

June 6, 1939.

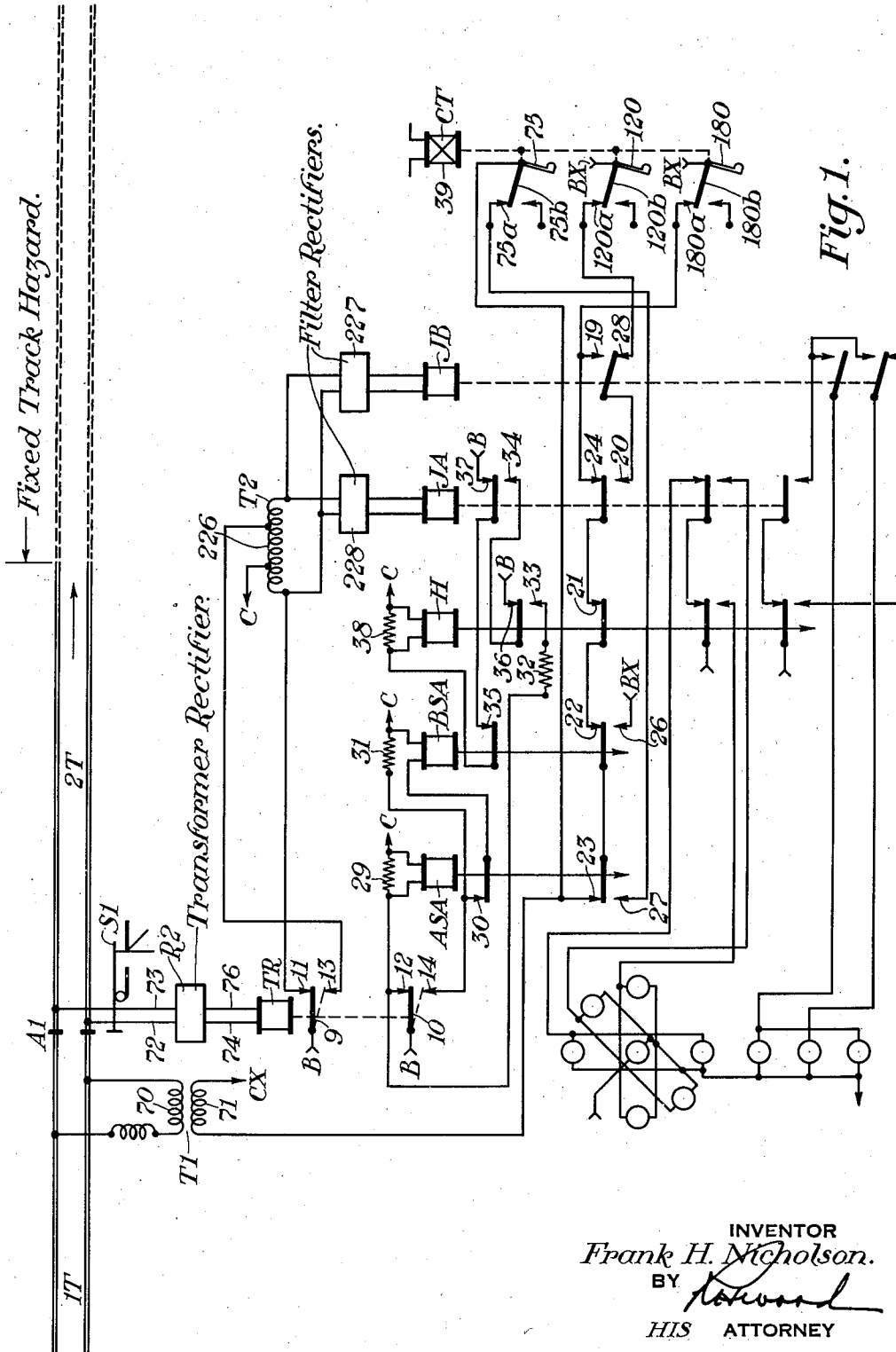
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2,160,894

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 28, 1937

4 Sheets-Sheet 1



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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 28, 1937

4 Sheets-Sheet 2

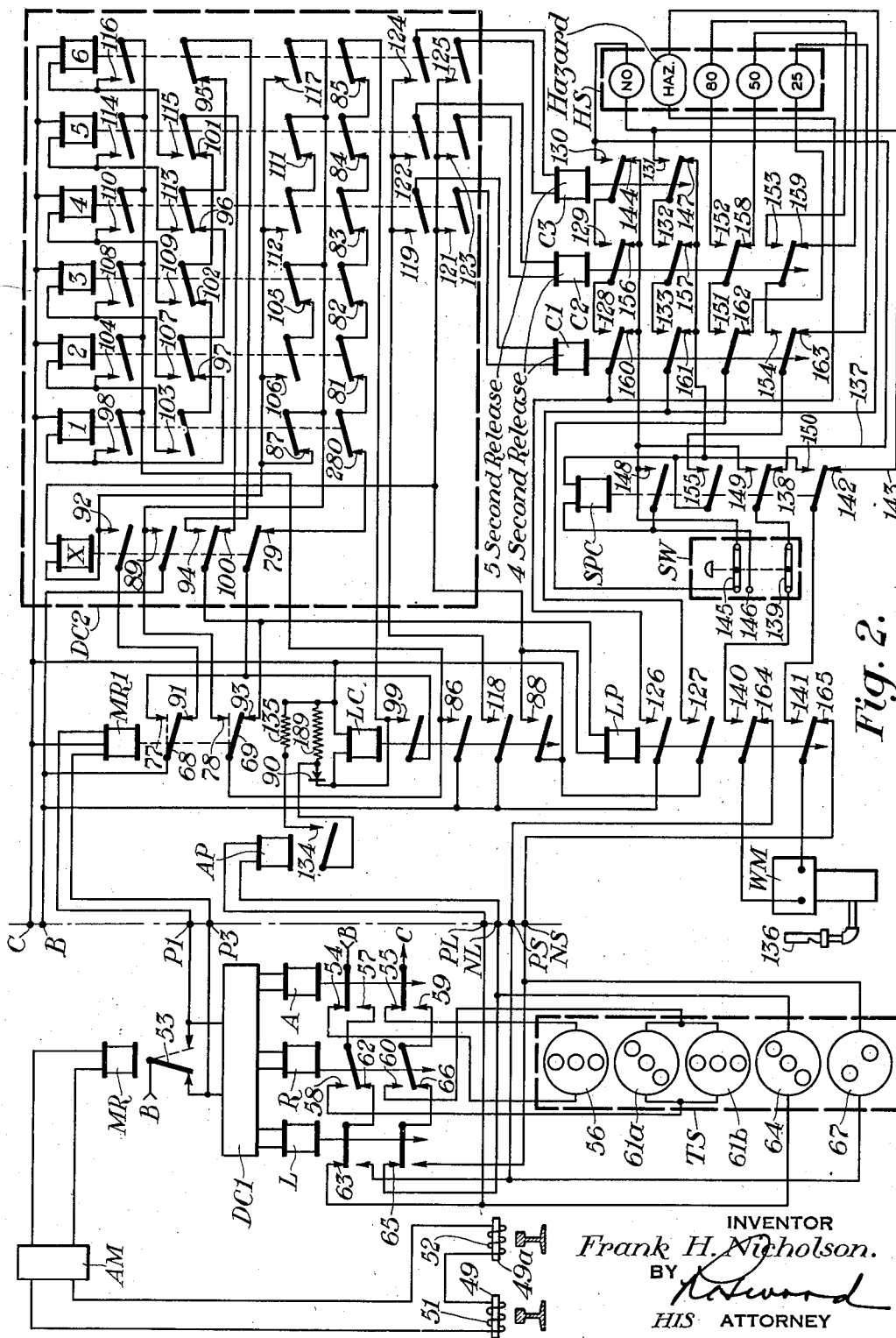


Fig. 2.

