Aug. 8, 1944. M. A. SCHEG 2,355,334

CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed March 10, 1942

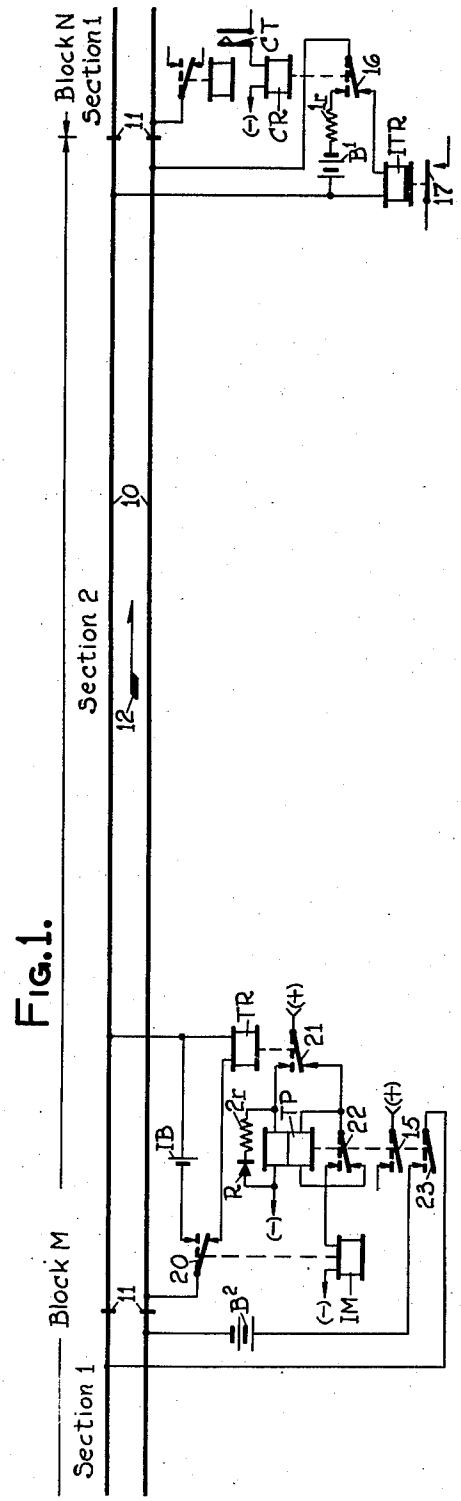


FIG. 1.

