

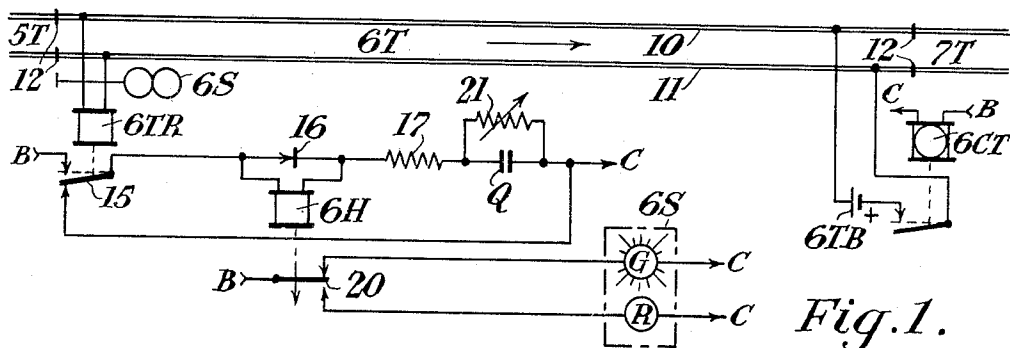
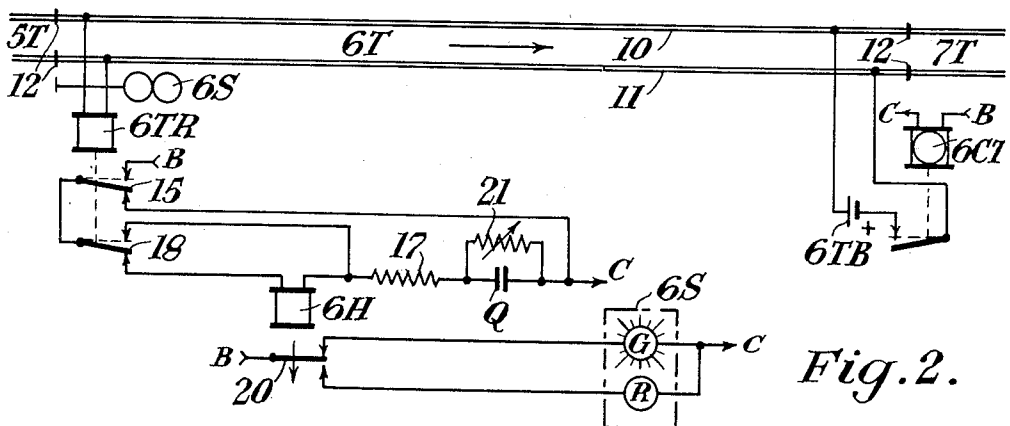
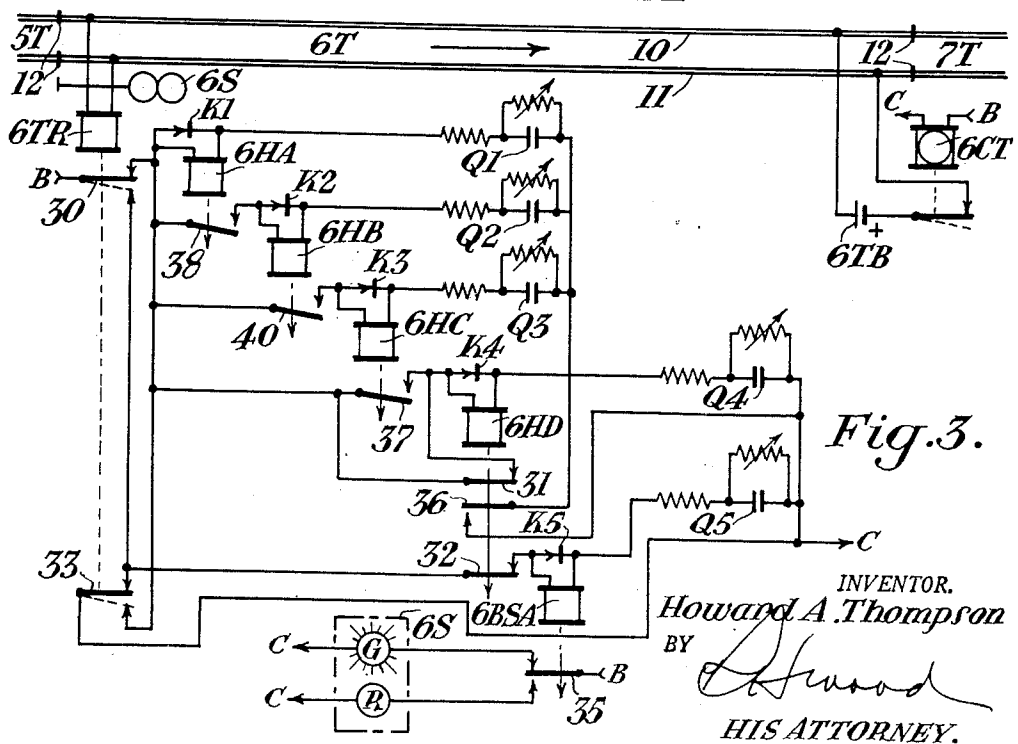
Feb. 28, 1950

H. A. THOMPSON
CODED SIGNALING APPARATUS

2,499,202

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2 Sheets-Sheet 1



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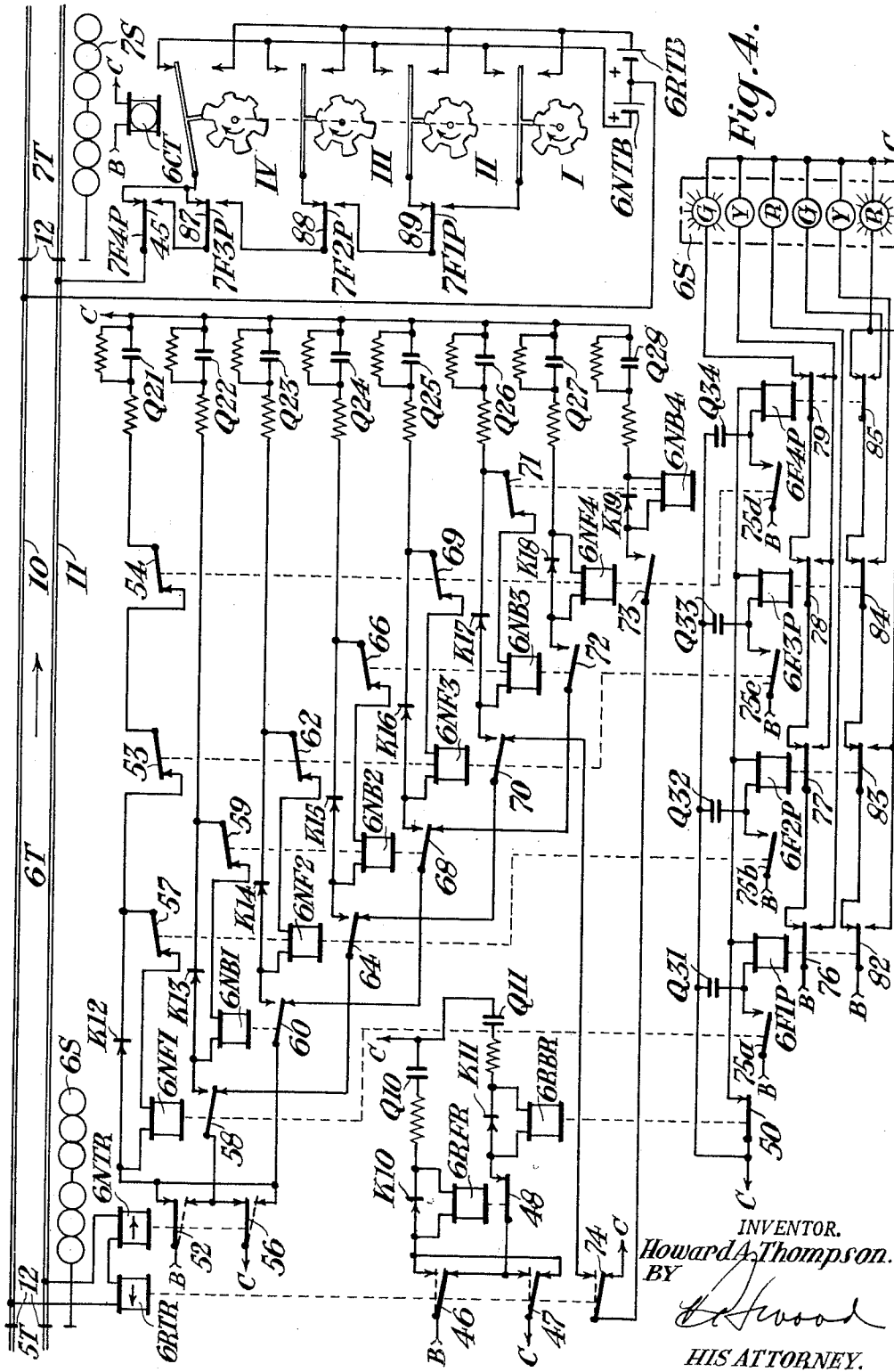
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UNITED STATES PATENT OFFICE

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CODED SIGNALING APPARATUS

Howard A. Thompson, Edgewood, Pa., assignor to
The Union Switch & Signal Company, Swiss-
vale, Pa., a corporation of Pennsylvania

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My invention relates to coded signaling apparatus.

An object of my invention is to provide improved means for detecting code following operation of a code following relay.

Another object of my invention is to provide improved code detecting means which will not be improperly energized in the event the contacts of the code following relay overlap.

An additional object of my invention is to provide improved code detecting means which will not respond until the code following relay has completed a predetermined number of cycles of operation, but which will respond quickly to a cessation of operation of the code following relay.

A still further object of my invention is to provide a novel arrangement of counting chain relays for decoding coded impulses of energy.

Another object of my invention is to provide a coded track circuit signaling system of the count code type utilizing a novel arrangement of counting chain relays and code detecting relays wherein a detector code and a control code may be transmitted concurrently over the section rails, and arranged so that the display of a restrictive indication is not delayed by the length of a control code cycle, but is governed by the faster detector code.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawings.

I shall describe a few forms of coded signal apparatus embodying my invention and shall then point out the novel features thereof in claims.

In the drawings,

Fig. 1 is a diagrammatic view of code detecting apparatus embodying my invention,

Fig. 2 shows a modification of the arrangement shown in Fig. 1,

Fig. 3 is a diagrammatic view of code detecting apparatus embodying my invention for delaying the response of the code detecting means until the code following relay has operated through several cycles, and

Fig. 4 is a diagrammatic view of a coded signaling system embodying my invention.

