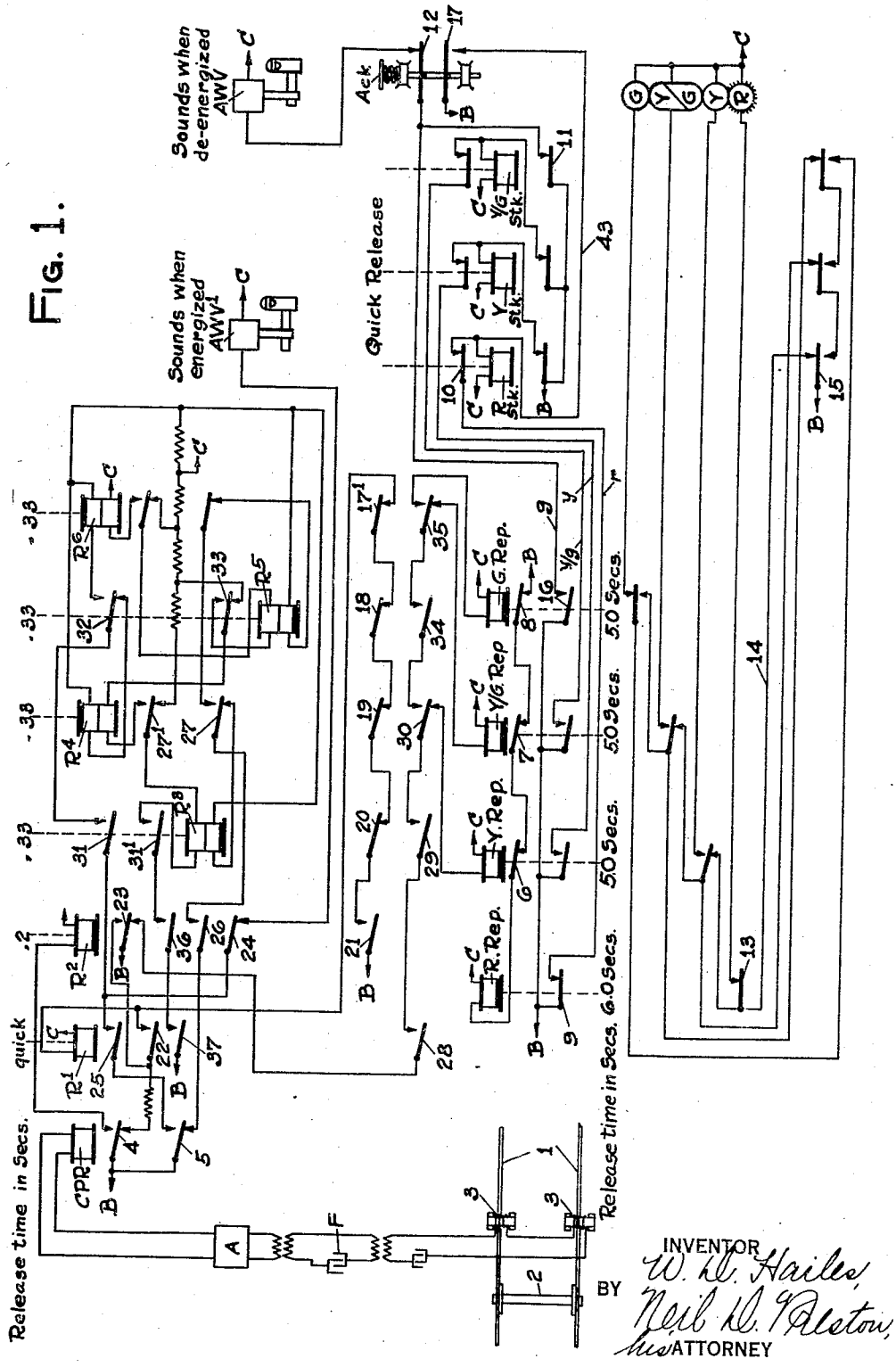
Sept. 22, 1931. W. D. HAILES 1,824,134

CONTINUOUS INDUCTIVE TRAIN CONTROL SYSTEM

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FIG. 1.



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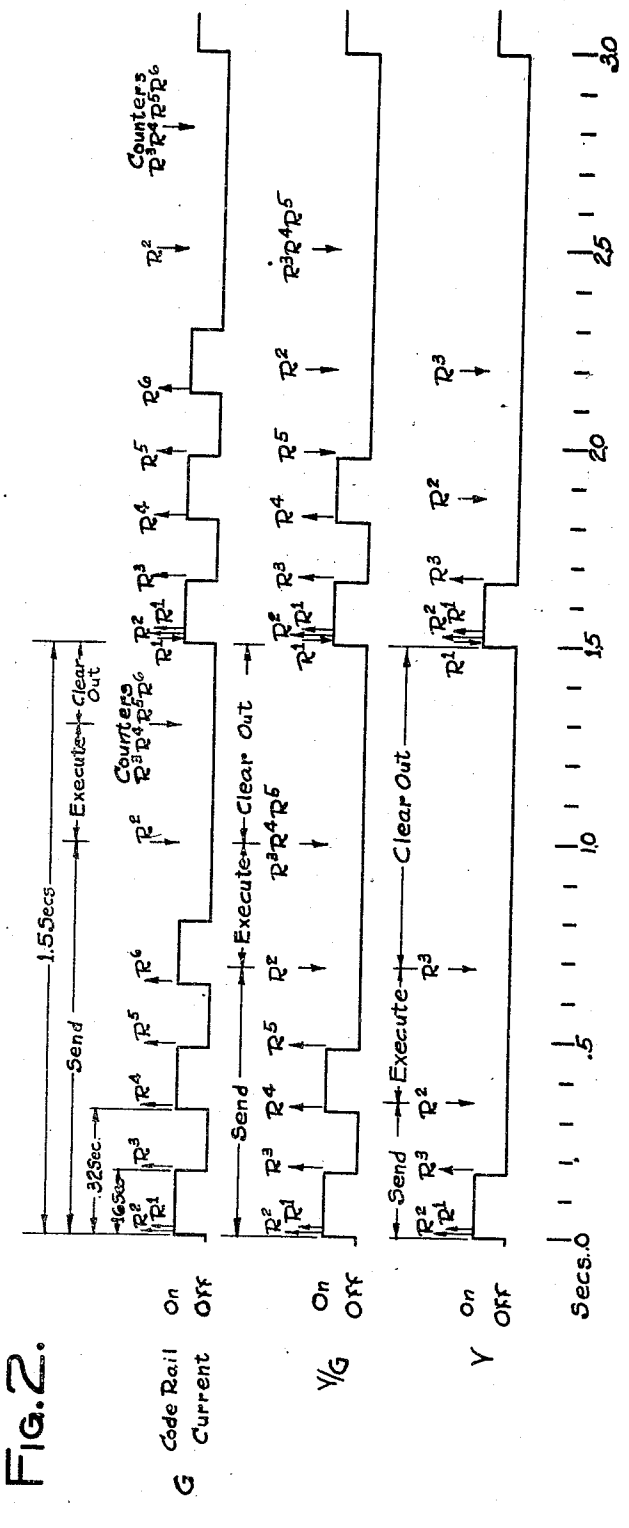


FIG. 2.

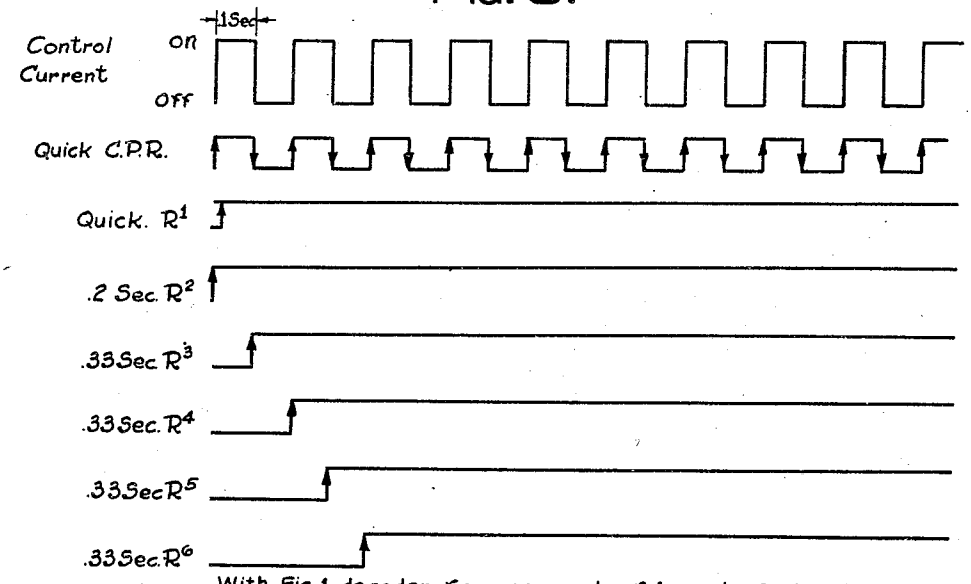
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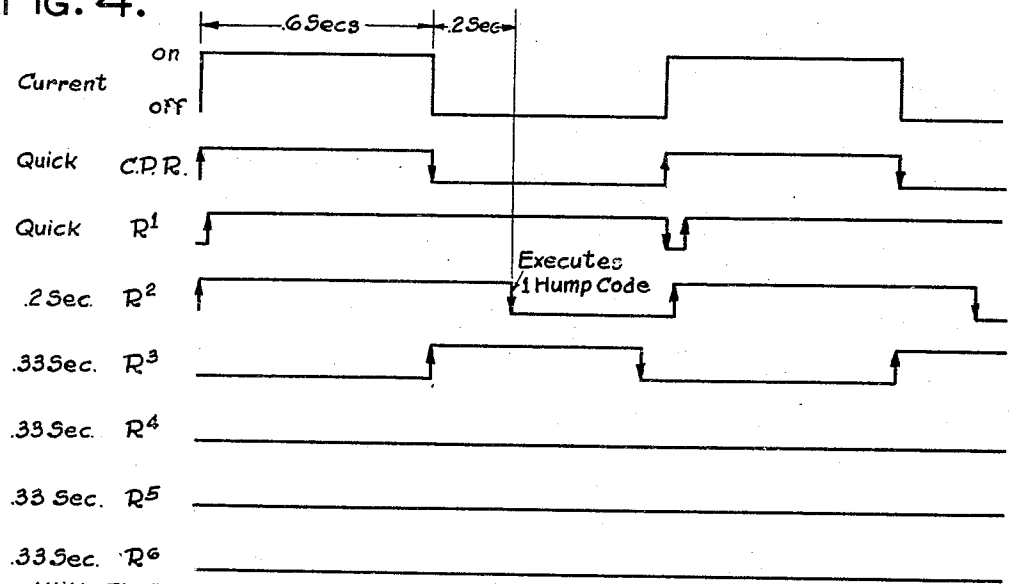
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FIG. 3.