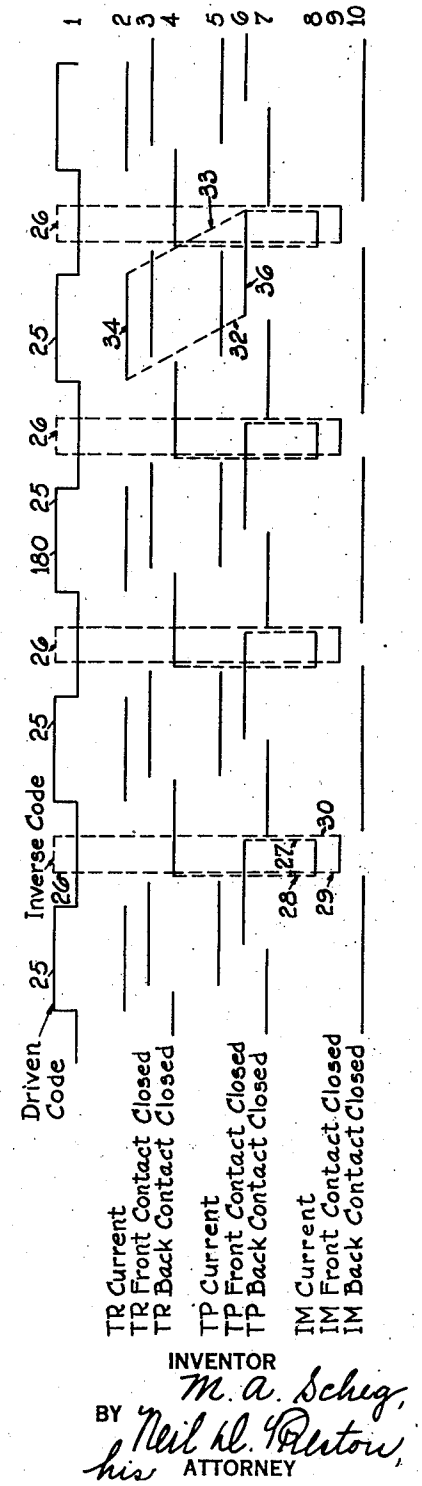


FIG. 2.

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Patented Aug. 8, 1944

2,355,334

UNITED STATES PATENT OFFICE

2,355,334

CODED TRACK CIRCUIT SIGNALING SYSTEM

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Application March 10, 1942, Serial No. 434,039

7 Claims. (Cl. 246—34)

The present invention relates to a railway signaling system and relays therefor and particularly to such a system employing track circuits of the coded type.

In signaling systems employing code type track circuits it is often found desirable to divide a single block into a plurality of sections either because the block is unusually long and must be shortened into sections, each of which is provided with its own track circuit, or because ballast conditions are so bad, as for instance in tunnels, that shorter blocks are required to be divided into sections to constitute exceptionally short track circuits. In the event a block is divided into sections it will be unnecessary to decode the code applied to one particular section and then re-apply a new code to the track section in the rear of the cut section in that the code elements may be directly repeated from the forward track section into the rearward track section, so that there is an impulse in each track section to the rear for each impulse in the track section in advance of the cut section.

If code following track relays pick up quicker than they drop away, or vice versa, the repeated code will step-by-step get longer or shorter depending on whether front contact or back contact repeating is employed as a result of which, for several repetitions, the code may be entirely lost. Also, by reason of approach control for lighting a signal or for controlling a highway crossing signal where the railroad is intersected by a highway, it is quite often necessary to employ, what is known as an inverse code, for transmitting a traffic condition through the track section in the same direction in which traffic is moving, it being understood that the driven code is ordinarily transmitted in a direction opposite to that in which traffic moves. The impulses of the inverse code must fall between the impulses of the driven code in view of which accurate timing of relays is required.

In view of the above and other considerations it is proposed in accordance with the present invention to employ, so far as possible, the same apparatus for transmitting the inverse code into the entrance end of a particular track section and for repeating the driven code received at that end of the track section into the exit end of the next track section in the rear. Another object of the present invention resides in the provision of a relay which does both, time the duration of the inverse code impulse and time the duration of the impulse repeated into the track circuit in the rear, in spite of the fact that these two impulses are of considerably different durations, this latter function being preferably accomplished by having this relay by its own pick-up and drop-away characteristics determine by its pick-up delay the duration of the impulse transmitted to the rear and by its drop-away delay alone determine the duration of the inverse code impulse.

Other objects, purposes, and characteristic features of the present invention will in part be described hereinafter and will in part be obvious from the accompanying drawing in which:

Fig. 1 shows a portion of a signaling system embodying the present invention; and

Fig. 2 shows a timing chart useful in studying the functioning of the relays of the embodiment of the invention illustrated in Fig. 1.

Structure.—The embodiment of the invention illustrated is shown applied to track rails 10 divided by insulating joints 11 into sections of which the sections 1 and 2 comprise a first and a second section of the same block M; whereas, the section 1 shown at the extreme right end of Fig. 1 constitutes a first section of a block N next in advance. As shown, the section 2 has a multiple impulse code applied to the exit end thereof, the direction of traffic being as illustrated by the arrow 12, by a code applying relay CR, which relay as illustrated is controlled by a code transmitter CT which in turn may be governed in accordance with traffic conditions in advance and may apply codes of 75, 120, or 180 impulses per minute as conditions require.