In the drawings, similar reference characters refer to similar parts in each of the several views.

In practicing my invention, I provide a condenser to which energy is supplied when the contacts of the code following relay are in one position and from which energy is supplied to a

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slow release code detecting relay when the contacts of the code following relay are in their other position, the relay and condenser being connected in series, and having an asymmetric unit, such as a rectifier or other device, for bypassing the winding of the relay while the condenser is being charged. The asymmetric unit is poled so that while the condenser is discharging energy will flow through the winding of the slow release code detector relay, causing it to pick up. This detector relay is slow in releasing so that its contacts will remain picked up during the intervals in which energy is not supplied to its winding.

Further, I extend the principle explained above to provide a chain of relays which are energized in sequence as a result of charging condensers associated therewith and discharging the condensers through their associated relays, in accordance with the operation of the contacts of a code following relay. A counting chain thus constructed is used to delay the pick-up of a first auxiliary relay, which after picking up, establishes a stick circuit for itself and interrupts the circuit for the counting chain relays, and thereafter in conjunction with a second auxiliary relay functions in the manner of the well-known FSA-BSA method of code detection.

Further extended, the counting chain described above may be used for the detection and decoding of control code energy consisting of recurring cycles of coded energy having a predetermined number of control code pulses in each control code cycle. The system embodying this counting chain is arranged so that a detector code and a control code are transmitted concurrently and operate separate code following relays each of which governs decoding means. The detector code has a much shorter code cycle than the control code so the detector code decoding means has a much shorter release delay period than the control code decoding means. The two sets of decoding means cooperate to control a signal in such manner that the most restrictive indication is displayed when the detector code decoding means is released to thereby insure prompt display of this indication when the supply of coded energy is interrupted.

In Fig. 1 of the drawings, there is shown a stretch of railroad track having track rails 10 and 11 which are divided by insulated joints 12 into the customary track sections. One complete section 6T, and portions of the adjoining sections 5T and 7T are shown. Traffic normally moves from left to right in the track stretch and

a signal 6S is located at the entrance end of section 6T and governs entrance of traffic into the section. A contact of a continuously operating code transmitter 6CT recurrently connects the track battery 6TB across the track rails at the exit end of section T. The contact of code transmitter 6CT may operate at any appropriate code speed, such as 75 times a minute, while the energy supplied to the section rails operates a code following track relay 6TR, the winding of which is connected across the section rails adjacent the entrance end of the section.

When the contact of code transmitter 6CT is closed and the section is vacant, energy from the battery 6TB picks up the contact of track relay 6TR with the result that energy is supplied from terminal B of a source of direct current, not shown, over front contact 15 of relay 6TR, through asymmetric unit 16, and resistance 17 to one element of a condenser Q, the other element of which is connected to terminal C of the same source of direct current. Accordingly, during the picked-up periods of track relay 6TR energy is supplied to the condenser Q and charges the condenser. The resistor 17 limits the energy supplied to the condenser Q and thus limits the current supplied through contact 15 on initial closing of this contact.

When the contact of code transmitter 6CT interrupts the circuit of battery 6TB, the relay 6TR releases and its contact 15 interrupts the supply of energy to the condenser Q and establishes the circuit for supplying energy from condenser Q to code detecting relay 6H. This circuit is traced from the left-hand element of condenser Q through resistor 17, winding of relay 6H, and back contact 15 of relay 6TR to the right-hand element of the condenser Q. The energy supplied from condenser Q to the winding of relay 6H picks up the relay contact 20 to interrupt the circuit of the red lamp R and establish the circuit of the green lamp G of signal 6S.

During the next picked-up period of track relay 6TR the circuit for supplying energy from condenser Q to relay 6H is interrupted while energy is again supplied to the condenser through asymmetric unit 16 over the circuit traced above. At this time the asymmetric unit 16 serves as a snubbing unit to retard release of relay 6H so that the relay contact 20 remains picked up in the periods during which the supply of energy to the relay is interrupted. In addition, the asymmetric unit 16 has very low resistance to flow of current from left to right with the result that very little energy flows through the winding of relay 6H in this direction. It is desirable that flow of energy through the winding of relay 6H from left to right be kept to a minimum since energy flowing through the relay winding in this direction destroys the flux in the relay core and tends to cause release of the relay.

As long as relay 6TR responds to coded energy the condenser Q is charged during the picked-up periods of the track relay and energy stored in the condenser is supplied to relay 6H during the released periods of the track relay, while the relay 6H is slow enough in releasing to remain picked up during the picked-up periods of the track relay so contact 20 maintains the circuit of the green lamp G of signal 6S.

When a train enters section 6T, the track relay 6TR is shunted and ceases to respond to coded energy and its contact 15 no longer establishes the circuit for supplying energy to the condenser

Q. Accordingly, the energy stored in the condenser discharges through the relay 6H after which the relay 6H releases and contact 20 interrupts the circuit of the green lamp G and establishes the circuit of the red lamp R of signal 6S so the signal indicates that the section is occupied.

An adjustable resistor 21 is connected across the terminals of the condenser Q and serves to limit the charge on the condenser. The resistor 21 also provides a path through which energy stored in the condenser may discharge when the supply of energy to the condenser is cut off. Accordingly, the resistor 21 limits the period during which the energy supplied from the condenser to the relay 6H keeps the contact 20 picked up after shunting of the track relay 6TR.

When the section is vacated, the track relay 6TR is again operated by coded energy so the condenser Q is charged during the picked-up periods of the relay and energy from the condenser is supplied to relay 6H during the released periods of the track relay so contact 20 again establishes the circuit of the green lamp G.

The equipment is arranged so that the relay 6H will not be picked up if movable contact 15 of track relay 6TR engages both its front and back points of contact at a time when the track relay is shunted. Under these conditions terminal B of the source is connected over contact 15 of relay 6TR and through rectifier or asymmetric unit 16 and resistance 17 to one element of the condenser Q, while terminal C of the source is also connected through front and back contacts of track relay contact 15 to the other element of the condenser Q. Accordingly, the condenser will not be charged and energy cannot be supplied from the condenser to the relay 6H and the relay 6H is certain to remain released.

If the condenser Q breaks down so that a circuit is established between the elements of the condenser, energy will not be stored in the condenser and therefore cannot be supplied from the condenser to the relay 6H so the relay is certain to remain released. If the condenser Q breaks down, the relay 6H will not be energized during the picked-up periods of the track relay as the asymmetric unit 16 provides a low resistance shunt across the terminals of the winding of relay 6H.

If the asymmetric unit or rectifier 16 breaks down, it will form a low resistance shunt across the terminals of the winding of relay 6H during the time energy is being supplied from the condenser Q, and insufficient energy will be supplied to the relay 6H to pick up its contact so the contact 20 remains released.

If the circuit of the asymmetric unit or rectifier 16 is open energy will be supplied from left to right through the winding of relay 6H during the picked-up periods of relay 6TR, and will be supplied from right to left through the winding of relay 6H during the released periods of relay 6TR. The relay 6H is a direct current relay and its contacts will not be picked up as a result of the supply to the relay winding of impulses of energy of alternately opposite polarity. Accordingly, if the asymmetric unit or rectifier 16 is open-circuited, the relay 6H will remain released and cause signal 6S to display its stop indication.

From the foregoing it will be seen that the relay 6H is energized when the track relay 6TR is operated by coded energy, but will not be energized if the front and back contacts of the track relay overlap so as to engage the movable contact simultaneously, while the relay 6H will not be energized if the condenser Q or the asymmetric unit

14 is defective. Accordingly, any failure of the equipment will result in release of relay 6H to cause the red or danger lamp to be lighted and cannot result in improper energization of relay 6H with consequent lighting of the green or clear lamp of the signal 6S.

In Fig. 2 of the drawings, there is shown therein a modification of the apparatus shown in Fig. 1. The arrangement of equipment in Fig. 2 is similar to that shown in Fig. 1, except that a contact of relay 6TR instead of an asymmetric unit is employed to prevent flow of energy through the winding of relay 6H during charging of the condenser Q and to cause energy to flow through the relay winding during discharge of the condenser. The equipment is shown in the condition which it assumes when the track stretch is vacant. At this time relay 6TR operates in response to the impulses of coded energy supplied thereto over the section rails 10 and 11.

When the contacts of relay 6TR pick up, energy is supplied to one element of the condenser Q by a circuit which is traced from terminal B over front contact 15 of relay 6TR, front contact 18 of relay 6TR, and through the resistor 17 to the left-hand element of condenser Q, the right-hand element of which is connected to terminal C. Accordingly, during the picked-up periods of track relay 6TR energy is supplied to the condenser Q and charges the condenser.

When the contact of code transmitter 6CT interrupts the circuit of battery 6TB, the relay 6TR releases and its contacts 15 and 18 interrupt the supply of energy to the condenser Q and establish the circuit for supplying energy from condenser Q to code detecting relay 6H. This circuit is traced from the left-hand element of condenser Q through resistor 17, winding of relay 6H, back contact 18 of relay 6TR, and back contact 15 of relay 6TR to the right-hand element of condenser Q. The energy supplied from condenser Q to the winding of relay 6H picks up the relay contact 20 to interrupt the circuit of the red lamp R and establish the circuit of the green lamp G of signal 6S.

During the next picked-up period of track relay 6TR the circuit for supplying energy from condenser Q to relay 6H is interrupted while energy is again supplied to the condenser through the circuit traced above including the front contact 18 of relay 6TR.

As long as relay 6TR responds to coded energy the condenser Q is charged during the picked-up periods of the track relay and energy stored in the condenser is discharged through the winding of relay 6H during the released periods of the track relay, while the relay 6H is of a type which is slow enough in releasing to remain picked up during the picked-up periods of the track relay so contact 20 maintains the circuit of the green lamp G of the signal 6S.

When a train enters section 6T, the track relay 6TR is shunted and ceases to respond to coded energy and its contacts 15 and 18 no longer establish the circuit for supplying energy to the condenser Q. Accordingly, the energy stored in the condenser discharges through the relay 6H after which the relay 6H releases and contact 20 interrupts the circuit of the green lamp G and establishes the circuit of the red lamp R of signal 6S.

When the section is vacated, the track relay 6TR is again operated by coded energy so the condenser Q is charged during the picked-up periods of the relay and energy from the con-

denser is supplied to relay 6H during the released periods of the track relay so contact 20 again establishes the circuit of the green lamp G of signal 6S.