With Fig.1 decoder, frequency code of .1 sec., ie., faster than release time (2sec) of executing relay R^2, all relays R^1-R^6 pick up, no execution is possible and cab signal is R

FIG. 4.



With Fig.1 decoder, frequency code of .6 secs., ie., slow enough to allow execution and clear out, by dropping R^2 and R^3-R^6 respectively, if up nothing more than a one-hump code can be executed, and relays R--R^3 only, can be picked up.

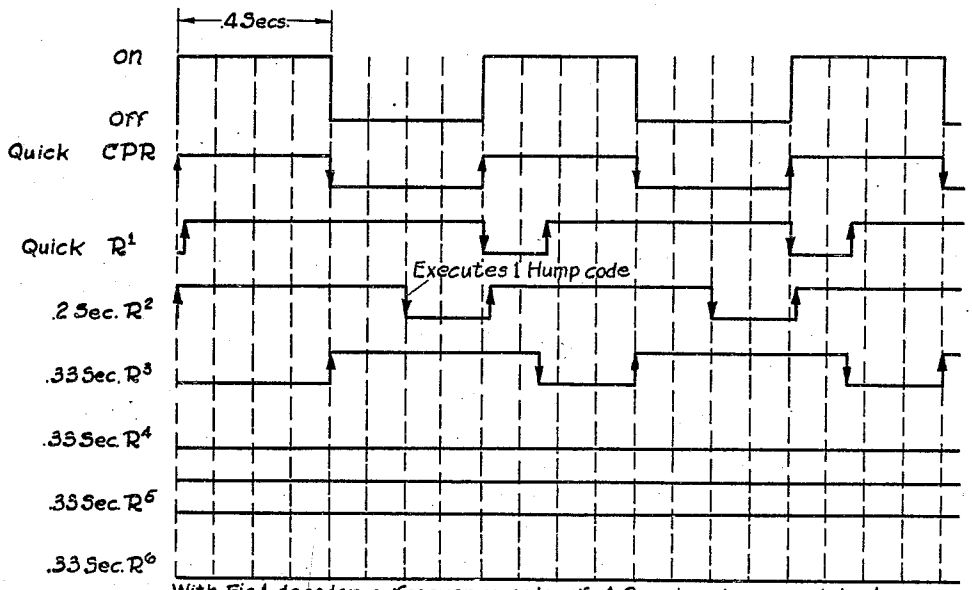
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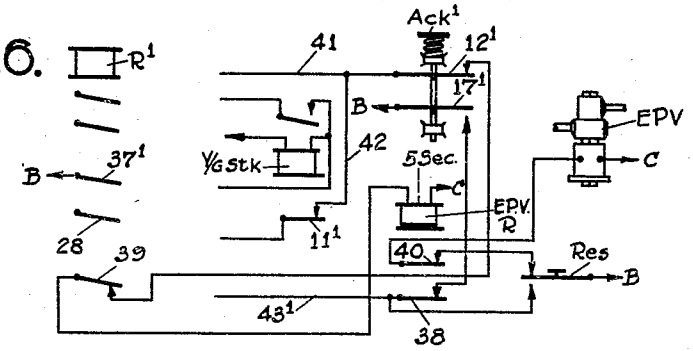
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FIG. 5.



With Fig.1 decoder, a frequency code of .4 Sec., ie., slow enough to drop executing relay R^2, but not slow enough to drop relays R^3-R^6 to clear out, monitor relay R^1 drops at second pick-up of CPR to enforce a clear-out so not only R^1-R^3 can be picked up as in Fig.4, to execute only a one-hump code

FIG. 6.



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FIG. 7.

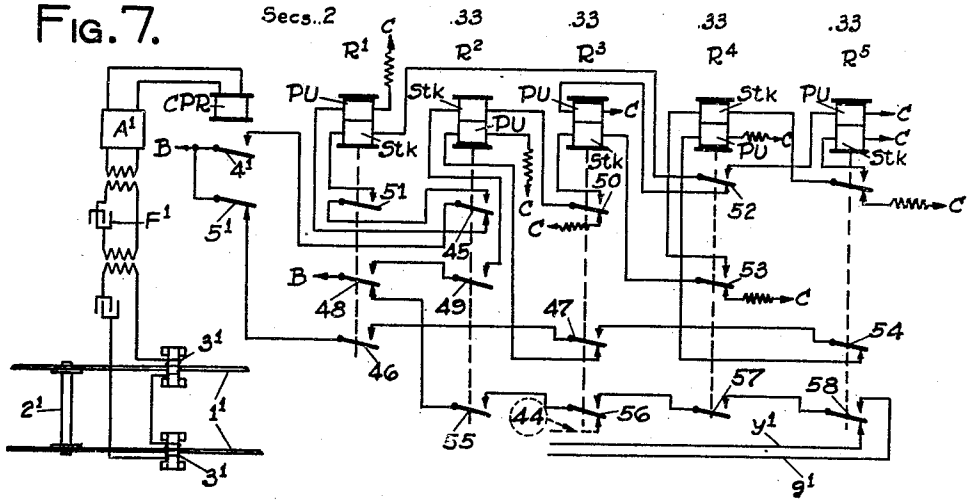
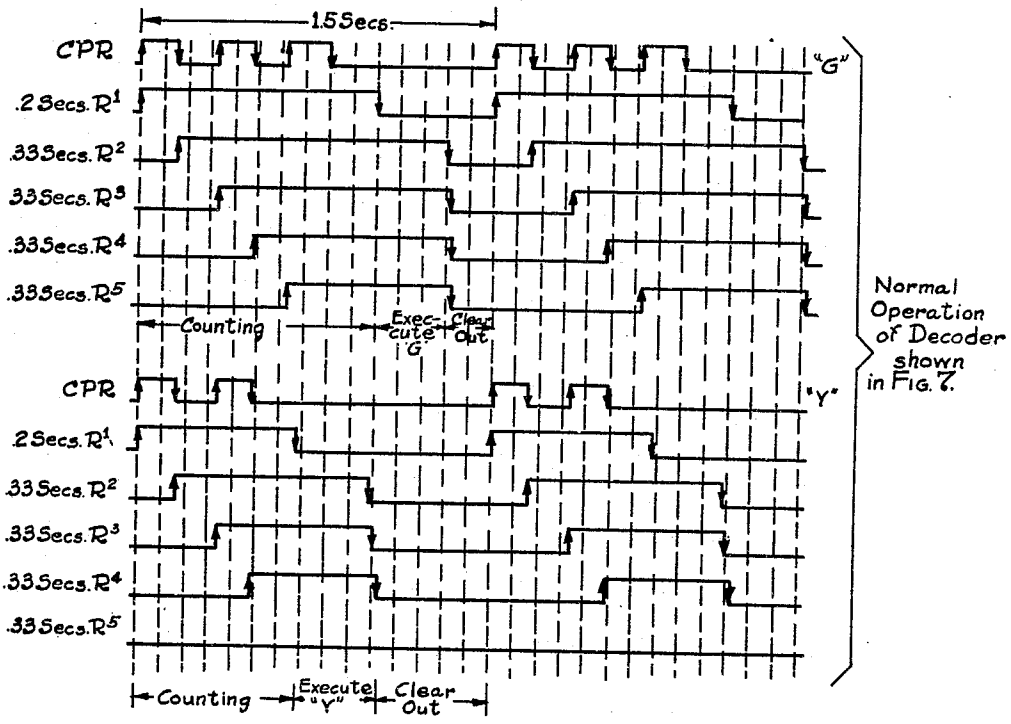


FIG. 8.