These codes may be decoded at the entrance end of the section 1 by suitable decoding apparatus (not shown) which is controlled through the medium of a front contact corresponding to the front contact 15 of a track repeater relay TP and located at the entrance end of section 2. The code applying relay CR (see exit end of section 2) is intermittently picked up in accordance with the intermittent closure of the coder contact of the code transmitter CT, and this relay CR through the medium of its front contact 16 connects the track battery B^1 across the track rails through the medium of a circuit including the usual series resistance $1r$. During periods of deenergization of the coder relay CR the contact 16 thereof connects the inverse code track relay ITR across the track rails, it being understood that the inverse code track relay ITR responds to the inverse code which receives its energy from the inverse code battery IB located at the entrance end of the section 2. This inverse code track relay ITR is provided with a back contact 17 which may, for convenience, be called an ap-

proach contact, and it may be used to approach light a signal located at the entrance to the block N, it being understood that sections 1 and 2 constitute a first and a second portion of the block M. This inverse code track relay ITR is slow dropping to an extent that it will remain in its energized position continuously when intermittently energized by inverse code impulses of durations as illustrated in Fig. 2 at either the 75, 120 or 180 impulse-per-minute code rate, and may also be used for other purposes such as highway crossing signal control.

At the entrance end of this section 2 is provided a track relay TR and inverse code track battery IB, which two instrumentalities are alternately connected to the track rails through the medium of contact 20 of the impulsing relay IM. The track repeater relay TP is preferably a two-winding relay in order that one winding may be provided with means for controlling the drop-away period of the relay and also serve as a control winding for the relay; whereas, the other winding may be provided with means for controlling the pick-up time of the relay. As shown, the upper winding of the track repeater relay TP constitutes the control winding and as shown it may be energized through the front contact 21 of the relay TR. In order to render this track repeater relay TP slightly slow dropping, its upper winding is shunted by a rectifier R connected in series with a resistance $2r$. The lower winding of this track repeater relay TP is provided with the proper number of turns and internal resistance to retard the picking up of the relay TP to the desired extent by shunting this lower winding through its own back contact 22.

The pulsing relay IM, which is a quick pick-up and quick drop-away relay, is energized through a circuit including the back contact 21 of the track relay TR and the front contact 22 of the track repeater relay TP, in series. This track repeater relay TP not only determines when the impulsing relay IM shall be deenergized, namely, by determining when its front contact 22 shall open but it also determines the duration of the impulse to be applied, through the medium of its contact 23, to the track circuit of the track section in the rear, namely, the section 1. This repeat impulse is derived from a suitable track circuit source B^2 corresponding to the track battery B^1.

The code impulses applied through the front contact 16 of the relay CR to the track section 2 may, for convenience, be called a driven code, because the duration of the pulses as well as the spacing therebetween is wholly determined by local impulse creating apparatus, this driven code being applied to the exit end of the section 2, so that under normal conditions of traffic the section under consideration is first occupied at the relay end thereof. The inverse code on the other hand, is applied to the entrance end of section 2 from the inverse code battery IB and through the medium of front contact 20 of the impulsing relay IM.

The impulses of the inverse code in order not to interfere with the pulses of the driven code must therefore be applied during the "off" periods of the driven code. If the impulses of the driven code were to be of substantially the same duration as are the "off" periods between these impulses, these impulses would continue only during one-sixth of a second for a 180 impulse per minute code, the time between impulses being of the same duration. It is thus seen that the inverse code impulses must be timed rather accurately in order that the inverse code impulse may fit between and not interfere with the driven code impulses, and must furthermore be quite short in order that the contact 20 of the impulsing relay IM, which applies these inverse code impulses, may have returned to its retracted position in time for the track relay TR to receive the next driven code impulse. For this reason, the impulse relay IM is made quick acting for both its pick-up and its drop-away characteristic, as is also the track relay TR.