The equipment is arranged so that the relay 6H will not be picked up if movable contact 15 engages both its front and back points of contact at a time when the track relay is shunted. Under these conditions terminal B of the source is connected over contact 15 of relay 6TR and through front contact 18 of relay 6TR to the left-hand element of condenser Q while terminal B of the source is also connected through front and back contacts of track relay contact 15 to the right-hand element of condenser Q. Accordingly, the condenser Q will not be charged and energy cannot be supplied from the condenser to the relay 6H and the relay 6H is certain to release and remain released.

If the condenser Q breaks down so that a circuit is established between the elements of the condenser, energy will not be stored in the condenser and therefore cannot be supplied from the condenser to the relay 6H so the relay is certain to remain released. If the condenser Q breaks down, the relay 6H will not be energized during the picked-up periods of the track relay as the contact 18 of relay 6TR will interrupt the circuit.

If the movable contact 18 of relay 6TR should engage both its front and back points of contact at a time when the track relay is shunted, it will be seen that the winding of relay 6H is thereby shunted, and insufficient energy will be supplied to relay 6H to pick up its contacts so contact 20 remains released.

From the foregoing it will be seen that with the equipment embodying my invention arranged as shown in Fig. 2, the relay 6H is energized when the track relay 6TR is operated by coded energy, but will not be energized if the front and back contacts of either of the movable contacts of the track relay overlap so as to engage the movable contact simultaneously, while the relay 6H will not be energized if the condenser Q is defective. Accordingly, any failure of the equipment will result in the release of relay 6H to cause the red or danger lamp of signal 6S to be lighted and cannot result in improper energization of relay 6H with consequent lighting of the green or clear lamp of the signal 6S.

In some situations it is desirable on initiation of coding operation of a relay to delay establishment of a control circuit until there have been a predetermined number of operations of the code following relay, but to interrupt the control circuit promptly on cessation of coding operation of the code following relay, and Fig. 3 is a diagram showing equipment arranged to provide this method of operation.

The equipment of Fig. 3 is similar to that of Fig. 1 and is shown in the condition which it assumes when the track stretch is vacant. During the picked-up periods of track relay 6TR energy is supplied over its front contact 30, front contact 31 of a first auxiliary relay 6HD, and through rectifier or asymmetric unit K4 to charge condenser Q4, while at this time energy stored in the condenser Q5 is supplied to the winding of a second auxiliary relay 6BSA over the circuit which includes front contact 32 of relay 6HD and front contact 33 of relay 6TR.

During the released periods of relay 6TR the circuits for supplying energy to condenser Q4, and for supplying energy from condenser Q5 to relay 6BSA are interrupted, while energy is

supplied from condenser Q4 over the circuit which is traced from the left-hand element of the condenser through the winding of relay 6HD, over front contact 31 of relay 6HD and over back contact 33 of relay 6TR to the other element of the condenser.

In addition, during the released period of track relay 6TR energy is supplied to condenser Q5 over the circuit which includes back contact 30 of relay 6TR, front contact 32 of relay 6HD, and asymmetric unit K5, and a charge is developed in the condenser Q5 so that energy may be supplied therefrom to relay 6BSA during the subsequent picked-up period of relay 6TR.

The energy supplied to relay 6HD during the released periods of track relay 6TR keeps the relay contacts picked up and the relay is slow enough in releasing to remain picked up during the picked-up periods of the track relay. Similarly, the energy supplied to relay 6BSA during the picked-up periods of the track relay 6TR keeps the relay contacts picked up and the relay is slow enough in releasing to remain picked up during the released periods of the track relay. As relay 6BSA is picked up its contact 35 establishes the circuit of the green lamp G of signal 6S and it is lighted to show that section 6T is not occupied.

As relay 6HD is picked up its contact 36 interrupts the circuits of condensers Q1, Q2 and Q3 so that energy cannot be supplied to these condensers during the picked-up periods of track relay 6TR, nor can energy be supplied from these condensers to relays 6HA, 6HB and 6HC during the released periods of track relay 6TR. Accordingly, the relays 6HA, 6HB and 6HC remain released.

If a train enters section 6T, the track relay 6TR is shunted and remains released with the result that contact 33 interrupts the circuit for supplying energy to relay 6BSA and after a short time interval the relay contact 35 releases and interrupts the circuit of the green lamp G and establishes the circuit of the red lamp R. In addition, after release of relay 6TR energy is supplied from condenser Q4 to relay 6HD over the circuit established by back contact 33 of track relay 6TR, but the energy from the condenser is soon exhausted and the relay 6HD thereafter releases so that its contact 31 interrupts the circuit shunting contact 37 of relay 6HC, while contact 32 interrupts the circuits of condenser Q5 and relay 6BSA, and contact 36 establishes the circuits of condensers Q1, Q2 and Q3 and of relays 6HA, 6HB and 6HC.

When the section is vacated, the track relay 6TR again responds to coded energy and during the first picked-up periods of the track relay contacts energy is supplied to condenser Q1 over the circuit which is traced from terminal B over front contact 30 of relay 6TR, through asymmetric unit K1 to one element of condenser Q1, and from the other element of this condenser over back contact 36 of relay 6HD to terminal C of the source. During the first released period of the track relay 6TR, the supply of energy to condenser Q1 is interrupted while energy is supplied from this condenser to relay 6HA over the circuit which is traced from the left-hand element of the condenser through the winding of relay 6HA, over back contact 33 of relay 6TR and back contact 36 of relay 6HD to the other element of the condenser Q1. The energy supplied to relay 6HA picks up the relay contact 38

so that during the next or second picked-up period of the track relay contact 30 energy is supplied not only to condenser Q1 but is supplied also over front contact 38 of relay 6HA to condenser Q2 with the result that during the next or second released period of the track relay 6TR energy is supplied from condenser Q1 to relay 6HA and is also supplied from condenser Q2 to relay 6HB over the circuit which includes front contact 38 of relay 6HA, back contact 33 of relay 6TR and back contact 36 of relay 6HD. The energy supplied to relay 6HA holds contact 38 picked up while the energy supplied to relay 6HB picks up its contact 40 so that during the next or third picked-up period of track relay 6TR energy is supplied to condenser Q3 as well as to condensers Q1 and Q2. During the next or third released period of the relay 6TR energy is supplied from condenser Q3 to relay 6HC to pick up its contact 37, while energy is supplied from condensers Q1 and Q2 to relays 6HA and 6HB to hold their contacts picked up.

During the next or fourth picked-up period of the track relay 6TR energy is supplied to condensers Q1, Q2 and Q3, and is also supplied to condenser Q4 over the circuit which includes front contact 37 of relay 6HC, while during the next or fourth released period of the track relay energy is supplied from condenser Q4 to relay 6HD and its contacts pick up so that contact 31 establishes the connection shunting contact 37 of relay 6HC in the circuits of relay 6HD and condenser Q4. In addition, when relay 6HD picks up, its contact 36 interrupts the circuits of condensers Q1, Q2 and Q3 so that energy is no longer supplied from these condensers to the associated relays and after a period the relays 6HA, 6HB and 6HC release, while energy remaining in the condensers is discharged through the resistors which are connected across the condenser terminals.

After picking up of relay 6HD energy is supplied over its front contact 32 to the condenser Q5 during the remainder of the released period of contact 30 of track relay 6TR so that during the next or fifth picked-up period of the contacts of track relay 6TR energy is supplied from condenser Q5 to relay 6BSA over the previously traced circuit for this relay and its contact 35 picks up to interrupt the circuit of the red lamp R and to establish the circuit of the green lamp G. On continued code following operation of the track relay the condensers Q4 and Q5 are alternately charged and the relays 6HD and 6BSA are alternately energized so the relay 6BSA maintains the circuit of the lamp G.

From the foregoing it will be seen that on initiation of code following operation of the track relay 6TR at a time when the auxiliary relays 6HD and 6BSA are released, the relay 6BSA remains released until the track relay picks up for the fifth time. Accordingly, if, while relays 6HD and 6BSA are released, the train fails to shunt the track relay momentarily and the track relay responds to one or two impulses of coded energy, the relays 6HA and 6HB may become picked up, but the relay 6BSA will remain released and maintain the circuit of the red lamp R and there is no possibility that the circuit of the green lamp G will be established even temporarily as a result of the momentary loss of shunt.

While several operations of the track relay are necessary to effect picking up of relay 6BSA, this relay releases promptly on entrance of a train into

the section. Where track relay 6TR is shunted and remains released, the circuit for supplying energy from condenser Q5 to relay 6BSA is interrupted and the relay 6BSA releases after a short time interval so that the circuit of the red lamp R is established promptly after entrance of a train into the section. On release of the track relay, energy is supplied from the condenser Q4 to relay 6HD but this energy is soon exhausted and the relay 6HD releases shortly after relay 6BSA, while after release of relay 6HD the relay 6BSA can be reenergized only as a result of continued code following operation of the track relay 6TR.

Although three stepping relays are shown in addition to relay 6HD with the result that five operations of the track relay 6TR are required to pick up the relay 6BSA, it should be understood that a larger or a smaller number of stepping relays may be provided if desired to thereby cause relay 6BSA to pick up in response to a larger or a smaller number of operations of the track relay.

The combination shown in Fig. 3 provides protection against improper energization of relay 6BSA in the event the contacts of relay 6TR are defective. If movable contact 30 of relay 6TR simultaneously engages its front and back points of contact, the battery will be short-circuited if contact 33 engages either its front or its back contact. Similarly, if movable contact 33 of relay 6TR should simultaneously engage both its front and back points of contact the battery is short-circuited if contact 30 engages either its front or its back contact. When the battery is short-circuited, energy will not be supplied therefrom to the relay 6BSA and it will be released and will interrupt the circuit of the green lamp G and establish the circuit of the red lamp R.

If the contacts of relay 6TR are out of adjustment so that front contact 30 and back contact 33 are closed at the same time, the battery will be short-circuited. Similarly, if back contact 30 and front contact 33 are closed at the same time, the battery will be short-circuited and relay 6BSA will remain released.

Likewise, as explained in connection with Fig. 1, the relays 6HD and 6BSA will remain released if an asymmetric unit or condenser associated therewith is defective.

In Fig. 4 of the drawings there is shown a modified form of code detecting means embodying this invention and arranged to selectively control a signal in accordance with the number of impulses of energy supplied over the rails of a section during one cycle of operation of the code transmitting means. The combination shown in Fig. 4 is also arranged to insure prompt display of the stop indication in the event the supply of coded energy over the rails of a track section is interrupted.