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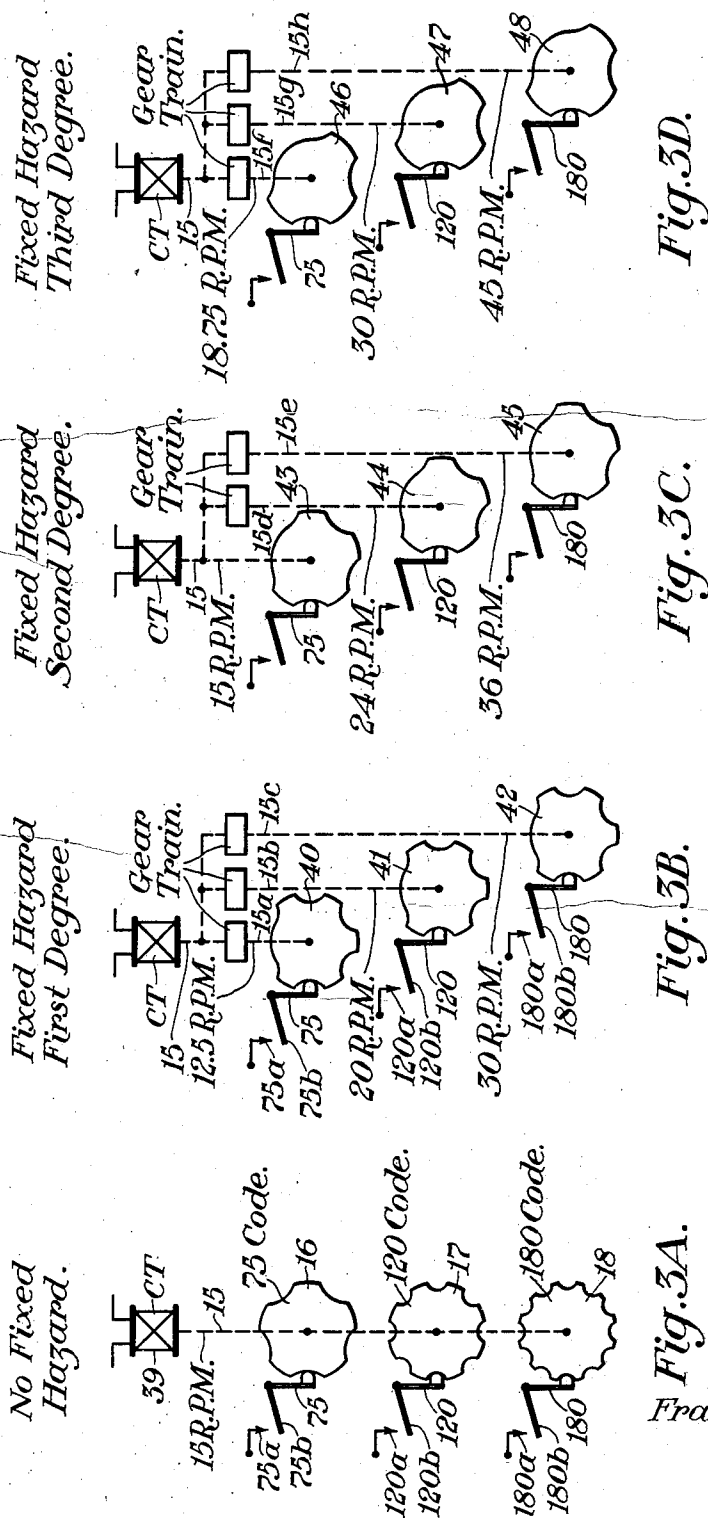
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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 28, 1937

4 Sheets-Sheet 3



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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 28, 1937

4 Sheets-Sheet 4

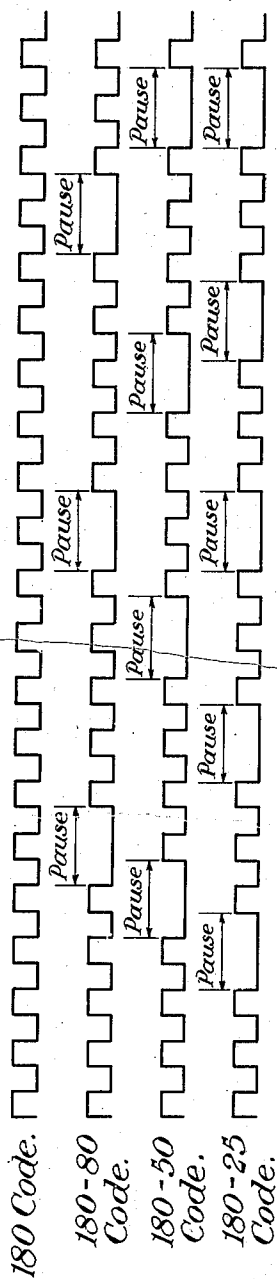


Fig. 4A.

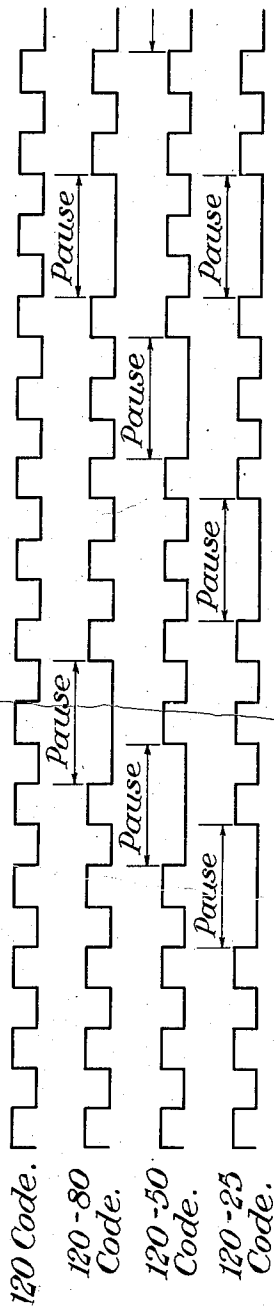


Fig. 4B.

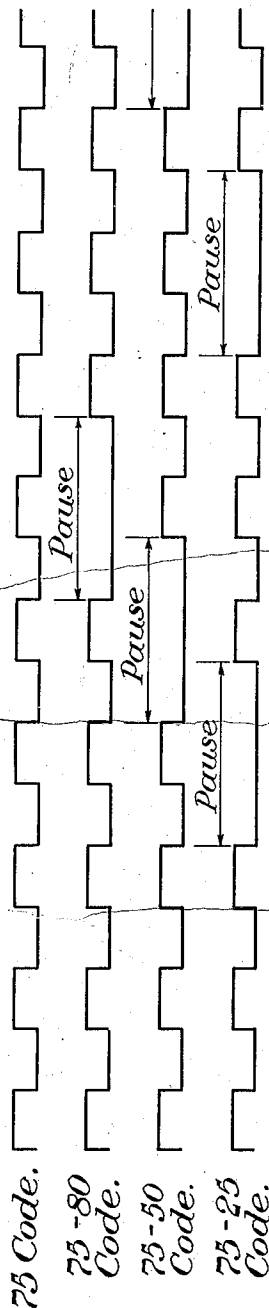


Fig. 4C.

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2,160,894

RAILWAY TRAFFIC CONTROLLING
APPARATUS

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Application September 28, 1937, Serial No. 166,101

16 Claims. (Cl. 246—63)

My invention relates to railway traffic controlling apparatus, and particularly to apparatus of the code signal type.

A feature of my invention is the provision of novel and improved apparatus for signal systems for railway trains to indicate by means of signal indications in the locomotive cab the approach to fixed track hazards, and the degree or nature of such hazards, as well as to indicate in the cab the different traffic conditions in advance of the train. A further feature of my invention is the provision of apparatus of the type contemplated wherewith the signal indications for the fixed hazards are obtained without changing the essential character of the codes used to reflect traffic conditions in the frequency code systems now in use on railroads. In other words, a feature of my invention is the provision of apparatus for a "group code" system for indicating different degrees of fixed track hazards and apparatus for a "frequency code" system for indicating different traffic conditions with the two apparatuses so interrelated that each functions without interference to the other. A still further feature of the invention is the provision of apparatus of the "group code" type with a retardation sufficient to compel two counts of the code before the corresponding signal indication is displayed. Again, a feature of the invention is the provision of apparatus of the "group code" type wherewith the retardation of the apparatus is automatically adjusted to fit the incoming code. Another feature of the invention is the provision of apparatus of the type here involved whereby the signal indications for the fixed track hazards are suppressed when low speed traffic conditions exist. Other features and advantages of my invention will appear as the specification progresses.

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

In the accompanying drawings, Figs. 1 and 2 are diagrammatic views of a preferred form of apparatus embodying my invention, Fig. 1 being the trackway portion of the apparatus and Fig. 2 being the train-carried portion. Fig. 3A is a diagrammatic view of one form of code transmitter that may be used to provide the frequency codes for the apparatus of Fig. 1. Figs. 3B, 3C and 3D are diagrammatic views of the code transmitter of Fig. 3A when modified so as to arrange the impulses of the different frequency codes into different groups. Figs. 4A, 4B and 4C are diagrams illustrating the various combinations

of frequency codes and group codes provided by the code transmitters of Figs. 3A, 3B, 3C and 3D.

In each of the views, similar reference characters designate similar parts.

Referring to Fig. 1, a stretch of railway track over which traffic normally moves in the direction indicated by an arrow is formed by the usual insulated rail joints into successive track sections, only the adjacent ends of the two track sections 1T and 2T being shown for the sake of simplicity. The junction of sections 1T and 2T constitutes a signal location identified by the reference character A1. It will be understood that the entire stretch of railway is formed into successive track sections, the junctions of adjacent sections constituting signal locations similar to the location A1.

This stretch of railway is characterized by curves, cuts, fills, tunnels, bridges and other fixed track hazards which require different permissible maximum speeds at different locations. As shown at the right-hand end of Fig. 1, the track section 2T includes a fixed track hazard at which a predetermined permissible maximum speed under all traffic conditions is required for safety.

The track sections of this stretch of railway are each provided with trackway apparatus as required for a combined wayside and cab signal system of the frequency code type, the apparatus at each signal location being substantially the same except as modified at locations in the vicinity of fixed track hazards to superpose on the frequency codes a group code to indicate the approach to the fixed track hazard and the degree of such fixed hazard.