The track relay TR is, however, slower in its response than is the impulse relay IM because it, the track relay, is connected across a track circuit having considerable ballast leakage which serves as a retarding element for this relay TR. The track repeater relay TP must be slow dropping for two reasons, (1) it must be slow dropping in order to stay up long enough to allow the current in the impulsing relay IM to build up to a value to cause its relay IM to pick up and (2) it must be slow dropping to an extent to determine the total time during which the front contact 20 of the impulse relay IM is closed in order to determine the length of the inverse code impulse. If now the track repeater relay TP is made slightly slow dropping by having its upper winding shunted for inductive-kick current direction by a rectifier R and a resistance unit $2r$, this relay TP would tend to keep its front contact 23 closed too long as compared with the duration of the impulse of the driven code received by the track relay TR were it not for the provision of means to render this track repeater relay TP also slow picking up to substantially the same extent.

Fig. 2 of the drawing has been devised to more clearly show the timing of the various relays when operating at a 180 impulse per minute code rate, it being understood that for codes of a lower rate, the inverse impulse can be more easily fitted into the time space between two successive impulses. Referring to the first line shown in Fig. 2 of the drawing, it will be seen that the driven code is applied at the right-hand end of the section 2 and is received at the left-hand end thereof. It should be understood that the square lobes 25 of this line show durations of current; whereas, the spaces between these lobes constitute time intervals between successive code elements or impulses. The small dotted lobes 26 one for each time space between the impulses of the driven code constitute impulses of the inverse code and it is proposed to point out how the timing of these inverse code impulses may be accomplished and how they are properly positioned between the impulses of the driven code.

The next nine lines of the timing chart illustrate the characteristics in groups of three of the relays TR, TP and IM respectively. That is, the first group, namely the second, third and fourth lines of Fig. 2 show respectively the duration of the current, the closed period of the front contact and the closed period of the back contact for the track relay TR; the second group, namely, the fifth, sixth and seventh lines show respectively the duration of the current applied to the track repeater relay TP, the time of closure of its front contact and the time of closure of its back contact; and the eighth, ninth and tenth lines of the time chart illustrate the time period of energization of the impulsing re-

lay IM, the time during which its front contact is closed and the time during which its back contact is closed.

Referring to line 2, it will be seen that the track relay TR is energized for each impulse of the driven code illustrated in line 1 of the time chart. This evidences that back contact 20 of impulsing relay IM closes early enough. Referring to line 3, it will be seen that a certain amount of delay in the closing of the front contact after current is applied to the track relay TR will occur and similarly that this front contact does not open until a certain period of delay after the impulse has been terminated. This delay in the picking up and dropping of the track relay TR is due to the fact that this track relay TR is at least at times shunted by the ballast leakage between the track rails and is also in part due to the fact that this track relay receives barely enough energy to pick it up on account of the inherent limitations in a track circuit well known to those skilled in the art. Referring now to line 4, it will be seen that the back contact closes a short time after the front contact has opened and vice versa. This delay is due to the time required for the moving parts of the track relay TR to operate from one position to another and vice versa.

Referring now to that portion of the time chart relating to track repeater relay TP, namely, the portion lines 5 to 7 inclusive, it should be observed that the dashes shown in line 5 are, as they should be, of the same duration and concurrent with the duration of closure of the front contact of the track relay TR as illustrated by the dashes in line 3 of this time chart. Referring now to line 6 of the time chart, it will be seen that a considerable amount of delay is experienced between the point in time that the current is cut off of the track repeater relay TP, as shown in line 5, and the time at which the front contacts thereof actually open. This delay in the start of the dropping of the track repeater relay TP is due to the slow-acting function injected by the rectifier R and the series resistance $2r$ included in series therewith. This retarding feature functions by allowing a slow dissipation of the energy stored in the magnetic field of the relay after deenergization of the upper winding of the relay TP, it being observed that when direct current is applied to the relay TP from the terminal (+) of a suitable source of current and through a front contact 21 of the relay TR that this current cannot flow through the by-pass including rectifier R and resistance $2r$ but that upon opening of this contact 21, resulting in an inductive kick voltage being developed in this upper winding in the same direction as the original current flow, will impress a voltage from left to right across the rectifier R and the resistance $2r$. This impressed voltage, since it is in a direction in which rectifier R does not block current flow, will cause current to circulate in the upper winding of the relay TP to allow a gradual dissipation of the flux stored energy in the core of this relay, as a result of which there is a delay in the opening of the front contact 22 of the track repeater relay TP. Referring to Fig. 1 it will be seen that the energizing circuit for relay IM must be opened at front contact 22 of relay TP because the circuit for relay TR is open. Referring now to the line 6 of the time chart, it will be seen that this delay in the dropping of the track repeater relay TP and the opening of its front contact 22 is what determines the duration of energization of impulsing relay IM as illustrated in line 8 of the time chart. That is, it is the opening of the front contact 22 of the track repeater relay TP that determines when the impulsing relay IM shall be deenergized. This is illustrated by the dotted line 27 connecting the ends of the dashes of lines 6 and 8. The time at which energy is applied to the impulsing relay IM, on the other hand, is determined by the time of closure of back contact 21 of relay TR (see line 4 of the time chart) and this point in time is illustrated by the dotted line 28 connecting the dashes in lines 4 and 8 of the chart. It is thus seen that the impulsing relay IM is energized for the period beginning at dotted line 28 and ending at dotted line 27.