Referring to Fig. 4, it will be seen that track relays 6RTR and 6NTR are connected in series across the section rails adjacent the entrance end of the section. The relays 6RTR and 6NTR are of the polar biased neutral type and each has contacts which normally occupy their released position from which they are moved to their picked-up position when and only when energy flows through the relay winding in a selected direction as indicated by the arrow on the relay winding. The relays 6RTR and 6NTR are connected across the track rails so that they respond to energy impulses of opposite relative polarity, the relay 6RTR being operated by impulses of reverse polarity, that is, when the track rail 11

is positive with respect to track rail 10, and the relay 6NTR being operated by impulses of normal polarity.

The relay 6RTR controls relays 6RFR and 6RBR while the relay 6NTR controls repeater relays 6NF1, 6NF2, 6NF3, 6NF4, 6NB1, 6NB2, 6NB3 and 6NB4. The repeater relays 6NF1, 6NF2, 6NF3 and 6NF4 cooperate with relay 6RBR to control slow release relays 6F1P, 6F2P, 6F3P and 6F4P which control the circuits of the lamps of signal 6S.

The supply of impulses of energy to the section rails is governed by a code transmitter 6CT which has a plurality of cam wheels which are continuously rotated at a suitable rate. The cam wheels are designated I, II, III and IV, and each has on the periphery thereof six projections which are separated by six recesses. The projections may be of either full or one-half height and control movable contact members in such manner that when the cam follower on a contact member engages the recessed surface between projections, the contact establishes a circuit over which energy of reverse polarity may be supplied from the battery 6RTB to the section rails. When the cam follower on a contact member engages a projection of one-half height, the contact member interrupts the circuits of both of the batteries 6NTB and 6RTB and thus cuts off the supply of energy to the section rails, but when the cam follower on a contact member engages a projection of full height, the contact establishes a circuit over which energy of normal polarity may be supplied from the battery 6NTB to the section rails.

As each of the cam wheels has six recesses, and as energy of reverse polarity is supplied to the section rails when a cam follower engages a recessed surface, it follows that six impulses of energy of reverse polarity are supplied to the section rails during each revolution of a cam wheel. The impulses of energy of reverse polarity are separated by intervals during which impulses of energy of normal polarity are supplied to the section rails, or in which the supply of energy to the section rails is cut off, depending on the arrangement of the projections which separate the recesses on the periphery of the cam wheels.

As hereinafter explained the impulses of track circuit energy of reverse polarity supplied to the section rails serve as a detector code and operate track relay 6RTR to indicate whether or not the section is occupied. Each impulse of track circuit energy of reverse polarity together with an accompanying interval in which energy of reverse polarity is not supplied constitutes one cycle of detector code energy, and as six impulses of energy of reverse polarity are supplied during each revolution of a cam wheel it follows that six complete cycles of detector code energy are supplied during each revolution of a cam wheel.

As explained below one cycle of control code is supplied to the track rails during each revolution of a cam wheel. Accordingly, the detector code has a much shorter code cycle than the control code and the code detecting means governed by the detector code can have a much shorter release delay period than the code detecting means governed by the control code.

The cam wheel I has one projection of full height and five projections of one-half height with the result that when this cam wheel controls the supply of energy to the section rails the six impulses of energy of reverse polarity supplied during one revolution of the cam wheel

are separated by one impulse of energy of normal polarity and by five intervals during which the supply of energy to the track rails is cut off.

The cam wheel II has two projections of full height located adjacent each other, and four projections of one-half height and when this cam wheel controls the supply of energy to the section rails the six impulses of energy of reverse polarity supplied during one revolution of the cam wheel are separated by two impulses of energy of normal polarity and by four intervals during which the supply of energy to the track rails is cut off.

The cam wheel III has three projections of full height located adjacent each other and three projections of one-half height and when this cam wheel governs the supply of energy to the section rails the six impulses of energy of reverse polarity supplied during each revolution of the cam wheel are separated by three impulses of energy of normal polarity and by three intervals during which the supply of energy to the track rails is cut off.

The cam wheel IV has four projections of full height located adjacent each other and two projections of one-half height and when this cam wheel controls the supply of energy to the section rails the six impulses of energy of reverse polarity supplied during one revolution of the cam wheel are separated by four impulses of energy of normal polarity and by two intervals during which the supply of energy to the track rails is cut off.

The circuits governed by the cam wheels I, II, III, and IV are controlled by relays 1F1P, 1F2P, 1F3P and 1F4P, not shown, which are governed by traffic conditions in advance in substantially the same manner as the relays 6F1P, 6F2P, 6F3P and 6F4P.

The equipment is shown in the condition which it assumes when the track stretch is vacant. At this time the relay 1F4P is picked up and its contact 45 connects track rail 11 to the movable contact associated with cam wheel IV. As explained above, during each revolution of this cam wheel there are supplied to the section rails six impulses of energy of reverse polarity which are separated by six intervals during four of which energy of normal polarity is supplied to the section rails and during the remaining two intervals the supply of energy to the track rails is cut off.

During the supply of each impulse of energy of reverse polarity over the section rails the contacts of the relay 6RTR pick up and those of relay 6NTR remain released. During the intervals between impulses of energy of reverse polarity supplied over the section rails the contacts of relay 6RTR release. During the picked-up period of the contacts of relay 6RTR energy is supplied from terminal B of a local source of direct current over front contact 46 of relay 6RTR, and through the asymmetric unit K10 to one terminal of the condenser Q10, the other terminal of which is connected to terminal C of the source. Accordingly, a charge is built up in this condenser and during the released period of relay 6RTR energy from the condenser is supplied through the winding of relay 6RFR over the circuit which includes back contact 47 of relay 6RTR. This energy picks up the contacts of relay 6RFR, while the rectifier K10 snubs the winding of relay 6RFR and renders the relay slow enough in releasing to cause its contacts to remain picked up during the picked-up periods of relay 6RTR.

When front contact 48 of relay 6RFR is closed, energy is supplied through asymmetric unit K11 to condenser Q11 during the released periods of contact 46 of relay 6RTR, and during the picked-up periods of relay 6RTR energy from the condenser Q11 is supplied through the winding of relay 6RBR over the circuit which includes front contact 47 of relay 6RTR. The energy supplied to relay 6RBR from condenser Q11 picks up the relay contact, while the relay is snubbed by rectifier K11 and is slow enough in releasing to remain picked up during the released periods of relay 6RTR.

Since six impulses of energy of reverse polarity are supplied over the section rails during each revolution of any one of the cam wheels the intervals between these impulses are relatively short, and the release time of relays 6RFR and 6RBR does not need to be very long to insure that these relays will remain picked up as long as relay 6RTR is operated by coded energy. Accordingly, if relay 6RTR ceases to be operated by coded energy, as is the case when a train enters the section, the relays 6RFR and 6RBR will release promptly and will cause prompt display of the stop indication by signal 6S, as explained in detail below. However, as long as the section is vacant and impulses of energy of reverse polarity are supplied over the section rails, the relays 6RFR and 6RBR are picked up and front contact 50 of relay 6RBR in the circuits of relays 6F1P, 6F2P, 6F3P and 6F4P is closed.

Since the control code cycle determined by each of the cam wheels contains 6 negative impulses, it will be seen that as long as the track section is vacant the equipment including relays 6RTR, 6RFR and 6RBR will operate as described above, and for purposes of brevity, the description of operation of that portion of the equipment will not be repeated hereafter.

As shown, the relays 1F4P and 1F3P are both picked up so that the supply of energy to the rails of section 6T is governed by the cam wheel IV. As illustrated, the movable contact associated with cam wheel IV engages a projection of full height so that the contact establishes a circuit for supplying energy of normal polarity from the battery 6NTB to the track rails. This energy feeds over the track rails and picks up the relay 6NTR with the result that when the relays NF and NB are all released, as shown in the drawings, energy is supplied over front contact 52 of relay 6NTR, through the rectifier K12 over back contact 53 of relay 6NF3 and back contact 54 of relay 6NF4 to one element of condenser Q21 so a charge is built up in this condenser.

On movement of the cam wheel IV the movable contact governed thereby interrupts the circuit of the battery 6NTB and establishes the circuit of the battery 6RTB with the result that relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, contact 52 of relay 6NTR interrupts the supply of energy to condenser Q21 and contact 56 of relay 6NTR establishes a circuit for supplying energy from condenser Q21 to relay 6NF1 over the circuit which is traced from the left-hand element of the condenser over back contact 54 of relay 6NF4, back contact 53 of relay 6NF3, back contact 57 of relay 6NF2, winding of relay 6NF1, and over back contact 56 of relay 6NTR to terminal C and thus to the other element of the condenser Q21. The energy supplied from condenser Q21 to relay 6NF1 picks up its contact so that during the remainder of the released period of the relay 6NTR energy is supplied to

condenser Q22 over the circuit which is traced from terminal B of the source over back contact 52 of relay 6NTR, front contact 58 of relay 6NF1, and through the asymmetric unit K13 to one terminal of the condenser Q22, the other terminal of which is connected to terminal C of the source. Accordingly, a charge is built up in condenser Q22.

On further movement of the cam wheel IV the movable contact associated therewith engages the second projection of full height so that the contact interrupts the circuit of the battery 6RTB and establishes the circuit of the battery 6NTB with the result that the contacts of relay 6NTR pick up so that contact 56 interrupts the circuit traced above for supplying energy from condenser Q21 to relay 6NF1 and establishes the circuit for supplying energy from condenser Q22 to relay 6NB1. This circuit is traced from the left-hand terminal of the condenser Q22 over back contact 59 of relay 6NB2, through the winding of relay 6NB1, over front contact 58 of relay 6NF1 and front contact 55 of relay 6NTR to terminal C and thus to the other element of condenser Q22. The energy supplied to relay 6NB1 picks up the relay contact 60 so that during the remainder of this second picked-up period of relay 6NTR energy is supplied to condenser Q23 over the circuit which is traced from terminal B over front contact 52 of relay 6NTR, front contact 60 of relay 6NB1, and through asymmetric unit K14 to one element of the condenser Q23, the other element of which is connected to terminal C of the source. At this time energy is also supplied to condenser Q24 over the circuit previously traced.

On further movement of the cam wheel IV the movable contact associated therewith interrupts the circuit of the battery 6NTB and establishes the circuit of the battery 6RTB with the result that relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, contact 52 of relay 6NTR interrupts the supply of energy to condensers Q21 and Q23 and contact 56 of relay 6NTR establishes a circuit for supplying energy from condenser Q23 to relay 6NF2 over the circuit which is traced from the left-hand element of condenser Q23 over back contact 62 of relay 6NF3, through the winding of relay 6NF2, over front contact 60 of relay 6NB1, and over back contact 56 of relay 6NTR to terminal C and thus to the other element of condenser Q23. The energy supplied to relay 6NF2 picks up the contacts of the relay and contact 57 of relay 6NF2 interrupts the circuit for supplying energy to relay 6NF1 from condenser Q21, and the energy stored in condenser Q21 is dissipated by the resistor connected around its elements.