The trackway apparatus of each track section includes a track circuit consisting of a source of alternating current connected across the rails at the exit end of the section and a track relay connected across the rails at the entrance of the section. Hence, the source of current for the track circuit of section 1T and the track relay for the track circuit of section 2T are located at the signal location A1. The immediate source of current for the track circuit of section 1T is the secondary winding 70 of a track transformer T1, the primary winding 71 of which is supplied with coded alternating current in a manner to be later described. The alternating current may be of any desired frequency such as, for example, 100 cycles per second. The alternating current would preferably be supplied to signal location A1 and to the other signal locations by means of a transmission line

and the usual line transformer, both of which are not shown in the drawings for the sake of simplicity, the two terminals of the source of alternating current being indicated by the reference characters BX and CX.

The track relay TR for the track circuit of section 2T is a code following direct current relay. The operating winding of relay TR is supplied with rectified current through the usual transformer-rectifier R2, the input terminals of which are connected across the track rails of section 2T over wires 72 and 73, and the output terminals of which are connected with the operating winding of relay TR over wires 74 and 76. The transformer-rectifier R2 may be any one of several types well-known in the art, and is shown conventionally since its structure forms no part of my present invention. It follows that as long as the track circuit of section 2T is supplied with alternating current the track relay TR is energized and picked up, causing its contact members 9 and 10 to engage front contacts 11 and 12, respectively, but that when no alternating current or an insufficient amount flows in the track circuit adjacent the entrance of section 2T the relay TR is deenergized and released, causing its contact members 9 and 10 to engage back contacts 13 and 14, respectively. Furthermore, when the alternating current supplied to the track circuit of section 2T is periodically interrupted or coded at a code frequency of, say 180, 120 or 75 times per minute, the relay TR is picked up during the "on" period of each code cycle and is released during the "off" period of each code cycle. In accordance with usual practice, the code frequency of the track circuit current is 180 per minute when "clear" traffic conditions exist, is 120 per minute under "approach-restricting" traffic conditions, and is 75 per minute under "approach" traffic conditions. If the track section 2T is occupied, the coded track circuit current is shunted by the train ahead and does not reach the track relay TR or the following train, giving the "caution-slow speed" traffic condition.

The trackway apparatus at location A1 includes a code transmitter CT and five control relays ASA, BSA, H, JA and JB for controlling the supply of current to the track circuit for the section 1T in the rear of section 2T, as well as for controlling the operating circuits of a wayside signal S1.

The code transmitter CT may be any one of several types and is here shown as being of the motor type, the operating or motor winding 39 of which is constantly supplied with alternating current so that the code transmitter is continuously active. When, in the vicinity of a signal location, no fixed track hazard exists that requires for safety a permissible maximum speed less than the prescribed permissible maximum speed for all trains of the railway, the code transmitter is constructed to provide the different frequency codes in accordance with the different traffic conditions as set forth hereinbefore. Under these circumstances, the construction of the code transmitter would preferably be as disclosed in Fig. 3A. When a fixed track hazard exists in the vicinity of a signal location, the construction of the code transmitter is modified so as to arrange the frequency code impulses into different successive groups, the modification of the transmitter being selected according to the degree or nature of the fixed hazard. To aid in the understanding of my invention, I shall assume that three different group codes are provided, a first one of which

would be used when the fixed track hazard is of the first degree and a permissible maximum speed of, say, 80 miles per hour under all traffic conditions is prescribed. A second group code would be used when the nature of the fixed hazard is of the second degree and the prescribed maximum speed is, say, 50 miles per hour; and the third group code would be selected when the nature of the fixed hazard is of the third degree that requires for safety a permissible maximum speed of, say, 25 miles per hour. For ready reference, I shall hereinafter refer to these different group codes as "first degree" or "80", "second degree" or "50", and "third degree" or "25". The preferred modifications for the code transmitter so as to provide the "80", "50" and "25" group codes are disclosed in Figs. 3B, 3C and 3D, respectively. It will be understood, of course, that my invention is not limited to the three codes for fixed hazards or to the maximum speed limits stated above, and these three codes will serve to illustrate the invention.

Looking at Fig. 3A, the motor element 39 of the code transmitter drives a shaft indicated by a dotted line 15 at the rate of, say, 15 revolutions per minute. Three code cams 16, 17 and 18 are mounted in fixed relation with the shaft 15 and rotate in the clockwise direction as viewed in Fig. 3A at 15 revolutions per minute, the cams being preferably of suitable insulating material. Cams 16, 17 and 18 are constructed with 5, 8 and 12 teeth, respectively. A code contact member 75 is associated with cam 16, the arrangement being such that the contact member 75 is actuated by each tooth of cam 16 to close a contact 75a-75b and to open the contact between successive teeth. Hence, the contact 75a-75b is opened and closed 75 (15×5) times per minute. A code contact member 120 is associated with cam 17 and is actuated to close a contact 120a-120b by each tooth of the cam, with the result that the contact 120a-120b is closed and opened at the rate of 120 (15×8) times per minute. In a similar manner, a code contact member 180 is associated with cam 18 and is operated by each tooth of the cam to close a contact 180a-180b, with the result that contact 180a-180b is opened and closed 180 (15×12) times per minute. It follows that the current flowing in a circuit in which the contact 180a-180b is interposed is periodically interrupted or coded 180 times per minute, or three times per second. Such coding of current is illustrated by the 180 code curve (upper curve) of Fig. 4A, the raised portions representing the "on" periods during which current flows and the depressed portions of the curve illustrating the "off" periods during which no current flows. In this case, each period of a code cycle is equal to one-sixth of a second. The 120 code curve of Fig. 4B represents in a similar manner the current flowing in a circuit in which the code contact 120a-120b is interposed, each "on" and "off" period of a code cycle being substantially equal to one-fourth of a second. Likewise, the 75 code curve of Fig. 4C represents the current flow in a circuit in which the contact 75a-75b is interposed, the "on" and "off" periods of each code cycle being equal to substantially four-tenths of a second.

When a fixed track hazard of the first degree exists in the vicinity of a signal location, the code transmitter of Fig. 3A is modified so that the frequency code impulses are grouped into successive groups of five impulses each, and each

group is separated from the preceding and succeeding groups by a predetermined interval. In the form of the invention here disclosed, an "off" interval or pause equivalent to three normal "off" intervals is inserted after five cycles of normal code. Looking at Fig. 3B, the shaft 15 of the code transmitter drives through suitable gear trains three shafts indicated by the dotted lines 15a, 15b and 15c, the gear trains being so proportioned that shaft 15a rotates at 12.5 revolutions per minute, shaft 15b rotates at 20 revolutions per minute and shaft 15c rotates at 30 revolutions per minute. Three code selectors or cams 40, 41 and 42 of suitable insulating material are fixed on the shafts 15a, 15b and 15c, respectively. Each of the code selectors 40, 41 and 42 is formed with six teeth and is mutilated by the removal of one tooth. The code contact members 75, 120 and 180 are actuated by the cams 40, 41 and 42, respectively. It is clear that with the code transmitter constructed as indicated in Fig. 3B the current flowing in a circuit in which the contact 180a—180b is interposed will be frequency and group coded in the manner illustrated by the curve 180—80 code of Fig. 4A to represent clear traffic conditions and a fixed hazard of the first degree, the cause or "off" interval between successive code groups being substantially equal to one-half second. The current flowing in a circuit in which the contact 120a—120b is interposed will be frequency and group coded in the manner illustrated by the curve 120—80 code of Fig. 4B to represent approach-restricting traffic conditions and a fixed hazard of the first degree. The current flowing in a circuit in which the contact 75a—75b is interposed will be frequency and group coded in the manner illustrated by the curve 75—80 code of Fig. 4C to represent approach traffic conditions and a fixed hazard of the first degree.

When the fixed hazard is of the second degree and a permissible maximum speed of 50 miles per hour is prescribed, the code transmitter is modified so that the frequency code impulses are grouped into successive groups of four impulses each and an "off" interval equivalent to three normal "off" intervals is inserted between the successive code groups. In this case, the code transmitter may be constructed in the manner shown in Fig. 3C. Looking at Fig. 3C, two shafts indicated by the dotted lines 15d and 15e are driven from shaft 15 through suitable gear trains so that the shaft 15d rotates at 24 revolutions per minute and the shaft 15e rotates at 36 revolutions per minute, it being recalled that shaft 15 rotates at 15 revolutions per minute. Three code selectors or cams 43, 44 and 45 of suitable insulating material are fixed on the shaft 15, 15d and 15e, respectively. Each of the cams 43, 44 and 45 is formed with five teeth, and is mutilated by the removal of one tooth. The code contact members 75, 120 and 180 are actuated by the three cams 43, 44 and 45, respectively, as in previous cases. With the code transmitter constructed in this manner, the current in the circuit in which the respective code contacts are interposed will be coded in the manner illustrated by the curves 180—50 code of Fig. 4A, 120—50 code of Fig. 4B and 75—50 code of Fig. 4C.

When the fixed track hazard is of the third degree and the permissible maximum speed of 25 miles per hour is prescribed, the code transmitter is modified so that the frequency code impulses are grouped into successive groups of three impulses each, and an "off" interval equivalent

to three normal "off" intervals is inserted between the successive code groups. To obtain such a code arrangement, the code transmitter may be constructed as disclosed in Fig. 3D. In this case, the shaft 15 drives through gear trains three shafts indicated by three dotted lines 15f, 15g and 15h, the gear trains being of such ratio that the shafts 15f, 15g and 15h rotate at 18.75, 30 and 45 revolutions per minute, respectively. Three code selectors or cams 46, 47 and 48 of suitable insulating material are fixed on the shafts 15f, 15g and 15h, respectively, and each is formed with four teeth and is mutilated by the removal of one tooth. The code contact members 180, 120 and 75 are operated by the cams 43, 47 and 46, respectively, with the result that the current for the circuit in which the respective contacts are interposed will be frequency and group coded as illustrated by the curves 180—25 code, 120—25 code and 75—25 code of Figs. 4A, 4B and 4C, respectively.

