June 28, 1938. N. D. PRESTON 2,122,379

SIGNALING SYSTEM FOR RAILROADS

Filed Aug. 24, 1935 3 Sheets-Sheet 1

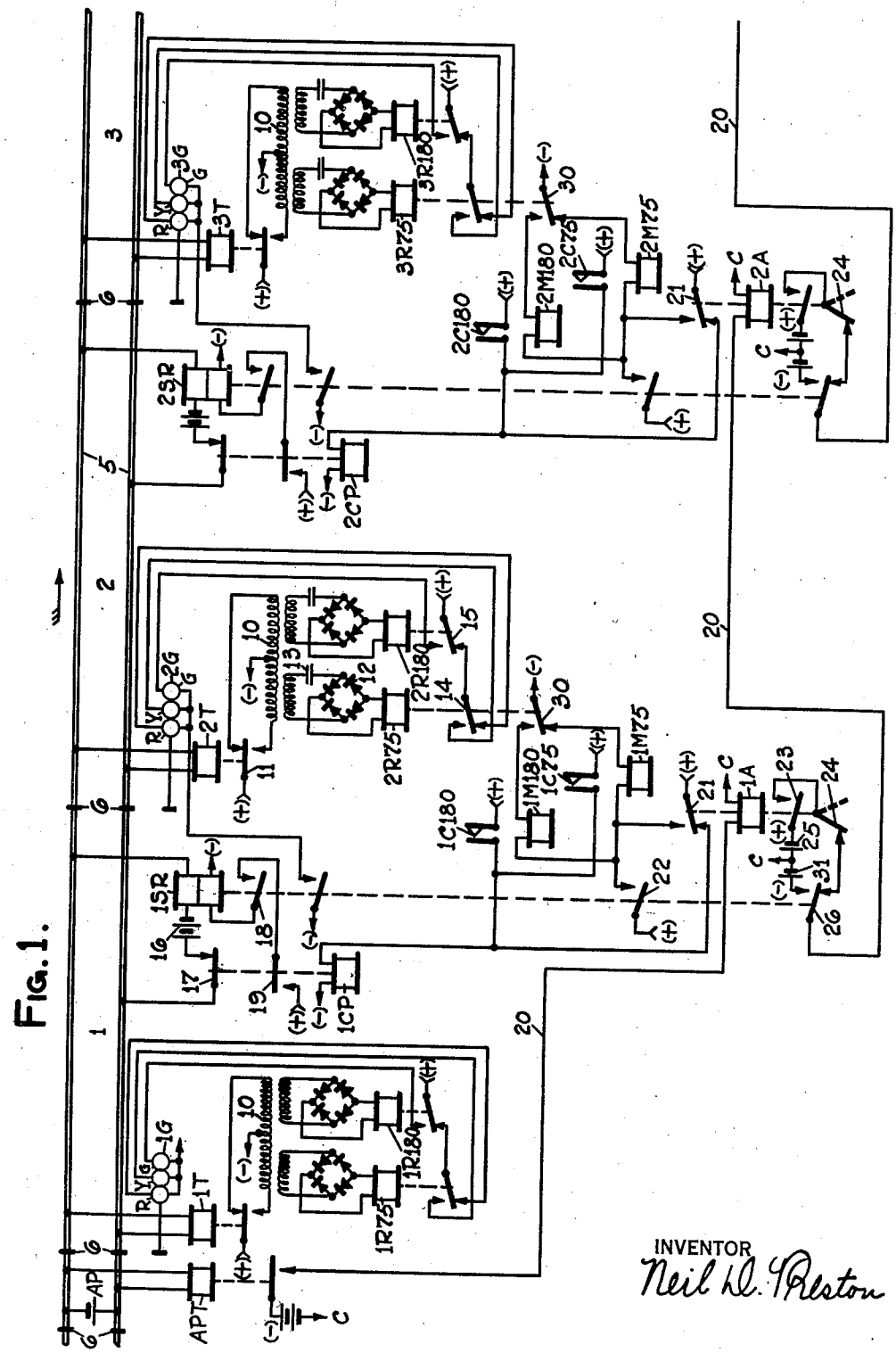


FIG. 1.

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SIGNALING SYSTEM FOR RAILROADS