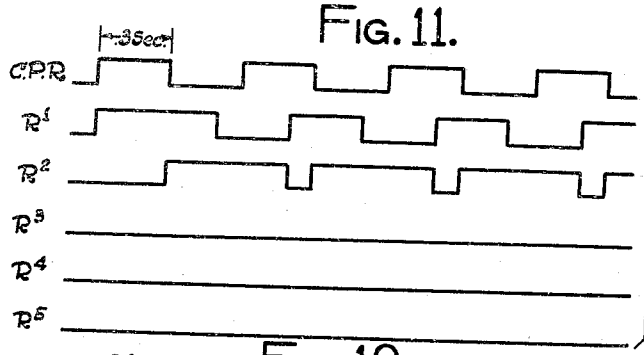
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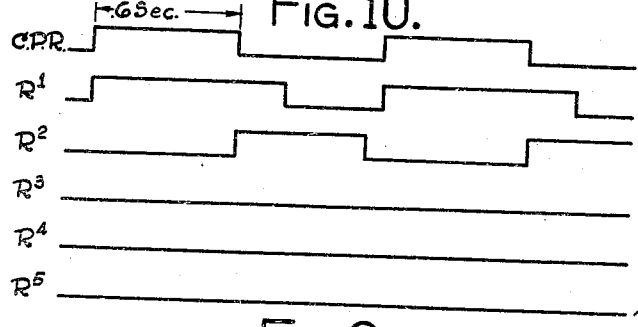
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FIG. 11.



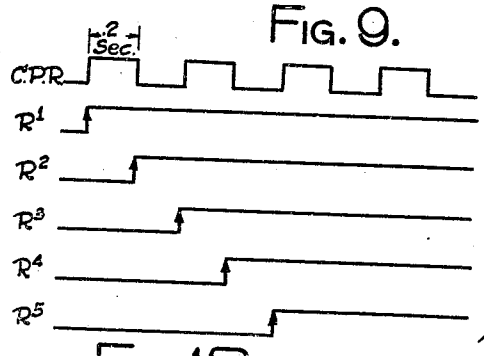
With Fig.7 decoder, a frequency code of .3 secs., ie., slow enough to drop executing relay R^1, but not slow enough to drop relays R^2-R^5 if up, to clear out R^1 is already down on second pick up of C.P.R, to enforce a clear out so that only R^1 and R^2 can be picked up, as in Fig.10, to execute only a one-hump code.

FIG. 10.



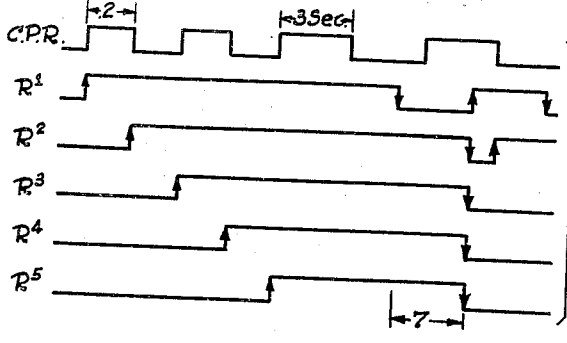
With Fig.7 decoder, a frequency code of .6 secs., ie., slow enough to allow execution and clear-out by dropping R^1 and R^3-R^5 respectively, if up, nothing more than a one-hump code can be executing, and relays R^1 and R^2 only, can be picked up.

FIG. 9.



With Fig.7 decoder, frequency code of .2 seconds, ie., not slower then release time (.2 sec.) of executing relay R^1, all relays R^1-R^5 pick up, no execution is possible and cab signal is R.

FIG. 12.



With Fig.7 decoder, assume fast Rate as Fig.9 has been picked up and then Changes to a slower rate as Fig.11, Execute one G impulse then no further executions other then a one-hump code can go over and one impulse of 'G' can not break down the Red that was set up by the fast rate

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UNITED STATES PATENT OFFICE

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CONTINUOUS INDUCTIVE TRAIN CONTROL SYSTEM

Application filed July 20, 1929. Serial No. 379,638.

This invention relates in general to coded continuous train control systems, responsive to counting or pattern type codes, as distinguished from frequency type codes, and has more particular reference to an improvement in decoding means for such systems whereby to make it non-responsive to frequency type codes to set up a favorable indication.

This invention solves the same general problem, with regard to cyclic or counting type code systems, as is solved by applicant's Patent 1,794,609 granted March 3, 1931, in connection with systems responsive to rate or frequency type codes.

The present invention is primarily an improvement in decoding means for use in connection with systems such, as shown for example, in the W. D. Hailes application Ser. No. 228,059, filed October 22, 1927, and relating to alternating current train control systems, and as shown in the Hailes application Ser. No. 249,457 filed January 25, 1928 and relating to direct current train control type of systems.

In the same manner in which one is much less likely to encounter accidentally produced coded train control current than to encounter accidentally produced uncoded train control current, it is quite apparent that one is less likely to encounter accidentally produced coded train control current of the counting or pattern type than to encounter accidentally produced coded train control current of the frequency or non-pattern type.

In the applications above referred to, the systems disclosed are designed to distinctively respond to coded train control current of the cyclic or counting code type as distinguished from the frequency code type, placed on the track rails. It is possible however to produce a code of the frequency type which will operate these systems to set up a proceed indication in the engine cab. It is thus seen that under danger or stop conditions, in which either no train control current, or a steady uninterrupted train control current, is normally present in the track rails, it is conceivable that a vibrating contact or loose wire or the like on the trackway or on the locomotive, might operate to accidentally produce a frequency type code so as to operate the decoder of the systems in question to set up a proceed cab indication.

With the forms of decoders shown in the applications 228,059 and 249,457, above referred to, (for example in Fig. 6 of application 228,059) the decoding means includes relays for selectively setting up circuits for the different cab indications, means for then placing energy on the particular circuit just set up, and means for then restoring the decoder to normal condition and breaking the circuit set up; for each cycle of code.

In other words, a cyclic code operates to first set up a circuit for controlling a given cab indication, a means for then energizing this circuit, and a means operable subsequently thereto for breaking this circuit, the last two means being relays and conveniently being considered as executing and clear-out relays respectively.

It is clear that with a frequency type code with a given timing of on and off periods of current which is insufficient to allow the executing relay to release, no proceed control circuit which this code can alternately set up can be executed or energized, and hence in accordance with the system in question, a stop indication results. In this case the frequency code is incapable of giving a favorable indication.

Again, with a frequency type code with a given timing of on and off periods of current which time is sufficient not only to allow the executing relay to release but also to permit clearing out of the decoder after such release, only the control circuit corresponding to a one-hump code can be set up and executed.

Again, if the frequency code is so timed that the off periods of current are long enough to allow the executing relay to release, but are too short to allow the clearing out of the decoder by release of the clear-out relay, such a frequency code can successively pick up the various relays in the decoder on each on period of current, and on each off period of current can execute the then set up circuit, without allowing subsequent clearing out.

In this manner it is possible for the decoding means of said two cases to respond to a frequency type code to successively set up more and more favorable indication circuits and to execute each in turn, thus to finally set up a proceed indication circuit which thereafter is maintained and periodically executed.

One purpose of the present invention is to provide a decoding means for counting or cyclic type codes which cannot respond to a frequency type code, regardless of the timing of such code, to set up favorable indications. This is accomplished by providing either a special supervisory or monitor relay for preventing such response to a frequency type code or it is accomplished by arranging the various counting relays constituting the decoder so as to give a monitor control and prevent such response to frequency type codes.

In the present invention, the functions of execution and clearing-out are combined in a single relay, instead of having them separately handled by two separate relays as in the said two applications.

It is further provided, in the present invention, that due either to the monitor relay, or to the particular arrangement of counting relays, execution cannot occur without clearing out also occurring immediately thereafter.

In this manner, as with the two Hailes applications 228,059 and 249,457, a frequency type code which is too fast to permit execution can only result in setting up a stop indication while a frequency type code which is slow enough to permit not only execution but clearing out, cannot pick up the decoding relays beyond those required for setting up the one-hump code circuit and hence can only result in intermittently setting up and executing a one-hump code circuit.

In other words a fast frequency code can pick up all the relays of the decoder but cannot execute any circuit, so that a stop indication is set up, while a slow frequency code, on the first off period of current, executes to execute a one-hump code indication if employed, and if the off period of current be long enough a clearing out of the decoder follows.

If, however, in the present invention, the period during which current is off is only long enough to execute, but not long enough to clear out in the normal manner, the next on period of current causes the monitor relay or control means to release and enforce clear-out of the decoder. Thus, regardless of the rate of the frequency type code, any execution must be followed by a clearing-out of the decoder so that the frequency code cannot operate through the decoder beyond the point for completing a one-hump code circuit.

In view of the above considerations, as will more clearly appear after the detailed description of the invention which is to follow, reference being made to the accompanying drawings, it is contemplated by this invention to use, if desired, but three indications, instead of four indications such as employed in the Hailes application 228,059 above referred to, with the caution or Y indication, corresponding to a one-hump cyclic code, entirely omitted. In this manner, by omitting the one-hump code indication, the decoder is made wholly non-responsive to frequency type codes for setting up anything but a stop indication.

If, however, it is desired to use four indications, it is contemplated by this invention to still omit the one-hump code indication and to supply an added indication by employing two additional counting relays (as R^7 and R^8) whereby to add to a thoroughly safeguarded system having three indications as considered just above, a fourth indication. This four indication system then would include indications in addition to the stop indication, corresponding to two, three and four hump codes for setting up in the cab, respectively, Y, Y/G, and G signals.

