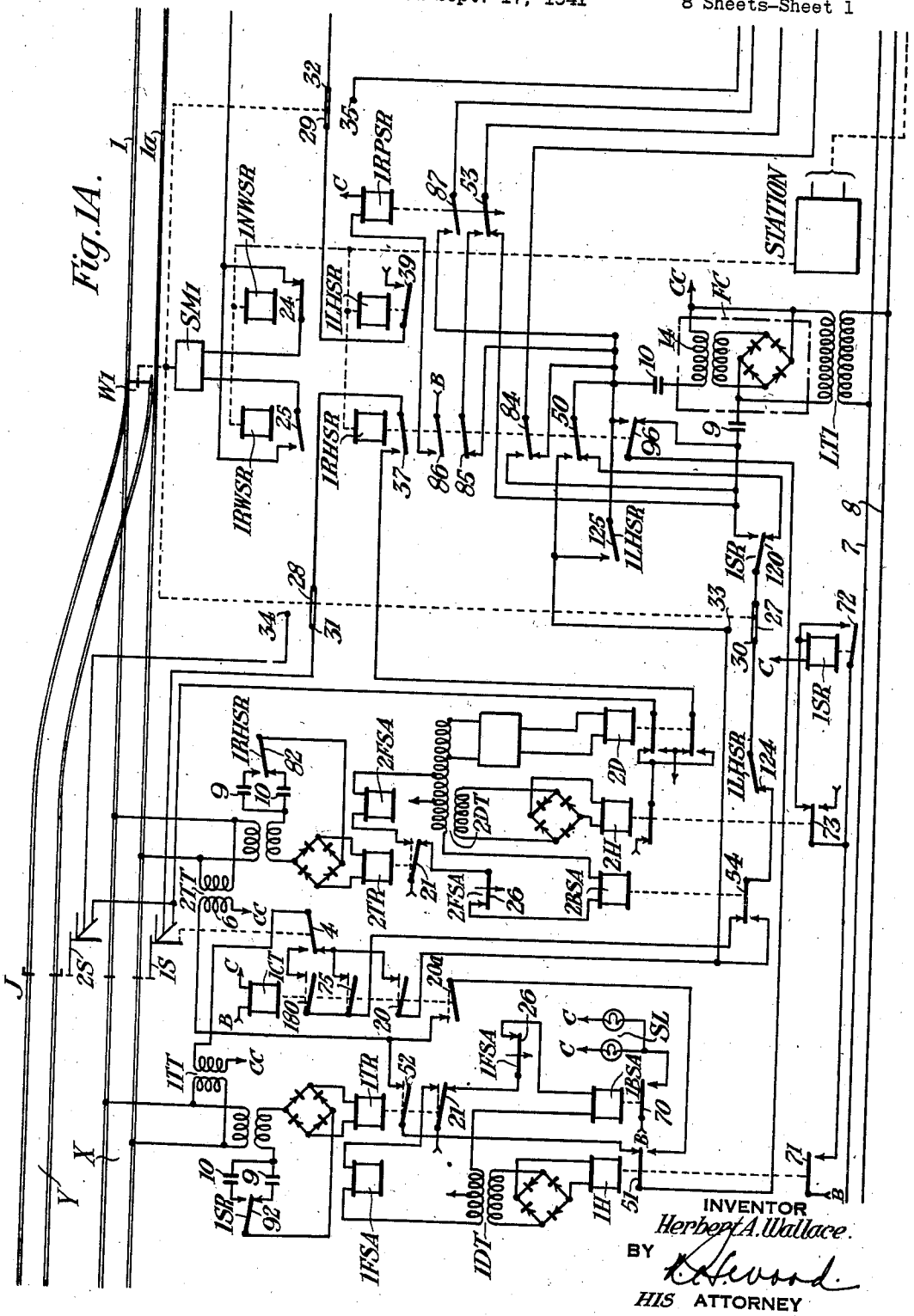
April 6, 1943. H. A. WALLACE 2,315,887

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 17, 1941 8 Sheets-Sheet 1

Fig. 1A.



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RAILWAY TRAFFIC CONTROLLING APPARATUS

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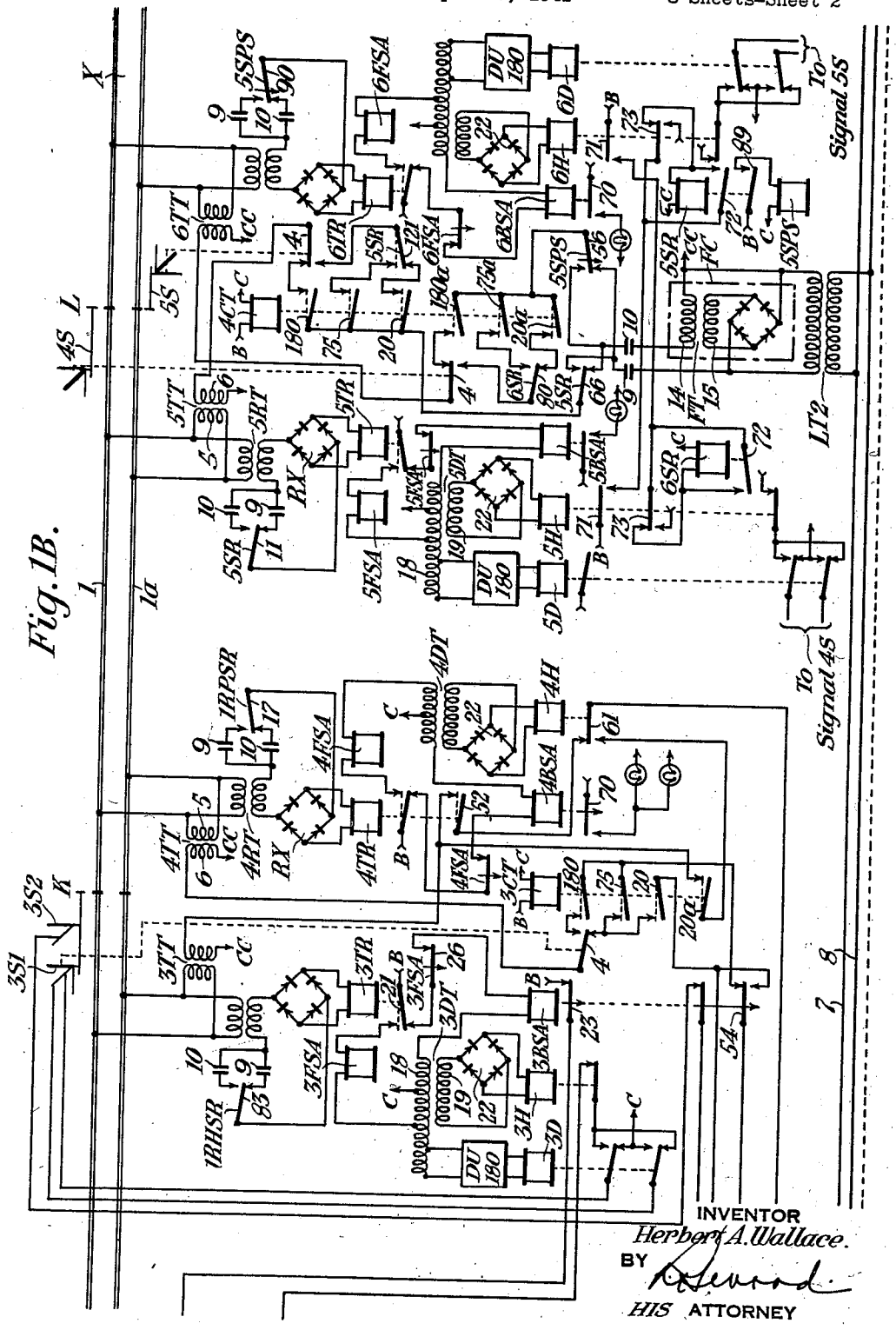


Fig. 1B.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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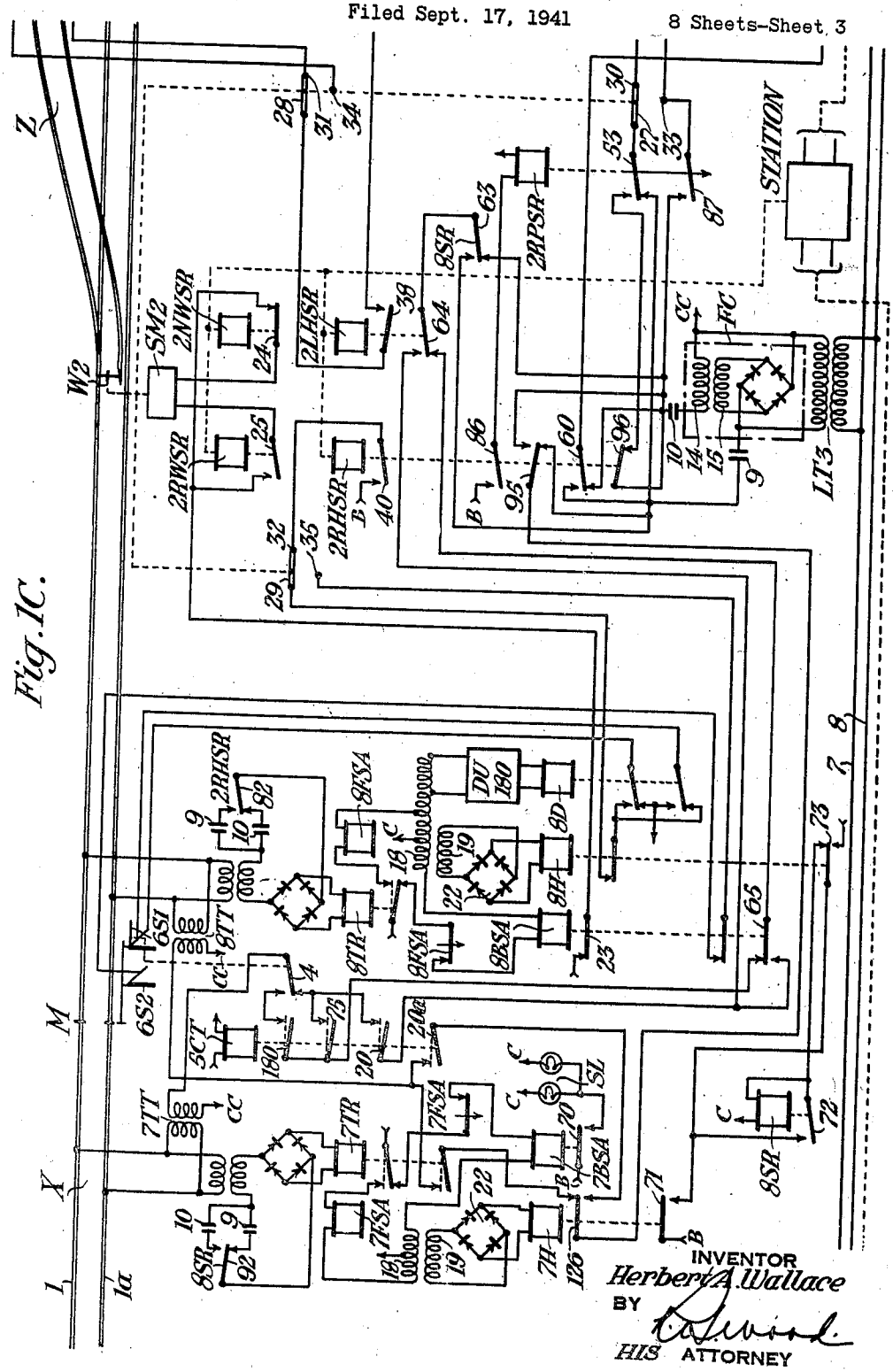


Fig. 1C.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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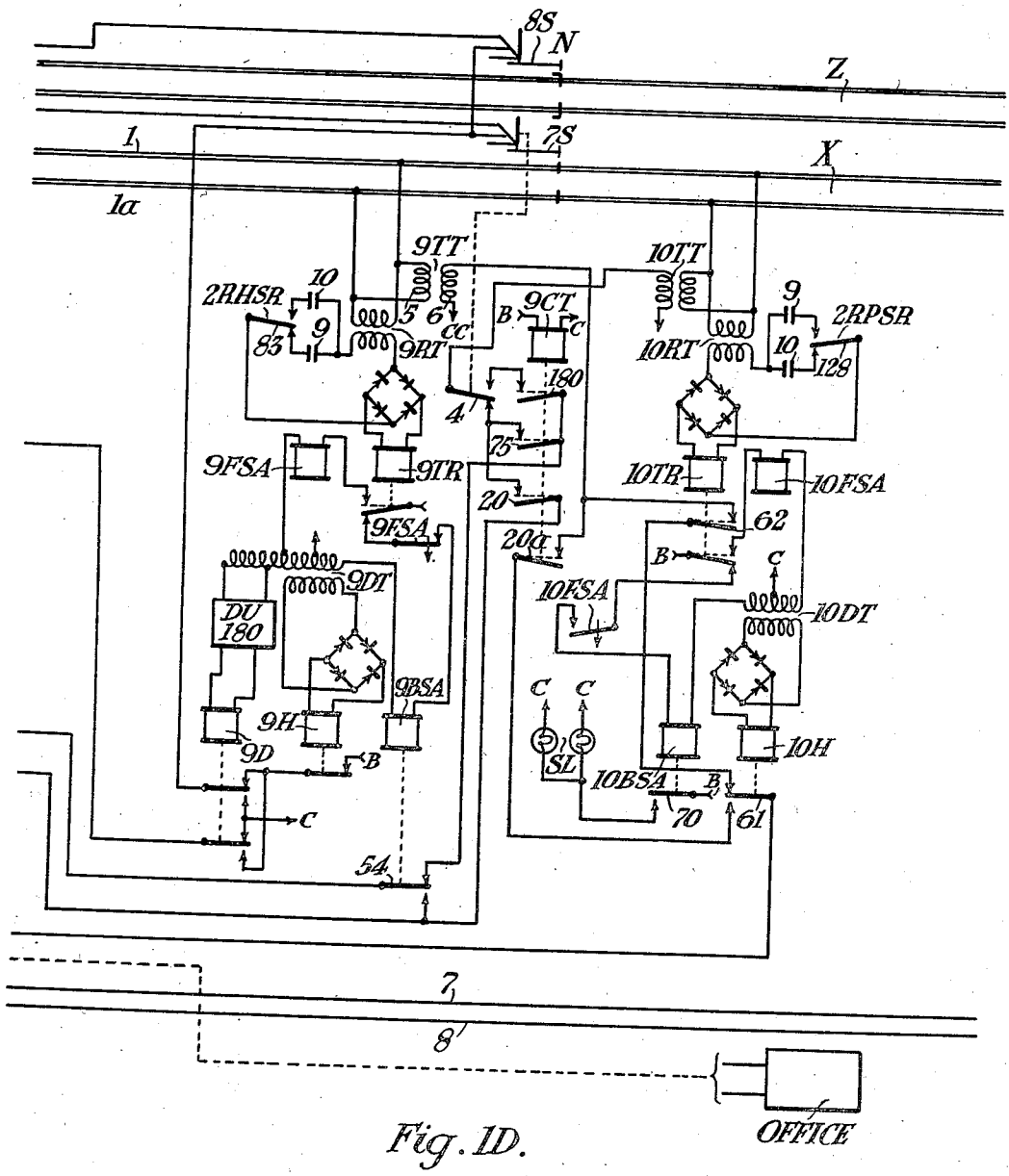


Fig. 1D.