Furthermore, when relay 6NF2 picks up its contact 57 interrupts the circuit by which rectifier K12 is connected across the terminals of the winding of relay 6NF1 so the rectifier K12 ceases to snub the relay 6NF1 and it releases promptly after picking up of relay 6NF2. When relay 6NF1 releases its contact 58 interrupts the circuit for supplying energy to condenser Q22 and establishes the circuit for supplying energy to the condenser Q24. This circuit is traced from terminal B over back contact 52 of relay 6NTR, back contact 58 of relay 6NF1, front contact 64 of relay 6NF2, and through asymmetric unit K15 to one element of the condenser Q24, the other element of which is connected to terminal C of the source.

When the third full-height projection on cam wheel IV engages the contact member, the cir-

cuit of battery 6RTB is interrupted and that of battery 6NTB is established with the result that relay 6RTR releases and relay 6NTR again picks up. When relay 6NTR picks up, contact 52 interrupts the supply of energy to condenser Q24 and contact 56 of relay 6NTR establishes a circuit for supplying energy from condenser Q24 to relay 6NB2. This circuit is traced from the left-hand element of condenser Q24, over back contact 66 of relay 6NB3, through the winding of relay 6NB2, over front contact 64 of relay 6NF2, back contact 58 of relay 6NF1, and over front contact 56 of relay 6NTR to terminal C and thus to the other element of condenser Q24. The energy supplied to relay 6NB2 picks up the contacts of the relay and contact 59 of relay 6NB2 interrupts the circuit for relay 6NB1 so that relay 6NB1 releases promptly. Additionally, contact 68 of relay 6NB2 establishes the circuit for supplying energy to the condenser Q25. This circuit is traced from terminal B, over front contact 52 of relay 6NTR, back contact 60 of relay 6NB1, front contact 68 of relay 6NB2 and through asymmetric unit K16 to one element of the condenser Q25, the other element of which is connected to terminal C of the source. Accordingly, a charge is built up in condenser Q25.

Further movement of the cam wheel IV causes the movable contact associated therewith to interrupt the circuit of battery 6NTB and to establish the circuit of battery 6RTB with the result that relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, contact 52 of relay 6NTR interrupts the supply of energy to condenser Q25 and contact 56 of relay 6NTR establishes the circuit for supplying energy from condenser Q25 to relay 6NF3. This circuit is traced from the left-hand element of condenser Q25, over back contact 69 of relay 6NF4, through the winding of relay 6NF3, over front contact 68 of relay 6NB2, back contact 60 of relay 6NB1, and over back contact 56 of relay 6NTR to terminal C and thus to the other element of condenser Q25. The energy supplied to relay 6NF3 picks up the contacts of the relay and contact 62 of relay 6NF3 interrupts the circuit of relay 6NF2 and it releases promptly, while contact 53 of relay 6NF3 interrupts the circuit of relay 6NF1 so that it cannot pick up. Additionally, contact 70 of relay 6NF3 establishes a circuit for supplying energy to the condenser Q26. This circuit is traced from terminal B, over back contact 52 of relay 6NTR, back contact 58 of relay 6NF1, back contact 64 of relay 6NF2, front contact 70 of relay 6NF3, and through asymmetric unit K17 to one element of condenser Q26, the other element of which is connected to terminal C. As a result, a charge of energy is built up in condenser Q26.

When the movable contact associated with cam wheel IV engages the fourth projection of full height, it interrupts the circuit of battery 6RTB and establishes the circuit of battery 6NTB. As a result, the relay 6RTR releases and relay 6NTR picks up. When relay 6NTR picks up, contact 52 interrupts the supply of energy to condenser Q26 and contact 56 of relay 6NTR establishes a circuit for supplying energy from condenser Q26 to relay 6NB3. This circuit is traced from the left-hand element of condenser Q26, over back contact 71 of relay 6NB4, through the winding of relay 6NB3, over front contact 70 of relay 6NF3, over back contact 64 of relay 6NF2, over back contact 58 of relay 6NF1, and over front contact 56 of relay 6NTR to terminal C and thus to the

other element of condenser Q26. The energy supplied to relay 6NB3 picks up the contacts of the relay and contact 66 of relay 6NB3 interrupts the circuit by which rectifier K15 is connected across the terminals of the winding of relay 6NB2 so that relay 6NB2 releases promptly. Additionally, contact 72 of relay 6NB3 establishes the circuit for supplying energy to the condenser Q27. This circuit is traced from terminal B, over front contact 52 of relay 6NTR, over back contact 60 of relay 6NB1, over back contact 68 of relay 6NB2, over front contact 72 of relay 6NB3, and through the asymmetric unit K18 to one element of condenser Q27, the other element of which is connected to terminal C. Accordingly, a charge of energy is built up in condenser Q27.

Further movement of the cam wheel IV causes the movable contact associated therewith to interrupt the circuit of battery 6NTB and to establish the circuit of battery 6RTB with the result that relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, contact 52 of relay 6NTR interrupts the supply of energy to condenser Q27 and contact 56 of relay 6NTR establishes the circuit for supplying energy to relay 6NF4 from the condenser Q27. This circuit is traced from the left-hand element of condenser Q27, through the winding of relay 6NF4, over front contact 72 of relay 6NB3, over back contact 68 of relay 6NB2, over back contact 60 of relay 6NB1, and over back contact 56 of relay 6NTR to terminal C and thus to the other element of condenser Q27. The energy supplied to relay 6NF4 picks up the contacts of the relay and contact 69 of relay 6NF4 interrupts the circuit for connecting the rectifier K16 across the terminals of the winding of relay 6NF3 so that it releases promptly while contact 54 of relay 6NF4 interrupts the circuit of relay 6NF1 so that relay 6NF1 remains released and cannot pick up at this time. Additionally, contact 73 of relay 6NF4 establishes the circuit for supplying energy to the condenser Q28. This circuit is traced from terminal B, over back contact 52 of relay 6NTR, over back contact 58 of relay 6NF1, over back contact 64 of relay 6NF2, over back contact 70 of relay 6NF3, over front contact 74 of relay 6RTR, over front contact 73 of relay 6NF4, and through asymmetric unit K19 to one element of condenser Q28, the other element of which is connected to terminal C. As a result, a charge of energy is built up in condenser Q28.

Further movement of cam wheel IV causes the movable contact to engage a projection of one-half height, thereby interrupting the circuit of battery 6RTB, resulting in the release of relay 6RTR. When relay 6RTR releases, its contact 74 interrupts the supply of energy to condenser Q28 and establishes the circuit for supplying energy from condenser Q28 to the relay 6NB4. This circuit is traced from the left-hand element of condenser Q28, through the winding of relay 6NB4, over front contact 73 of relay 6NF4, and over back contact 74 of relay 6RTR to terminal C and thus to the other element of condenser Q28. The energy supplied to relay 6NB4 picks up the contacts of the relay, and contact 71 of relay 6NB4 interrupts the circuit for connecting rectifier K17 across the terminals of the winding of relay 6NB3 so that this relay will release promptly and its contact 72 interrupts the circuit for supplying energy from condenser Q27 to relay 6NF4 and it releases after a short time interval.

Further movement of the cam wheel IV causes the movable contact associated therewith to es-

tablish the circuit of battery 6RTB with the result that relay 6RTR picks up. When relay 6RTR picks up, its contact 74 interrupts the circuit for supplying energy from condenser Q28 to the relay 6NB4, and relay 6NB4 thereafter releases.

Because of the snubbing effect of the rectifiers connected across the terminals of the windings of the relays 6NF4 and 6NB4, these relays remain picked up for a short time subsequent to interruption of the supply of energy to each of these relays from the associated condenser. However, the snubbing circuits for relays 6NF4 and 6NB4 delay release of these relays only for a limited period and these relays will release before the relay 6NTR picks up to start a new cycle of operation.

When the movable contact associated with the cam wheel IV engages the second projection of half height, the circuit of battery 6RTB is interrupted and relay 6RTR releases, and when the contact moves into the next depression of cam wheel IV, relay 6RTR again picks up.

Further movement of cam wheel IV causes movable contact associated therewith to again be engaged with the first projection of full height, and the complete cycle described above is again repeated.

From the foregoing it will be seen that during one revolution of the cam wheel IV the relay 6NTR picks up and releases four times, and that as a result of the operation of relay 6NTR the stepping relays NF and NB are picked up and released in sequence. Each stepping relay must pick up to prepare the circuit for the succeeding relay, while each stepping relay must release to prepare a circuit for another of the relays. As operation of the stepping relay chain requires each stepping relay to pick up and to release, it follows that each operation of all of these relays is fully checked and failure of any one of these relays to pick up or release will prevent some of all of the other stepping relays from picking up. As explained below, the display of permissive indications by the wayside signals is dependent on continued operation of the stepping relays, and as failure of any one of the stepping relays to operate as intended stops operation of the relay chain it follows that any failure of the stepping relay chain will not result in a hazardous condition.

The repeater relays 6F1P, 6F2P, 6F3P and 6F4P are each supplied with energy over a front contact of one of the stepping relays 6NF1, 6NF2, 6NF3 and 6NF4, respectively, these contacts being designated by the characters 75a, 75b, 75c, and 75d, in the order named. Each of the repeater relays is provided with a condenser, which condensers are designated Q31, Q32, Q33 and Q34, respectively. The circuits governed by the stepping relays for supplying energy to the repeater relays and the associated condensers, and for connecting the condensers across the terminals of the winding of the repeater relays include front contact 50 of relay 6RBR so that these circuits are established when and only when relay 6RBR is picked up.

During the cycle of operation described above, it will not be noted that relays 6NF1, 6NF2, 6NF3 and 6NF4 pick up and release once during each control code cycle. As a result, each of the repeater relays 6F1P, 6F2P, 6F3P and 6F4P is energized, and each of the condensers Q31, Q32, Q33 and Q34 is charged once each cycle. These repeater relays and the condensers are selected

so that the energy stored in a condenser is sufficient to retain the associated relay in its picked-up condition for the duration of one complete control code cycle.

Accordingly, at this time energy is supplied to the upper green lamp G of the signal 6S by the circuit which is traced from terminal B, over front contact 76 of relay 6F1P, over front contact 77 of relay 6F2P, over front contact 78 of relay 6F3P, over front contact 79 of relay 6F4P, and through the upper lamp G to terminal C. Additionally, energy is supplied to the lower red lamp R by the circuit which is traced from terminal B, over front contact 82 of relay 6F1P, front contact 83 of relay 6F2P, front contact 84 of relay 6F3P, front contact 85 of relay 6F4P, and through the lower lamp R to terminal C. As a result, the signal displays an aspect of green-over-red, which indicates "clear."