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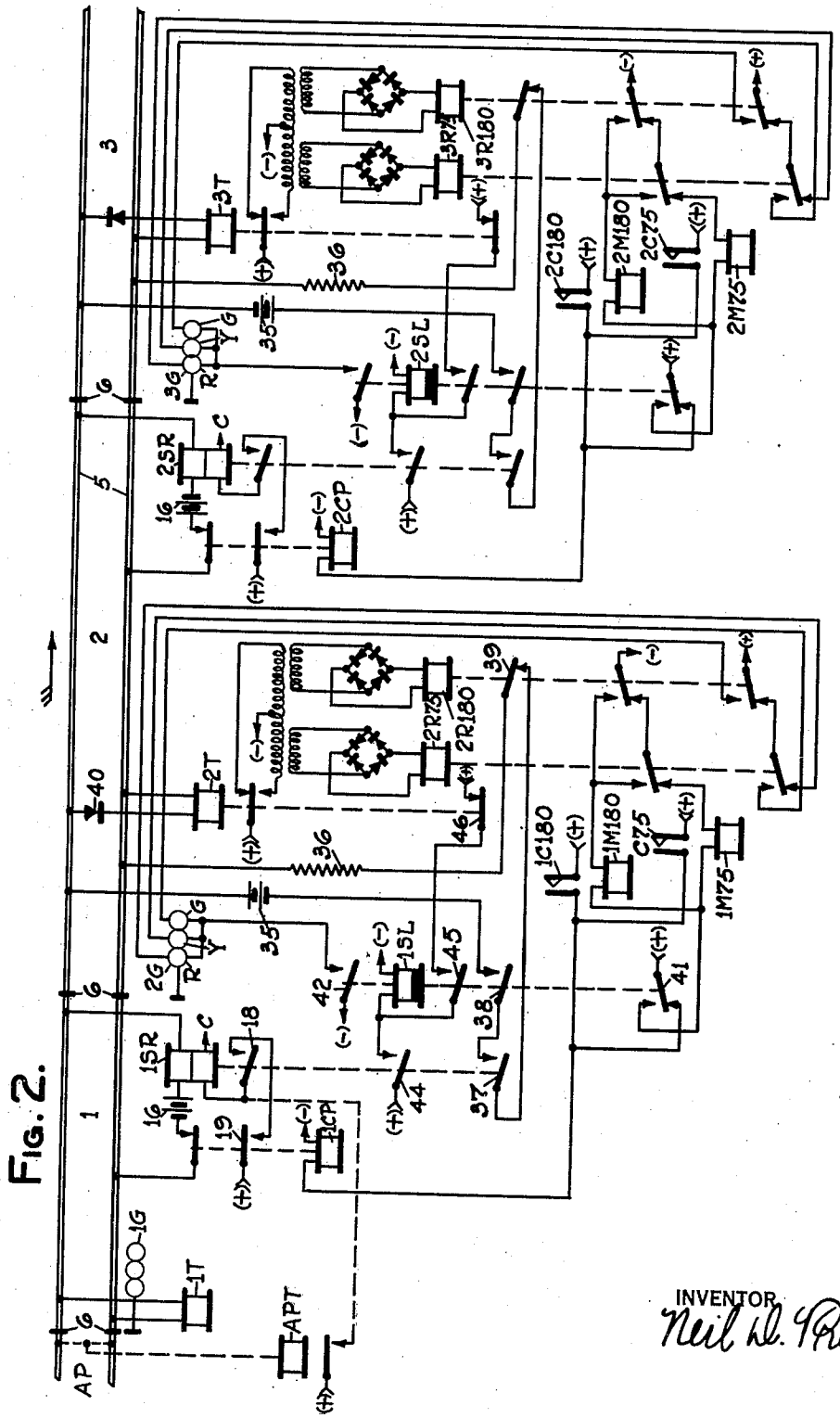


FIG. 2.

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SIGNALING SYSTEM FOR RAILROADS

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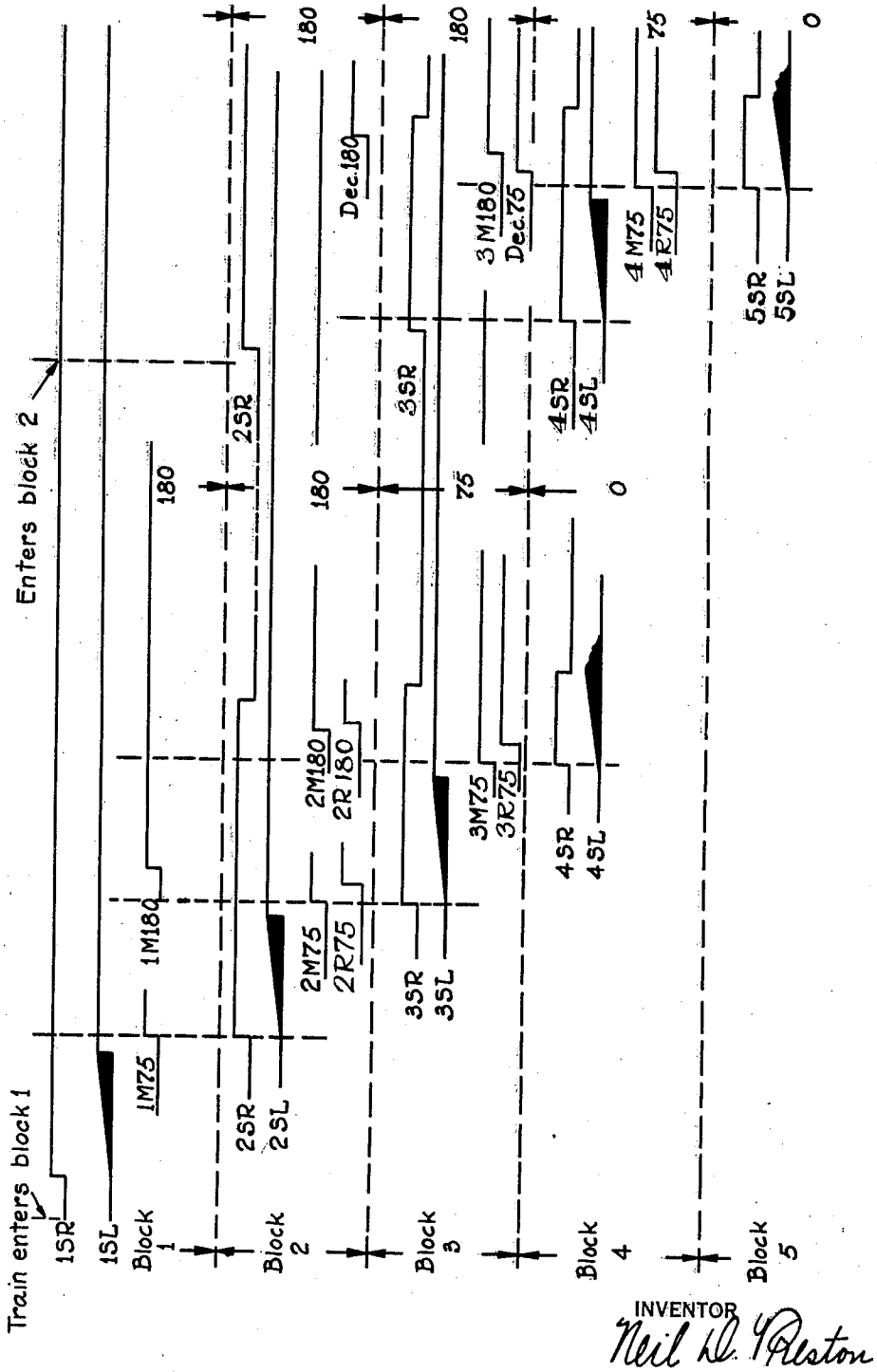