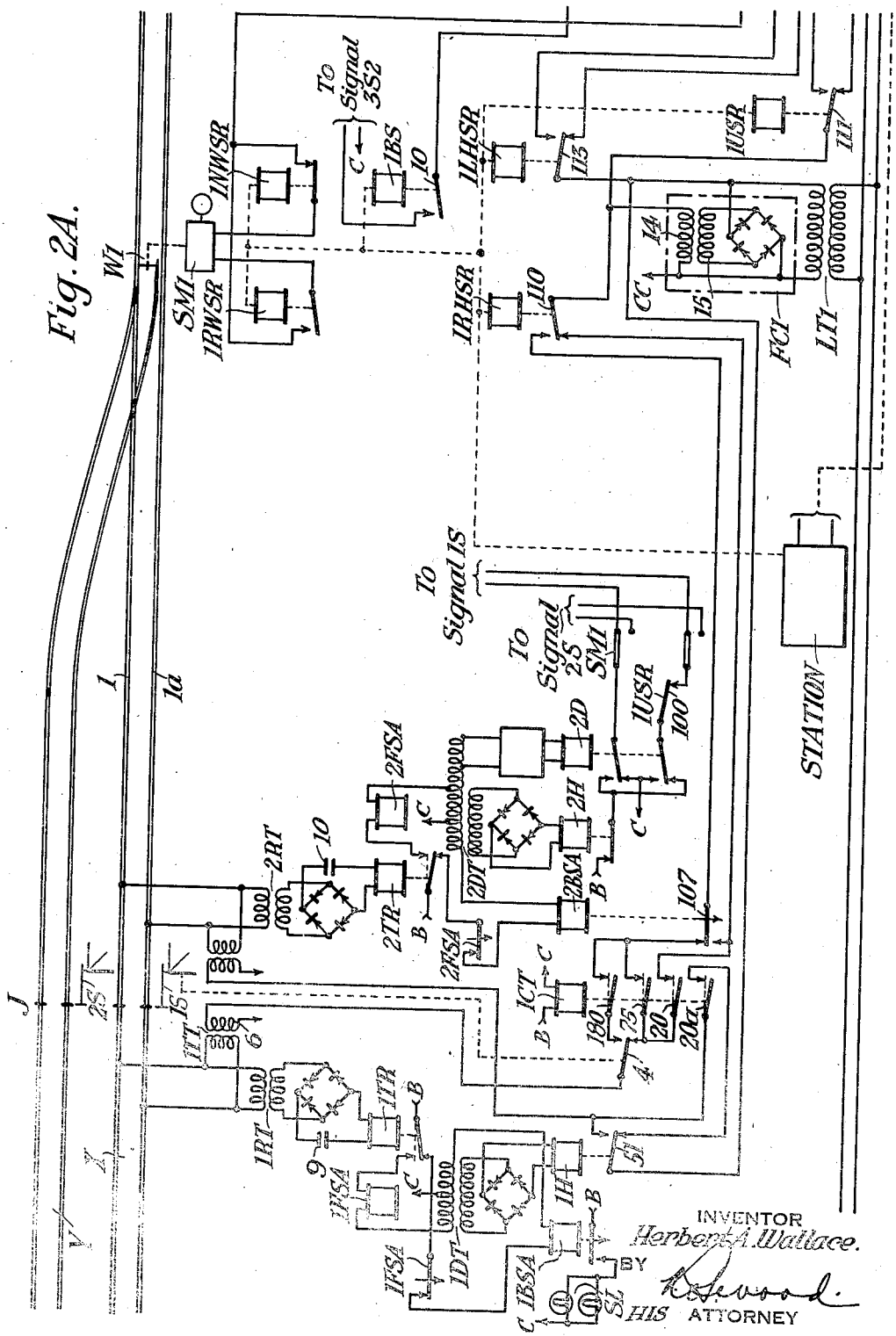
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RAILWAY TRAFFIC CONTROLLING APPARATUS

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Fig. 2A.



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RAILWAY TRAFFIC CONTROLLING APPARATUS

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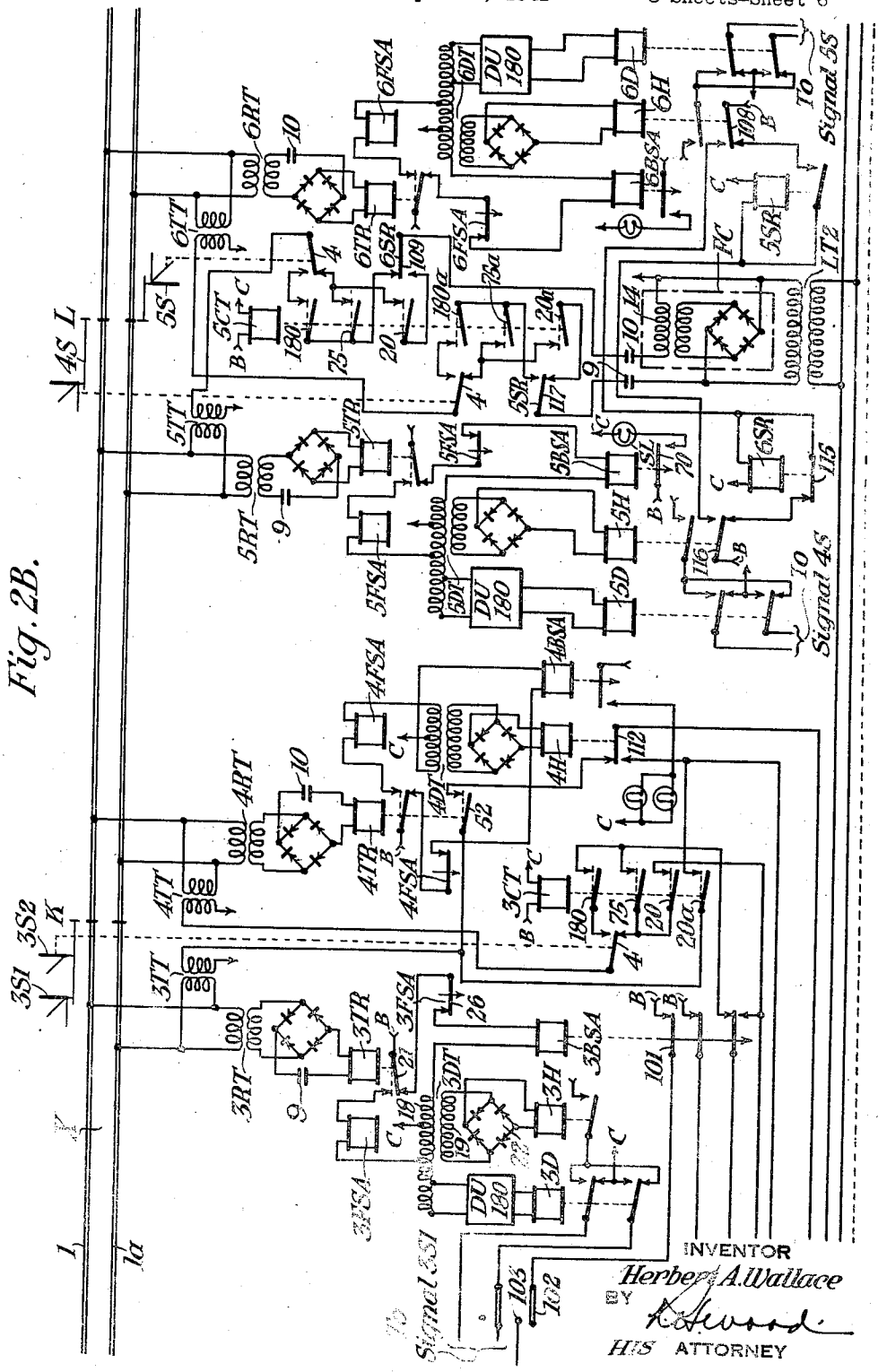


Fig. 2B.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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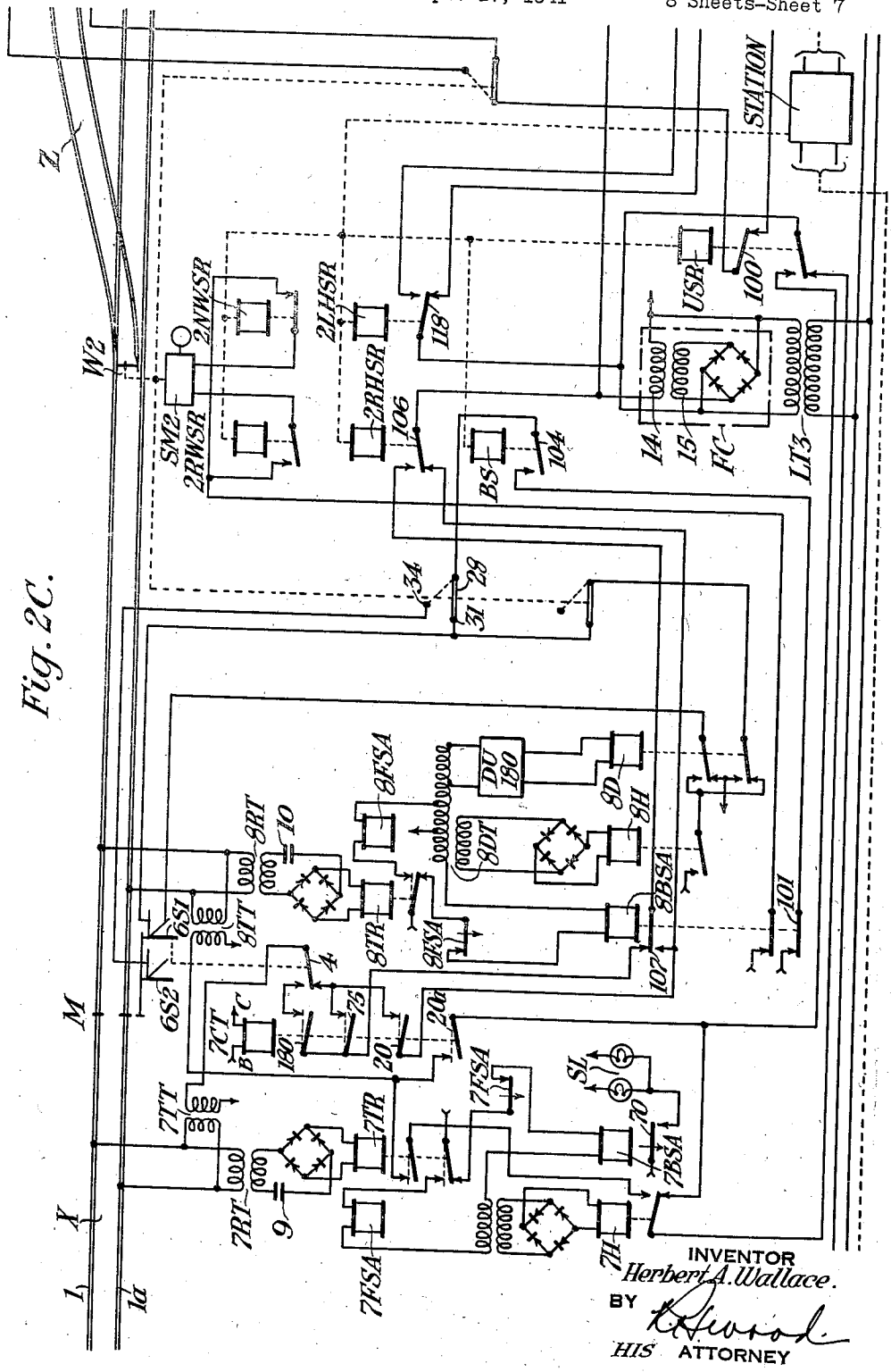


Fig. 2C.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 17, 1941 8 Sheets-Sheet 8