In the above manner, this invention contemplates a system having decoding means capable of giving any desired number of distinctive indications, and at the same time be wholly non-responsive to frequency type codes to set up any but a stop indication.

It is further contemplated to provide means for checking the operativeness of the monitor relay, whereby to indicate when the system is not protected against response to frequency type codes by the monitor control.

Further objects, purposes and characteristic features of the invention will appear as the description progresses, reference being made to the accompanying drawings showing, solely by way of example, and in no manner whatsoever in a limiting sense, several forms which the invention can assume. In the drawings:—

Fig. 1 is a diagrammatic view of car-carried apparatus in accordance with one form of this invention, in which a warning whistle is included, but in which no brake applying means is employed, the apparatus including a check whistle (or check red light), which sounds or lights up once for each cycle of code in case the monitor relay improperly sticks up.

Fig. 2 is a diagrammatic view of counting or cyclic codes useable in connection with the apparatus of Fig. 1, and also shows the operation of the Fig. 1 apparatus by the respective codes.

Figs. 3, 4 and 5 are time studies, in graphic form, of the effects on the apparatus of Fig. 1 of fast, slow, and medium rate frequency codes, respectively.

Fig. 6 is a diagrammatic view of a slightly modified form of the car-carried apparatus of Fig. 1, in which the whistle is omitted but brake applying apparatus is included, and wherein a control is included for giving an absolute stop regardless of acknowledgment.

Fig. 7 is a diagrammatic view of another embodiment of the invention, and shows car-carried apparatus in which no monitor relay, per se, is employed, but in which decoding relays are so connected up as to give monitor control.

Fig. 8 is a graphic time study of the normal operation of the apparatus of Fig. 7 by pattern or cyclic type codes.

Figs. 9, 10, and 11 are graphic time studies, respectively, of the response of the Fig. 7 apparatus, to fast, slow, and medium frequency or rate codes.

Fig. 12 is a graphic time study of the response of the Fig. 7 apparatus to a fast-changing-to-slow frequency or rate code.

Referring now to the drawings, there is shown in Fig. 1, a stretch of railway track constituted by rails 1, to which is applied, and from which is removed, train control current, either alternating or direct, in accordance with the various codes used in connection with the car-carried apparatus. For example, the codes can be as shown in Fig. 2, wherein it is graphically represented that current is applied for a short period of time to the track rails, and is then removed therefrom for a short period of time, to be again applied and again removed, etc., until one complete cycle of codes has been sent, after which the current is kept off of the rails for a selectively long time before another cycle of code is sent.

In Fig. 2 are shown codes wherein the proceed, or G, code is constituted by three successive on and off periods followed by an extended off period to thus constitute a three-hump code. For the approach restricting indication, Y/G, there is a two-hump code while for the caution or Y code there is a one-hump code. The timing of the codes is chosen to properly cooperate with the car-carried apparatus and of course this timing of the codes and also of various parts of the car-carried apparatus can be varied at will without departing from the present invention.

Carried on a car, represented by wheels and axles 2, are receiving coils 3 in inductive relation to the track rails, whereby to receive energy inductively from the train control currents and pass this energy through a filter F designed to pass only the desired frequency of current if alternating current be employed. The filter is connected to an amplifier A, the output side of which is connected to a coding primary relay CPR having contact fingers 4 and 5. The apparatus just described is substantially identical with the corresponding parts of the Hailes applications 228,059 and 249,457.

It will be seen from the above that relay CPR operates its contact fingers 4 and 5 to attracted and retracted position according as train control current is on, or off, the track rails.

Controlled by the coding primary relay CPR is a bank of decoding relays R^1, R^2, R^3, R^4, R^5 and R^6 which are connected up to pick up and to stay up in certain arrangements so as to place energy on the particular one of a repeater relay group constituted by relays R *Rep*, Y *Rep*, Y/G *Rep.*, and G *Rep*, which corresponds to the particular code being received. The R *Rep* relay corresponds to stop conditions and is energized when none of the codes of Fig. 2 are being received by coils 3, under which conditions relay CPR is maintained either in attracted or retracted position, so that the stop indication is given when train control current is either steady on or steady off.

Depending on which one of the repeater group of relays is energized, a particular one of the wires *g*, *y/g*, *y* or *r* is energized. For example, with relay R *Rep*, energized energy is applied to wire *r*.

Included in the invention is a group of acknowledging relays R *Stk*, Y *Stk*, and Y/G *Stk*, which, together with an acknowledging contactor *Ack*, is arranged to silence an audible signal AWV, in the form of a whistle valve which sounds when de-energized, the circuits being arranged so that any change to a more restrictive condition causes de-energization of the whistle AWV which continues to sound until the acknowledging contactor is operated.

There is also included in the invention a visual cab signal for indicating the different traffic conditions, by showing G, Y/G, Y, or R, corresponding respectively to proceed, approach restrictive, approach and stop, and these cab signals are controlled by various contacts of the acknowledging group of relays and of the repeater group of relays.

With the exception of the decoding means constituted primarily by relays R^1—R^4 and an associated audible check signal AWV^1 which is a whistle which sounds when energized, all of the parts above described in connection with Fig. 1, are substantially as set forth in the previously mentioned Hailes application 228,059 and 249,457. Accordingly only a further very brief description of the operation of this part of the apparatus is deemed necessary in the present application.

The apparatus of Fig. 1 is shown in the condition and position assumed when the car is in a danger or stop block. Under these conditions, relay CPR is down and all of the relays R^1—R^6 of the decoding group of relays, are down, whereby to break the ener-

gizing circuit for all of the repeater relays except relay R R*ep*, which is energized through a circuit including contact finger 6 and back point of Y R*ep*, contact finger 7 and back point of Y/G R*ep* and contact finger 8 and back point of G R*ep*. Energization of this R R*ep* relay places energy on wire *r* to hold relay R S*tk* in energized position through a stick circuit which includes contact finger 9 and front point of R R*ep*, wire *r*, contact finger 10 and front point of R S*tk*, and the winding of R S*tk*, (it being understood that acknowledgment has been performed to first pick up relay R S*tk*, as is clear from the other Hailes applications).

With relay R S*tk* in picked up condition relay Y S*tk*, is held picked up through its pick-up circuit which includes a front point of R S*tk* and likewise relay Y/G S*tk* is held up through a front point of Y S*tk*. With Y/G S*tk* in attracted position energy is applied to the acknowledging whistle AWV through a circuit which includes contact finger 11 and front point of Y/G S*tk*, acknowledging contact finger 12 and front point thereof, and the whistle in question.

Also with the conditions outlined above the R cab signal is energized through a circuit which includes the R signal, contact finger 13 and front point of relay R R*ep*, wire 14 and contact finger 15 and front point of relay R S*tk*.

On a change in traffic conditions as, for example, to clear, in which the G, or three-hump, code of Fig. 2 is placed on the track rails and picked up by the receiving coils 3, relay CPR picks up and releases in a manner to follow the code and thereby operate the decoding relays R^1—R^6 in a manner to be more specifically described below, to pick them all up and hold them up, whereby to place energy on relay G R*ep* to pick such relay up so as to put energy on wire *g* through contact finger 16 and front point of relay G R*ep*.

After expiration of the release time for relay R R*ep*, this relay drops to thereby de-energize its corresponding stick relay R S*tk* which in turn drops the other two stick relays of the acknowledging group whereby to take energy off of the whistle AWV. But with the G R*ep* relay up energy is placed on the *g* wire to thereby energize the whistle AWV through acknowledging contact finger 12 and front point thereof to thus prevent any sounding of the whistle on a change to more favorable traffic conditions. Thus, it will be observed, no acknowledgment is necessary when the change is to more favorable traffic conditions. Likewise, the G cab signal is energized through a circuit including a contact finger and front point of the G R*ep* relay and a contact finger and back point of each of the three acknowledging relays.

If there now be a change in traffic conditions to less favorable conditions such, for example, as from proceed, or G, to approach restricted, or Y/G, the Y/G code, the two-hump code, operates CPR to cause the decoding group R^1—R^6 to remove energy from relay G R*ep* and place it on relay Y/G R*ep*. As a result of relay G R*ep* releasing, energy is removed from the whistle AWV, and the whistle sounds and continues to sound until the acknowledging contactor A*ck* is depressed.

This act results in picking up the R S*tk* relay through a circuit including the normally open acknowledge contact finger 17 and back point thereof. With relay R S*tk* momentarily up, relay Y S*tk* picks up through a front point of R S*tk*, i. e. its next inferior relay, and in like manner and in sequence Y/G S*tk* picks up though a front point of its next inferior stick relay, and this last relay, after picking up, sticks up through wire *y/g* which is now energized due to the Y/G R*ep* relay being picked up, whereby to apply energy to whistle AWV through contact finger 11 and front point of Y/G S*tk* relay, etc., whereby to silence the whistle. At the same time, the visual signal Y/G in the cab is energized through a front point of its corresponding repeater relay, Y/G R*ep*, a front point of the acknowledging relay Y/G S*tk* and a back point of each of the other two acknowledging relays.

Thus, on a change to less favorable conditions, whistle AWV is sounded, and continues to sound until acknowledgment is performed.