FIG. 3.

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Patented June 28, 1938 2,122,379

UNITED STATES PATENT OFFICE

2,122,379

SIGNALING SYSTEM FOR RAILROADS

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Application August 24, 1935, Serial No. 37,744

24 Claims. (Cl. 246—41)

This invention relates to signaling systems for railroads of the so-called coded track circuit type, and more particularly to a coded track circuit system in which the coding equipment is normally inactive, but is automatically set into operation upon the approach of a train.

In the so-called coded track circuit type of block signaling, cab signaling, or train control system, the track circuit is intermittently energized, causing intermittent energization of the track relay; and it is desirable to avoid continuous operation of relay contacts and other moving parts employed in connection with such intermittent energization or coding of the track circuit, unless a train is present to make it necessary to control the indications of wayside signals or the rail current for cab signaling or train control purposes.

Generally speaking, and without attempting to define the nature and scope of the present invention, it is proposed to provide a simple and effective organization of relays and circuits for initiating operation of the coding and decoding equipment associated with several blocks upon the approach of a train, with a minimum number of line wires, or by the use of track rails alone without any line wires.

Various characteristic features, attributes, and advantages of the invention will be in part apparent, and in part pointed out as the description progresses.

In the accompanying drawings, Fig. 1 illustrates in a simplified and diagrammatic manner one embodiment of the invention employing one line circuit for each block for approach control;

Fig. 2 illustrates a modified organization in which the approach control is obtained by current impulses conducted over the track rails and without line wires; and

Fig. 3 is a diagram or chart of an explanatory character to facilitate the explanation and understanding of the sequence of relay operations for the modification of Fig. 2.

Referring to the drawings, the track rails 5 are bonded together in the usual way and divided by insulated joints 6 into track sections, it being assumed for simplicity that these track sections will be long enough to constitute the usual block, although the same principles may be applied to blocks consisting of two or more separate track sections.

Considering briefly the organization of parts associated with each block in accordance with this invention, certain corresponding devices for the three blocks 1, 2 and 3 shown are given corresponding prefix numbers. A code following track relay T of a suitable type is connected across the track rails at the entrance end of the block (the normal direction of traffic being from left to right as indicated by the arrow). This track relay T operates suitable decoding means to selectively energize code responsive or decoder relays R75 and R180. This decoding means may take any suitable form, but as shown comprises a transformer 10, with its primary having a mid-tap connected to one terminal (—) of a suitable source of direct current, the terminals of said primary being connected to the other (+) terminal of the same source through front and back contacts 11 of the track relay T. The two secondaries of the transformer 10 are connected through a double wave rectifier 12 to the respective decoder relays R75 and R180, with condensers 13, with or without additional reactance coils, in the in-put circuits of these rectifiers proportioned to allow the maximum uni-directional current for the energization of the decoder relays to flow when the track relay T is energized and deenergized at the rate of 75 and 180 times per minute, respectively, all in a manner characteristic of decoding means of this type, and as shown and described, for example, in the patent to W. D. Hailes, No. 1,852,409, April 5, 1932, for a locomotive equipment.

The decoder relays R75 and R180 control the indications of the wayside block signal at the entrance to the corresponding wayside block, such signals G of the color light type being illustrated, with control circuits governed by front and back contacts 14 and 15 of said decoder relays.

Associated with each block is a modulator or coder of suitable construction, arranged to intermittently close contacts at the different code rates or periodicities; and since it is assumed that the track circuit is to be operated by direct current, such coder for each code rate is preferably in the form of a device having an oscillating or vibrating member operated by electromagnets energized by direct current and actuating contacts, as distinguished from a coder driven by a polyphase or synchronous motor, such as is commonly used where alternating current is available. One form of an oscillatory coder of the type contemplated is disclosed, for example, in the patent to P. N. Bossart, No. 1,858,876, May 17, 1932. For convenience in explanation, it is assumed that two code rates of 75 and 180 per minute, will be used, which however are merely typical for this purpose. These code rates are produced by coders

or modulators, diagrammatically illustrated as comprising magnets M75 and M180 operating contacts C75 and C180.

At the exit end of each block the usual track battery 16 is connected across track rails 5 in series with the front contact 17 of a code repeater relay CP and the upper winding of a series relay SR. It is contemplated that this upper winding of the relay SR will act as the limiting resistance commonly used with primary batteries, or other sources of track circuit current having relatively negligible internal resistance. The relay SR is provided with a stick circuit including its lower winding, its own front contact 18, and the back contact 19 of the code repeater relay CP. The relays SR also provide for approach lighting of the signals G.