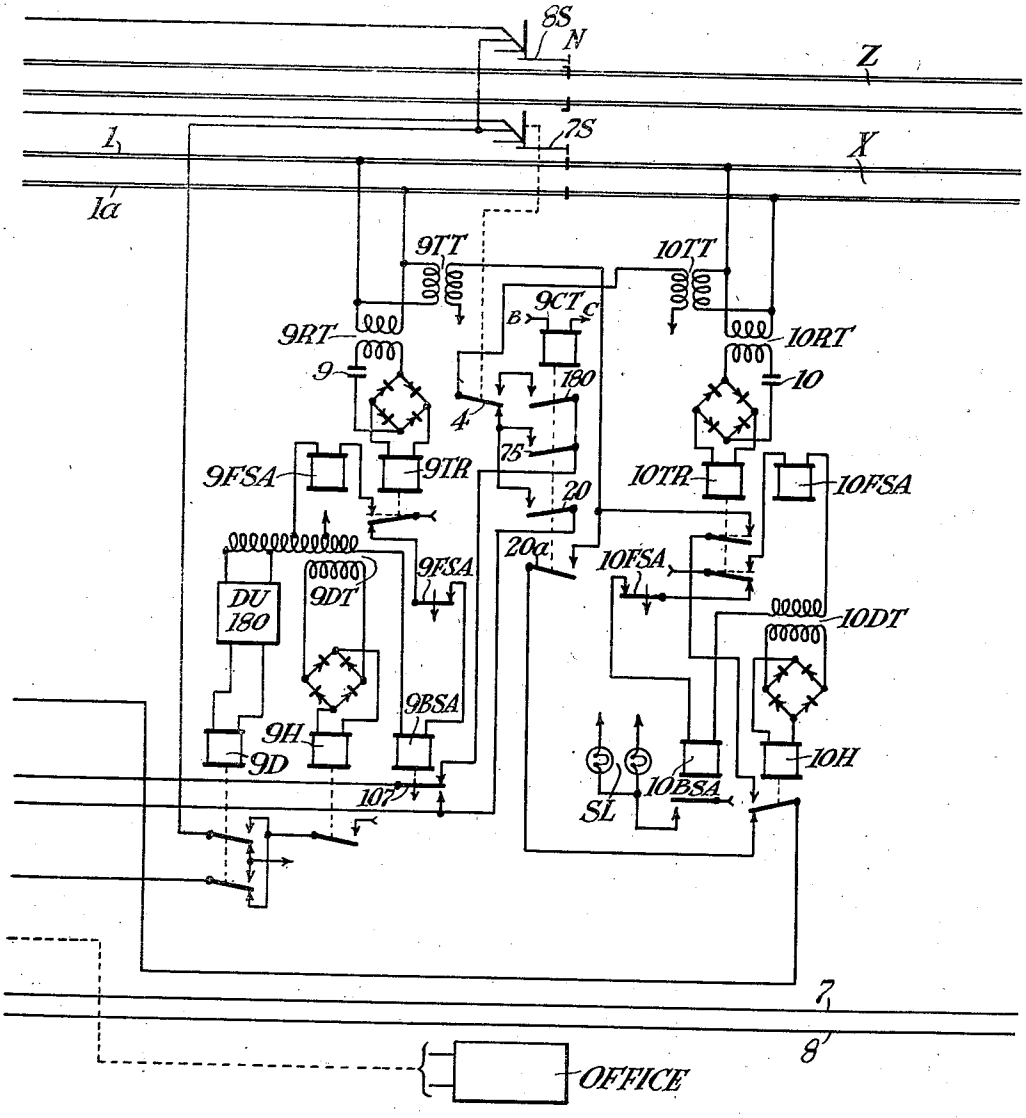


Fig 2D.

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Patented Apr. 6, 1943 2,315,887

UNITED STATES PATENT OFFICE

2,315,887

RAILWAY TRAFFIC CONTROLLING APPARATUS

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Application September 17, 1941, Serial No. 411,162

7 Claims. (Cl. 246—3)

My invention relates to railway traffic controlling apparatus, and it has particular reference to the organization of such apparatus into railway block signal systems for governing traffic movements in both directions over stretches of single track railway. More particularly, my invention relates to systems of the class wherein the direction of traffic movements is governed from a central office by means of a suitable communication system, and in which the signals are controlled in accordance with trackway conditions without the use of line wires.

An object of my invention is to provide railway signal systems of the class described and incorporating novel and improved means for controlling signals through the medium of coded or periodically interrupted current supplied to the track rails.

Another object is to provide railway signal systems of the class described and incorporating novel and improved means whereby signals governing traffic in both directions on a stretch of single track railway are controlled by traffic conditions on the track by means of current transmitted wholly through the track rails of the stretch.

A further object of my invention is to provide novel and improved railway signal systems for governing traffic in both directions on a stretch of single track railway wherein the direction of traffic is controlled by means selectively controlled from a central office station and the signals are controlled by means of current transmitted through the track rails, thereby obviating the necessity of line wires along the track for controlling the signals.

An additional object is to provide novel and improved signal systems of the class described.

The above-mentioned and other important objects and characteristic features of my invention which will become readily apparent from the following description, are attained in accordance with my invention by controlling signals governing traffic in both directions on a stretch of railway track by providing each track section with two track circuits, one for each direction of traffic and each comprising a track relay constantly connected and a source of current intermittently connected to the rails of the section. The two track circuits of each section are arranged to be independent of each other due to the characteristics of energy utilized, and the track circuit apparatus for each direction is arranged to establish control over signals governing traffic in the associated direction wholly through the medium of the track circuit current. My invention further comprises means selectively controlled from a remote office or central station and effective to control the characteristics or coding of the current applied to the track rails whereby to establish control over the signals governing traffic on the stretch.

The invention further resides in the arrangement and organization of railway traffic controlling apparatus into improved forms of block signal systems, as will be made clear in the following description.

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

In the accompanying drawings, Figs. 1A, 1B, 1C and 1D when placed end to end with Fig. 1A on the left, constitute a diagrammatic view showing one form of apparatus embodying my invention, and will be referred to in the description as Fig. 1. Figs. 2A, 2B, 2C and 2D, when placed end to end with Fig. 2A on the left, constitute another diagrammatic view, which will be referred to as Fig. 2, representing a modified arrangement embodying my invention of the apparatus represented in Figs. 1A–1D, inclusive. In each of the two views, similar reference characters have been employed to designate corresponding parts.

Referring to Fig. 1, the reference characters 1 and 1*a* designate the track rails of a stretch of railway track X connected at one end by means of a track switch W1 to a siding or passing track Y and connected at the opposite end by another switch W2 to another siding or passing track Z. The rails of stretch X are divided by insulated joints 2 into a plurality of successive adjoining track sections J—K, K—L, L—M and M—N.

The reference characters S with distinguishing prefixes designate signals for governing traffic on stretch X. Eastbound traffic, that is, traffic operating from left to right as viewed in Fig. 1, is governed by signal 1S or 2S and by signal 5S, while traffic in the opposite or westbound direction is governed by signal 7S or 8S and by signal 4S. In addition, signals 3S and 6S are provided for governing the entrance of traffic into the siding sections J—K and M—N, respectively. These signals may be of any desired type, but for the purposes of this description it is assumed that the signals are of the searchlight type each having an operating mechanism such as is shown in United States Letters Patent No. 2,172,724 granted on September 12, 1939, to W. B. Wells and W. K.

Lockhart for Light signals. It is deemed sufficient to state that when the mechanism of a signal S is energized by current of one polarity, it is conditioned to display its clear indication; when energized by current of the opposite polarity, the signal is conditioned to display its approach indication; and when the mechanism is deenergized the signal is conditioned to display its stop indication. Each signal also is provided with an associated circuit controller comprising a movable member 4 which is operated by the associated signal mechanism to its upper or front position when the signal is conditioned to display either its clear or its caution aspect, and which member is operated by the signal mechanism out of its front and into its back position when the signal is conditioned to display its stop aspect. Each signal also has a signal lamp, designated by the reference character SL, which lamp normally is dark but which at times becomes illuminated in a manner to be made clear presently. As shown, the signals 3S and 6S preferably comprise two searchlight signal units mounted on a single mast. I shall refer to these units as being upper and lower units, corresponding to their location on the mast, and have designated the upper and lower units by the reference characters of the signal together with the suffix 1 or 2 respectively.

It is, of course, to be understood that the specific arrangement of signals shown in the drawings is merely illustrative and other arrangements of signals may be employed. For example, additional signals may be provided for the stretch in pairs, as at location corresponding to L, or singly if desired.

Each section of track is provided with two track circuits, one for each direction of traffic, both including the rails of the section and arranged to be independent of each other due to the distinctive characteristics of the energy employed. Section K—L, for example, has two track circuits formed by connecting suitable sources of differently characterized currents to opposite ends respectively of the section, and by connecting two track relays, designated by the reference characters TR with suitably distinguishing prefixes, to the track rails at opposite ends of the section, respectively. The track relays of the sections are arranged to respond only to current of the character supplied at the opposite end of the section, and for the purposes of this description I shall assume that the distinctively characterized currents employed are alternating currents of different frequencies, and that the relays are conditioned by suitable tuning means, to respond selectively to alternating current of one frequency or the other.

As shown in Fig. 1, the track circuit apparatus of the several sections is arranged in such manner that the rails of each section normally are supplied at the east-bound entrance or left-hand end, as viewed in the drawings, with current of a particular frequency to control a track relay TR at the other end arranged to respond only to current of such particular frequency, and are supplied at the westbound entrance or right-hand end with current of a different frequency which controls another track relay TR at the left-hand end arranged to respond only to current of such different frequency. Considering section K—L, for example, the rails of this section are supplied at end K with alternating current of a particular frequency by means of a track transformer 4TT which has its secondary winding 5 connected to the rails and has its primary winding 6 connected through a circuit to be traced shortly, to a transformer LT1 which in turn is connected to a pair of line wires 7 and 8 supplied with energy from a suitable source of alternating current, such as a generator, not shown, generating current of the particular frequency. Such current may, for example, have a frequency corresponding to that ordinarily employed in railway signaling to control train-carried apparatus such as cab signals. Current of this frequency I shall term current of the first or train-control frequency, and for the purposes of this explanation I shall assume that this frequency is of the order of 100 cycles per second. At the opposite end L of the section, relay 5TR is connected through a receiving transformer 5RT and a rectifier RX to the rails of the section, and the connection of the relay to the rails is suitably tuned by means which may, for example, include a condenser 9, to effective resonance at the frequency corresponding to the frequency of current applied at the opposite end of the section. At times, however, another condenser 10 is utilized to tune relay 5TR, and condenser 9 or 10 is rendered effective to tune the connection of relay 5TR to effective resonance at the first or at another frequency according as contact 11 operated by a relay 5SR, hereinafter referred to, is in its released back position or is in its attracted front position, respectively.

The rails of section K—L are supplied at end L with current of the other frequency through track transformer 5TT having a secondary winding 5 connected to the track rails and its primary winding 6 connected through a circuit presently to be traced, to a source of alternating current having a frequency different from the first frequency. Current of such different frequency may be obtained from any suitable source such as, for example, another pair of line wires connected to another generator generating current of such different frequency, or as shown, such current may be obtained from the secondary winding 14 of a transformer FT forming a part of a frequency changer FC, which frequency changer comprises a rectifier 16 having its input terminals connected through line transformer LT2 to the line wires 7 and 8 and having its output terminals connected to the primary winding 15 of transformer FT. It is readily apparent that rectifier 16 when energized by current of the first frequency supplies two pulses of unidirectional current to winding 15 of transformer FT in each cycle of alternating current, hence there is induced in secondary winding 14 by these double frequency pulses of unidirectional current, an alternating electromotive force having a frequency which is double the frequency of current in wires 7 and 8. It follows, therefore, that secondary winding 14 of transformer FT may be considered as a source of alternating current having a second frequency of 200 cycles per second, or a frequency distinctively different from the alternating current of the first frequency supplied at the opposite end of the section.

Relay 4TR is connected to the rails of section K—L at end K through rectifier RX and transformer 4RT tuned by condenser 10 to effective resonance at a frequency corresponding to the second frequency supplied at the opposite end of the section. Another condenser 9 also is provided, and relay 4TR may be tuned to respond to current of the second or the first frequency according as condenser 10 or 9 is rendered effective to tune the circuit connection when contact 17 of a relay 1RPSR, to be referred to later, is

in its released back position or is in its attracted front position, respectively.

The current of each character supplied to the sections is coded or periodically interrupted in any suitable manner. The currents supplied to section K—L, for example, are coded by code transmitters or coders 3CT and 4CT. These coders may be of any suitable type, and each has been represented conventionally in the drawings as comprising a constantly energized winding operating a plurality of contacts 20, 75 and 180, each at a different code rate of, say, 20, 75 and 180 times per minute, respectively. It is to be understood that the contacts of these transmitters close at the rate of 20, 75 and 180 times per minute, respectively, in such manner as to produce interrupted current having "on" and "off" periods in the track circuit. The currents supplied to the other sections are similarly coded either by means of code transmitters CT, or by means of the track relays TR which may be employed in the usual manner to repeat the code from one section into the next.

The track relays TR are of the code following type, and each has associated therewith code responsive or decoding apparatus arranged to respond to frequency type code energy. This decoding apparatus comprises a decoding transformer, designated by the reference character DT with a suitably distinguishing prefix, a plurality of code responsive relays, designated by the reference characters FSA, BSA, H and D, each with a distinguishing prefix, and a decoding unit DU180. The decoding apparatus represented in Fig. 1B associated with relay 3TR is typical and a detailed description of such apparatus will serve also to describe the decoding apparatus associated with each of the other track relays.

Referring now to Fig. 1B, decoding transformer 3DT associated with relay 3TR has a portion of its primary winding 18 supplied with unidirectional current from a suitable source, such as a battery not shown but having its opposite terminals designated in the drawing by the reference characters B and C, at such times as contact 21 of relay 3TR is in its front position to complete a circuit extending from terminal B through front contact 21 of relay 3TR, the winding of relay 3FSA, and a portion of winding 18 to terminal C. When contact 21 of relay 3TR is in its back position and front contact 26 of relay 3FSA is closed, another portion of winding 18 is energized over a circuit extending from terminal B through back contact 21 of relay 3TR, front contact 26 of relay 3FSA, the winding of relay 3BSA, and a portion of winding 18 to terminal C. The relays 3FSA and 3BSA are sufficiently slow releasing as to bridge respectively the "off" and "on" intervals of 20 code energy, hence when relay 3TR operates in response to energy coded at the rate of 20 or more cycles per minute, relay 3FSA is energized each time relay 3TR closes its front contact 21 due to an "on" interval of code energy received from the rails of the associated section, and with front contact 26 of relay 3FSA closed, relay 3BSA is energized each time relay 3TR closes its back contact 21 in response to an "off" interval of code in the associated section. When, however, relay 3TR is steadily energized, relay 3BSA is released since its energizing circuit is held open at back contact 21 of relay 3TR, or if relay 3TR is steadily released, both relays 3FSA and 3BSA are released since the circuit of relay 3FSA is open at front contact 21 of relay 3TR and with front contact 26 of relay 3FSA open, relay 3BSA is placed on open circuit. It follows, therefore, that relay 3BSA is energized when and only when its associated relay 3TR operates in response to coded energy received from its associated section, and that by properly proportioning the release periods of relays 3FSA and 3BSA, relay 3BSA may be employed to detect operation of its associated track relay by energy coded at the rate of 20 or more code cycles per minute.