The above described operation is substantially the same as occurs in the Hailes application 228,059 above referred to, to which reference should be made for a more detailed description.

Coming now to the arrangement and operation of the decoding group of relays R^1—R^6, for setting up energizing circuits for the various repeater relays R R*ep*, etc., it will be noted that relay R^1, which is conveniently termed a monitor relay, is energized through a pick up circuit including a contact finger 17^1 and back point of R^6, contact finger 18 and back point of relay R^5, contact finger 19 and back point of relay R^4, contact finger 20 and back point of relay R^3 and contact finger 21 and front point of relay R^2, whereby relay R^1 cannot pick up until after relay R^2 is up and only then provided relays R^3—R^6 are down.

When once picked up, relay R^1 can be stuck up through a stick circuit including contact finger 22 and front point of relay R^1, and contact finger 4 and back point of relay CPR, and also through a stick circuit including contact finger 22 and front point of R^1, and contact finger 23 and front point of R^2.

Before proceeding further in the description it should be noted that the relays are

variously timed as indicated in the figures of drawings, from which it is seen that relay R^1 is quick to pick up and quick to release, while relays R^2—R^6 are all quick to pick up, but are slow to release, R^2 having a release time of approximately .2 seconds, while relays R^3—R^6 inclusive have release times of approximately .33 seconds.

As will appear more clearly as the discription progresses, relays R^3—R^6 each has a pick-up circuit and a stick-up circuit, the pick-up circuit of each relay including a front point of either R^1 or R^2 and a front point of all other relays of lower exponent value, (that is, of the relays to the left as viewed in Fig. 1,) together with a back point of the relay having the next higher exponent value, (that is, of the relay next to the right as viewed in Fig. 1.)

Furtherore, the stick circuit for each of the relays R^3—R^6 includes a front point of relay R^1, R^2, of the relay in question, and any other relay to the left thereof as viewed in Fig. 1, together with a back point of the relay, if any, immediately to the right thereof.

Also included in connection with the decoder of this invention, is the above mentioned whistle AWV^1, which has an energizing circuit including a contact finger 24 and back point of relay R^2, a contact finger 25 and front point of relay R^1, and contact finger 5 and front point of relay CPR, whereby to operate, as described more fully below, to sound once for each cycle of code, in the event the monitor relay R^1 improperly stays in attracted position. This furnishes a check on the functioning of monitor relay R^1 which, if functioning properly prevents response of the decoder to frequency type codes to set up anything but a stop indication.

Considering now the operation of the decoder, assume that a one-hump code, such as shown in Fig. 2, for Y, be applied to the track rails 1. Relay CPR picks up once and releases once for each cycle of code. On the first pick up of relay CPR, relay R^2 is energized through contact finger 4 and front point of relay CPR, through a circuit which is obvious from the drawing. Immediately on picking up of relay R^2, its contact finger 21 and front point completes the above referred to pick up circuit for relay R^1, whereupon relay R^1 picks up, and being picked up, sticks up as referred to above through contact finger 23 and front point of relay R^2.

On the first release of relay CPR, relays R^1 and R^3 being up, relay R^3 is picked up through a circuit including contact finger 5 and back point of CPR, contact finger 26 and front point of relay R^2, and contact finger 27 and back point of relay R^4.

Thus the one-hump code operates to pick up relays R^1—R^3 which operate, on the subsequent release of relay R^2, two-tenths seconds after its de-energization, to complete an energizing circuit for the repeater relay Y *Rep*, corresponding to the Y code, which circuit includes contact finger 23 and back point of R^2, contact finger 28 and front point of R^1, contact finger 29 and front point of R^3 and contact finger 30 and back point of R^4.

If, instead of the one-hump, or Y, code, a two-hump or Y/G code is received, on the second successive pick-up of relay CPR, relay R^4 is picked up through a circuit including the contact fingers 5 and 25 and their front points, contact finger 31 and front point of R^3, and contact finger 32 and back point of R^5. Once up, relay R^4 is stuck up through a stick circuit which includes contact fingers 37, 36, 31^1 and 27^1 and front points of relays R^1, R^2, R^3 and R^4, and contact finger 33 and back point of R^5.

On the second release of relay CPR, relay R^5 is picked up through contact finger 5 and back point of relay CPR, etc., in a manner similar to that described in connection with the pick up of relay R^3, and when once picked up, relay R^5 is stuck up in a manner similar to that described in connection with relay R^4.

Thus with a two-hump code, relays R^1—R^5 are picked up, with R^3—R^5 stuck up, whereby, upon the subsequent release of relay R^2, an energizing circuit is completed for repeater relay Y/G *Rep*, which includes contact finger 23 and back point of R^2, contact finger 28 and front point of R^1, contact finger 29 and front point of R^3, contact finger 30 and front point of R^4, contact finger 34 and front point of R^5 and contact finger 35 and back point of R^6.

In a similar manner, with a three-hump or G code, as shown in Fig. 2, the third successive pick-up of CPR picks up and sticks up R^6, the third release of CPR having no operative effect, whereby, with this code, energy is transferred by contact finger 35 and back point of relay R^6, from the Y/G *Rep* relay to the G *Rep* relay.

In Fig. 2, not only are the different codes graphically shown, but also is shown the normal operation of the decoder relays R^1—R^6 in response to the codes.

Considering the G code, for example, it is seen that on the first pick-up of relay CPR, first relay R^2 picks up, and immediately thereafter relay R^1 picks up, and on the first release of CPR, relay R^3 picks up and sticks up. On the second pick up of CPR, relay R^4 picks up and sticks up, while on the second release of CPR relay R^5 picks up and sticks up. On the third pick up of CPR, relay R^6 picks up and sticks up while on the third release of CPR nothing immediately occurs, but it is clear from Fig. 1, that energy is removed, by the release of CPR, from relay R^2 which can be conveniently considered the executing relay.

As shown in Fig. 2, with the particular

timing chosen, .2 of a second after CPR releases, for the third time, relay R^2 releases to thereby energize the G R*ep* relay.

Release of executing relay R^2 also breaks the stick-up circuit for relays R^3—R^6 at contact finger 36 of relay R^2, whereby .33 seconds after the release of relay R^2, relays R^3—R^6 release to clear out the decoder and prepare it for the next cycle of code, whatever that may be.

It should be noted that the stick circuit for relays R^3—R^6 runs through a front point of relay R^2 and is also brought through contact finger 37 and front point of monitor relay R^1. During execution by the release of relay R^2, relay CPR is down and accordingly, while the stick circuit for relay R^1, which passes through contact finger 23 and front point of relay R^2, is broken, the other stick circuit for relay R^1 which passes through contact finger 4 and back point of relay CPR is intact so that relay R^1 is maintained up.

On the first pick up, however, of relay CPR in the next cycle of code, the last referred to stick circuit for relay R^1 is broken by the picking up of contact finger 4 of CPR and shortly thereafter the other stick circuit for relay R^1 is completed by R^2 picking up its contact finger 23. During this intervening period however, during which both stick circuits for relay R^1 are broken, relay R^1 releases to thereby break the stick circuit for relays R^3—R^6 by releasing its contact finger 37.

As shown in Fig. 2, in connection with the G code, immediately after relay R^2 picks up on the first impulse in a cycle of code, relay R^1 immediately follows provided all of the relays R^3—R^6 are at that time down, or, in other words, provided a clearing out of the decoder has taken place between successive cycles of code.

Thus it is seen that in the normal operation of the decoder of Fig. 1, at the beginning of each cycle of code monitor relay R^1 first releases and then, after the picking up of relay R^2, immediately picks up, since under the normal operation, there is a sufficient blank or off period of current between successive cycles of code to not only permit relay R^2 to release and thus apply energy to the particular repeater relay chosen, but also sufficient to permit relays R^3—R^6 to release.

We come now to the operation of the decoder under abnormal conditions, that is, for example, under conditions of frequency codes which may accidentally be present and against which it is necessary to be protected.

In Fig. 3, for example, there is shown a frequency code, that is a code having no particular pattern and including no extended off or blank periods. As indicated by the caption of the Figure, this code is fast enough, .1 second, to be faster than the release time of executing relay R^2 so that the first three impulses of code will successively pick up the various relays R^1—R^6 as described above. But inasmuch as there is an insufficient time during which current is removed from the track rails to permit relay R^2 to release its contact fingers, no energy can be applied to the circuit which has been set up for repeater relay G R*ep*. Thus, with no execution, energy is on relay R R*ep* and stop conditions are set up, so that with this timing of frequency code the decoder is incapable of responding thereto to give a favorable indication.

Referring now to Fig. 4, a frequency code is here shown having a different timing, namely, a timing in which the off periods or blanks are of sufficient duration not only to permit release of relay R^2 and effect an execution, but also to release all of the relays R^3—R^6 which may have been picked up, to thus permit clearing out of the decoder.

With such a code, relays R^1—R^3 are picked up on the first on and off, and then the circuit set up, which is for the repeater relay Y R*ep*, is executed by release of relay R^2, after which relay R^3 releases. Thus when the next impulse of code is received the decoder responds anew and merely repeats what has already been described. Hence this timing of code cannot progress through the decoder beyond the R^3 relay. It is thus seen that the most that can be done with such a code is to cause the decoder to respond to execute a one-hump code and set up the indication corresponding to a one-hump code.