I shall now take up the description of the apparatus of Fig. 1 and point out the results effected when the code transmitter is of the construction of Figs. 3A, 3B, 3C and 3D.

Referring to Fig. 1 and assuming that the control relays occupy the position illustrated in the drawings, which, as will shortly appear, is the position of the relays under "clear" traffic conditions for section 2T, a circuit can be traced from the BX terminal of the source of alternating current over code contact 180a—180b of the code transmitter CT, front contacts 24, 21, 22 and 23 of relays JA, H, BSA and ASA, respectively, primary winding 71 of transformer T1, and to the CX terminal of the current source. Again, when the relay JB is picked up and relay JA is released, as will be the condition of the relays when "approach-restricting" traffic conditions exist for section 2T, the above traced circuit is completed at the front contact 19 of relay JB and the back contact 20 of relay JA. Consequently, when the control relays of signal location A1 are energized in accordance with either "clear" or "approach-restricting" traffic conditions for section 2T, the track circuit current for the section 1T is coded according to the 180 frequency code. In the event no fixed track hazard exists in the vicinity of section 2T, then this frequency code alone would be impressed upon the track circuit current for section 1T. If the fixed hazard shown at the right-hand end of section 2T is one of the first degree and the code transmitter of Fig. 1 is modified according to the construction disclosed by Fig. 3B, then the current supplied to the track circuit of section 1T over the circuit traced above would be frequency and group coded as illustrated by the 180—80 code curve of Fig. 4A. If the track hazard of section 2T is one of the second degree and the code transmitter is modified according to the construction of Fig. 3C, the above traced circuit, including code contact 180a—180b would supply to the track circuit of section 1T current, frequency and group coded as illustrated by the 180—50 code curve of Fig. 4A. Again, if the fixed hazard in the vicinity of section 2T is one of the third degree and the code transmitter is modified according to the construction of Fig. 3D, current coded according to the 180—25 code curve of Fig. 4A is supplied to the track circuit of section 1T by the circuit including the code contact 180a—180b.

Assuming the relays JA and JB are both released and the relays ASA, BSA and H are picked up, which, as will shortly appear, is the condition

of the relays under "approach" traffic conditions for section 2T, a circuit extends from BX terminal of the source of alternating current over code contact 120a—120b, back contacts 28 and 20 of relays JB and JA, respectively, front contacts 21, 22 and 23 of relays H, BSA and ASA, respectively, primary winding 71 and terminal CX. With the code transmitter CT modified to agree with the nature of the fixed track hazard in the vicinity of section 2T, the track circuit current for section 1T would be frequency and group coded by this circuit including code contact 120a—120b according to the 120—80 code, 120—50 code or 120—25 code, of Fig. 4B depending upon the nature of the fixed track hazard.

Assuming that track section 2T is occupied and the track relay TR inactive and all the control relays released, a circuit extends from the BX terminal over back contacts 26 and 27 of relays BSA and ASA, respectively, code contact 75a—75b, primary winding 71 of transformer T1 and CX terminal, and the track circuit current for section 1T is coded at the 75 frequency code to reflect "approach" traffic conditions for section 1T. Modification of the code transmitter to agree with the nature of the fixed hazard of Fig. 1 results in the current supplied to the track circuit of section 1T over this circuit, including code contact 75a—75b, being coded according to the 75—80 code, 75—50 code or 75—25 code of Fig. 4C, depending upon the nature of the track hazard.

On the assumption no fixed track hazard exists along the track section next in advance of section 2T, that is, the section next to the right as viewed in Fig. 1, the track circuit for the section 2T will be coded at the frequency code according to traffic conditions in the manner just explained in connection with the track circuit for section 1T. If clear traffic conditions exist and the track circuit current of section 2T is of the 180 frequency code, the track relay TR is operated in step with this code frequency to alternately close the contacts 9—11 and 9—13, as well as to alternately close the contacts 10—12 and 10—14. With the contacts 9—11 and 9—13 alternately closed, current is alternately supplied to the two portions of the winding 226 of an autotransformer T2 from a source of direct current, the two terminals of which are identified by the reference characters B and C. It follows that an electromotive force is induced in the winding 226 of a frequency corresponding to the 180 code frequency. The winding 226 of transformer T2 is connected with the operating winding of relay JA through a filter rectifier 228 which is proportioned and adjusted to pass and rectify current of a frequency corresponding to the 180 code and to suppress other frequencies. Hence, relay JA is energized and picked up in response to the 180 code frequency for the track circuit current of section 2T.

With "approach restricting" traffic conditions in advance of section 2T and the track circuit current for the section 2T coded at the 120 frequency code, relay TR is operated in step with this frequency, and the resultant electromotive force induced in the winding 226 is of the frequency corresponding to the 120 code. The winding 226 is connected with the operating winding of relay JB through a filter rectifier 227 which is proportioned and adjusted to pass and rectify current of the frequency corresponding to the 120 code and to suppress other frequencies, and hence relay JB is energized and picked up in

response to the 120 code for the track circuit of section 2T.

If "approach" traffic conditions exist for section 2T and its track circuit current is coded at the 75 frequency code, the resultant electromotive force induced in the winding 226 of transformer T2 will be of a frequency outside of the pass band of the filter rectifiers 227 and 228, and both relays JA and JB will be deenergized.

Starting from the time no current is supplied to the relay TR and its contact members 9 and 10 are stationary in engagement with their respective back contacts and all the control relays are released, and assuming that current of the 180 code frequency is supplied to the track circuit for section 2T, the relay TR is energized to lift its contact members 9 and 10 into engagement with the front contacts 11 and 12, respectively, during the "on" period of the first impulse. The closing of contact 10—12 completes a simple circuit easily traced for relay ASA, and that relay is picked up. Relay ASA is provided with slow release characteristics by virtue of a snubbing resistor 29 and remains picked up from one code impulse to the next. On the "off" period of the first impulse the relay TR is released closing contact 10—14, and current flows from the B terminal over contact 10—14, front contact 39 of relay ASA, winding of relay BSA and to the C terminal, and relay BSA is picked up. Relay BSA is provided with slow release characteristics by virtue of resistor 31 connected across the winding of relay BSA over front contact 30 of relay ASA. At the "on" period of the second impulse, relay TR is picked up closing contact 10—12 again, and current is supplied from the B terminal over contact 10—12, resistor 32, back contact 33 of relay H, back contact 34 of relay JA, front contact 35 of relay BSA, winding of relay H and to the C terminal, and relay H is picked up, the back contact 33 being of such construction that relay H picks up over its own back contact. Relay H is provided with slow release characteristics by virtue of resistor 38. Relay H is provided with a stick circuit which includes its own front contact 38, back contact 34 of relay JA, and front contact 35 of relay BSA, and is also provided with an energizing circuit including front contact 37 of relay JA and front contact 35 of relay BSA.

From this point on, the relays ASA, BSA and H are retained picked up as long as the code frequency persists. After a few code impulses, the electromotive force induced in the winding 226 of transformer T2 becomes effective to select relay JA, and that relay is picked up.

In the event current of the 120 code is supplied to the track circuit for section 2T immediately subsequent to a period when no current is supplied and the control relays are all released, the operation of the relays ASA, BSA and H in response to the first two impulses of the code is the same as described in connection with the 180 code. This time, relay JB is selected and is picked up. In the event current of the 75 code is supplied to the track circuit for section 2T subsequent to a period when no current is supplied, the operation of the relays ASA, BSA and H is again the same, but this time the relays JA and JB remain deenergized. It is to be noted that relays ASA, BSA and H are sequentially picked up in response to the first and second impulses of each code frequency of the track circuit current of section 2T, are retained picked up by continued operation of track relay TR, are released when relay TR is not operated, and these relays control over

front and back contacts the supply of track circuit current for section 1T. The relays ASA, BSA and H provide broken down insulated rail joint protection desirable in signal systems of the type here involved but which protection need not here be described in detail since it forms no part of my present invention and is not required for a full understanding of the invention.

It is to be pointed out that in the event the track circuit current for section 2T is group coded according to some fixed track hazard as well as being frequency coded according to different traffic conditions, the operation of the control relays of Fig. 1 is substantially the same as described hereinbefore and the relays are retained energized since the resistors 29, 31 and 38 are proportioned to provide the respective relay with a slow release period sufficient to bridge the "off" period inserted between code groups. Also, the circuits for the relays JA and JB are proportioned and adjusted so that when one of these relays is selected in response to a frequency code it remains picked up during the "off" period inserted between the code groups.

Location A1 is provided with a wayside signal S1 for governing traffic through the section 2T. The signal S1 may be any one of the standard types and is here shown as a position light signal capable of displaying "clear", "approach-restricting", "approach" and "stop" indications. The operating circuits for the signal S1 are shown at the lower portoin of Fig. 1 and are governed by the control relays according to standard practice, and it is thought to be unnecessary to describe these circuits in detail.