With winding 18 of transformer 3DT supplied with energy in the manner described, it is readily apparent that the direction of flux in the transformer is reversed at a rate corresponding to the rate at which relay 3TR operates its contact 21, hence there is induced in secondary winding 19 of transformer 3DT, an alternating electromotive force having a frequency corresponding to the code rate of operation of relay 3TR. Relay 3H is connected through a rectifier 22 to winding 19, and the relay and transformer are proportioned and constructed in such manner that relay 3H is effectively energized and picked up whenever relay 3TR operates at any one of the usual code rates of 75 or more cycles per minute, but not when relay 3TR operates at a relatively low code rate of, say, 20 cycles per minute.

Relay 3D is connected by means of a decoding unit DU180 to winding 18 of transformer 3DT. The details of construction of decoding unit DU180 are not shown in the drawings, but usually such unit comprises a reactor condenser tuning unit tuned to resonance at a frequency corresponding to the 180 code rate. Relay 3D is, therefore, effectively energized when and only when relay 3TR operates at the 180 code rate to induce in transformer 3DT an alternating electromotive force having a frequency corresponding to the 180 code rate.

Located adjacent the left-hand end, as viewed in the drawings, of the stretch are two manually controllable switch control relays 1RWSR and 1NWSR for controlling the adjacent switch W1, and two manually controllable signal control relays, one relay 1RHSR for governing the associated signals 1S and 2S and the other relay 1LHSR for governing signal 3S. Relay 1RHSR is provided with a repeater relay 1RPSR having quick pick-up and slow release characteristics. These switch and signal control relays as shown are remotely controlled by means of a communication system which may be of any suitable type, but is here assumed to be of the selective or code type, in which communication is established intermittently by means of impulse codes transmitted from an office over line wires to the various field stations, as shown, for example, in the Lewis Patent No. 2,229,249, granted on January 21, 1941, for Remote control systems.

The opposite end of the stretch is likewise provided with two manually controllable switch control relays 2RWSR and 2NWSR for controlling the adjacent switch W2, and two manually controllable signal control relays, one relay 2RHSR for governing the associated signal 6S and the other relay 2LHSR for governing signals 7S and 8S. These relays as shown are controlled over the same communication system which controls the manually controlled switch and signal control relays at the left-hand end of the stretch. Relay 2RHSR is provided with a quick pick-up, slow release repeater relay 2RPSR.

The switches W1 and W2 are provided with power operated switch mechanisms SM1 and SM2, respectively. These switch mechanisms may be of any suitable type such as of the electric or electropneumatic type, and it is deemed sufficient to state that when the associated section J—K is unoccupied so that relay 3BSA is picked up to close its front contact 23, the selection of relay 1NWSR for operation by the communication system causes that relay to pick up and close its front contact 24 to cause the associated switch mechanism SM1 to operate switch W1 to its normal position, as represented in the drawings. When the section is unoccupied so that relay 3BSA closes its front contact 23, the selection of relay 1RWSR for operation by the communication system causes relay 1NWSR to be released, and relay 1RWSR to be picked up to close its front contact 25 and cause switch mechanism SM1 to operate switch W1 to its reverse position. The operation of switch W2 is similarly controlled by relay 6BSA in response to traffic conditions in section M—N and by switch control relays 2NWSR and 2RWSR.

Each switch mechanism is provided in the usual manner with a circuit controller including contacts operated in accordance with the position of the switch. Contacts 27, 28 and 29, for example, are operated by switch W1 and switch mechanism SM1 into engagement with contacts 30, 31 and 32, respectively, when switch W1 is in its normal position, and are operated out of engagement with such contacts and into engagement with contacts 33, 34 and 35, respectively, when the switch is in its reverse position. Contacts 27, 28 and 29 associated with switch mechanism SM2 are operated in a similar manner in accordance with the position of switch W2.

The signals S1 and S2 at the left-hand end of the stretch are controlled jointly by traffic conditions on the stretch and by manually controllable relay 1RHSR. When switch W1 is in its normal position and contact 28 controlled thereby engages contact 31 to close a circuit controlling contact 28—31, the selection of relay 1RHSR by the communication system for operation and consequent energization of such relay to close its front contact 37 causes signal 1S to be energized over an easily traced circuit by current of one relative polarity when both relays 2D and 2H are picked up, and to be energized by current of the opposite relative polarity when relay 2D is released but relay 2H is picked up. The polarity of current supplied to signal 1S when both relays 2D and 2H are picked up is selected to condition that signal to display its clear aspect, while current of the opposite polarity conditions the signal to display its caution aspect. When both relays 2D and 2H are released, or relay 1RHSR is deenergized, or contact 28—31 of switch W1 is opened, the signal mechanism of signal 1S is deenergized and the signal accordingly is conditioned to display its stop indication. It is, of course, readily apparent that when switch W1 is reversed so that contact 28 is operated to close contact 28—34, the energization of relay 1RHSR causes the signal mechanism of signal 2S to condition the signal to display its clear or its caution aspect, respectively, according as both relays 2D and 2H are picked up, or relay 2D is released and relay 2H is picked up. Signal 2S obviously is deenergized and is conditioned to display its stop aspect whenever switch W1 is in its normal position so that contact 28—34 is open, or whenever relay 1RHSR is released, or when both relays 2H and 2D are released. The signals 7S and 8S at the opposite end of the stretch are similarly controlled by relay 2LHSR, the position of switch W2, and relays 9H and 9D, as is readily apparent from an inspection of the drawing.

Signal 3S is controlled by traffic conditions in advance and by relay 1LHSR, with the upper or lower unit respectively being selected for control according as switch W1 is in its normal or its reverse position to close contact 29—32 or 29—35, respectively. When relay 1LHSR is selected for operation by the communication system, and the upper unit is selected by the position of switch W1 for control, the unit is conditioned to display its clear or its caution aspect, respectively, according as both relays 3D and 3H are picked up, or relay 3D is released and relay 3H is picked up. This unit of signal 3S of course is deenergized and is conditioned to display its stop aspect whenever relay 1LHSR is released, or when both relays 3D and 3H are released. The lower unit of signal 3S is controlled over an obvious circuit completed when front contact 39 of relay 1LHSR, switch contact 29—35 and front contact of relay 3BSA are closed. Signal 6S at the opposite end of the section is controlled in a similar manner, as can be seen from an inspection of the drawing, by relay 2RHSR, the position of switch W2, and relays 8H, 8D and 8BSA.

Signals 4S and 5S are controlled in the usual manner by the decoding relays associated with track relays 5TR and 6TR, respectively. That is to say, each signal is conditioned to display its clear aspect when both the associated decoding relays D and H are picked up; the signal is conditioned to display its caution indication when the associated decoding relay H is picked up and the associated decoding relay D is released; and the signal is conditioned to display its stop aspect when both the associated H and D decoding relays are released.

The apparatus at intermediate signal location L includes two directional stick relays 5SR and 6SR associated with track relays 5TR and 6TR, respectively. Relay 5SR is provided with a slow releasing repeater relay 5SPS. The functions of these relays will be made clear presently, but at this time it should be pointed out that relays 5SR and 5SPS may at times be utilized to alter the tuning of track relays 5TR and 6TR, respectively. Other stick relays 1SR and 8SR associated with track relays 1TR and 8TR, respectively, are provided for altering at times the tuning of relays 1TR and 7TR, respectively, while the tuning of the remaining track relays may be altered by relays 1RHSR, 1RPSR, 2RPSR and 2RHSR, as will be made clear presently.

In the drawings, certain contacts have been represented remote from the relays controlling such contacts, but in each case such a contact has been designated not only by a reference character individual to such contact but also by placing adjacent the contact the reference character of the relay operating such contact.

The apparatus embodying my invention is in its normal condition, as represented in the drawing, when switch control relays 1NWSR and 2NWSR are picked up, switches W1 and W2 are in their respective normal positions, sections J—K, K—L, L—M and M—N are unoccupied, and the sections (not shown) extending to the left of section J—K and to the right of section M—N are likewise unoccupied. In this condi-

tion of the apparatus, signals 4S and 5S are caused to display their respective caution aspects, while signals 1S, 2S, 3S, 6S, 7S and 8S are caused to display their respective stop aspects. All track relays connected at the right-hand ends of the sections (the relays having odd-numbered prefixes) are tuned to respond to current having the first frequency while the remaining track relays connected at the opposite ends of the sections are tuned to respond to current of the second frequency.

Coded current having the first frequency is supplied to the track rails of section J—K at end J over a circuit extending from one terminal of line transformer LT1 through condenser 9, back contact 96 of relay 1RHSR, front contact 51 of relay 1H, front contact 52 (when closed) of track relay 1TR, primary winding 6 of track transformer 2TT and through a common connection, indicated by the reference character CC, to the opposite terminal of the secondary winding of transformer LT1. This current is caused to be coded in response to relay 1TR following coded current in the rails of the section to the left of section J—K, which section may be supplied with track circuit current of the first frequency by means of apparatus substantially corresponding to that hereinafter to be described whereby the rails of the section extending to the right of section M—N are supplied with track circuit current of the first frequency. As will be made clear presently, current of the first frequency supplied to the section to the left of section J—K is normally coded at the 75 code rate, with the result that relay 1TR operates at the 75 code rate to hold relays 1H, 1FSA and 1BSA energized and to repeat the 75 code current into section J—K. The current of the first frequency coded at the 75 code rate and supplied at J to section J—K, causes relay 3TR to operate and to hold relays 3H, 3FSA and 3BSA energized, but relay 3D is released.

With signal 3S in its stop position to cause its associated contact 4 to assume its back position, current of the first frequency coded at the 75 code rate is likewise supplied to section K—L at end K over a circuit extending from one terminal of secondary winding of transformer LT1 through condenser 9, back contact 53 of relay 1RPSR, front contact 54 of relay 3BSA, contact 75 of coder 3CT, back contact 4 of signal 3S, primary winding 6 of track transformer 4TT, and common connection CC to the other terminal of the secondary winding of transformer LT1. It should, however, be noted that if signal 3S is conditioned to display either its caution or its clear aspect so that the associated contact member 4 is in its front position, then the current supplied over the just traced circuit is coded at the 180 code rate. With, however, section K—L supplied with 75 code current of the first frequency, relay 5TR operates to hold relays 5H, 5BSA and 5FSA energized, thereby conditioning the signal mechanism of signal 4S to cause that signal to display its caution aspect. Current of the first frequency and coded at the rate of 180 cycles per minute is supplied to the rails of section L—M at L over a circuit including the secondary winding of line transformer LT2, condenser 9, back contact 56 of relay 5SPS, contact 180*a* operated by coder 4CT, front contact 4 operated by signal 4S, and primary winding 6 of track transformer 6TT. Relay 7TR accordingly operates at the 180 code rate to hold relays 7H, 7FSA and 7BSA picked up, and to repeat this 180 code current of the first frequency into section M—N at M over a circuit substantially corresponding to the circuit previously traced and over which section J—K is supplied with current of the first frequency. Relay 9TR of section M—N of course follows this 180 code current in section M—N to hold relays 9D, 9H, 9FSA and 9BSA picked up, but with relay 2LHSR released, signal 7S is at stop and contact 4 operated thereby is closed in its back position so that 75 code current of the first frequency is supplied to the section to the right of section M—N over a circuit substantially corresponding to the circuit previously traced and by means of which current of the first frequency is supplied at K to the rails of section K—L.

Relay 10TR normally operates at the 75 code rate due to current received from the rails of the section to the right of section M—N, which rails preferably are energized by current of the second frequency coded at the 75 code rate and supplied to the rails by apparatus (not shown) substantially corresponding to the apparatus hereinafter described whereby the rails of the section extending to the left of section J—K are suppplied with current of the second frequency.

Coded current of the second frequency is supplied to the rails of section M—N at N over a circuit extending from one terminal of winding 14 of frequency changer FC through condenser 10, back contact 60 of relay 2RHSR, front contact 61 of relay 10H, front contact 62 (when closed) of relay 10TR, primary winding 6 of track transformer 9TT and the common connection to the other terminal of winding 14. With relay 10TR responding to 75 code current from the rails of the section to the right of section M—N, the current supplied to section M—N is coded at the 75 code rate and causes relay 8TR to respond and pick up relays 8FSA, 8BSA and 8H, but relay 8D is released. Relay 2RHSR also is released hence signal 6S is causes to display its stop aspect.

With signal 6S at stop so that its associated contact member 4 is in its back position, section L—M is supplied at M with 75 code current of the second frequency over a circuit extending from one terminal of winding 14 of frequency changer FC through condenser 10, back contact 63 of relay 6SR, back contact 64 of relay 2LHSR, front contact 65 of relay 6BSA, contact 75 of coder 5CT, back contact 4 operated by signal 6S, and the primary winding of track transformer 7TT through common connection CC to the other terminal of winding 14. Relay 6TR accordingly operates at the 75 code rate and relays 6H, 6FSA and 6BSA are energized, but relay 6D is released, so that signal 5S is conditioned to display its caution aspect and contact 4 operated thereby is in its front position. Current of the second frequency coded at the 180 code rate is supplied at L to section K—L over a circuit including secondary winding 14 of frequency changer FC, condenser 10, back contact 66 of relay 5SR, contact 180 of coder 4CT, front contact 4 operated by signal 5S and primary winding 6 of track transformer 5TT. Relay 4TR operates at this 180 code rate to hold relays 4H, 4FSA and 4BSA picked up, and to repeat this 180 code current of the second frequency into section J—K at K over a circuit substantially corresponding to the circuit previously traced over which section M—N is supplied at N with current of the second frequency. Relay 2TR of course follows this 180 code current to hold relays 2D, 2H, 2FSA and 2BSA picked up, but with relay 1RHSR released,

signals 1S and 2S controlled thereby are conditioned to display their stop aspects and contact 4 operated by signal 1S is operated to its back position so that 75 code current of the second frequency is supplied to the section to the left of section J—K over a circuit including winding 14 of frequency changer FC, condenser 10, back contact 50 of relay 1RHSR, back contact 120 of relay 1SR, contact 27—30 operated by switch W1, back contact 124 of relay 1LHSR, front contact 54 of relay 2BSA, contact 75 of coder 1CT, back contact 4 of signal 1S and the primary winding of transformer 1TT.