In the arrangement of Fig. 1, the operation of the coders M75 and M180 is governed by an approach control relay A of the neutral-polar type which is energized over a line wire 20 and a common return connection indicated by the symbol C; and the operation of these approach control relays, in conjunction with the series relays SR, provides for initiating the operation of the coders, which are normally inactive, upon the approach of a train.

The various circuits are shown conventionally, with the symbols (+) and (—) indicating connections to opposite terminals of a battery, or other suitable source of direct current. The details of these circuit connections are more conveniently considered in describing the operation.

Considering now the operation of the organization shown in Fig. 1, the various parts are illustrated in the normal condition when no trains are present. The approach control relays A are deenergized, closing the circuits through their back contacts 21, which may be readily traced, for maintaining the corresponding code repeater relay CP steadily energized, so that the track battery 16 of each block is continuously connected across the track rails to energize steadily the code following track relay T of the corresponding block. The operating characteristics of the series relay SR are so selected or adjusted that this normal track circuit current, with no train present, is not sufficient to attract the armature of this relay. The code following track relay T of each block being steadily energized, there is no change in the current through the primary of the transformer 10, and no voltage induced in the secondary of this transformer to energize the decoder relays R75 and R180, so that both of these relays are deenergized to display a stop indication by lighting the red lamp R of the signal S, or in a similar way. Since the approach relay A and the series relay SR of each block are both deenergized, their front contacts 21 and 22 are open, and no current is applied to the coders M75 and M180.

Thus, under these normal conditions with no trains present, the coders are inactive, the track relays are steadily energized, and there are no relay contacts or other moving parts in operation.

In explaining how the system is set into operation upon the approach of a train to display the proper wayside signal indications, it is assumed that at the various places along the railroad where trains may enter the equipped territory, as at terminals, junctions and the like, there will be a preliminary approach track section, such as the track section AP, with its usual track relay APT, located in the rear of the first signal at the entrance to the equipped territory. When a train enters such preliminary approach section and deenergizes track relay APT, a circuit is established over the line wire 20 to energize the approach relay 1A for the first block 1 of the equipped territory, the polarity of such energization being assumed to be (—), so that the neutral armature 23 of relay A is attracted, while its polar armature is positioned to the left. This energization of relay 1A closes a circuit over the line wire 20 to energize the relay 2A for the next block 2 in advance with the opposite (+) polarity, such circuit being traced from C, battery 25, neutral front contact 23 of relay 1A, polar contact 24 of relay 1A to the left, back contact 26 of series relay 1SR, line wire 20, and relay 2A to C. This circuit energizes the relay 2A to attract its neutral armature 23 and position its polar armature to the right; but the line circuit 20 for the next approach relay ahead is connected to the other or negative contact of said polar armature, the next approach relay (not shown) is not energized. In short, the entrance of a train into the preliminary approach section AP energizes the approach relays 1A and 2A, but not any other approach relays for blocks further ahead.

The code following track relay 3T of the block 3 being still steadily energized under the conditions under discussion, the decoder relay 3R75 of that block is deenergized and its back contact 30 is closed, so that when approach relay 2A is energized to close its front contact 21, the coder 2M75 for the caution code is energized, operating its contacts 2C75, to intermittently energize the code repeater relay 2CP for the block 2, the opening of back contact 21 of relay 2A breaking the circuit normally maintaining the relay 2CP steadily energized. This applies the 75 code rate to the block 2, operating its code following track relay 2T at the same rate, which causes energization of decoder relay 2R75 to display a caution indication at signal 2G. This decoder relay 2R75 of block 2 being energized to close its front contact 30, the energization of approach relay 1A supplies current to the coder 1M180 at the exit end of block 1, which in the same manner operates relay 1CP and 1T at the 180 code rate to energize 1R180 at the entrance to block 1 and display a proceed indication at signal 1G.

Thus, when a train enters the preliminary approach section AP, assuming no trains present in blocks 1 or 2, the decoder relay 1R180 of the block 1 is energized to display a proceed or green indication, the decoder relay 2R75 of block 2 is energized to display a yellow or caution indication, and both decoder relays 3R75 and 3R180 of block 3 remain deenergized to display a red or stop indication. In other words, when a train enters the preliminary approach section at the entrance to equipped territory, the coding equipment is automatically started into operation for two blocks ahead to display a proceed indication for such approaching train, assuming that these two blocks are not occupied.

It will be evident, without further explanation, that if a train should be present in block 2, its code following track relay 2T would not be energized, and decoder relays 2R75 and 2R180 of that block would both be deenergized to display a stop indication, and also provide the caution 75 code rate for block 1 in the rear to display a caution indication at signal 1G at the entrance to that block. Similarly, if a train is present in block 1, the code following track relay 1T is not operated, and both decoder relays

are deenergized to display a stop indication at signal 1G.

Assuming now that the approaching train in question enters block 1, its wheels and axles shunt the coded current from the track relay 1T, so as to give a red or stop indication at the entrance to this block. Also, the shunting effect of the wheels and axles of this train increases the current through the upper winding of the series relay 1SR to the extent that this relay attracts its armature. When the relay 1CP drops to cut off the current from the battery through the upper winding of this relay 1SR, the back contact 19 of relay 1CP closes a stick circuit for holding up relay 1SR, it being desirable in this connection to make the relays SR slightly slow releasing, or adjust the back contacts 19 to make at the same time front contacts 17 break, so that these series relays SR will not release their armatures as the relays CP operate.