Although the impulse relay IM is a very fast relay, it will be seen by referring to line 9 in the time chart that the closure of front contact 20 of relay IM, as indicated by dotted line 29, slightly lags the beginning of energization of the winding of the impulsing relay IM as shown by the dashes in line 8 of the chart, as illustrated by spacing between dotted lines 28 and 29; whereas, the actual opening of front contact 20 of impulsing relay IM, as indicated by dotted line 30, lags slightly behind the deenergization of relay IM and the opening of front contact 22 of track repeater relay TP as indicated by the spacing between the dotted lines 27 and 30. That is, dotted lines 29 and 30 have been projected upwardly from the line 9 to the line 1 of the timing chart to determine the location of the inverse code impulse with respect to the driven impulse, which inverse impulse is created by the closure of front contact 20 of the relay IM, it being understood that the inverse track battery IB is connected to the track rails so long as the front contact 20 of the relay IM is closed.

Thus far, we have discussed why the track repeater relay TP has been made slow dropping, namely, in order to prolong the duration of the inverse impulse to the desired extent. It is now desired to point out what provision has been made to prevent this slow-drop away feature of the track repeater relay TP prolonging the impulse applied to the next track section in the rear. It is readily understood that the time for each impulse during which front contact 23 of the track repeater relay TP is closed should be the same as the duration of the corresponding impulse applied to the track circuit of section 2 in advance. In order to avoid the contact 23 being closed too long, the relay TP having been made slow dropping, to result in the impression of a longer impulse upon the section 1 than was present on section 2, it is necessary to delay the closure of this front contact 23, the time of its opening having already been fixed by the time of opening of front contact 21 and the drop away delay of relay TP. This delay in the closure of front contact 22 (see line 6 of the timing chart) which signifies front contact closures lagging behind periods of energization of the relay TP as shown in line 5 of this timing chart, is resorted to in order to make the total time of closure of front contact 23 of relay TP no longer than the period of energization of the relay TR. This is illustrated by the dotted lines 32 and 33 which in combination with horizontal lines 34 and 36, which represent the period of energization of relay TR and the period of contact closure of front contacts of relay TP, respectively, constitute a parallelogram. In other words, the dotted parallel lines 32 and 33 which

join the ends of the parallel lines 34 and 36 clearly show that the lines 34 and 36 are of the same length, namely, that the period of energization of relay TR is of the same duration as the period of closure of front contact 23 of the track repeater relay TP. In other words, the driven code received at the entrance end of section 2 is repeated into the exit end of section 1 by impulses of the same duration, although these repeated impulses are somewhat delayed as a whole by the time lost to operate the impulsing relay apparatus. It will be seen that this constitutes front contact code repeating and that occupancy of section 2 is reflected by a deenergization of the track relay (not shown) for section 1. It should be understood that the time chart of Fig. 2 is merely illustrative of how the duration of the inverse code impulses may be determined and that in practicing the invention the inverse code impulses are preferably of slightly larger duration than illustrated.