The system shown in Fig. 1 is arranged to control both wayside signals and train-carried cab signals or train control apparatus, hence the organization is such that whenever the apparatus is conditioned for a traffic movement in either direction, track circuit current of the first or train-control frequency (here assumed to be of the frequency of 100 cycles per second) is fed to the rails of each section so as to be transmitted through the rails toward the approaching train, and current of the other frequency is fed to the rails so as to be transmitted away from the train. In the normal condition of this apparatus, as represented in the drawings, each of the sections is supplied at its left-hand end with track circuit current having a frequency of 100 cycles per second, while current of the other frequency of 200 cycles per second is fed to the sections at the right-hand end. The apparatus is, therefore, normally conditioned for a westbound train movement since the current of train-control frequency is supplied to the stretch in the direction to be fed toward a westbound train.

I shall now assume that the operator wishes to move a westbound train over the signaled stretch. To do so, apparatus (not shown) is first conditioned so as to cause the current in the section to the right of section M—N, operating relay 10TR, to be shifted to the 20 code rate, in a manner substantially corresponding to that hereinafter described in detail whereby relay 1LHSR is caused to shift the code rate of energy supplied at J to the section to the left of section J—K. Relay 10H releases and completes an obvious circuit path, including its own back contact 61 and contact 20*a* of coder 9CT, whereupon section M—N is supplied at N with 20 code current. Relay 8TR follows this 20 code current to release relays 8H and 8D.

The westbound signal 7S may now be cleared by the operator suitably controlling the communication system to cause relay 2LHSR to pick up and close its front contact 38 to thereby establish the previously mentioned circuit over which signal 7S is conditioned to display its clear aspect. The lamp of signal 7S is not illuminated at this time, however, since the section to the right of section M—N is assumed to be unoccupied and relay 10BSA accordingly is energized to hold open its back contact 70 which when closed completes an obvious energizing circuit for the lamps SL of signals 7S and 8S. Signal 7S when conditioned to display its clear aspect causes the associated contact 4 to operate from its back to its front position to alter the coding of the current supplied at N to the section to the right of section M—N from 75 to the 180 code rate, while front contact 64 of relay 2LHSR closes to shift the 200 cycle current supplied to section L—M from the 75 code rate to the 20 code rate. This 20 code current is supplied to section L—M over a circuit including winding 14 of frequency changer FC, condenser 10, back contact 63 of relay 8SR, front contact 64 of relay 2LHSR, contact 20 of coder 5CT, back contact 4 operated by signal 6S and the primary winding of track transformer 7TT. Relay 6TR of course follows this 20 code current so that relays 6H and 6D associated therewith are released to condition signal 5S to display its stop aspect. Stick relay 6SR is picked up over a circuit extending from terminal B through back contact 71 of relay 6H, front contact 73 of relay 5H, the winding of relay 6SR to terminal C, and relay 6SR closes its front contact 72. Signal 5S when conditioned to display its stop aspect causes the associated contact 4 to operate to its back position to complete an obvious path, including back contact 4 of signal 5S, back contact 121 of relay 5SR and contact 20*a* of coder 4CT, whereupon the coding of the current supplied to section K—L is shifted from the 180 to the 20 code rate. Relay 4TR operates at this 20 code rate with the result that the associated decoding relay 4H is released to close its back contact 61 and complete an obvious circuit path including that contact and contact 20*a* of coder 3CT, whereby section J—K is supplied with 20 code current which causes relay 2TR to operate at the 20 code rate so that relays 2H and 2D associated therewith release. It follows, therefore, that the energization of signal control relay 2LHSR clears westbound signal 7S, and conditions the opposing signal 5S to display its stop indication. Also, the apparatus controlling the opposing signals 1S and 2S is conditioned so that if relay 1RHSR is picked up by the communication system in an attempt to clear signal 1S or 2S, such signal is retained conditioned to display its stop aspect and cannot be cleared because the associated control relays 2H and 2D are released.

The operator may, however, establish control over westbound signal 3S by causing the communication system to pick up relay 1LHSR to cause it to close its front contact 39. Signal 3S accordingly is conditioned to display its caution aspect since it has been assumed that relay 3TR normally follows 75 code in section J—K, hence relay 3D is normally released. However, with signal 3S conditioned to display its caution aspect, contact 4 associated therewith is caused to operate to its front position to shift the coding of current supplied to section K—L from the 75 to the 180 code rate, thereby causing relay 5TR to operate at the 180 code rate and energize all the associated decoding relays 5BSA, 5FSA, 5H and 5D and cause signal 4S to be conditioned to display its clear aspect. The lamps SL of signals 3S and 4S are not at this time illuminated since their obvious energizing circuits are open at back contacts 70 of relays 4BSA and 6BSA, respectively.

In addition, the energization of relay 1LHSR causes the current supplied at J to the section to the left of section J—K, to be shifted from the 75 code rate to the 20 code rate. This shifting of the code rate is effected when relay 1LHSR opens its back contact 124 interposed in the previously traced circuit over which energy is supplied to the section, and front contact 125 of relay 1LHSR closes to complete an obvious circuit comprising winding 14 of frequency changer FC, front contact 125 of relay 1LHSR, contact 20*a* of coder 1CT, back contact 4 operated by signal 1S, and the primary winding of transformer 1TT.

If, with the apparatus in the condition described and arranged for a westbound movement, a westbound train enters the section to the right

of section M—N, relay 10TR is shunted, and relay 10BSA releases to close its back contact 70 to complete an obvious circuit for the lamps SL of signals 7S and 8S. The lamps of these signals are, therefore, approach lighted when a train enters the section in the rear of such signals.

When the train enters section M—N, both relays 8TR and 9TR are shunted with the result that relays 9FSA, 9BSA, 9H and 9D release to cause signal 7S to display its stop aspect, and relay 8BSA also releases. If the train is equipped with train-carried apparatus, which may, for example, be of the type shown in United States Letters Patent No. 1,773,515, granted on August 19, 1930, to C. C. Buchanan for Railway traffic controlling apparatus, such apparatus of course responds to current of the train-control frequency coded at the 180 code rate available in section M—N, thereby causing the train-carried cab signal to display a clear aspect.

Relays 6TR and 7TR are of course shunted when the train enters section L—M, and relay 8BSA is caused to release to close its back contact 70 and thereby illuminate the signal lamp of signal 4S. The train-carried cab signal of course continues to display its clear aspect due to the 180 code current of the train control frequency available in section L—M.

When the train vacates the section to the right of section M—N, current of the train-control frequency coded at the 20 code rate is supplied at N to the section to the right of section M—N, relay 10TR follows 20 code current of the second frequency made available in the section in a manner to be made clear presently, and relay 10BSA picks up to open its back contact 70 and thereby deenergize signal lamps SL of signals 7S and 8S. Current of the 20 code rate is supplied at this time to section M—N at N, but is shunted away from relay 8TR until the train vacates the section. When this happens, relay 8TR operates and relays 8FSA and 8BSA are picked up. Relay 9TR at this time also operates at the 20 code rate, due to current supplied at M to section M—N over a circuit path comprising contact 20*a* of coder 5CT and back contact 120 of relay 7H. Relays 9FSA and 9BSA are picked up, but relays 9H and 9D remain released to maintain signal 7S conditioned to display its stop aspect. The current supplied at N to the section to the right of section M—N is shifted from the 20 code rate to the 75 code rate, since front contact 54 of relay 9BSA closes to complete the normal circuit, previously traced, over which 75 code current of the train-control frequency is supplied at N to the rails of the section to the right of section M—N.

When the train accepts signal 4S and enters section K—L, relays 4TR and 5TR are shunted, relay 4BSA releases to complete an obvious circuit for lamp SL of signal 3S, and relays 5FSA, 5BSA, 5H and 5D release to condition signal 4S to display its stop aspect. Relay 6SR is now held energized over its stick circuit including back contact 73 of relay 5H, and its own front contact 72 and winding. Current of the second frequency, coded at the 20 code rate, is supplied at M to section L—M, with the result that after the train vacates section L—M, relay 6TR responds and picks up relays 6FSA and 6BSA to restore signal 4S to its normally dark condition. Also, with signal 4S at stop so that contact 4 associated therewith is in its back position, and with stick relay 6SR energized to close its front contact 80, current of the first frequency coded at the 75 code rate is supplied at L to section L—M over a circuit including the secondary winding of line transformer LT2, back contact 56 of relay 5SPS, contact 75*a* of coder 4CT, front contact 80 of relay 6SR, back contact 4 associated with signal 4S, and the primary winding of track transformer 6TT. This 75 code current causes operation of relay 7TR; relays 7H and 7BSA are picked up; and the 75 code current is repeated by relay 7TR into section M—N and causes relay 9TR to pick up relays 9FSA, 9BSA and 9H, which relays in turn condition signal 7S to display its caution indication. Contact 4 associated with signal 7S accordingly is caused to operate to its front position so that current of the first or train-control frequency supplied to the section to the right of section M—N is carried through contact 180 of coder 9CT and is caused to be coded at the 180 code rate.

When the train accepts signal 3S and enters section J—K, both relays 2TR and 3TR become shunted, relays 3FSA, 3BSA, 3H and 3D are released to condition signal 3S to display its stop aspect, and relay 2BSA releases. Relay 1TR is shunted, and relays 1H, 1FSA and 1BSA release when the train enters the section to the left of section J—K. Current of the second frequency, coded at the 20 code rate, is supplied at this time at L to section K—L, so that when the train vacates the section, relay 4TR operates to pick up relay 4BSA, thereby deenergizing the signal lamps SL of signal 3S. Relay 5TR also operates at the 20 code rate, due to 20 code current supplied at K to section K—L over a circuit path including back contact 54 of relay 3BSA and contact 20 of coder 3CT, with the result that relay 5BSA is picked up.

After the train vacates section J—K, relay 2TR operates at the 20 code rate and picks up relay 2BSA, while current of the first frequency coded at the 20 code rate is supplied at J to section J—K, over an obvious circuit path including back contact 51 of relay 1H and contact 20*a* of coder 1CT. Relay 3TR follows this 20 code current, and relay 3BSA is picked up to close its front contact 34 and complete the previously traced normal circuit over which 75 code current is supplied at K to section K—L. Relay 5TR follows this 75 code current to pick up relay 5H and condition signal 4S to display its caution indication. Contact 4 of signal 4S accordingly operates to its front position to shift the current, supplied at L to section L—M, from the 75 to the 180 code rate. Relay 7TR functions to repeat this 180 code into section M—N and cause relay 9TR to pick up relay 9D, thereby causing signal 7S to be conditioned to display its proceed indication.

Signal 3S is conditioned to display its caution aspect, and signal 4S is conditioned to display its clear aspect, after current of the first frequency, coded at the 75 code rate, is made available in the section to the left of section J—K by apparatus not shown but substantially corresponding to the apparatus hereinbefore described and by means of which current of the first frequency is supplied at N to the section to the right of section M—N. This 75 code current causes operation of relay 1TR, causes relays 1H, 1FSA and 1BSA to be picked up, and causes relay 1TR to repeat the 75 code current into section J—K where it causes operation of relay 3TR. Relay 3H is picked up when relay 3TR follows 75 code, and signal 3S is conditioned to display its caution aspect and operates its contact 4 to its front position to shift the cur-

rent, supplied at K to section K—L, from the 75 to the 180 code rate. Relay 5TR, in responding to this 180 code energy, picks up relay 5D and conditions signal 5S to display its clear indication.

At this time, the rails of the section to the left of section J—K are supplied at J with 20 code current of the second frequency, and it follows that the apparatus of Fig. 1 is restored to the condition hereinbefore described wherein it is arranged for a westbound train movement.

From the foregoing, it is readily apparent that the apparatus of Fig. 1 is organized so that when the communication system is suitably controlled by the operator to permit westbound train movements, the movement of a westbound train through the stretch causes the westbound signals in its rear to become successively cleared as the train proceeds through the stretch. This control of the signals by the train is established without the use of line wires solely through the medium of track circuit current transmitted through the track rails, and it permits other westbound trains to follow the first through the stretch under signal indications governed by traffic conditions in advance.

The apparatus of Fig. 1 may now be restored to its normal condition by the operator causing the communication system to deenergize relay 2LHSR, in which case front contact 38 opens to condition signal 7S to display its stop aspect, and back contact 64 closes to complete the previously mentioned circuit over which 75 code current is supplied at M to section L—M. This 75 code current of course causes relay 6TR to operate and pick up relay 6H, thereby releasing stick relay 6SR, and signal 5S is conditioned to display its caution aspect and operates its contact 4 to its front position so that 180 code current is supplied at L to section K—L to cause relay 4TR to operate and pick up relay 4H. Relay 4TR is effective to repeat the 180 code current into section J—K, and relay 2TR operates at this 180 code current to hold relays 2FSA, 2BSA, 2H and 2D energized, thereby conditioning the apparatus to be effective to clear signals 1S or 2S in the event that relay 1RHSR is caused to be energized by the operator over the communication system.

Signal 3S may likewise be caused to display its normal stop aspect by the operator causing the communication system to release relay 1LHSR. When this happens, back contact 124 of relay 1LHSR closes to complete the previously traced normal circuit over which 75 code current of the second frequency is supplied at J to section J—K. In addition, front contact 39 of relay 1LHSR opens to deenergize signal 3S1, whereupon the associated contact 4 is caused to operate to its back position to shift the coding of current supplied at K to section J—K to the 75 code rate, and relay 5TR follows the 75 code current to cause relay 5D to release. Signal 4S accordingly is conditioned to display its caution aspect, and the apparatus of Fig. 1 is restored to its normal condition as represented in Fig. 1.