Thus, to discard the one-hump code is indicated, and by so doing the decoder is made wholly immune to respond to such codes for showing anything but a stop indication.

Coming now to Fig. 5, there is here shown a frequency code, as indicated by the caption, which falls between the two previously considered codes with regard to its timing. In this case the timing is such that execution is permitted by the blank or off period but it is of insufficient duration to permit the usual clearing out of the decoder by the dropping of such of the relays R^3—R^6 as may have been picked up.

In this case, after the first on and off period, relays R^1—R^3 are up, and on release of relay R^2 to execute, energy is applied to the Y R*ep* relay and one of the stick circuits for R^1 is broken. On the next on period of current, relay CPR picks up as usual, and thereby breaks the only remaining stick circuit for relay R^1, the monitor relay, which releases before its other stick circuit, through contact finger 23 and front point of relay R^2, is completed by the subsequent picking up of relay R^2. With the monitor relay R^1 down, the stick circuit holding R^3 up is, and remains, broken, and hence after a proper lapse of time, depending on the release time for relay R^3, such relay releases to thus clear

out the decoder, and it is only after the release of such of the relays R^3—R^6 as are then up, that monitor relay R^1 picks up so as to permit the normal operation of the decoder.

Thus, in the case of a code such as that of Fig. 5, all that it can accomplish is to operate through the decoder up to picking up relay R^3, the monitor relay then stepping in if, as in this last case, the blank period is not long enough to clear out the decoder as is the case in Fig. 4, and enforces clearing out of the decoder. In this manner the code of Fig. 5 can do no more than repeatedly set up and execute a one-hump code, and accordingly, as in connection with Fig. 4, the discarding of any indication corresponding to a one-hump code is indicated and is contemplated by this invention.

By employing only codes of two or more humps, the decoder of the form of Fig. 1 is made wholly immune against frequency codes to set up favorable indications. In the present instance, by discarding the one-hump code, the system becomes a three-indication system having proceed, caution and stop indicated, respectively, by G, Y and R cab indications, and set up, respectively, in response to a three-hump code, a two-hump code, and current either steady on or steady off.

If a four, or more, indication system be desired, all that is necessary is to employ two additional counting relays as R^7 and R^8 (not shown) for each added indication, arranged in the same relative manner to the rest of the decoder as are present relays R^5 and R^6. We should then have, for example, a four-indication system, including relays R^1—R^8, and responding to four, three and two hump codes and current steady on or steady off, for setting up cab indications of G, Y/G, Y, and R. This process can be applied to the decoder to give any number of indications desired.

It is seen from the above discussion that the immunity of the decoder from favorably responding to frequency codes, is dependent on the proper functioning of the monitor relay R^1. This relay may improperly stick in either the attracted or retracted position.

If relay R^1 sticks in the retracted position, the executing circuit is permanently opened since it includes contact finger 28 of monitor relay R^1, and with this executing circuit open, energy can only be applied to the R *Rep* relay of the repeater relay group, so that only a stop or R indication can be set up. Thus this failure is on the side of safety and is self-checking and self-revealing.

If, on the other hand, relay R^1 sticks in its attracted position, so as not to release when de-energized, the protection normally afforded by this monitor relay is lost, and a frequency code timed such as shown in Fig. 5, can first pick up relays R^1—R^3, then execute Y, and before clearing out is possible, can then on the next hump of code, pick up relays R^4 and R^5 to then execute Y/G, after which, before clearing out can occur, the next hump can pick up R^6 after which the indication G, or proceed, is periodically executed after each hump of code. In other words, a code which, can cause execution, but is too fast to allow clearing out, can operate the decoder of Fig. 1 by successively picking up and executing the different indications, until it reaches the highest or least restrictive indication, and then can continue to repeatedly execute this least restrictive indication, unless the monitor relay R^1 be operative to enforce a clearing out after each execution, as explained in detail in connection with Fig. 5.

But with the arrangement shown in Fig. 1, should monitor relay R^1 improperly stick up, warning signal AWV^1, which sounds when energized, will sound once for each cycle of code so as to indicate that monitor relay protection is not present. The energizing circuit for whistle AWV^1 passes through contact finger 24 and back point of relay R^2, contact finger 25 and front point of relay R^1 and contact finger 5 and front point of relay CPR. Thus the whistle is not energized when relay CPR is down and likewise is not energized when relay CPR is up, since, on CPR picking up, relay R^1 releases before relay R^2 picks up, and the release of relay R^1 breaks the energizing circuit just referred to for the signal. Thus, in normal operative condition of relay R^1, signal AWV^1 is silent. If, however, relay R^1 sticks up so that the decoder is deprived of monitor control, each time relay CPR picks up after execution, the energizing circuit is completed for whistle AWV^1 and remains energized for a short period until relay R^2 picks up and breaks this circuit.

From the foregoing it can be seen that the decoder, when subject to monitor control, is wholly immune from frequency type codes for setting up favorable indications, and when not subject to monitor control, if the defective operation of the monitor relay is such as to destroy this immunity from favorable operation by frequency codes, an intermittent warning signal is sounded. Of course, a visual or other type of signal can be used to replace either or both of the whistles AWV^1 and AWV.

Referring now to Fig. 6, there is here shown a fragmentary portion of car-carried-apparatus which constitutes a slight modification of the form shown in Fig. 1. With this form of apparatus, an added indication is obtained, whereby a rate type code of sufficient rapidity operates to enforce a stop control regardless of anything that the engineer can do.

In the form shown in Fig. 6, there is included an electro-magnetic device, EPV, which can be of any usual or desired form, and arranged to be normally energized and

when de-energized to automatically apply the brakes. The energizing circuit for the EPV includes a reset contactor *Res* and front point, and a contact finger 40 and front point of a control relay EPV—R, whereby release of relay EPV—R results in de-energization of the brake applying device EPV. This relay EPV—R is provided with means, as by a copper band or the like, for making it slow acting on release, so that it requires approximately five seconds release time, whereby de-energization thereof for short periods of time does not result in the relay releasing.

This control relay EPV—R is energized in much the same manner as is the whistle AWV in Fig. 1, its energizing circuit including a contact finger 39 and back point of relay R^1, the acknowledging finger 12^1 and front point, and either the wire 41, or the wire 42 and contact finger 11^1 and front point of the Y/G *Stk* relay. Thus this control relay is energized in a manner similar to the whistle AWV of Fig. 1, deriving its energy either directly through wire 41 and the proceed repeater relay G *Rep*, or, upon proper operation of the acknowledging contactor *Ack*^{1}, through a contact finger (11^1) and front point of the Y/G *Stk* relay. The main difference in Fig. 6, from Fig. 1, is that the energizing circuit in question also includes the contact finger 39 and back point of relay R^1 (the relay R^1 having an aditional contact finger 39 in the Fig. 6 form).

From the above described apparatus, it can be seen that, as in the Fig. 1 form, on changing to more favorable conditions, relay EPV—R remains energized without necessity for acknowledgment, in the same manner as with AWV in Fig. 1. On the other hand, when going to more restrictive conditions, energy is taken off of relay EPV—R and is put on this relay again only if acknowledgment be performed within the release time, five seconds, of the relay. Acknowledgment after release of relay EPV—R is of no avail since the acknowledging circuit includes a contact finger 38 and front point of relay EPV—R.

If acknowledgment be not performed within the required time, on passing into more restrictive territory, relay EPV—R releases to thereby open the energizing circuit for the brake applying device EPV, with the result that an automatic brake application is incurred. It is then necessary, in order to release the brakes, and permit the train to proceed, to first bring the train to a full stop and then depress the reset contactor *Res*, which is accessible only from the ground, whereby to place energy on wire 43^1 which operates in a manner similar to the Fig. 1 form to successively pick up the various stick acknowledging relays, to thus re-energize relay EPV—R whereby to re-energize EPV.

Coming now to the function performed by contact finger 39 of relay R^1, it is clear that unless this contact finger be released at least once every five seconds, the energizing circuit for relay EPV—R is broken for a sufficient time to drop this relay and de-energize EPV, thereby to apply the brakes. Thus, by sending a frequency code having a timing fast enough to prevent release of relay R^1 that is, fast enough to prevent execution, (see Fig. 1) relay R^1 which, as explained above is stuck up through a circuit including contact finger 23 and front point of relay R^2, remains up indefinitely, with the result that relay EPV—R drops and causes an automatic brake application. It is obvious that contact finger 39 can be transferred to relay R^2 from R^1 and obtain the same control of EPV—R.

While no whistle or other signal corresponding to AWV of Fig. 1 is shown in Fig. 6, it is clear that such a whistle can be employed, and connected up, in Fig. 6 in the same manner as in Fig. 1 so that, on going into more restrictive territory, an audible signal is given to indicate that acknowledgment is necessary. If acknowledgment be performed within the drop-away time of relay EPV—R, the acknowledging signal will be silenced and an automatic brake application will be forestalled. If, however, acknowledgment be not performed in due time, an automatic brake application results and the acknowledging whistle continues to sound until the reset contactor is operated.

It is to be understood that all of the features of Fig. 1 are to be retained in the form shown in Fig. 6, this Fig. 6 showing merely the features additional to Fig. 1, which features are constituted primarily by the absolute stop control in response to a relatively rapid frequency code, together with the brake applying means etc. In Fig. 6, therefore, there is shown a system which includes not only four cab indications in the same manner as in the form of Fig. 1, but a fifth control which is an absolute stop control, produced by a relatively rapid frequency code and which cannot be forestalled by acknowledgment or any other act which the engineer can perform.