Referring to Fig. 2, the train-carried portion of the apparatus includes as essential elements pick-up apparatus, code responsive apparatus for governing a traffic cab indicator and other code responsive apparatus for governing a fixed hazard cab indicator.

The pick-up apparatus includes two magnetizable cores 49 and 49a located in advance of the first pair of locomotive wheels and disposed in inductive relation with the two track rails according to usual practice. The core 49 is provided with a winding 51, and the core 49a is provided with a winding 52, the two windings being connected so that electromotive forces induced therein by alternating current flowing in the two rails in opposite directions are additive. The two windings 51 and 52 are connected with the input terminals of an amplifier AM, the output terminals of amplifier AM being in turn connected with the operating winding of a code following master relay MR. The amplifier AM is shown conventionally only for the sake of simplicity, since it may be any one of several well-known types. The master relay MR is preferably of the direct current polar type commonly employed in frequency code signal systems for railroads. As is usual practice, the relay MR is controlled by the amplifier AM in a manner so that the building up of energy induced in the windings 51 and 52 causes an impulse of current in the operating winding of relay MR which is of a polarity that will position the armature 53 of relay MR in the right-hand position, that is, in the position illustrated by the dotted line in Fig. 2. The dying away of energy induced in the windings 51 and 52 causes a current impulse in the winding of relay MR which is of a polarity that positions the armature 53 in the left-hand position, that is, in the position illustrated by the solid line in Fig. 2. It follows that the ar-

mature 53 is operated in step with the code impulses of alternating current flowing in the track circuit, including the track rails. That is, when the track circuit of a section is supplied with alternating current of 180, 120 or 75 code frequency, the armature 53 of relay MR is operated at the corresponding code frequency. When the track circuit current is coded according to the frequency codes and group codes explained hereinbefore in connection with the trackway apparatus of Fig. 1, the armature 53 is operated at the corresponding frequency code and is held stationary at the left-hand position during the interval inserted between the code groups. The master relay MR governs the apparatus responsive to the frequency codes and also operates a code following repeater relay MR1, which relay MR1 in turn governs the apparatus responsive to the group codes.

The apparatus responsive to the frequency codes includes a decoding unit DC1, three control relays A, R and L, and a cab indicator TS. Current impulses are supplied to the input terminals of the decoding unit DC1 over the armature 53 of relay MR, and the output terminals of the unit are connected to the operating windings of the relays A, R and L, as will be readily understood by an inspection of Fig. 2.

The decoding unit DC1 may be any one of several types well known to the art, and is shown conventionally only in order to simplify the drawings as much as possible. It is deemed sufficient for the present application to point out that the decoding unit DC1 is selectively responsive to the different frequency codes so that relay L is energized and picked up on each of the 180, 120 and 75 frequency codes, relay R is energized and picked up on the 120 frequency code only, and relay A is energized and picked up on the 180 frequency code only. The relays L, R and A are each provided with slow release characteristics so that the relay, when picked up, it retained picked up during the interval inserted between the various code groups referred to hereinbefore.

The relays L, R and A govern the circuits for the cab indicator TS for indicating in the locomotive cab the traffic condition corresponding to the frequency code picked up from the track rails. With relay A picked up in response to the 180 code, closing its front contacts 54 and 55, a circuit is completed for the indicator lamp 56, and the lamp 56 is illuminated to display a "clear" cab signal. When relay R is picked up in response to the 120 code and relay A is de-energized, a circuit is completed, including back contact 57 of relay A and front contact 58 of relay R on one side, and including back contact 59 of relay A and front contact 60 of relay R on the other side, for the two lamps 61a and 61b in parallel, and these two lamps are illuminated to display the "approach-restricting" cab signal. When relays A and R are both released and relay L is picked up in response to the 75 code, a circuit is completed from the B terminal over back contacts 57 and 62 of relays A and R, respectively, front contact 63 of relay L, lamp 64, front contact 65 of relay L, back contacts 66 and 59 of relays R and A, respectively, and terminal C, and lamp 64 is illuminated to display the "approach" cab signal. When there is an absence of code current in the track rails and relay MR is not operated and all the relays A, R and L are released, the lamp 67 of indicator TS is provided with a circuit including a back contact

of each of the three control relays in series, as will be readily understood by an inspection of Fig. 2, and lamp 67 is illuminated to display a "caution-slow speed" cab signal.

5 It will be understood, of course, that the usual acknowledging device may be associated with the cab indicator TS. It is also to be noted that, when relays A and R are deenergized and relay L is energized in response to the 75 frequency code, positive and negative energy are impressed upon the terminals PL and NL, respectively. 10 When relays A, R and L are all released in response to "caution-slow speed" traffic conditions, positive and negative energy are impressed 15 on the terminals PS and NS, respectively.

With the master relay MR operating in the manner explained above, positive energy is alternately impressed on the terminals P1 and P3, which terminals are connected with the outside 20 terminals of the operating winding of the repeater relay MR1. The mid terminal of the winding of relay MR1 is connected with the common or C terminal of the current source. When positive energy is impressed on terminal P3, the relay MR1 25 is energized with a polarity such that its code contact members 68 and 69 are moved to the lower position, as viewed in Fig. 2. When positive energy is impressed on terminal P1, the relay MR1 is energized with a polarity such that its contact 30 members 68 and 69 are moved to the raised position, as viewed in Fig. 2. It follows that the code following repeater relay MR1 is operated to repeat the code operating the master relay MR, and the code contact members 68 and 69 are retained 35 in their lower positions during an interval inserted between the code groups. The relay MR1 governs the apparatus responsive to the code groups in accordance with the code group impressed on the track circuit current by the trackway apparatus to reflect a fixed track hazard in the vicinity of the track section.

The essential elements of the apparatus responsive to the group codes consist of a decoding unit designated as a whole by the reference character DC2, a retardation governing device including relays LC and AP, three control relays C1, 45 C2 and C3, a cab indicator HS, an acknowledging device including a manually operated switch SW, relay SPC and a whistle magnet WM, and a signal suppressing relay LP. 50

The decoding unit DC2 consists of a relay X and a chain of six counting relays 1 to 6, inclusive. The relays 4, 5 and 6 of the counting chain of relays govern the control relays C1, C2 and C3, respectively, as will later appear. The control relays C1, C2 and C3 are provided with slow release characteristics of the order indicated on the drawing to require at least two operations of the relays of the counting chain of relays to effect a change in the position of the control relays. The control relays C1, C2 and C3 in turn govern the circuits for the lamps of the indicator HS in a manner to later appear. The relay LP is provided to prevent the display of the hazard indicator HS during a "caution-slow speed" traffic condition. 65

The relay LC of the retardation device causes the decoding unit DC2 to remain inoperative 70 when the current picked up from the track circuit is frequency coded only, the relay AP automatically adjusting the retardation action of relay LC to fit the normal "off" period of the frequency code received. The relay LC causes operation of 75 the decoding unit DC2 according to the group

code when the track circuit current is both frequency and group coded.

It is believed that the operation of the apparatus governed by the repeater relay MR1 in response to the different group codes for the different fixed track hazards can best be understood by a description of its operation.

In Fig. 2, the relays responsive to the group codes are all illustrated in the released position ready to respond to any incoming code picked up from the track rails. I shall first describe in step-by-step fashion the operations following the picking up of a 180 frequency code current. The "on" period of the first impulse picked up causes relay MR1 to lift its contact members 68 and 69 into engagement with contacts 77 and 78, respectively. A circuit is completed from the B terminal of the current source over contact 68—77, back contact 79 of relay X, back contacts 280, 81, 82, 83, 84 and 85 of relays 1, 2, 3, 4, 5 and 6, respectively, winding of relay LC and to the C terminal, and relay LC is picked up. With relay LC picked up, another circuit is completed from B terminal over front contact 86 of relay LC, contact 69—78 of relay MR1, back contact 87 of relay 1, winding of relay X, front contact 88 of relay LC and to the C terminal, and relay X is also picked up during the "on" period of the first impulse. When relay MR1 operates its contacts 68 and 69 to the lower position during the "off" period of the first impulse, relay LC remains picked up due to the slow release period established by virtue of a resistor 189 and a rectifier 90 connected across its operating winding. During the "off" period of the first impulse, relay X is retained energized over a stick circuit including two branch paths, one path of which extends from B terminal over contact 68—91, front contact 92 of relay X, winding of relay X, front contact 88 of relay LC and C terminal. The other branch path extends from B terminal over front contact 89 of relay X, back contact 87 of relay 1, winding of relay X and front contact 88 to the C terminal. With relay X thus retained energized during the "off" period of the first impulse, a circuit can be traced from the B terminal over front contact 86 of relay LC, contact 69—93 of relay MR1, front contact 94 of relay X, back contacts 95, 96 and 97 of relays 6, 4 and 2, respectively, winding of relay 1 and to the C terminal, and relay 1 is picked up. Relay 1 is then retained energized over a stick circuit including B terminal, front contact 86 of relay LC, front contact 98 and winding of relay 1, and to the C terminal. It follows that relay 1 of the counting chain of relays is picked up and retained energized in response to the first impulse. 50

When relay MR1 lifts its contact members 68 and 69 in response to the "on" period of the second impulse, the relay LC is provided with an energizing impulse over a circuit including contact 68—77 and the front contact 99 of relay LC. Both paths of the stick circuit for the relay X are now opened and relay X is released during the "on" period of the second impulse. The "off" period of the second impulse causes relay MR1 to lower its contact members 68 and 69. Since relay X is now released, the closing of contact 69—93 completes a circuit from B terminal over front contact 86, contact 69—93, back contact 100 of relay X, back contacts 101 and 102 of relays 5 and 3, respectively, front contact 103 of relay 1, winding of relay 2 and to the C terminal, and relay 2 is picked up. Relay 2 is then retained energized over a stick circuit including its own 75

front contact 104 and the front contact 86 of relay LC. Thus, relay 2 of the counting chain of relays is picked up and retained energized in response to the second impulse.