If, with the apparatus of Fig. 1 in its normal condition, the operator wishes to move an eastbound train through the stretch, 20 code current of the second frequency is caused to be supplied to the section to the left of section J—K, in a manner substantially corresponding to that hereinafter described in detail whereby 20 code current of the second frequency is supplied at N to the rails of the section to the right of section M—N when relay 2RHSR is caused to be picked up. This 20 code current in the section to the left of section J—K is ineffective to operate relay 1TR since that relay is tuned to respond to current of the first frequency, hence relay 1TR becomes inactive and relay 1FSA, 1BSA and 1H release. Relay 1SR becomes energized over an obvious pick-up circuit including back contact 71 of relay 1H, front contact 73 of relay 2H and the winding of relay 1SR, and relay 1SR picks up to close its front contact 72 to complete an obvious stick circuit through back contact 71 of relay 1H.

Relay 1SR closes its front contact 92 to tune relay 1TR to current of the second frequency, whereupon relay 1TR responds to the 20 code current of second frequency and causes relays 1FSA and 1BSA to pick up. In addition, contact 120 of relay 1SR operates from its back to its front contact to shift the current, supplied at J to the section to the left of section J—K, from the second to the first frequency, by completing a circuit comprising the secondary winding of transformer LT1, front contact 120 of relay 1SR, switch controlled contact 27—30, back contact 124 of relay 1LHSR, front contact 54 of relay 2BSA, contact 75 of coder 1CT, back contact 4 operated by signal 1S, and the primary winding of transformer 1TT.

The operator may now suitably control the communication system to cause relay 1RHSR to pick up. In such an event, front contact 37 of relay 1RHSR closes to complete the previously mentioned circuit of signal 1S so that signal 1S is cleared, and contact 4 associated therewith is operated to its front position to shift the coding of current supplied at J to the section to the left of section J—K, from the 75 to the 180 code rate. Also, front contacts 82 and 83 of relay 1RHSR close to shift the tuning of relays 2TR and 3TR, respectively. Relay 3TR is now tuned to respond only to current of the second frequency, while relay 2TR is tuned to respond only to current of the first or train-control frequency. Relay 1RPSR picks up to close its front contact 17 and tune relay 4TR to current of the first frequency.

The energization of relay 1RHSR also operates its contact 96 from its back to its front position to shift the current supplied at J to section J—K from the first to the second frequency, contact 84 is operated by relay 1RHSR from its back to its front position to shift the current supplied at K to section J—K from the second to the first frequency, back contact 85 of relay 1RHSR opens, and front contact 87 of relay 1RPSR closes to complete a circuit including winding 14 of frequency changer FC, condenser 10, front contact 87 of relay 1RPSR, contact 20 of coder 3CT, back contact 4 operated by signal 3S, and primary winding 6 of track transformer 4TT, whereupon 20 code current of the second frequency is supplied at K to section K—L. This current is ineffective to operate relay 5TR, which is tuned to respond to current of the first frequency, hence relays 5TR, 5D, 5H, 5FSA and 5BSA are released. Signal 4S accordingly is conditioned to display its stop aspect, and relay 5SR becomes energized over a circuit extending from terminal B through back contact 71 of relay 5H, front contact 73 of relay 6H and the winding of relay 5SR to terminal C, and relay 5SR accordingly picks up to close its front stick contact 72. Front contact 11 of relay 5SR also closes to tune relay 5TR to current of the second frequency, and relay 5TR accordingly

responds to the 20 code current in section K—L, and causes relays 5FSA and 5BSA to pick up. In addition, contact 66 of relay 5SR is caused to operate from its back to its front position, to shift the current, supplied at L to section K—L, from the second to the first frequency, as can readily be seen from an inspection of the drawings.

Relay 5SPS picks up over an obvious circuit including front contact 89 of relay 5SR, to operate contact 90 from its back to its front position to shift the tuning of relay 6TR from current of the second to the first frequency, and contact 56 of relay 5SPS operates from its back to its front position to shift the current supplied at L to section L—M from the first to the second frequency, whereupon section L—M is supplied at L with current of the second frequency coded at the 20 code rate, over a circuit including secondary winding 14 of frequency changer FC and primary winding 6 of track transformer 6TT, back contact 4 associated with signal 4S, back contact 60 of relay 6SR, contact 20a of coder 4CT and front contact 56 of relay 5SPS. Relay 7TR is nonresponsive to current of the second frequency, hence relays 7TR, 7H, 7FSA and 7BSA drop. Relay 8SR accordingly becomes energized over a circuit including back contact 71 of relay 7H, front contact 73 of relay 8H, and the winding of relay 8SR. Relay 8SR picks up to close its front stick contact 72, and operates its contact 92 from its back to its front position to tune relay 7TR to current of the second frequency, whereupon relay 7TR responds to the 20 code current in section L—M with the result that relays 7FSA and 7BSA pick up. Relay 8SR also operates its contact 63 from its back to its front position so that current of the first frequency is supplied at M to section L—M over a circuit including back contact 4 associated with signal 6S, contact 75 of coder 5CT, front contact 65 of relay 8BSA, back contact 64 of relay 2LHSR, front contact 63 of relay 8SR and the secondary winding of transformer LT3.

It is, of course, apparent that with relay 7TR tuned to current of the second frequency, relay 7TR functions to repeat the 20 code current from section L—M into section M—N, and at this time it is to be noted that section M—N is supplied at M with current of the first frequency to which relay 9TR is responsive. Relay 9TR, in following the 20 code current of the first frequency, causes relays 9H and 9D to be released. Relay 8TR responds at this time to current of the second frequency supplied at the opposite end N of the section.

From the foregoing description, it is readily apparent that when relay 1RHSR is energized, signal 1S is cleared; the opposing signal 4S is conditioned to display its stop aspect; the apparatus associated with the opposing signals 7S and 8S is conditioned to prevent clearing of those signals (due to the releasing of relays 9H and 9D) should relay 2LHSR be energized; the frequencies of the track circuit currents supplied to the sections up to the siding section in advance are so controlled that current of train-control frequency is applied to the sections in the direction to be fed toward an eastbound train; and the track relays of such sections are tuned to respond selectively to current of the frequency applied at the opposite end of the associated section.

Signal 6S may be cleared by energizing relay 2RHSR, whereupon front contact 49 closes to complete the energizing circuit of signal 6S and that signal is conditioned to display its caution indication since relay 8D is released when relay 8TR operates in response to 75 code current repeated by relay 10TR into section M—N. Contact 4 operated by signal 6S accordingly is caused to assume its front position, whereupon the current supplied at M to section L—M is shifted from the 75 to the 180 code rate. Relay 6TR follows this 180 code current and picks up contact 60 to cause signal 5S to display its clear aspect.

The energization of relay 2RHSR also causes its front contacts 82 and 83 to operate from their back to their front positions, and as a result relay 8TR is tuned to respond to current of the first frequency while relay 9TR is tuned to respond to current of the second frequency. Contact 95 of relay 2RHSR operates from its back to its front position to shift the current supplied at M to section M—N from the first frequency to the second; contact 60 of relay 2RHSR operates from its back to its front position to shift the current supplied at N to section M—N from the second to the first frequency; back contact 96 of relay 2RHSR opens; and front contact 86 of relay 2RHSR closes to energize repeater relay 2RPSR. Contact 128 of relay 2RPSR accordingly operates from its back to its front position to tune relay 10TR to current of the first frequency; and front contact 87 of relay 2RPSR closes to complete a circuit, comprising winding 14 of frequency changer FC, condenser 10, front contact 87 of relay 2RPSR, contact 20 of coder 9CT, back contact 4 operated by signal 7S, and the primary winding of transformer 10TT; with the result that 20 code current of the second frequency is supplied at N to the section to the left of section M—N. This 20 code current, as pointed out hereinbefore, is effective to cause apparatus (not shown) at the opposite end of the section to cause current of the first frequency, effective to operate relay 10TR, to be supplied to the section. Relay 10TR accordingly responds to such current, which will be assumed to be coded at its normal or 75 code rate.

It follows, therefore, that with relays 1RHSR and 2RHSR caused to be energized over the communication system, the apparatus represented in Fig. 1 is conditioned for an eastbound train movement and is arranged to supply track circuit current to each section so as to be transmitted through the track rails toward an eastbound train, thereby rendering possible the control of train-carried apparatus on the train.

If, now, an eastbound train enters the section to the left of section J—K, relay 1TR is shunted and relays 1FSA and 1BSA release. Relay 1BSA closes its back contact 70 to complete an obvious energizing circuit for the lamps of signals 1S and 2S, with the result that signal 1S becomes effective to display an illuminated clear indication. When the train accepts signal 1S and enters section J—K, both relays 2TR and 3TR are shunted, and relays 2FSA, 2BSA, 2H, 2D, 3FSA and 3BSA release. Signal 1S accordingly is caused to display its stop aspect, and contact 4 associated therewith is operated to its back position to complete a circuit path, including contact 20 of coder 1CT and back contact 54 of relay 2BSA, over which 20 code current of the first frequency is supplied at J to the section to the left of section J—K after the train vacates the section.

When the train enters section K—L, relays 4TR and 5TR are shunted, relays 4BSA and

5BSA are released, and contact 70 of relay 5BSA closes to complete an obvious energizing circuit for the lamp SL of signal 5S, whereupon the signal is caused to display its illuminated clear aspect.

Relay 3TR is caused to operate at the 20 code rate, after the train vacates the associated section J—K, due to current supplied at J to the section, and relay 3BSA picks up. In addition, relay 2TR also is caused to operate at the 20 code rate by virtue of current supplied at K to section J—K over a circuit path including contact 20a of coder 3CT and back contact 61 of relay 4H. Relay 2BSA accordingly is caused to close its front contact 54 and complete an easily traced circuit over which 75 code current is supplied at J to the section to the left of section J—K.

When the train passes signal 5S and enters section L—M, relays 6TR and 7TR are shunted. Relays 6FSA, 6BSA, 6H and 6D release to cause signal 5S to display its stop aspect, and contact 4 is operated by signal 5S into its back position to establish a circuit, including contact 75 of coder 4CT and front contact 121 of relay 5SR, over which 75 code current is supplied to section K—L at L. This 75 code current causes operation of relay 4TR when the train vacates the section, and relay 4H is picked up to condition relay 4TR to repeat the 75 code energy into section J—K, where it causes operation of relay 2TR and causes relay 2H to be picked up to condition signal 1S to display its approach indication and operate its contact 4 to its front position to shift the coding of current, supplied at J to the section to the left of section J—K, to the 180 code rate. Relay 5TR also is caused to operate, when section K—L is vacated, at the 20 code rate and relays 5FSA and 5BSA are picked up, the latter relay opening the energizing circuit for the lamp of signal 5S.

When the train enters section M—N, relays 8TR and 9TR are shunted, the decoding relays associated with relay 8TR are released, and signal 6S is caused to display its stop aspect. Relay 10TR is likewise shunted when the train enters the section to the right of section M—N. After section L—M becomes vacated, 20 code current is supplied at M to section L—M over a circuit comprising the secondary winding of transformer LT3, condenser 9, front contact 63 of relay 8SR, back contact 64 of relay 2LHSR, back contact 65 of relay 8BSA, contact 20 of coder 5CT, back contact 4 operated by signal 6S and the primary winding of transformer 7TT. This 20 code current causes operation of relay 6TR and causes relays 6FSA and 6BSA to pick up, but does not alter the condition of signal 5S. Relay 7TR also operates at the 20 code rate when section L—M becomes vacated, and relays 7FSA and 7BSA are picked up.

After the train vacates section M—N, relay 8TR operates at the 20 code rate, due to current supplied at N over a circuit path including back contact 61 of relay 10H and contact 20 of coder 9CT, and relays 8FSA and 8BSA and accordingly are picked up. Front contact 65 of relay 8BSA closes to supply 75 code current at M to section L—M, over an easily traced circuit, and relay 6TR in response thereto picks up relay 6H to condition signal 5S to display its caution indication. Contact 4 is operated by signal 5S into its front position, thereupon shifting the current supplied at L to section K—L to the 180 code rate. This 180 code current is repeated by relay 4TR into section J—K where it causes operation of relay 2TR with the result that relay 2D is picked up, and signal 1S is conditioned to display its clear indication.

Relay 9TR is caused to operate at the 20 code rate when section M—N becomes vacated, relays 9FSA and 9BSA are picked up, and 20 code current is supplied at N to the section to the right of section M—N.

Relay 10TR is caused to operate at the 75 code rate in response to current supplied to the section in a manner, not shown but substantially corresponding to the manner described hereinbefore whereby 75 code current is caused to be supplied to the section to the left of section J—K after the passage of the eastbound train, and when this happens, relay 10H is picked up and relay 10TR repeats the 75 code into section M—N. Relay 8TR thereupon operates at the 75 code rate, and relay 8H is picked up to condition signal 6S to display its caution aspect. Contact 4 of signal 6S operates to its front position to shift the coding of current supplied at M to section L—M to the 180 code rate, whereupon relay 6TR operates to pick up relay 6D and condition signal 5S to display its clear aspect. It follows, therefore, that the apparatus of Fig. 1 is restored to the condition hereinbefore described wherein it is arranged for an eastbound train movement.

It is apparent from the foregoing that the apparatus of Fig. 1 is organized so that when the communication system is suitably controlled for an eastbound train movement, the movement of an eastbound train through the stretch causes the eastbound signals in the rear to be successively cleared as the train proceeds through the stretch. This control of the signals is established without the use of line wires solely through the medium of track circuit current of the train-control frequency, hence it provides means for controlling either or both wayside signals and train-carried signals to permit following eastbound trains to move under signal indications governed by traffic conditions in advance.