Referring now to Fig. 7, there is here shown a portion of car-carried apparatus constituting a simplified and improved decoder wherein the monitor control for guarding against operation of the decoder by frequency type codes for setting up favorable indications, is present, although one relay less, for a given number of indications, is employed in the decoder.

In this form of invention, as in the form of Fig. 1, there are track rails 1^1, occupied by a car indicated by wheels and axles 2^1, carrying receiving coils 3^1, connected up through a filter F^1 and an amplifier A^1 to a coding primary relay CPR having contact fingers 4^1 and 5^1 whereby the contact fingers

4^1 and 5^1 pick up and release in accordance with coded current in the track rails 1^1.

Controlled by relay CPR is a decoder constituted primarily by five decoding relays R^1—R^5.

Each of the relays R^1—R^5 has a pick-up winding and a stick-up winding, and is arranged, as indicated on the drawings, to be slow to release, relay R^1 requiring .2 seconds to release, and each of the others requiring .33 seconds to release.

In accordance with the particular code on the track rails, this decoder operates to place energy on the various wires y^1 and g^1 to energize, respectively, a caution repeater relay, and a proceed repeater relay, as in the form shown in Fig. 1. A wire 44 is indicated in dotted line in Fig. 7 to indicate that this wire which would be energized by a one-hump code, is entirely discarded in order to make the decoder wholly immune from frequency or rate type codes, as explained above. Accordingly the decoder of Fig. 7 is arranged to give three indications, a proceed or G indication by placing energy on the g^1 wire in response to a three-hump code, a caution or Y indication by placing energy on the y^1 wire in response to a two-hump code and a stop or R indication in response to a one-hump code, and to current steady on or steady off. The red repeater relay, R *Rep*, of Fig. 1 is, in the form shown in Fig. 7, energized through a circuit including a back point of each of the relays Y—*Rep* and G—*Rep* whereby in the absence of either a proceed or a caution indication, a stop indication must necessarily be shown.

If it be desired to have the decoder of Fig. 7 give four indications instead of three, it is preferable, instead of using the indication corresponding to a one-hump code, to employ two additional decoding relays, as R^6 and R^7, connected to the right of relay R^5, in the same manner as to be described in detail below in connection with relays R^4 and R^5, whereby to give an indication controlled by a four-hump code. In this manner a decoder can be built up giving any desired number of indications and still be wholly immune from favorably responding to a frequency or rate type code.

Before giving a detailed description of the various circuits involved in the decoder of Fig. 7 it may make for clearness to state that, with current steady on or steady off, all of he relays R^1—R^5 are down. With a one-hump code only relays R^1 and R^2 are picked up, for executing a one-hump code indication (which as just described has been wholly discarded). With a two-hump code relays R^1—R^4 are picked up to place energy, upon execution, on the y^1 wire. With a three-hump code relays R^1—R^5 are picked up to place energy, upon execution, on the g^1 wire.

The operation of the decoder will be traced in response to a three-hump or proceed code such as shown, for example, in Fig. 8, and this will explain clearly the operation of the decoder in response to the two-hump code and a one-hump code if any, it being remembered that the two-hump code stops at picking up relay R^4, while the one-hump code stops at picking up relay R^2.

On relay CPR picking up for the first time, relay R^1 is picked up through a circuit including contact finger 4^1 and front point of CPR, contact finger 45 and back point of R^2 and the pick up winding PU of R^1.

On the subsequent release of CPR, relay R^2 is picked up through a circuit including contact finger 5^1 and back point of CPR, contact finger 46 and front point of R^1, contact finger 47 and back point of R^3 and the pick up winding PU of R^2. After being picked up, R^2 is stuck up through a circuit including contact finger 48 and front point of R^1, contact finger 49 and front point of R^2, the stick winding *Stk* of R^2 and contact finger 50 and back point of R^3.

On the second pick-up of CPR relay R^3 is picked up through a circuit including contact finger 4^1 and front point of CPR, contact finger 45 and front point of R^2, contact finger 51 and front point of R^1, the stick winding of R^1, contact finger 52 and back point of R^4, and the pick up winding of R^3. R^3, after being picked up is stuck up through a circuit including the stick circuit traced above for R^2, but with contact finger 50 of R^3 in raised position, and contact finger 53 and back point of R^4.

On the following, or second, release of CPR, relay R^4 is picked up through a circuit including the contact fingers 5^1, 46 and 47 and front points of CPR, R^1 and R^3 respectively, contact finger 54 and back point of R^5 and the pick-up winding of R^4. After being picked up, relay R^4 is stuck up in a manner similar to what has already been described.

On the third pick-up of relay CPR, relay R^5 is picked up through a circuit which should now be easily traceable on Fig. 7, and is stuck up through a stick circuit which also should now be easily traceable.

On the third release of relay CPR, no further relays are picked up, but both the pick-up and stick circuits for relay R^1 are broken by the release of contact finger 4^1 of relay CPR, so that, in the present case .2 seconds after this last release of CPR, relay R^1 releases to break the stick circuit for the four relays R^2—R^5, and at the same time to complete an executing circuit for the particular code being received, in the present case the three-hump, or proceed, code. This executing circuit includes contact finger 48 and

back point of R^1, contact finger 55 and front point of R^2, contact finger 56 and front point of R^3, contact finger 57 and front point of R^4 and contact finger 58 and front point of R^5, to thus place energy on the g^1 wire.

It can be readily seen that, with a two-hump code, relays R^1—R^4 are picked up in sequence in the manner described above, but relay R^5 remains down, whereby to leave contact finger 58 of relay R^5 down, thus to place energy on wire y^1 instead of g^1, to thus execute for the caution or two-hump code.

The normal operation of the decoder shown in Fig. 7, and just described, is illustrated graphically in Fig. 8, with regard to both the G, or proceed, code and the Y, or caution, code. In this figure is shown graphically how, after one cycle of code has progressed through the decoding relays, the dropping of relay CPR de-energizes R^1 which can be considered both an executing and a clear-out relay. On release of R^1, contact finger 48 thereof drops to execute by placing energy on the proper repeater relay wire, and to break the stick circuit for the remaining relays which have been picked up and are stuck up, so that these remaining relays subsequently release and clear out the decoder in preparation for the next cycle of code.

Referring now to Fig. 9, there is here shown in graphic form the response of the coder of Fig. 7 to a frequency or rate code which is equal to or faster than, the release time of the executing relay R^1. As indicated in the figure, the first three humps of the rate code pick up relays R^1—R^5 but in as much as there is insufficient time during which CPR is down, for R^1 to drop, no execution can follow. Therefore, no energy can be placed on either the y^1 or g^1 wire, with the result that the red repeater relay is energized to set up a stop indication.

Referring now to Fig. 10, there is here shown, in graphic form, the response of the decoder of Fig. 7 to a frequency or rate type code which is slow enough not only to allow execution, by the dropping of relay R^1, but also to allow the subsequent release of such of relays R^2—R^5 as have been picked up. As can be seen from the figure, the first on and off period of current picks up relays R^1 and R^2, after which R^1 drops to execute a one-hump code indication if it be used, but in the present case this indication has been discarded, and then relay R^2 releases to clear out the decoder. Thus it is seen that with a slow rate code, as illustrated, the code can progress through the decoder only up to picking up of relay R^2 and the time is sufficient during the off period of current to drop both of these relays so that each succeeding current impulse must start at the beginning of the decoder.

Referring now to Fig. 11, there is here shown in graphic form the manner in which the decoder of Fig. 7 responds to a frequency type code which is slow enough to permit execution by the release of R^1, but is not slow enough to permit release of relays R^2—R^5 in the normal manner.

In this case, on the first pick-up of CPR, R^1 picks up through a front point of CPR and a back point of R^2. On the first release of CPR, R^2 picks up through a back point of CPR, a front point of R^1 and a back point of R^3 and is then stuck up as described above. Relay R^1 then releases .2 seconds after the release of CPR to execute a one-hump code if used, that is, to attempt to place energy on such as the dotted wire 44 which, as explained, has been omitted. Before relay R^2, however, has time to release, relay CPR picks up for the second time, but since the pick-up circuit for relay R^3 includes contact finger 51 and front point of R^1, R^3 cannot be picked up, and also, since R^2 is still up, R^1 cannot be picked up, with the result that the second pick-up of relay CPR can have no effect until after relay R^2 releases and thus clears out the decoder.

Thus it is seen that, with a rate type code such as in Fig. 11, the code cannot progress through the decoder beyond picking up relay R^2, and it is also clear that, if any attempted execution occurs by the release of relay R^1, it is necessary that clearing out of all of the other relays of the decoder which may have been picked up, be completed, before the code can further operate the decoder relays.

The form of decoder shown in Figure 7, therefore, accomplishes the same useful results as accomplished by the form shown in Fig. 1, but is simpler and cheaper in that it eliminates one of the relays of Fig. 1. That is, relays R^1 and R^2 of Fig. 1 are, in effect, replaced in Fig. 7 by the single relay R^1.