When relay 1SR is thus picked up and held up by the entrance of a train into the block 1, it closes its front contact 22 to maintain the supply of current to coders 1M75 and 1M180, even though the train later clears the approach section AP and relay 1A is deenergized. Also, the energization of relay 1SR closes its front contact 26 to supply current of opposite or negative polarity from battery 31 to the approach relay 2A, causing its polar contact 24 to move to the left, for supplying current of (+) polarity over the line wire 20 to the next approach relay (not shown) for block 3, the polar contact of such next approach control relay being shifted to a position where the line circuit for the approach control relay of the next block still further in advance is not closed. The energization of the approach control relay of block 3 starts the coder at the end of this block to pick up decoder relay 3R75 for block 3 and change the stop indication to a caution indication, in the same manner as previously explained; and the energization of decoder relay 3R75 of block 3 changes the code rate for block 2 to the 180 rate to change the indication of the signal at the entrance to that block from caution to proceed, of course assuming that block 3 is not occupied.

When the train in question enters block 2, series relay 2SR is energized, and the same operation of initiating the coder for another block ahead is repeated; and as the train progresses through the several blocks the same action occurs, the coders for two blocks in advance of the one occupied by the train being set into operation to provide a proceed indication for such train, provided the next two blocks ahead are clear. In other words, the coding equipments are progressively set into operation for two blocks ahead as the train advances, so that the train receives proceed indications so long as these two blocks ahead of it are clear.

When a train leaves a block, the current through the series relay SR of that block is reduced to its normal value, and when the corresponding relay CP is held energized, the stick circuit of relay SR is broken and this relay releases its armature, opening its front contact 22 to stop the coders, and remaining deenergized until the next train approaches.

The invention is illustrated as providing for the control of indications of wayside signals; but the same scheme of approach control of coders may be utilized for a cab signal or train control system. In this connection, the front contact 22 of the series relay SR maintains in operation the coder relay CP at the exit end of the corresponding block, even though the train has cleared the block in the rear, thereby maintaining coding of the track rail current, even though such coded current is unnecessary for the purpose of controlling the indication of the wayside signal at the entrance to such corresponding block, this signal indicating stop. In other words, the invention provides a scheme of approach control for maintaining a coded rail current for cab signal or train control purposes as well as governing the indications of wayside signals. As shown the track rail current is interrupted or pulsed uni-directional current; and the locomotive equipment must be adapted to respond to such rail current, in the manner disclosed, for example, in the patent to W. D. Hailes, No. 1,914,329, granted June 13, 1933. If desired, alternating current of a suitable frequency, such as 100 cycles may be superimposed on the pulsed direct current, or in fact used to energize the code following track relay through a double wave rectifier, such alternating current being obtained by a local vibrator or oscillator, or from a transmission line, as convenient or desired. These and various other adaptations and applications of the invention have not been specifically illustrated; but it should be recognized that the approach control means of this invention may be utilized in connection with various types and forms of systems employing trackway coding apparatus.

The embodiment of the invention shown in Fig. 1 requires line wires extending from block to block for energization of the approach control relays A; and since one of the advantages of a coded track circuit system is the elimination of line wires for the control of signal indications, it may be considered desirable to eliminate the use of line wires even for approach control purposes. Such an organization for approach control or advance starting of coding equipment without the use of line wires is shown in Fig. 2, this organization being in the nature of a modification or improvement in the system for a similar purpose disclosed and claimed in the prior application of Meyer Hormats, Ser. No. 15,646, filed April 10, 1935, no claim being made herein to subject matter disclosed in said Hormats application.

Referring to the modification of Fig. 2, the general organization of coding equipment is the same as already described, and the same series relay SR is used with each track circuit; but provision is made for energizing this series relay SR under certain conditions due to the presence of a train in the rear, as well as by the entrance of a train into the same block. For this purpose, an extra or supplemental battery 35 is provided at the entrance end of the block, with means to connect this battery across the track rails 5 in series with a resistance 36, when (*a*) the series relay SR of the next block in the rear is energized and its front contact 37 is closed, (*b*) a slow acting relay SL is energized to close its front contact 38, and (*c*) the decoder relay R180 of the corresponding block is deenergized to close its back contact 39. This supplemental battery 35 is connected across the track rails with a polarity to add to the voltage of the regular track battery 16. A rectifier 40 of suitable construction, such as a copper-oxide rectifier, blocks the flow of current through the track relay T of the corre-

sponding supplemental battery 35. The value of the resistance 36 is selected or adjusted to provide the necessary drop of potential across the track rails to energize the track relay T.

The approach control function is performed in the arrangement of Fig. 2 by the slow acting relay SL which, when energized and stuck up in a manner to be presently explained, opens at its back contact 41 the circuit maintaining the code repeater relay CP steadily energized, and closing at its front contact 41 the circuit for coders M75 and M180. This relay SL is also shown as providing approach lighting of the associated wayside signal by closing its front contact 42, the indications of these signals being controlled by the decoder relays R75 and R180 in the same way.

The operation of the modification of Fig. 2 involves the sequential operation of various relays at certain time intervals; and the diagram of Fig. 3 serves to facilitate an explanation and understanding of this operation. It should be understood that the representations of time intervals and the like in this diagram of Fig. 3 are merely for explanatory and illustrative purposes, and are susceptible of suitable variations in practice.

Considering the operation of Fig. 2, the parts are shown in the normal inactive condition with no trains present. The code repeater relays CP and track relays T are steadily energized; and the series relays SR, decoder relays R75 and R180, and the slow acting relays SL are all deenergized and the coders inactive.