5 With relay MR! lifting its contact members 68 and 69 during the "on" period of the third impulse, relay LC is again provided with an energizing impulse, and a circuit is formed for relay X from B terminal over front contact 86, 10 contact 69—78, back contact 105 of relay 3, front contact 106 of relay 2, winding of relay X and to the C terminal, and relay X is again picked up. Relay X is now provided with a stick circuit including two branch paths, one 15 of which involves contact 68—91 of relay MR! and front contact 92 of relay X, and the other path of which involves B terminal, front contact 89, back contact 105 of relay 3, front contact 106 of relay 2, winding of relay X, front contact 20 88 of relay LC and terminal C.

With contact members 68 and 69 operated to the lower position in response to the "off" period of the third impulse, a circuit is formed for relay 3 which extends from B terminal over front contact 86, contact 69—93, front contact 94 of relay 25 X, back contacts 95 and 96 of relays 6 and 4, respectively, front contact 107 of relay 2, winding of relay 3 and C terminal, and relay 3 is picked up. Relay 3 is then retained energized over a 30 stick circuit including its own front contact 108 and front contact 86 of relay LC. Hence, during the third impulse the relay 3 of the counting chain of relays is picked up and retained energized.

35 The "on" period of the fourth impulse causes relay MR! to lift contact members 68 and 69, and relay LC is again provided with an energizing impulse. Relay X is now deenergized and releases during the "on" period of the fourth impulse, since both paths of its stick circuit are open. The "off" period of the fourth impulse 40 shifts contact members 68 and 69 back to the lower position and completes a circuit from B terminal over front contact 86, contact 69—93, back contact 100 of relay X, back contact 101 of relay 5, front contact 109 of relay 3, winding of relay 4 and C terminal, and relay 4 is picked up. Relay 4 is then held energized over a stick circuit including its own front contact 110 and 50 front contact 86 of relay LC. Consequently, relay 4 of the counting chain of relays is operated during the fourth impulse.

The "on" period of the fifth impulse causes contact members 68 and 69 to be shifted back 55 to the raised position and a circuit is formed for relay X at contact 69—78, back contact 111 of relay 5 and front contact 112 of relay 4. Relay X is again provided with a stick circuit including two branch paths, one of which includes its own front contact 92 and contact 68—91, and 60 the other of which includes its own front contact 89, back contact 111 of relay 5 and front contact 112 of relay 4. Contact members 68 and 69 are next shifted back to the lower position during the "off" period of the fifth impulse. Since relay X is retained energized, a circuit is 65 formed from B terminal over front contact 86, contact 69—93, front contact 94 of relay X, back contact 95 of relay 6, front contact 113 of relay 4, winding of relay 5 and to the C terminal, and relay 5 is picked up and retained energized over a stick circuit including its own front contact 114 and front contact 86 of relay LC. Thus, relay 5 is picked up in response to the 70 fifth impulse.

The "on" period of the sixth impulse shifts contact members 68 and 69 to the raised position, and relay X is released since both paths of its stick circuit are now open. When contact 5 members 68 and 69 are shifted to the lower position during the "off" period of the sixth impulse, a circuit is formed from B terminal over front contact 86, contact 68—93, back contact 100 of relay X, front contact 115 of relay 5, winding of relay 6 and to the C terminal, and relay 6 is 10 picked up and retained energized over a stick circuit including its own front contact 116 and front contact 86 of relay LC. It follows that relay 6 is picked up by the sixth impulse.

The "on" period of the seventh impulse shifts 15 the contact members 68 and 69 to the raised position to again provide relay LC with an energizing impulse and to complete a circuit for relay X at contact 69—78 and front contact 117 of relay 6, and relay X is then retained energized 20 over a stick circuit including its own front contact 89, front contact 117 of relay 6, and front contact 88 of relay LC. Each subsequent impulse causes contact members 68 and 69 to be 25 lifted and relay LC provided with an energizing impulse, with the result that relay LC, relay X and each relay of the chain of counting relays are retained energized, the relays of the chain of relays being retained energized over stick cir- 30 cuits each of which includes front contact 86 of relay LC and relay X being energized over a stick circuit including front contact 117 of relay 6 and front contact 88 of relay LC.

When counting relay 4 is picked up, a circuit 35 is formed for the control relay C1, and that relay is energized. This circuit can be traced from terminal B over front contact 118 of relay LC, front contact 119 of relay 4, winding of relay C1, front contact 121 of relay 4, front contact 28 of relay LC and to the C terminal. The picking 40 up of counting relay 5, closing its front contacts 122 and 123, completes a similar circuit for relay C2, and relay C2 is energized. Likewise, the picking up of counting relay 6, closing its front contacts 124 and 125, completes a circuit easily 45 traced for relay C3, and that relay is energized. It follows that all three of the control relays C1, C2 and C3 are energized in response to the 180 frequency code.

Since relay LC is picked up during the "on" 50 period of the first impulse and is subsequently retained energized in response to reception of the 180 frequency code current, the relay LP is energized during each "off" period of the code impulses. The circuit for relay LP includes ter- 55 minal B, front contact 86 of relay LC, contact 69—93, winding of relay LP, front contact 88 of relay LC and to the C terminal. Relay LP is slow releasing in character, and hence remains picked up from one code impulse to the next. 60 When relay LP is picked up, closing its front contacts 126 and 127, a circuit easily traced is completed for the hazard lamp "HAZ" of indicator HS, and that lamp is illuminated. When the control relays C1, C2 and C3 are all energized, 65 a circuit is formed for the "NO" lamp of indicator HS. This circuit for the "NO" lamp involves the elements, B terminal, front contact 126 of relay LP, front contacts 128, 129 and 130 of relays C1, C2 and C3, respectively, the "NO" 70 lamp, front contacts 131, 132 and 133 of relays C3, C2 and C1, respectively, and front contact 127 of relay LP to the C terminal. It follows that the "no hazard" indication is displayed by the indicator HS when current coded at the 180 75

frequency code is picked up from the track circuit.

Assuming next that current of the 120 frequency code is picked up from the track rails and relays MR and MR1 are operated at the frequency rate of 120 times per minute, the operation of relay LC and the relays of the decoding unit DC2 in response to the first six impulses of the code current is substantially the same as explained in connection with the first six code impulses of the 180 code current, the retardation period in the release of relay LC as provided by resistor 189 and rectifier 90 being a little greater than one-fourth second and thus sufficient to bridge the normal "off" periods of the 120 code current. Hence, the "no hazard" cab signal is displayed by indicator HS when the track circuit current is of the 120 frequency code.

In the event current of the 75 frequency code is picked up from the track rails and relays MR and MR1 are operated at the rate of 75 times per minute, the operation of the relay LC and the relays of the decoding unit DC2 is substantially the same as explained hereinbefore, since the retardation period in the release of relay LC is increased so that it is sufficient to bridge the normal "off" periods of the 75 frequency code current. It will be recalled that, when relays R and A are released and relay L is picked up in response to 75 frequency code current, energy is impressed upon the terminals PL and NL, and hence relay AP is energized and picked up, closing its front contact 134 in response to current of the 75 frequency code. The closing of front contact 134 connects a resistor 135 in parallel with resistor 189 across the winding of relay LC to increase its slow release period to a little over four-tenths of a second.

With the apparatus actuated to display the "no hazard" cab signal in response to either the 180, 120 or 75 code current, a circuit is formed for the whistle magnet WM and the whistle 136 is retained silent. This circuit can be traced from terminal B over front contact 126 of relay LP, front contacts 128, 129 and 130 of relays C1, C2 and C3, respectively, wire 137, back contact 138 of relay SPC, normally closed contact 139 of switch SW, front contact 140 of relay LP, operating winding of whistle magnet WM, front contact 141 of relay LP, back contact 142 of relay SPC, wire 143, front contacts 131, 132, 133 and 127 and to the C terminal.