The apparatus of Fig. 1 may be restored to its normal condition, as represented in the drawings, by the operator suitably controlling the communication system to cause relays 1RHSR and 2RHSR to be released, and by causing relay 1SR to be released and relay 1TR to be tuned to current of the first frequency. When relay 2RHSR releases, front contact 40 opens to deenergize signal 6S and cause that signal to be conditioned to display its stop aspect, whereupon contact 4 associated therewith operates to its back position to cause the current, supplied at M to section L—M, to be coded at the 75 code rate. This 75 code current causes operation of relay 6TR, and relay 6D is released to cause signal 5S to be conditioned to display its normal caution aspect. The releasing of relay 2RHSR also causes its back contact 82 to close to tune relay 8TR to current of the second frequency; back contact 83 to close to tune relay 9TR to current of the first frequency; back contact 95 to close to shift current supplied at M to section M—N to current of the first frequency; back contact 60 to close to shift the current, supplied at N to section M—N, to current of the second frequency; front contact 86 to open to deenergize repeater relay 2RPSR; and back contact 96 to close. During the slow release interval of relay 2RPSR, current of the second frequency, coded at the 75 code rate, is supplied at N to the section to the right of sec-

tion M—N, over a circuit comprising winding 14 of frequency changer FC, condenser 10, back contact 96 of relay 2RHSR, front contact 53 of relay 2RPSR, switch controlled contact 22—30, front contact 54 of relay 3BSA, contact 75 of coder 9CT, back contact 4 operated by signal 7S and the primary winding of track transformer 10TT. This 75 code current of the second frequency is effective to cause the apparatus at the opposite end of the section to supply current of second frequency to the section, to operate relay 10TR. The manner in which this is effected will be understood best by considering the apparatus represented in Fig. 1A, which apparatus substantially corresponds to that provided at the opposite end (not shown) of the section to the right of section M—N. Referring to Fig. 1A, when 75 code energy of the second frequency is made available in the section to the left of section J—K, relay 1TR is caused to operate, and relays 1FSA, 1BSA and 1H are picked up. Relay 1SR accordingly is released, and its back contact 92 closes to tune relay 1TR to current of the first frequency, and back contact 120 also closes to shift the current, supplied at J to the section to the left of section J—K, to the second frequency. The slow releasing characteristics of relay 2RPSR are selected so that this relay releases at substantially the same instant that the stick relay at the opposite end of the section releases. When relay 2RPSR releases, its back contact 128 closes to tune relay 10TR to current of the second frequency, and contact 53 operates from its front to its back position to shift the current, supplied at N to the section to the right of section M—N, from the second to the first frequency. It is apparent, therefore, that the track circuit apparatus of the section to the right of section M—N (which corresponds to that of the corresponding section to the left of section J—K) is restored to its normal condition wherein current of the first frequency coded at the 75 code rate is supplied to the rails for transmission in the westbound direction and current of the second frequency is supplied to the rails for transmission in the eastbound direction.

When relay 1RHSR is caused to release, front contact 37 opens to deenergize signal 1S and condition it to display its stop indication and operate its contact 4 to its back position to shift the current, supplied at J to the section to the right of section J—K, to the 75 code rate. In addition, relay 1RHSR closes its back contact 82 to tune relay 2TR to current of the second frequency; back contact 83 closes to tune relay 3TR to current of the first frequency; back contact 96 closes to shift the current, supplied at J to section J—K, to the first frequency; back contact 50 closes to shift the current, supplied at K to section J—K, to the second frequency; front contact 86 opens to deenergize repeater relay 1RHSR; and back contact 85 closes. During the slow release interval of relay 1RPSR, current of the second frequency coded at the 75 code rate is supplied at K to section K—L, over a circuit comprising winding 14 of frequency changer FC, condenser 10, back contact 85 of relay 1RHSR, front contact 53 of relay 1RPSR, front contact 54 of relay 3BSA, contact 75 of coder 3CT, back contact 4 operated by signal 3S, and the primary winding of transformer 4TT. This 75 code current causes operation of relay 5TR, and relay 5H is picked up to cause relay 5SR to release. When this happens, back contact 11 closes to tune relay 5TR to current of the first frequency, back contact 121 of relay 5SR closes to shift the current supplied at L to section K—L to the second frequency, and front contact 89 of relay 5SR opens to deenergize repeater relay 5SPS. The slow acting characteristics of relay 1RPSR are selected so that this relay releases at substantially the same time that relay 5SR releases. When relay 1RPSR releases, relay 4TR is tuned to current of the second frequency, current of the first frequency is supplied over back contact 53 of relay 1RPSR, to section L—M, and the track circuit apparatus of section L—M is restored to its normal condition wherein current of the first frequency is caused to operate relay 5TR and current of the second frequency is caused to operate relay 4TR.

This current of the first frequency, operating relay 5TR, is coded at the normal rate of 75 cycles per minute, hence signal 4S is conditioned to display its approach aspect and contact 4 is in its front position. At this time, during the slow release interval of relay 5SPS, current of the second frequency coded at the 180 code rate is supplied at L to section L—M, over a circuit comprising winding 14 of frequency changer FC, condenser 10, front contact 56 of relay 5SPS, contact 180a of coder 4CT, front contact 4 operated by signal 4S, and the primary winding of transformer 6TT. Relay 7TR accordingly is caused to operate at the 180 code rate, and picks up relays 7FSA, 7BSA and 7H. The 180 code current is repeated by relay 7TR into section M—N where it causes operation of relay 9TR to pick up relays 9H and 9D.

Relay 8SR also is caused to release when relay 7H picks up, and relay 8SR closes its back contacts 92 and 63 to shift, respectively, the tuning of relay 7TR to current of the first frequency, and the current supplied at M to section M—N to the second frequency. The slow releasing characteristics of relay 5SPS are selected so as to permit relay 5SPS to release at substantially the same instant that relay 8SR releases. When relay 5SPS releases, relay 6TR is tuned to current of the second frequency, current of the first frequency is supplied at L to section L—M, and the track circuit apparatus of section L—M is restored to its normal condition wherein relay 7TR follows 180 code current of the first frequency and relay 6TR follows 75 code current of the second frequency. The apparatus of Fig. 1 accordingly is restored to its normal condition, as represented in the drawings.

From the foregoing, it is readily apparent that the apparatus of Fig. 1 is arranged so as to be conditioned from a remote point for either an eastbound or a westbound traffic movement, and when so conditioned the apparatus is arranged so as to effect the control of either or both wayside signals and train-carried cab signals by means operated, without the use of control line wires, solely through current transmitted through the track rails.

A modified arrangement of the apparatus of Fig. 1 is represented in Fig. 2, wherein apparatus embodying my invention is arranged to control only wayside signals and not cab signals, hence no provision is made for governing the frequencies of current fed to the rails of a section so as always to supply the current for transmission through the rails toward a train on the stretch.

Referring now to Figs. 2A to 2D, inclusive, the track relays TR connected to the right-hand ends

of the track sections and having odd numbers as prefixes are represented as being constantly tuned by condensers 9 to current of the first frequency while the other relays connected at the opposite or left-hand ends are represented as being constantly tuned by condensers 10 to current of the second frequency. Each relay TR represented in Fig. 2 is energized by current of the proper frequency supplied at the opposite end of the section, and such current is normally coded at the relatively low code rate of, say 20 code cycles per minute. This coding of the current, as pointed out hereinbefore, is ineffective to cause the track relays TR to pick up the associated H and D decoding relays, but the associated FSA and BSA relays are picked up. With all signal control decoding relays H and D released, and the remotely controlled signal control relays 1RHSR, 1LHSR, 2RHSR and 2LHSR released, all signals are conditioned to display their respective stop aspects.

In addition to the previously mentioned remotely controlled switch and signal control relays of Fig. 1, the apparatus of Fig. 2 is arranged to provide each station at the ends of the stretch, with two other remotely controlled relays, one relay USR of which is provided for locally conditioning an associated signal to display its stop indication. Relay USR, at the right-hand end of the stretch, for example, when energized opens back contact 100 interposed in the easily traced control circuit of signals 7S and 8S, with the result that if signal 7S is conditioned to be cleared by the energization of either or both of the associated signal control decoding relays 9H and 9D, the energization of relay USR removes relays 9H and 9D from control of such signal and the signal accordingly is set to stop. The other remotely controlled relay BS at that end of the stretch is provided for clearing locally signal 6S2, as is customary in remote control of signals. For example, when section M—N is unoccupied so that relay 8BSA is energized to close its front contact 101, and switch W1 is reversed so that contact 28 operated by the switch mechanism is in engagement with contact 34, the energization of relay BS and consequent closing of its front contact 104 completes an easily traced circuit for signal 6S2, whereupon that signal is cleared.

In the normal condition of the apparatus of Fig. 2, as represented in the drawings, it is assumed that the section to the right of section M—N is supplied with current of the second frequency coded at the 20 code rate to cause relay 10TR to operate at such code rate and pick up relays 10FSA and 10BSA, while current of the first frequency coded at the 20 code rate is supplied to the section to the left of section J—K and causes relay 1TR to respond and pick up relays 1FSA and 1BSA. With the two end sections supplied with current of 20 code, and all remotely controlled signal and switch control relays released, as shown, sections J—K, K—L, L—M and M—N are supplied at their respective left-hand ends with 20 code current of the first frequency. For example, with relay 1H released, 20 code current of the first frequency is supplied to section J—K at J over a circuit including the secondary winding of line transformer LT1, back contact 51 of relay 1H, contact 20*a* of coder 1CT and the primary winding of track transformer 2TT. These sections are likewise supplied at their opposite or right-hand ends with 20 code current of the second frequency, as is readily apparent from an inspection of the drawings. All signals, are therefore conditioned to display their respective stop aspects.

If, now, the operator wishes to clear signal 1S at the left-hand end of the stretch, he may suitably control the communication system so as to energize and pick up signal control relay 2RHSR at the opposite end of the stretch. Relay 2RHSR operates its contact 106 from its back to its front position, and 75 code current of the second frequency is supplied at M to section L—M over an easily traced circuit including secondary winding 14 of frequency changer FC, front contact 106 of relay 2RHSR, front contact 107 of relay 8BSA, contact 75 of coder 7CT, back contact 4 associated with signal 6S and the primary winding of track transformer 7TT. Relay 6TR follows this 75 code current and relay 6H is picked up to condition signal 5S to display its caution aspect. Relay 6SR also picks up over an obvious circuit including front contact 108 of relay 6H, and front contact 115 of relay 6SR closes to complete an obvious stick circuit through back contact 116 of relay 5H. Current of the second frequency coded at the 180 code rate is now supplied to section K—L over a circuit including primary winding 14 of frequency changer FC, front contact 109 of relay 6SR, contact 180 of coder 5CT, front contact 4 associated with signal 5S and the primary winding of track transformer 5TT. Relay 4TR responds to this 180 code current and picks up relay 4H. With relay 4H picked up, relay 4TR functions to repeat into section J—K the 180 code current, over a circuit comprising winding 14 of frequency changer FC, back contact 111 of relay 1USR, front contact 112 of relay 4H, contact 52 (when closed) of relay 4TR, and the primary winding of track transformer 3TT, thereby causing relay 2TR to operate and pick up relays 2H and 2D. Signal 1S accordingly is cleared when relays 2H and 2D pick up, and it follows that when relay 2RHSR at one end of the stretch is energized, signal 1S at the opposite end is cleared by means of control energy which is transmitted from one end to the other of the stretch wholly through the rails of the stretch. When signal 1S clears, contact 4 associated therewith operates to its front position to condition the apparatus to permit the signal at the other end (not shown) of siding track Y to be cleared. That is to say, if signal 1S is cleared and the operator selects relay 1RHSR for operation by the communication system and causes that relay to pick up and close its front contact 110, 180 code current of the second frequency is supplied to the section to the rear of section J—K over a circuit including secondary winding 14 of frequency changer FC1, front contact 116 of relay 1RHSR, front contact 107 of relay 2BSA, contact 180 of coder 1CT, front contact 4 associated with signal 1S, and the primary winding of track transformer 1TT. While the intermediate portion and opposite end of siding track Y are not shown, the siding ordinarily will be provided with apparatus substantially corresponding to the apparatus shown in Figs. 2D and and 2C, corresponding to the intermediate portion and the left-hand end of siding track Z, respectively. The complete siding Y may, therefore, be illustrated by placing Figs. 2C, 2D and 2A together in the order named with Fig. 2C on the left, and it follows that if signal 1S is cleared and relay 1RHSR is picked up, the 180 code current supplied to the section in the rear of section J—K is effective to operate the track relay (which may correspond to relay 8TR of Fig. 2C)

associated with the signal (which may correspond to signal 6S of Fig. 2C) at the entrance end of siding track Y. Under the assumed conditions, such track relay of course operates at the 180 code rate to cause the associated signal control relays H and D associated therewith to pick up, with the result that the signal at such location is cleared.

In the event that signal 1S is cleared and a train enters the section in the rear of the signal, relay 1TR is shunted and relay 1BSA releases to cause the lamps SL of signals 1S and 2S to be lighted over an obvious circuit. If the train accepts the signal and enters section J—K, relay 2TR is shunted and relays 2H, 2D, 2FSA and 2BSA release so that signal 1S is caused to display its stop aspect. Relay 3TR is also shunted and relay 3BSA releases, but this action has no useful function at this time. When the train enters section K—L, relays 4TR and 5TR are shunted, and relays 4H, 4BSA and 5BSA release. Lamp SL of signal 4S accordingly becomes illuminated over an obvious circuit including back contact 70 of relay 5BSA, while back contact 112 of relay 4H completes an obvious circuit including that contact and contact 20*a* of coder 3CT whereby section J—K is supplied with 20 code current of the second frequency when the train vacates section J—K. This current causes relay 2TR to operate and pick up relays 2FSA and 2BSA, whereupon the section in the rear of section J—K is supplied with 75 code current over a circuit including back contact 4 associated with signal 1S, contact 75 of coder 1CT, front contact 107 of relay 2BSA and front contact 119 of relay 1RHSR.