Operation.—Let us now assume that the coding relay CR is intermittently energized in response to intermittent closure of the coding contact CT at the 180 impulse per minute rate, resulting in a driven code as illustrated by the lobes 25 (line 1 of Fig. 2). This will result in intermittent energization of the track relay TR as shown by the dashes in line 2 of the timing chart, in the closure of front contact 21 of the track relay TR (see line 3) and in the opening of this contact 21 (see line 4) a short period of delay after the energization and deenergization respectively of the winding of the track relay TR. The picking up of the contact 21 of relay TR results in energization of the track repeater relay TP as illustrated by the pulses of energization indicated in line 5 of the time chart. This front contact 21 of track relay TR is closed for a sufficient period of time to bring the core structure of the track repeater relay TP up to the desired magnetic saturation. Upon termination of the driven code impulse the track relay TR drops its front contact 21 and since the front contact 22 of the track repeater relay is now closed, an energizing circuit for the impulsing relay IM, including the back contact 21 of track relay TR and the front contact 22 of the track repeater relay TP, is closed.

Since the track relay TR cannot pick up so long as impulsing relay IM assumes its energized position, the back contact 20 of the relay IM included in the energizing circuit of relay TR being open, the termination of the energization of the impulsing relay IM must be determined by the opening of front contact 22 of the track repeater relay TP, and this timing is determined by the slow-dropping means associated with the upper winding of this relay TP. The track circuit next in the rear, namely, the track circuit for the section 1, of course becomes energized when the track repeater relay TP picks up and since this track repeater relay TP is slow dropping, its pick-up delay must be fixed to substantially match its drop-away delay. This delay in the picking up of the relay TP is accomplished by short circuiting its lower winding through its own back contact 22 and the resistance and inductive coupling characteristics of this lower winding are such as to give the track repeater relay TP the proper retardation insofar as picking up of its armature, after energization of the upper winding, is concerned.

It is thus seen that the impulses applied to the exit end of the section 2 are accurately reproduced at the exit end of section 1 of the block M insofar as the number and duration of the impulses is concerned, the impulses applied to the section 1, however, being delayed somewhat as a whole as is illustrated by the offset in the lines 34 and 36 of the parallelogram 32—36. It is, of course, understood that each of the inverse impulses conventionally illustrated by the lobes 26 in line 1 of the time chart of Fig. 2 are present at the right-hand end of the section 2 when the contact 16 of the coding relay CR is in its retracted positions so that these inverse code impulses are intermittently applied to the inverse track relay ITR. This will cause the inverse track relay ITR to pick up in response to the first impulse of the code and be maintained up during the remaining impulses of a continuous code, this by reason of the fact that the inverse track relay ITR is sufficiently slow dropping to hold up between successive impulses of inverse code irrespective of whether the code is of the 180, 120 or 75 impulse per minute rate.

It is readily understood that occupancy of the track section 2 by a train will cause the track relay TR to be continuously deenergized so that no inverse code impulses are any longer applied to this track section from which it is apparent that the inverse track relay ITR at the exit end of this section 2 will also assume and remain in its deenergized position so long as this track section is occupied. Furthermore, if inverse code impulses were actually applied to the entrance end of this track section 2, these impulses could not reach the inverse track relay ITR because they would be shunted away through the wheels and axles of the train. If the apparatus at the entrance end of section 2 were to be used for controlling one or more signals these signals would be controlled through suitable decoding apparatus controlled by front contact 15 of the track repeater relay TP. That is, the relays TR, TP and IM are not only used to create an inverse code in the track circuit to which they are connected and used to relay a driven code from one track circuit in the next track circuit in the rear but may also be used to control suitable decoding apparatus for controlling signals adjacent thereto or for controlling other devices. It should also be understood that in practice the entrance end of the section 1 of block M is provided with similar relays TR, TP and IM for controlling decoding apparatus and for creating inverse codes when required. Similarly, the inverse track relay ITR may not only be used for approach lighting a signal governing the movement of traffic into block N constituting a stretch of track in advance of the section 2 but may also be used for governing highway crossing signals, releasing lever locks controlling an opposing signal in an absolute-permissive-block signaling system and the like.