Assuming now that the train enters the preliminary approach section AP, the dropping of track relay APT closes a line circuit, special to this approach section and indicated by dash lines, to energize the lower winding of series relay 1SR for block 1. This closes front contact 44 of relay 1SR to energize relay 1SL, which is stuck up through its own front contact 45 and front contact 46 of the track relay 2T of block 2.

This energization of relay 1SL starts the coder 1M75 of block 1, and at the same time connects the supplemental battery 35 across the track rails at the entrance to block 2, relay 1SR being energized and R180 of block 2 deenergized at this time. This picks up series relay 2SR and in turn slow acting relay 2SL, which starts the coder 2M75 at the exit end of block 2. This applies the 75 rate code to block 2, causing energization of decoder relay 2R75 of block 2, which in turn starts the coder 1M180 to supply the 180 code rate to block 1.

When relay 2SL is energized, it connects the supplemental battery 35 to the block 3, energizing 3SR (not shown), which in turn energizes a relay 3SL of block 3, starting the coder 3M75 (not shown) for that block, which causes decoder relay 3R75 of block 3 to be energized. This starts the coder 2M180 of block 2, and in turn causing decoder 2R180 of block 2 to be energized.

When the decoder relay 2R180 of block 2 is energized, the circuit for connecting the supplemental battery 35 across the track rails of block 2 is broken, and 2SR drops and cuts off supplemental battery 35 from block 3, so that 3SR in turn drops and cuts off the supplemental battery 35 for block 4. The reason relay 2SR drops is because energy is cut off its lower winding with the back contact of relay 2CP open (relay 2CP up), during the intermittent operation of relay 2CP in response to the code being transmitted by coder 2M180 and energy in its upper winding is reduced to the drop-away value with relay 2R180 up and its back contact 39 open. Relay 2SR (and likewise other SR relays) is sufficiently quick in releasing to drop during a period that relay 2CP is up. Relay 2SR will not drop when a train is in the associated block because one winding or the other is always energized to the hold up value, depending on the position of relay 2CP. While this sequential operation just described is occurring, following energization of 3SL, relay 4SR of the next block 4 is energized and supplies current to relay 4SL of that block, but as indicated in the chart in Fig. 3, the pick up time of this relay 4SL is such that it does not have time to attract its armature and establish its stick circuit before relay 4SR is deenergized and breaks the pick-up circuit for this relay, due to the sequential building up of the code rates for blocks 1 and 2, and the sequential deenergization of relays 2SR and 3SR.

In this connection, it should be understood that the accuracy of the timing of the relays SL is not material to satisfactory operation; and there may be considerable variation in the pick up times of these relays SL, due to variations in battery voltage or the like. The slow acting relay, such as 3SL in the case just described, for the last block ahead where it is needed to start the coders, must pick up before the supplemental battery 35 is applied to the next block ahead to energize its relay 4SR and start the timing of its slow acting relay 4SL. Consequently, the energizing time for the relays SL may be as long as desired, even comparable with the time taken for a train to travel through a block. On the other hand, if a slow acting relay, such as 4SL in the case just described, is so quick in its operation as to pick up and stick before there is time for the building up of the code rates and sequential deenergizations of relays 2SR, 3SR and 4SR to occur, the coding equipment will be started for one block further ahead than necessary; but the building up of code rates and the sequential deenergization of relays SR will be too quick to allow two slow acting relays 4SL and 5SL to pick up in succession. In this connection, it is apparent that dash-pots, thermal elements, or other devices may be employed to render these slow acting relays SL sufficiently slow in their operation.

Thus, by employing the track rails to energize the series relays SR, in conjunction with slow acting relays SL, entrance of a train into the preliminary approach section and the resulting energization of the first series relay 1SR is followed by the sequential energizations of the relays SL for three blocks in advance, initiating the coders for these blocks and causing operation of the code following track relays and decoding equipments in a manner to display two proceed signals, a caution signal and a stop signal in advance of the train.

When the train in question enters the block 2, relay 2SR is again energized by the shunting effect of the wheels and axles of this train, again applying the supplemental battery 35 across the track rails at the entering end of the next block 3 to energize relay 3SR, which similarly causes energization of 4SR, followed by energization of 4SL, starting the coder 4M75 (not shown) for one additional block 4 ahead, and changing the code rate applied to block 3 to the next higher code rate until, when decoder relay 3R180 is energized, the supplemental battery 35 is disconnected from block 3, and relays 3SR, 4SR and

5SR are deenergized successively before relay 5SL has time to attract its armature, in the same manner already explained.

When the train in question leaves block 1, relay 1SL is deenergized, since relay 1SR drops and opens its pick-up circuit and track relay 2T is deenergized to open its stick circuit. This restores the parts of block 1 to the normal condition, ready for the next operation.

It can be seen that the organization of Fig. 2 provides for the approach starting of decoders for three blocks in advance of an approaching train, by control transmitted over the track rails and without the use of line wires. One advantage of this arrangement for starting the coders for three blocks in advance of the train is that the coding equipment, supplying the proceed code rate to the track rails at the exit end of a block, is in operation before the train enters that block, so that as the train travels from block to block, the rail current for cab signaling or train control at the high speed or proceed rate exists before the train enters the block, and it is not necessary to employ quick starting coders, or have a time lag in the locomotive equipment to avoid receiving a restrictive indication before the proceed rail current is established upon entering a block.

One characteristic feature of this organization of Fig. 2 is the special provision made, by use of a supplemental track battery **35** and the rectifier **40** in series with the track relay, to obtain controlled energization of the series relay SR. The supplemental battery **35** has such voltage as is necessary to obtain the satisfactory margin of energization of the relay SR greater than its normal energization if no train is present; and the rectifier **40** in series with the track relay avoids improper operation of this track relay by such a supplemental battery. The resistance **36** is necessary to provide a sufficient voltage drop across the track rails to energize the track relay from the regular track battery **16**.