When the train enters section L—M, both relays 6TR and 7TR are shunted and relays 7BSA, 6BSA and 6H release. The lamp of signal 6S is now illuminated over an obvious circuit including back contact 70 of relay 7BSA. Signal 5S is caused to display its stop aspect when relay 6H releases, and when the train vacates section K—L, 75 code current is supplied to that section over a circuit including back contact 4 associated with signal 5S, contact 75 of coder 5CT, and front contact 109 of relay 6SR. This 75 code current causes relay 4TR to pick up relay 4H, whereupon relay 4TR repeats the 75 code current into section J—K to cause relay 2TR to pick up relay 2H. Signal 1S accordingly is conditioned to display its caution indication, and operates its contact 4 to its front position to shift the coding of current, supplied to the section to the left of section J—K, to the 180 code rate.

Relays 8TR and 9TR are shunted when the train enters section M—N, and as a result relays 8FSA, 8BSA and 8H release. Signal 6S is, therefore, caused to assume its stop position with the result that back contact 4 associated therewith closes so that after the train vacates section L—M, 20 code current is supplied to that section over a circuit including front contact 106 of relay 2RHSR, front contact 107 of relay 8BSA, contact 20 of coder 7CT and back contact 4 associated with signal 6S. Relay 6TR responds to this 20 code current and picks up relay 6BSA.

When the train enters the section to the right of section M—N, relay 10TR is shunted and relays 10BSA and 10FSA release. Section M—N is, however, supplied at N with 20 code current over a circuit previously traced so that after the train vacates section M—N, relay 8TR operates to pick up relay 8BSA, whereupon front contact 107 of relay 8BSA closes and completes a circuit over which 75 code current is supplied at M to section L—M. This 75 code current causes relay 6TR to operate and pick up relay 6H, thereby operating signal 5S to its caution position to shift the coding of current supplied at L to section K—L from the 75 to the 180 code rate. This 180 code current is repeated by relay 4TR into section J—K and causes relay 2TR to operate and energize relays 2FSA, 2BSA, 2H and 2D. Signal 1S accordingly is operated to its clear position. After the train vacates the section to the right of section M—N, relay 10TR operates at the 20 code rate and relays 10FSA and 10BSA pick up.

It is readily apparent from the foregoing that the apparatus of Fig. 2 is restored, after an eastbound train traverses a stretch, to its previously described condition wherein the signals are controlled to permit an eastbound move but prevent westbound moves. It follows, therefore, that after an eastbound train travels the stretch, the apparatus remains in the condition to permit eastbound moves until such time as the operator suitably controls the remotely controlled signal control relays through the medium of the communication system to condition the system for a westbound move. To do this, the communication system is caused to release relays 1RHSR and 2RHSR, and is caused to pick up relays 1LHSR and 2LHSR. When this happens, the current supplied at M to section M—N is shifted back to its 20 code rate, and relay 6H releases to cause signal 5S to be conditioned to display its stop aspect and operate its contact 4 to its back position to shift the coding of current supplied at L to section K—L to the 75 code rate. This 75 code current is repeated into section J—K where it operates relay 2TR and causes relay 2D to release and condition signal 1S to display its approach aspect.

In addition, front contact 113 of relay 1LHSR closes to shift the current supplied at K to section J—K, to the 75 code rate. This current is supplied over an obvious circuit comprising the secondary winding of transformer LT1, front contact 113 of relay 1LHSR, front contact 107 of relay 3BSA, contact 75 of coder 3CT, back contact 4 associated with signal 3S, and the primary winding of track transformer 4TT. Relay 5TR accordingly operates at the 75 code rate, and picks up relay 5H to open, at back contact 116, the previously mentioned stick circuit of relay 6SR whereupon relay 6SR releases. When this happens, back contact 109 of relay 6SR closes to shift to the 20 code rate the current supplied at L to section K—L, whereupon relay 4TR operates at the 20 code rate and relay 4H releases. Current of the 20 code rate is, therefore, supplied at K to section J—K to cause relay 2TR to release relay 2H and signal 1S to be conditioned to display its stop aspect. With relay 1RHSR released, 20 code current is supplied at J to the section to the left of section J—K.

The energization of relay 5H and closing of its front contact 116 causes relay 6SR to be energized over an obvious circuit, and relay 6SR picks up to close its own front contact and complete an obvious stick circuit through back contact 108 of relay 6H. Signal 4S also is conditioned to display its caution aspect and operates its contact 4 to its front position to supply current of 180 code to section L—M over a circuit comprising the secondary winding of transformer LT2, front contact 117 of relay 5SR, contact 180 of coder 5CT, front contact 4 operated by signal 4S, and the primary winding of track transformer 6TT. Relay 7TR follows this 180 code current to pick

up relay 7H and repeats such current into section M—N, and relay 9TR operates to pick up relays 9H and 9D and conditions signal 7S to display its clear indication.

With signal 7S conditioned to display its clear indication, and relay 2LHSR energized to close its front contact 118, current of the 180 code rate is supplied at N to the section to the right of section M—N, over a circuit comprising the secondary winding of transformer LT3, front contact 118 of relay 2LHSR, front contact 107 of relay 9BSA, contact 180 of coder 9CT, front contact 4 operated by signal 7S, and the primary winding of track transformer 10TT. This current is effective to cause apparatus (not shown) to condition the signal at the other end of the siding to display its clear aspect, in a manner which will readily become apparent by placing Figs. 2C, 2D, 2A and 2B side by side in the order named, with Fig. 2C on the left.

The operation of the apparatus for a westbound train substantially corresponds to that heretofore described in detail for an eastbound train, and further detailed description is believed to be unnecessary. After the westbound train vacates the stretch, the apparatus assumes the condition just described and is maintained in such condition until the operator causes the communication system to establish an eastbound movement. When this happens, relay 5SR is released by relay 6H picking up in response to 75 code current caused to be supplied to section L—M at M when relay 2RHSR picks up, and the apparatus of Fig. 2 is caused to be conditioned, in the manner described hereinbefore, to permit an eastbound train movement.

It should be noted that the apparatus of Fig. 2 is arranged to clear a signal at one end of the stretch, by means of control apparatus at the opposite end changing the code rate of track circuit current transmitted through the rails from the other to the one end. In addition, it should be noted that when the apparatus is conditioned for, say, a westbound movement, and the train proceeds past signals 7S and 4S, and vacates section L—M, the apparatus is capable of being controlled to govern a reverse move of the train. That is to say, under the assumed conditions relay 2RHSR may be picked up to cause signal 5S at L to display its approach aspect, in the manner described hereinbefore, and thus govern the train should it be desired to return the train on signal indication.

From the foregoing description, it is readily apparent that I have provided apparatus arranged so as to permit the direction of traffic movements to be established from a remote point, and in which the control of the signals governing traffic is established, without the use of control line wires, through the medium of track circuit current transmitted through the track rails.

Although I have herein shown and described only two forms of railway traffic controlling 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 with a stretch of railway track divided into a plurality of track sections, means for applying current having distinctively different characteristics to opposite ends respectively of each of said sections, means normally effective to code at a given code rate the current applied at each end of said sections and at times effective to code such current at one or another of a plurality of different code rates in accordance with traffic conditions in the sections respectively adjacent thereto, two code responsive relays for each section one connected constantly to the rails at either end of the section, said relays being responsive only to current of the character supplied to the opposite end of the associated section, code responsive means for each relay including decoding means rendered active in response to current coded at said given rate and other decoding means selectively responsive to current coded at one or the other of said plurality of different rates, signals governing traffic in both directions on said stretch and caused to assume the most restrictive condition when said first-mentioned decoding means are active, means controlled by said other decoding means when active for causing said signals to assume less restrictive or clear conditions, and means remotely controlled from a central station for at times controlling the code rate of current supplied to either end of said stretch to render active the said other decoding means associated with the signals governing traffic in a given direction on said stretch while maintaining active the said first-mentioned decoding means associated with the other signals of said stretch governing traffic in the opposite direction.

2. In combination with a stretch of railway track divided into a plurality of track sections each having two track circuits one for each direction of traffic, the track circuits of each section comprising two track relays constantly connected to opposite ends and two sources of distinctively characterized current also connected respectively to opposite ends of the rails of the section, said relays being responsive only to current of the character applied to the opposite end of the associated section, code responsive means for each relay including decoding means rendered active in response to current coded at said given rate and other decoding means rendered active and selectively responsive to current coded at said plurality of rates, signals governing traffic in both directions on said stretch, means for controlling the signals governing traffic in one direction in said stretch for permitting traffic movements when the said other decoding means of the track circuits of the associated direction are rendered active, and preventing said traffic movements when said first-mentioned decoding means are rendered active, and means governing the code rate of current supplied to the track circuits of a given direction for rendering active the said other decoding means of such track circuits while maintaining active the said first-mentioned decoding means of the track circuits of the opposite direction.

3. A railway signal system for governing by cab signals the operation of trains on a single track portion of railway track divided into successive adjoining track sections, said trains being equipped with cab signals controlled by train-carried apparatus responsive to alternating current energy in the track rails and selectively responsive to preselected characteristics of such energy such as the frequency and code pattern thereof, comprising in combination, track circuit apparatus for providing each of said sections with two track circuits one for each direction of train movement, means for supplying one of the two track circuits of each section with track cir-

cuit energy having preselected characteristics of the type effective to cause response of train-carried apparatus, means for supplying the other of the two circuits of each section with track circuit current having different characteristics ineffective to cause response of said train-carried apparatus, means for coding, in accordance with traffic conditions in advance for the associated direction of traffic movement, the energy applied to each of said circuits, remotely controlled means for conditioning the signals associated with the said other track circuits to prevent traffic movements while conditioning the other signals governing traffic in the said one direction to permit traffic movements, and other remotely controlled means for supplying to the said other track circuits track circuit energy having said preselected characteristics while supplying to said one track circuits said differently characterized energy, and for conditioning the said signals associated with said other track circuits to permit traffic movements while conditioning the said one track circuits to prevent traffic movements.

4. In combination with a stretch of railway track divided into a plurality of successive adjoining track sections, each section of which has connected across the rails at one end a first track relay tuned to be responsive to current of a first frequency and a source of current of a second frequency, and has connected across the rails at the opposite end a second track relay tuned to be responsive to current of said second frequency and a source of current of said first frequency, each section of which also has a first signal governing traffic in the section in a first direction and a second signal governing traffic in the section in the opposite direction, means for at times coding the current supplied to the rails of each section at a given rate and at other times at one or another of a plurality of code rates in accordance with traffic conditions in advance, code responsive means for each of said track relays and including decoding means rendered active in response to current coded at said given code rate and other decoding means selectively responsive to current coded at one or another of said plurality of code rates, means controlled by the decoding means of the said first and second track relays of a section for controlling the associated first and second signals, respectively, to cause each signal to display its most restrictive aspect when said first-mentioned decoding means are active and to display less restrictive or clear indications when said other decoding means are active, and means remotely controlled from a central office for coding at one or another of said plurality of rates the current supplied to the rails for energizing either the said first or second track relays while causing the coding at said given rate of the current supplied to energize the other of such relays.

5. In combination with a stretch of railway track divided into a plurality of successive adjoining track sections, each section of which has connected across the rails at one end a first track relay tuned to be responsive to current of a first frequency and a source of current of a second frequency, and has connected across the rails at the opposite end a second track relay tuned to be responsive to current of said second frequency and a source of current of said first frequency, each section of which also has a first signal governing traffic in the section in a first direction and a second signal governing traffic in the section in the opposite direction, means for at times coding the current supplied to the rails of each section at a given rate and at other times at one or another of a plurality of code rates in accordance with traffic conditions in advance, code responsive means for each of said track relays and including decoding means rendered active in response to current coded at said given code rate and other decoding means selectively responsive to current coded at one or another of said plurality of code rates, means controlled by the decoding means of the said first and second track relays of a section for controlling the associated first and second signals, respectively, to cause each signal to display its most restrictive aspect when said first-mentioned decoding means are active and to display less restrictive or clear indications when said other decoding means are active, and means for governing from a remote point the code rate at which current is supplied to the rails of each of said sections, for causing the current energizing a selected one of said first and said second relays to be coded in accordance with traffic conditions while the current energizing the other one of such relays is coded at said given rate.

6. In combination with a stretch of railway track divided into a plurality of successive adjoining track sections, each section of which has connected across the rails at one end a first track relay tuned to be responsive to current of a first frequency and a source of current of a second frequency, and has connected across the rails at the opposite end a second track relay tuned to be responsive to current of said second frequency and a source of current of said first frequency, each section of which also has a first signal governing traffic in the section in a first direction and a second signal governing traffic in the section in the opposite direction, means for at times coding the current supplied to the rails of each section at a given rate and at other times at one or another of a plurality of code rates in accordance with traffic conditions in advance, code responsive means for each of said track relays and including decoding means rendered active in response to current coded at said given code rate and other decoding means selectively responsive to current coded at one or another of said plurality of code rates, means controlled by the decoding means of the said first and second track relays of a section for controlling the associated first and second signals, respectively, to cause each signal to display its most restrictive aspect when said first-mentioned decoding means are active and to display less restrictive or clear indications when said other decoding means are active, means for governing from a remote point the code rate at which current is supplied to the rails of each of said sections, for causing the current energizing a selected one of said first and said second relays to be coded in accordance with traffic conditions while the current energizing the other one of such relays is coded at said given rate, and means rendered effective when current supplied to said first relays is coded at said given rate, for reversing the tuning of said first and second relays and for supplying to said second relays current of said first frequency.

7. In combination, a stretch of railway track divided into a plurality of successive adjoining track sections, means for supplying two distinctive track circuit currents, one for each direction of traffic, to each of said sections, one of said track circuit currents having preselected char-

acteristics adapted to effect control over train-carried apparatus, signals governing traffic in opposite directions through said stretch, means controlled from a remote point for conditioning said signals to permit a train movement in one direction through said stretch while preventing opposing movements, means controlled by said track circuit currents for controlling said signals, when conditioned for a train movement, in accordance with traffic conditions on said stretch, and means also controlled by said track circuit currents for causing track circuit current of said preselected characteristics to be supplied to the sections for transmission through the track rails toward a train on the stretch irrespective of the direction of the train movement.

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