From the foregoing it is clear that the circuits for controlling the lamps of the signal 6S are arranged so that all of the repeater relays must be energized to cause the signal to display its clear indication. Accordingly, if for any reason one of the repeater relays fails to pick up, the signal cannot display its clear indication but will display a restrictive indication. This provides a further check that the stepping relays are operating as intended since all of the repeater relays will not be picked up unless the stepping relays are operating properly.

The repeater relays 6F1P, 6F2P, 6F3P and 6F4P also control the supply of coded energy to the rails of section 5T, in substantially the same manner as the corresponding relays 7F1P, 7F2P, 7F3P and 7F4P control the supply of coded energy to the rails of section 6T. In order to simplify this disclosure the means for supplying coded energy to the rails of section 5T has not been shown.

With the equipment operating as described above, it will now be assumed that a train, moving from left to right, passes signal 6S and enters section 6T. The wheels and axles of the train shunt the relays 6NTR and 6RTR, and these relays release and remain released as long as the train occupies section 6T.

As previously pointed out, the relays 6RFR and 6RBR release in a very short time after relay 6RTR stops operating. When relay 6RBR releases, its front contact 50 interrupts the circuits for supplying energy to the repeater relays 6F1P, 6F2P, 6F3P, and 6F4P while it also interrupts the circuits for connecting the condensers across the terminals of the windings of the repeater relays and these relays release promptly. The upper red lamp R of signal 6S is now supplied with energy by a circuit including back contact 76 of relay 6F1P, and the circuit previously traced for supplying energy to the upper green lamp G of signal S is interrupted by contact 76 of relay 6F1P, while the lower red lamp R is supplied with energy by a circuit including the back contact 82 of relay 6F1P. Accordingly, while section 6T is occupied, the signal 6S will display an aspect of red-over-red, indicating "stop."

The relays 7F4P, 7F3P, 7F2P and 7F1P are governed in a similar manner to that described above for relay 6F4P, 6F3P, 6F2P and 6F1P, and accordingly, when the train enters section 7T, the relays 7F4P, 7F3P, 7F2P and 7F1P release.

When the train vacates section 6T, coded energy is again supplied to the track relays 6NTR and 6RTR. At this time the energy supplied from batteries 6NTB and 6RTB to the section rails is governed by the contact associated with cam

wheel I and is supplied over a circuit which includes back contact 45 of relay 7F4P, back contact 87 of relay 7F3P, back contact 88 of relay 7F2P, and back contact 89 of relay 7F1P. During each revolution of cam wheel I one impulse of positive polarity and six impulses of negative polarity are supplied to the rails of section 6T, and since the cam wheel I rotates continuously, the coded energy supplied to relays 6NTR and 6RTR consists of a succession of negative impulses separated by "off" periods, with every sixth "off" period being replaced by a positive impulse.

The relay 6RTR will again operate its contacts on the reception of impulses of negative energy, and as previously described, relays 6RFR and 6RBR will be energized and their contacts will pick up. When contact 50 of relay 6RBR picks up, it again establishes the connection it governs for controlling the repeater relays 6F1P, 6F2P, 6F3P and 6F4P.

When the movable contact associated with cam wheel I engages the projection of full height, the circuit of battery 6RTB is interrupted and the circuit of battery 6NTB is established and as a result relay 6RTR releases and relay 6NTR picks up.

When relay 6NTR picks up, energy is supplied to the condenser Q21 over the circuit previously traced. On continued movement of the cam wheel I, its movable contact interrupts the circuit of battery 6NTB and establishes the circuit of battery 6RTB, with the result that relay 6NTR releases, and relay 6RTR picks up. When relay 6NTR releases, the energy stored in condenser Q21 is supplied to relay 6NF1 and the relay contacts pick up. After a time interval the energy supplied from condenser Q21 is ineffective to hold the relay 6NF1 picked up and it releases. The equipment is arranged and proportioned so that the energy supplied from condenser Q21 to the relay 6NF1 will keep the relay contacts picked up for an interval equal to one step in the code cycle, but will not hold it picked up for a substantially longer period. Accordingly, relay 6NF1 picks up and remains picked up for a short time, but releases before relay 6NTR picks up again.

During the period in which relay 6NF1 is picked up, energy is supplied to condenser Q22 by the circuit including back contact 52 of relay 6NTR and front contact 58 of relay 6NF1 and a charge is built up in condenser Q22. However, since relay 6NTR remains released for the remainder of the control code cycle, and as relay 6NF1 releases after a short period, the circuit for supplying energy from condenser Q22 to relay 6NB1 is not established and relay 6NB1 remains released, while the energy stored in condenser Q22 is dissipated by the resistor connected across its terminals. Accordingly it will be seen that at this time the relay 6NF1 will be picked up and released once during each control code cycle. The relay 6F1P will therefore be supplied with energy by the circuit governed by the front contact 75a of relay 6NF1, which circuit is established once during each control code cycle. The energy supplied to the condenser Q31 will retain the relay 6F1P picked up during the intervals between the supply of energy thereto. The relays 6F2P, 6F3P and 6F4P are not supplied with energy and their contacts remain released.

At this time, therefore, the top yellow lamp Y of signal 6S is supplied with energy by the circuit which is traced from terminal B, over front contact 76 of relay 6F1P, back contact 77 of relay 6F2P, and through the upper yellow lamp Y of

signal 6S to terminal C. Additionally, the lower red lamp R of signal 6S is supplied with energy by the circuit including front contact 82 of relay 6F1P, back contact 83 of relay 6F2P, and through the lower red lamp R of signal 6S to terminal C. The signal therefore displays an aspect of yellow-over-red, indicating "approach next signal prepared to stop."

As the train under discussion progresses, the relays 7F1P, 7F2P, 7F3P and 7F4P are progressively energized in the order named. When the train vacates section 7T, the contact 89 of relay 7F1P is picked up so that the contact operated by cam wheel I no longer governs the supply of energy to section 6T, and energy is now supplied to the track section 6T by a circuit including back contact 45 of relay 7F4P, back contact 87 of relay 7F3P, back contact 88 of relay 7F2P, front contact 89 of relay 7F1P, and the movable contact of cam wheel II.

The construction of the cam wheel II is such that during each revolution of this wheel there are supplied to the track rails six impulses of energy of reverse polarity separated by two periods in which impulses of energy of normal polarity are supplied to the track rails and four periods in which no energy is supplied to the track rails.

When the movable contact associated with cam wheel II engages the first projection of full height, the circuit of battery 6RTB is interrupted, and the circuit of battery 6NTB is established, and as a result, the relay 6RTR releases and the relay 6NTR picks up.

When relay 6NTR picks up, the circuit previously traced for supplying energy to the condenser Q21 is established and a charge of energy is built up in condenser Q21. Further movement of the cam wheel II causes the movable contact to interrupt the circuit of battery 6NTB and establish the circuit of battery 6RTB so that relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, the circuit previously traced for supplying energy to the relay 6NF1 from condenser Q21 is established, and relay 6NF1 picks up. Additionally, condenser Q22 is supplied with energy by the circuit previously traced which includes back contact 52 of relay 6NTR and front contact 58 of relay 6NF1. Accordingly, a charge is built up on condenser Q22.

Further movement of the cam wheel II causes the movable contact to engage the second projection of full height, so that the circuit of battery 6RTB is interrupted and the circuit of battery 6NTB is established, with the result that relay 6RTR releases and relay 6NTR picks up. When relay 6NTR picks up, the circuit previously traced for supplying energy to relay 6NB1 from condenser Q22 is established and relay 6NB1 picks up, establishing the circuit for supplying energy to condenser Q23, which circuit includes front contact 52 of relay 6NTR and front contact 60 of relay 6NB1. As a result, a charge of energy is built up in condenser Q23. When further movement of the cam wheel II causes the movable contact to be disengaged from the second projection of full height, the circuit of battery 6NTB is interrupted, and the circuit of battery 6RTB is established, with the result that relay 6NTR releases, and relay 6RTR picks up. When relay 6NTR releases, it establishes the circuit previously traced for supplying energy to the relay 6NF2 from condenser Q23 and relay 6NF2 picks up. When relay 6NF2 picks up its contact 57 interrupts the circuit of relay 6NF1 and also

interrupts the circuit for connecting the rectifier K12 across the terminals of the winding of relay 6NF1 so the relay contacts release quickly. When relay 6NF1 releases it establishes the circuit previously traced for supplying energy to condenser Q24, which circuit includes back contact 52 of relay 6NTR, back contact 58 of relay 6NF1, and contact 64 of relay 6NF2. Accordingly, a charge of energy is built up in condenser Q24, but since relay 6NTR does not again pick up to establish the circuit for supplying energy from condenser Q24 to relay 6NB2, the relay 6NB2 remains released. The circuit for supplying energy to condenser Q24 is interrupted on subsequent release of relay 6NF2, and the energy stored in condenser Q24 is dissipated by the resistor connected across its terminals.

As explained above, on release of relay 6NTR following its second picked-up period the circuit is established for supplying energy from the condenser Q23 to relay 6NF2. As relay 6NTR thereafter remains released for a substantial period the energy stored in the condenser Q23 is discharged through the winding of relay 6NF2 and the contacts of relay 6NF2 release before relay 6NTR picks up again. Accordingly, when the relay 6NTR is picked up during the succeeding control code cycle the operation of the stepping relays starts from the beginning and not from an intermediate point in the chain.

From the foregoing it will be seen that when the cam wheel II governs the supply of coded energy to section 6T, the relays 6NF1 and 6NF2 are picked up and release once during each control code cycle, while the relays 6RFR and 6RBR remain picked up continuously. As a result, energy is supplied at intervals to the repeater relays 6F1P and 6F2P and their associated condensers Q31 and Q32. The relays 6F3P and 6F4P are not supplied with energy at this time and their contacts remain released.

At this time, therefore, the upper yellow lamp Y of signal 6S is supplied with energy over the circuit including front contact 76 of relay 6F1P, front contact 77 of relay 6F2P, and back contact 78 of relay 6F3P, while the lower yellow lamp Y of signal 6S is supplied with energy over the circuit including front contact 82 of relay 6F1P front contact 83 of relay 6F2P, and back contact 84 of relay 6F3P. The signal 6S, therefore, displays an aspect of yellow-over-yellow, indicating "approach second signal prepared to stop."