I shall next take up the operating steps which follow when the locomotive enters a track section in the vicinity of a fixed track hazard and a group code is superposed on the traffic frequency code. I shall assume that the track hazard is one of the first degree and that the code picked up from the track rails is of the 180—80 code, and consequently each group of five code impulses is separated from the preceding and succeeding groups by an interval equivalent to three normal "off" periods of the code current. I shall also assume that the apparatus associated with the indicator HS has previously been operated in a manner set forth hereinbefore so as to cause the "no hazard" cab signal to be displayed. It is to be recalled that resistor 189 and rectifier 90 establish a release period for relay LC which is slightly greater than one-fourth of a second in order to span the normal "off" period of the 120 code impulses and that the release period of the relay LC is increased to something over four-tenths second to span the normal "off" period of the 75 code frequency impulses. Hence, under the 180—80 code the release period of relay LC

is of the order of one-fourth of a second and at the first interval or pause, which is of the order of one-half second, interposed between two code groups the relay LC is released. When relay LC is released, opening its front contact 86 interposed in the stick circuits for the counting relays, the counting relays are all deenergized and immediately released, relay X also being released since its stick circuit is opened at both front contact 117 of relay 6 and front contact 88 of relay LC. Reenergization of relay LC in response to the first impulse of the next code group causes the counting relays to be sequentially operated in the manner already explained. At the next long "off" period or pause the relay LC is again released and the counting relays deenergized and then again operated during the next code group. Since there are but five impulses in each group, the relay 6 is never picked up, with the result that relay C3 is deenergized and releases at the end of its slow release period. Five code impulses plus a pause of the 180—80 code span a period of something like two and one-sixth seconds, and hence relay C3, which is provided with a release period of the order of five seconds, does not release until subsequent to the completion of a second operation or count of the counting relays. That is to say, two counts are required of the counting relays before a change in the position of the control relays is effected, with the result that an interruption such as may occur at an insulated rail join location does not change the condition of the control relays C1, C2 and C3, and in turn the condition of the cab indicator HS.

Inasmuch as relays 4 and 5 are picked up during each code group, the relays C1 and C2 are retained energized. With relay C3 released and relays C1 and C2 energized, the circuit for the "NO" lamp is opened at front contacts 139 and 131 of relay C3. Opening of front contacts 139 and 131 also causes deenergization of the whistle magnet WM and the whistle 136 is sounded. The engineman acknowledges this change in the hazard cab indicator by operating the switch SW to pick up the relay SPC. The pick-up circuit for relay SPC includes B terminal, front contact 126 of relay LP, front contacts 128 and 129, back contact 144, contact 145—146 of switch SW, winding of relay SPC, back contact 147, front contacts 132, 133 and 127 and to the C terminal. Relay SPC is retained energized subsequent to switch SW being returned to its normal position over its own front contact 148 in shunt with the contact 145—146. The whistle magnet WM is now energized over a circuit including the following elements: 126, 128, 129, 144, 149, 139, 140, whistle magnet WM, 141, 150, 147, 132, 133 and 127. The lamp "80" of indicator HS is now provided with a circuit that includes the elements: E terminal, front contacts 126, 128 and 129, back contact 144, contact 145 of switch SW, front contacts 151 and 152 of relays C1 and C2, respectively, lamp "80", front contacts 153, 154 and 155, back contact 147, front contacts 132, 133 and 127 to the C terminal. To sum up, reception of the 180—80 code current is effective to cause the display of the "clear" lamp 56 of indicator TS in a manner previously described, and to display the "HAZ—80" lamp of indicator HS, the change in the signal displayed by the indicator HS requiring acknowledgment by the engineman.

Assuming the fixed track hazard to be one of the second degree and the current is of the 180—50 code, the operation of the apparatus is simi-

lar to that described for the 180—80 code except for the fact that each code group now includes only four impulses and only four counting relays are operated by each group. Since neither relay 5 nor 6 is now operated, both control relays C2 and C3 are deenergized and released at the end of their slow release period. Again, it is to be noted that the release period of relays C2 and C3 is such as to span at least two code groups, with the result that at least two counts of the counting relays are required before a change in the position of the control relays is effected. When relays C2 and C3 are released, the "NO" lamp for indicator HS is extinguished as before and also the whistle magnet WM is deenergized. The engineman would acknowledge this change in the indicator HS in the same manner previously pointed out in connection with the 180—80 code. Since relay 4 is picked up during each code group, relay C1 is retained energized, and with relay C1 picked up and relays C2 and C3 deenergized a circuit is formed for the "50" lamp of indicator HS. This circuit involves the following elements: B terminal, front contacts 126 and 128, back contact 156, contact 145, front contact 151, back contact 158, the "50" lamp, back contact 159, front contact 154, front contact 155, back contact 157, front contacts 133 and 126 and C terminal. Hence, the "HAZ—50" cab signal is displayed to indicate the approach to a track hazard of the second degree.

If the fixed track hazard is one of the third degree and the code is 180—25, the lamp 56 of indicator LS is displayed in response to the 180 frequency code to reflect "clear" traffic conditions, the same as in previous cases, and the relay LC, together with the counting relays, are operated in the manner previously described, except for the fact that only three counting relays 1, 2 and 3 are operated since the code groups contain only three impulses. Under these circumstances, the three control relays C1, C2 and C3 are all released at the expiration of their slow release period, causing the "NO" lamp of indicator HS to be extinguished and the whistle magnet to be deenergized, sounding whistle 136. The engineman acknowledges the change in the hazard indicator HS by operating the switch SW to energize relay SPC in the manner previously pointed out. The picking up of relay SPC prepares a circuit for the "25" lamp of indicator HS, which circuit is completed when the control relays are released, with the result that the "HAZ—25" cab signal is displayed. This circuit for the lamp "25" includes the elements: B terminal, front contact 126, back contact 160, contact 145, back contact 162, the "25" lamp, back contact 163, front contact 155, back contact 161, front contact 127 and the C terminal.

It is to be seen from the foregoing description that, when the locomotive enters the track section, the trackway apparatus of which is set to reflect "clear" traffic conditions and is modified in accordance with a fixed track hazard in the vicinity of the section, the indicator TS displays a "clear" traffic signal and the indicator HS displays the degree of the fixed track hazard, the response of the apparatus governing indicator HS being such as to require two counts of the group code and the acknowledging device requiring that the engineman acknowledge the change in the hazard indicator.

In the event the trackway apparatus of the section in the vicinity of the track hazard is set to reflect "approach-restricting" traffic con-

ditions and the code is 120—80, 120—50 or 120—25, depending upon the degree of the fixed hazard, the operation of the train-carried apparatus would be similar to that described under "clear" traffic conditions for the track sections, except for the fact that lamps 61a and 61b of indicator TS are illuminated to display the "approach-restricting" cab signal.

Again, in the event the trackway apparatus for the section in the vicinity of the fixed track hazard is set to reflect "approach" traffic conditions and the code is 75—80, 75—50 or 75—25, depending upon the degree of the fixed hazard, the operation of the train-carried apparatus is similar to that described under clear traffic conditions, except for the fact that lamp 64 of indicator TS is illuminated to display the "approach" cab signal and the relay AP is picked up to increase the release period of relay LC so that relay LC bridges the normal "off" periods of the 75 code frequency but is released during the long interval inserted between the code groups.

In the event this track section in the vicinity of a fixed track hazard is occupied and "caution-slow speed" traffic conditions exist for a second or following train, the relays MR and MR1 of the second train are both inactive. Under these circumstances, the control relays A, R and L are all released, causing lamp 67 of indicator TS to be illuminated to display the "caution-slow speed" cab signal. The relays LC and LP, as well as the counting relays and their associated control relays C1, C2 and C3, are also deenergized and released, the release of relay LP causing the lamps of the indicator HS to be extinguished and thereby preventing the display of a hazard cab signal under the "caution-slow speed" traffic conditions. When relay LP is released, closing its back contacts 164 and 165, an auxiliary circuit is provided for the whistle magnet and the whistle 136 remains silent.

Although I have herein shown and described only one form 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. Railway traffic controlling apparatus for a railroad the track of which is characterized by fixed track hazards of different nature and which track is divided into insulated track sections for signaling, trackway apparatus for the section next in the rear of a given fixed track hazard including traffic governed means and a code transmitter and operative to supply to the track rails of the section current of any one of a plurality of different codes according to different traffic conditions in advance of the section, and said code transmitter of predetermined construction to modify each of said code currents supplied to the rails of the section by a distinctive characteristic selected according to the nature of said fixed hazard.

2. Railway traffic controlling apparatus for a railroad the track of which is characterized by fixed track hazards of different degrees and which track is divided into insulated track sections for signaling, trackway apparatus for the section next in the rear of a given fixed track hazard including traffic governed means and a code transmitter and operative to supply to the track rails of the section current of any one of a plurality of different codes according to different

traffic conditions in advance of the section, and said code transmitter provided with a modification predetermined according to the degree of said fixed track hazard to provide for each of said code currents a distinctive characteristic selected according to the degree of said fixed track hazard.

3. Railway traffic controlling apparatus for a railroad the track of which is characterized by fixed track hazards of different degrees that require different permissible maximum speeds for trains at their respective locations and which track is divided into insulated track sections for signaling, trackway apparatus for the section adjacent a given fixed track hazard responsive to different traffic conditions in advance of the section, and a code transmitter governed by said trackway apparatus for supplying to the track rails of the section next in the rear current impulses at different code frequencies with a distinctive frequency code for each of said different traffic conditions, said code transmitter provided with a modification predetermined by the degree of said fixed track hazard to separate such current impulses into a distinctive group of impulses which is separated from the preceding and succeeding groups by a predetermined interval to provide a distinctive group code corresponding to the permissible maximum speed for said hazard.

4. Railway traffic controlling apparatus for a railroad the track of which is characterized by fixed track hazards of different degrees and which track is divided into insulated track sections for signaling, a track circuit for said section next in the rear of a fixed track hazard of a given degree including a source of signaling current, coding means for said section operative to code the current of the associated track circuit with a different traffic code for each of a plurality of different traffic conditions in advance of the section, and said coding means including a code modifier of a construction predetermined according to the degree of said fixed hazard to provide each of said different traffic codes with a distinctive modification selected according to the degree of said fixed hazard.