It is to be understood, of course, that the check signal AWV^1 of Fig. 1, and the acknowledging whistle AWV of Fig. 1, and also the brake control means EPV and EPV—R of Fig. 6, can all be used in connection with the decoder of Fig. 7. In other words it is contemplated that the decoder (R^1—R^5) of Fig. 7 can be substituted for the decoder (R^1—R^6) of Fig. 1.

Referring now to Fig. 12, it is here shown in graphic form how the decoder of Fig. 7 is immune to a fast rate code which changes to a slow rate code as, for example, a rate code of .2 seconds changing to a rate code of .3 seconds.

During the time the fast rate code, .2 seconds, is being received, response of the decoder is as indicated in Fig. 9, in which all of the relays R^1—R^5 are picked up and are held up with no possibility of an execution since there is insufficient time for the release of executing relay R^1.

On the code changing to a slower rate, as

.3 seconds, relay R^1 releases to execute the circuit then set up, which is the proceed or G indication. Thus energy is placed on wire g^1 on the first release of R^1. Since execution has taken place, a clearing out of all of the relays R^2—R^5 is enforced in the same manner as described in connection with Fig. 11, whereby, after this single execution of the G code, nothing further is possible except the attempted execution of a one-hump code which it is contemplated to wholly omit.

Furthermore a single execution of the G code cannot break down the stop or R code that was set up by the fast rate code since, as shown in Fig. 1, the red repeater relay R *Rep* requires 6 seconds to release. Before this relay has had a chance to release, the effect of the single execution of G code has been dissipated and G *Rep* releases, and again energizes R *Rep* to thereby retain the stop or R indication.

As mentioned in the introductory portions of this specification, the timings of the various relays and of the various codes is not of the essence of the present invention, it being contemplated that these times can be widely varied, at will, in accordance with the attendant circumstances, just so long as the code timing is chosen to properly cooperate with the relay timing to give operating characteristics as described.

By means of the above described systems, applicant has provided train control systems which are designed to respond normally to pattern or cyclic or counting type codes, to set up distinctive cab indications and train controls, with the apparatus so arranged as to be wholly immune to operation by rate type codes, regardless of the particular timing of such rate codes, to set up anything but stop indications and stop controls.

The above rather detailed description of several forms of applicant's invention, is given solely by way of illustration, and is not intended, in any manner whatsoever, in a limiting sense. Obviously, the invention can assume many physical forms, and is susceptible of numerous modifications, and all such forms and modifications are intended to be embraced by this invention, as come within the scope of the appended claims.

Having described my invention, I now claim:

1. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder having means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs an off period, which is long relatively to said alternate off periods.

2. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder being arranged to distinguish between cyclic codes differing from each other by the number of separate current impulses per cycle of code, and including means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs an off period which is long relatively to said alternate off periods.

3. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder having means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs a relatively extended off period, and out-of-order indicating means initiated upon said decoder failing to guard against responding favorably to a code having no intermittently occurring relatively extended off period.

4. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means. said decoder being arranged to distinguish between cyclic codes differing from each other by the number of separate current impulses per cycle of code, and including means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs a relatively extended off period, and out-of-order indicating means initiated upon said decoder failing to guard against responding favorably to a code having no intermittently occurring relatively extended off period.

5. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder having means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs an off period which is long relatively to said alternate off periods, and a brake applying device controlled by said secondary circuits and operating when initiated, to apply the brakes, said decoder responding to a "stop" code of sufficient rapidity and having no

said intermittently occurring extended off periods to initiate said brake applying device.

6. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder being arranged to distinguish between cyclic codes differing from each other by the number of separate current impulses per cycle of code, and including means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs an off period which is long relatively to said alternate off periods, and a brake applying device controlled by said secondary circuits and operating when initiated, to apply the brakes. said decoder responding to a "stop" code of sufficient rapidity and having no said intermittently occurring extended off periods to initiate said brake applying device.

7. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder having means making is incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs a relatively extended off period, an out-of-order indicating means initiated upon said decoder failing to guard against responding favorably to a code having no intermittently occurring relatively extended off period, and a brake applying device controlled by said secondary circuits and operating, when initiated, to apply the brakes, said decoder responding to a "stop" code of sufficient rapidity and having no said intermittently occurring extended off periods to initiate said brake applying devce.

8. In continuous train control systems, in combination with code receiving means and secondary circuits for setting up controls of varying restrictiveness, a decoder for governing the secondary circuits and operated by the receiving means, said decoder having means making it incapable of setting up a favorable control in response to code having spaced alternate on and off periods of current, unless there intermittently occurs a relatively extended off period, a brake applying device controlled by said secondary circuits and operating, when initiated, to apply the brakes, said decoder responding to a "stop" code of sufficient rapidity and having no said intermittently occurring extended off periods, to initiate said brake applying device, means for initiating the brake applying device on going into more restrictive territory, and an acknowledging contactor incapable of preventing initiation of the brake applying device due to said "stop" code, but operable to prevent the other said initiation thereof.

9. A train control decoder, comprising, a plurality of stepping relays for selectively energizing different control circuits and operable in response to a primary relay connected to successively pick up and release to thus follow a code, the stepping relays picking up in succession as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, said first stepping relay controlling all said control circuits, and a monitor relay picked up through a back point of each of said stepping relays and stuck up, in multiple, through a back point of the primary relay, and a front point of the first stepping relay.

10. A train control decoder, comprising, a plurality of stepping relays for selectively energizing different control circuits and operable in response to a primary relay connected to successively pick up and release to thus follow a code, the stepping relays picking up in succession as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, said first stepping relay controlling all said control circuits, and a monitor relay, picked up through a back point of each of said stepping relays and stuck up, in multiple, through a back point of the primary relay and a front point of the first stepping relay, said monitor relay also controlling all said control circuits.

11. A train control decoder, comprising a plurality of stepping relays, for selectively energizing different control circuits and operable in response to a primary relay connected to successively pick up and release to thus follow a code, the stepping relays picking up in successiion as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and back point of the immediately succeeding relay, said stepping relay controlling all said control circuits, and a monitor relay, picked up through a back point of each of

said stepping relays, and stuck up, in multiple, through a back point of the primary relay and a front point of the first stepping relay, said monitor relay also controlling all said control circuits, and the stick circuits for the stepping relays, through its front points.

12. A train control decoder, comprising, a plurality of stepping relays for selectively energizing different control circuits and operable in response to a primary relay connected to successively pick up and release to thus follow a code, the stepping relays picking up in succession as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, said first stepping relay controlling all said control circuits, and a monitor relay, picked up through a back point of each of said stepping relays, and stuck up, in multiple, through a back point of the primary relay, and a front point of the first stepping relay, said monitor relay also controlling all said control circuits and being quick enough acting to release if the primary relay picks up when the first stepping relay is down.

13. A train control decoder, comprising, a plurality of stepping relays for selectively energizing different control circuits and operable in response to a primary relay connected to pick up and release to thus follow a code, the stepping relays picking up in succession as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and back point of the immediately succeeding relay, said first stepping relay controlling all said control circuits, and a monitor relay, picked up through a back point of each of said stepping relays, and stuck up, in multiple, through a back point of the primary relay and a front point of the first stepping relay, said monitor relay also controlling all said control circuits and the stick circuits for the stepping relays, through its front points, the monitor relay being quick enough acting to release if the primary relay picks up when the first stepping relay is down.

14. A train control decoder, comprising, a plurality of stepping relays for selectively energizing different control circuits and operable in response to a primary relay connected to pick up and release to thus follow a code, the stepping relays picking up in succession as the primary relay operates, each stepping relay picking up through a circuit including a front point of each preceding relay and a back point of the immediately succeeding relay, and all, save the first, being stuck up through a circuit including a front point of each preceding relay and back point of the immediately succeeding relay, said first stepping relay controlling all said control circuits, and a monitor relay, picked up through a back point of each of said stepping relays and stuck up, in multiple, through a back point of the primary relay and a front point of the first stepping relay, said monitor relay also controlling all said control circuits and the stick circuits for the stepping relays through its front points, the monitor relay being quick enough acting to release if the primary relay picks up when the first stepping relay is down, and an out-of-order indication connected to be energized if the monitor relay fails to release when de-energized.

15. A decoder for train control systems, consisting, of only a plurality of stepping relays picked up in succession as a primary relay, arranged to follow train control code, picks up and releases, each stepping relay, except the last, picking up through a back point of a following relay, and each stepping relay, except the first, picking up through a front point of a preceding relay.

16. A decoder for train control systems, comprising a plurality of stepping relays picked up in succession as a primary relay, arranged to follow train control code, picks up and releases, each stepping relay, except the last, picking up through a back point of a following relay, and each stepping relay, except the first, picking up through a front point of a preceding relay, a stick circuit for the first stepping relay including a front point of the primary relay, a stick circuit for the other stepping relays including a front point of the first stepping relay, and a plurality of induction control circuits energizable through a back point of the first stepping relay.

17. A decoder for train control systems, comprising, a plurality of stepping relays picked up in succession as a primary relay, arranged to follow train control code, picks up and releases, each stepping relay, except the last, picking up through a back point of a following relay, and each stepping relay, except the first picking up through a front point of a preceding relay, a stick circuit for the first stepping relay including a front point of the primary relay, and front and back points of succeeding relays, a stick circuit for the other stepping relays including a front point of the first stepping relay, and a plurality of indication control circuits energizable through a back point of the first stepping relay.

In testimony whereof I affix my signature.

WILLIAM D. HAILES.