One outstanding attribute and advantage of a coded track circuit system embodying this invention is that the coding equipment is normally inactive, and there are no coders or transmitters, code following track relays, or other apparatus in operation while no trains are present. This obviously materially increases the useful life of apparatus of this character, and is in marked contrast with a coded track circuit system which is continuously operating whether trains are present or not. It is obvious that no particular useful purpose is served by having coders or code following track relays operating at times when there are no approaching trains to take advantage of the wayside signal indications or cab signaling.

If the approach control organization of this invention should, for any reason, fail to function with respect to any particular block or blocks, such failure will not affect other blocks. The entrance of a train into any block and resultant energization of the series relay SR will initiate operation of the coders ahead, irrespective of what may have occurred previously. The use of a preliminary approach section AP is shown so that block 1 may be taken as part of signaled or equipped territory; but the approach track for signaled territory may make use of a series relay SR as the starting device, omitting relay 1A and its control in Fig. 1 and the energizing line circuit for 1SR in Fig. 2, in a manner so obvious as not to require illustration.

The specific embodiments of the invention shown and described are merely illustrative, and various adaptations, variations and modifications may be made in the specific embodiments without departing from the invention.

What I claim is:—

1. A coded track circuit system for railroads comprising, in combination with a track circuit having a source of current connected across the track rails at one end, a normally inactive coding device for intermittently interrupting the supply of current from said source to the track circuit, and means including a relay in series with said source and between the source and the track rails for automatically initiating operation of said coding device upon entrance of a train into said track circuit.

2. A coded track circuit system for railroads comprising, in combination with a plurality of track sections each having a source of current connected across the track rails at the exit end, a normally inactive coding device associated with each track section for controlling the supply of current from said source to the track rails of the corresponding section, and means including relays in series with said sources of current for automatically setting into operation a plurality of said coding devices in advance of a train entering a given track section.

3. An approach control system for coded track circuits comprising, in combination with a plurality of track sections each having a source of track rail current and a normally inactive coding device, of electro-responsive means for each track section connected in series with its source of current and responsive to an increase in current normally supplied to the track rails for governing the operation of the corresponding coding device, and means controlled by said coding device for governing the series connection of the corresponding electro-responsive means with the corresponding source of current.

4. In a coded track circuit system, the combination with a plurality of track sections each having a source of current and a normally inactive coding device, a series relay for each track section effectively energized by an increase in the current normally supplied to the track rails of the corresponding track section from its source, approach control means for each coding device, and means including said series relay for rendering effective said approach control means for a plurality of track sections in advance of a given track section occupied by a train.

5. An approach control system for coded track circuits comprising, in combination with a plurality of track sections each having a source of current and a normally inactive coding device, an approach control relay associated with each track section for automatically initiating operation of the corresponding coding device, a line circuit extending from each track section to the next in advance for energizing said approach control relay, each approach control relay when having a given condition of energization causing energization of the line circuit for the approach control relay next in advance with a different condition of energization, a series relay associated with each track section and effectively energized by the increase in current normally supplied to that track section caused by the presence of a train, and means actuated by each series relay for energizing the line circuit extending to the approach control relay for the

next track section in advance with said given condition of energization.

6. An approach control system for coded track circuits comprising, in combination with a plurality of track sections each having a source of current and a normally inactive coding device, a neutral polar approach control relay associated with each track section and acting when energized with either polarity to initiate operation of the corresponding coding device, a series relay for each track section energized by the increase of current normally supplied to the track rails of that section caused by the presence of a train, a line circuit for energizing each approach control relay extending to the track rails next in the rear, each approach control relay when energized with a given polarity causing energization of said line circuit for the approach control relay next in advance with the opposite polarity, and means actuated by each of said series relays for energizing the line circuit extending to the approach control relay next in advance with said given polarity.

7. An approach control system for coded track circuits comprising, in combination with a series of track sections each having a source of current and a normally inactive coding device for controlling the supply of current to the track rails of the corresponding section from said source to conform with distinctive codes, a relay for each track section in series with its source of current and effectively energized by the increase in current normally supplied to the track rails caused by the presence of a train, said relay when effectively energized automatically initiating operation of the corresponding coding device, and a stick circuit for each of said relays controlled by the corresponding coding device for maintaining said relay energized while said source of current is disconnected from the track rails.

8. In a system of the character described, a track circuit section, a source of track current, a coding device having a contact intermittently opened and closed, a series relay, a circuit connecting said source of current across the track rails at one end of said track circuit and including in series said contact of said coding device and said series relay, a stick circuit for said series relay including its own front contact, and means governed by said coding device for closing said stick circuit only while said contact is open.

9. In a system of the character described, a plurality of track sections each having a source of track rail current, a marginal series relay for each track section effectively energized only by a predetermined increase in the current above that normally supplied to the track rails of that track section when not occupied by a train, and means governed by each series relay for causing effective energization over the track rails of the series relay of the next track section in advance.

10. A system of approach control for coded track circuits comprising, in combination with a plurality of track sections each having a source of current and a normally inactive coding device, a series relay for each track section effectively energized by an increase in the current normally supplied to the track rails of that section, approach control means for each track section governed by the corresponding series relay for initiating operation of the corresponding coding device, said approach control means when actuated causing effective energization over the track rails of the series relay for the next track section in advance, and decoding means associated with each track section for controlling the code produced by the coding device of the track section next in the rear, said decoding means of each track section when responding to a predetermined code rendering said approach control means of the next track section in the rear ineffective to control the series relay of the track section next in advance of said next track section in the rear.