When the train under consideration vacates the section in advance of section 7T, the relay 7F2P picks up, interrupting the circuit governed by cam wheel II and establishing the circuit governed by cam wheel III. Coded energy is now supplied to section 6T over the circuit which includes back contact 45 of relay 7F4P, back contact 87 of relay 7F3P, front contact 88 of relay 7F2P, and the movable contact associated with cam wheel III. At this time, therefore, during each control code cycle there are supplied to the rails of section 6T, six impulses of energy of negative polarity which are separated by three impulses of energy of normal polarity and by three "off" intervals. The supply of impulses of negative polarity to relay 6RTR causes this relay to continue operating, and as a result, the relays 6RFR and 6RBR are maintained picked up.

When the movable contact associated with cam wheel III engages the first projection of full height, the circuit of battery 6NTB is established and the circuit of battery 6RTB is interrupted,

with the result that relay 6NTR picks up and relay 6RTR releases. When relay 6NTR picks up, the condenser Q21 is charged, as previously explained. On further movement of the cam wheel III, the circuit of battery 6NTB is interrupted and the circuit of battery 6RTB is established, so that relay 6NTR is released and relay 6RTR picks up. When relay 6NTR releases, the circuit for supplying energy to relay 6NF1 from condenser Q21 is established and relay 6NF1 picks up. The condenser Q22 is then supplied with energy over the circuit including back contact 52 of relay 6NTR and the front contact 58 of relay 6NF1.

When the movable contact engages the second projection of full height on cam wheel III, the circuit for battery 6RTB is interrupted and the circuit for battery 6NTB is established, as a result of which the relay 6NTR is picked up and the relay 6RTR is released. When relay 6NTR picks up, the energy stored in condenser Q22 is supplied to relay 6NB1 over the circuit previously traced, and relay 6NB1 picks up, thereby establishing the circuit for supplying energy to condenser Q23, while during this picked up period of relay 6NTR energy is supplied to condenser Q21. As a result, a charge of energy is built up in condensers Q21 and Q23.

Further movement of cam wheel III disengages the movable contact from the second projection of full height, interrupting the circuit of battery 6NTB, with the result that relay 6NTR is released and relay 6RTR is picked up. When relay 6NTR releases, the circuit previously traced for supplying energy to condensers Q21 and Q23 is interrupted, and relay 6NF2 is supplied with energy from condenser Q23 over the circuit previously traced. As a result, relay 6NF2 picks up and its contact 57 interrupts the circuit for supplying energy from condenser Q21 to relay 6NF1 and for connecting rectifier K12 across the terminals of the winding of relay 6NF1 with the result that relay 6NF1 releases promptly and the energy stored in condenser Q21 is dissipated by the resistor connected across its terminals. Additionally, when contact 64 of relay 6NF2 picks up, energy is supplied to condenser Q24 over the circuit previously traced. Accordingly, a charge of energy is built up in condenser Q24.

When the movable contact associated with cam wheel III engages the third projection of full height, the circuit of battery 6RTB is interrupted, and the circuit of battery 6NTB is established, with the result that relay 6RTR releases and relay 6NTR picks up. During this third picked-up period of relay 6NTR, energy is supplied to relay 6NB2 from condenser Q24 over the circuit previously traced. When relay 6NB2 picks up, its contact 59 interrupts the circuit for connecting the rectifier K13 across the terminals of the winding of relay 6NB1 so that relay 6NB1 releases. Additionally, when relay 6NB2 picks up, energy is supplied over its front contact 68 to the condenser Q25 and a charge of energy is built up in condenser Q25.

Further movement of the cam wheel III disengages the movable contact from the third projection so that the circuit of battery 6NTB is interrupted, and the circuit of battery 6RTB is established. Accordingly, the relay 6NTR releases and relay 6RTR picks up. When relay 6NTR releases, energy is supplied to relay 6NF3 from condenser Q25 and relay 6NF3 is picked up. When relay 6NF3 picks up, its contact 53 interrupts the circuit of condenser Q21 so that relay 6NF1 is certain to remain released, and

contact 62 of relay 6NF3 interrupts the circuit for connecting rectifier K14 across the terminals of the winding of relay 6NF2 so that relay 6NF2 releases promptly. When relay 6NF2 releases, energy is supplied to condenser Q26 over the circuit which includes front contact 70 of relay 6NF3. Accordingly, a charge of energy is built up in condenser Q26. However, relay 6NTR does not pick up again during the remainder of the code cycle and therefore does not establish the circuit for supplying energy from condenser Q26 to relay 6NB3 so relay 6NB3 remains released. After a short time interval, relay 6NF3 releases, and its contact 70 interrupts the supply of energy to condenser Q26, and the charge of energy in the condenser is thereafter dissipated through the resistor connected across the terminals of condenser Q26. Since relay 6NB3 does not pick up, the circuits for charging condensers Q27 and Q28 are not established, and as a result the relays 6NF4 and 6NB4 do not pick up.

The relay 6RTR is thereafter picked up and released during the portion of the control code cycle remaining in this revolution of the cam wheel III, and the movable contact associated with cam wheel III then engages the first projection of full height, and the cycle described above is repeated.

It will be seen, therefore, that during the time that cam wheel III governs the supply of energy to the track section 6T, the relay 6RTR operates continuously, being picked up and released six times during each control code cycle, so that relays 6RFR and 6RBR are picked up, and the connection governed by contact 50 of relay 6RBR for supplying energy to the repeater relays 6F1P, 6F2P, 6F3P and 6F4P is established. Additionally, the relays 6NF1, 6NB1, 6NF2, 6NB2 and 6NF3 are picked up and released once during each control code cycle. When relays 6NF1, 6NF2 and 6NF3 pick up, energy is supplied to their respective repeater relays and associated condensers, so that at this time, relays 6F1P, 6F2P and 6F3P are picked up.

At this time, therefore, the upper yellow lamp Y of signal 6S is supplied with energy by the circuit which is traced from terminal B, over front contact 76 of relay 6F1P, front contact 77 of relay 6F2P, front contact 78 of relay 6F3P, back contact 79 of relay 6F4P, and through the upper yellow lamp Y to terminal C. Also, the lower green lamp G of signal 6S is supplied with energy by the circuit which is traced from terminal B, over front contact 82 of relay 6F1P, front contact 83 of relay 6F2P, front contact 84 of relay 6F3P, back contact 85 of relay 6F4P, and through the lower green lamp G of signal 6S to terminal C. The signal 6S therefore displays an aspect of yellow-over-green, indicating "proceed approaching next signal at medium speed."

When the train under consideration progresses further, the relay 7F3P picks up, interrupting the circuit governed by cam wheel III and establishing the circuit governed by cam wheel IV. When the train progresses still further, the relay 7F4P picks up, which maintains the circuit governed by cam wheel IV. The operation of the equipment at this time is the same as that originally described, and the equipment is restored to its normal condition with signal 6S displaying an aspect of green-over-red, indicating "clear."

Although I have shown and described a coded railway signaling system embodying my inven-

tion whereby four distinctive code cycles are employed, it is to be understood that the number of code cycles may be varied as desired, with corresponding changes in the number of relays necessary to decode the code cycle steps.

From the foregoing it will be seen that the system shown in Fig. 4 operates on a count code basis to govern the wayside signals in accordance with the number of impulses of energy of normal polarity supplied over the rails of a track section during one code cycle. In addition, it will be seen that regardless of traffic conditions in advance impulses of energy of reverse polarity are supplied over the section rails at uniform relatively frequent intervals and operate the relay 6RTR to keep the relays 6RFR and 6RBR picked up. As the relay 6RTR operates at a rapid rate the release delay period of the relays 6RFR and 6RBR is relatively short and on entrance of a train into section 6T these relays will release quickly and put signal 6S to stop. Accordingly, the shunting time of the equipment for a track section is not governed by the length of the code cycle and this may be made as long as desired to provide numerous distinctive indications without objectionably delaying the display of the stop indication after entrance of a train into the section.

Although I have herein shown and described only a few forms of coded signaling apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention what I claim is:

1. In combination, a code following relay having a movable contact operable between a first position in which it engages a first stationary contact which is connected to the first terminal of a source of direct current and a second position in which it engages a second stationary contact which is connected to the second terminal of said source, a condenser, a code detecting relay, a circuit including said code following relay movable contact and operative when said contact is in its first position to connect said condenser across the terminals of said source independently of the winding of said code detecting relay, and a circuit including said code following relay movable contact and operative when said contact is in its second position to connect said condenser across the terminals of the winding of said code detecting relay.

2. In combination, a source of direct current having a first and a second terminal, a code detecting relay having a winding having a first and a second terminal, a condenser having its first terminal connected to the second terminal of said source of current and having its second terminal connected to the second terminal of the winding of said code detecting relay, and a code following relay having a movable contact operable between a first position in which it establishes a connection independent of the winding of said code detecting relay from the first terminal of said source of direct current to the second terminal of said condenser and a second position in which it establishes a connection from the second terminal of said condenser to the first terminal of said condenser and including in series therewith the winding of said code detecting relay.

3. In combination, a code following relay hav-

ing a movable contact which is moved between a first position in which it engages a first stationary contact and a second position in which it engages a second stationary contact, a condenser having a first and a second terminal, a source of direct current having its first terminal connected to said first stationary contact and having its second terminal connected to the first terminal of said condenser and also to said second stationary contact, a code detecting relay having one terminal of its winding connected to said movable contact and having the other terminal of its winding connected to the second terminal of said condenser, and means independent of the winding of said code detecting relay for supplying energy from said source to said condenser when the movable contact of said code following relay engages said first stationary contact.

4. In combination, a code following relay having a first and a second movable contact operated substantially in synchronism, said contacts being moved between a first position in which the first movable contact engages a first stationary contact and the second movable contact engages a second stationary contact and a second position in which the first movable contact engages a third stationary contact and the second movable contact engages a fourth stationary contact, a condenser having a first and a second terminal, a source of direct current having its first terminal connected to said first stationary contact and having its second terminal connected to the first terminal of said condenser and also to said third stationary contact, a code detecting relay having one terminal of its winding connected to said fourth stationary contact and having the other terminal of its winding connected to the second terminal of said condenser and also connected to said second stationary contact, said first and second movable contacts being connected so that when they occupy their first position energy is supplied to said condenser from said source independently of the winding of said code detecting relay, and a circuit governed by a contact of said code detecting relay.

5. In combination, a series of relays, a series of condensers, one each of said condensers being associated with each of the relays in said series, a code following relay having contacts movable between a first and a second position, a circuit for supplying energy to the condenser associated with each of said relays including a contact of said code following relay closed in its first position, the circuit for supplying energy to each of said condensers except the condenser associated with the first relay of said series including a front contact of the preceding relay in said series, a discharge circuit for supplying energy from each of said condensers to the associated relay, each of said discharge circuits including a contact of said code following relay closed in its second position, the discharge circuit for supplying energy to each of said relays except the first relay in said series including a front contact of the preceding relay in said series, and control means selectively governed by said series of relays.