It may be pointed out that the reason for not repeating the code from one track circuit into the next track circuit in the rear through the medium of a contact on the track relay itself is due to the fact that these track relays are only capable of handling one front and one back contact. Also, it may be pointed out that although the track relay TR has been shown conventionally as constituting a neutral relay this relay is preferably polarity responsive so as not to respond to either the inductive kick of an inverse code impulse or the condenser effect of the track circuit after an inverse code impulse.

Having thus shown and described one rather specific embodiment of the present invention, it is desired to be understood that the particular

embodiment illustrated has been selected to facilitate description of the principles and operating features of the invention rather than the scope of the invention or the particular means to be employed in practicing the invention and that various changes, modifications and additions may be made to adapt the invention to the particular problem encountered in practicing the same without departing from the spirit or scope of the invention, except as demanded by the scope of the following claims.

What I claim as new is:

1. In a signaling system of the coded track circuit type, the combination with a railway track block divided into two sections by insulating joints, code creating means at the exit end of the second section for applying code impulses to said second section for actuating a code following track relay at the entrance end of said second section, a track repeater relay at the entrance end of said second section and having a front contact for repeating said code into the exit end of the first section, an energizing circuit for said track repeater relay including a front contact of said track relay, an impulsing relay, an energizing circuit for said impulsing relay including a front contact of said track repeater relay and a back contact of said track relay, means for retarding the dropping of said track repeater relay to determine the period of energization of said impulsing relay, and means for retarding the picking up of said track repeater relay so that in spite of the retardation of its dropping its front contacts will not be closed any longer than the duration of the code impulses applied to said track relay, whereby the same track repeater relay may be used to time the duration of the impulses of the inverse code and the duration of the impulses of the code repeated into the track section in the rear.

2. In a signaling system of the coded track circuit type, the combination with a railway track block divided into two sections by insulating joints, code creating means at the exit end of the second section for applying code impulses to said second section for actuating a code following track relay at the entrance end of said second section, a repeater relay at the entrance end of said second section and having a front contact for repeating said code into the exit end of the first section, an energizing circuit for said repeater relay including a front contact of said track relay, an impulsing relay, an energizing circuit for said impulsing relay including a front contact of said repeater relay and a back contact of said track relay, means including a rectifier for retarding the dropping of said repeater relay to determine the time of dropping of said impulsing relay, and means including a contact controlled shading coil for retarding the picking up of said repeater relay so that in spite of the retardation of its dropping its front contacts will not be closed any longer than for the duration of the code impulses applied to said track relay, whereby the same repeater relay may be used to time the duration of the impulses of the inverse code and the duration of the impulses of the code repeated into the track section in the rear.

3. In a railway signaling system, the combination with a block of railway track divided into a first and a second section, code creating means at the exit end of the second section for transmitting a driven multiple impulse rate code to the entrance end thereof comprising impulses of electrical energy separated by "off" periods, an impulsing relay, a track relay at the entrance end of said second section connected to the track rails through a back contact of said impulsing relay, a track repeater relay controlled through a front contact of said track relay, an energizing circuit for said impulsing relay including a back contact of said track relay and a front contact of said track repeater relay, a front contact on said track repeater relay for repeating the driven code received at the entrance end of said second section into the exit end of said first section, and an inverse current source connected to the track rails through a front contact of said impulsing relay to create an inverse code in said second section, said track repeater relay having a retarded pick-up and retarded drop-away such that the driven code impulses in said first section are of the same duration as the driven code impulses in said second section and such that the inverse code impulses fall into the "off" periods of the driven code in said second section.