11. An approach control system for coded track circuits comprising, in combination with a plurality of track sections each having a source of track circuit current and a normally inactive coding device, a series relay for each track section effectively energized by an increase in the current normally supplied to the track rails of that track section, a time element device operated after a time following the energization of each series relay for automatically initiating operation of the corresponding coding device, approach control means rendered effective by operation of said time element device for causing effective energization over the track rails of the series relay for the next track section in advance, and decoding means for each track section governing the code delivered to the next track section in the rear by its coding device, said decoding means of a given track section when responding to a predetermined code automatically rendering ineffective said approach control means governed by the time element device of the track section next in the rear.

12. In a system of approach control for coded track circuits, a series relay for each track section effectively energized by a predetermined increase in the current normally supplied to that track section when not occupied, means governed by each series relay for causing effective energization over the track rails of the series relay for the next track section in advance, a normally inactive coding device associated with each track section, and means including said series relays for automatically initiating operation of said coding device for the first two track sections in advance of a track section occupied by a train.

13. A track circuit for railroads comprising, a first source of current connected across the track rails at one end, a series relay connected in series with said first source and effectively energized by a predetermined increase in the current normally supplied from said source to the track rails, a second source of current, means for at times connecting said second source of current across the track rails at the other end of said track circuit to act cumulatively with said first source and thereby cause effective energization of said series relay, a track relay, and means blocking the flow of current through said track relay from said second source.

14. A track circuit for railroads comprising, a track battery, a relay in series with said battery, a separate source of direct current, means for at times connecting said separate source across the track rails at the other end of the track circuit, said separate source acting cumulatively with said track battery to increase the current through said relay, a resistance in series with said separate source, a track relay, and a rectifier blocking the flow of current through said track relay from said separate source.

15. In a system of the character described, means for communicating approach control in advance of a train comprising, in combination with a plurality of track sections each having a

track battery connected across the track rails at the exit end and a track relay connected across the track rails at the entering end, a series relay in series with each track battery and effectively energized only when the current normally supplied to the track section when not occupied is increased to a predetermined degree, means controlled by each series relay for connecting a supplemental battery across the track rails at the entering end of the next track section in advance to cause effective energization of the series relay of that advance track section, and decoding means governed by each track relay for rendering ineffective the control of the series relay of its track section by the series relay of the track section next in the rear.

16. A system of approach control for coded track circuits in which a relay in series with the source of current for each track section is effectively energized by the presence of a train in that track section, means controlled by each relay for effectively energizing the series relay of the track section next in advance, and means for rendering ineffective such effective energization of an advance series relay by the one in the rear when a proceed code is transmitted to the entering end of such advance section.

17. In combination, a stretch of railway track divided into sections, means for supplying train control current to a plurality of said sections in sequential order when a train enters the first section of said plurality, timing means for measuring off a predetermined interval of time following the entrance of said train into said first section, and means controlled by said timing means for determining the number of said sections to which said train control current is supplied.

18. In combination, a stretch of railway track divided into sections, means for supplying train control current to a plurality of said sections from a separate source of current at each section in sequential order when a train enters the first section of said plurality, timing means controlled from said separate sources of current for measuring off a predetermined interval of time following the entrance of said train into said first section, and means controlled by said timing means for determining the number of said sections to which said train control current is supplied.

19. In combination, a stretch of railway track divided into sections, a plurality of control relays sequentially operated in response to the occupancy of one of said sections, means controlled by each of said control relays for starting an associated coding device, means controlled by each coding device for supplying coded track current to the associated section, means for maintaining certain of said control relays operated for variable time intervals, and means controlled by the time interval of operation of one of said control relays for determining the number of said sections to which coded track current is applied.

20. In combination, a stretch of railway track divided into sections, a plurality of control relays sequentially operated by the sequential application of current to said sections in response to the occupancy of one of said sections, means controlled by each of said control relays for starting an associated coding device, means controlled by each coding device for applying coded track current to the associated section, means for maintaining certain of said control relays operated for variable time intervals, and means controlled by the time interval of operation of one of said control relays for determining the number of said sections to which coded track current is applied.

21. In combination, a stretch of railway track divided into sections, a control relay for each section energized from the source of track current supplied to each section when not occupied but not picked up by said source of track current until the associated section is occupied, and means including a booster source of current for picking up the control relay when the associated section is unoccupied.

22. In combination, a stretch of railway track divided into sections, a control relay for each section energized from the source of track current supplied to each section when not occupied but not picked up by said source of track current until the associated section is occupied, means including a booster source of current for picking up the control relay when the associated section is unoccupied, and means including contacts of each control relay for controlling the application of said booster current to the next section.

23. In combination, a stretch of railway track divided into sections, a transformer energized at various rates, means responsive to the occupancy of one of said sections for applying electrical energy to a plurality of said sections, means controlled by the number of said sections to which said electrical energy is applied for determining the rate of energization of said transformer, and means responsive to the rate of energization of said transformer for controlling the application of said electrical energy to said sections.

24. In combination, a track circuit, a first source of direct current, a transformer, means including said first source of current for intermittently energizing said transformer, a control circuit, means for closing said control circuit to effect the energization of said track circuit from a second source of direct current, means responsive to a particular rate of intermittent energization of said transformer for opening said control circuit, and means responsive to said closing of said control circuit for effecting the intermittent energization of said transformer at said particular rate.

NEIL D. PRESTON.