immediately in advance of section 1T, contact K will be moved to its 75 position in which 75 code energy will be supplied to section 1T over front contact *a* of coder 75CT. Accordingly, relay TR will operate at a 75 code rate. Therefore, the contacts of relays 180RR and 120RR will remain inactive and the contacts of relay 75RR will commence operating at a 75 code rate. Accordingly, capacitor C will be charged 75 times each minute over its previously traced charging circuit and will discharge 75 times each minute over a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, front contact *a* of relay 75RR, and the winding of relay 75DR to negative terminal N of battery LB which is connected to the left-hand terminal of capacitor C. Therefore, relay 75DR will be energized 75 times each minute and with relay 75DR provided with a slow release characteristic, it will remain picked up during the time that its energizing circuit is open. Therefore, relay 75DR will be picked up as long as 75 code energy is being supplied to section 1T. At this time, of course, relays 120DR and 180DR will remain released. Therefore, a circuit will be established for energizing the yellow lamp Y of signal 1S which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay 180DR, back contact *b* of relay 120DR, front contact *c* of relay 75DR, and the yellow lamp Y of signal 1S to negative terminal N of battery LB.

When the train or vehicle vacates the section immediately in advance of section 1T and occupies the section two sections in advance of section 1T, contact K will be moved to its 120 position and, accordingly, 120 code energy will be supplied to section 1T from track battery TB over front contact *a* of relay 120CT. Therefore, track relay TR will commence operating at the 120 code rate, the contacts of relay 75RR will become inactive and the contacts of relay 120RR will commence operating at the 120 code rate. The contacts of relay 180RR will remain inactive. Therefore, energy will be supplied to capacitor C 120 times per minute over its previously traced charging circuit and capacitor C will discharge 120 times per minute through a circuit which may be traced from the right-hand terminal of capacitor C, through resistor Z, back contact *a* of relay 75RR, front contact *a* of relay 120RR, and the winding of relay 120DR to negative terminal N of battery LB which is connected to the left-hand terminal of capacitor C. In this manner relay 120DR will be energized 120 times per minute and with relay 120DR provided with a slow release characteristic, it will remain picked up as long as 120 code energy is supplied to section 1T. At this time, relays 75DR and 180DR will be released. With the decoding relays in the condition described, energy will be supplied to signal 1S in such a manner that it will display its Y/G or approach medium aspect. The energizing circuit for the signal may be traced from positive terminal B of battery LB, over back contact *a* of relay 180DR, front contact *b* of relay 120DR, back contact *b* of relay 75DR, and lamp Y/G of signal 1S to negative terminal N of battery LB.

When the train vacates the section two sections in advance of section 1T and occupies the section three sections in advance of section 1T, contact K will be moved to its 180 position and the contacts of relay 180RR will commence operating and the contacts of relay 120RR will become inactive. The contacts of relay 75RR will remain inactive. Therefore, relay 180DR will pick up, relay 120DR will release and relay 75DR will remain released. With the decoding relays in the described condition the green lamp G of signal 1S will again be energized and the system will be restored to its normal condition.

Let it now be supposed that due to vibration or code scrambling or for some other reason, the contacts of relays 180RR and 120RR both commence operating. With the contacts of these two resonant relays operating, decoding relays 180DR and 120DR will both pick up while relay 75DR will be released. Accordingly, a circuit will be established for energizing the red lamp R of signal 1S through a suitable flasher device F, which circuit may be traced from positive terminal B of battery LB, over front contact *a* of relay 180DR, front contact *a* of relay 120DR, flasher device F, and red lamp R of signal 1S to negative terminal N of the battery LB. It will be seen that with 180DR and 120DR picked up the green lamp G of signal 1S will not be energized nor will the yellow over green signal of the lamp of 1S be energized. In this manner, a flashing red aspect will be displayed by signal 1S in order to indicate to approaching traffic that there is something faulty in the apparatus. In the event that relays 120DR and 75DR are both picked up, a second circuit will be established for energizing signal 1S to display its flashing red aspect which circuit may be traced from positive terminal B of battery LB, over back contact *a* of relay 180DR, front contact *b* of relay 120DR, front contact *b* of relay 75DR, flasher device F, and the red lamp R of signal 1S to negative terminal N of battery LB. Furthermore, if relays 180DR and 75DR were for some reason simultaneously picked up, a third circuit will be established for causing signal 1S to display its flashing red aspect which circuit may be traced from positive terminal B of battery LB, over front contact *a* of relay 180DR, back contact *a* of relay 120DR, front contact *a* of relay 75DR, flasher device F, and red lamp R of signal 1S to negative terminal N of battery LB. Furthermore, it will be obvious that even if relays 180DR, 120DR and 75DR were simultaneously energized, a flashing red aspect will be displayed. It will be seen, therefore, that whenever the resonant relays are falsely operated to thereby energize their associated decoding relays, red lamp R of signal 1S will become energized in series with flasher device F to provide a flashing red aspect. In this manner the enginemen controlling approaching trains will be given sufficient warning of a fault in the equipment.

It will be clear that although I have herein described my novel railway traffic control apparatus in conjunction with a wayside signal and a direct current coded track circuit the system will operate just as effectively where coded alternating current is employed and where cab signals are employed in place of or in conjunction with the wayside signals.

Although I have herein shown and described only three forms of my novel railway traffic control apparatus, it will be 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 a coded railway signaling system in which energy of a distinct code rate is supplied to the system to correspond with each of several distinct traffic conditions, a first relay which normally becomes energized only when a first of said traffic conditions exists, a second relay which normally becomes energized only when a second

of said traffic conditions exists, a signal which may display proceed, approach and warning aspects, respectively, circuit means for causing said signal to display its proceed aspect closed when said first relay is energized and said second relay is deenergized, circuit means for causing said signal to display its approach aspect closed when said first relay is deenergized and said second relay is energized, and circuit means for causing said signal to display its warning aspect closed when said first and second relays are both energized.

2. In combination, a stretch of railway track divided by insulated joints to form a track section, a source of energy located at one end of said section, means for coding energy supplied by said source to said section at first, second and third code rates in response to traffic conditions along said stretch, a code following track relay located at the other end of said section, first, second and third sets of mechanically resonant contacts which operate when and only when said track relay is operating at said first, second and third code rates, respectively, first, second and third code detecting relays associated with said first, second and third sets of mechanically resonant contacts, circuit means for energizing said code detecting relays effective when and only when the associated set of mechanically resonant contacts is operating, a color

light signal having first, second, third and fourth lamps for displaying proceed, approach medium, approach and stop aspects, respectively, circuit means for energizing said first lamp closed when said first code detecting relay is energized and said second and third code detecting relays are deenergized, circuit means for energizing said second lamp closed when said first and third code detecting relays are deenergized and said second code detecting relay is energized, circuit means for energizing said third lamp closed when said first and second code detecting relays are deenergized and said third code detecting relay is energized, circuit means for energizing said fourth lamp closed when all said code detecting relays are deenergized, a flasher device, and circuit means for energizing said flasher device in series with one of said lamps to thereby produce a flashing warning signal closed when at least any two of said code detecting relays are energized.

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