5. Railway traffic controlling apparatus comprising, a track circuit, trackway coding means operative to supply to said track circuit impulses of current coded at different frequency codes according to different traffic conditions in advance of said track circuit, said coding means constructed to arrange the different frequency codes with a group code predetermined according to a fixed track hazard in advance of said track circuit, train-carried receiving means electrically coupled with said track circuit effectively influenced by the impulses of said different codes, a first decoding unit governed by the receiving means selectively responsive to the different frequency codes, a second decoding unit governed by said receiving means responsive to said group code, a first indicator governed by said first unit to display a signal corresponding to the traffic condition reflected by the frequency code, and a second indicator governed by said second unit to indicate the approach to said fixed track hazard.

6. Railway traffic controlling apparatus comprising, a track circuit, trackway coding means operative to supply to said track circuit impulses of current coded at different frequency codes according to different traffic conditions in advance of said track circuit, said coding means provided with a predetermined modification to group said

frequency codes with a particular one of a plurality of different group codes according to fixed track hazards of different degrees, train-carried receiving means electrically coupled with said track circuit and effectively influenced by the impulses of said different codes, a first decoding unit governed by the receiving means and selectively responsive to the different frequency codes, a second decoding unit governed by the receiving means and selectively responsive to said group code, a first indicator governed by said first unit, and a second indicator governed by said second unit.

7. Railway traffic controlling apparatus comprising, a track circuit, trackway coding means operative to periodically supply to said track circuit current impulses of like duration coded at different codes, each of said codes consisting of recurring groups of impulses with each group made up of a distinctive number of impulses and each group separated from the preceding and succeeding groups by a predetermined interval, train-carried receiving means electrically coupled with said track circuit and effectively influenced by said current impulses, decoding means governed by the receiving means operative to count the impulses of each group to distinguish between the different codes, and control means selectively governed by the decoding means according to the number of impulses of a code group and characterized by a retardation in its operation to require counting of the impulses of two groups to effect the corresponding operation.

8. Railway traffic controlling apparatus comprising, a track circuit, trackway coding means operative to supply to said track circuit current impulses of different frequency codes according to different traffic conditions in advance of said track circuit, said coding means constructed to arrange the impulses supplied to the track circuit in a distinctive group code predetermined according to the degree of a given fixed track hazard, said group code made up of recurring groups of impulses with each group consisting of a number of impulses distinctive for the code and separated from the preceding and succeeding groups by an interval greater than the interval between successive impulses of the code, train-carried receiving means effectively influenced by said track circuit, a first and a second decoding means governed by the receiving means, said first decoding means selectively responsive to the different frequency codes and characterized to bridge the interval between successive groups, said second decoding means made active by said interval between successive groups and selectively responsive to said group code, and a first and a second cab indicator governed by the first and second decoding means respectively.

9. In combination with a stretch of railway track having at different points fixed track hazards that require due to their different degrees different permissible maximum speeds for trains at their respective locations which speeds are less than that required at other locations and which track is formed into insulated track sections for signaling, a track circuit for a section in the rear of a given fixed track hazard, trackway coding means for said section operative to supply to the track circuit of the section current impulses of different code frequencies according to different traffic conditions in advance of the section, and to group the impulse of the different frequency codes supplied to the track circuit of the section into successive groups each of which consists of

a number of impulses selected according to the degree of the fixed hazard, train-carried receiving means effectively influenced by the track circuit of the section when occupied, a first decoding unit governed by the receiving means selectively responsive to the different frequency codes to display a cab signal corresponding to the traffic condition of the section, a second decoding unit governed by the receiving means selectively responsive to said group code to display a cab signal corresponding to the permissible maximum speed at the fixed hazard in advance of the section.

10. In combination, a code following relay capable of operating its armature in step with current impulses periodically supplied to its winding when such impulses are coded at any one of a plurality of different frequency codes and when any one of said frequency codes is modified by the impulses being arranged according to any one of a plurality of different group codes with each group of a code separated from the preceding and succeeding groups by an interval greater than the interval between two successive impulses of the same code, a first decoding means governed by said armature selectively responsive to the different frequency codes and characterized to bridge the intervals between the successive groups, retardation means governed by said armature including a relay which is retained energized during the interval between successive impulses of the codes and is released during the interval between the different groups, and a second decoding means governed by said armature and said relay selectively responsive to the different group codes.

11. In combination, a code following relay capable of operating its armature in step with current impulses periodically supplied to its winding when such impulses are coded at any one of a plurality of different frequency codes and when any one of said frequency codes is modified by the impulses being arranged according to any one of a plurality of different group codes with each group of a code separated from the preceding and succeeding groups by an interval greater than the interval between two successive impulses of the same code, a first decoding means governed by said armature selectively responsive to the different frequency codes and characterized to bridge the intervals between the successive groups, retardation means governed by said armature including a relay which is retained energized during the interval between successive impulses of the codes and is released during the interval between the different groups, and a second decoding means governed by said armature and said relay including a chain of counting relays which are sequentially operated by the successive impulses of a code group to differentiate between the different group codes by the number of relays operated.

12. In combination, a code following relay capable of operating its armature in step with current impulses periodically supplied to its winding when such impulses are coded at any one of a plurality of different frequency codes and when any one of said frequency codes is modified by the impulses being arranged according to any one of a plurality of different group codes with each group of a code separated from the preceding and succeeding groups by an interval greater than the interval between two successive impulses of the same code, a slow release relay governed by said armature, means controlled by said armature in

response to the frequency codes to automatically adjust the slow release period of said slow release relay to cause the relay to bridge the interval between successive impulses of the code operating the armature and to be released during the interval between successive groups of the code, a chain of counting relays sequentially energized in response to operation of said armature, and circuit means controlled by said slow release relay when released to deenergize the counting relays to start a new operation of the counting relay with each group of a code.

13. In combination, a code following relay capable of operating its armature in step with current impulses periodically supplied to its winding when such impulses are coded at any one of a plurality of different frequency codes and when any one of said frequency codes is modified by the impulses being arranged according to any one of a plurality of different group codes with each group of a code separated from the preceding and succeeding groups by an interval greater than the interval between two successive impulses of the same code, a slow release relay governed by said armature, means controlled by said armature in response to the frequency codes to automatically adjust the slow release period of said slow release relay to cause the relay to bridge the interval between successive impulses of the code operating the armature and to be released during the interval between successive groups of the code, a chain of counting relays sequentially energized in response to operation of said armature, circuit means controlled by said slow release relay when released to deenergize the counting relays to start a new operation of the counting relay with each group of a code, signaling means governed by said counting relays to display a particular signal for each of said group codes, and another slow release relay periodically energized by each operation of said armature effective when released to prevent the signaling means from displaying any signal.

14. In combination, a code following relay capable of operating its armature in step with current impulses periodically supplied to its winding when such impulses are coded at any one of a plurality of different frequency codes and when the impulses of any one of said frequency codes are arranged according to any one of a plurality of different group codes with each group of impulses separated from the preceding and succeeding groups by an interval greater than the interval between two successive impulses of the same code, a first decoding means governed by said armature selectively responsive to the different frequency codes, retardation means governed by said armature including a slow release relay which is retained energized during the interval between successive impulses of the codes and is released during the interval between the different groups, a second decoding means governed by said armature including a chain of counting relays which are sequentially energized in response to operation of said armature, circuit means controlled by said slow release relay when released to deenergize the counting relays to start a new operation of the counting relays with each group of a code, signaling means governed by said counting relays to display different indications in response to the different group codes and to display a particular indication in response to a frequency code only, means to at times supply to said code following relay a frequency code only, and other means to

at other times supply said code following relay a frequency code arranged with a group code.

15. In combination with a stretch of railway track characterized by fixed track hazards of different degrees and which track is divided into insulated track sections for signaling, a train to travel on said track, train-carried receiving means effectively influenced by the track circuit of the section occupied by the train, a first decoding unit governed by said receiving means selectively responsive to current of different frequency codes to display different indications of a first cab signal, a second decoding unit governed by the receiving means selectively responsive to different group codes to display different indications of a second cab signal, a track circuit for a selected section, trackway apparatus including a code transmitter responsive to different traffic conditions in advance of that section to supply to said track circuit current impulses of different code frequencies to display an indication of said first cab signal according to traffic conditions, and said code transmitter predetermined in construction according to the degree of a given fixed hazard in advance of said section to arrange the current impulses of said track circuit in a selected group code to display a predetermined indication of said second cab signal.

16. Railway traffic controlling apparatus for a railroad the track of which is characterized by fixed track hazards of at least two different degrees and which track is divided into successive insulated track sections for signaling, a track circuit for each section; three code transmitters of different construction and all of which are effective to produce at least two different frequency codes to correspond to different traffic conditions, one of which transmitters is effective to arrange such frequency codes with a first group code to correspond to a first degree fixed track hazard and a second one of which transmitters is effective to arrange such frequency codes with a second group code to correspond to a second degree fixed track hazard; trackway apparatus for a selected section selectively responsive to at least two different traffic conditions in advance of that section, said trackway apparatus operative to govern any predetermined one of said code transmitters for correspondingly coding the current supplied to the track circuit for the section next in the rear of said selected section, and train-carried means effectively influenced by said track circuit when occupied by the train and selectively responsive to such frequency and group codes.

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