6. In combination, a series of stepping relays, a series of condensers, one each of said condensers being associated with each of the stepping relays in said series, a code following relay having contacts movable between a first and a second position, a first auxiliary relay, a circuit including a back contact of said first auxiliary relay for supplying energy to the condenser associated with each of said stepping relays including a con-

tact of said code following relay closed in its first position, the circuit for supplying energy to each of said condensers except the condenser associated with the first relay in said series including a front contact of the preceding relay in said series, a discharge circuit including a back contact of said first auxiliary relay for supplying energy from each of said condensers to the associated stepping relay, each of said discharge circuits including a contact of said code following relay closed in its second position, the discharge circuit for supplying energy to each of said relays except the first relay in said series including a front contact of the preceding relay in said series, a condenser associated with said first auxiliary relay, a circuit including a contact of said code following relay closed in its first position for supplying energy to the condenser associated with said first auxiliary relay, said last-named circuit including a front contact of the last relay in said series, which contact is by-passed by a front contact of said first auxiliary relay, a circuit including a contact of said code following relay closed in its second position for supplying energy from the condenser associated with said first auxiliary relay to said relay, said last-named circuit including a front contact of the last stepping relay in said series, which contact is by-passed by a front contact of said first auxiliary relay, a second auxiliary relay having a condenser associated therewith, a circuit including a front contact of said first auxiliary relay and a contact of said code following relay closed in its second position for supplying energy to the condenser associated with said second auxiliary relay, a circuit including a front contact of said first auxiliary relay and a contact of said code following relay closed in its first position for supplying energy to said second auxiliary relay from the condenser associated therewith, and a circuit controlled by a contact of said second auxiliary relay.

7. In combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the section rails detector code energy comprising impulses of energy of reverse polarity separated by time intervals, means at the exit end of said section for supplying to the section rails in said intervals recurring cycles of one or another of a plurality of different numbers of impulses of energy of normal polarity, a first and a second code following track relay located at the entrance end of said section and operated by energy supplied over the section rails, said first track relay having a contact which is moved from a first to a second position only in response to energy of normal polarity and said second track relay having a contact which is moved from a first to a second position only in response to energy of reverse polarity, a series of stepping relays each having an asymmetric unit connected across the terminals of its winding and each being connected in series with a condenser, circuit means governed by contacts of said first track relay for charging said condensers in sequence through said asymmetric units and for discharging said condensers in sequence through the windings of the associated relays to thereby energize one or more of said stepping relays in accordance with the number of impulses of energy of normal polarity included in each control code cycle, a code detecting relay having an asymmetric unit connected across its terminals, a condenser associated with said code detecting

relay, circuit means effective in one position of the contacts of said second track relay for supplying energy to said last named condenser through the asymmetric unit connected across the terminals of said code detecting relay, circuit means effective in the other position of the contacts of said second track relay for supplying energy from said last named condenser to the winding of said code detecting relay, a signal governing entrance of traffic into said track section, said signal being controlled by said code detecting relay so that when said code detecting relay is released said signal displays its most restrictive indication and when said code detecting relay is picked up said signal displays one or another of a plurality of different permissive indications according to the number of said stepping relays which are energized during each control code cycle.

8. In a coded signaling system, in combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the rails of said section recurring cycles of control code comprising impulses of energy of a first type, means governed by traffic conditions in advance of said section for causing each of said control code cycles to include one or another of a different number of energy impulses, means at the exit end of said section for supplying to the rails of said section detector code comprising impulses of energy of a second type, said impulses of detector code energy being of such duration and being supplied at such intervals that a plurality of such impulses are supplied during one cycle of said control code, a first and a second code following track relay located at the entrance end of said section and operated by energy supplied over the rails of said section, said first code following relay being responsive only to energy of said first type and said second code following relay being responsive only to energy of said second type, a first code detecting means governed by said first code following relay and selectively responsive to the number of times said first code following relay is operated during each of said control code cycles, a second code detecting means governed by said second code following relay, a signal governing entrance of traffic into said section, and means governed by said second decoding means for holding said signal at stop or for causing said signal to display one or the other of a plurality of different permissive indications selected by said first code detecting means.

9. In a coded signaling system, in combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the rails of said section recurring cycles of control code comprising impulses of energy of a first type, means governed by traffic conditions in advance of said section for causing each of said control code cycles to include one or another of a different number of energy impulses, means at the exit end of said section for supplying to the rails of said section detector code comprising impulses of energy of a second type, said impulses of detector code energy being of such duration and being supplied at such intervals that a plurality of such impulses are supplied during one cycle of said control code, code following means at the entrance end of said section operated by energy supplied over the rails of said section, said code following means being selectively re-

sponsive to energy of said first or said second type, a first code detecting means governed by response of said code following means to energy of said first type and selectively responsive to the number of times said code following means is operated by energy of said first type during each of said control code cycles, a second code detecting means governed by response of said code following means to energy of said second type, a signal governing entrance of traffic into said section, and means governed by said second decoding means for holding said signal at stop or for causing said signal to display one or the other of a plurality of different permissive indications selected by said first code detecting means.

10. In a coded signaling system, in combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the rails of said section detector code energy comprising impulses of energy separated by intervals, means at the exit end of said section and effective during said intervals for supplying to the rails of said section impulses of control code energy, the impulses of control code consisting of energy of a first type and the impulses of detector code consisting of energy of a second type, means governed by traffic conditions in advance of said section for governing the supply of impulses of control code energy to the rails of said section to cause them to be supplied in recurring cycles each of which includes one or another of a different number of energy impulses, code following means at the entrance end of said section operated by energy supplied over the rails of said section, said code following means being selectively responsive to energy of said first or said second type, a first code detecting means governed by response of said code following means to energy of said first type and selectively responsive to the number of times said code following means is operated by energy of said first type during each of said control code cycles, a second code detecting means comprising a slow release relay governed by response of said code following means to energy of said second type, said relay being sufficiently slow in releasing to remain picked up only for a period slightly longer than an interval between successive impulses of energy of said second type, a signal governing entrance of traffic into said section, and means effective when said slow release relay is released for causing said signal to display its stop indication and effective when said slow release relay is picked up to cause said signal to display one or another of a plurality of different permissive indications selected by said first code detecting means.

11. In a coded signaling system, in combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the rails of said section detector code energy comprising impulses of energy separated by intervals, means at the exit end of said section and effective during said intervals for at times supplying to the rails of said section impulses of control code energy, the impulses of control code consisting of energy of one polarity and the impulses of detector code consisting of energy of the other polarity, means governed by traffic conditions in advance of said section for governing the supply of impulses of control code energy to the rails of said section to cause them to be supplied in recurring cycles, each of which

includes one or another of a different number of energy impulses, code following means at the entrance end of said section operated by energy supplied over the rails of said section and selectively responsive to the polarity of such energy, a first code detecting means governed by response of said code following means to energy of said other polarity and selectively responsive to the number of times said code following means is operated by energy of said other polarity during each of said control code cycles, a second code detecting means comprising a slow release relay governed by response of said code following means to energy of said one polarity, said relay being sufficiently slow in releasing to remain picked up only for a period slightly longer than an interval between successive impulses of energy of said one polarity, a signal governing entrance of traffic into said section, and means governed by said first and second code detecting means for controlling said signal, said means being effective when said slow release relay is released to cause said signal to display its most restrictive indication and being effective when said slow release relay is picked up to cause said signal to display one or another of a plurality of different permissive indications selected by said first decoding means.

12. In a coded signaling system, in combination, a section of railway track through which traffic normally moves in a given direction, means at the exit end of said section for supplying to the rails of said section detector code energy comprising impulses of energy separated by intervals, means at the exit end of said section and effective during said intervals for at times supplying to the rails of said section impulses of control code energy, the impulses of control code consisting of energy of one polarity and the impulses of detector code consisting of energy of the other polarity, means governed by traffic conditions in advance of said section for governing the supply of impulses of control code energy to the rails of said section to cause them to be supplied in recurring cycles, each of which includes one or another of a different number of energy impulses, a first and a second code following track relay at the entrance end of said section operated by energy supplied over the section rails, said first track relay being responsive only to energy of said one polarity and said second track relay being responsive only to energy of said other polarity, a chain of counting relays governed by said first track relay so that during each control code cycle successive relays are picked up on successive operations of said first track relay with the result that the number of said counting relays which are energized varies in accordance with the number of control code impulses in each control code cycle, a slow release relay energized in response to operation of said second track relay, said slow release relay being sufficiently slow in releasing to remain picked up only for a period slightly longer than an interval between successive impulses of energy of said one polarity, a signal governing entrance of traffic into said section and means governed by said slow release relay and by said counting relays for controlling said signal, said means being effective when said slow release relay is released to cause said signal to display its most restrictive indication and being effective when said slow release relay is picked up to cause said signal to display one or another of a plurality of different permissive indications selected

in accordance with the number of said counting relays which are energized during each control code cycle.

13. In combination, a code detecting relay, a source of direct current, a condenser, a code following relay operable recurrently between a first position in which a first stationary contact is engaged by the operation of said relay to establish a circuit connection to one terminal of said source and a second position in which a second stationary contact is engaged thereby to establish a circuit connection to the other terminal of said source, said connections being so arranged that the source is effectively short circuited in the event both stationary contacts are engaged at the same time, a circuit independent of the winding of said code detecting relay but including said source, said condenser, and the connection established when said first stationary contact is engaged for charging said condenser from said source, and a circuit independent of said source but including said condenser, the winding of said code detecting relay and the connection established when said second stationary contact is engaged for discharging said condenser through the winding of said code detecting relay.

14. In combination, a code detecting relay, a source of direct current, a condenser, a code following relay operable recurrently between a first position in which a first stationary contact is engaged by the operation of said relay to establish a circuit connection to one terminal of said

source and a second position in which a second stationary contact is engaged thereby to establish a circuit connection to the other terminal of said source, said connections being so arranged that the source is effectively short circuited in the event both stationary contacts are engaged at the same time, a circuit for charging said condenser by energy from said source which includes said condenser and source in series with the connection established when said first stationary contact is engaged, a circuit for discharging such stored energy through the winding of said code detecting relay which includes said winding and condenser in series with the connection established when said second stationary contact is engaged, and means associated with said winding for preventing the effective energization of said code detecting relay by energy supplied directly from said source.

HOWARD A. THOMPSON.

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