4. In a railway signaling system, the combination with a block of railway track divided into a first and a second section, code creating means at the exit end of the second section for transmitting a driven multiple impulse rate code to the entrance end thereof comprising impulses of electrical energy separated by "off" periods, an impulsing relay, a track relay at the entrance end of said second section connected to the track rails through a back contact of said impulsing relay, a track repeater relay controlled through a front contact of said track relay, an energizing circuit for said impulsing relay including a back contact of said track relay and a front contact of said track repeater relay, a front contact on said track repeater relay for repeating the driven code received at the entrance end of said second section into the exit end of said first section, and an inverse current source connected to the track rails through a front contact of said impulsing relay to create an inverse code in said second section, said track repeater relay including means for producing a retarded pick-up, and means for producing a retarded drop away each independent of the other such that the driven code impulses in said first section are of the same duration as the driven code impulses in said second section and such that the inverse code impulses fall into the "off" periods of the driven code in said second section.

5. In combination with a track block divided into a first and a second section by insulating joints for governing traffic moving in a direction to first occupy said first section; of a track circuit for each section including a track battery and a code following main track relay; an inverse code following relay; a coding contact at the exit end of said second section for alternately connecting the track battery and said inverse code following relay in the track circuit for said second section to create a driven code in the track circuit of said second section; a track repeater relay, an impulsing relay and an inverse code battery at the entrance end of said second section; an energizing circuit for said impulsing relay including a local source of current, a front contact of said track repeater relay and a back contact of the associated code following track relay; a double throw contact on said impulsing relay for alternately connecting said inverse code battery and the associated code following track relay in the track circuit for said second section at the entrance end thereof for creating an inverse code in the track circuit of said second sec-

tion; and two separate means for respectively rendering said track repeater relay slow dropping and slow picking up to extents to cause the duration of the impulses repeated from the track circuit of said second section into the track circuit of said first section to be substantially of the same duration and so that the impulses of said inverse code fall between the impulses of said driven code.

6. In combination with a track block divided into a first and a second section by insulating joints for governing traffic moving in a direction to first occupy said first section; of a track circuit for each section including a track battery and a code following main track relay; an inverse code following relay; a coding contact at the exit end of said second section for alternately connecting the track battery and said inverse code following relay in the track circuit for said second section to create a driven code in the track circuit of said second section; a track repeater relay, an impulsing relay and an inverse code battery at the entrance end of said second section; said track repeater relay being controlled from a local battery through a front contact of the associated code following track relay; and energizing circuit for said impulsing relay including a local source of current, a front contact of said track repeater relay and a back contact of the associated code following track relay; a double throw contact on said impulsing relay for alternately connecting said inverse code battery and the associated code following track relay in the track circuit for said second section at the entrance end thereof for creating an inverse code in the track circuit of said second section; and two separate means for respectively rendering said track repeater relay slow dropping and slow picking up to extents to cause the duration of the impulses repeated from the track circuit of said second section into the track circuit of said first section to be substantially of the same duration and so that the impulses of said inverse code fall between the impulses of said driven code, each of said two separate means including a separate winding which under particular conditions acts as a retarding winding.

7. In a track circuit; the combination with a section of track, a code following track relay at the entrance end of said section, code creating means at the exit end of said section for creating and applying a code consisting of a series of impulses of current to the rails of said section for actuating said track relay, said impulses of current being separated by "off" periods, a track repeater relay at the entrance end of said section, an energizing circuit for said track repeater relay including a front contact of said track relay, an impulsing relay, an energizing circuit for said impulsing relay including a front contact of said track repeater relay and a back contact of said track relay, means for rendering said repeater relay slow dropping to an extent to allow picking up of said impulsing relay through said front contact of said repeater relay in spite of the deenergized condition of said repeater relay, an inverse code source at the entrance end of said section, contacts on said impulsing relay for alternately connecting said inverse code source and said track relay to the track rails when said impulsing relay assumes its energized and deenergized condition respectively, whereby said inverse code source is connected to the track rails of said section during the "off" periods of said code, and means for retarding the picking up of said track repeater relay to substantially the same extent as its drop away is delayed; whereby said track repeater relay accurately repeats said track relay, in spite of its slow dropping characteristics necessary to enable intermittent energization and control of said impulsing relay, to enable contacts of said track repeater relay to control decoding apparatus.

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